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BHP BILLITON ILLAWARRA COAL:

Appin Colliery – Longwalls 901 to 904

Subsidence Predictions and Impact Assessments for Natural Features and Surface Infrastructure in Support of the Extraction Plan

DOCUMENT REGISTER

Revision	Description	Author	Checker	Date
01	Draft Issue	JB	-	4th Jun 10
02	Revised Draft	JB	-	27th Oct 10
03	Revised Draft	JB	-	2nd Feb 11
A	Final Issue	JB	DJK	11th April 12
B	Minor Revisions	JB	DJK	15th Jun 12

Report produced to:- Support the Extraction Plan for submission to the Department of Planning and Infrastructure (DoPI).

Associated reports:- MSEC404 (Revision D) – The Prediction of Subsidence Parameters and the Assessment of Mine Subsidence Impacts on Natural Features and Surface Infrastructure Resulting from the Bulli Seam Operations in Support of the Part 3A Application (August 2009).

Background reports available at *www.minesubsidence.com*:-

Introduction to Longwall Mining and Subsidence (Revision A)

General Discussion of Mine Subsidence Ground Movements (Revision A)

Mine Subsidence Damage to Building Structures (Revision A)

BHP Billiton Illawarra Coal (IC) proposes to continue its underground coal mining operations at Appin Colliery, which is located in the Southern Coalfield of New South Wales, by extracting coal from the Bulli Seam using longwall mining techniques. IC is seeking approval to extract Longwalls 901 to 904, which are located to the west of the current longwalls in Appin Area 7. The overall layout of the proposed longwalls is shown in Drawing No. MSEC448-01, which together with all other drawings, is included in Appendix F.

Mine Subsidence Engineering Consultants (MSEC) has been commissioned by IC to study the current mining proposals, to identify all the natural features and items of surface infrastructure and to prepare subsidence predictions and impact assessments for the proposed Longwalls 901 to 904. This report has been prepared to support the Extraction Plan to be assessed by the Department of Planning and Infrastructure.

The *Study Area* has been defined as the surface area enclosed by a 35 degree angle of draw line from the limit of proposed mining and by the predicted 20 mm subsidence contour resulting from the extraction of the proposed Longwalls 901 to 904. The features located outside the *Study Area* which could experience far-field movements and could be sensitive to these movements have also been included in the assessments provided in this report.

A number of natural features and items of surface infrastructure have been identified within or in the vicinity of the Study Area, including the Nepean River, drainage lines, cliffs, steep slopes, the Main Southern Railway, the Nepean Twin Bridges, local roads, powerlines, optical fibre cables, copper telecommunications cables, farm dams, rural building structures, houses and associated non-residential structures.

A number of variations in the layout of the proposed Longwalls 901 to 904 were considered as part of the process to develop the final mining geometry. These included variations in the locations of the ends of the proposed longwalls relative to the Nepean River valley. The proposed layout has been optimised so as to maximise the extraction of coal while reducing the potential levels of impact on the Nepean River and associated cliffs.

Chapter 1 of this report provides a general introduction to the study, which also includes a description of the mining geometry and geological details of the proposed mining area. Chapter 2 defines the Study Area and provides a summary of the natural features and items of surface infrastructure within the Study Area.

Chapter 3 includes an overview of conventional and non-conventional subsidence movements and the methods that have been used to predict these movements resulting from the extraction of the proposed longwalls. Chapter 4 provides the maximum predicted subsidence parameters resulting from the extraction of the proposed longwalls.

Chapters 5 through 11 provide the descriptions, predictions and impact assessments for each of the natural features and items of surface infrastructure within the Study Area. Recommendations for each of these features are also provided, which have been based on the predictions and impact assessments.

The assessments provided in this report should be read in conjunction with the assessments provided in the reports by other specialist consultants on the project. The main findings from this report are as follows:-

- The Nepean River is a perennial stream with the bed comprising Hawkesbury Sandstone overlain by fluvial sediment. The river within the Study Area has been characterised into two sections, the upper *Section 1*, where the surface water flows are controlled by stream features including boulder fields and rockbars and, the lower *Section 2*, where the river is a flooded valley controlled by the Douglas Park Weir.

  The proposed longwalls have been setback from the Nepean River by a minimum distance of 125 metres from the closest bank. The river is predicted to experience 30 mm subsidence, 110 mm upsidence and 200 mm closure, resulting from the extraction of the proposed longwalls, which are similar to those provided in the Part 3A Application.

  The assessments indicate that the river will not experience any significant changes in the levels of ponding, flooding or scouring of the river banks, or any significant changes in the water levels or stream alignment, resulting from the proposed mining.

  Minor and isolated fracturing of the river bed could occur, however, it is not expected to result in any loss of surface water flows. This is supported by the fact that there has been no reported or no observed loss of surface water as a result of previous longwall mining near and directly beneath the Nepean River by Tower Longwalls 15 to 20 and Appin Longwalls 701 to 704. This includes observations at a monitoring site that was located directly above Tower Longwall 17, which mined directly beneath the river for a length of approximately 800 metres.

  The majority of the controlling stream features in *Section 1* of the Nepean River are boulder fields, which are less susceptible to fracturing than rockbars. There are only two rockbars which have been identified within the Study Area and it is unlikely that these features would be adversely impacted given the proposed setback distances.

- The drainage lines are ephemeral and generally commence on the Razorback Range and flow southwards to where they join the Nepean River. The drainage lines have sections with sedimentary deposits or exposed bedrock, which often occur in the lower reaches, near the Hawkesbury Sandstone and Wianamatta Shale interface.

  The predicted changes in grade along the drainage lines are small in comparison with the natural gradients and it is unlikely, therefore, that there will be any significant increases in the levels of ponding, flooding or scouring along the drainage lines resulting from the extraction of the proposed longwalls.

  Fracturing of the uppermost bedrock could occur along the drainage lines located directly above or immediately adjacent to the proposed longwalls. Where the bases of the drainage lines have exposed bedrock, there may be some diversion of surface water flows into the dilated strata beneath them and the draining of pooled water within the alignments. It is unlikely, however, that there would be any net loss of water from the catchment.

- The cliffs are generally located within the valley of the Nepean River and associated tributaries. The proposed longwalls have been setback from the cliffs by a minimum distance of 50 metres, which is the same commitment adopted for the longwalls in Appin Area 7 and the Part 3A Application.

  Based on the previous experience of mining at Appin and Tower Collieries, it is possible that isolated rock falls could occur as a result of the extraction of the proposed longwalls. It is not expected, however, that any large cliff instabilities would occur as a result of the extraction of the longwalls, as the longwalls are not proposed to be extracted directly beneath the cliffs.

  The cliffs along Harris Creek are located at a distance of 650 metres from the proposed longwalls. At this distance, the likelihood of mining-induced impacts at these cliffs is considered to be extremely low. The cliffs along the western valley side of Harris Creek overhang Douglas Park Drive and, therefore, any potential for rock falls could be a public safety risk. It is recommended that IC, in consultation with Wollondilly Shire Council, develop management measures to ensure that the road remains safe and serviceable throughout the mining period.

- The steep slopes along the Razorback Range are located directly above the proposed longwalls. The range has natural slopes typically ranging between 1 in 3 and 1 in 2, with isolated areas having natural slopes greater than 1 in 2.

  The slopes along the Razorback range are steep, exhibit natural soil erosion and are predicted to experience the full range of mine subsidence movements and, therefore, it is likely that the proposed mining could result in large surface cracks near the tops or along the sides of these slopes. Previous experience from the Southern Coalfield indicates that large cracks have been observed at the tops of very steep slopes and adjacent to large rock formations, in the order of 100 mm to 150 mm, where the depths of cover have been greater than 400 metres, such as the case in the Study Area. Further discussions are provided in the report by *Coffey* (2012).

- The Main Southern Railway crosses directly above the proposed Longwalls 901 and 902. The predicted movements are similar to those where the railway has been directly mined beneath in Appin Area 7. It is expected, that the potential impacts on the railway could be managed with the implementation of suitable management strategies similar to those successfully adopted at Appin Area 7 and Tahmoor Colliery.

- The HW2 Hume Highway is located at a distance of 750 metres south-east of Longwall 901, at its closest point to the proposed longwalls. At this distance, the highway pavement and associated infrastructure are unlikely to experience any adverse impacts resulting from the proposed mining.

- The Nepean Twin Bridges at Douglas Park are located at a distance of 1 kilometre south of the proposed Longwall 901. The bridges could experience small far-field horizontal movements resulting from the proposed mining. IC has developed management strategies for the Twin Bridges for the previously extracted Longwalls 16 and 17 at Tower Colliery and Longwalls 701 to 704 at Appin Colliery. It is expected, with the implementation of suitable management strategies, that the bridges could be maintained in safe and serviceable conditions.

- Menangle Road crosses directly above the proposed Longwalls 902 to 904 and there are other minor local roads also located directly above the proposed longwalls. It is expected that the local roads located directly above the proposed longwalls could experience cracking and heaving of the road surfaces. Previous experience of mining beneath local roads in the Southern Coalfield indicates that these impacts can be managed with the implementation of suitable management strategies.

- Moreton Park Road Bridge (South) and Blades Bridge are located at distances of 1,000 metres and 650 metres, respectively, from the proposed longwalls. At these distances, the bridges are not expected to experience any adverse impacts resulting from the proposed mining.

- Potable water pipelines are partially located above the proposed longwalls. Based on previous experience from the Southern Coalfield, it is expected that some minor leakages of the water pipelines could occur, however, the incidence of impacts is expected to be low. Any impacts are expected to be of a minor nature which could be readily remediated.
- The Douglas Park Weir and Fish Passage are located approximately 900 metres south of the proposed longwalls. At this distance, it is unlikely that this infrastructure would experience any adverse impacts resulting from the proposed mining.
- The electrical infrastructure comprises 66 kV, 11 kV and low voltage powerlines. Previous experience from the Southern Coalfield indicates that the powerlines could experience some minor impacts. It is expected that the remedial measures would include some adjustments of the cable catenaries, pole tilts and the consumer cables, as has been undertaken in the past, but any other impacts are expected to be relatively infrequent and easily repaired.
- The telecommunications infrastructure comprises direct buried optical fibre cables, aerial and direct buried copper cables and a mobile phone telecommunications tower. The optical fibre and copper cables are located directly above the proposed longwalls. Previous experience from the Southern Coalfield indicates that the incidence of impacts on optical fibre and copper cables is low. The strains transferred into the optical fibre cables can be monitored using Optical Time Domain Reflectometry (OTDR).

  The telecommunications tower is predicted to experience less than 20 mm subsidence resulting from the proposed mining. It is unlikely, therefore, that the tower would experience any adverse impacts resulting from the proposed mining.
- There are 652 rural structures identified within the Study Area, which includes sheds, garages, gazebos, pergolas, greenhouses, playhouses, shade structures and other non-residential building structures. There is extensive experience of mining directly beneath rural building structures in the Southern Coalfield which indicates that the incidence of impacts on these structures is very low. It is expected, that these structures would remain safe and serviceable and that any impacts could be remediated using well established building techniques.
- There are 149 farm dams which have been identified within the Study Area. Based on previous experience from the Southern Coalfield, it is expected that the incidence of impacts on the farm dams would be extremely low. Any cracking or leakage of water in the farm dam walls could be readily identified and repaired, as required.
- The business establishments include Arctic Seals, Douglas Park Cellars and Service Station, Douglas Park General Store, Douglas Park Physical Culture Club, the Dugout Cafe, Pots Works and the Fidgety Frogs Long Day Care Centre. These establishments are located in Douglas Park, outside the extents of the proposed longwalls. It is unlikely, that these business establishments would experience any adverse impacts resulting from the proposed mining.
- There are 251 houses which have been identified within the Study Area, of which, 49 are located directly above the proposed longwalls. The potential impacts on the houses have been assessed using the method developed as part of ACARP Research Project C12015, which is described in Appendix C. This method is based on the experience at Tahmoor Colliery, which has affected more than 1,000 houses, and the experiences at Teralba, West Cliff and West Wallsend Collieries, which have affected around 500 houses.

  It has been assessed, that 231 houses (i.e. 92 %) would experience nil or R0 impacts, 15 houses (i.e. 6 %) would experience R1 or R2 impacts, 4 houses (i.e. 2 %) would experience R3 or R3 impacts and that approximately 1 house (< 0.5 %) would experience R5 impacts. The repair categories R0 to R5 are described in Table C.4 in Appendix C.

  All houses within the Study Area are expected to remain safe and serviceable throughout the mining period, provided that they are in sound structural condition prior to mining. It should be noted, however, that the assessments indicate that the impact to approximately one house within the Study Area may be such that the cost of repair may exceed the cost of replacement.

  Detailed site investigations and studies of the potential impacts on the steep slopes along the Razorback Range have been undertaken and are described in the reports by *Coffey* (2012) and the *UoW* (2012). As described in these reports, it is recommended that the houses in close proximity of the steep slopes along the Razorback Range are inspected prior to and after the proposed longwalls mine directly beneath them.

The assessments in this report indicate that the levels of impact on the natural features and items of surface infrastructure can be managed by the preparation and implementation of the appropriate management strategies. It should be noted, however, that more detailed assessments of some natural features and items of surface infrastructure have been undertaken by other consultants, and the findings in this report should be read in conjunction with the findings in all other relevant reports.

Monitoring of ground movements is recommended, as subsidence occurs, so that the observed ground movements can be compared with those predicted, to allow the prediction method to be continually improved and to allow regular reviews of the impact assessments in the light of new measured data.

This report provides revised predictions of the conventional and non-conventional subsidence effects and subsidence impacts for the Area 9 Extraction Plan, incorporating relevant information obtained since approval of the Bulli Seam Operations. The level of impact and proposed management strategies for Area 9 is consistent with the Bulli Seam Operations Environmental Assessment and Conditions of Approval (08_0150).

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Figures are prefixed by the number of the chapter or the letter of the appendix in which they are presented.

Drawings

Drawings referred to in this report are included in Appendix F at the end of this report.

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1.1. Background

BHP Billiton Illawarra Coal (IC) proposes to continue its underground coal mining operations at Appin Colliery, which is located in the Southern Coalfield of New South Wales, by extracting coal from the Bulli Seam using longwall mining techniques.

IC previously submitted a Part 3A Application for the extraction of future longwalls in Areas 2, 3, 5, 7, 8 and 9 and North Cliff in December 2007. Report No. MSEC404 (Rev. D) was issued in August 2009 in support of that application. A Preferred Project Report (PPR) under the EP&A Act was prepared following a request by the Director-General of the NSW Department of Planning and Infrastructure (DoPI). The key changes made via the PPR comprised the excision of the North Cliff and Appin Area 2 Extended mining domains, the majority of the Appin Area 3 Extended mining domain and two longwalls from the West Cliff Area 5 mining domain. DoPI granted IC approval under the EPA Act on the 22nd December 2011 (08_0150).

IC is now seeking approval to extract Longwalls 901 to 904 in Appin Area 9, which are located to the west of the current longwall mining operations in Appin Area 7. The layout of the proposed longwalls is shown in Drawing No. MSEC448-01, which together with all other drawings, is included in Appendix F.

The layout of the proposed longwalls in Appin Area 9 has been modified from the layout of the EA Base Plan Longwalls which was indicated in the Part 3A Application. The longwall layout indicated in the Part 3A Application and in Report No. MSEC404 is referred to as the *Part 3A Layout* in this report. The currently proposed longwall layout in Area 9 is referred to as the *Extraction Plan Layout* in this report. The comparison between the Part 3A Layout and the Extraction Plan Layout is provided in Fig. 1.1.

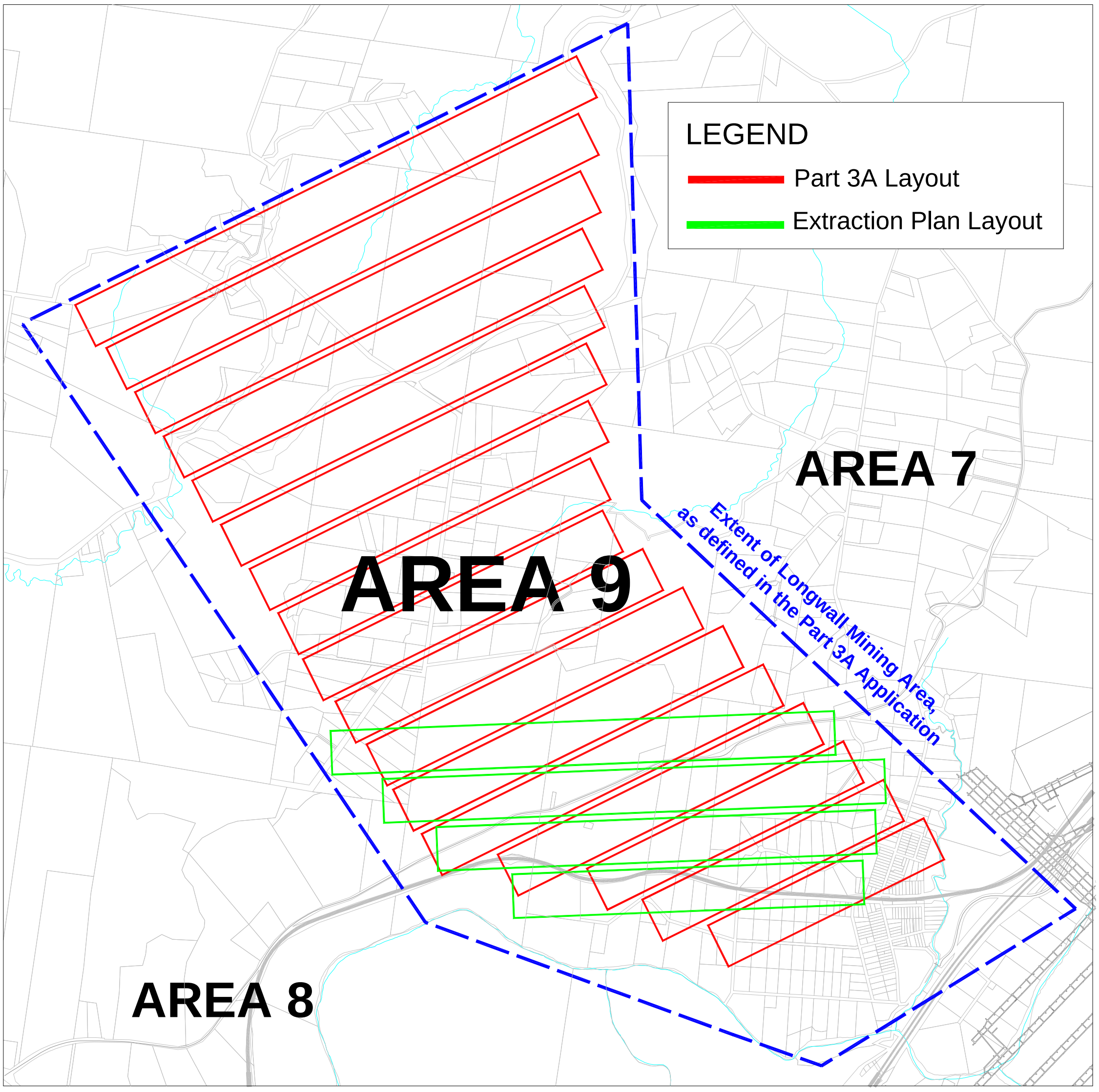

Fig. 1.1 Comparison between the Part 3A Layout and the Extraction Plan Layout

Mine Subsidence Engineering Consultants (MSEC) has been commissioned by IC to:-

- Study the current mining proposals,
- Identify the natural features and items of surface infrastructure in the vicinity of the proposed Longwalls 901 to 904,
- Provide subsidence predictions for each of these natural features and items of surface infrastructure, and to
- Provide impact assessments, in conjunction with other specialist consultants, for each of these natural features and items of surface infrastructure.

The proposed longwalls and the Study Area, as defined in Section 2.1, have been overlaid on an orthophoto of the area, which is shown in Fig. 1.2. The major natural features and surface infrastructure in the vicinity of the proposed longwalls can be seen in this figure.

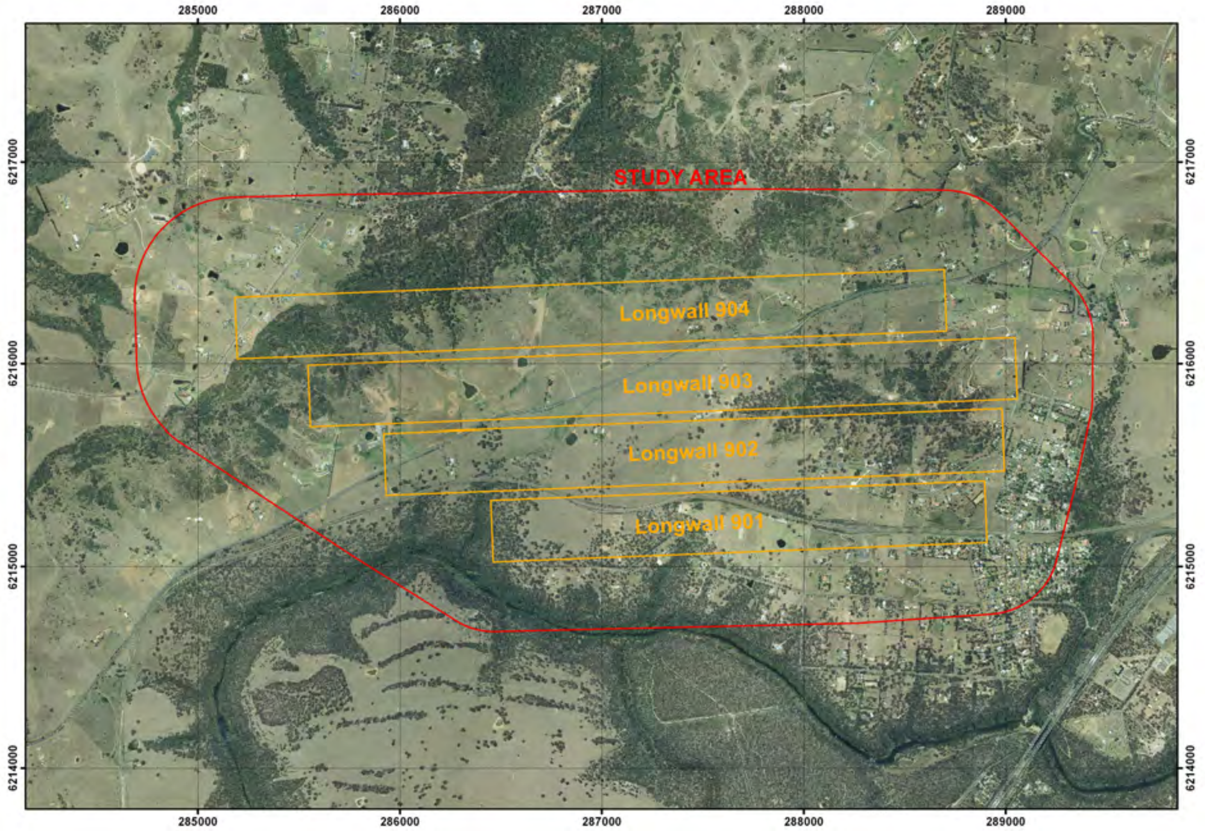

Fig. 1.2 Aerial Photograph Showing Longwalls 901 to 904 and the Study Area

Chapter 2 defines the Study Area and provides a summary of the natural features and items of surface infrastructure within the Study Area.

Chapter 3 includes an overview of conventional and non-conventional subsidence movements and the methods that have been used to predict these movements resulting from the extraction of the proposed longwalls.

Chapter 4 provides the maximum predicted subsidence parameters resulting from the extraction of the proposed longwalls.

Chapters 5 through 11 provide the descriptions, predictions and impact assessments for each of the natural features and items of surface infrastructure within the Study Area. Recommendations for each of these features are also provided, which have been based on the predictions and impact assessments.

1.2. Development of the Longwall Layout

A number of variations in the layout of Longwalls 901 to 904 were considered as part of the process to develop the final mining geometry. These included variations in the orientations, widths, lengths and offsets of the proposed longwalls from the Nepean River valley. These options were reviewed, analysed and modified until an optimised longwall layout in Area 9 was achieved.

Two important objectives which formed part of the longwall layout optimisation were:-

- Setback from the Nepean River and the cliffs within the valley, so as to minimise the potential for impacts, and
- Minimisation of the volume of sterilised coal which could be efficiently extracted while meeting the stream impact minimisation criteria from the Bulli Seam Operations EA and the requirements of the Project Approval.

Some examples of longwall layouts which were considered in Area 9 as part of this process are illustrated in Fig. 1.3. These layouts were constrained within the *Extent of Longwall Mining Area*, which was defined in the Part 3A Application, and is illustrated as the blue dashed line in Fig. 1.1 and the figure below.

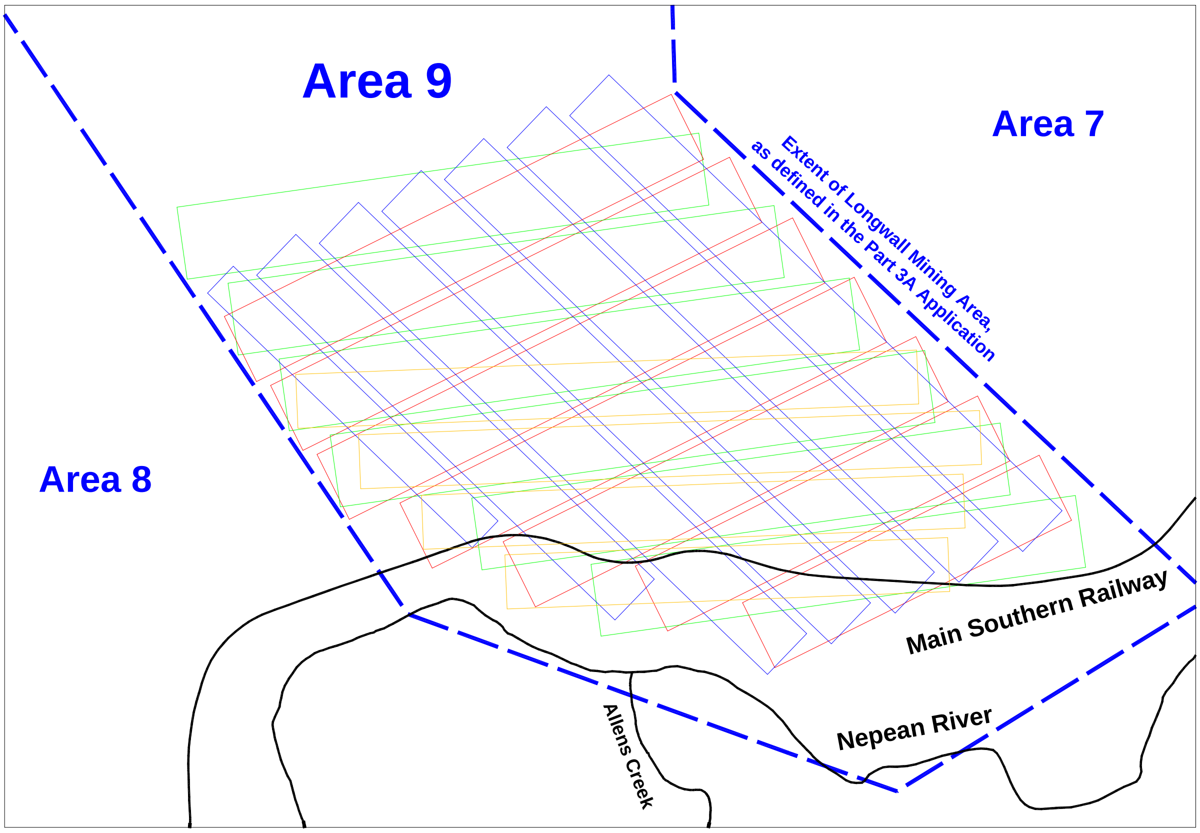

Fig. 1.3 Examples of Layouts Considered in the Development of the Extraction Plan Layout

Sensitivity analyses were also undertaken by considering various setbacks from the Nepean River. An example of this is illustrated in Fig. 1.4, which shows the Extraction Plan Layout of the proposed longwalls with Longwall 901 extended to mine directly beneath the river, the longwall touching the centreline of the river and the longwall offset by 100, 200, 300, 400 and 500 metres from the centreline of the river. The comparison of the predicted total subsidence, upsidence and closure movements along the river for each of these cases is provided in Fig. 1.5.

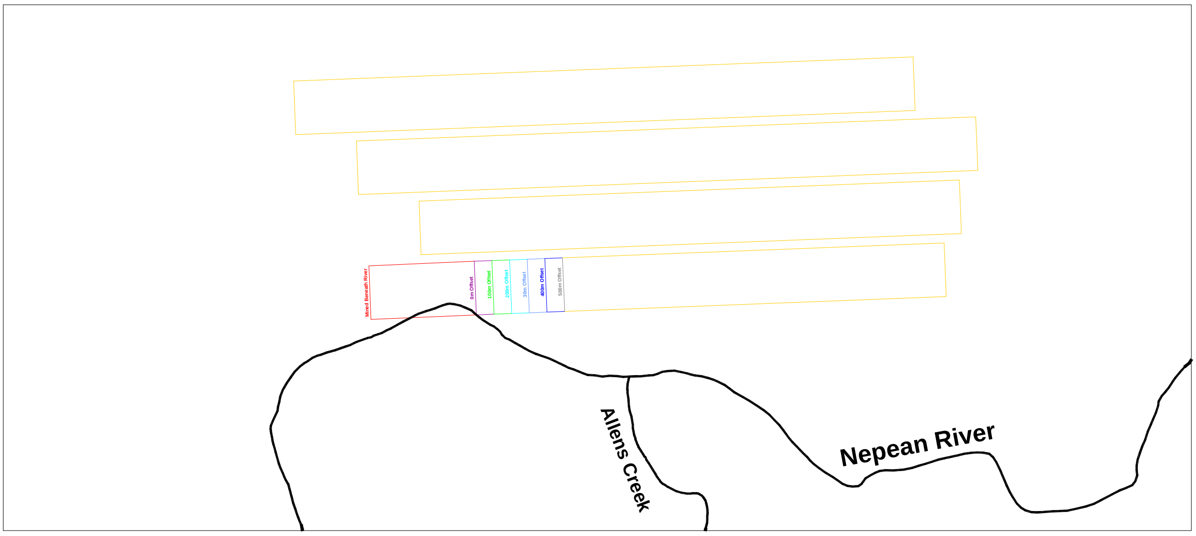

Fig. 1.4 Proposed Longwalls with Varying Offsets of Longwall 901

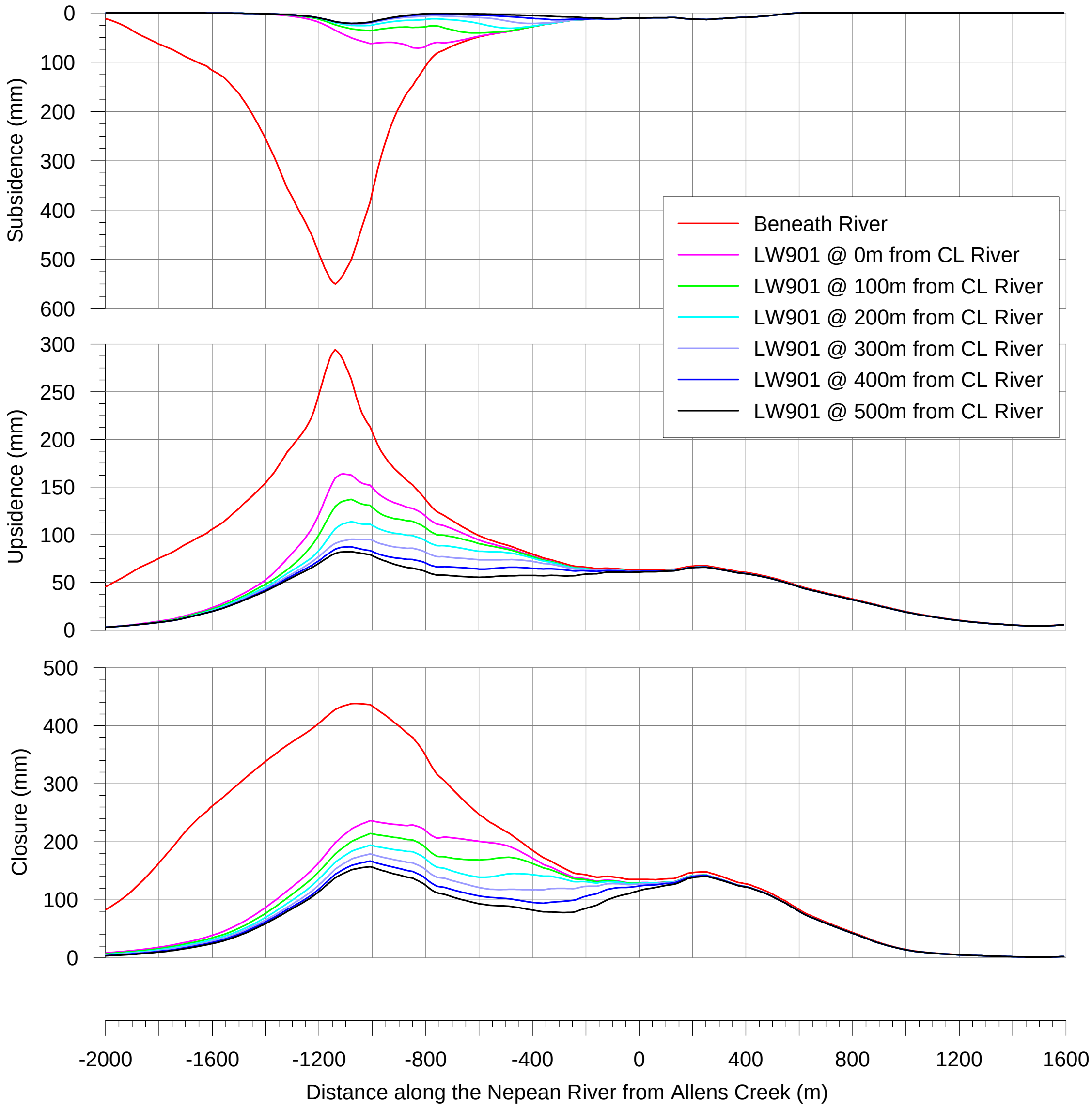

Fig. 1.5 Predicted Total Subsidence, Upsidence and Closure for Proposed Longwalls with Varying Offsets of Longwall 901

It can be seen from this example, that the maximum predicted subsidence, upsidence and closure movements along the Nepean River, for the case where the river is directly mined beneath, are significantly greater than those predicted for the cases where the longwalls do not mine beneath the river.

In the example provided, the maximum predicted subsidence along the river, based on the case where the river is directly mined beneath, is around 8 times that predicted where the longwall is touching the centreline of the river. In addition to this, the maximum predicted upsidence and closure movements along the river, based on the case where the river is directly mined beneath, are approximately 1.8 times and 1.9 times, respectively, those predicted where the longwall is touching the centreline of the river.

The adopted mine plan has Longwall 901 commencing 130 metres from the centreline of the Nepean River.

1.3. Mining Geometry

The proposed layout of Longwalls 901 to 904 is shown in Drawing No. MSEC448-01. A summary of the proposed longwall dimensions is provided in Table 1.1.

Table 1.1 Geometry of the Proposed Longwalls 901 to 904

Longwall	Overall Void Length Including Installation Heading (m)	Overall Void Width Including First Workings (m)	Overall Tailgate Chain Pillar Width (m)
LW901	2445	305	-
LW902	3065	305	45
LW903	3505	305	45
LW904	3515	305	45

The Part 3A Layout within Area 9 comprised longwalls having overall lengths varying between 1675 metres and 3900 metres, overall void widths of 320 metres and chain pillars of 45 metres.

1.4. Surface Topography

The surface level contours in the vicinity of the proposed longwalls are shown in Drawing No. MSEC448-02, which were generated from a 2009 airborne laser scan of the area.

The major topographical features within the Study Area are the Razorback Range, which is located in the northern part of the Study Area, and the Nepean River valley, which is located in the southern part of the Study Area.

The surface levels within the Study Area vary from a low point of approximately 60 metres AHD, in the base of the Nepean River valley, to a high point of approximately 325 metres AHD, above the commencing (western) end of the proposed Longwall 904.

1.5. Seam Information

The seam floor contours, seam thickness contours and depth of cover contours, for the Bulli Seam, are shown in Drawing Nos. MSEC448-03, MSEC448-04 and MSEC448-05, respectively.

The depth of cover to the Bulli Seam within the Study Area varies between a minimum of 430 metres, in the base of the Nepean River valley, and a maximum of 745 metres, in the northern part of the Study Area. The depth of cover directly above the proposed longwalls varies between a minimum of 490 metres, above the western end of the proposed Longwall 901, and a maximum of 725 metres, above the western end of the proposed Longwall 904.

The seam floor within the Study Area generally dips from the south to the north. The seam thickness within the proposed longwall goaf areas varies between 2.65 metres and 3.15 metres. The proposed longwalls will extract the full seam height.

1.6. Geological Details

Appin Colliery lies in the southern part of the Permo-Triassic Sydney Basin, within which the main coal bearing sequence is the Illawarra Coal Measures, of Late Permian age. The Illawarra Coal Measures contain several seams, the uppermost of which is the Bulli Seam.

All of the sediments that form the overburden to the Bulli Seam belong to the Hawkesbury Tectonic Stage, which comprises three stratigraphic divisions. The lowest division is the Narrabeen Group, which is subdivided into a series of interbedded sandstone and claystone units. It ranges in age from Lower to Middle Triassic and varies in thickness with a median of 310 metres. Overlying the Narrabeen Group is the Hawkesbury Sandstone Group, which is a series of bedded sandstone units which dates from the Middle Triassic and has a median thickness of 170 metres. Above the Hawkesbury Sandstone is the Wianamatta Group, which consists of shales and siltstones with a variable thickness within the Study Area, ranging from less than 10 metres to 200 metres. A typical stratigraphic section for Appin Area 9, through the Razorback Range, is shown in Fig. 1.6 below.

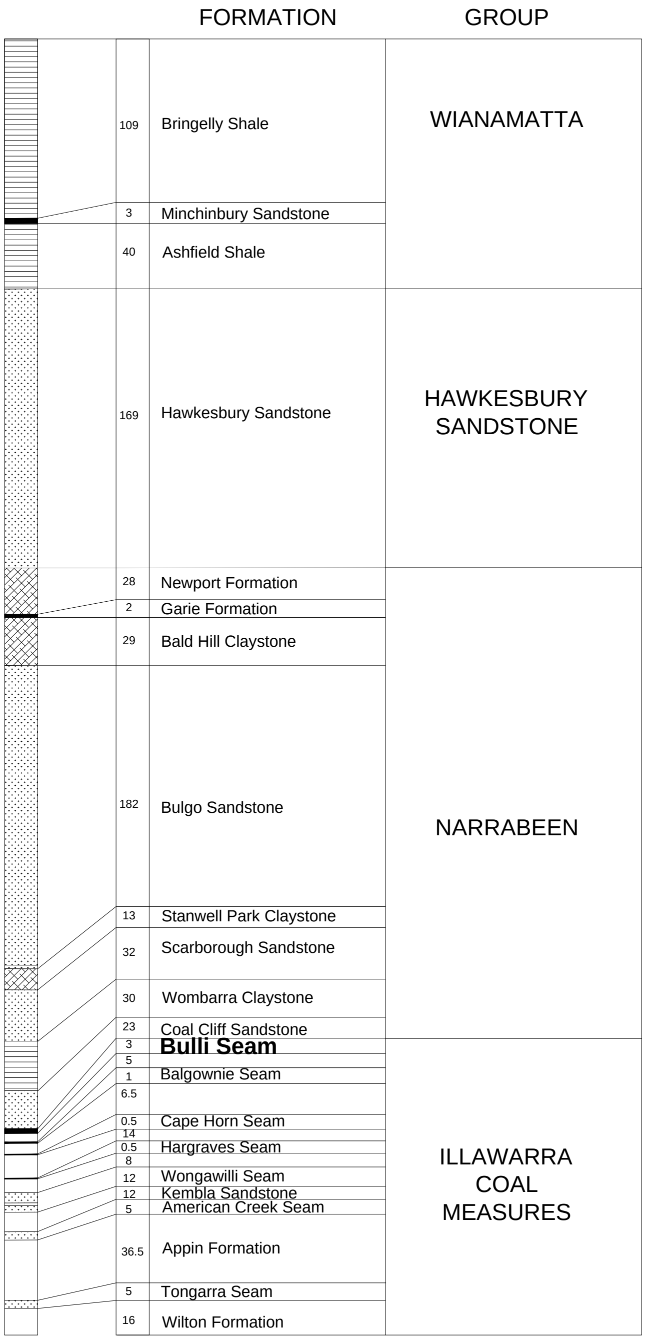

Fig. 1.6 Typical Stratigraphic Section for Appin Area 9 through the Razorback Range

The major sandstone units are interbedded with shale and claystone units. The major sandstone units are the Scarborough, the Bulgo and the Hawkesbury Sandstones. The rocks exposed in the Nepean River valley belong to the Hawkesbury Sandstone Group. The creeks and drainage lines within the Study Area traverse the Wianamatta Group Shale to where they enter the Nepean River valley. Within the Narrabeen Group, the claystones and shales generally exist in discrete but thinner beds of less than 15 metres thickness, or are interbedded as thin bands within the sandstone.

The major claystone units are the Bald Hill and Stanwell Park Claystones, which lie above and below the Bulgo Sandstone at the base of the Hawkesbury Sandstone. The claystones vary in thickness and, in some places, are more than 25 metres thick. Due to the nature of the claystone, which swells when it is wetted, it tends to act as an aquitard.

The geological structures which have been identified at seam level are shown in Drawing No. MSEC448-06. There are no significant geological features that have been identified within the extents of the proposed Longwalls 901 to 904.

Where these geological structures extend near to the surface, it is possible that irregular subsidence movements could result, which is discussed in Sections 3.4.1 and 4.7. Further details on irregular subsidence movements (i.e. anomalies) are provided in the background report entitled *General Discussion on Mine Subsidence Ground Movements* which can be obtained from *www.minesubsidence.com*.

The surface lithology within the Study Area can be seen in Fig. 1.7, which shows the proposed longwalls overlaid on Geological Series Sheet 9029-9129, which is published by DTIRIS.

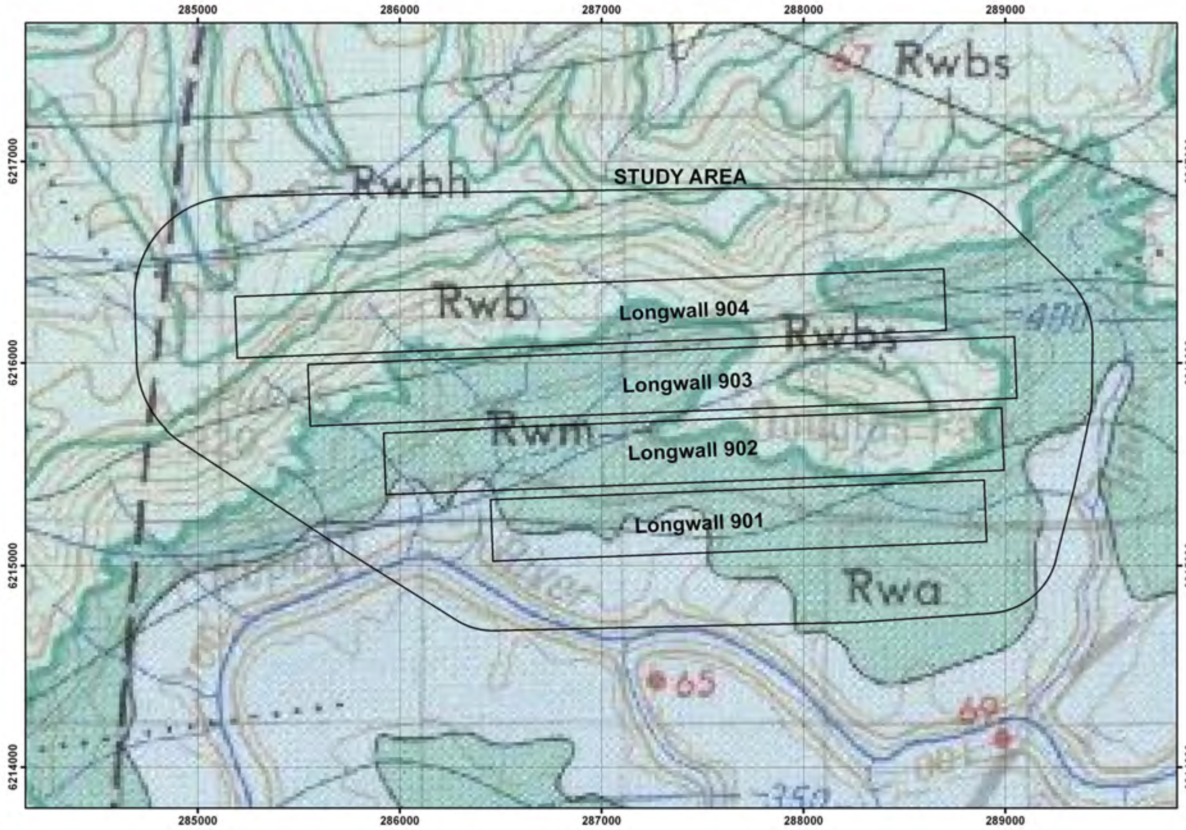

Fig. 1.7 Surface Lithology within the Study Area (DTIRIS Geological Series Sheet 9029-9129)

It can be seen from the above figure that the surface lithology within the Study Area comprises predominately of areas derived from the Wianamatta Group (Rwa, Rwb, Rwbh and Rwbs). The exposure of the Hawkesbury Sandstone (Rh) is limited to the Nepean River valley, Harris Creek valley and the lower sections of the tributaries in the southern part of the Study Area.

2.1. Definition of the Study Area

The *Study Area* is defined as the surface area that is likely to be affected by the proposed mining of Longwalls 901 to 904 in Appin Area 9. The extent of the Study Area has been calculated by combining the areas bounded by the following limits:-

- A 35 degree angle of draw line from the proposed extents of Longwalls 901 to 904, and
- The predicted limit of vertical subsidence, taken as the 20 mm subsidence contour, resulting from the extraction of the proposed Longwalls 901 to 904.

The depth of cover contours are shown in Drawing No. MSEC448-05. It can be seen from this drawing, that the depth of cover directly above the proposed longwalls varies between a minimum of 490 metres, above the western end of Longwall 901, and a maximum of 725 metres, above the western end of Longwall 904. The 35 degree angle of draw line, therefore, has been determined by drawing a line that is a horizontal distance varying between 345 metres and 510 metres around the limits of the proposed extraction areas.

The predicted limit of vertical subsidence, taken as the predicted total 20 mm subsidence contour, has been determined using the Incremental Profile Method, which is described in Chapter 3. The predicted total subsidence contours, resulting from the extraction of Longwalls 901 to 904, are shown in Drawing Nos. MSEC448-34 to MSEC448-37.

A line has therefore been drawn defining the Study Area, based upon the 35 degree angle of draw line and the predicted total 20 mm subsidence contour, whichever is furthest from the proposed longwalls, and is shown in Drawing No. MSEC448-01.

There are areas that lie outside the Study Area that are expected to experience either far-field movements, or valley related movements. The surface features which could be sensitive to such movements have been identified and have been included in the assessments provided in this report. These features are listed below and details of these are provided in later sections of the report:-

- Watercourses, within the predicted limits of 20 mm total upsidence and 20 mm total closure,
- Cliffs,
- The Twin Bridges over the Nepean River,
- Moreton Park Road Bridge (South) and Harris Creek Bridge,
- Groundwater bores, and
- Survey control marks.

2.2. Natural Features and Items of Surface Infrastructure within the Study Area

The major natural features and items of surface infrastructure within the Study Area can be seen in the 1:25,000 Topographic Map of the area, published by the Central Mapping Authority (CMA), numbered PICTON 9029-4-S. The proposed longwalls and the Study Area have been overlaid on an extract of this CMA map in Fig. 2.1.

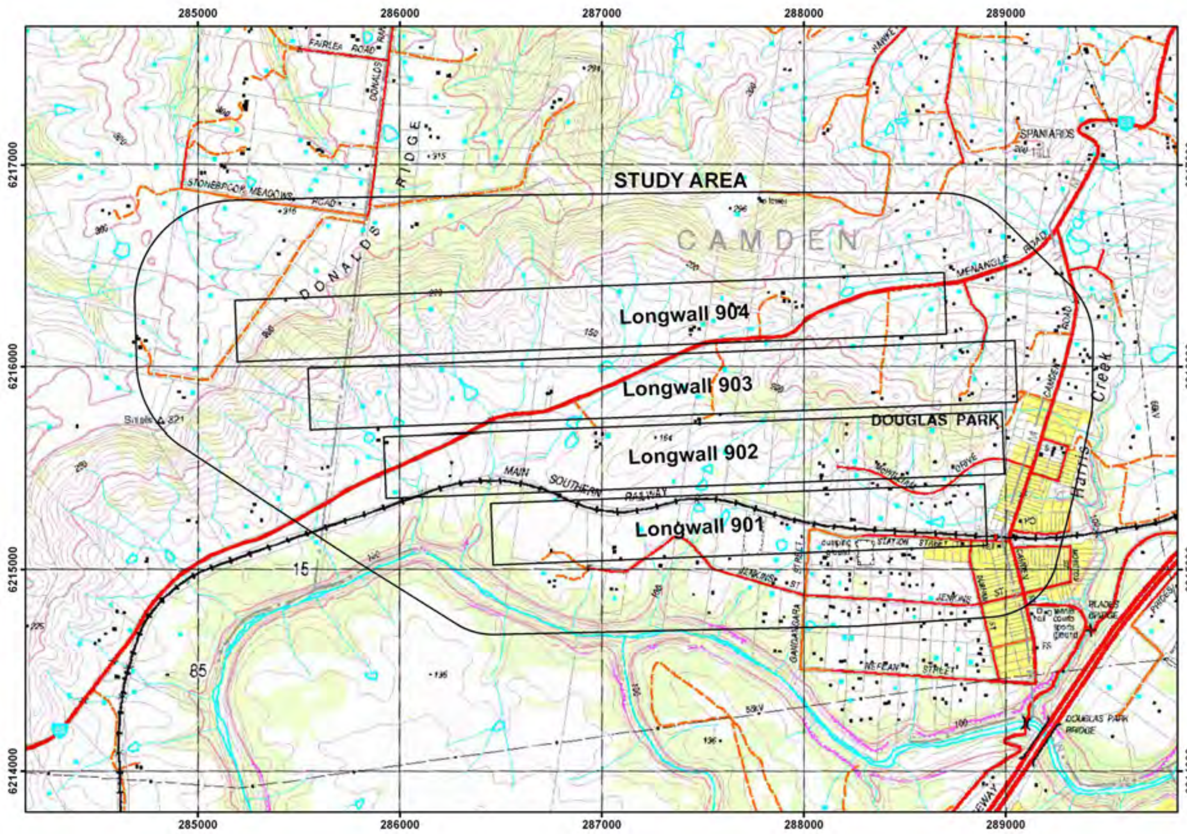

Fig. 2.1 The Proposed Longwalls and the Study Area Overlaid on CMA Map No. Picton 9029-4-S

A summary of the natural features and items of surface infrastructure within the Study Area is provided in Table 2.1. The locations of these features are shown in Drawing Nos. MSEC448-07 to MSEC448-33, in Appendix F.

The descriptions, predictions and impact assessments for the natural features and items of surface infrastructure are provided in Chapters 5 though to 11. The section number references are provided in Table 2.1.

Table 2.1 Natural Features and Surface Infrastructure

Item	Within Study Area	Section Number Reference
NATURAL FEATURES		
Catchment Areas or Declared Special Areas	×	
Rivers or Creeks	✓	5.2 & 5.3
Aquifers or Known Groundwater Resources	✓	5.4
Springs	×	
Sea or Lake	×	
Shorelines	×	
Natural Dams	×	
Cliffs or Pagodas	✓	5.5
Steep Slopes	✓	5.7
Escarpments	✓	5.8
Land Prone to Flooding or Inundation	✓	5.9
Swamps, Wetlands or Water Related Ecosystems	✓	5.10
Threatened or Protected Species	✓	5.11
National Parks	×	
State Forests	×	
State Conservation Areas	×	
Natural Vegetation	✓	5.14
Areas of Significant Geological Interest	×	
Any Other Natural Features Considered Significant	×	
	×	
PUBLIC UTILITIES	×	
Railways	✓	6.1
Roads (All Types)	✓	6.2 & 6.4
Bridges	✓	6.3 & 6.5
Tunnels	×	
Culverts	✓	6.7
Water, Gas or Sewerage Infrastructure	✓	6.8 & 6.9
Liquid Fuel Pipelines	×	
Electricity Transmission Lines or Associated Plants	✓	6.13
Telecommunication Lines or Associated Plants	✓	6.14
Water Tanks, Water or Sewage Treatment Works	×	
Dams, Reservoirs or Associated Works	×	
Air Strips	×	
Any Other Public Utilities	×	
	×	
PUBLIC AMENITIES	×	
Hospitals	×	
Places of Worship	×	
Schools	✓	7.3
Shopping Centres	×	
Community Centres	×	
Office Buildings	×	
Swimming Pools	×	
Bowling Greens	×	
Ovals or Cricket Grounds	×	
Race Courses	×	
Golf Courses	×	
Tennis Courts	×	
Any Other Public Amenities	×	

Item	Within Study Area	Section Number Reference
FARM LAND AND FACILITIES		
Agricultural Utilisation or Agricultural Suitability of Farm Land	✓	8.1
Farm Buildings or Sheds	✓	8.2
Tanks	✓	8.3
Gas or Fuel Storages	✓	8.4
Poultry Sheds	×	
Glass Houses	×	
Hydroponic Systems	×	
Irrigation Systems	×	
Fences	✓	8.5
Farm Dams	✓	8.7
Wells or Bores	✓	8.8
Any Other Farm Features	×	
INDUSTRIAL, COMMERCIAL AND BUSINESS ESTABLISHMENTS		
Factories	×	
Workshops	×	
Business or Commercial Establishments or Improvements	✓	9.3
Gas or Fuel Storages or Associated Plants	✓	9.4
Waste Storages or Associated Plants	×	
Buildings, Equipment or Operations that are Sensitive to Surface Movements	×	
Surface Mining (Open Cut) Voids or Rehabilitated Areas	×	
Mine Infrastructure Including Tailings Dams or Emplacement Areas	✓	9.8
Any Other Industrial, Commercial or Business Features	×	
AREAS OF ARCHAEOLOGICAL OR HERITAGE SIGNIFICANCE	✓	10.1 & 10.2
ITEMS OF ARCHITECTURAL SIGNIFICANCE	×	
PERMANENT SURVEY CONTROL MARKS	✓	6.18
RESIDENTIAL ESTABLISHMENTS		
Houses	✓	11.1
Flats or Units	×	
Caravan Parks	×	
Retirement or Aged Care Villages	×	
Associated Structures such as Workshops, Garages, On-Site Waste Water Systems, Water or Gas Tanks, Swimming Pools or Tennis Courts	✓	11.5 11.6 11.7 11.8
Any Other Residential Features	×	
ANY OTHER ITEM OF SIGNIFICANCE	×	
ANY KNOWN FUTURE DEVELOPMENTS	×	

3.0 OVERVIEW OF CONVENTIONAL AND NON-CONVENTIONAL SUBSIDENCE MOVEMENTS AND THE METHODS USED TO PREDICT THESE MOVEMENTS FOR THE PROPOSED LONGWALLS

3.1. Introduction

Overviews of longwall mining, the development of mine subsidence and the methods of predicting mine subsidence movements were provided in Report No. MSEC404 (Rev. D), which supported the Part 3A Application. Further information is also provided in the background reports entitled *Introduction to Longwall Mining and Subsidence* and *General Discussion on Mine Subsidence Ground Movements* which can be obtained from *www.minesubsidence.com*.

The following sections provide brief overviews of conventional and non-conventional mine subsidence movements and the methods that have been used to predict these movements. For further discussions and details, refer to Report No. MSEC404 and the background reports.

3.2. Overview of Conventional Subsidence Parameters

The normal ground movements resulting from the extraction of longwalls are referred to as conventional or systematic subsidence movements. These movements are described by the following parameters:-

- **Subsidence** usually refers to vertical displacement of a point, but subsidence of the ground actually includes both vertical and horizontal displacements. These horizontal displacements in some cases, where the subsidence is small beyond the longwall goaf edges, can be greater than the vertical subsidence. Subsidence is usually expressed in units of *millimetres (mm)*.

- **Tilt** is the change in the slope of the ground as a result of differential subsidence, and is calculated as the change in subsidence between two points divided by the distance between those points. Tilt is, therefore, the first derivative of the subsidence profile. Tilt is usually expressed in units of *millimetres per metre (mm/m)*. A tilt of 1 mm/m is equivalent to a change in grade of 0.1 %, or 1 in 1000.

- **Curvature** is the bending of the ground as a result of differential subsidence, and is calculated as the change in tilt between two adjacent sections of the tilt profile divided by the average length of those sections. Curvature is usually expressed as the inverse of the **Radius of Curvature** with the units of *1/kilometres* (km^{-1}), but the values of curvature can be inverted, if required, to obtain the radius of curvature, which is usually expressed in *kilometres (km)*.

- **Strain** is the relative differential horizontal movements of the ground. **Normal strain** is calculated as the change in horizontal distance between two points on the ground, divided by the original horizontal distance between them. Strain is typically expressed in units of *millimetres per metre (mm/m)*. **Tensile Strains** occur where the distance between two points increases and **Compressive Strains** occur when the distance between two points decreases. So that ground strains can be compared between different locations, they are typically measured over bay lengths that are equal to the depth of cover between the surface and seam divided by 20.

  Whilst mining induced normal strains are measured along monitoring lines, ground shearing can also occur both vertically and horizontally across the directions of monitoring lines. Most of the published mine subsidence literature discusses the differential ground movements that are measured along subsidence monitoring lines, however, differential ground movements can also be measured across monitoring lines using 3D survey monitoring techniques.

- **Horizontal shear deformation** across monitoring lines can be described by various parameters including horizontal tilt, horizontal curvature, mid-ordinate deviation, angular distortion and shear index. It is not possible, however, to determine the horizontal shear strain across a monitoring line using standard 2D or 3D monitoring techniques. High deformations along monitoring lines (i.e. normal strains) are generally measured where high deformations have been measured across the monitoring line (i.e. shear deformations) and vice versa.

The **incremental** subsidence, tilts, curvatures and strains are the additional parameters which result from the extraction of each longwall. The **total** subsidence, tilts, curvatures and strains are the accumulated parameters which result from the extraction of a series of longwalls. The **travelling** tilts, curvatures and strains are the transient movements as the longwall extraction face mines directly beneath a given point.

3.3. Far-field Movements

The measured horizontal movements at survey marks which are located beyond the longwall goaf edges and over solid unmined coal areas are often much greater than the observed vertical movements at those marks. These movements are often referred to as *far-field movements*.

Far-field horizontal movements tend to be bodily movements towards the extracted goaf area and are accompanied by very low levels of strain. These movements generally do not result in impacts on natural features or surface infrastructure, except where they are experienced by large structures which are very sensitive to differential horizontal movements.

In some cases, higher levels of far-field horizontal movements have been observed where steep slopes or valleys exist nearby, as these features influence both the magnitude and the direction of ground movement patterns. Similarly, increased observed horizontal movements are often observed around sudden changes in geology or where blocks of coal are left between longwalls or near other previously extracted series of longwalls. In these cases, the levels of observed subsidence can be slightly higher than normally predicted, but these increased movements are generally accompanied by very low levels of tilt, curvature and strain.

Far-field horizontal movements and the method used to predict such movements are described further in Section 4.6.

3.4. Overview of Non-Conventional Subsidence Movements

Conventional subsidence profiles are typically smooth in shape and can be explained by the expected caving mechanisms associated with overlying strata spanning the extracted void. Normal conventional subsidence movements due to longwall extraction are easy to identify where longwalls are regular in shape, the extracted coal seams are relatively uniform in thickness, the geological conditions are consistent and surface topography is relatively flat.

As a general rule, the smoothness of the profile is governed by the depth of cover and lithology of the overburden, particularly the near surface strata layers. Where the depth of cover is greater than 400 metres, such as the case within the Study Area, the observed subsidence profiles along monitoring survey lines are generally smooth. Where the depth of cover is less than 100 metres, the observed subsidence profiles along monitoring lines are generally irregular. Very irregular subsidence movements are observed with much higher tilts, curvatures and strains at very shallow depths of cover where the collapsed zone above the extracted longwalls extends up to or near to the surface.

Irregular subsidence movements are occasionally observed at the deeper depths of cover along an otherwise smooth subsidence profile. The cause of these irregular subsidence movements can be associated with:-

- sudden or abrupt changes in geological conditions,
- steep topography, and
- valley related mechanisms.

Non-conventional movements due to geological conditions, steep topography and valley related movements are discussed in the following sections.

3.4.1. Non-conventional Subsidence Movements due to Changes in Geological Conditions

It is believed that most non-conventional ground movements are a result of the reaction of near surface strata to increased horizontal compressive stresses due to mining operations. Some of the geological conditions that are believed to influence these irregular subsidence movements are the blocky nature of near surface sedimentary strata layers and the possible presence of unknown faults, dykes or other geological structures, cross bedded strata, thin and brittle near surface strata layers and pre-existing natural joints. The presence of these geological features near the surface can result in bumps in an otherwise smooth subsidence profile which are usually accompanied by locally increased tilts, curvatures and strains.

Even though it may be possible to attribute a reason behind most observed non-conventional ground movements, there remain some observed irregular ground movements that still cannot be explained with the available geological information. The term “anomaly” is therefore reserved for those non-conventional ground movement cases that were not expected to occur and cannot be explained by any of the above possible causes.

It is not possible to predict the locations and magnitudes of non-conventional anomalous movements. In some cases, approximate predictions for the non-conventional ground movements can be made where the underlying geological or topographic conditions are known in advance. It is expected that these methods will improve as further knowledge is gained through ongoing research and investigation.

In this report, non-conventional ground movements are being included statistically in the predictions and impact assessments, by basing these on the frequency of past occurrence of both the conventional and non-conventional ground movements and impacts. The analysis of strains provided in Section 4.4 includes those resulting from both conventional and non-conventional anomalous movements. The impact assessments for the natural features and items of surface infrastructure, which are provided in Chapters 5 through to 11, include historical impacts resulting from previous longwall mining which have occurred as the result of both conventional and non-conventional subsidence movements.

3.4.2. Non-conventional Subsidence Movements due to Steep Topography

Non-conventional movements can also result from downslope movements where longwalls are extracted beneath steep slopes. In these cases, elevated tensile strains develop near the tops of the steep slopes and elevated compressive strains develop near the bases of the steep slopes. The potential impacts resulting from down slope movements include the development of tension cracks at the tops and the sides of the steep slopes and compression ridges at the bottoms of the steep slopes.

Further discussions on the potential for down slope movements for the steep slopes within the Study Area are provided in Section 5.7.

3.4.3. Valley Related Movements

The watercourses within the Study Area may be subjected to valley related movements, which are commonly observed along river and creek alignments in the Southern Coalfield. Valley bulging movements are a natural phenomenon, resulting from the formation and ongoing development of the valley, as illustrated in Fig. 3.1. The potential for these natural movements are influenced by the geomorphology of the valley.

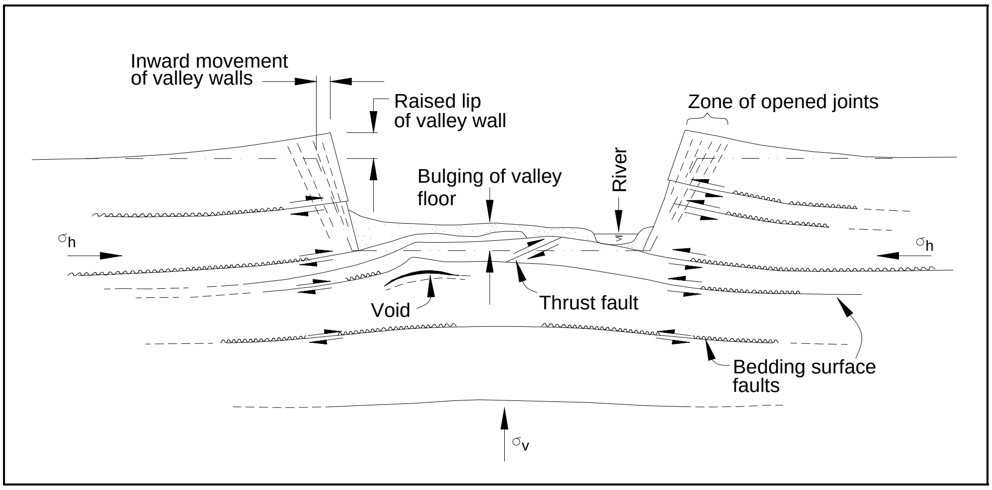

Fig. 3.1 Valley Formation in Flat-Lying Sedimentary Rocks (after Patton and Hendren 1972)

Valley related movements can be caused by or accelerated by mine subsidence as the result of a number of factors, including the redistribution of horizontal in-situ stresses and down slope movements. Valley related movements are normally described by the following parameters:-

- **Upsidence** is the reduced subsidence, or the relative uplift within a valley which results from the dilation or buckling of near surface strata at or near the base of the valley. The magnitude of upsidence, which is typically expressed in the units of *millimetres (mm)*, is the difference between the observed subsidence profile within the valley and the conventional subsidence profile which would have otherwise been expected in flat terrain.

- **Closure** is the reduction in the horizontal distance between the valley sides. The magnitude of closure, which is typically expressed in the units of *millimetres (mm)*, is the greatest reduction in distance between any two points on the opposing valley sides.

- **Compressive Strains** occur within the bases of valleys as a result of valley closure and upsidence movements. **Tensile Strains** also occur in the sides and near the tops of the valleys as a result of valley closure movements. The magnitudes of these strains, which are typically expressed in the units of *millimetres per metre (mm/m)*, are calculated as the changes in horizontal distance over a standard bay length, divided by the original bay length.

The predicted valley related movements resulting from the extraction of the proposed longwalls were made using the empirical method outlined in ACARP Research Project No. C9067 (Waddington and Kay, 2002). Further details can be obtained from the background report entitled *General Discussion on Mine Subsidence Ground Movements* which can be obtained at *www.minesubsidence.com*.

Research has commenced with the objective of modifying the current ACARP upsidence and closure prediction method to allow for variations in surface geology, to provide probabilistic predictions and to provide specific predictions for specific "subset" cases. The industry has escalated its level of research to gain a better understanding of the impacts of these ground movements, in response to comments provided in the recent Southern Coalfield Inquiry. An improved method for predicting upsidence and closure movements at pools and rock bars and an improved method for assessing the possible impacts of upsidence and closure movements will evolve from these studies. Analyses for this report have been undertaken using the current ACARP method of predicting upsidence and closure together with some minor adjustments and with appropriate assessments of the local topography, geometry and geology of the pools and rock bars.

The ACARP Prediction Method provided one set of upsidence and closure prediction curves that was drawn over the available upsidence and closure monitoring data. Now that the available monitoring database has been extended with many more cases and, since the recently proposed mine plans involve extracting coal resources up to but not under the creeks and rivers, consideration has been given to the preparation of a new set of upsidence and closure prediction curves using specific "subsets" of the total database.

As indicated in the following two plots, Fig. 3.2 and Fig. 3.3, lower values of upsidence, closure and strain have been observed within those valley monitoring sites that have not been undermined by either the current or the previously extracted longwalls (shown in blue circles), than the upsidence, closure and strain observed in those valleys that have been undermined (shown as black diamonds). Sometimes these subsets have been described as the "never undermined" case.

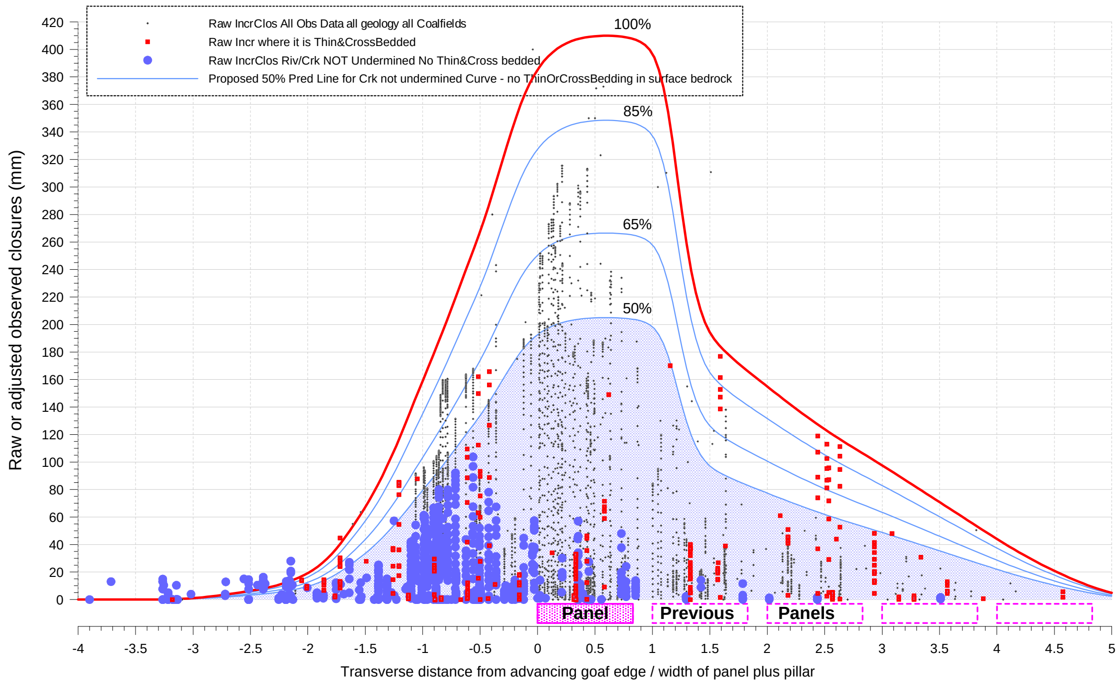

Fig. 3.2 Comparison of Raw Observed Incremental Closure versus Lateral Distances from Edges of the Incremental Panel for All Data, Valley Sites affected by Thin and Cross Bedded Bedrock Strata and Valley Sites not Undermined by Current or Previous Longwalls

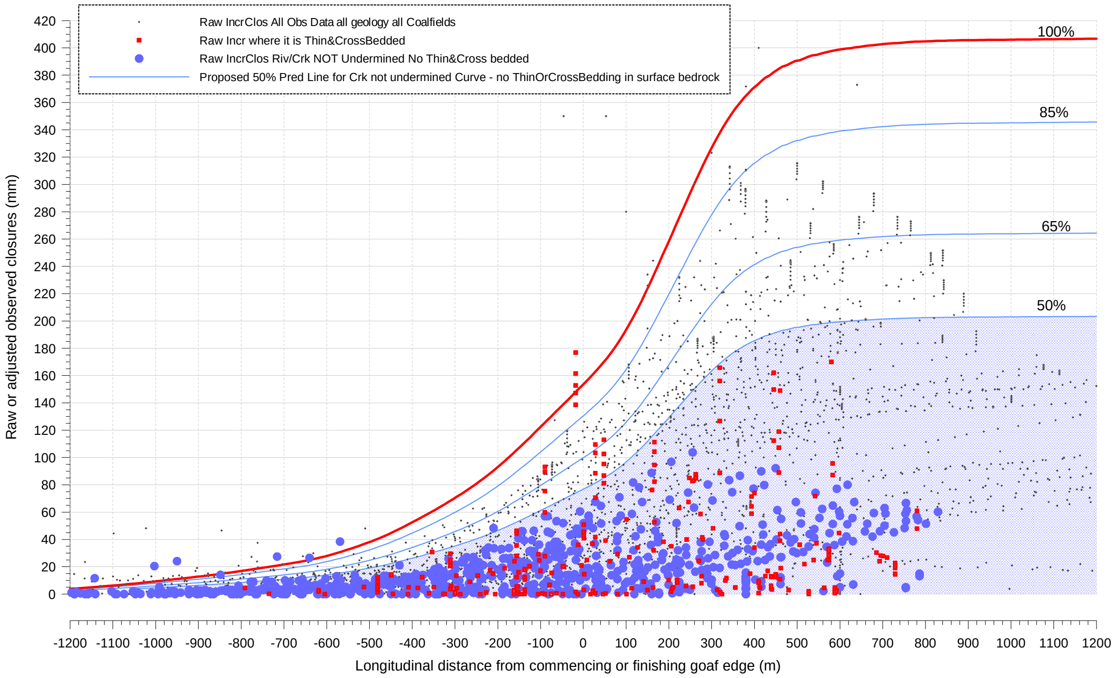

Fig. 3.3 Comparison of Raw Observed Incremental Closure versus Longitudinal Distances from Edges of the Incremental Panel for All Data, Valley Sites affected by Thin and Cross Bedded Bedrock Strata and Valley Sites not Undermined by Current or Previous Longwalls

The red points shown on these figures are the monitoring points where there is “Known Weak Geology” in the valley base and it is clear that, wherever the geology of the bedrock in the base of the valley comprises thin highly jointed layers, the resulting upsidence and closure can be higher than where the bedrock comprises strong thick homogeneous strata layers.

Research is continuing in this regard, but, it is initially clear from these two figures that a reduction factor of about 0.5 could be applied when predicting upsidence and closure for those streams that have not been undermined by the current or previous longwalls. But to be conservative, for now, a reduction factor of 0.7 has been adopted for the “never undermined” case until the ongoing research proves that lower reduction factors would be appropriate. After applying this 0.7 reduction factor, the majority of the observed closures were still less than half of those predicted and only 2 % of the observed closures exceeded those predicted.

The reliability of the predicted valley related upsidence and closure movements is discussed in Section 3.7.

3.5. The Incremental Profile Method

The predicted conventional subsidence parameters for the longwalls were determined using the Incremental Profile Method (IPM), which was developed by MSEC, formally known as Waddington Kay and Associates. The method is an empirical model based on a large database of observed monitoring data from previous mining within the Southern, Newcastle, Hunter and Western Coalfields of New South Wales.

The database consists of detailed subsidence monitoring data from Collieries in NSW including: Angus Place, Appin, Baal Bone, Bellambi, Beltana, Blakefield South, Bulli, Chain Valley, Clarence, Coalcliff, Cooranbong, Cordeaux, Corrimal, Cumnock, Dartbrook, Delta, Dendrobium, Eastern Main, Ellalong, Fernbrook, Glennies Creek, Gretley, Invincible, John Darling, Kemira, Lambton, Liddell, Mandalong, Metropolitan, Mt. Kembla, Munmorah, Nardell, Newpac, Newstan, Newvale, Newvale 2, South Bulga, South Bulli, Springvale, Stockton Borehole, Teralba, Tahmoor, Tower, Wambo, Wallarah, Western Main, Ulan, United, West Cliff, West Wallsend, and Wyee.

The database consists of the observed incremental subsidence profiles, which are the additional subsidence profiles resulting from the extraction of each longwall within a series of longwalls. It can be seen from the normalised incremental subsidence profiles within the database, that the observed shapes and magnitudes are reasonably consistent where the mining geometry and local geology are reasonably similar.

Subsidence predictions made using the Incremental Profile Method use the database of observed incremental subsidence profiles, the longwall geometries, local surface and seam information and geology. The method has a tendency to over-predict the conventional subsidence parameters (i.e. is slightly conservative) where the mining geometry and geology are within the range of the empirical database. The predictions can be further tailored to local conditions where observed monitoring data is available close to the mining area.

Further details on the Incremental Profile Method are provided in Report No. MSEC404 and the background report entitled *General Discussion on Mine Subsidence Ground Movements* which can be obtained from *www.minesubsidence.com*.

3.6. Reliability of the Predicted Conventional Subsidence Parameters

The Incremental Profile Method is based upon a large database of observed subsidence movements in the Southern Coalfield and has been found, in most cases, to give reasonable, if not, slightly conservative predictions of maximum subsidence, tilt and curvature. The predicted profiles obtained using this method also reflect the way in which each parameter varies over the mined area and indicate the movements that are likely to occur at any point on the surface.

Discussions on the reliability of the Incremental Profile Method were provided in Report No. MSEC404. These discussions included comparisons between the observed and predicted profiles of subsidence, tilt and curvature for a number of monitoring lines at the nearby Appin Area 3, Appin Area 4, Appin Area 5, West Cliff Area 3 and West Cliff Area 5. The following findings were made based on these comparisons:-

- The observed subsidence profiles reasonably match those predicted using the standard Bulli Seam prediction curves. While there is reasonable correlation, it is highlighted that in some locations away from the points of maxima and, in particular beyond the longwall goaf edges, that the observed subsidence exceeds that predicted. In these locations, however, the magnitude of subsidence is low and there were no associated significant tilts, curvatures and strains.
- In some cases, however, the observed subsidence exceeds those predicted. It is highlighted, that in one rare case in the Southern Coalfield, the maximum observed subsidence substantially exceeded that predicted above Longwall 24A and parts of Longwalls 25 and 26 at Tahmoor Colliery. In the Tahmoor case, the maximum observed subsidence of around 1200 mm, or 55 % of the extracted seam thickness, was more than double the predicted amounts of 500 mm to 600 mm, or around 23% to 27% of the extracted seam thickness. This was a very unusual and rare event for the Southern Coalfield and geotechnical advice indicates the cause was unusual geology. To put this in perspective, the surface area that was affected by increased subsidence at Tahmoor represents less than 1 % of the total surface area affected by longwall mining in the Southern Coalfield.
- The observed tilt and curvature profiles also reasonably matched the predicted profiles using the standard Bulli Seam prediction curves. The observed curvatures were derived from the smoothed subsidence profiles, so as to obtain overall levels of curvature, rather than the localised curvatures at each survey mark.
- The maximum observed tilts and curvatures were, in most cases, similar to the maximums predicted using the standard Bulli Seam prediction curves. The observed tilts and curvatures exceeded those predicted at the tributary crossings, at the locations of the upsidence movements, as the predicted profiles did not include non-conventional valley related movements. There was also some scatter in the observed tilt and curvature profiles.

The prediction of the conventional subsidence parameters at a specific point is more difficult than the prediction of the maxima anywhere above the longwalls. Variations between predicted and observed parameters at a point can occur where there is a lateral shift between the predicted and observed subsidence profiles, which can result from seam dip or variations in topography. In these situations, the lateral shift can result in the observed parameters being greater than those predicted in some locations, whilst the observed parameters being less than those predicted in other locations.

The prediction of strain at a point is even more difficult as there tends to be a large scatter in observed strain profiles. It has been found that measured strains can vary considerably from those predicted at a point, not only in magnitude, but also in sign, that is, the tensile strains have been observed where compressive strains were predicted, and vice versa. For this reason, the prediction of strain in this report has been based on a statistical approach, which is discussed in Section 4.4.

The tilts, curvatures and strains observed at the streams are likely to be greater than the predicted conventional movements, as a result of valley related movements, which is discussed in Section 3.4.3. Specific predictions of upsidence, closure and compressive strain due to the valley related movements are provided for the streams in Sections 5.2 and 5.3. The impact assessments for the streams are based on both the conventional and valley related movements.

It is also likely that some localised irregularities will occur in the subsidence profiles due to near surface geological features. The irregular movements are accompanied by elevated tilts, curvatures and strains, which often exceed the conventional predictions. In most cases, it is not possible to predict the locations or magnitudes of these irregular movements. For this reason, the strain predictions provided in this report are based on a statistical analysis of measured strains in the Southern Coalfield, including both conventional and non-conventional anomalous strains, which is discussed in Section 4.4. Further discussions on irregular movements are provided in Section 4.7.

The Incremental Profile Method approach allows site specific predictions for each natural feature or item of surface infrastructure and, hence, provides a more realistic assessment of the subsidence impacts than by applying the maximum predicted parameters to every point, which would be overly conservative and would yield an excessively overstated assessment of the potential subsidence impacts.

It is expected, therefore, that the standard Incremental Profile Method should generally provide reasonable, if not, slightly conservative predictions for conventional subsidence, tilt and curvature resulting from the extraction of the proposed longwalls. Allowance should, however, be made for the possibility of observed movements exceeding those predicted as the result of anomalous or non-conventional movements, or for greater subsidence, to occur in some places.

The reliability of the predictions obtained using the Incremental Profile Method is illustrated by comparing the magnitudes of observed movements with those predicted for previously extracted longwalls in the Southern Coalfield. The comparisons have been made for monitoring lines at Appin Colliery (Areas 3, 4 and 7), Tower Colliery and West Cliff Colliery (Area 5).

The comparison between the observed incremental subsidence and the predicted incremental subsidence along the monitoring lines is illustrated in Fig. 3.4. The results shown in this figure are the observed and predicted subsidence at each survey mark at the completion of each longwall.

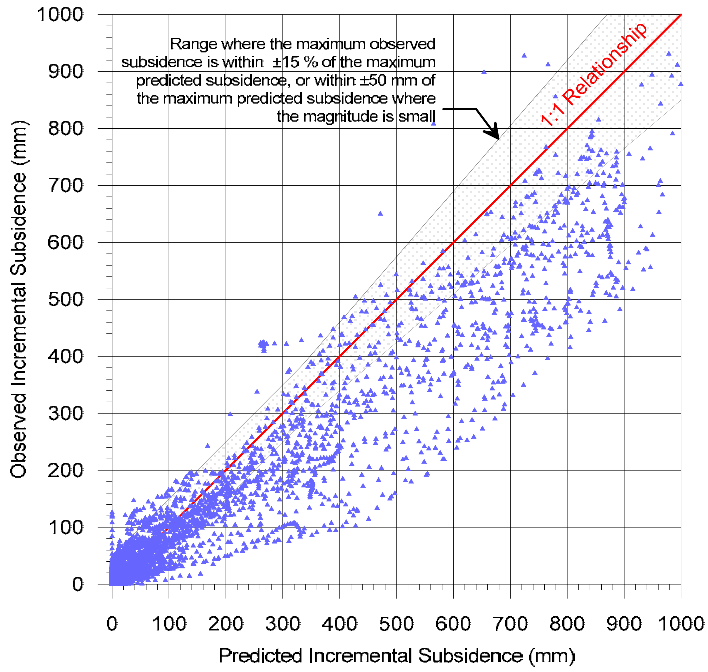

Fig. 3.4 Comparisons between Observed Incremental Subsidence and Predicted Incremental Subsidence for the Previously Extracted Longwalls

It can be seen from the above figure, that in the locations where the magnitude of subsidence was high (i.e. at or near the point of maximum subsidence), the observed subsidence was typically less than that predicted. In the locations where the magnitude of subsidence was in the mid range (i.e. away from the point of maximum subsidence), the observed subsidence exceeded that predicted, in some cases, but was typically within +15 % or +50 mm of the prediction. In the locations where the magnitude of subsidence was small (i.e. beyond the limits of the active longwall), the observed subsidence was typically within ±100 mm of the prediction.

The comparison between the maximum observed incremental subsidence and the maximum predicted incremental subsidence for the monitoring lines is illustrated in Fig. 3.5. The results shown in this figure are the maximum observed and predicted subsidence for each monitoring line at the completion of each longwall.

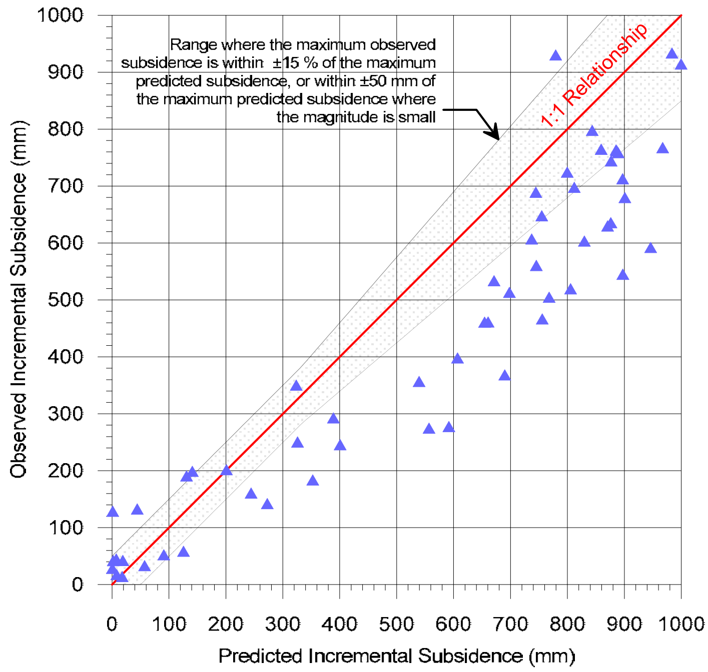

Fig. 3.5 Comparisons between Maximum Observed Incremental Subsidence and Maximum Predicted Incremental Subsidence for the Previously Extracted Longwalls

The distribution of the ratio of the maximum observed to maximum predicted incremental subsidence for the monitoring lines is illustrated in Fig. 3.6 (left). A gamma distribution has been fitted to the results which is also shown in this figure.

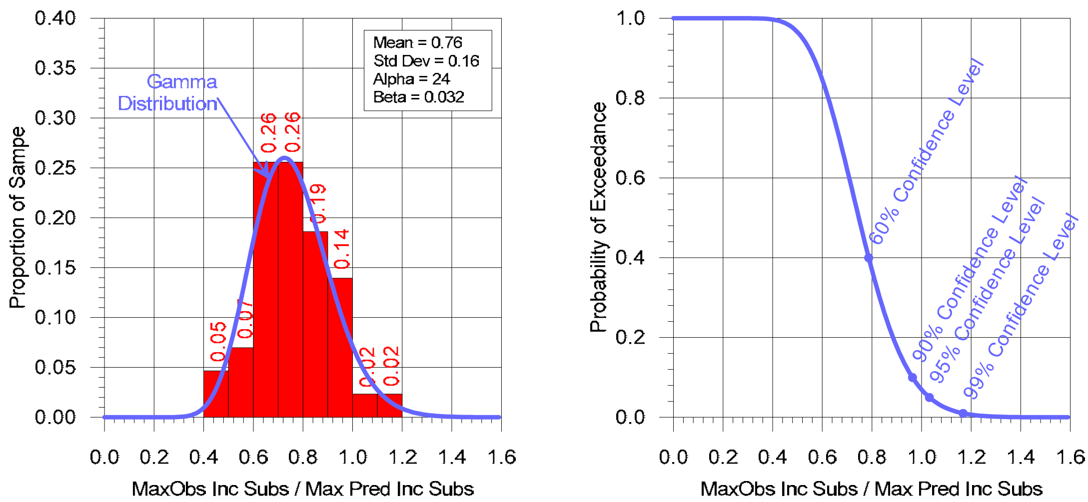

Fig. 3.6 Distribution of the Ratio of the Maximum Observed to Maximum Predicted Incremental Subsidence for Previously Extracted Longwalls

The probabilities of exceedance have been determined, based on the gamma distribution, which is shown in Fig. 3.6 (right). It can be seen from this figure that, based on the monitoring data, there is an approximate 93 % confidence level that the maximum observed incremental subsidence will be less than the maximum predicted incremental subsidence.

3.7. Reliability of the Predicted Upsidence and Closure Movements

The predicted valley related movements resulting from the extraction of the proposed longwalls were made using the empirical method outlined in ACARP Research Project No. C9067 (Waddington and Kay, 2002). Further details can be obtained from the background report entitled *General Discussion on Mine Subsidence Ground Movements* which can be obtained at *www.minesubsidence.com*. Discussions on the reliability of the method of prediction were provided in Report No. MSEC404.

The development of the predictive methods for upsidence and closure are the result of recent and ongoing research and the methods do not, at this stage, have the same confidence level as conventional subsidence prediction techniques. As further case histories are studied, the method will be improved, but it can be used in the meantime, so long as suitable factors of safety are applied. This is particularly important where the predicted levels of movement are small, and the potential errors, expressed as percentages, can be higher.

Whilst the major factors that determine the levels of movement have been identified, there are some factors that are difficult to isolate. One factor that is thought to influence the upsidence and closure movements is the level of in-situ horizontal stress that exists within the strata. In-situ stresses are difficult to obtain and not regularly measured and the limited availability of data makes it impossible to be definitive about the influence of the in-situ stress on the upsidence and closure values. The methods are, however, based predominantly upon the measured data from Tower Colliery in the Southern Coalfield, where the in-situ stresses are high. The methods should, therefore, tend to over-predict the movements in areas of lower stress.

Variations in local geology can affect the way in which the near surface rocks are displaced as subsidence occurs. In the compression zone, the surface strata can buckle upwards or can fail by shearing and sliding over their neighbours. If localised cross bedding exists, this shearing can occur at relatively low values of stress. This can result in fluctuations in the local strains, which can range from tensile to compressive. In the tensile zone, existing joints can be opened up and new fractures can be formed at random, leading to localised concentrations of tensile strain.

Another factor that is thought to influence the movements is the characteristics of near surface geology, particularly in stream beds. Upsidence in particular is considered to be sensitive to the way in which the bedrock responds, since thin strata layers may respond differently to thicker ones. The location of the point of maximum upsidence is also considered to be strongly influenced by the characteristics of near surface geology.

Another factor that is thought to influence upsidence and closure movements is the presence of geomorphological features. Recent monitoring along a deeper and more incised valley has shown variable measurements around bends. There tended to be less movement at the apex of the bend than in the straight sections.

4.1. Introduction

The following sections provide the maximum predicted conventional subsidence parameters resulting from the extraction of the proposed Longwalls 901 to 904. The predicted subsidence parameters and the impact assessments for the natural features and surface infrastructure are provided in Chapters 5 through to 11.

The predicted subsidence, tilt and curvature have been obtained using the Incremental Profile Method, based on the standard prediction curves for the Southern Coalfield, as described in Section 3.5. The predicted strains have been determined by analysing the strains measured during the previous extraction of longwalls at Appin Colliery, as well as at other nearby collieries.

The maximum predicted subsidence parameters and the predicted subsidence contours provided in this report describe and show the conventional movements and do not include the valley related upsidence and closure movements, nor the effects of faults and other geological structures. Such effects have been addressed separately in the impact assessments for each feature provided in Chapter 5 through to 11.

4.2. Maximum Predicted Conventional Subsidence, Tilt and Curvature

The maximum predicted conventional subsidence parameters resulting from the extraction of the proposed longwalls were determined using the Incremental Profile Method, which was described in Chapter 3. A summary of the maximum predicted values of incremental conventional subsidence, tilt and curvature, due to the extraction of each of the proposed longwalls, is provided in Table 4.1.

Table 4.1 Maximum Predicted Incremental Conventional Subsidence, Tilt and Curvature Resulting from the Extraction of Each of the Proposed Longwalls

Longwall	Maximum Predicted Incremental Conventional Subsidence (mm)	Maximum Predicted Incremental Conventional Tilt (mm/m)	Maximum Predicted Incremental Conventional Hogging Curvature (km^{-1})	Maximum Predicted Incremental Conventional Sagging Curvature (km^{-1})
LW901	600	3.0	0.03	0.04
LW902	850	6.0	0.06	0.12
LW903	800	6.0	0.05	0.11
LW904	825	5.5	0.05	0.10

The predicted total conventional subsidence contours, resulting from the extraction of Longwalls 901 to 904 are shown in Drawing Nos. MSEC448-34 to MSEC448-37. A summary of the maximum predicted values of total conventional subsidence, tilt and curvature, after the extraction of each of the proposed longwalls, is provided in Table 4.2. The predicted tilts provided in this table are the maxima after the completion of each of the proposed longwalls. The predicted curvatures are the maxima at any time during or after the extraction of each of the proposed longwalls.

Table 4.2 Maximum Predicted Total Conventional Subsidence, Tilt and Curvature after the Extraction of Each of the Proposed Longwalls

Longwalls	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
LW901	600	3.0	0.03	0.04
LW902	925	6.5	0.06	0.12
LW903	1150	6.0	0.07	0.12
LW904	1200	6.0	0.07	0.12

The maximum predicted total subsidence, after the completion of the proposed longwalls, is 1200 mm which represents around 40 % of the seam thickness. The maximum predicted total conventional tilt is 6.5 mm/m (i.e. 0.7 %), which represents a change in grade of 1 in 155. The maximum predicted total conventional curvatures are 0.07 km^{-1} hogging and 0.12 km^{-1} sagging, which represent minimum radii of curvature of 14 kilometres and 8 kilometres, respectively.

The predicted conventional subsidence parameters vary across the Study Area as the result of, amongst other factors, variations in the depths of cover, longwall geometry and extraction heights. To illustrate this variation, the predicted profiles of conventional subsidence, tilt and curvature have been determined along Prediction Line 1, the location of which is shown in Drawing Nos. MSEC448-34 to MSEC448-37.

The predicted profiles of conventional subsidence, tilt and curvature along Prediction Line 1, resulting from the extraction of the proposed longwalls, are shown in Fig. E.01, in Appendix E. The predicted incremental profiles along the prediction line, due to the extraction of each of the proposed longwalls, are shown as dashed black lines. The predicted total profiles along the prediction line, after the extraction of each of the proposed longwalls, are shown as solid blue lines. The range of predicted curvatures in any direction to the prediction line, at any time during or after the extraction of the proposed longwalls, is shown by the grey shading.

The reliability of the predictions of subsidence, tilt and curvature, obtained using the Incremental Profile Method, is discussed in Section 3.6.

4.3. Comparison of Maximum Predicted Conventional Subsidence, Tilt and Curvature

The comparison of the maximum predicted subsidence parameters resulting from the extraction of the proposed longwalls with those provided in the Part 3A Application is provided in Table 4.3. The Part 3A Layout comprised 17 longwalls over a greater extent than the Extraction Plan Layout. So as to allow comparisons, the parameters provided in the table for the Part 3A Layout are the maxima which occur within the extent of the Study Area for the currently proposed longwalls.

Table 4.3 Comparison of Maximum Predicted Conventional Subsidence Parameters based on the Part 3A and Extraction Plan Layouts

Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
Part 3A Layout (Report No. MSEC404)	1400	6.5	0.07	0.12
Extraction Plan Layout (Report No. MSEC448)	1200	6.5	0.07	0.12

It can be seen from the above table, that the maximum predicted subsidence, based on the Extraction Plan Layout, is less than that predicted based on the Part 3A Layout. The maximum predicted tilt and curvatures, based on the Extraction Plan Layout, are similar to those predicted based on the Part 3A Layout.

The comparison of the maximum predicted subsidence parameters resulting from the extraction of the proposed longwalls with those predicted for the longwalls in Appin Area 3, Appin Area 4, Appin Area 7 and West Cliff Area 5 is provided in Table 4.4.

Table 4.4 Comparison of Maximum Predicted Conventional Subsidence Parameters

Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
Appin Area 3 LW301 and 302	800	6.5	0.07	0.13
Appin Area 4 LW401 to LW409	1600	7.5	0.07	0.14
Appin Area 7 LW705 to LW710	1500	8.0	0.09	0.15
West Cliff Area 5 LW34 to LW36	1250	6.0	0.07	0.13
Appin Area 9 Extraction Plan Layout (Report No. MSEC448)	1200	6.5	0.07	0.12

It can be seen from the above table, that the maximum predicted subsidence parameters, resulting from the extraction of the proposed longwalls, are similar to or slightly less than those predicted for the longwalls in Appin Area 4, Appin Area 7 and West Cliff Area 5. The maximum predicted subsidence for the proposed longwalls, however, is greater than that predicted in Appin Area 3.

4.4. Predicted Strains

The prediction of strain is more difficult than the predictions of subsidence, tilt and curvature. The reason for this is that strain is affected by many factors, including curvature and horizontal movement, as well as local variations in the near surface geology, the locations of pre-existing natural joints at bedrock, and the depth of bedrock. Survey tolerance can also represent a substantial portion of the measured strain, in cases where the strains are of a low order of magnitude. The profiles of observed strain, therefore, can be irregular even when the profiles of observed subsidence, tilt and curvature are relatively smooth.

In previous MSEC subsidence reports, predictions of conventional strain were provided based on the best estimate of the average relationship between curvature and strain. Similar relationships have been proposed by other authors. The reliability of the strain predictions was highlighted in these reports, where it was stated that measured strains can vary considerably from the predicted conventional values.

Adopting a linear relationship between curvature and strain provides a reasonable prediction for the conventional tensile and compressive strains. The locations that are predicted to experience hogging or convex curvature are expected to be net tensile strain zones and locations that are predicted to experience sagging or concave curvature are expected to be net compressive strain zones. In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the maximum predicted curvatures and the maximum predicted conventional strains.

The maximum predicted conventional strains resulting from the extraction of Longwalls 901 to 904, based on applying a factor of 15 to the maximum predicted curvatures, are 1 mm/m tensile and 2 mm/m compressive.

At a point, however, there can be considerable variation from the linear relationship, resulting from non-conventional movements or from the normal scatters which are observed in strain profiles. When expressed as a percentage, observed strains can be many times greater than the predicted conventional strain for low magnitudes of curvature. In this report, therefore, we have provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The range of potential strains above the proposed longwalls has been determined using monitoring data from the previously extracted longwalls in the Southern Coalfield. The monitoring data was used from Appin Colliery, as well as the nearby Tower, West Cliff and Tahmoor Collieries, where the overburden geology and mining geometry are reasonably similar to those for the proposed longwalls. The range of strains measured during the extraction of these longwalls should, therefore, provide a reasonable indication of the range of potential strains for the proposed longwalls.

The data used in the analysis of observed strains included those resulting from both conventional and non-conventional anomalous movements, but did not include those resulting from valley related movements, which are addressed separately in this report. The strains resulting from damaged or disturbed survey marks have also been excluded.

4.4.1. Analysis of Strains Measured in Survey Bays

For features that are in discrete locations, such as building structures, farm dams and archaeological sites, it is appropriate to assess the frequency of the observed maximum strains for individual survey bays.

The survey database has been analysed to extract the maximum tensile and compressive strains that have been measured at any time during the extraction of the previous longwalls in the Southern Coalfield, for survey bays that were located directly above goaf or the chain pillars that are located between the extracted longwalls, which has been referred to as "*above goaf*".

The strain distributions were analysed with the assistance of the centre of Excellence for Mathematics and Statistics of Complex Systems (MASCOS). A number of probability distribution functions were fitted to the empirical data. It was found that a *Generalised Pareto Distribution (GPD)* provided a good fit to the raw strain data.

The histogram of the maximum observed total tensile and compressive strains measured in survey bays above goaf, for monitoring lines from the Southern Coalfield, is provided in Fig. 4.1. The probability distribution functions, based on the fitted GPDs, have also been shown in this figure.

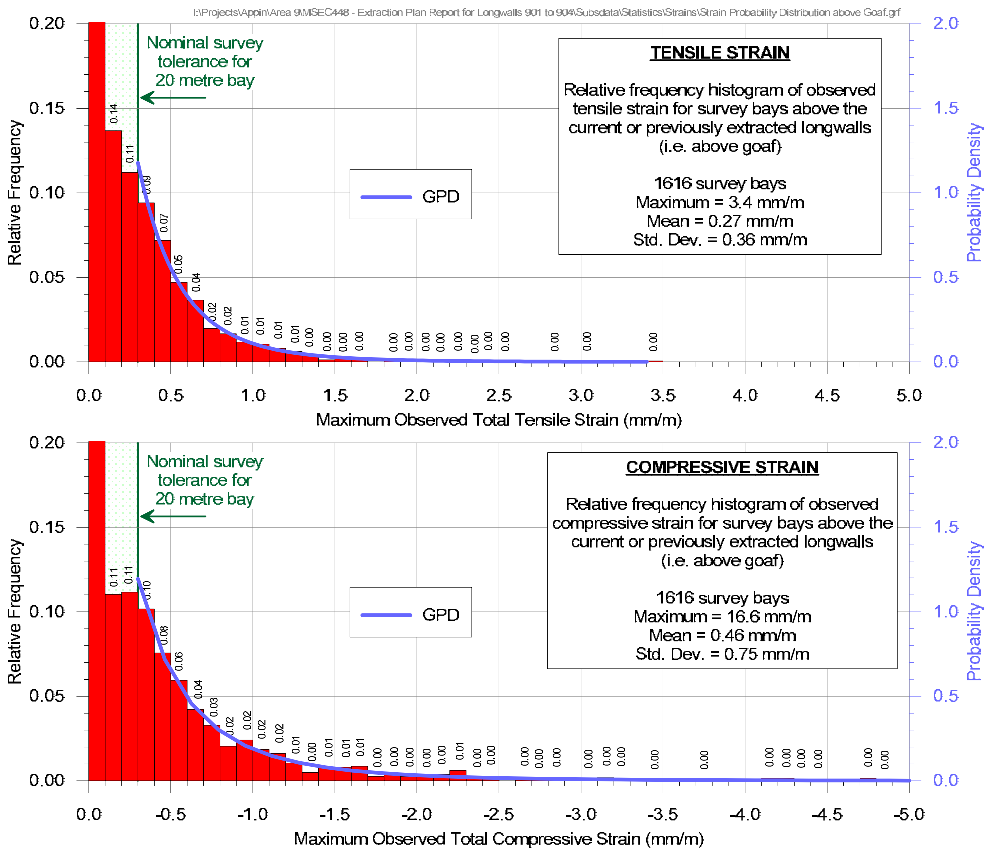

Fig. 4.1 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield for Bays Located Above Goaf

Confidence levels have been determined from the empirical strain data using the fitted GPDs. In the cases where survey bays were measured multiple times during a longwall extraction, the maximum tensile strain and the maximum compressive strain were used in the analysis (i.e. single tensile strain and single compressive strain measurement per survey bay).

A summary of the probabilities of exceedance for tensile and compressive strains for survey bays located above goaf, based on the fitted GPDs, is provided in Table 4.5.

Table 4.5 Probabilities of Exceedance for Strain for Survey Bays Located above Goaf

Strain (mm/m)		Probability of Exceedance
Compression	-6.0	1 in 500
	-4.0	1 in 175
	-2.0	1 in 35
	-1.0	1 in 10
	-0.5	1 in 3
	-0.3	1 in 2
Tension	+0.3	1 in 3
	+0.5	1 in 6
	+1.0	1 in 25
	+2.0	1 in 200
	+3.0	1 in 1,100

The 95 % confidence levels for the maximum total strains that the individual survey bays above goaf experienced at any time during mining were 0.9 mm/m tensile and 1.6 mm/m compressive. The 99 % confidence levels for the maximum total strains that the individual survey bays above goaf experienced at any time during mining were 1.6 mm/m tensile and 3.2 mm/m compressive.

It is noted, that the maximum observed compressive strain of 16.6 mm/m, which occurred along the T-Line at the surface above Appin Longwall 408, was the result of movements along a low angle thrust fault which daylighted above the Cataract Tunnel. All remaining compressive strains were less than 7 mm/m. The inclusion of the strain at the fault above Longwall 408 has a substantial influence on the probabilities of exceeding the strains provided in Table 4.5, particularly at the high magnitudes of strain.

The probabilities for survey bays located above goaf are based on the strains measured anywhere above the previously extracted longwalls in the Southern Coalfield. As described previously, tensile strains are more likely to develop in the locations of hogging curvature and compressive strains are more likely to develop in the locations of sagging curvature.

This is illustrated in Fig. 4.2, which shows the distribution of incremental strains measured above previously extracted longwalls in the Southern Coalfield. The distances have been normalised, so that the locations of the measured strains are shown relative to the longwall maingate and tailgate sides. The approximate confidence levels for the incremental tensile and compressive strains are also shown in this figure, to help illustrate the variation in the data.

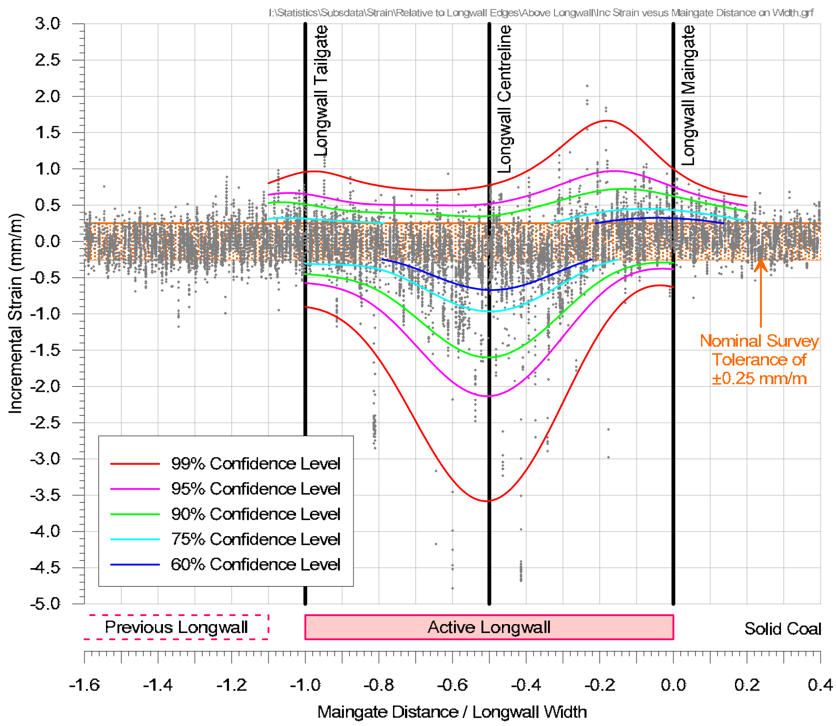

Fig. 4.2 Observed Incremental Strains versus Normalised Distance from the Longwall Maingate for Previously Extracted Longwalls in the Southern Coalfield

The survey database has also been analysed to extract the maximum tensile and compressive strains that have been measured at any time during the extraction of the previous longwalls in the Southern Coalfield, for survey bays that were located outside and within 250 metres of the nearest longwall goaf edge, which has been referred to as "*above solid coal*".

The histogram of the maximum observed tensile and compressive strains measured in survey bays above solid coal, for monitoring lines in the Southern Coalfield, is provided in Fig. 4.3. The probability distribution functions, based on the fitted GPDs, have also been shown in this figure.

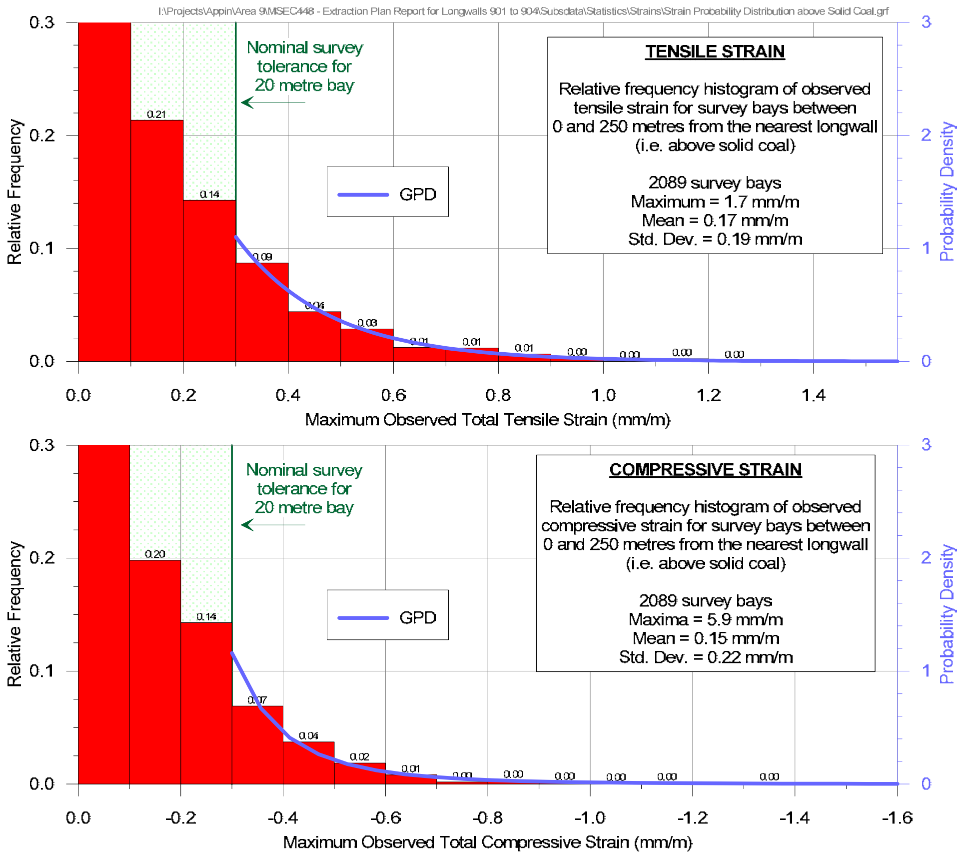

Fig. 4.3 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield for Bays Located Above Solid Coal

Confidence levels have been determined from the empirical strain data using the fitted GPDs. In the cases where survey bays were measured multiple times during a longwall extraction, the maximum tensile strain and the maximum compressive strain were used in the analysis (i.e. single tensile strain and single compressive strain measurement per survey bay).

A summary of the probabilities of exceedance for tensile and compressive strains for survey bays located above solid coal, based the fitted GPDs, is provided in Table 4.6.

Table 4.6 Probabilities of Exceedance for Strain for Survey Bays Located above Solid Coal

Strain (mm/m)		Probability of Exceedance
Compression	-2.0	1 in 2,000
	-1.5	1 in 800
	-1.0	1 in 200
	-0.5	1 in 25
	-0.3	1 in 7
Tension	+0.3	1 in 5
	+0.5	1 in 15
	+1.0	1 in 200
	+1.5	1 in 2,500

The 95 % confidence levels for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining were 0.6 mm/m tensile and 0.5 mm/m compressive. The 99 % confidence levels for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining were 0.9 mm/m tensile and 0.8 mm/m compressive.

4.4.2. Analysis of Strains Measured Along Whole Monitoring Lines

For linear features such as roads, cables and pipelines, it is more appropriate to assess the frequency of the maximum observed strains along whole monitoring lines, rather than for individual survey bays. That is, an analysis of the maximum strains measured anywhere along the monitoring lines, regardless of where the strain actually occurs.

The histogram of maximum observed total tensile and compressive strains measured anywhere along the monitoring lines, at any time during or after the extraction of the previous longwalls in the Southern Coalfield, is provided in Fig. 4.4.

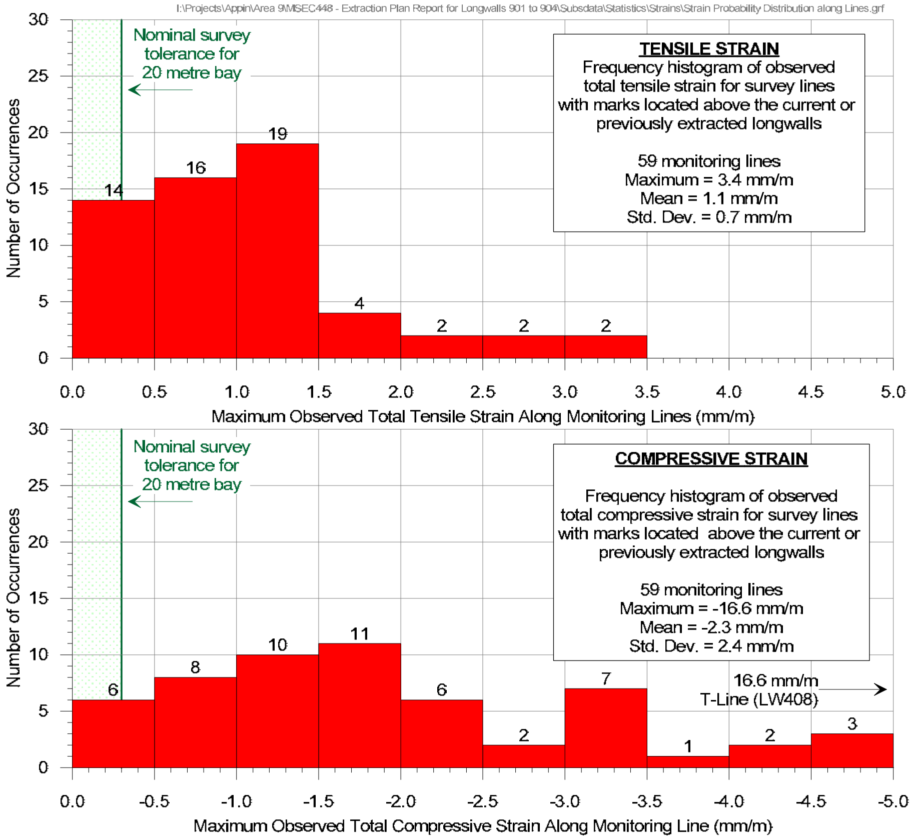

Fig. 4.4 Distributions of Measured Maximum Tensile and Compressive Strains along the Monitoring Lines during the Extraction of Previous Longwalls in the Southern Coalfield

It can be seen from Fig. 4.4, that 30 of the 59 monitoring lines (i.e. 51 %) have recorded maximum total tensile strains of 1.0 mm/m, or less, and that 53 monitoring lines (i.e. 89 %) have recorded maximum total tensile strains of 2.0 mm/m, or less. It can also be seen, that 35 of the 59 monitoring lines (i.e. 59 %) have recorded maximum compressive strains of 2.0 mm/m, or less, and that 51 of the monitoring lines (i.e. 86 %) have recorded maximum compressive strains of 4.0 mm/m, or less.

4.4.3. Analysis of Strains Resulting from Valley Closure Movements

The streams within the Study Area are expected to experience compressive strains resulting from valley related movements. The strains resulting from valley related movements are more difficult to predict than strains in flatter terrain, as they are dependent on many additional factors, including the valley shape and valley height, the valley geomorphology and the local geology in the valley base. The development of a prediction method for strains resulting from valley related movements is part of a current ACARP research project.

The predicted strains resulting from valley related movements, for the streams located directly above the proposed longwalls, have been determined using the monitoring data for longwalls which have previously mined directly beneath streams in the Southern Coalfield.

The relationship between total closure strain and total closure movement, based on monitoring data for longwalls which have previously mined directly beneath streams in the Southern Coalfield, is provided in Fig. 4.5. The confidence levels, based on the fitted GPDs, have also been shown in this figure.

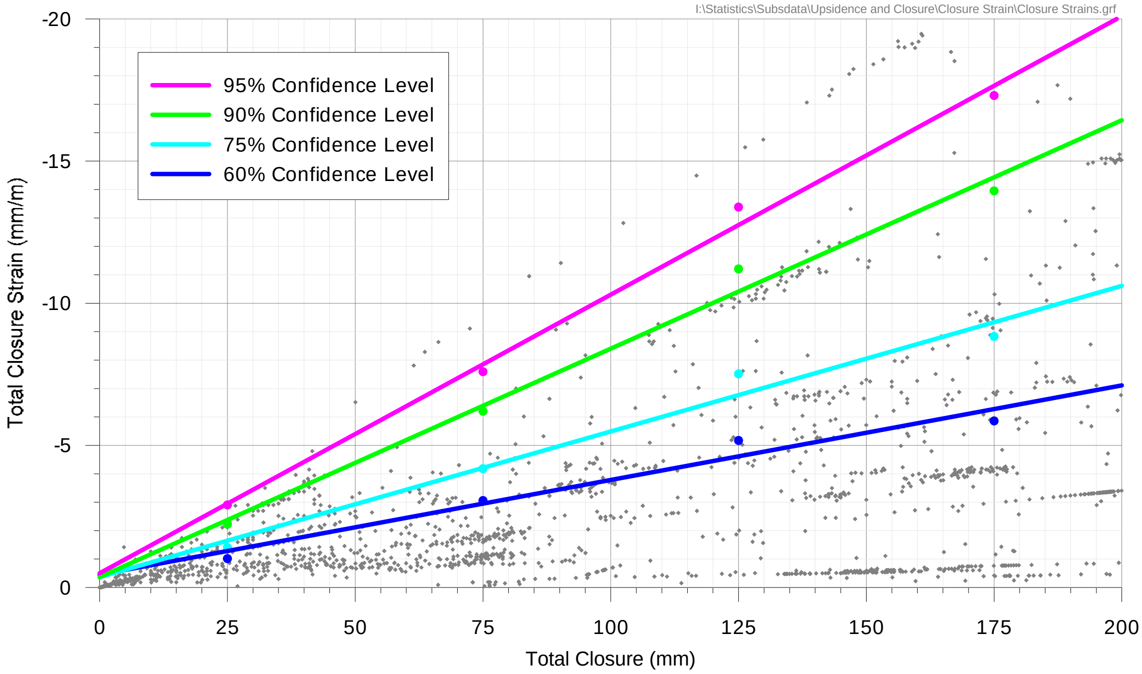

Fig. 4.5 Total Closure Strain versus Total Closure Movement Based on Monitoring Data for Streams Located Directly Above Longwalls in the Southern Coalfield

The reliability of the predicted valley related upsidence and closure movements is discussed in Section 3.7.

4.4.4. Analysis of Shear Strains

As described in Section 3.2, ground strain comprises two components, being normal strain and shear strain, which can be interrelated using Mohr's Circle. The magnitudes of the normal strain and shear strain components are, therefore, dependant on the orientation in which they are measured. The maximum normal strains (i.e. principal strains) are those in the direction where the corresponding shear strain is zero.

Normal strains along monitoring lines can be measured using 2D and 3D techniques, by taking the change in horizontal distance between two points on the ground and dividing by the original horizontal distance between them. This provides the magnitude of normal strain along the orientation of the monitoring line and, therefore, this strain may not necessarily be the maximum (i.e. principal) strain.

Shear deformations are more difficult to measure, as they are the relative horizontal movements perpendicular to the direction of measurement. However, 3D monitoring techniques provide data on the direction and the absolute displacement of survey marks and, therefore, the shear deformations perpendicular to the monitoring line can be determined. But, in accordance with rigorous definitions and the principles of continuum mechanics, (e.g. Jaeger, 1969), it is not possible to determine horizontal shear strains in any direction relative to the monitoring line using 3D monitoring data from a straight line of survey marks.

As described in Section 3.2, shear deformations perpendicular to monitoring lines can be described using various parameters, including horizontal tilt, horizontal curvature, horizontal mid-ordinate deviation, angular distortion and shear index. In this report, horizontal mid-ordinate deviation has been used as the measure for shear deformation, which is defined as the differential horizontal movement of each survey mark, perpendicular to a line drawn between two adjacent survey marks.

The frequency distribution of the maximum total horizontal mid-ordinate deviations measured at survey marks above goaf, for previously extracted longwalls in the Southern Coalfield, is provided in Fig. 4.6. As the typical survey bay length was 20 metres, the calculated mid-ordinate deviations were over a chord length of 40 metres. The probability distribution function, based on the fitted GPD, has also been shown in this figure.

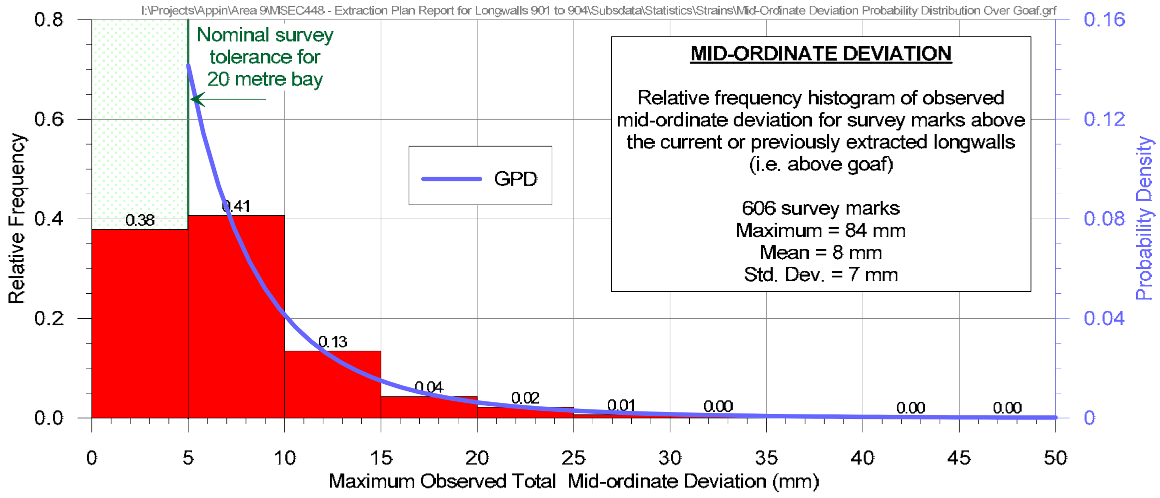

Fig. 4.6 Distribution of Measured Maximum Mid-ordinate Deviation during the Extraction of Previous Longwalls in the Southern Coalfield for Marks Located Above Goaf

A summary of the probabilities of exceedance for total horizontal mid-ordinate deviation for survey bays located above goaf, based the fitted GPD, is provided in Table 4.7.

Table 4.7 Probabilities of Exceedance for Mid-Ordinate Deviation for Survey Marks above Goaf for Monitoring Lines in the Southern Coalfield

Horizontal Mid-ordinate Deviation (mm)		Probability of Exceedance
Mid-ordinate Deviation over 40 metre Chord Length	10	1 in 4
	20	1 in 20
	30	1 in 70
	40	1 in 175
	50	1 in 400
	60	1 in 800
	70	1 in 1,400
	80	1 in 2,300

The 95 % and 99 % confidence levels for the maximum total horizontal mid-ordinate deviation that the individual survey marks located above goaf experienced at any time during mining were 20 mm and 35 mm, respectively.

4.5. Predicted Conventional Horizontal Movements

The predicted conventional horizontal movements over the proposed longwalls are calculated by applying a factor to the predicted conventional tilt values. In the Southern Coalfield a factor of 15 is generally adopted, being the same factor as that used to determine the maximum conventional strains from the maximum conventional curvatures, and this has been found to give a reasonable correlation with measured data. This factor will in fact vary and will be higher at low tilt values and lower at high tilt values. The application of this factor will therefore lead to over-prediction of horizontal movements where the tilts are high and under-prediction of the movements where the tilts are low.

The maximum predicted conventional tilt within the Study Area, at any time during or after the extraction of the proposed longwalls, is 6.5 mm/m, which occurs adjacent to the maingate of the proposed Longwall 902 at the completion of this longwall. This area will experience the greatest predicted conventional horizontal movement towards the centre of the overall goaf area. The maximum predicted conventional horizontal movement is, therefore, approximately 100 mm, i.e. 6.5 mm/m multiplied by a factor of 15.

Conventional horizontal movements do not directly impact on natural features or surface infrastructure, rather impacts occur as the result of differential horizontal movements. Strain is the rate of change of horizontal movement. The impacts of strain on the natural features and surface infrastructure are addressed in the impact assessments for each feature, which have been provided in Chapters 5 through to 11.

4.6. Predicted Far-field Horizontal Movements

In addition to the conventional subsidence movements that have been predicted above and adjacent to the proposed longwalls, and the predicted valley related movements along the streams, it is also likely that far-field horizontal movements will be experienced during the extraction of the proposed longwalls.

An empirical database of observed incremental far-field horizontal movements has been compiled using monitoring data primarily from the Southern Coalfield. The far-field horizontal movements resulting from longwall mining were generally observed to be orientated towards the extracted longwall. At very low levels of far-field horizontal movements, however, there was a high scatter in the orientation of the observed movements.

The observed incremental far-field horizontal movements, resulting from the extraction of longwalls in the Southern Coalfield, is provided in Fig. 4.7. The confidence levels, based on fitted GPDs, have also been shown in this figure to illustrate the spread of the data.

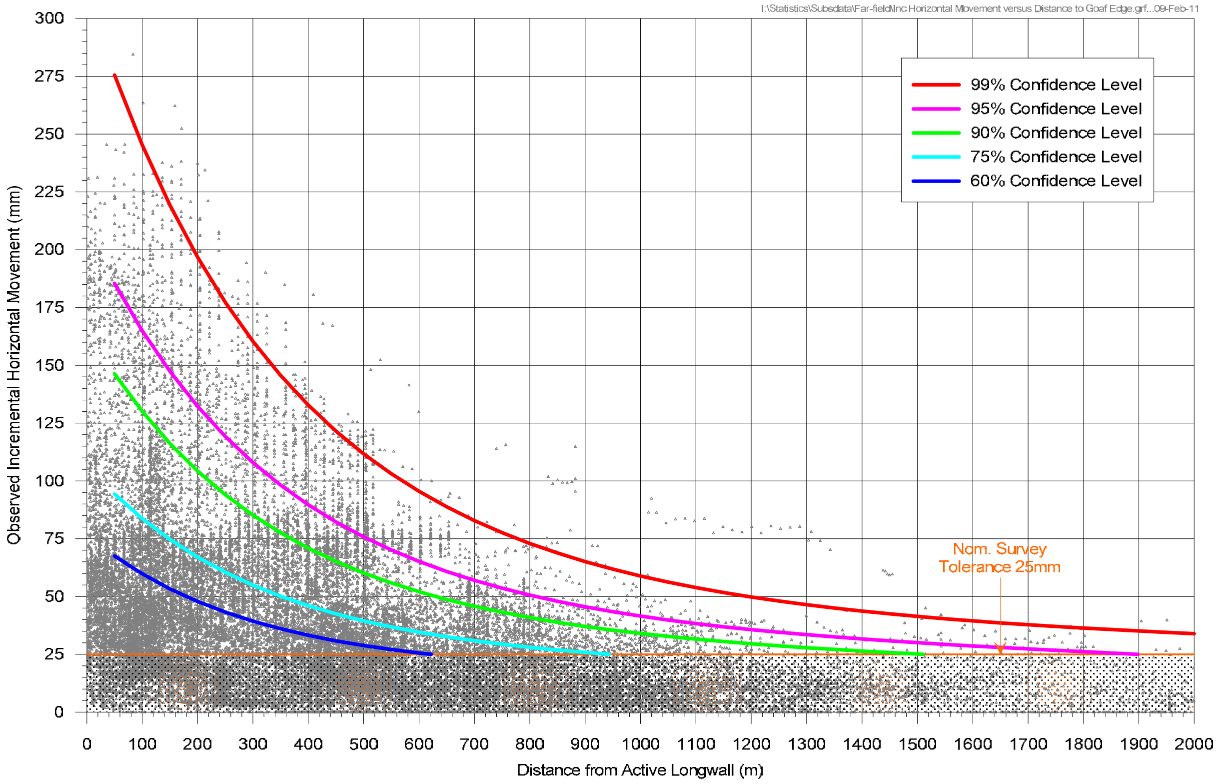

Fig. 4.7 Observed Incremental Far-Field Horizontal Movements from the Southern Coalfield

As successive longwalls within a series of longwalls are mined, the magnitudes of the incremental far-field horizontal movements tend to decrease. This is possibly due to the fact that once the in-situ stresses within the strata has been redistributed around the collapsed zones above the first few extracted longwalls, the potential for further movement is reduced. The total far-field horizontal movement is not, therefore, the sum of the incremental far-field horizontal movements for the individual longwalls.

The predicted far-field horizontal movements resulting from the extraction of the proposed longwalls are very small and could only be detected by precise surveys. Such movements tend to be bodily movements towards the extracted goaf area, and are accompanied by very low levels of strain, which are generally in the order of survey tolerance (i.e. less than 0.3 mm/m).

The impacts of far-field horizontal movements on the natural features and surface infrastructure in the vicinity of the proposed longwalls is not expected to be significant, except where they occur at large structures which are sensitive to small differential movements, which may include the Nepean Twin Bridges which is discussed in Section 6.3.

4.7. Non-Conventional Ground Movements

It is likely non-conventional ground movements will occur within the Study Area, due to near surface geological conditions, steep topography and valley related movements, which were discussed in Section 3.4. These non-conventional movements are often accompanied by elevated tilts, curvatures and strains, which are likely to exceed the conventional predictions.

Specific predictions of upsidence, closure and compressive strain due to the valley related movements are provided for the streams in Sections 5.2 and 5.3. The impact assessments for the streams are based on both the conventional and valley related movements. The potential for non-conventional movements associated with steep topography is discussed in the impact assessments for the steep slopes provided in Section 5.7.

In most cases, it is not possible to predict the exact locations or magnitudes of the non-conventional anomalous movements due to near surface geological conditions. For this reason, the strain predictions provided in this report are based on a statistic analysis of measured strains in the Southern Coalfield, including both conventional and non-conventional anomalous strains, which is discussed in Section 4.4. In addition to this, the impact assessments for the natural features and surface infrastructure, which are provided in Chapters 5 through to 11, include historical impacts resulting from previous longwall mining which have occurred as the result of both conventional and non-conventional subsidence movements.

The largest known case of non-conventional movement in the Southern Coalfield occurred above Appin Longwall 408. In this case, a low angle thrust fault was re-activated in response to mine subsidence movements, resulting in differential vertical and horizontal movements across the fault. Observations at the site showed that the non-conventional movements developed gradually and over a period of time. Regular ground monitoring across the fault indicated that the rate of differential movement was less than 0.5 mm/day at the time non-conventional movements could first be detected. Subsequently as mining progressed, the rate of differential movement increased to a maximum of 28 mm/week.

The development of strain at the low angle thrust fault, as measured along the T-Line during the extraction of Longwall 408, is illustrated in Fig. 4.8. Photographs of the anomalous ground movements associated with this fault are provided in the photographs in Fig. 4.9 and Fig. 4.10.

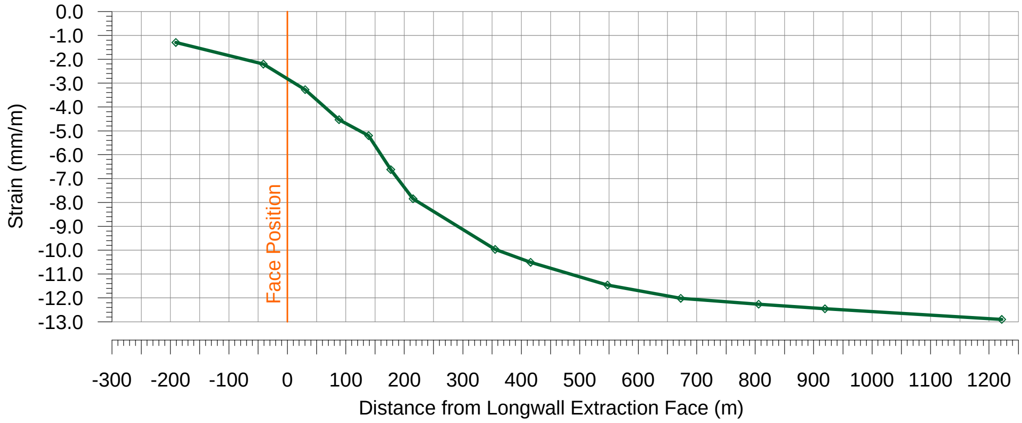

Fig. 4.8 Development of Strain at the Low Angle Thrust Fault Measured along the T-Line during the Extraction of Appin Longwall 408

Fig. 4.9 Surface Compression Humping due to Low Angle Thrust Fault

Fig. 4.10 Surface Compression Humping due to Low Angle Thrust Fault

The developments of strain at anomalies identified in the Southern Coalfield and elsewhere, excluding the low angle thrust fault discussed previously, are illustrated in Fig. 4.11. It can be seen from this figure, that the non-conventional movements develop gradually. For these cases, the maximum rate of development of anomalous strain was around 2 mm/m per week. Based on the previous experience of longwall mining in the Southern Coalfield and elsewhere, it has been found that non-conventional anomalous movements can be detected early by regular ground monitoring and visual inspections.

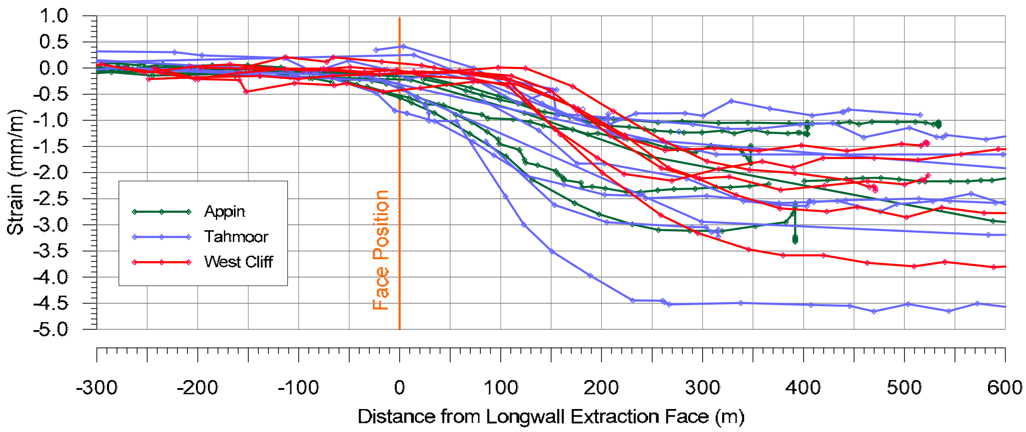

Fig. 4.11 Development of Non-Conventional Anomalous Strains in the Southern Coalfield

A study of the majority of ground survey data within the Southern Coalfield was undertaken in 2006 by MSEC. Forty-one monitoring lines were examined for anomalies, which represent a total of 58.2 kilometres of monitoring lines, and approximately 2,980 survey marks. The monitoring lines crossed over 75 longwalls. The selected lines represented all the major lines over the subsided areas, at that time, and contained comprehensive information on subsidence, tilt and strain measurements. A total of 20 anomalies were detected, of which four were considered to be significant. The observed anomalies affected 41 of the approximately 2,980 survey marks monitored. This represented a frequency of around 1.4 %.

The above estimates are based on ground survey data that crossed only a small proportion of the total surface area affected by mine subsidence. Recent mining beneath urban and semi-rural areas at Tahmoor and Thirlmere by Tahmoor Colliery Longwalls 22 to 25 provides valuable “whole of panel” information. A total of approximately 35 locations (not including valleys) have been identified over the four extracted longwalls. The surface area directly above the longwalls is approximately 2.56 km^2. This equates to a frequency of 14 sites per square kilometre or one site for every 7 hectares.

4.8. General Discussion on Mining Induced Ground Deformations

Longwall mining can result in surface cracking, heaving, buckling, humping and stepping at the surface. The extent and severity of these mining induced ground deformations are dependent on a number of factors, including the mine geometry, depth of cover, overburden geology, locations of natural jointing in the bedrock and the presence of near surface geological structures.

Faults and joints in bedrock develop during the formation of the strata and from subsequent distressing associated with movement of the strata. Longwall mining can result in additional fracturing in the bedrock, which tends to occur in the tensile zones, but fractures can also occur due to buckling of the surface beds in the compressive zones. The incidence of visible cracking at the surface is dependent on the pre-existing jointing patterns in the bedrock as well as the thickness and inherent plasticity of the soils that overlie the bedrock.

Surface cracking in soils as the result of conventional subsidence movements (i.e. away from valleys and steep slopes) is not commonly observed where the depths of cover are greater than, say 400 metres, such as the case in Appin Area 9. Surface cracking that has been observed as the result of conventional subsidence movements has generally been relatively isolated and of a minor nature.

Cracking is found more often in the bases of valleys due to the compressive strains associated with upsidence and closure movements, which is discussed in Sections 5.2 and 5.3. Cracking can also occur at the tops of steep slopes as the result of downslope movements, which is discussed in Section 5.7.

Surface cracks are more readily observed in built infrastructure such as road pavements. In many cases, no visible ground deformations can be seen in the natural ground adjacent to the cracks in the road pavements. In rare instances, more noticeable ground deformations, such as humping or stepping of the ground can be observed at thrust faults. Examples of ground deformations previously observed in the Southern Coalfield, where the depths of cover exceed 400 metres, are provided in the photographs in Fig. 4.12 to Fig. 4.15 below.

Fig. 4.12 Surface Compression Buckling Observed in a Pavement

Fig. 4.13 Surface Tension Cracking along the Top of a Steep Slope

Fig. 4.14 Surface Tension Cracking along the Top of a Steep Slope

Fig. 4.15 Fracturing and Bedding Plane Slippage in Sandstone Bedrock in the Base of a Stream

Localised ground buckling and shearing can occur wherever faults, dykes and abrupt changes in geology occur near the ground surface. The identified geological structures within the Study Area are discussed in Section 1.6. Discussions on irregular ground movements were provided in Section 4.7.

4.9. Estimated Height of the Fractured Zone

The extraction of longwalls results in deformation throughout the overburden strata. The terminology used by different authors to describe the strata deformation zones above extracted longwalls varies considerably and caution should be taken when comparing the recommendations from differing authors. Forster (1995) noted that most studies have recognised four separate zones, as shown in Fig. 4.16, with some variations in the definitions of each zone.

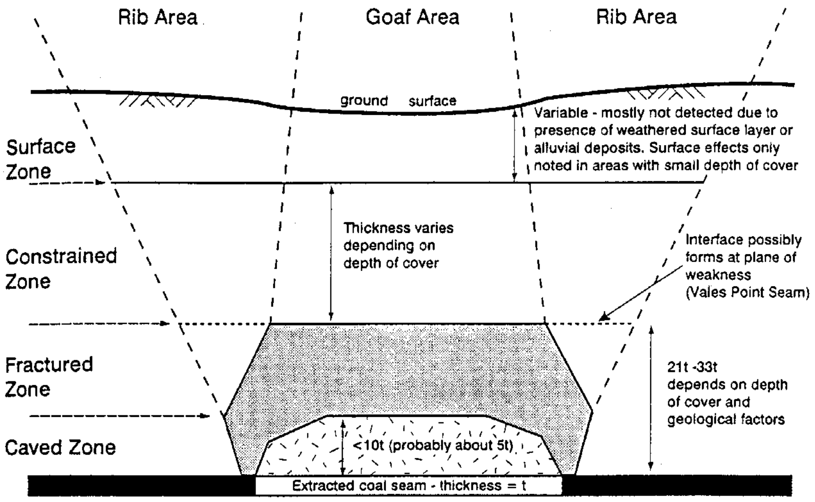

Fig. 4.16 Zones in the Overburden according to Forster (1995)

Peng and Chiang (1984) recognised only three zones as reproduced in Fig. 4.17.

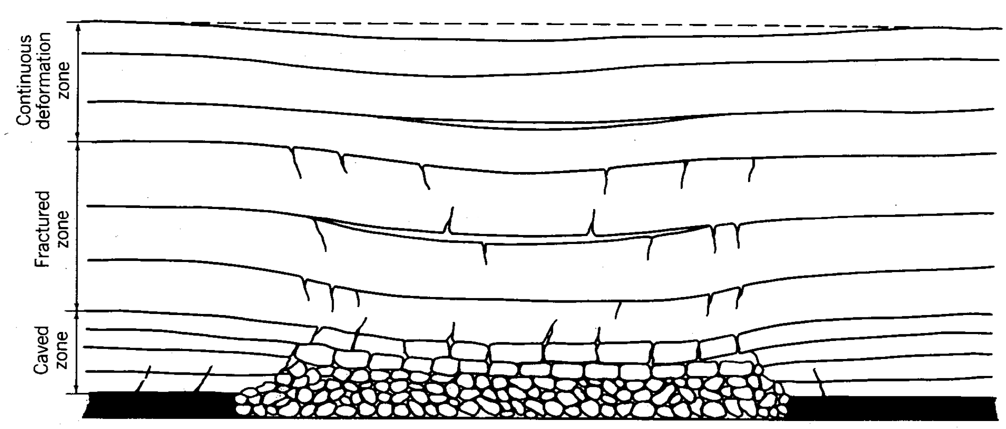

Fig. 4.17 Zones in the Overburden According to Peng and Chiang (1984)

McNally et al (1996) also recognised three zones, which they referred to as the caved zone, the fractured zone and the elastic zone. Kratzsch (1983) identified four zones, but he named them the immediate roof, the main roof, the intermediate zone and the surface zone.

For the purpose of these discussions, the following zones, as described by Singh and Kendorski (1981) and proposed by Forster (1995), as shown in Fig. 4.16, have been adopted:-

- *Caved* or *Collapsed Zone* comprises loose blocks of rock detached from the roof and occupying the cavity formed by mining. This zone can contain large voids. It should be noted, that some authors note primary and secondary caving zones.
- *Disturbed* or *Fractured Zone* comprises in-situ material lying immediately above the caved zone which have sagged downwards and consequently suffered significant bending, fracturing, joint opening and bed separation. It should be noted, that some authors include the secondary caving zone in this zone.

- *Constrained* or *Aquiclude Zone* comprises confined rock strata above the disturbed zone which have sagged slightly but, because they are constrained, have absorbed most of the strain energy without suffering significant fracturing or alteration to the original physical properties. Some bed separation or slippage can be present as well as some discontinuous vertical cracks, usually on the underside of thick strong beds, but not of a degree or nature which would result in connective cracking or significant increases in vertical permeability. Some increases in horizontal permeability can be found. Weak or soft beds in this zone may suffer plastic deformation.
- *Surface Zone* comprises unconfined strata at the ground surface in which mining induced tensile and compressive strains may result in the formation of surface cracking or ground heaving.

Just as the terminology differs between authors, the means of determining the extents of each of these zones also varies. Some of the difficulties in establishing the heights of the various zones of disturbance above extracted longwalls stem from the imprecise definitions of the fractured and constrained zones, the differing zone names, the use of different testing methods and differing interpretations of monitoring data, such as extensometer readings.

Some authors interpret the collapsed and fractured zones to be the zone from which groundwater or water in boreholes would flow freely into the mine and, hence, look for the existence of aquiclude or aquitard layers above this height to confirm whether surface water would or would not be lost into the mine.

The heights of the collapsed and fractured zones above extracted longwalls are affected by a number of factors, which include the:-

- widths of extraction,
- heights of extraction,
- depths of cover,
- types of previous workings, if any, above the current extractions,
- interburden thicknesses to previous workings,
- presence of pre-existing natural joints within each strata layer,
- thickness, geology, geomechanical properties and permeability of each strata layer,
- angle of break of each strata layer,
- spanning capacity of each strata layer, particularly those layers immediately above the collapsed and fractured zones,
- bulking ratios of each strata layer within the collapsed zone, and the
- presence of aquiclude or aquitard zones.

Some authors have suggested simple equations to estimate the heights of the collapsed and fractured zones based solely on the extracted seam height, others have suggested equations based solely on the widths of extraction, whilst others have suggested equations based on the width-to-depth ratios of the extractions. As this is a complex issue, MSEC understand that no simple geometrical equation can properly estimate the heights of the collapsed and fractured zones and a more thorough analysis is required, which should include other properties, such as geology and permeability, of the overburden strata. The following discussions provide background information and an estimation of the height of fracturing based on mining geometry only.

While there are many factors that may influence the height of fracturing and dilation, it is generally considered by various authors, e.g. Gale (ACARP C13013, 2008) and Guo et al (ACARP C14033, 2007), that an increase in panel width will generally result in an increase in the height of fracturing and dilation.

The theoretical height of the fractured zone can be estimated from the mining geometry, as being equal to the panel width (W) minus the span (w) divided by twice the tangent of the angle of break. These are illustrated in Fig. 4.18.

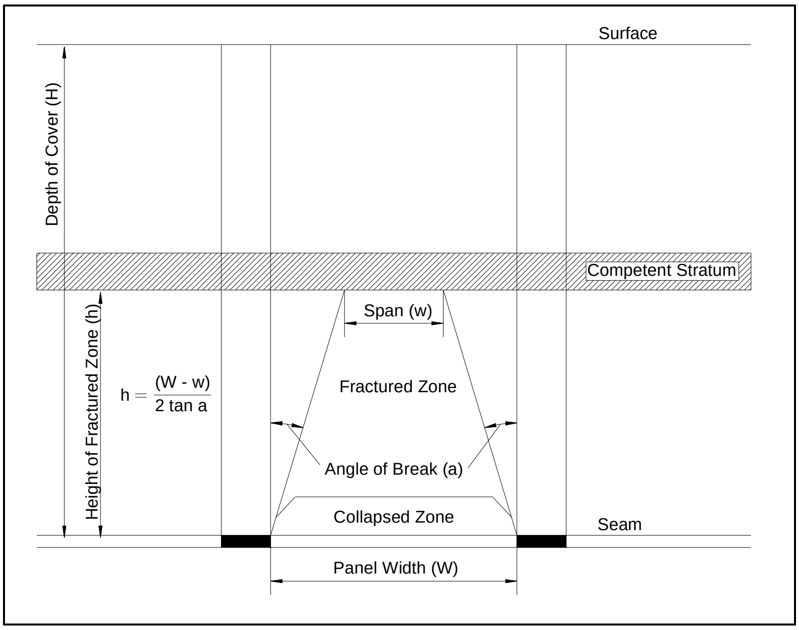

Fig. 4.18 Theoretical Model Illustrating the Development and Limit of the Fractured Zone

MSEC has gathered observed data sourced from a number of literature studies. The data points collected to date are shown in Fig. 4.19. The data points are compared with the results of the theoretical model developed by MSEC, using an angle of break of 20 degrees and spanning width of 30 metres. The results are also compared with lines representing factors of 1.0 times and 1.5 times the panel width, which was suggested by Gale (2008).

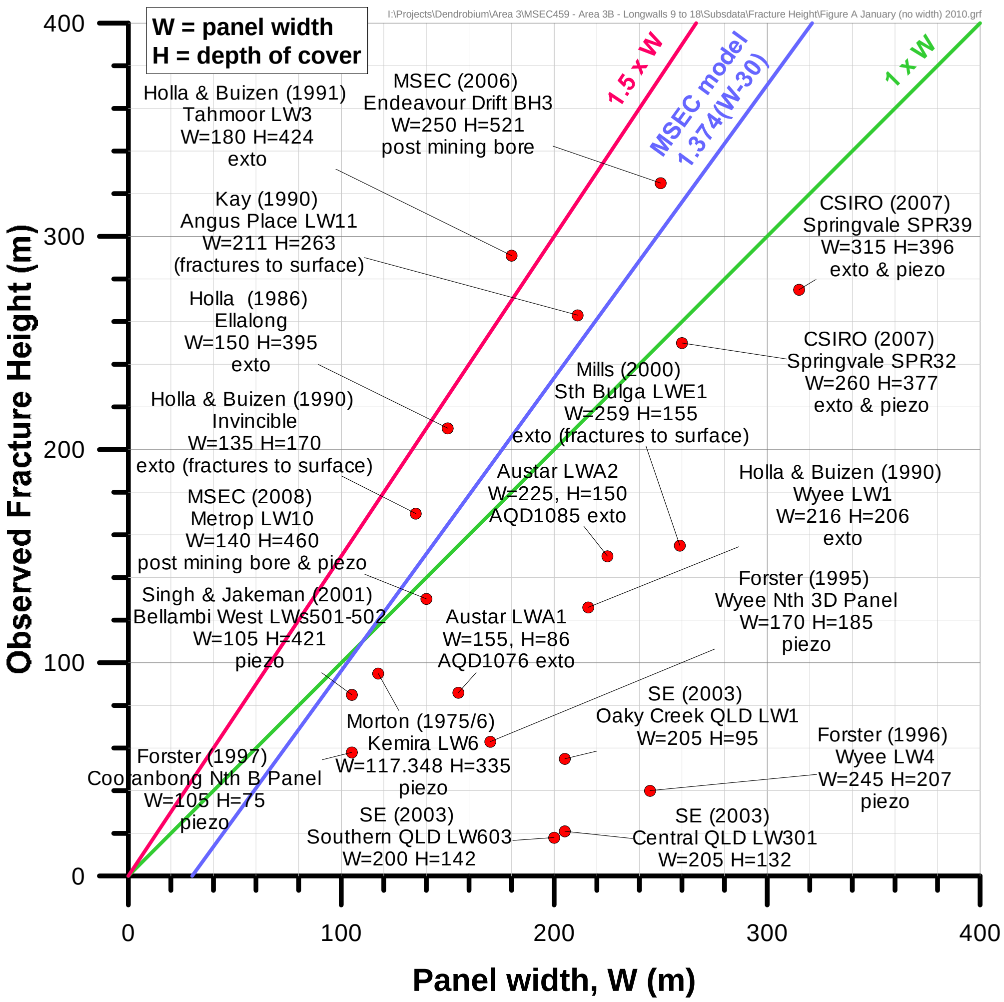

Fig. 4.19 Observed Fracture Heights versus Panel Width

It can seen from Fig. 4.19, that the MSEC model and Gale's suggested factors of 1.0 and 1.5 provide similar estimates for the height of fracturing based on panel width. As described previously, however, it is necessary to undertake a more detailed review of the site specific geology and permeability before determining whether these heights are reasonable for this site.

In the Southern Coalfield, the upper layers in the overburden strata are relatively strong sandstones. These sandstone strata are particularly strong and would be expected to be capable of spanning at least 30 metres. If an average angle of break of 20 degrees is assumed, with an extracted panel width of 305 metres, then a height of 375 metres would be required above the seam to reduce the effective span to 30 metres. If an angle of break of 23 degrees is assumed, then a height of 325 metres would be required above the seam to reduce the effective span to 30 metres.

The depth of cover directly above the proposed longwalls varies between 490 metres and 725 metres and, therefore, it is unlikely that the fractured zone would extend up to the surface. It is expected that a *Constrained Zone* or *Continuous Deformation Zone* would occur between the fractured zone and the surface, as illustrated in Fig. 4.16 and Fig. 4.17, if the local geology is suitable.

It is noted, that the height of fracturing, based on significant bed separation and vertical dilation, measured by extensometers, does not imply that vertical permeability has increased. It simply means that bed separation and horizontal permeability has increased. The height of fracturing based on this approach may include part of the constrained zone, as defined by Forster (1995), which is shown in Fig. 4.16.

The constrained zone comprises confined rock strata which have sagged slightly, but, because they are constrained, have absorbed most of the strain energy without suffering significant fracturing or alteration to the original physical properties. Some bed separation or slippage can be present as well as discontinuous vertical cracks (usually on the underside of thick strong beds). Weak or soft beds in this zone may suffer plastic deformation.

5.0 DESCRIPTIONS, PREDICTIONS AND IMPACT ASSESSMENTS FOR THE NATURAL FEATURES WITHIN THE STUDY AREA

The following sections provide the descriptions, predictions and impact assessments for the natural features within the Study Area. The natural features located outside the Study Area, which may be subjected to far-field movements or valley related movements and may be sensitive to these movements, have also been included as part of these assessments.

5.1. Catchment Areas and Declared Special Areas

There are no drinking water catchment areas, or declared special areas within the Study Area.

5.2. The Nepean River

The location of the Nepean River is shown in Drawing No. MSEC448-07 and the major stream features are shown in Drawing Nos. MSEC448-08 to MSEC448-11. The descriptions, predictions and impact assessments for the river are provided in the following sections.

5.2.1. Description of the Nepean River

The Nepean River is part of the Hawkesbury-Nepean River system which begins in the uplands west of Wollongong and flows northward past Camden to its junction with the Warragamba River near Wallacia, where it becomes part of the Hawkesbury River. The total length of the Nepean River is approximately 145 kilometres.

It can be seen from Drawing No. MSEC448-07, that the proposed longwalls do not directly mine beneath the river. A summary of the minimum distance of the Nepean River from each of the proposed longwalls is provided in Table 5.1.

Table 5.1 Minimum Distances of the Proposed Longwalls from the Nepean River

Longwall	Minimum Distance from the Centreline of River (m)	Minimum Distance from the Closest Bank of River (m)*
LW901	130	125
LW902	280	270
LW903	630	620
LW904	980	970

Note: * denotes that the banks of the Nepean River were determined from the 2009 airborne laser scan and are shown in Drawing Nos. MSEC440-08 to MSEC440-11.

The total length of the Nepean River within the Study Area, which is defined by the 35 degree angle of draw line and the predicted total 20 mm subsidence contour, is 1.1 kilometres. The total length of the river within the predicted limits of 20 mm total upsidence and 20 mm total closure is approximately 2.7 kilometres.

The river is a perennial stream with water derived from the licensed discharges of the Upper Nepean Dams, comprising the Cataract, Cordeaux, Avon and Nepean Dams. The flow in the section of river within the Study Area is controlled by the Maldon Weir, which is located approximately 5 kilometres south-west of the proposed longwalls. This section of the Nepean River within the Study Area does not form part of a *Drinking Water Catchment Area* and is not a *Declared Special Area*.

Historical flows have been recorded by the Sydney Catchment Authority (SCA) at both the upstream Maldon Weir and the downstream Menangle Weir. The water flow recorded at these weirs, between January 1990 and January 2010, is illustrated in Fig. 5.1.

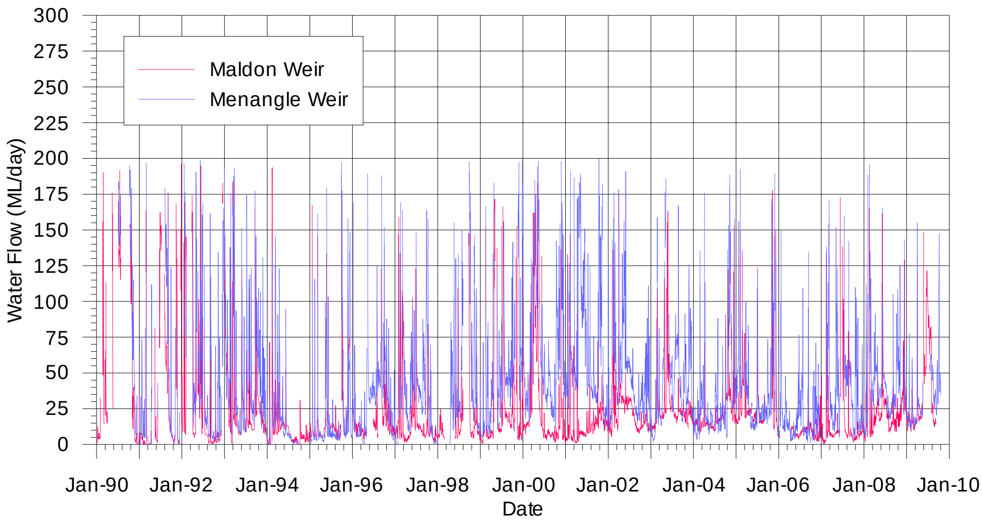

Fig. 5.1 Water Flows Recorded at Maldon and Menangle Weirs (between the January 1990 and the January 2010)

The distributions of the water flows at the weirs are illustrated in Fig. 5.2. The water flows measured at the Maldon Weir during this period typically varied between 3 ML/day and 50 ML/day, with an average water flow of around 25 ML/day. The water flows measured at the Menangle Weir during this period typically ranged between 5 ML/day and 100 ML/day, with an average water flow of 40 ML/day.

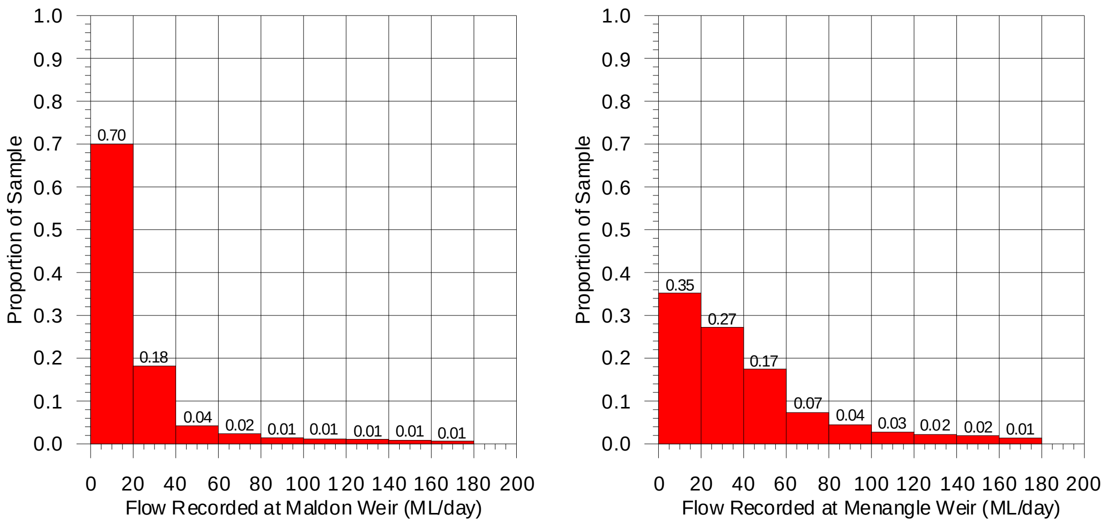

Fig. 5.2 Distribution of Water Flow at Maldon Weir (Left) and Menangle Weir (Right)

The difference in the water flow rates between Maldon and Menangle Weirs can be explained by the number of sources of additional flow that enter the river between the weirs. These include flows from the Cataract River and other drainage lines, licensed discharge flows from Appin Colliery and flows from other catchment areas. The water flows in the Nepean River within the Study Area, therefore, is somewhere between those measured at Maldon and Menangle Weirs.

The Nepean River valley within the Study Area is up to 60 metres high and is steeply sided, comprising cliffs and talus slopes in a number of locations. The descriptions of the cliffs and steep slopes within the Nepean River valley are included in Sections 5.5 and 5.7, respectively. Cross-sections through the valley are provided in Fig. 5.3 to Fig. 5.7, the locations of which are indicated in Drawing No. MSEC448-07.

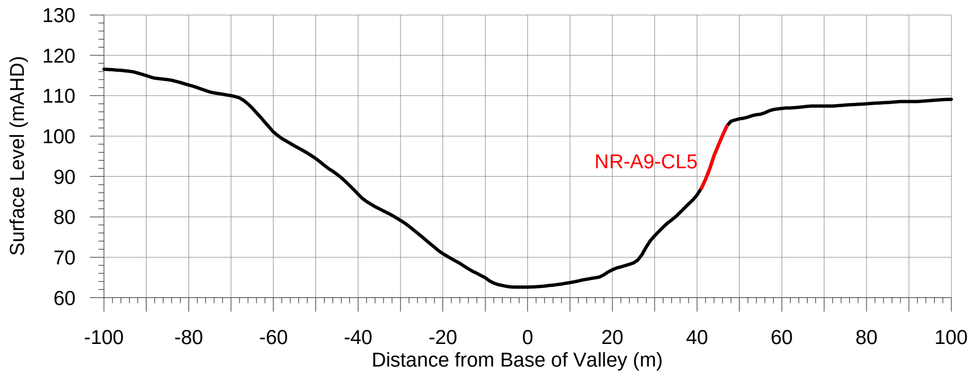

Fig. 5.3 Nepean River Cross-section 1 (Looking West)

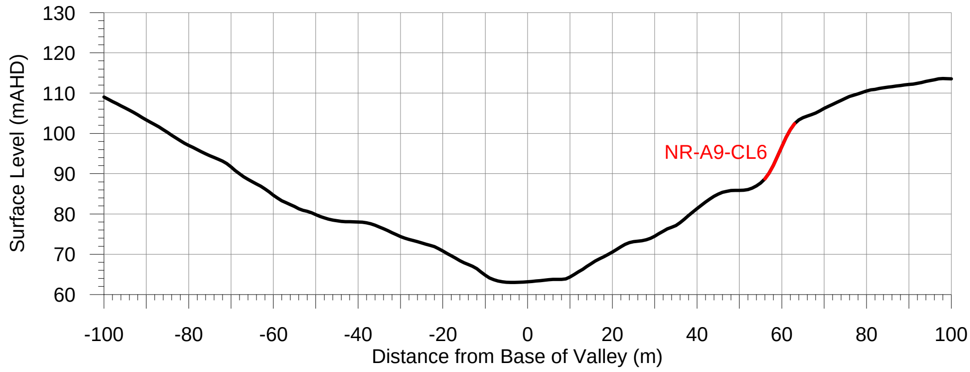

Fig. 5.4 Nepean River Cross-section 2 (Looking West)

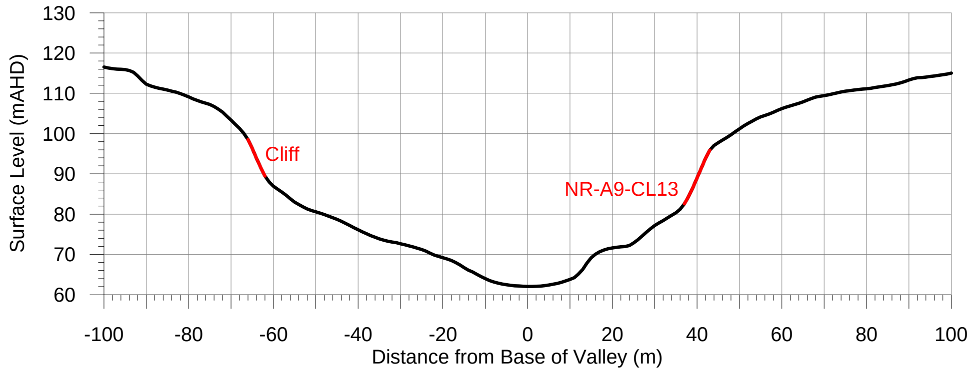

Fig. 5.5 Nepean River Cross-section 3 (Looking West)

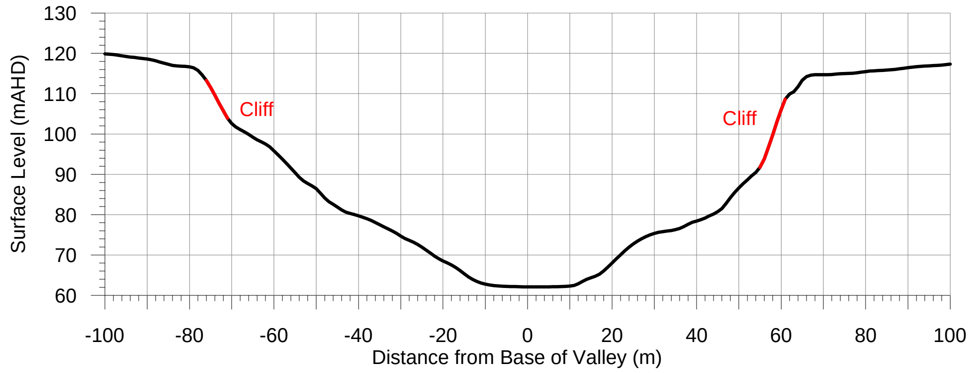

Fig. 5.6 Nepean River Cross-section 4 (Looking West)

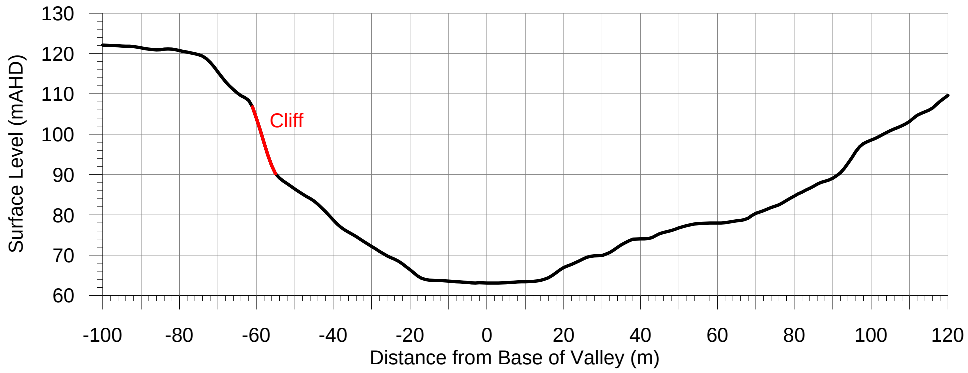

Fig. 5.7 Nepean River Cross-section 5 (Looking East)

The bed of the Nepean River comprises Hawkesbury Sandstone overlain by fluvial sediment. The river within the Study Area has been characterised into two sections, the upper *Section 1*, where the surface water flows are controlled by stream features including boulder fields and rockbars and, the lower *Section 2*, where the river is a flooded valley controlled by the Douglas Park Weir. The extents of these sections are shown in Drawing No. MSEC448-07 and further descriptions are provided below.

Section 1

The Nepean River Section 1 is the stretch of river upstream of Allens Creek. The controlling features along this section of the river are shown in Drawing Nos. MSEC448-08 to MSEC448-11 and are described in Table 5.2.

Table 5.2 Controlling Features in Section 1 of the Nepean River

Label	Type	Location
NR-A9-BF01	Boulder Field	470 metres south-west of LW902
NR-A9-BF02	Boulder Field	390 metres south-west of LW902
NR-A9-BF03	Boulder Field	370 metres south-west of LW902
NR-A9-RB01	Rockbar	370 metres south-west of LW902
NR-A9-BF04	Boulder Field	340 metres south-west of LW902
NR-A9-BF05	Boulder Field	290 metres south of LW902
NR-A9-RB02	Rockbar (Submerged at time of field inspection)	280 metres south of LW902
NR-A9-BF06	Boulder Field	220 metres west of LW901
NR-A9-BF07	Boulder Field	150 metres west of LW901
NR-A9-WR01	Small Weir	130 metres south-west of LW901
NR-A9-BF08	Boulder Field	130 metres south-west of LW901
NR-A9-BF09	Boulder Field	170 metres south of LW901
NR-A9-BF10	Boulder Field	190 metres south of LW901
NR-A9-BF11	Boulder Field	290 metres south of LW901
NR-A9-BF12	Boulder Field	380 metres south of LW901

It can be seen from the above table, that the majority of the controlling features along Section 1 of the river are boulderfields. There are two rockbars identified within the Study Area, which are located at distances of 370 metres and 280 metres from the proposed longwalls. There is also a very small weir which has been constructed near boulderfield NR-A9-BF08.

Photographs of some of these stream features are provided in Fig. 5.8 to Fig. 5.11.

Fig. 5.8 Photographs of Boulder Fields NR-A9-BF3 (Left) and NR-A9-BF5 (Right)

Fig. 5.9 Photographs of Pool and Isolated Boulders Downstream of NR-A9-BF5

Fig. 5.10 Photograph of Rockbar NR-A9-RB02 (Submerged at the Time of the Field Inspection)

Fig. 5.11 Photograph of Small Weir NR-A9-WR01

Section 2

The Nepean River Section 2 is the stretch of river downstream of Allens Creek. This section of river is a flooded valley, with the surface water level regulated by the Douglas Park Weir, which is located approximately 900 metres south of the proposed Longwall 901. The crest of the weir is at approximately RL 60.994 mAHD. A photograph of Section 2 of the river is provided in Fig. 5.12.

Fig. 5.12 Photograph of a Typical Stretch of the Nepean River Section 2 within the Study Area

5.2.2. Predictions for the Nepean River

The predicted profiles of subsidence, upsidence and closure along the Nepean River, resulting from the extraction of the proposed longwalls, are shown in Fig. E.02, in Appendix E. The predicted incremental profiles, due to the extraction of each of the proposed longwalls, are shown as dashed black lines. The predicted total profiles, after the extraction of each of the proposed longwalls, are shown as solid blue lines.

A summary of the maximum predicted values of total subsidence, upsidence and closure along the river, after the extraction of each of the proposed longwalls, is provided in Table 5.3.

Table 5.3 Maximum Predicted Total Subsidence, Upsidence and Closure at the Nepean River Resulting from the Extraction of the Proposed Longwalls

Location	Longwall	Maximum Predicted Subsidence (mm)	Maximum Predicted Upsidence (mm)	Maximum Predicted Closure (mm)
Nepean River	After LW901	30	50	120
	After LW902	30	90	170
	After LW903	30	100	190
	After LW904	30	110	200

The profile of the equivalent valley height used to determine the predicted valley related upsidence and closure movements along the Nepean River is shown in Fig. E.02, which is the height of the valley within a half depth of cover of the valley base. The proposed longwalls do not directly mine beneath the river and the section of river within the Study Area has not been previously mined beneath. For this reason, a solid coal factor of 0.7 has been used in calculating the predicted valley related upsidence and closure movements, which is discussed in Section 3.4.3.

A summary of the maximum predicted values of total subsidence, upsidence and closure at the mapped features along the Nepean River, resulting from the extraction of the proposed longwalls, is provided in Table 5.4.

Table 5.4 Maximum Predicted Total Subsidence, Upsidence and Closure at the Mapped Features along the Nepean River Resulting from the Extraction of the Proposed Longwalls

Location	Longwall	Maximum Predicted Subsidence (mm)	Maximum Predicted Upsidence (mm)	Maximum Predicted Closure (mm)
NR-A9-BF01	After LW904	< 20	30	40
NR-A9-BF02	After LW904	< 20	40	60
NR-A9-BF03	After LW904	< 20	50	80
NR-A9-RB01	After LW904	< 20	50	80
NR-A9-BF04	After LW904	< 20	60	90
NR-A9-BF05	After LW904	< 20	90	150
NR-A9-RB02	After LW904	30	110	190
NR-A9-BF06	After LW904	30	110	200
NR-A9-BF07	After LW904	< 20	100	190
NR-A9-BF08	After LW904	< 20	90	170
NR-A9-BF09	After LW904	< 20	90	150
NR-A9-BF10	After LW904	< 20	80	140
NR-A9-BF11	After LW904	30	80	140
NR-A9-BF12	After LW904	< 20	60	130

5.2.3. Comparison of Predictions for the Nepean River with those provided in the Part 3A Application

The comparison of the maximum predicted subsidence parameters for the Nepean River with those provided in the Part 3A Application is provided in Table 5.5.

Table 5.5 **Comparison of the Maximum Predicted Conventional Subsidence Parameters for the Nepean River**

Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Upsidence (mm)	Maximum Predicted Total Closure (mm)
Part 3A Layout (Report No. MSEC404)	30	175	190
Extraction Plan Layout (Report No. MSEC448)	30	110	200

It can be seen from the above table, that the maximum predicted subsidence along the Nepean River, based on the Extraction Plan Layout, is similar to the maximum predicted based on the Part 3A Layout. The maximum predicted upsidence is less and the maximum predicted closure is similar to, but slightly greater than the maximum predicted based on the Part 3A Layout.

5.2.4. Overview of the Previous Longwall Mining near and beneath the Nepean River

Longwall mining has previously occurred in the vicinity as well as directly beneath the Nepean River. Tower Longwalls 15 to 20 and Appin Longwalls 701 to 703 have been extracted near the river downstream of the Study Area. At the time of this report, Appin Longwall 704 was also being extracted in Appin Area 7. The locations of these longwalls relative to the Nepean River are shown in Fig. 5.13.

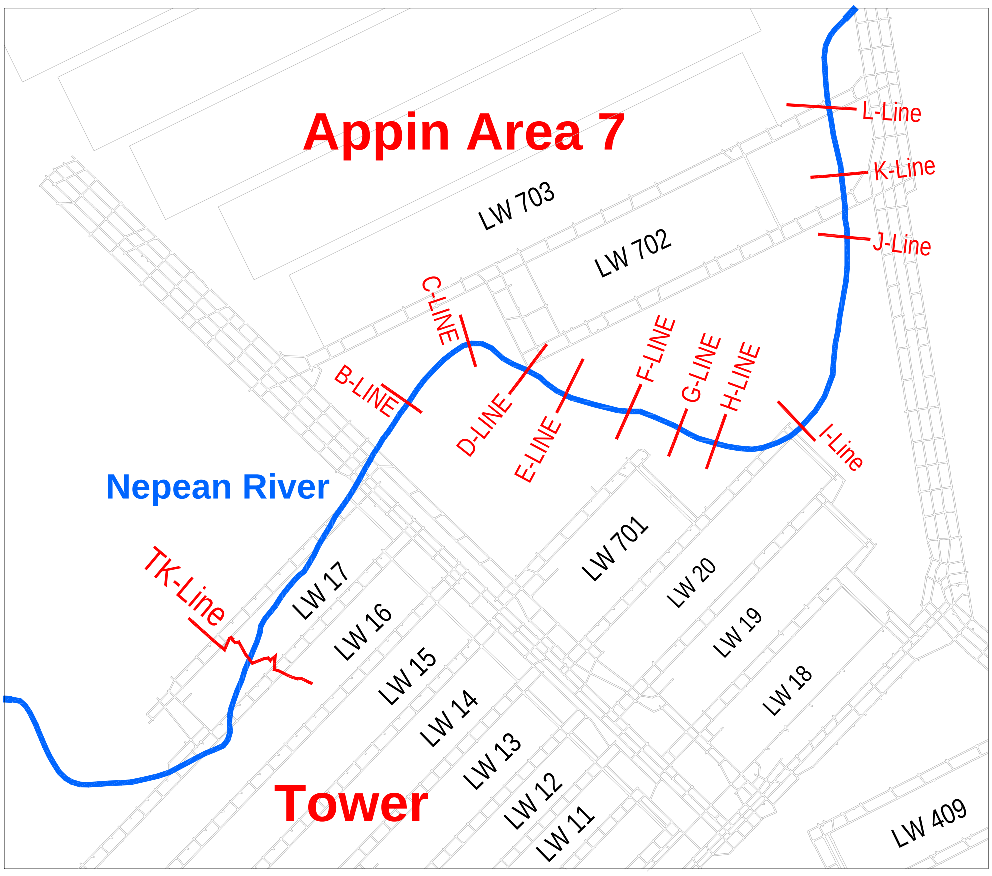

Fig. 5.13 Locations of Previous Longwall Mining Near the Nepean River

It can be seen from the above figure, that Tower Longwall 17 and part of Tower Longwall 16 were extracted directly beneath the river, whilst the remaining longwalls were extracted near the river. A summary of the minimum distance of the Nepean River from each of the previously extracted longwalls is provided in Table 5.6.

Table 5.6 Minimum Distances of the Previously Extracted Longwalls from the Nepean River

Longwall	Location Relative to Nepean River (m)
Tower LW16	160 metres of river directly mined beneath
Tower LW17	800 metres of river directly mined beneath
Tower LW20	Mined up to but not directly beneath the river
Appin LW701	Minimum distance of 200 metres from the centreline of the river
Appin LW702	Minimum distance of 175 metres from the centreline of the river

The movements in the Nepean River valley were measured along the TK-Line during the extraction of Tower Longwall 17 beneath the river. A summary of the maximum observed and maximum predicted movements at the river, resulting from the extraction of this longwall, is provided in Table 5.7.

Table 5.7 Observed and Predicted Movements at the Nepean River Resulting from the Previous Extraction of Tower Longwall 17

Parameter	Maximum Observed (mm)	Maximum Predicted (mm)
Net Vertical Movement	25 (Uplift)	90 (Uplift)
Upsidence	275	310
Closure	320	240

The movements in the Nepean River valley were measured along the B-Line to L-Line during the extraction of Appin Longwalls 701 to 703 near the river. A summary of the maximum observed and maximum predicted movements along the river, resulting from the extraction of these longwall, is provided in Table 5.8.

Table 5.8 Observed and Predicted Movements at the Nepean River Resulting from the Previous Extraction of Appin Longwalls 701 to 703

Parameter	Maximum Observed (mm)	Maximum Predicted (mm)
Subsidence (along CL of river)	< 20	< 20
Upsidence	79	185
Closure	163	305

It should be noted, that the B-Line to L-Line do not extend up the full height of the Nepean River valley and, therefore, the measured upsidence and closure movements could be less than the actual maximum movements in these locations.

It can be seen from Table 5.7 and Table 5.8, that the observed movements were similar to or less than those predicted as the result of the previous extractions of Tower Longwall 17 and Appin Longwalls 701 to 703.

There were no visible fractures or surface water diversions reported in the Nepean River as a result of the previous extraction of longwalls at Tower and Appin Collieries. There were, however, a number of temporary gas release zones observed, which may indicate the reactivation of existing fracturing or additional fracturing in the river bed has occurred below the water level. Temporary iron staining was also reported in the Nepean River and Elladale Creek, a tributary to the river, as a result of the previous longwall mining.

A summary of the previously reported impacts along the Nepean River is provided in Table 5.9. The locations of these impacts are illustrated in Fig. 5.14.

Table 5.9 Reported Impacts along the Nepean River Resulting from the Previous Extraction of Longwalls at Tower and Appin Collieries

Longwall	Reported Impacts
Tower LW16 and LW17	Temporary gas release zones, primarily where the river was directly mined beneath, with isolated gas release outside the extracted longwall
Tower LW18 to LW20	Temporary gas release zone in the location where Longwall 20 mined up to the river
Appin LW701	Four temporary gas release zones and one minor iron stain
Appin LW702	Two additional temporary gas release zones and the temporary reactivation of an existing gas release zone previously observed during Longwall 701.
Appin LW703	Four additional temporary gas release zones and the temporary reactivation of three existing gas release zones observed during Longwall 702.

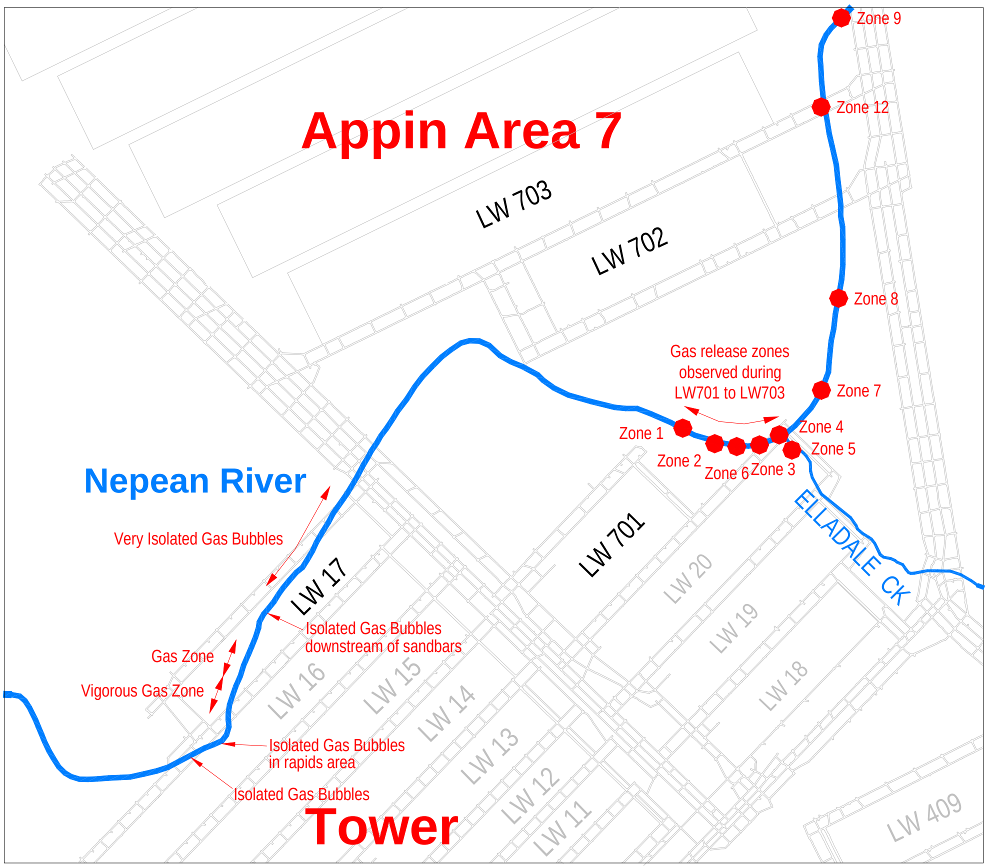

Fig. 5.14 Locations of Reported Impacts along the Nepean River

5.2.5. Impact Assessments for the Nepean River

The impact assessments for Nepean River are provided in the following sections. The assessments provided in this report should be read in conjunction with the assessments provided in the reports by *Ecoengineers* (2012), *Cardno Ecology Lab* (2012) and *Biosis* (2012a).

Potential for Changes in the Surface Water Levels

The surface water levels in Section 1 of the river are controlled by the restricting stream features, which generally comprise boulder fields, but also includes two rocks bars and a small weir.

The maximum predicted subsidence and upsidence in Section 1 are 30 mm and 110 mm, respectively. The predicted net vertical movements are small when compared with the hydraulic drop along this section of river, which is approximately 1 metre between NR-A9-BF01 and NR-A9-BF12. The changes in water level in this section of the river, resulting from the extraction of the proposed longwalls, are small in comparison with the changes during flood conditions and, therefore, are not expected to result in any measurable impact.

The surface water levels in Section 2 of the river are controlled by the downstream Douglas Park Weir. The maximum predicted subsidence and upsidence at the weir are both less than 20 mm and, therefore, are not significant. It is unlikely, therefore, that there would be any significant change in the surface water level in this section of the river resulting from the extraction of the proposed longwalls.

Whilst the surface water level in Section 2 is not expected to change, the levels of the river bed and banks could change as a result of the predicted movements. The maximum predicted subsidence and upsidence in Section 2 are less than 20 mm and 70 mm, respectively. The predicted movements are small when compared with the change in bed level along this section of river, which is approximately 4 metres between Allens Creek and the Douglas Park Weir and, therefore, are not expected to result in any measurable impact.

Potential for Increased Levels of Ponding, Flooding and Scouring of the River Banks

Longwall mining can potentially result in increased levels of flooding or scouring of the stream banks in the locations where the mining induced tilts considerably increase the natural stream gradients. Longwall mining can also potentially result in increased levels of ponding in the locations where the mining induced tilts considerably decrease the natural stream gradients. The potential for these impacts are dependent on the magnitudes and locations of the mining induced tilts, the natural stream bed gradients, as well as the depth, velocity and rate of surface water flows.

The maximum predicted tilt along the alignment of the Nepean River, resulting from the extraction of the proposed longwalls, is less than 0.2 mm/m (i.e. < 0.1 %), which represents a change in grade of less than 1 in 5,000. The average natural gradients along the river within the Study Area are around 1 mm/m to 2 mm/m, which represent natural grades of 1 in 1,000 to 1 in 500.

The predicted changes in grade are small when compared to the existing natural grades along the alignment of the Nepean River. It is unlikely, therefore, that there would be any significant changes in the levels of ponding, flooding or scouring of the river banks resulting from the extraction of the proposed longwalls.

Potential for Changes in Stream Alignment

Longwall mining can potentially result in changes in stream alignment as the result of mining induced cross-bed tilts. The potential for mining-induced changes in the stream alignment depends upon the magnitudes and locations of the mining induced cross-bed tilts, the natural stream cross-bed gradients, as well as the depth, velocity and rate of surface water flows. Changes in stream alignment can potentially impact upon riparian vegetation, or result in increased scouring of the stream banks.

The maximum predicted conventional tilt across the alignment of the Nepean River, resulting from the extraction of the proposed longwalls, is less than 0.5 mm/m (i.e. < 0.1 %), which represents a change in cross-grade of less than 1 in 2,000. The predicted maximum change in cross-gradient for the river is very small and is unlikely, therefore, to result in any significant changes in stream alignment.

The predicted changes in the cross-bed gradients are small and are expected to be an order of magnitude less than the natural stream cross-bed gradients. The potential impacts associated with changes in the stream alignment, resulting from the extraction of the proposed longwalls are, therefore, not expected to be significant.

The potential impacts of the changes in stream alignment are expected to be minor when compared to the changes in the surface water flow depths and widths that occur during natural flooding events. In the locations where the stream beds comprise sediments and deposited debris, rainfall events can result in changes in the stream alignment. In a large storm event, rocks and vegetation can be carried away downstream. The increased flow velocities in such events are likely to be an order of magnitude greater than those resulting from mining induced changes to bed gradients.

Potential for Fracturing in the River Bed

Fractures and joints in bedrock occur naturally during the formation of the strata and from erosion and weathering processes, which include natural valley bulging movements.

When longwall mining occurs in the vicinity of streams, mine subsidence movements can result in additional fracturing or reactivation of existing joints. A number of factors are thought to contribute to the likelihood of mining-induced fracturing and these are listed below:-

- Mining-related factors, which affect the level of mining-induced ground movements in the valley. These include, amongst other factors, the depth of cover and proximity of the mining to the stream, panel width and extracted thickness and geology of the overburden,
- Topographic factors associated with the stream valley, which include valley depth, valley width and the shape and steepness of the valley sides,
- Local, near-surface geological factors, which include alluvial deposit thickness, bedrock lithology such as rock strength, thickness of beds within the strata, orientation and dip of strata, degree of cross-bedding and existing jointing,
- In-situ horizontal stresses in the bedrock, and
- Presence of deep alluvial deposits covering the bedrock.

Monitoring of stream beds affected by longwall mining indicates that mining-induced fractures in bedrock are greatest in size and number directly above the extracted longwalls. Where mining has occurred close to but not directly beneath streams, a smaller number of mining-induced fractures were observed in the bedrock. These fractures are generally only be visible when the bedrock is exposed. The level of pre-existing stress in the valley bedrock varies depending on its position in the natural erosive cycle and the level of regional stress that has been imposed on it. The bedrock strength varies along the streams depending on the type of rock, its layer thickness and extent of natural joints and fractures.

In this case, Longwalls 901 to 904 are not proposed to be extracted directly beneath the Nepean River. The proposed longwalls are located at a distance of 130 metres from the centreline of the river, at their closest point. Away from this location, the majority of the river within the Study Area is located at distances more than 250 metres from the proposed longwalls. Historical observations indicate that, at these distances, only isolated and minor fracturing is expected to occur in the bed of the river.

This is supported by the fact that there were no reported visible fractures in the bed of the Nepean River resulting from the extraction of Tower Longwalls 15 and 20 or from Appin Longwall 701 to 703. There were, however, a number of temporary gas release zones, which indicates that the reactivation of existing fracturing or additional fracturing is likely to have occurred in the river bed below the water level. These observations include a monitoring site that was located directly above Tower Longwall 17, which mined directly beneath the river for a length of approximately 800 metres.

Whilst fracturing has been previously observed in the beds of the Cataract, Georges and Bargo Rivers, the extent of fracturing was significantly reduced in the sections of river where the longwalls were set back and not directly mined beneath the river valleys. Examples of this include:-

- Minor fracturing was observed in six locations along the lower Cataract River where Appin Area 4 longwalls were mined adjacent to but not directly beneath the river. The fractures were observed primarily off the end of Longwall 405 which was mined to within approximately 25 metres from the centreline of the river.
- Minor fracturing was observed in 15 locations along the upper Cataract River where Appin Area 3 longwalls were mined adjacent to but not directly beneath the river. The fractures were observed primarily off the side of Longwall 301, which was located at a minimum distance of 100 metres from the centreline of the river. Fracturing was also observed off the ends of Longwalls 301 and 302, which were located at a minimum distance of 90 metres from the centreline of the river.
- Minor fracturing was observed along the Georges River where West Cliff Longwalls 29, 31 and 32 were mined up to but not directly beneath the river. More significant fracturing was observed in the river, however, where Longwall 33 mined up to the edge of the river.

The furthest distance of an observed fracture from longwall mining was at the base of Broughtons Pass Weir, which was located approximately 415 metres from Appin Longwall 401. Another minor fracture was also recorded in the upper Cataract River, approximately 375 metres from Appin Longwall 301. This fracture occurred in a large rockbar, which was formed in thinly bedded sandstone, which had experienced movements from nearby previously extracted longwalls.

It is expected, that any fracturing that occurs in the bed of the Nepean River, resulting from the extraction of the proposed longwalls, will be isolated and minor in nature. Fractures may be visible within the base of the river valley in exposed areas of bedrock, or be inferred from the emission of gas bubbles in the river. The likelihood of fracturing is very low for bedrock that is located beyond the predicted limit of subsidence, although some minor fracturing may occur up to or beyond approximately 400 metres from the proposed longwalls.

Potential for Loss or Diversion of Surface Water Flows

The majority of the controlling stream features in Section 1 of the Nepean River are boulder fields, which are less susceptible to fracturing than rockbars, as they are not vertically confined. There are only two rockbars which have been identified within the Study Area. Rockbar NR-A9-RB01 is located 370 metres from the proposed longwalls and, therefore, any fracturing in this location is expected to be isolated and minor in nature. Rockbar NR-A9-RB02 was submerged at the time of the field inspection and, therefore, does not restrict the surface water flows at times of high flow (i.e. does not control the upstream pool).

The potential for the diversion of surface water in Section 2 of the Nepean River is very low as the river bed is flooded and the gradient of the river is very flat. This is supported by the fact that there has been no reported or no observed loss of surface water as a result of previous longwall mining near and directly beneath the Nepean River by Tower Longwalls 15 to 20 and Appin Longwalls 701 to 703. This includes observations at a monitoring site that was located directly above Tower Longwall 17, which mined directly beneath the river for a length of approximately 800 metres.

The extraction of the proposed longwalls could result in the uplift and dilation of the bedrock in the base of the Nepean River. It has been observed in the past, that the depth of dilation of the uppermost bedrock, resulting from valley related movements, is generally less than 10 metres to 15 metres (SCT, 2003 and Mills and Huuskes, 2004). As the Nepean River is a flooded valley, the dilated strata is likely to be immediately filled by water. The volume of water that fills these voids is a small proportion of the total volume of the surface water flow and represents a one-off and minor increase in the stored water in the river system.

The potential for infiltration of water into the groundwater system is very low as the Nepean River represents the regional low point in the water table. Further detailed discussions on the potential for this form of flow diversion are provided in the reports by *Ecoengineers* (2012) and *Geoterra* (2012).

The potential for loss of surface water into the mine is also unlikely due to the depth of cover, the offsets of the longwalls in relation to the river and the presence of various finely grained shale and claystone layers, such as the Bald Hill Claystone, which act as aquitards. Various studies have been undertaken to determine appropriate depths of cover and layouts for mining to safely occur beneath stored waters, including the Inquiry into Coal Mining under Stored Water by Justice Reynolds in 1977.

Following careful mine planning and rigorous assessments and approvals by the Dams Safety Committee (DSC), the Sydney Catchment Authority (SCA) and DTIRIS, mining has successfully occurred beneath various stored waters in the Southern Coalfield. Intensive monitoring of mining beneath or near the Cataract, Cordeaux, Woronora, Avon and Brennans Creek Storages indicate that no adverse impacts have occurred.

It is therefore assessed that the potential for surface water flow diversions to occur as a result of the extraction of the proposed longwalls is very low. In addition, even if flow diversions were to occur, there would be negligible environmental consequence on surface water flows for the following reasons:-

- It is assessed that only isolated and minor fracturing would occur along the river,
- There are substantial surface water flows along the river, i.e. average of 25 ML/day at Maldon Weir,
- The majority of the controlling features along Section 1 of the river are boulderfields, with only two rockbars identified within the Study Area, and
- Section 2 of the river is a flooded valley.

Further detailed discussions on the consequences of changes in the surface water flows are provided in the reports by *Ecoengineers* (2012) and *Geoterra* (2012).

Potential for Ground Water Inflows

There are no identified natural springs along the Nepean River within the Study Area, although it is likely that some seepage occurs into the river. Although the proposed longwalls do not mine directly beneath the Nepean River, it is possible that mining-induced springs could develop following the extraction of the proposed longwalls. The chemical characteristics of mining-induced springs near previously mined longwalls in the Southern Coalfield suggest that the water passes through upland Wianamatta Shale areas and permeates through natural or mining-induced fractures or joints in the Hawkesbury Sandstone before emerging in the valley (*Ecoengineers*, 2012).

Vertical dilation between the Wianamatta Shale and Hawkesbury Sandstone is possible along the tributaries to the Nepean River, particularly if the thickness of the shale is less than 10 metres to 15 metres, since field studies suggest that vertical dilation in creeks and rivers extend, as a maximum, to this depth (Mills and Huuskes, 2004). The confluences of the tributaries which flow into the Nepean River is not directly mined beneath and, in these locations, the vertical dilation is expected to be small. The upper reaches of these tributaries, however, are directly mined beneath by the proposed longwalls.

Further discussions on the potential impacts of groundwater inflows and springs are provided in a report by *Ecoengineers* (2012).

Potential for Gas Emissions

It is known that mining results in changes in stress and the fracturing of the strata above the extraction area and this may result in the liberation of methane and other gases. Gas emissions have typically occurred within river valleys, although gas emissions have also been observed in creeks and water bores. Emissions are most noticeable in the form of bubbles in the water. In recent experience, where mining has been set back from the streams, the observed gas bubbles were not capable of sustaining a flame if lit.

Gas emissions typically occur in isolated locations and the majority of gas emissions occur in areas that are directly mined beneath. These emissions are also typically the most vigorous. However, gas emissions have occurred in areas that have not been directly mined beneath.

Gas release zones were reported during the previously extracted Longwalls 15 to 20 at Tower Colliery and Longwalls 701 to 704 at Appin Colliery. The locations of these gas release zones are shown in Fig. 5.14. It is likely, therefore, that mining-induced gas emissions will also be observed during the extraction of the proposed Longwalls 901 to 904. A photograph of gas emissions observed in the Nepean River during the extraction of Appin Longwall 701 is shown in Fig. 5.15.

Fig. 5.15 Photograph of Recent Gas Emissions in the Nepean River (21st April 2008) (Courtesy of IC)

The gas emission rates are extremely small when placed in perspective with other industrial and natural processes, such as agriculture. Recent estimates of gas emissions in the Nepean River during the extraction of Appin Longwalls 701 to 703 indicate gas emissions of about 3 L/sec. All recorded gas release zones have been temporary, typically lasting only a few months before dissipating.

It is expected that the gas emissions in the Nepean River, resulting from the extraction of the proposed longwalls, would be similar to those experienced in Appin Area 7. This assessment is made on the basis that the geological and strata gas conditions in Area 9 are similar to Area 7 and that the mining geometry in Area 9 (i.e. longwalls widths, depths of cover and setback distances from the river) are similar to Area 7.

Further discussions on the potential impacts of gas emissions on water quality are provided in the report by *Ecoengineers* (2012). Further discussions on the potential impacts of gas emissions on flora and fauna are provided in the report by *Biosis* (2012a).

Potential for Changes in Water Quality

It is possible that some localised iron staining could occur as a result of the extraction of the proposed longwalls. Localised iron staining has been previously observed in the Nepean River and, in Elladale Creek, which is a tributary of the river, during the extraction of Appin Longwalls 701 and 702. A photograph of the iron stain previously observed in Elladale Creek is shown in Fig. 5.16.

Fig. 5.16 Photograph of Recent Iron Stain in Elladale Creek (Courtesy of IC)

Further discussions on the potential impacts of the proposed longwalls on water quality are provided in the report by *Ecoengineers* (2012).

Potential for Impacts on Terrestrial and Aquatic Flora and Fauna

Flora and fauna and, in particular, riparian vegetation can potentially be affected by changes in the levels of the river banks resulting from mine subsidence movements. As described previously, the changes in the levels of the river banks are predicted to be small and, therefore, are unlikely to have a significant effect on the surface water levels along the banks.

Vegetation may also be adversely impacted by the emission of gas at the surface and habitats can be affected by the fracturing of bedrock and the cracking and displacement of the surface soils. Reports on the potential impacts of mine subsidence on flora and fauna in the Nepean River valley are provided in the reports by *Biosis* (2012a) and *Cardno Ecology Lab* (2012).

Potential Impact on River Use

There are two pumps which draw water from the Nepean River which have been identified upstream of the Douglas Park Weir, of which, only one is located within the Study Area. The locations of these pumps are shown in Drawing No. MSEC448-08. A photograph of a typical river pump is provided in Fig. 5.17.

Fig. 5.17 Photograph of a Pump in the Nepean River

The pump intakes are typically submerged around 500 mm below the water surface and, therefore, are unlikely to be impacted by mining-induced changes in the bank or water levels. However, if it was found during mining that the invert was exposed above the water surface, the intakes could be readily relocated to a deeper location. It is the role of the MSB to undertake repairs to any infrastructure impacted by subsidence, including water supply infrastructure.

There are also a number of other river uses that are not expected to be impacted, including swimming, boating and canoeing. There is a rock used for jumping into the river, shown in Fig. 5.27, which is located south of the Study Area and, therefore, is not expected to be impacted by mining. The potential impacts on fishing are discussed in the report by *Cardno Ecology Lab* (2012).

5.2.6. Impact Assessments for the Nepean River Based on Increased Predictions

If the actual conventional subsidence movements exceeded those predicted by a factor of 2 times, the tilts along and across the alignment of the river would still be less than 0.5 mm/m (i.e. < 0.1 %), which represents a change in grade of less than 1 in 2,000. The increased levels of ponding, flooding and scouring of the river banks would still be small in comparison with those which occur during natural flooding conditions.

If the actual valley related upsidence and closure movements exceeded those predicted by a factor of 2 times, it would be expected that the extent of fracturing in the bedrock would increase in the section of river closest to the proposed longwalls. The depth of fracturing and dilation would still be expected to extend no greater than 10 metres to 15 metres and, as the river is a flooded valley, no loss of surface water would be anticipated.

While the predicted ground movements are important parameters when assessing the potential impacts on the river, it is noted that the impact assessments for fracturing, loss of surface water and gas release were primarily based on historical observations from previous longwall mining near and beneath the Nepean River and other streams in the Southern Coalfield. The overall levels of impact on the Nepean River, resulting from the extraction of the proposed longwalls, are expected to be similar to those previously observed along the river as the result of mining the longwalls at Tower Colliery and in Appin Area 7.

5.2.7. Recommendations for the Nepean River

A surface water and groundwater management plan has been previously developed by IC to manage the potential impacts on the Nepean River as a result of the extraction of the longwalls in Appin Area 7. The management plan, which has been developed in consultation with DTIRIS and the Department of Environment, Climate Change and Water (DECCW), includes surface and groundwater monitoring. It is recommended that these management measures are reviewed, in consultation with DTIRIS and DECCW, and extended to include the proposed Longwalls 901 to 904. With these management strategies in place, it is unlikely that there would be any significant long term impacts on the Nepean River resulting from the extraction of the proposed longwalls.

5.3. Drainage Lines

The locations of the drainage lines within the Study Area are shown in Drawing No. MSEC448-07. The descriptions, predictions and impact assessments for the drainage lines are provided in the following sections. The descriptions, predictions and impact assessments for the Nepean River are provided in Section 5.2.

5.3.1. Descriptions of the Drainage Lines

The drainage lines within the Study Area are ephemeral and generally commence on the Razorback Range and flow southwards to where they join the Nepean River. A number of farm dams have been developed along the drainage lines, which are shown in Drawing No. MSEC448-07, which are used as water sources on the rural properties within the Study Area.

The upper reaches of the drainage lines generally have beds comprised of natural surface soils derived from Wianamatta Shale. The drainage lines have sections with sedimentary deposits or exposed bedrock, which often occur in the lower reaches, near the Hawkesbury Sandstone and Wianamatta Shale interface. Photographs of typical exposed bedrock along the upper reaches and lower reaches are shown in Fig. 5.18 and Fig. 5.19, respectively.

Fig. 5.18 Photographs of Exposed Bedrock in the Upper Reaches of the Drainage Lines

Fig. 5.19 Photograph of Exposed Bedrock in Lower Reaches of a Drainage

Descriptions of the larger drainage lines within the Study Area are provided below:-

Nepean River Tributary 1 is located directly above the proposed Longwalls 902 to 904. The lower reaches of the tributary is fourth order, of which, 120 metres is located directly above Longwall 902, with the remainder located south of the proposed longwalls. The two, third order, branches of the tributary are located above the proposed Longwalls 902 and 903, having a total length of approximately 1.1 kilometres.

The natural grade of the Nepean River Tributary 1 is illustrated in Fig. 5.20. It can be seen from this figure, that the natural grade typically varies between 10 mm/m and 50 mm/m, with the greatest natural grades of 200 mm/m to 300 mm/m occurring on the Razorback Range and the lower reaches where the tributary joins the Nepean River.

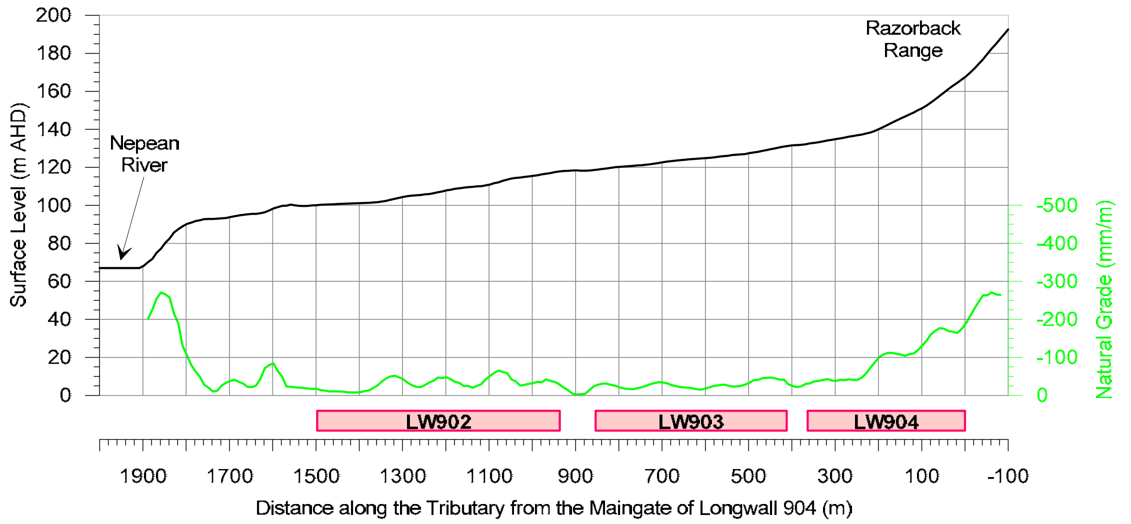

Fig. 5.20 Long-section of the Nepean River Tributary 1

Harris Creek is located east of the proposed longwalls and is at a distance of 400 metres from Longwall 903 at its closest point. The creek is located just outside the Study Area, however, as the creek could experience valley related movements, it has been included in the assessments provided in this report. The section of creek adjacent to the proposed longwalls is third order, having a total length of approximately 3.0 kilometres.

The natural grade of Harris Creek is illustrated in Fig. 5.21. It can be seen from this figure, that the natural grade typically varies between 10 mm/m and 50 mm/m, with the greatest natural grade of 150 mm/m occurring in the lower reaches where the creek joins the Nepean River. A cross-section through Harris Creek is provided in Fig. 5.22, which indicates the locations of the cliffs along the creek.

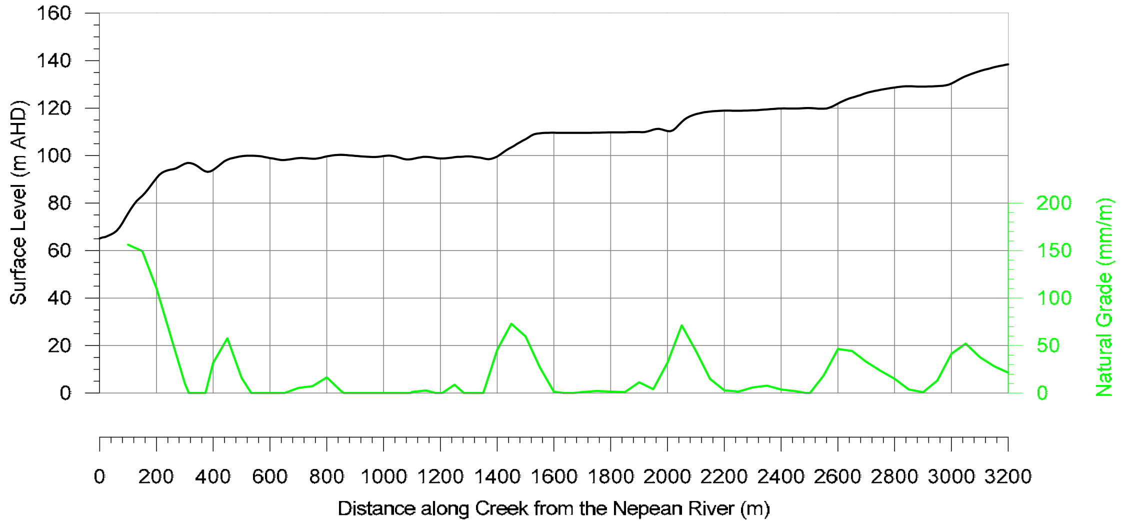

Fig. 5.21 Long-section of Harris Creek

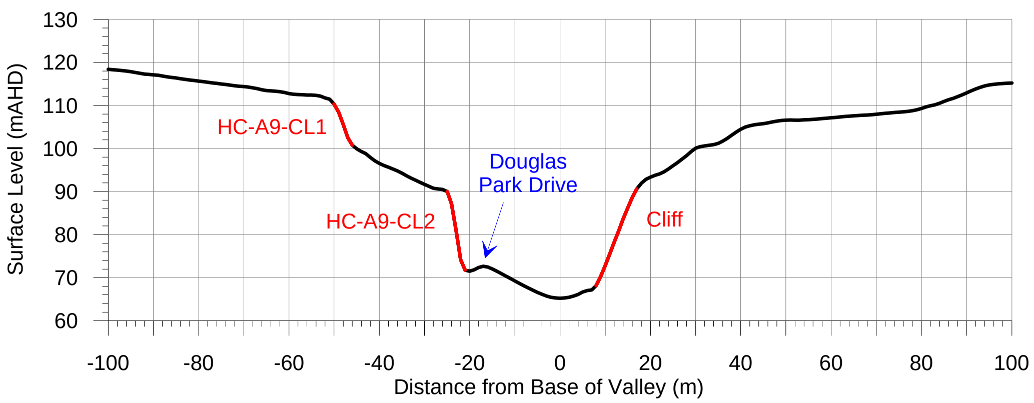

Fig. 5.22 Harris Creek Cross-section (Looking North)

5.3.2. Predictions for the Drainage Lines

The predicted profiles of subsidence, upsidence and closure along the Nepean River Tributary 1 and Harris Creek, resulting from the extraction of the proposed longwalls, are shown in Figs. E.03 and E.04, respectively, in Appendix E. The predicted incremental profiles, due to the extraction of each of the proposed longwalls, are shown as dashed black lines. The predicted total profiles, after the extraction of each of the proposed longwalls, are shown as solid blue lines.

A summary of the maximum predicted values of total subsidence, upsidence and closure for these drainage lines, after the extraction of each of the proposed longwalls, is provided in Table 5.10.

Table 5.10 Maximum Predicted Total Subsidence, Upsidence and Closure at the Drainage Lines Resulting from the Extraction of the Proposed Longwalls

Location	Longwall	Maximum Predicted Subsidence (mm)	Maximum Predicted Upsidence (mm)	Maximum Predicted Closure (mm)
Nepean River Tributary 1	After LW901	60	125	100
	After LW902	900	275	275
	After LW903	1125	350	450
	After LW904	1175	575	625
Harris Creek	After LW901	< 20	< 20	< 20
	After LW902	< 20	< 20	< 20
	After LW903	< 20	< 20	< 20
	After LW904	< 20	< 20	< 20

The other watercourses which are located directly above the proposed longwalls could experience the full range of predicted subsidence movements. A summary of the maximum predicted conventional subsidence movements within the Study Area is provided in Chapter 4.

The maximum predicted changes in grade along the drainage lines, resulting from the extraction of the proposed longwalls, is provided in Table 5.11. The maximum predicted increases in grades occur downstream of the longwall maingates, whilst the maximum predicted decreases in grade occur upstream of the longwall tailgates.

Table 5.11 Maximum Predicted Changes in Grade along the Drainage Lines Resulting from the Extraction of the Proposed Longwalls

Location	Maximum Change in Grade (mm/m)		Maximum Conventional Curvature (km^{-1})	
	Increase in Grade	Decrease in Grade	Hogging Curvature	Sagging Curvature
Nepean River Tributary 1	5.5	3.5	0.07	0.12
Harris Creek	< 0.5	< 0.5	< 0.01	< 0.01
Remaining Drainage Lines	6.5	6.5	0.07	0.12

The predicted changes in grade provided in the above table are the maxima along the alignments of the drainage lines after the extraction of any or all of the proposed longwalls. The predicted curvatures are the maxima in any direction at any time during or after the extraction of the proposed longwalls.

The drainage lines will also experience strains resulting from conventional subsidence and valley related movements. The discussions on strain are provided in the impact assessment for the drainage lines.

5.3.3. Comparison of Predictions for the Watercourses with those provided in the Part 3A Application

The comparisons of the maximum predicted subsidence parameters for the Nepean River Tributary 1, Harris Creek and the remaining drainage lines, with those provided in the Part 3A Application, are provided in Table 5.12, Table 5.13 and Table 5.14, respectively.

Table 5.12 Comparison of the Maximum Predicted Conventional Subsidence Parameters for the Nepean River Tributary 1

Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Upsidence (mm)	Maximum Predicted Total Closure (mm)
Part 3A Layout (Report No. MSEC404)	1275	725	1300
Extraction Plan Layout (Report No. MSEC448)	1175	575	625

Table 5.13 Comparison of the Maximum Predicted Conventional Subsidence Parameters for Harris Creek

Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Upsidence (mm)	Maximum Predicted Total Closure (mm)
Part 3A Layout (Report No. MSEC404)	725	375	225
Extraction Plan Layout (Report No. MSEC448)	< 20	< 20	< 20

Table 5.14 Comparison of Maximum Predicted Conventional Subsidence Parameters for the Other Watercourses Located Directly Above the Proposed Longwalls

Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
Part 3A Layout (Report No. MSEC404)	1400	6.5	0.07	0.12
Extraction Plan Layout (Report No. MSEC448)	1200	6.5	0.07	0.12

It can be seen from the above tables, that the maximum predicted subsidence movements for the drainage lines, based on the Extraction Plan Layout, are similar to or less than the maxima predicted based on the Part 3A Layout.

5.3.4. Impact Assessments for the Watercourses

The impact assessments for the drainage lines within the Study Area are provided in the following sections. The assessments provided in this report should be read in conjunction with the assessments provided in the reports by *Ecoengineers* (2012), *Cardno Ecology Lab* (2012) and *Biosis* (2012a).

Potential for Increased Levels of Ponding, Flooding and Scouring

The maximum predicted tilts along the alignments of the Nepean River Tributary 1 and Harris Creek, resulting from the extraction of the proposed longwalls, are 5.5 mm/m (i.e. 0.6 %) and less than 0.5 mm/m (i.e. less than 0.1 %), respectively, which represent changes in grade of 1 in 180 and less than 1 in 2,000, respectively. The maximum predicted tilt for the remaining drainage lines within the Study Area is 6.5 mm/m (i.e. 0.7 %), which represents a change in grade of 1 in 155.

The natural grades along the alignments of the drainage lines within the Study Area typically vary between 10 mm/m and 50 mm/m, with natural grades greater than 100 mm/m on the Razorback Range and the lower reaches where the drainage lines join the Nepean River.

The predicted changes in grade are small when compared to the existing natural grades along the alignments of the drainage lines. This is illustrated in Fig. 5.23, which shows the initial and predicted final grades along the alignment of the Nepean River Tributary 1. It can be seen from this figure, that there are no predicted reversals of grade along the tributary resulting from the extraction of the proposed longwalls.

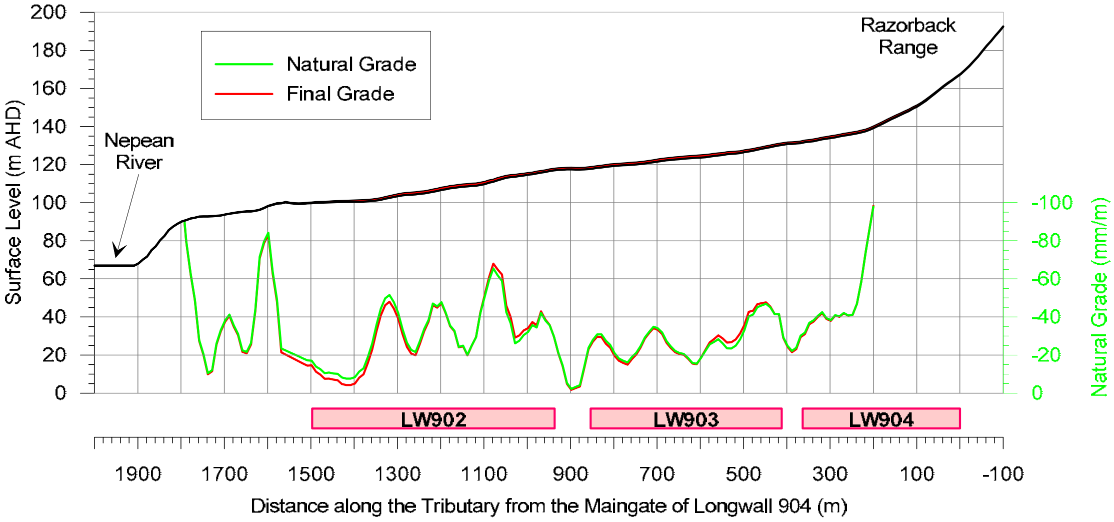

Fig. 5.23 Initial and Predicted Final Grades along the Nepean River Tributary 1

It is unlikely, therefore, that there will be any significant increases in the levels of ponding, flooding or scouring along the drainage lines resulting from the extraction of the proposed longwalls. It is possible that there could be very localised areas along the drainage lines which could experience small increases in the levels of ponding and flooding, where the predicted maximum tilts occur in the locations where the natural gradients are low. As the predicted changes in grade are less than 1 %, however, any localised changes in ponding or flooding are expected to be minor and not result in adverse impacts on the drainage lines.

Potential for Cracking in the Creek Beds and Fracturing of Bedrock

The maximum predicted conventional curvatures for the drainage lines located directly above the proposed longwalls are 0.07 km^{-1} hogging and 0.12 km^{-1} sagging, which equate to minimum radii of curvature of 14 kilometres and 8 kilometres, respectively. The maximum predicted hogging and sagging curvatures for Harris Creek are both less than 0.01 km^{-1}, which equates to minimum radius of curvature of greater than 100 kilometres.

The range of non-valley related movement strains above the proposed longwalls is expected to be similar to the range of strains measured during the previously extracted longwalls in the Southern Coalfield, which is described in Section 4.4 and the results illustrated in Fig. 4.4. It is also likely, that the drainage lines would experience elevated compressive strains as a result of valley closure movements.

The maximum predicted closure movements across the alignments of the Nepean River Tributary 1 and Harris Creeks are 575 mm and less than 20 mm, respectively. The predicted maximum closure movements at the remaining drainage lines are expected to be in the range of the closure movements predicted for the Nepean River Tributary 1 and Harris Creek, depending on the locations relative to the proposed longwalls.

The compressive strains resulting from valley related movements are more difficult to predict than conventional strains. It has been observed in the past, however, that compressive strains due to valley related movements greater than 10 mm/m have occurred above previously extracted longwalls, where the magnitudes of closure were similar to that predicted at the Nepean River Tributary 1. The compressive strain due to closure movements at Harris Creek is predicted to be less than 0.5 mm/m.

Fracturing of the uppermost bedrock has been observed in the past, as a result of longwall mining, where the tensile strains have been greater than 0.5 mm/m or where the compressive strains have been greater than 2 mm/m. It is likely, therefore, that fracturing would occur in the uppermost bedrock along the drainage lines located directly above the proposed longwalls, based on the predicted maximum strains. It has been observed in the past, that the depth of buckling and dilation of the uppermost bedrock, resulting from valley related movements, is generally less than 10 metres to 15 metres (SCT, 2003 and Mills and Huuskes, 2004).

Where the beds of the drainage lines comprise natural surface soils, it is possible that fracturing in the bedrock would not be seen at the surface. In the event that fracturing of the bedrock occurs in these locations within the alignments of the drainage lines, the fractures are likely to be filled with soil during subsequent flow events.

Where the beds of the drainage lines have exposed bedrock, there may be some diversion of surface water flows into the dilated strata beneath them and the draining of pooled water within the alignments. It is unlikely that there would be any net loss of water from the catchment, however, as the depth of dilation and fracturing is expected to be less than 10 metres to 15 metres and, therefore, any diverted surface water is likely to re-emerge into the catchment further downstream.

The drainage lines are ephemeral and so water typically flows during and for a period of time after each rain event. In times of heavy rainfall, the majority of the runoff would flow over the beds and would not be diverted into the dilated strata below. In times of low flow, however, some of the water could be diverted into the dilated strata below the beds and this could affect the quality and quantity of the water flowing in the drainage lines. It is unlikely, however, that this would result in adverse impacts on the overall quantity and quality of water flowing from the catchment.

Any surface cracking would tend to be naturally filled with soil during subsequent flow events, especially during times of heavy rainfall. If any surface cracks were found not to fill naturally, some remedial measures may be required at the completion of mining. Where necessary, any significant surface cracks in the drainage line beds could be remediated by infilling with soil or other suitable materials, or by locally regrading and recompacting the surface.

The maximum predicted curvatures and the range of potential strains at the drainage lines, resulting from the extraction of the proposed longwalls, are similar to those typically experienced elsewhere in the Southern Coalfield. Longwalls in the Southern Coalfield have been successfully mined directly beneath drainage lines in the past, and some of these cases are provided in Table 5.15.

Table 5.15 Examples of Previous Experience of Mining Beneath Drainage Lines in the Southern Coalfield

Longwalls	Drainage Lines	Observed Movements	Observed Impacts
Appin Area 3 Longwalls 301 and 302	2.7 kilometres of drainage lines and tributaries directly mined beneath	650 mm Subsidence 4.5 mm/m Tilt 1 mm/m Tensile Strain 3 mm/m Comp. Strain (Measured M & N-Lines)	No reported fracturing which resulted in surface water flow diversions
Appin Area 4 Longwalls 401 to 409	3.8 kilometres of drainage lines directly mined beneath, including Creek 2A, Rocky Ponds Creek and Simpsons Creek	700 mm Subsidence 5 mm/m Tilt 1 mm/m Tensile Strain 2 mm/m Comp. Strain (Measured A6000-Line)	No reported fracturing which resulted in surface water flow diversions
Appin Area 7 Longwalls 701 to 703	1.5 kilometres of drainage lines directly mined beneath	1000 mm Subsidence 7 mm/m Tilt 1 mm/m Tensile Strain 3 mm/m Comp. Strain (Measured MPR-Line)	No reported fracturing which results in surface water flow diversions
West Cliff Area 5 Longwalls 29 to 34	4.2 kilometres of drainage lines directly mined beneath, including Unnamed Creek, Ousedale Creek, Mallaty Creek and Leafs Gully	1100 mm Subsidence 10 mm/m Tilt 1 mm/m Tensile Strain 5.5 mm/m Comp. Strain (Measured B-Line)	Fracturing observed in the bed of Mallaty Creek, loss of water holding capacity in one pool (Ref. MC109).

Based on the previous experience of mining beneath drainage lines in the Southern Coalfield, it is likely that some fracturing will occur along the drainage lines, particularly those located directly above or adjacent to the proposed longwalls. It is unlikely, however, that there would be any net loss of water from the catchment. The predicted mine subsidence movements and, hence, the assessed impacts for the drainage lines are similar to or less than that assessed in the Bulli Seam Operations Environmental Assessment.

Further discussions on the potential impacts of surface cracking and changes in surface water flows are provided in the reports by *Ecoengineers* (2012), *Cardno Ecology Lab* (2012) and *Biosis* (2012a).

5.3.5. Impact Assessments for the Watercourses Based on Increased Predictions

If the actual conventional subsidence movements exceeded those predicted by a factor of 2 times, the maximum tilts along the drainage lines would be 13 mm/m (i.e. 1.3 %), which represents a change in grade of 1 in 75. In this case, increased levels of ponding and flooding could occur upstream of the longwall tailgates and increased levels of scouring could occur downstream of the longwall maingates. This is illustrated in Fig. 5.24, which shows the natural and predicted final surface level and grade along the Nepean River Tributary 1, based on the subsidence exceeding the predictions by a factor of 2.

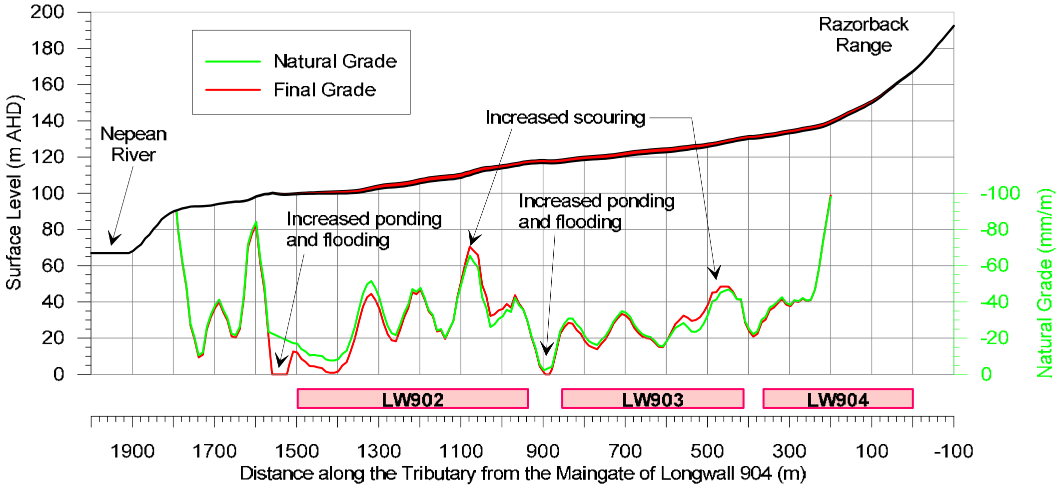

Fig. 5.24 Initial and Predicted Final Grades along the Nepean River Tributary 1 Based on Subsidence Exceeding Predictions by a Factor of 2 Times

The changes in grade are small, typically less than 1 % and, therefore, any localised changes in ponding, flooding or scouring would still expected to be minor. If necessary, the natural grades of the drainage lines could be remediated by regrading and recompacting the surface soil beds. It is noted, that a number of the drainage lines have already been altered by the installation of farm dams within their alignments.

If the actual strains or valley related movements exceeded those predicted by a factor of 2 times, it would be expected that the extent of fracturing in the uppermost bedrock would increase along the drainage lines which are located directly above the proposed longwalls. The depth of fracturing and dilation would still be expected to extend no greater than 10 metres to 15 metres and, therefore, no loss of surface water from the catchment would be anticipated.

While the predicted ground movements are important parameters when assessing the potential impacts on the drainage lines, it is noted that the impact assessments for fracturing and loss of surface water were primarily based on historical observations from previous longwall mining in the Southern Coalfield. The overall levels of impact on the drainage lines, resulting from the extraction of the proposed longwalls, are expected to be similar to those observed where longwalls have previously mined directly beneath drainage lines in the Southern Coalfield.

5.3.6. Recommendations for the Watercourses

It is recommended that the drainage lines are periodically visually monitored during the extraction of the proposed longwalls and that any significant surface cracking is remediated by infilling with soil or other suitable materials, or by locally regrading and recompacting the surface, as required.

IC has developed a number of management strategies for drainage lines which have been directly mined beneath by previously extracted longwalls at Appin, Tower and West Cliff Collieries. It is recommended that similar management strategies are developed, in consultation with DECCW, for the drainage lines within the Study Area. With these management strategies in place, it is unlikely that there would be any significant long term impacts on the drainage lines resulting from the extraction of the proposed longwalls.

5.4. Aquifers and Known Groundwater Resources

There are no *Ground Water Management Areas*, as defined by the Department of Environment, Climate Change and Water (DECCW), within the Study Area. There are, however, groundwater resources within the Study Area, which are extracted using groundwater bores, the locations of which are shown in Drawing No. MSEC448-32 and details provided in Section 8.8. Further discussions on the groundwater within the Study Area are provided in the report by *Geoterra* (2012).

5.4.1. Springs

No natural springs or groundwater seeps have been identified along the Nepean River or along the drainage lines within the Study Area. Further details on the surface and groundwater within the Study Area are provided in the reports by *Ecoengineers* (2012) and *Geoterra* (2012).

5.4.2. Sea or Lake

There are no seas, or lakes within the Study Area.

5.4.3. Shorelines

There are no shorelines within the Study Area.

5.4.4. Natural Dams

There are no natural dams within the Study Area. There are, however, a number of farm dams within the Study Area, which are described in Section 8.7.

5.5. Cliffs

The locations of the cliffs within the Study Area are shown in Drawing No. MSEC448-12. The descriptions, predictions and impact assessments for the cliffs are provided in the following sections.

5.5.1. Descriptions of the Cliffs

For the purposes of this report, a cliff has been defined as a continuous rockface having a minimum height of 10 metres and a minimum slope of 2 in 1, i.e. having a minimum angle to the horizontal of 63°. The locations of cliffs within the Study Area were determined from site investigations, from the orthophotograph and from the 1 metre surface level contours which were generated from an aerial laser scan of the area.

The cliffs within the Study Area are generally located within the valley of the Nepean River and associated tributaries. The cliffs within the valley of Harris Creek, which are located just outside the Study Area, have also been included in the assessments, as they overhang Douglas Park Drive. There are also rock outcrops which are located along the Razorback Range, which are discussed in Section 5.6.

The cliffs have formed from the Hawkesbury Sandstone Sedimentary Group. The locations of the cliffs within the vicinity of the proposed longwalls are shown in Drawing No. MSEC448-12 and details are provided in Table 5.16.

Table 5.16 Details of Cliffs within Vicinity of the Study Area

Cliff Ref.	Overall Length (m)	Maximum Height (m)	Description
NR-A9-CL1	40	15	280 metres south of the western end of Longwall 902
NR-A9-CL2	40	10	140 metres south of the western end of Longwall 902
NR-A9-CL3	40	10	170 metres south of the western end of Longwall 902
NR-A9-CL4	40	15	240 metres south of the western end of Longwall 902
NR-A9-CL5	70	20	230 metres south of the western end of Longwall 902
NR-A9-CL6	80	20	180 metres west of the western end of Longwall 901
NR-A9-CL7	90	25	110 metres west of the western end of Longwall 901
NR-A9-CL8	60	20	60 metres south-west of the western end of Longwall 901
NR-A9-CL9	30	10	220 metres south of the western end of Longwall 901
NR-A9-CL10	70	15	230 metres south of the western end of Longwall 901
NR-A9-CL11	40	10	270 metres south of the western end of Longwall 901
NR-A9-CL12	60	15	270 metres south of Longwall 901
NR-A9-CL13	140	15	310 metres south of Longwall 901
NR-A9-CL14	50	15	330 metres south of Longwall 901
NR-A9-CL15	60	10	310 metres south of Longwall 901
NR-A9-CL16	100	20	340 metres south of Longwall 901

Cliff Ref.	Overall Length (m)	Maximum Height (m)	Description
HC-A9-CL1	100	10	750 metres south-east of the eastern end of Longwall 901
HC-A9-CL2	100	10	770 metres south-east of the eastern end of Longwall 901
HC-A9-CL3	200	10	650 metres south-east of the eastern end of Longwall 901

It should be noted, that the maximum cliff heights, provided in the above table, are less than the overall heights of the Nepean River and Harris Creek valleys. This is because the cliff heights do not include the talus slopes and because the slopes of some rockfaces, though steep, are not considered steep enough to describe them as parts of the cliffs. This is illustrated in Fig. 5.3 to Fig. 5.7 and Fig. 5.22, which provide cross-sections through the Nepean River and Harris Creek valleys and indicate the relative locations of the cliffs.

Photographs of the cliffs along the Nepean River are provided in Fig. 5.25 to Fig. 5.27.

Fig. 5.25 Photograph of Cliff NR-A9-CL5

Fig. 5.26 Photograph of Cliff NR-A9-CL16

Fig. 5.27 Photograph of Cliff South of Study Area

The cliffs on the western side of the Harris Creek valley (i.e. HC-A9-CL1 to HC-A9-CL3) overhang the adjacent Douglas Park Drive. A photograph of these cliffs is provided in Fig. 5.28. A cross-section through the cliffs in the Harris Creek valley is provided in Fig. 5.22.

Fig. 5.28 Photograph of Cliffs along Douglas Park Drive

5.5.2. Predictions for the Cliffs

A summary of the maximum predicted total conventional subsidence parameters at the cliffs, resulting from the extraction of the proposed longwalls, is provided in Table 5.17.

Table 5.17 Maximum Predicted Total Conventional Subsidence Parameters for the Cliffs Resulting from the Extraction of the Proposed Longwalls

Cliff Ref.	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
NR-A9-CL1	< 20	< 0.5	< 0.01	< 0.01
NR-A9-CL2	75	0.5	< 0.01	< 0.01
NR-A9-CL3	50	0.5	< 0.01	< 0.01
NR-A9-CL4	25	< 0.5	< 0.01	< 0.01
NR-A9-CL5	50	< 0.5	< 0.01	< 0.01
NR-A9-CL6	50	< 0.5	< 0.01	< 0.01
NR-A9-CL7	100	0.5	< 0.01	< 0.01
NR-A9-CL8	50	< 0.5	< 0.01	< 0.01
NR-A9-CL9	< 20	< 0.5	< 0.01	< 0.01
NR-A9-CL10	< 20	< 0.5	< 0.01	< 0.01
NR-A9-CL11	< 20	< 0.5	< 0.01	< 0.01
NR-A9-CL12	50	< 0.5	< 0.01	< 0.01
NR-A9-CL13	25	< 0.5	< 0.01	< 0.01
NR-A9-CL14	25	< 0.5	< 0.01	< 0.01
NR-A9-CL15	25	< 0.5	< 0.01	< 0.01
NR-A9-CL16	25	< 0.5	< 0.01	< 0.01
HC-A9-CL1	< 20	< 0.5	< 0.01	< 0.01
HC-A9-CL2	< 20	< 0.5	< 0.01	< 0.01
HC-A9-CL3	< 20	< 0.5	< 0.01	< 0.01

The predicted tilts and curvatures provided in the above table are the maxima at any time during or after the extraction of each of the proposed longwalls.

The cliffs are located outside the extents of longwall mining, at a minimum distance of 60 metres from the proposed longwalls and, therefore, the strains are expected to be in the range of those measured above solid coal during previous longwall mining. The distribution of strain measured in survey bays located above solid coal during the mining of previous longwalls in the Southern Coalfield is illustrated in Fig. 4.3 and Table 4.6.

Non-conventional movements can also occur and have occurred in the NSW Coalfields as a result of, among other things, anomalous and valley related movements. The analysis of strains provided in Chapter 4 includes those resulting from both conventional and non-conventional anomalous movements.

The maximum predicted conventional strains for the cliffs, based on applying a factor of 15 to the maximum predicted conventional curvatures, are less than the order of survey tolerance (i.e. less than 0.3 mm/m).

5.5.3. Comparison of Predictions for the Cliffs with those provided in the Part 3A Application

The comparison of the maximum predicted subsidence parameters for cliffs along the Nepean River valley with those provided in the Part 3A Application is provided in Table 5.18.

Table 5.18 Comparison of the Maximum Predicted Conventional Subsidence Parameters for the Cliffs Based on the Part 3A and Extraction Plan Layouts

Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
Part 3A Layout (Report No. MSEC404)	50	0.5	0.01	0.01
Extraction Plan Layout (Report No. MSEC448)	100	0.5	< 0.01	< 0.01

It can be seen from the above table, that the maximum predicted subsidence at the cliffs, based on the Extraction Plan Layout, is a similar order of magnitude to, but slightly greater than the maximum predicted based on the Part 3A Layout. The maximum predicted subsidence of 100 mm occurs at Cliff NR-A9-CL7, with the predicted subsidence at all other cliffs being similar to or less than the maximum provided in the Part 3A. The maximum predicted tilt and curvatures for the cliffs, based on the Extraction Plan Layout, are similar to or slightly less than the maxima predicted based on the Part 3A Layout.

5.5.4. Impact Assessments for the Cliffs

There are no cliffs identified directly above the proposed longwalls. The cliff closest to the proposed longwalls is Cliff Ref. NR-A9-CL8, which is located approximately 60 metres south-west of the commencing (western) end of the Longwall 901. The commencing ends of the proposed longwalls have been established so as to achieve a minimum setback of 50 metres from the identified cliffs, which is the same commitment adopted for the longwalls in Appin Area 7 and the Part 3A.

The maximum predicted conventional tilt for the cliffs, resulting from the extraction of the proposed longwalls, is 0.5 mm/m (i.e. < 0.1 %), or a change in grade of 1 in 2,000. Tilt does not directly induce differential movements along cliffs, which is the main cause of cliff instabilities. Tilt, however, can potentially increase the overturning moments in steep or overhanging cliffs which, if of sufficient magnitude, could result in toppling type failures. The predicted maximum tilts for the cliffs within the Study Area are very small in comparison to the existing slopes of the cliff faces and are unlikely, therefore, to result in toppling type failures in these cases.

It is possible, however, that if the curvatures and strains are of sufficient magnitude, sections of rock could fracture along existing bedding planes or joints and become unstable, resulting in sliding or toppling type failures along the cliffs, especially during or after heavy rainfall events.

The maximum predicted curvature for the cliffs, resulting from the extraction of the proposed longwalls, is less than 0.01 km^{-1}, which represent a minimum radius of curvature of greater than 100 kilometres.

The cliffs could also be subjected to valley related movements resulting from the extraction of the proposed longwalls. The predicted profiles of the upsidence and closure movements along the Nepean River, the Nepean River Tributary 1 and Harris Creek, resulting from the extraction of the proposed longwalls, are shown in Figs. E.02, E.03 and E.04, respectively, in Appendix E.

The maximum predicted upsidence and compressive strain due to closure movements occur in the bases of the valleys and are unlikely, therefore, to result in impacts on the cliffs, which are located up the valley sides. Closure movements tend to be bodily movements of the valley sides, however, stresses can be induced in the strata where differential closure movements occur around bends in the river valleys. It can be seen from Drawing No. MSEC448-12, however, that the cliffs in the vicinity of the proposed longwalls are relatively straight.

It is extremely difficult to assess the likelihood of cliff instabilities based upon predicted ground movements. The likelihood of a cliff becoming unstable is dependent on a number of factors which are difficult to fully quantify. These factors include jointing, inclusions, weaknesses within the rockmass, groundwater pressure and seepage flow behind the rockface. Even if these factors could be determined, it would still be difficult to quantify the extent to which these factors influence the stability of a cliff naturally or when it is exposed to mine subsidence movements. It is possible, therefore, that cliff instabilities may occur during mining that may be attributable to either natural causes, mine subsidence, or both.

The likelihood of cliff instabilities within the Study Area can be assessed using case studies where previous longwall mining has occurred close to but not directly beneath cliffs. Although very minor rock falls have been observed over solid coal outside the extracted goaf areas of longwall mining in the Southern Coalfield, there have been no recorded large cliff instabilities outside the extracted goaf areas of longwall mining in the Southern Coalfield. This statement is based on the following observations:-

- *Appin Longwalls 301 and 302 near the Cataract River*

  Appin Longwalls 301 and 302 mined adjacent to a number of cliff lines located along the Cataract River valley. A total of 68 cliffs were identified within a 35 degree angle of draw from the longwalls. The cliffs had continuous lengths ranging between 5 metres and 230 metres, overall heights ranging between 10 metres and 37 metres and had been formed within the Hawkesbury Sandstone.

  Appin Longwalls 301 and 302 have void widths of 260 metres, solid chain pillar widths of 40 metres and were extracted from the Bulli Seam at a depth of cover of 500 metres. These longwalls mined to within 50 metres of the identified locations of the cliffs along the Cataract River valley.

  There were no large cliff instabilities observed as a result of the extraction of Appin Longwalls 301 and 302. There were, however, five minor rock falls or disturbances which occurred during the mining period, of which, three were considered likely to have occurred due to a significant rainfall event and natural instability of the cliff overhang. The length of cliff line disturbed as a result of the extraction of Appin Longwalls 301 and 302 was, therefore, estimated to be less than 0.5 % of the total face area of the cliff lines within the mining domain.

- *Tower Longwalls 18 to 20 and Appin Longwalls 701 to 703 near the Nepean River*

  Tower Longwalls 18 to 20 and Appin Longwalls 701 to 703 mined adjacent to a number of cliff lines located along the Nepean River valley. A total of around 50 cliffs were identified within a 35 degree angle of draw from these longwalls. The cliffs had continuous lengths ranging between 5 metres and 225 metres, overall heights ranging between 10 metres and 40 metres and had been formed within the Hawkesbury Sandstone.

  Tower Longwalls 18 to 20 have void widths of 235 metres, solid chain pillar widths of 40 metres and were extracted from the Bulli Seam at a depth of cover of 500 metres. Appin Longwalls 701 to 703 have void widths of 320 metres, solid chain pillar widths of 40 metres and were extracted from the Bulli Seam at a depth of cover of 500 metres.

  Tower Longwall 20 mined directly beneath some cliffs located at the confluence of Elladale Creek and the Nepean River. Appin Longwalls 701 to 703 mined to within 75 metres of the identified locations of the cliffs along the Nepean River valley.

  There were no cliff instabilities observed as a result of the extraction of Tower Longwalls 18 to 20 and Appin Longwalls 701 to 703.

Based on the previous experience of mining at Appin and Tower Collieries, it is possible that isolated rock falls could occur as a result of the extraction of the proposed longwalls. Any impacts are expected to represent less than 0.5 % of the total face area of the cliffs within the Area 9 Domain. It is also unlikely that any large cliff instabilities would occur as a result of mining, as the longwalls are not proposed to be extracted directly beneath the cliffs.

While the risk of large cliff instabilities is extremely low, some risk remains and attention must therefore be paid to any structures or roads that are located in the vicinity of the cliffs. The following sections provide discussions on the risks associated with the cliffs which are located in the vicinity of the proposed longwalls.

Cliffs along Harris Creek

The cliffs along Harris Creek (Refs. HC-A9-CL1 to HC-A9-CL3) are located at a distance of 650 metres south-east of Longwall 901 at their closest point to the proposed longwalls. At this distance, the likelihood of mining-induced impacts at these cliffs is considered to be extremely low.

The cliffs along the western valley side of Harris Creek (Refs. HC-A9-CL1 and HC-A9-CL2) overhang Douglas Park Drive, which is shown in Fig. 5.28 and is illustrated in Fig. 5.22. Given the potential for severe consequences from any rock falls, it is recommended that IC, in consultation with Wollondilly Shire Council, develop management measures to ensure that the road remains safe and serviceable throughout the mining period. The management plan would require input from geotechnical and subsidence engineers. The management measures may include:-

- Site investigation of the cliffs along Douglas Park Drive by a qualified geotechnical engineer,
- Detailed monitoring of absolute and differential movements of the cliffs,
- Regular review and assessment of the monitoring data,
- Development of a traffic management plan, and
- Implementation of planned responses if triggered by monitoring and inspections.

A detailed investigation of the cliffs along Harris Creek has been undertaken which is described in the report by *GHD Geotechnics* (2012).

Cliffs along the Nepean River Valley

There are a number of access tracks located above and in the vicinity of the cliffs along the Nepean River valley, some of which are shown in Drawing No. MSEC448-12. There are also a number of houses above and in the vicinity of the cliffs, which are shown in Drawing Nos. MSEC448-19 to MSEC448-31. Given the potential for severe consequences from any rock falls, it is recommended that IC, in consultation with landowners, develop management measures to ensure that their properties remain safe and serviceable throughout the mining period. The management plan may require input from structural, geotechnical and subsidence engineers. The management measures may include:-

- Avoidance of use during the active mining period,
- Site investigation of the cliffs and structures by qualified structural and geotechnical engineers,
- Consideration and possible implementation of mitigation measures to reduce the potential for impacts,
- Detailed monitoring of absolute and differential movements of the ground and the structures,
- Regular review and assessment of the monitoring data, and
- Implementation of planned responses if triggered by monitoring and inspections.

5.5.5. Impact Assessments for the Cliffs Based on Increased Predictions

If the actual tilts exceeded those predicted by a factor of 2 times, the maximum tilt at the cliffs would be 1.0 mm/m (i.e. 0.1 %), or a change in grade of 1 in 1,000. The tilts at the cliffs would still be extremely small in comparison with the existing slopes of the rockfaces, which exceed 2 in 1. In addition to this, tilt does not directly induce differential movements along cliffs, which is the main cause of cliff instabilities and, therefore, the potential for impacts would not be expected to significantly increase.

If the actual curvatures exceeded those predicted by a factor of 2 times, the maximum curvature at the cliffs would be around 0.01 km^{-1}, which represents a minimum radius of curvature of 100 kilometres. The curvatures at the cliffs would still be small and, therefore, the likelihood of cliff instabilities would not be expected to increase significantly.

While the predicted ground movements are important parameters when assessing the potential impacts on the cliffs, it is noted that the impact assessments for cliff instabilities have primarily been based on historical observations from previous longwall mining in the Southern Coalfield. The overall levels of impact on the cliffs, resulting from the extraction of the proposed longwalls, are expected to be similar to those observed where longwalls have previously mined close to but not directly beneath the cliffs in the Southern Coalfield.

In any case, the levels of impact on the cliffs within the Study Area are expected to be much less than that observed where previous longwall mining has occurred directly beneath cliffs in the Southern Coalfield. An example of this is Tower Longwalls 1 to 17, which were mined beneath approximately 5 kilometres of cliffline within the Cataract River and Nepean River valleys. There were a total of 10 cliff instabilities recorded along these valleys which represents approximately 4 % of the total length of the clifflines directly mined beneath.

5.5.6. Recommendations for the Cliffs

IC has developed a *Cliff and Steep Slope Management Plan* for Longwalls 701 to 710 in Appin Area 7 so as to manage the potential impacts on the cliffs in the Nepean River valley. The Management Plan addresses monitoring, response action, reporting and public safety. It is recommended that the management plan be reviewed and, where required, revised to include the proposed Longwalls 901 to 904.

GHD Geotechnics (2012) has undertaken geotechnical investigations to assess the potential for instabilities for the cliffs along Harris Creek which rise above and overhang Douglas Park Drive. It is recommended that management strategies are developed based on the detailed investigations to ensure the safety of people using the road.

5.6. Rock Outcrops

The descriptions, predictions and impact assessments for the rock outcrops are provided in the following sections.

5.6.1. Descriptions of the Rock Outcrops

There are rock outcrops located across the Study Area, primarily along the Razorback Range and within the Nepean River valley and associated tributaries. For the purposes of this report, a rock outcrop has been defined as an isolated rockface having a height of less than 10 metres. Rockfaces having minimum heights of 10 metres and minimum slopes of 2 in 1 have been defined as cliffs in this report, which are discussed in Section 5.5.

5.6.2. Predictions for the Rock Outcrops

The rock outcrops are located across the Study Area and, therefore, are expected to experience the full range of predicted subsidence movements. A summary of the maximum predicted conventional subsidence movements within the Study Area is provided in Chapter 4.

The rock outcrops are at discrete locations and, therefore, the most relevant distributions of strain are the maximum strains measured in individual survey bays from previous longwall mining. The analysis of strains in survey bays during the mining of previous longwalls in the Southern Coalfield is discussed in Section 4.4.1. The results for survey bays above goaf are provided in Fig. 4.1 and Table 4.5. The results for survey bays above solid coal are provided in Fig. 4.3 and Table 4.6.

Non-conventional movements can also occur and have occurred in the NSW Coalfields as a result of, among other things, anomalous movements. The analysis of strains provided in Chapter 4 includes those resulting from both conventional and non-conventional anomalous movements.

The maximum predicted conventional strains for the rock outcrops, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 1 mm/m tensile and 2 mm/m compressive.

5.6.3. Impact Assessments for the Rock Outcrops

The extraction of the proposed longwalls is likely to result in some fracturing of the rock outcrops and, where the rock is marginally stable, could then result in instabilities. Previous experience in the Southern Coalfield indicates that the percentage of rock outcrops that are likely to be impacted by mining is very small. The potential for isolated rockfalls, however, could result in a public safety risk where houses or infrastructure are located beneath large rock outcrops.

5.6.4. Impact Assessments for the Rock Outcrops Based on Increased Predictions

If the actual subsidence movements exceeded those predicted by a factor of 2 times, the extent of fracturing and, hence, the incidence of impacts would increase for the rock outcrops located directly above the proposed longwalls. The incidence of impacts on the rock outcrops (i.e. not including the large cliff lines) was small at Dendrobium Mine, where the predicted curvatures and strains were 2 to 5 times those predicted within the Study Area. Based on this previous experience, it would still be expected that the incidence of impacts on the rock outcrops in the Study Area would still be small if the actual movements exceeded those predicted by a factor of 2 times.

5.6.5. Recommendations for the Rock Outcrops

IC has developed a *Cliff and Steep Slope Management Plan* for Longwalls 701 to 710 in Appin Area 7 so as to manage the potential impacts on the rock outcrops in the Nepean River valley. The Management Plan addresses monitoring, response action, reporting and public safety. It is recommended that the management plan be reviewed and, where required, revised to include the proposed Longwalls 901 to 904.

5.7. Steep Slopes

The locations of the steep slopes within the Study Area are shown in Drawing No. MSEC448-12. The descriptions, predictions and impact assessments for the steep slopes are provided in the following sections.

5.7.1. Descriptions of the Steep Slopes

For the purposes of this report, a steep slope has been defined as an area of land having a natural gradient greater than 1 in 3 (i.e. a grade of 33 %, or an angle to the horizontal of 18°). The reason for identifying steep slopes is to highlight areas in which existing ground slopes may be marginally stable.

The steep slopes within the Study Area were identified from the 1 metre surface contours which were generated from an airborne laser scan of the area. The areas identified as having steep slopes are shown in Drawing No. MSEC448-12.

There are steep slopes along the **Razorback Range** which is located directly above the proposed longwalls. The range has natural slopes typically ranging between 1 in 3 and 1 in 2, with isolated areas having natural slopes greater than 1 in 2. A photograph of the Razorback Range is provided in Fig. 5.29.

Fig. 5.29 Steep Slope along Razorback Range

The soil along the Razorback Range has been derived from Wianamatta Shale. The extent of the Wianamatta Shale within the Study Area has been mapped and further discussions are provided in the report by *Coffey* (2012).

There are also steep slopes within the valleys of the **Nepean River** and its tributaries. These steep slopes are generally located to the south of the proposed longwalls, however, the steep slopes along the upper reaches of the tributaries are located directly above the proposed Longwalls 901 and 902.

The natural slopes in the Nepean River valley and lower reaches of the tributaries are typically greater than 1 in 2. The natural slopes in the upper reaches of the tributaries, which are directly mined beneath, are typically less than 1 in 2. A photograph of a typical steep slope within the Nepean River valley is provided in Fig. 5.30.

Fig. 5.30 Example of Steep Slope within Nepean River Valley

5.7.2. Predictions for the Steep Slopes

A summary of the maximum predicted values of total conventional subsidence, tilt and curvature at the steep slopes, resulting from the extraction of the proposed longwalls, is provided in Table 5.19.

Table 5.19 Maximum Predicted Total Conventional Subsidence, Tilt and Curvature at the Steep Slopes Resulting from the Extraction of the Proposed Longwalls

Location	Longwall	Maximum Predicted Conventional Subsidence (mm)	Maximum Predicted Conventional Tilt (mm/m)	Maximum Predicted Conventional Hogging Curvature (km^{-1})	Maximum Predicted Conventional Sagging Curvature (km^{-1})
Razorback Range	After LW901	< 20	< 0.5	< 0.01	< 0.01
	After LW902	925	6.5	0.06	0.12
	After LW903	1150	6.0	0.07	0.12
	After LW904	1200	6.0	0.07	0.12
Tributaries to the Nepean River	After LW901	500	3.0	0.02	0.02
	After LW902	575	3.5	0.03	0.02
	After LW903	575	3.5	0.03	0.02
	After LW904	575	3.5	0.03	0.02
Nepean River Valley	After LW901	75	1.0	0.01	< 0.01
	After LW902	75	1.0	0.01	< 0.01
	After LW903	75	1.0	0.01	< 0.01
	After LW904	75	1.0	0.01	< 0.01

The predicted tilts provided in the above table are the maxima after the completion of each of the proposed longwalls. The predicted curvatures are the maxima at any time during or after the extraction of each of the proposed longwalls.

The steep slopes are planar features and, therefore, the most relevant distribution of strain is the maximum strains measured along whole monitoring lines above previous longwall mining. The analysis of strains along whole monitoring lines during the mining of previous longwalls in the Southern Coalfield is discussed in Section 4.4 and the results are provided in Fig. 4.4.

Non-conventional movements can also occur and have occurred in the NSW Coalfields as a result of, among other things, anomalous movements. The analysis of strains provided in Chapter 4 includes those resulting from both conventional and non-conventional anomalous movements.

The maximum predicted conventional strains for the steep slopes, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 1 mm/m tensile and 2 mm/m compressive.

5.7.3. Comparison of Predictions for the Steep Slopes with those provided in the Part 3A Application

The comparison of the maximum predicted subsidence parameters for steep slopes with those provided in the Part 3A Application is provided in Table 5.20.

Table 5.20 Comparison of the Maximum Predicted Conventional Subsidence Parameters for the Steep Slopes Based on the Part 3A and Extraction Plan Layouts

Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
Part 3A Layout (Report No. MSEC404)	1600	6.5	0.07	0.12
Extraction Plan Layout (Report No. MSEC448)	1200	6.5	0.07	0.12

It can be seen from the above table, that the maximum predicted mine subsidence movements at the steep slopes, based on the Extraction Plan Layout, are similar to or slightly less than those predicted based on the Part 3A Layout.

5.7.4. Impact Assessments for the Steep Slopes

The maximum predicted tilt at the steep slopes along the Razorback Range, resulting from the extraction of the proposed longwalls, is 6.5 mm/m (i.e. 0.7 %), which represents a change in grade of 1 in 155. The predicted tilt at the steep slopes in the Nepean River valley and associated tributaries is 3.5 mm/m (i.e. 0.4 mm/m), which represents a change in grade of 1 in 285.

The predicted changes in grade are small when compared to the natural grades of the steep slopes, which are greater than 1 in 3 and, therefore, the tilts are unlikely to result in any adverse impacts on the stability of the steep slopes.

The steep slopes are more likely to be impacted by curvatures and strains. The potential impacts would generally result from the down slope movement of the soil, causing tension cracks to appear at the tops and along the sides of the slopes and compression ridges to form at the bottoms of the slopes.

The maximum predicted curvatures for the steep slopes along the Razorback Range, resulting from the extraction of the proposed longwalls, are 0.07 km^{-1} hogging and 0.12 km^{-1} sagging, which represent minimum radii of curvature of 14 kilometres and 8 kilometres, respectively. The maximum predicted curvatures at the steep slopes are similar to those typically experienced in the Southern Coalfield.

There is extensive experience of mining beneath steep slopes in the Southern Coalfield. These include steep slopes along the Cataract, Nepean, Bargo and Georges Rivers. No large-scale slope failures have been observed along these slopes, even where longwalls have been mined directly beneath them. Although no large-scale slope failures have been observed in the Southern Coalfield, tension cracking has been observed at the tops and along the sides of steep slopes as the result of downslope movements.

Cracks resulting from downslope movements at depths of cover greater than 400 metres, such as the case in the Study Area, have been observed with typical widths in the order of 25 mm to 50 mm. Larger cracks have been also observed at the tops of very steep slopes and adjacent to large rock formations, having typical widths in the order of 100 mm to 150 mm. A photograph of a tension crack near the top of a steep slope in the Southern Coalfield is provided in Fig. 5.31.

Fig. 5.31 Example of Surface Tension Cracking along the Top of a Steep Slope

The soils within the Study Area are generally derived from the Wianamatta Shale Group and there is extensive natural erosion in some locations. A photograph of natural erosion within the Study Area is provided in Fig. 5.32.

Fig. 5.32 Photograph of Natural Soil Erosion within the Study Area

As the slopes along the Razorback range are steep, exhibit natural soil erosion and are predicted to experience the full range of predicted subsidence movements, it is likely that the extraction of the proposed longwalls would result in large surface cracks near the tops and along the sides of these slopes. Detailed site investigations and studies of the potential impacts on the steep slopes along the Razorback Range have been undertaken and are described in the reports by *Coffey* (2012) and the *UoW* (2012).

The steep slopes along the Nepean River valley and associated tributaries are not directly mined beneath by the proposed longwalls. It is likely, therefore, that only minor cracking would occur near the tops of these steep slopes.

If tension cracks were to develop, as the result of the extraction of the proposed longwalls, it is possible that soil erosion could occur if these cracks were left untreated. It is possible, therefore, that some remediation would be required, including infilling of surface cracks with soil or other suitable materials, or by locally regrading and recompacting the surface. In some cases, erosion protection measures may be needed, such as the planting of additional vegetation in order to stabilise the slopes in the longer term.

While in most cases, impacts on steep slopes are likely to consist of surface cracks, there remains a low probability of large-scale downslope movements. Experience indicates that the probability of mining induced large-scale slippages is extremely low due to the significant depth of cover within the Study Area.

While the risk is extremely low, some risk remains and attention must therefore be paid to any features or items of infrastructure that are located in the vicinity of steep slopes directly above the proposed longwalls, which include the:-

- Houses,
- Local roads,
- Low voltage powerlines,
- Optical fibre and copper cables, and
- Survey control marks.

The locations of the surface infrastructure in the vicinity of steep slopes are shown in Drawing No. MSEC448-12. The risks associated with the proximity of the steep slopes are discussed in the impact assessments for each item of infrastructure.

Further discussions and recommendations for the steep slopes along the Razorback Range are provided in the reports by *Coffey* (2012) and the *UoW* (2012).

5.7.5. Impact Assessments for the Steep Slopes Based on Increased Predictions

If the actual tilts exceeded those predicted by a factor of 2 times, the maximum tilt at the steep slopes would be 13 mm/m (i.e. 1.3 %), which represents a change in grade of 1 in 75. The tilts at the steep slopes would still be small in comparison with the existing natural grades, which exceed 1 in 3.

If the actual curvatures exceeded those predicted by a factor of 2 times, the maximum curvature at the steep slopes would be 0.24 km^{-1}, which represents a minimum radius of curvature of 4 kilometres. The curvature at the steep slopes would still be less than those predicted to have occurred as the result of the extraction of the longwalls in Dendrobium Areas 1 and 2, which mined directly beneath ridgelines having natural steep slopes up to 1.2 in 1. Whilst large tensile cracks were observed near the tops of the steep slopes, in the order of 300 mm, there were no reported slope instabilities.

Any significant surface cracking could be remediated by infilling of surface cracks with soil or other suitable materials, or by locally regrading and recompacting the surface. In some cases, erosion protection measures may be needed, such as the planting of additional vegetation in order to stabilise the slopes in the longer term.

5.7.6. Recommendations for the Steep Slopes

IC has engaged a team of consultants including the University of Wollongong, Coffey Geosciences and Cardno Forbes Rigby, to assess the existing stability and the potential for subsidence impacts on the steep slopes associated with the Razorback Range. The risks and management measures are assessed in the reports by *Coffey* (2012) and the *UoW* (2012).

IC has developed a *Cliff and Steep Slope Management Plan* for Longwalls 701 to 710 in Appin Area 7. The existing Management Plan addresses monitoring, response action, reporting and public safety. It is recommended that the management plan be reviewed and, where required, revised to include the proposed Longwalls 901 to 904.

5.8. Escarpments

The Razorback Range forms a well defined escarpment on the southern side of the range. The descriptions, predictions and impact assessments for the rock outcrops and steep slopes along the Razorback Range are provided in Sections 5.6 and 5.7, respectively.

5.9. Land Prone to Flooding and Inundation

There are areas prone to flooding or inundation within the Nepean River valley. Discussions on the increased likelihoods of ponding and flooding along the river are provided in Section 5.2.

5.10. Swamps, Wetlands and Water Related Ecosystems

There are no swamps or wetlands within the Study Area. There are water related ecosystems within the Study Area associated with the major watercourses, including the Nepean River and the major tributaries. Discussions on the water related ecosystems are provided in the reports by *Biosis* (2012a) and *Cardno Ecology Lab* (2012).

5.11. Threatened, Protected Species or Critical Habitats

There are no lands within the Study Area that have been declared as critical habitat under the *Threatened Species Conservation Act 1995*. There are, however, threatened and protected species within the Study Area which are described in the report by *Biosis* (2012a) and *Cardno Ecology Lab* (2012).

5.12. National Parks or Wilderness Areas

There are no National Parks nor any land identified as wilderness under the Wilderness Act 1987 within the Study Area.

5.13. State Recreational or Conservation Areas

There are no State Recreational Areas nor Conservation Areas within the Study Area.

5.14. Natural Vegetation

The extent of natural vegetation can be seen from the aerial photograph provided in Fig. 1.2. The locations of the *Endangered Ecological Communities* are indicated on Drawing No. MSEC448-07. A survey of the natural vegetation within the Study Area has been undertaken and details are provided in the report by *Biosis* (2012a).

5.15. Areas of Significant Geological Interest

There are no areas of significant geological interest within the Study Area.

5.16. Any Other Natural Feature Considered Significant

There are no other natural features considered significant within the Study Area.

The following sections provide the descriptions, predictions and impact assessments for the Public Utilities within the Study Area. The public utilities located outside the Study Area, which may be subjected to far-field movements or valley related movements and may be sensitive to these movements, have also been included as part of these assessments.

6.1. The Main Southern Railway

The location of the Main Southern Railway is shown in Drawing No. MSEC448-13. The descriptions, prediction and impact assessments for the railway are provided in the following sections.

6.1.1. Description of the Main Southern Railway

The Main Southern Railway is a key national transport route that carries significant freight and passenger services between Sydney and Melbourne. The Main Southern Railway is leased by Australian Rail Track Corporation (ARTC), who is responsible for maintaining the track.

Approximately 3.8 km of track is located within the Study Area between 72.98 km and 76.78 km. Approximately 2.9 km of track is located directly above proposed Longwalls 901 to 902 between 73.37 km and 76.24 km. The proposed Longwalls 903 and 904 will not mine directly beneath the track.

The railway line is a dual track consisting of 60 kg rail on concrete sleepers with a mix of straight and curved track sections within the Study Area. The maximum speed limits on both tracks are 115 km/h for normal services and 125 km/h for XPT services. A photograph of a section of the railway within the Study Area is provided in Fig. 6.1.

Photograph courtesy David Christie

Fig. 6.1 Photograph of the Main Southern Railway

The key features along the railway within the Study Area are listed below. Further details on each feature are provided later in this report.

- Culverts, embankments and cuttings,
- A partially filled subway,
- An emergency crossover,
- Douglas Park Station,
- Automated vehicular level crossing at Camden Road, Douglas Park,
- Two small level crossings for private property access, and
- Signalling and communications systems, including a communications tower.

6.1.2. Predictions for the Main Southern Railway

The predicted profiles of conventional subsidence and tilt along the alignment of Main Southern Railway, resulting from the extraction of the proposed longwalls, are shown in Fig. E.05, in Appendix E. The initial and the predicted post mining grade of the track are also shown in this figure.

The predicted incremental profiles along the alignment of the railway, due to the extraction of each of the proposed longwalls, are shown as dashed black lines in Fig. E.05. The predicted total profiles along the alignment of the railway, after the extraction of each of the proposed longwalls, are shown as solid blue lines.

A summary of the maximum predicted total conventional subsidence parameters along the alignment of the railway, after the extraction of each of the proposed longwalls, is provided in Table 6.1.

Table 6.1 Maximum Predicted Total Conventional Subsidence Parameters along the Alignment of the Main Southern Railway after the Extraction of the Proposed Longwalls

Location	Longwall	Maximum Predicted Subsidence (mm)	Maximum Predicted Tilt Along Alignment (mm/m)	Maximum Predicted Hogging Curvature Along Alignment (km^{-1})	Maximum Predicted Sagging Curvature Along Alignment (km^{-1})
Main Southern Railway	After LW901	575	2.0	0.02	0.03
	After LW902	825	2.0	0.04	0.03
	After LW903	875	2.0	0.04	0.03
	After LW904	875	2.0	0.04	0.03

Given that the track is located directly above proposed Longwalls 901 and 902, very little additional subsidence is expected to develop during the mining of Longwalls 903 and 904. A summary of the maximum predicted incremental conventional subsidence parameters is provided in Table 6.2.

Table 6.2 Maximum Predicted Incremental Conventional Subsidence Parameters along the Alignment of the Main Southern Railway due to the Extraction of the Proposed Longwalls

Location	Longwall	Maximum Predicted Incremental Subsidence (mm)	Maximum Predicted Incremental Tilt Along Alignment (mm/m)	Maximum Predicted Incremental Hogging Curvature Along Alignment (km^{-1})	Maximum Predicted Incremental Sagging Curvature Along Alignment (km^{-1})
Main Southern Railway	Due to LW901	575	2.0	0.02	0.03
	Due to LW902	650	1.5	0.03	0.02
	Due to LW903	75	< 0.5	0.01	< 0.01
	Due to LW904	25	< 0.5	< 0.01	< 0.01

The railway is a linear feature and, therefore, the most relevant distribution of strain is the maximum strains measured along whole monitoring lines above previous longwall mining. The analysis of strains along whole monitoring lines during the mining of previous longwalls in the Southern Coalfield is discussed in Section 4.4 and the results are provided in Fig. 4.4.

Non-conventional movements can occur and have occurred previously in the Southern Coalfield as a result of, among other things, valley closure and upsidence movements, and movements at geological features. Please refer to Sections 3.4 and 4.7 for further details.

The maximum predicted incremental conventional strains along the alignment of the railway, based on applying a factor of 15 to the maximum predicted incremental conventional curvatures along the alignment of the railway, are 0.3 mm/m tensile and 0.5 mm/m compressive.

6.1.3. Predictions of Subsidence Along the Railway during the Mining of each Longwall

Subsidence will develop gradually while mining progresses. Predictions of subsidence have been made along the railway for proposed Longwalls 901 and 902 for every 50 metres of travel, which represents approximately one week of mining. The results are shown in Fig. 6.2 below.

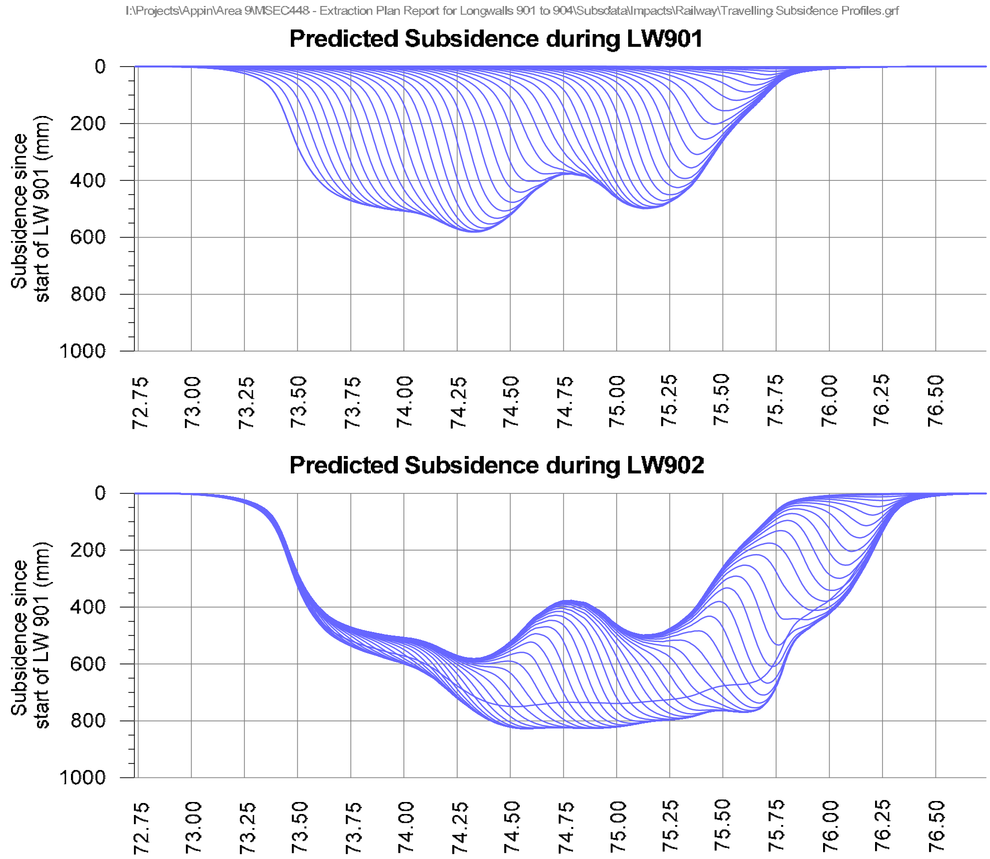

Fig. 6.2 Development of Subsidence during the Mining of Longwalls 901 and 902

Subsidence will first develop at the country (southern) end of the track during the mining of each longwall. The active subsidence zone will then migrate along the track towards the north as each longwall progresses.

While approximately 2.9 km of track is located directly above the proposed longwalls, the majority of subsidence movements that develop during any week of mining is expected to concentrate within a section of track that is approximately 400 metres in length.

As the proposed longwalls are oriented almost parallel to the track, greater mining-induced tilts and curvatures are expected to occur during mining as the longwalls travel directly beneath, compared to the final tilts and curvatures that remain at the completion of mining. This is demonstrated by, for example, the predictions of tilts along the alignment of the railway at any time during or after the extraction of the proposed longwalls, as shown by the grey shading in Fig. E.05.

A summary of the maximum predicted incremental conventional subsidence parameters, at any time during the extraction of the proposed longwalls, is provided in Table 6.3.

Table 6.3 Maximum Predicted Incremental Conventional Subsidence Parameters along the Alignment of the Railway at Any Time during the Extraction of the Proposed Longwalls

Location	Longwall	Maximum Predicted Incremental Subsidence (mm)	Maximum Predicted Incremental Tilt Along Alignment (mm/m)	Maximum Predicted Incremental Hogging Curvature Along Alignment (km^{-1})	Maximum Predicted Incremental Sagging Curvature Along Alignment (km^{-1})
Main Southern Railway	During LW901	575	3.0	0.03	0.03
	During LW902	650	3.0	0.03	0.03
	During LW903	75	< 0.5	< 0.01	< 0.01
	During LW904	25	< 0.5	< 0.01	< 0.01

6.1.4. Comparison of Predictions for the Railway with those provided in the Part 3A Application

The comparison of the maximum predicted final subsidence parameters for Main Southern Railway with those provided in the Part 3A Application is provided in Table 6.4. The comparison is shown graphically in Fig. E.05.

Table 6.4 Comparison of the Maximum Predicted Final Conventional Subsidence Parameters for the Main Southern Railway Based on the Part 3A and Extraction Plan Layouts

Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Tilt Along Alignment (mm/m)	Maximum Predicted Hogging Curvature Along Alignment (km^{-1})	Maximum Predicted Sagging Curvature Along Alignment (km^{-1})
Part 3A Layout (Report No. MSEC404)	1600	6.5	0.07	0.11
Extraction Plan Layout (Report No. MSEC448)	875	2.0	0.04	0.03

It can be seen from the above table, that the maximum predicted final subsidence movements at Main Southern Railway, based on the Extraction Plan Layout, are less than those predicted based on the Part 3A Layout.

6.1.5. Management of Potential Impacts on the Main Southern Railway

IC and the Australian Rail Track Corporation (ARTC) have developed a detailed risk management plan for managing potential mine subsidence impacts on the Main Southern Railway due to the extraction of Longwalls 703 and 704 at Appin Colliery.

The management measures described in this plan are similar to those that have been developed in consultation with ARTC and successfully implemented during the mining of Longwalls 25 and 26 at Tahmoor Colliery.

A Rail Technical Committee has been coordinated to develop the risk management strategies. This Technical Committee includes representatives from ARTC, IC, Tahmoor Colliery, the Mine Subsidence Board and specialist consultants in the fields of railway track engineering, geotechnical engineering, structural engineering, track signalling, mine subsidence, risk assessment and project management. The Technical Committee consults with DTIRIS and the Independent Transport Safety and Reliability Regulator.

Works by the Rail Technical Committee include:-

- Identification of potential impacts on the railway,
- Undertaking a risk management approach, where identified risks are assessed and risk control measures are implemented, and
- Development of management measures that include mitigation and preventive works, monitoring plans, triggered response plans and communication plans.

It is noted that by the time Appin Colliery extracts Longwall 901 beneath the railway, the Technical Committee will have benefited from the collective experiences of mining several longwalls beneath the railway at Appin Area 7 and Tahmoor Colliery. It is therefore expected that management strategies and plans will be further developed immediately prior to the mining of the proposed Longwall 901 to 904. This will enable the maximum benefit of knowledge and understanding from the previous experiences to be transferred into the management of this area.

The following sections provide subsidence predictions and likely management measures that will likely be used to manage potential impacts on rail infrastructure during the mining of Longwalls 901 to 904.

6.1.6. Changes in Track Geometry

Mine subsidence will result in changes to track geometry. Changes to track geometry are described using a number of parameters:-

- Vertical misalignment (top) – vertical deviation of the track from design,
- Horizontal misalignment (line) – horizontal deviation of the track from design,
- Changes in Track Cant – changes in superelevation across the rails of each track from design, and
- Track Twist – changes in superelevation over a length of track from design.

The Australian Rail Track Corporation's Base Operating Standards for Track Geometry provide allowable deviations in track geometry. Predictions of conventional subsidence, tilt and horizontal movement have been made at 5 metre intervals along the railway to calculate each track geometry parameters at any stage of mining. The predicted changes in cant and long twist for the railway are shown in Fig. E.06. A summary of the maximum allowable and maximum predicted changes in geometry are provided in Table 6.5.

Table 6.5 Allowable and Predicted Maximum Changes in Track Geometry due to Conventional Subsidence Movements

Track Geometry parameter	Description	Value at which speed limit is first applied*	Value at which trains are stopped*	Predicted Maximum due to Conventional Subsidence
Top	Mid-ordinate vertical deviation over a 10 m chord	38 mm	46 mm	< 2
Line	Mid-ordinate horizontal deviation over an 8 m chord	35 mm	53 mm	< 2
Change in Cant	Deviation from design superelevation across rails spaced 1.435 m apart	41 mm	75 mm	5
Long Twist	Changes in Cant over a 14 m chord	43 mm	65 mm	< 1

Note: * denotes values have been taken from the trigger levels in the IC Railway Management Plan, which were based on the ARTC operating standards.

It can be seen from the above table, that the predicted changes in track geometry are an order of magnitude less than the maximum allowable deviations specified in the Base Operating Standards, if conventional subsidence occurs. For example, the maximum allowable change in cant is 75 mm over a length of 1.435 metres before the trains are stopped. In mining terminology, this represents a tilt of approximately 50 mm/m, which is substantially greater than the maximum predicted tilt anywhere above the proposed longwalls of 6.5 mm/m.

It is recognised that subsidence predictions in the Southern Coalfield are generally based on the results of surveys marks that are spaced nominally 20 metres apart. The bay lengths used to measure the track geometry parameters, described in Table 6.5, are less than these mark spacings, particularly for changes in track cant and twist. However, confidence in the predictions is gained from the following observations:-

- Recent monitoring of track geometry at 125 mm intervals along both tracks during the mining of Longwalls 25 and 26 at Tahmoor Colliery and Longwalls 703 and 704 at Appin Colliery have shown that the observed changes compared reasonably well with predictions. The observed changes were very small and an order of magnitude less than the Base Operating Standards.

- Negligible changes to track geometry have been observed during the mining of Glennies Creek Longwalls 8 and 9 directly beneath the Mt. Owen Spur Line in the Hunter Valley, where the measured changes compared reasonably well within predictions.

It is, however, possible that mine subsidence could result in changes in track geometry that exceed ARTC Standards in the following ways:-

- Track becomes unstable as the result of rail stress, which is discussed in the following section, or
- Track loses support as the result of failure or collapse of culverts or embankment slopes, or
- Development of substantial non-conventional ground movements.

Non-conventional movements can occur and have occurred in the Southern Coalfield as a result of, among other things, valley upsidence and closure movements and anomalous movements. The impact assessments for the valley related movements at the drainage line crossings are provided in Section 6.1.8. Discussion on the likelihood and nature of anomalous movements is provided in Sections 3.4 and 4.7.

An example of substantial non-conventional movement in the Southern Coalfield occurred above Appin Longwall 408. In this case, a low angle thrust fault was re-activated in response to mine subsidence movements, resulting in differential vertical and horizontal movements across the fault. Observations at the site showed that the non-conventional movements developed gradually and over a long period of time. Regular ground monitoring across the fault indicated that the rate of differential movement was less than 0.5 mm/day at the time non-conventional movements could first be detected. Subsequently as mining progressed, the rate of differential movement increased to a maximum of 28 mm/week. In comparison with Base Operating Standards, the maximum allowable deviations in track geometry are between 35 mm and 43 mm for the first speed limit and 46 mm to 75 mm before trains must be stopped.

It is therefore considered that while non-conventional movements may potentially result in changes to track geometry that exceed Base Operating Standards, the potential risk to track safety can be managed through early detection via monitoring and early response through the implementation of triggered response plans. It is likely that the following management measures will be used to manage changes in track geometry:-

- Assess pre-mining track condition and adjust track (if necessary) so that pre-mining track geometry is at or close to design prior to the development of subsidence,
- Identify potential sites of non-conventional movement, such as creeks and geological structures,
- Install a monitoring system, which includes, among other things, the monitoring of ground movements, rail stress, rail temperature, switch displacement and track geometry,
- Conduct regular visual inspections of the track, and
- Adjust the track in response to monitoring results during mining if required.

It is considered that with the adoption of appropriate management measures, changes to track geometry can be managed, even if actual subsidence movements are greater than the predictions or substantial non-conventional movements occur.

6.1.7. Changes in Rail Stress

Mine subsidence will result in changes to rail stress unless preventive measures are implemented. If no action is taken, it is predicted that the rails will become unstable as a result of the mining of the proposed longwalls. The maximum predicted change in stress free temperature is approximately 30 degrees if 100 % of predicted ground strains are transferred into the rails. In comparison, a change in stress free temperature of approximately 14 degrees is sufficient to warrant immediate preventative action on a track with concrete sleepers.

Management of rail stress during active mine subsidence has been a primary focus of the Rail Technical Committee. Traditionally, rail stress has been managed in Australia and overseas by rail strain or stress monitoring. Once measured changes in rail stress reach defined triggers, the stress is dissipated by unclipping the rails from the sleepers, cutting the rails and adding steel to, or removing steel from the rails as required, followed by re-stressing the rails to their desired stress. This process is effective but it is labour intensive and very difficult to undertake on busy tracks such as the Main Southern Railway, particularly if the frequency of required rail re-stressing is likely to be more often than weekly, as would be expected during the mining of the proposed Longwalls 901 and 902.

For this reason, the Rail Technical Committee has introduced a combination of rail expansion switches and zero toe load clips to dissipate mining and temperature related rail stress during mining. Rail expansion switches consist of a tapered joint in the track, which allow the rails on each side of the joints to slide independently. Maximum allowable displacements of expansion switches vary between different types of switches and those that have been employed above Appin Longwalls 703 and 704 have a capacity of approximately 310 mm. Expansion switches are standard rail equipment and operate in non-subsidence applications in Australia and overseas to accommodate, for example, differential thermal movements between bridges and natural ground. A photograph of a rail expansion switch is shown in Fig. 6.3.

Fig. 6.3 Rail Expansion Switch

Zero toe load clips allow the rails to slide longitudinally along the track while maintaining lateral stability. In combination, the rails are able to expand or contract in response to mine subsidence and thermal loads into and out of the expansion switches. It is estimated that the switches will be spaced between 200 metres and 400 metres apart along the track within the subsidence area.

The combination of expansion switches and zero toe load clips has been successfully employed during the mining of Longwalls 25 and 26 at Tahmoor Colliery and previously at two trial locations.

A significant advantage of using rail expansion switches and zero toe load clips is that the system is flexible and can be adjusted during mining should the tolerance of the switches reach their design limits. The rails can be cut and steel can be either added or removed as necessary to restore capacity in the switches. The process is significantly faster than conventional re-stressing work as the clips do not have to be removed and reinstated and no stressing work is required. The process can be safely achieved in between the passage of trains without delaying the operation of trains.

It is likely that the following management measures will be used to manage changes in rail stress:-

- Assess pre-mining track condition and adjust track if required so that pre-mining track geometry and sleeper arrangements are at or close to design prior to the development of subsidence,
- Identify potential sites of non-conventional movement, such as creeks and geological structures,
- Assess the required spacing of expansion switches based on the predicted ground movements,
- Install the expansion switches and zero toe load clips,
- Install a monitoring system, which includes, among other things, the monitoring of ground movements, rail stress, rail temperature, switch displacement and track geometry,
- Regularly review and assess the monitoring data,
- Conduct regular visual inspections of the track, switches and clips, and
- Adjust the track in response to monitoring results during mining if required.

It is considered that with the adoption of appropriate management measures, changes to rail stress can be managed, even if actual subsidence movements are greater than the predictions or substantial non-conventional movements occur.

6.1.8. Potential Impacts on Railway Culverts at Creek Crossings

A summary of the railway culverts within the Study Area is provided in Table 6.6.

Table 6.6 Railway Culverts within the Study Area

ARTC Kilometrage	Location	Description
72.852	Harris Creek Culvert 550 metres east of LW901	3 m brick and stone arch culvert with brick and stone base
74.336	Above Longwall 901	900 mm brick arch culvert with concrete pipe extensions at each end
74.810	Above Longwall 901	1.2 m brick arch culvert with concrete pipe extension on the Up side
75.855	Above Longwall 902	3 m brick arch culvert with an extension of corrugated steel on the Up side
76.212	Above Longwall 902	3 m brick arch culvert with an extension of corrugated steel on the Up side
76.774	400 metres south-west of Longwall 902	900 mm dia brick arch culvert, with concrete pipe extensions at each end
76.837	440 metres south-west of Longwall 902	900 mm dia brick arch culvert, with concrete pipe extensions at each end

The two most significant culverts are at 75.855 km and 76.212 km. These brick arch culverts are approximately 3 metres in diameter with Armco extensions on the Up side (northern or upstream ends). Photographs of these culverts are provided in Fig. 6.4 and Fig. 6.5.

Fig. 6.4 Photographs of Railway Culvert at 75.855 km

Fig. 6.5 Photographs of Railway Culvert at 76.212 km

Harris Creek Culvert at 72.852 km is a 50 metre long stone and brick arch culvert, as shown in Fig. 6.6. While this culvert is located outside the Study Area, it has been included in the assessments as it is located in an incised creek valley and the masonry is considered sensitive to differential subsidence movements.

Photograph courtesy David Christie

Fig. 6.6 Photograph of Harris Creek Railway Culvert at 72.852 km

The railway track also crosses a small valley near 74.590 km, where there is no culvert present. The surface water from the small watercourse is diverted to the culvert at 74.810 km, as shown in Fig. 6.7. This section of track has the potential to experience valley upsidence and closure movements and predictions have been provided in this section of the report.

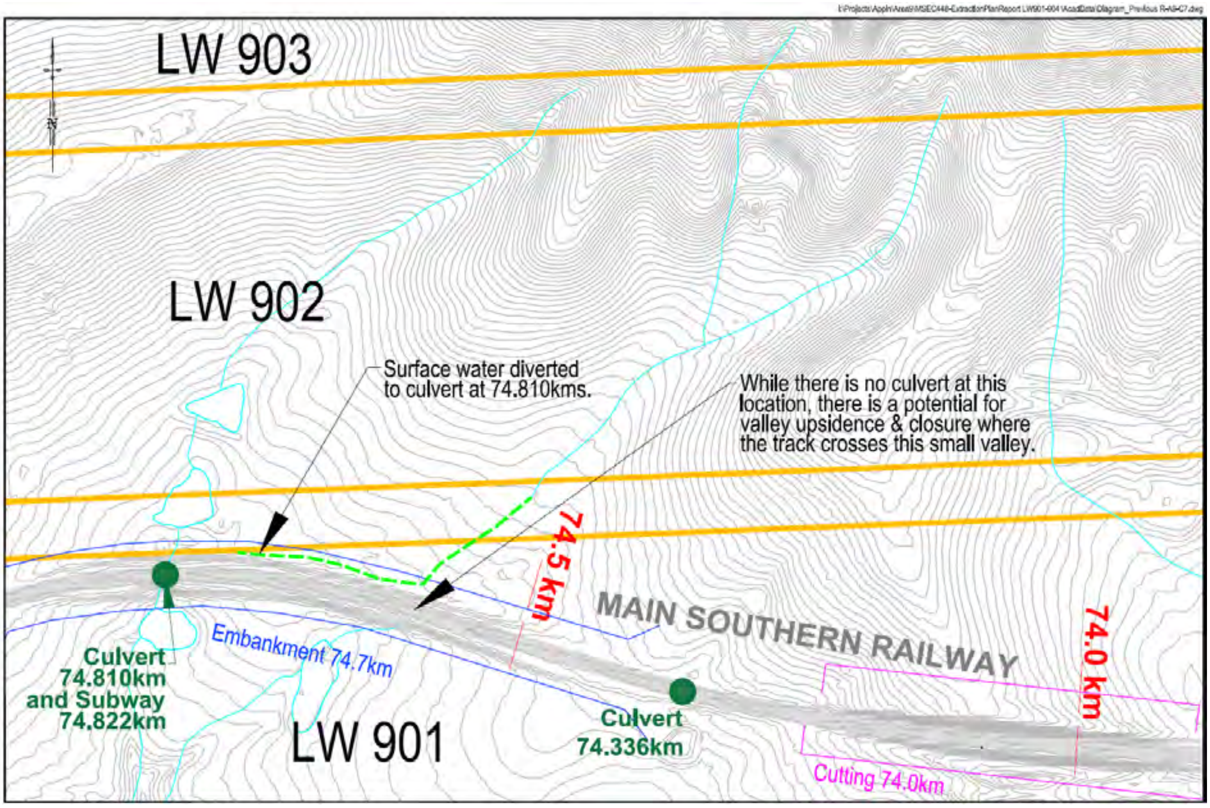

Fig. 6.7 Map showing Railway Creek Crossing at 74.590 km

A summary of the maximum predicted total conventional subsidence parameters at the culverts and creek crossing, resulting from the extraction of the proposed longwalls, is provided in Table 6.7.

Table 6.7 Maximum Predicted Total Conventional Subsidence Parameters at the Railway Culverts after the Extraction of the Proposed Longwalls

ARTC Kilometrage	Maximum Predicted Subsidence (mm)	Maximum Predicted Tilt in Any Direction (mm/m)	Maximum Predicted Hogging Curvature in Any Direction (km^{-1})	Maximum Predicted Sagging Curvature in Any Direction (km^{-1})
72.852	< 20	< 0.5	< 0.01	< 0.01
74.336	825	2.0	0.02	0.03
74.810	875	0.5	0.02	0.01
75.855	650	3.5	0.04	0.02
76.212	300	2.5	0.02	0.01
76.774	< 20	< 0.5	< 0.01	< 0.01
76.837	< 20	< 0.5	< 0.01	< 0.01

The predicted tilts provided in the above table are the maxima in any direction after the completion of all of the proposed longwalls. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each of the proposed longwalls.

The culverts and creek crossing are located within the alignments of tributaries and could, therefore, be subject to valley related movements. A summary of the maximum predicted total upsidence and closure movements at the culverts and creek crossing, resulting from the extraction of the proposed longwalls, is provided in Table 6.8.

Table 6.8 Maximum Predicted Total Upsidence and Closure at the Drainage Culverts after the Extraction of the Proposed Longwalls

ARTC Kilometrage	Maximum Predicted Upsidence (mm)	Maximum Predicted Closure (mm)
72.852	25	25
74.336	50	25
74.810	125	100
75.855	275	250
76.212	125	125
76.774	< 20	< 20
76.837	< 20	< 20

Given that the maximum predicted tilt at the drainage culverts is 3.5 mm/m, which is less than a 0.5 % change in grade, it is expected that mining-induced conventional tilts will not significantly impact the drainage flows in the culverts. It is, however, recommended that the culverts be cleared of ballast which may have accumulated in the culvert prior to mining.

The main impact identified with the brick arch culverts is the potential for physical impacts on occur. It is possible that these culverts will experience some cracking and spalling of the masonry as a result of mining the longwalls. Cracking may occur in the masonry arch or in the headwalls. The predicted movements are not considered likely to result in collapse of the culvert.

However, given the potentially severe consequences of culvert collapse, the Rail Technical Committee will consider mitigation measures prior to each culvert experiencing subsidence movements. Mitigation works could include, for example, sleeving the masonry arch with new structural steel pipes. Alternatively, a steel baulk structure could be placed above the culvert to prevent impacts on the track in the event of culvert collapse.

More significant mitigation measures are expected to be introduced for the larger culverts, which may include replacement of the culvert with a bridge structure, or substantial strengthening of the culvert. Substantial strengthening of the culvert has successfully been undertaken at a large culvert above Longwall 25 at Tahmoor Colliery (Leventhal, et al, 2011).

The concrete pipe and Armco extensions to some culverts are less susceptible to impacts due to their inherent strength.

It is likely that the following management measures will be used to manage potential impacts on culverts:-

- Assess pre-mining condition of culverts,
- Consider and implement mitigation measures to reduce or avoid the potential for culvert collapse,
- Install a monitoring system, which includes, among other things, the monitoring of ground movements around the culvert and change in track geometry and rail stress,
- Regularly review and assess the monitoring data,
- Conduct regular visual inspections of the culverts, and
- Provide additional track and/or culvert support in response to actual measurements and observations during mining.

It is considered that with the adoption of appropriate management measures, potential impacts on culverts can be managed, even if actual subsidence movements are greater than the predictions or substantial non-conventional movements occur.

The predicted valley upsidence and closure movements are also expected to result in changes in track geometry and rail stress. This includes the creek crossing location at 74.590 km, where there is no culvert. Methods for managing of changes in track geometry and rail stress are provided in Section 6.1.6 and Section 6.1.7.

6.1.9. Potential Impacts on Subway

There is a brick arch Subway located at 74.822 km. The Subway previously provided access to private property owners at the location. It is approximately 4 metres wide and 6 to 8 metres high. As shown by the photograph in Fig. 6.8.

Photograph courtesy David Christie

Fig. 6.8 Photograph of Subway at 74.822 km

The opening has been blocked by partial filling during the construction of a vehicular access road along the Up side of the track. ARTC have advised that there is no formal access agreement with landowners for this subway.

A summary of the maximum predicted total conventional subsidence parameters at the subway, resulting from the extraction of the proposed longwalls, is provided in Table 6.9.

Table 6.9 Maximum Predicted Total Conventional Subsidence Parameters at the Subway after the Extraction of the Proposed Longwalls

Maximum Predicted Subsidence (mm)	Maximum Predicted Tilt in Any Direction (mm/m)	Maximum Predicted Hogging Curvature in Any Direction (km^{-1})	Maximum Predicted Sagging Curvature in Any Direction (km^{-1})
875	0.5	0.02	0.01

While there are three 900 mm diameter concrete pipes at the base of the subway, the structure is not located at the base of a watercourse. A culvert is located adjacent to the subway at 74.810 km. Given its close proximity to the watercourse, it is possible that the valley upsidence and closure movements could concentrate at the subway instead of at the culvert. A summary of the maximum predicted total upsidence and closure movements at the Subway, resulting from the extraction of the proposed longwalls, is provided in Table 6.10.

Table 6.10 Maximum Predicted Total Upsidence and Closure at the Subway after the Extraction of the Proposed Longwalls

Maximum Predicted Upsidence (mm)	Maximum Predicted Closure (mm)
125	100

It is possible that the subway will experience some cracking and spalling of the masonry as a result of mining the proposed longwalls. Cracking may occur in the masonry arch or in the headwalls. The predicted movements are not considered likely to result in collapse of the subway.

However, given the potentially severe consequences of collapse, the Rail Technical Committee will introduce mitigation measures prior to the subway experiencing subsidence movements. Mitigation works may include, for example, a complete filling of the subway opening, or construction of structural support. A steel baulk structure could be placed above the subway to prevent impacts on the track in the event of collapse.

It is likely that the following management measures will be used to manage potential impacts on the subway:-

- Assess pre-mining condition of the subway,
- Consider and implement mitigation measures to reduce or avoid the potential for collapse,
- Install a monitoring system, which includes, among other things, the monitoring of ground movements around the subway and change in track geometry and rail stress,
- Regularly review and assess the monitoring data,
- Conduct regular visual inspections of the subway or the embankment if it is filled, and
- Provide additional track and/or structural support in response to actual measurements and observations during mining.

It is considered that with the adoption of appropriate management measures, the potential impacts on the subway can be managed, even if actual subsidence movements are greater than the predictions or substantial non-conventional movements occur.

6.1.10. Potential Impacts on Cuttings

A summary of the railway cuttings within the Study Area is provided in Table 6.11.

Table 6.11 Railway Cuttings within the Study Area

Cutting Label	Approximate Kilometrage	Location	Description
Cutting 74.0 km	73.76 ~ 74.24	Above Longwall 901	15 metres high
Cutting 75.3 km	75.00 ~ 75.49	Above Longwall 901	10 metres high
Cutting 76.6 km	76.46 ~ 76.75	50 metres south-west of Longwall 902	5 metres high

The cutting batters consist of weathered shale and some are steeply sided. The cuttings have been inspected by the geotechnical engineer *David Christie* and the inspection report states that "*Only minor geological structures are visible in the cutting faces*" (Christie, 2010).

Cross-sections through the cuttings, looking eastwards (i.e. up track), are provided in Fig. 6.9 to Fig. 6.11. The largest cutting is at 76.6 km, which is 15 metres high, and a photograph is provided in Fig. 6.12.

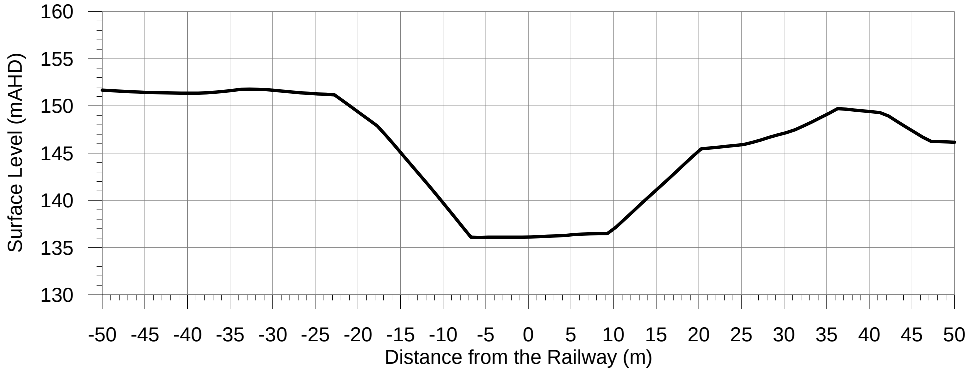

Fig. 6.9 Cross-section through Cutting 74.0 km – Looking East (Up Track)

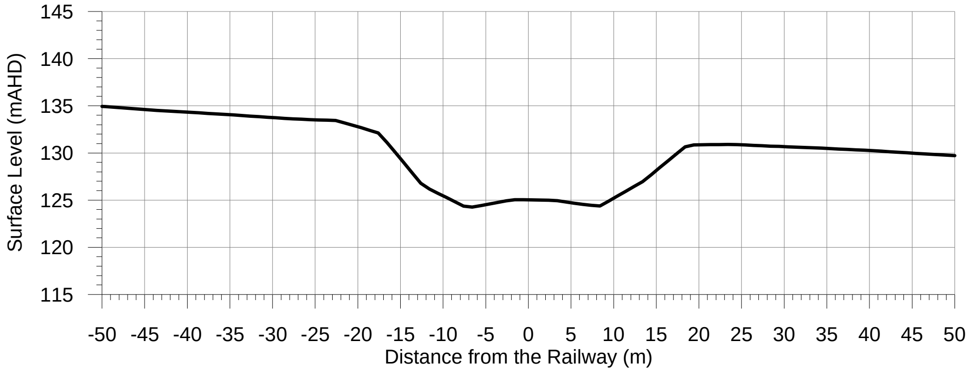

Fig. 6.10 Cross-section through Cutting 75.3 km – Looking East (Up Track)

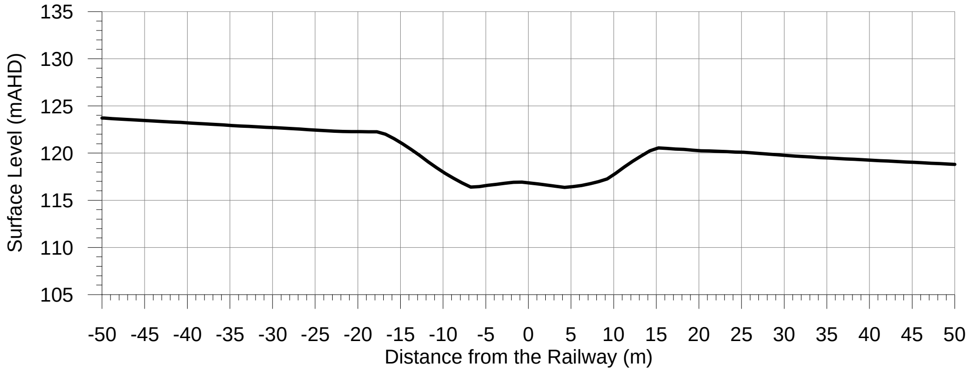

Fig. 6.11 Cross-section through Cutting 76.6 km – Looking East (Up Track)

Fig. 6.12 Photograph of Cutting 76.6 km – Looking West (Down Track)

A summary of the maximum predicted total conventional subsidence parameters for the railway cuttings, resulting from the extraction of the proposed longwalls, is provided in Table 6.12.

Table 6.12 Maximum Predicted Total Conventional Subsidence Parameters at Railway Cuttings after the Extraction of the Proposed Longwalls

Cutting Label	Maximum Predicted Subsidence (mm)	Maximum Predicted Tilt in Any Direction (mm/m)	Maximum Predicted Hogging Curvature in Any Direction (km^{-1})	Maximum Predicted Sagging Curvature in Any Direction (km^{-1})
Cutting 74.0 km	750	3.0	0.02	0.03
Cutting 75.3 km	875	1.0	0.03	0.03
Cutting 76.6 km	50	0.5	< 0.01	< 0.01

The predicted tilts provided in the above table are the maxima in any direction after the completion of all of the proposed longwalls. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each of the proposed longwalls.

In the unlikely event that the faces of these cuttings are impacted by mine subsidence, the failure is likely to be very minor, in the form of small fragments of rock, and likely to fall into the clear area adjacent to the railway, referred to as *the cess* (Christie, 2010).

The Rail Technical Committee will consider mitigation measures before the cuttings experience subsidence movements. Mitigation works could include, for example, scaling the cutting faces and removing debris from the cess.

It is likely that the following management measures will be used to manage potential impacts on the cuttings:-

- Assess condition of the cuttings prior to mining,
- Consider and implement mitigation measures such as scaling the cutting faces and removing debris from the cess,
- Install a monitoring system, which includes, among other things, the monitoring of ground movements at the cuttings,
- Regularly review and assess the monitoring data,
- Conduct regular visual inspections of the cuttings, and
- Clear the cess of debris if required based on observations during mining.

It is considered that with the adoption of appropriate management measures, the potential impacts on the cuttings can be managed, even if actual subsidence movements are greater than the predictions or substantial non-conventional movements occur.

6.1.11. Potential Impacts on Embankments

A summary of the railway embankments within the Study Area is provided in Table 6.13.

Table 6.13 Railway Embankments within the Study Area

Embankment Label	Approximate Kilometrage	Location	Approximate Height
Embankment 73.4 km	73.30 ~ 73.63	Above Longwall 901	3 metre high
Embankment 74.7 km	74.39 ~ 74.96	Above Longwall 901	10 metre high
Embankment 75.7 km	75.49 ~ 76.03	Above Longwall 902	20 metre high
Embankment 76.2 km	76.12 ~ 76.33	Above Longwall 902	15 metre high

Cross-sections through the embankments, looking eastwards (i.e. up track), are provided in Fig. 6.13 to Fig. 6.16. The largest embankment in the Study Area is Embankment 75.7 km, which is around 20 metres high, and a photograph is provided in Fig. 6.17.

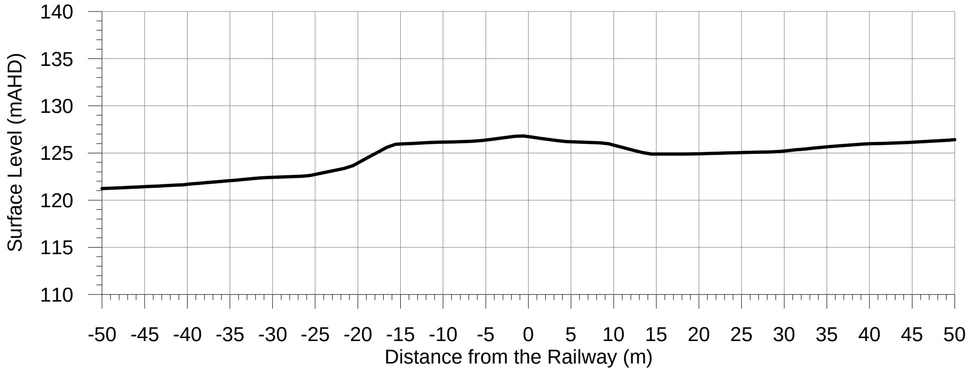

Fig. 6.13 Cross-section through Embankment 73.4 km - Looking East (Up Track)

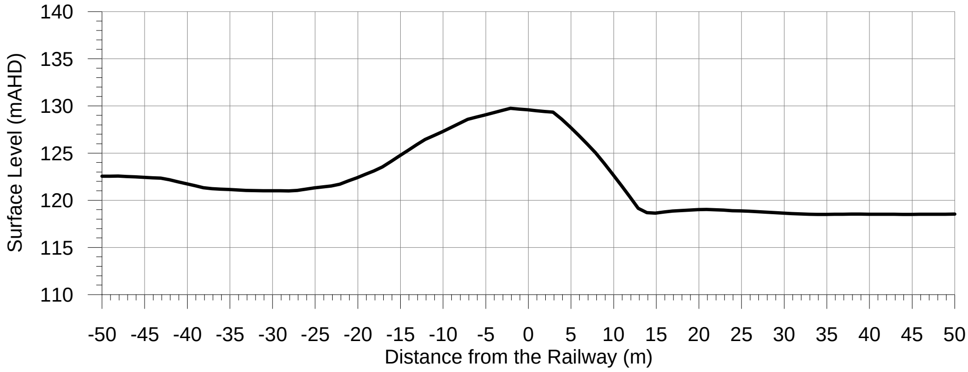

Fig. 6.14 Cross-section through Embankment 74.7 km - Looking East (Up Track)

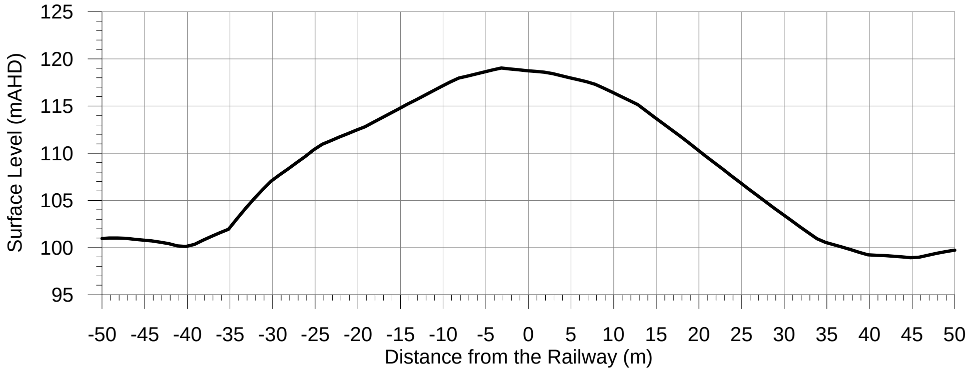

Fig. 6.15 Cross-section through Embankment 75.7 km - Looking East (Up Track)

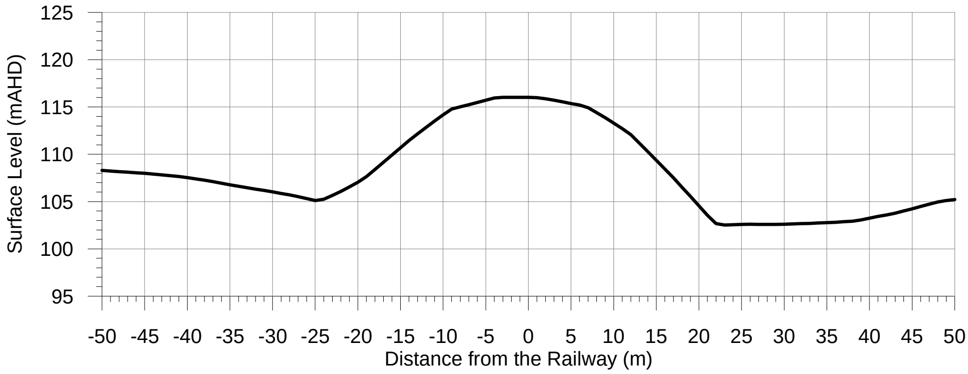

Fig. 6.16 Cross-section through Embankment 76.2 km - Looking East (Up Track)

Fig. 6.17 Photograph of Embankment 75.7 km - Looking West (Down Track)

The embankments have been inspected by the geotechnical engineer *David Christie* (2010).

A summary of the maximum predicted total conventional subsidence parameters at the railway embankments, resulting from the extraction of the proposed longwalls, is provided in Table 6.14.

Table 6.14 Maximum Predicted Total Conventional Subsidence Parameters at the Railway Embankments after the Extraction of Each of the Proposed Longwalls

Embankment Label	Maximum Predicted Subsidence (mm)	Maximum Predicted Tilt in Any Direction (mm/m)	Maximum Predicted Hogging Curvature in Any Direction (km^{-1})	Maximum Predicted Sagging Curvature in Any Direction (km^{-1})
Embankment 73.4 km	500	3.0	0.02	0.02
Embankment 74.7 km	875	2.0	0.02	0.03
Embankment 75.7 km	925	4.0	0.04	0.03
Embankment 76.2 km	425	3.0	0.02	0.01

The predicted tilts provided in the above table are the maxima in any direction after the completion of all of the proposed longwalls. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each of the proposed longwalls.

IC has commissioned studies and reviews on potential changes to embankment stability as a result of mine subsidence for an embankment located above longwalls at Appin Area 7 at 69 km. The studies include:-

- Geotechnical investigations of the embankment material,
- Finite element modelling of potential changes to embankment stress and strain due to mine subsidence,
- Slope stability analyses of existing embankment condition and potential condition if a tension crack formed in the embankment, and
- Independent peer review.

The studies concluded that the mine subsidence will not result in significant changes to embankment stability. The greatest risk to embankment stability is saturation of the fill material, which may occur as a result of blockage to culverts.

The study site at 69 km is close to and appears to be similar in material to the embankments in the Study Area. It is therefore considered that the knowledge gained from the study at 69 km can be used to assist with understanding the potential for impacts on the embankments in the Study Area for the proposed Longwalls 901 to 904. In this case, culverts pass through three of the four embankments in the Study Area and it is important that these culverts are clear and serviceable.

The Rail Technical Committee will consider mitigation measures before each embankment experiences subsidence movements. Mitigation works could include, for example, cleaning out or strengthening of the culverts within the embankments.

It is likely that the following management measures will be used to manage potential impacts on the embankments:-

- Assess pre-mining condition of the embankments,
- Consider and implement mitigation measures such as cleaning out of culverts and strengthening of the culverts to prevent collapse,
- Install a monitoring system, which includes, among other things, the monitoring of ground movements at the embankments,
- Regularly review and assess the monitoring data,
- Conduct regular visual inspections of the embankments and culverts, and
- Provide additional culvert support in response to actual measurements and observations during mining.

It is considered that with the adoption of appropriate management measures, the potential impacts on the embankments can be managed, even if actual subsidence movements are greater than the predictions or substantial non-conventional movements occur.

6.1.12. Potential Impacts on Emergency Crossover

An emergency crossover is located on the country side of Douglas Park Station between 73.4 km and 73.5 km. The crossover allows trains to cross from one track to the other in emergency situations. The crossover is located directly above the finishing end of proposed Longwall 901 and a photograph is provided in Fig. 6.18.

Photograph courtesy Pidgeon Civil Engineering

Fig. 6.18 Photograph of Emergency Crossover

ARTC are undertaking a review of its traffic management infrastructure and is considering the installation of high speed crossovers at strategic locations before the commencement of mining in Area 9. It is possible that a high speed crossover will be installed within the Study Area. The existing crossover will likely be decommissioned if high speed crossovers are installed.

If the crossover remains operational during the mining of Longwalls 901 and 902, the Rail Technical Committee will conduct an engineering assessment on the potential impacts of mine subsidence on the crossover and potential effects on its operations following the implementation of the track expansion system. Management measures will be developed to ensure that the crossover is serviceable during mining.

It is considered that with the adoption of appropriate management measures, the potential impacts on the crossover can be managed, even if actual subsidence movements are greater than the predictions or substantial non-conventional movements occur.

6.1.13. Potential Impacts on Douglas Park Station

Douglas Park Railway Station at 73.319 km is located just beyond the finishing end of Longwall 901. The station consists of concrete platform structures and small single storey structures, as shown in Fig. 6.19.

Fig. 6.19 Photograph of Douglas Park Station

A summary of the maximum predicted total conventional subsidence parameters for the station, resulting from the extraction of the proposed longwalls, is provided in Table 6.15.

Table 6.15 Maximum Predicted Total Conventional Subsidence Parameters at the Douglas Park Railway Station after the Extraction of the Proposed Longwalls

Maximum Predicted Subsidence (mm)	Maximum Predicted Tilt Along in Any Direction (mm/m)	Maximum Predicted Hogging Curvature in Any Direction (km^{-1})	Maximum Predicted Sagging Curvature in Any Direction (km^{-1})
100	1.0	0.01	< 0.01

Tahmoor Railway Station recently experienced a total of approximately 150 mm of subsidence movements during the mining of Longwalls 22 to 25 and no impacts were experienced. Given that the proposed longwalls in Area 9 will not mine directly beneath the station, the potential for physical impacts on the structures is considered to be low.

ARTC's Base Operating Standards provide for allowable clearances between the track and the railway platforms. It is possible, although unlikely, that differential horizontal movements between the track and platforms will results in an exceedance of the Base Operating Standards. The likelihood is assessed as low as the clearances from the Base Operating Standards between the track and the platforms and between the two tracks are typically an order of magnitude greater than predicted differential horizontal movements.

A plan for managing potential impacts on railway stations has been developed by the Rail Technical Committee during the mining of Tahmoor Longwalls 22 to 25. A management plan using similar management measures will likely be adopted during the mining of the proposed Longwalls 901 to 902, which could include:-

- Assess pre-mining track condition and clearances to the platforms and between the tracks,
- Assess pre-mining condition of the station platform and structures,
- Install a monitoring system, which includes, among other things, the monitoring of platform and centreline clearances,
- Regularly review and assess the monitoring data,

- Conduct regular visual inspections of the track and platform structures, and
- Adjust the track or repair impacts on the structures if they are observed during mining.

It is considered that with the adoption of appropriate management measures, the potential impacts on the station can be managed, even if actual subsidence movements are greater than the predictions or substantial non-conventional movements occur.

6.1.14. Potential Impacts on Level Crossings

The Camden Road automated vehicular level crossing is located next to the Douglas Park Railway Station, just beyond the end of Longwall 901. The level crossing consists of, among other things, boom gates, signage and warning lights, as shown in Fig. 6.20.

Fig. 6.20 Photograph of Camden Road Crossing

The maximum predicted total conventional subsidence parameters at the crossing are slightly less than the predicted movements at the station, which are provided in Table 6.15.

An automated pedestrian level crossing with automatic gates adjacent to Tahmoor Railway Station recently experienced a total of approximately 150 mm of subsidence movements during the mining of Longwalls 22 to 25 and no impacts were experienced.

It is unlikely that the boom gate structures will experience impacts due to mining. Mining-induced ground strains are unlikely to affect the structures, which consist of isolated single poles. Mining-induced ground tilts are unlikely to result in impacts, as the boom gates consist of single horizontal bars with substantial ground clearance.

The operation of the level crossing is managed by the signalling system and methods of managing this system are described in 6.1.15. A plan for managing potential impacts on automated level crossings with gates has been developed by the Rail Technical Committee during the mining at Tahmoor Colliery. A management plan using similar management measures will likely be adopted during the mining of the proposed Longwalls 901 to 902:-

- Assess pre-mining condition of the level crossing,
- Install a monitoring system, which includes, among other things, the monitoring of ground movements in the vicinity of the level crossing,
- Regularly review and assess the monitoring data,
- Brief ARTC inspectors to pay specific attention to the operation of the gates during mining,
- Conduct regular visual inspections of the track and level crossing, and
- Adjust or the level crossing if required during mining.

There are also two small vehicular level crossings at 76.13 km and 76.38 km and their locations are shown in Drawing No. MSEC448-13. A photograph of one crossing is shown in Fig. 6.21.

Fig. 6.21 Photograph of Vehicle Crossing at 76.13 km

A small level crossing experienced subsidence movements during the mining of Longwall 25 and no impacts were experienced. It is unlikely that the gaps between the rails and the timbers will close as a result of differential horizontal movements between the rails and the timbers as the timbers rest on top of the stiff concrete sleepers. The potential impacts at level crossings can, however, be managed by visual inspections during mining.

It is considered that with the adoption of appropriate management measures, the potential impacts on the level crossings can be managed, even if actual subsidence movements are greater than the predictions or substantial non-conventional movements occur.

6.1.15. Potential Impacts on Signalling and Communications Systems

The ARTC signalling system is controlled remotely by ARTC Train Control at Junee. The signalling and communications system within the Study Area include:-

- Underground copper and optical fibre cabling along the UP side of the rail corridor,
- Signalling sheds, and
- Signals.

The optical fibre cable is buried in conduit and is used for CCTV security surveillance. The potential for impacts on the CCTV cable is considered low. Based on previous longwall mining experience at similar depths of cover, it has been found that optical fibre cables buried in conduit can typically tolerate mine subsidence movements without adverse impacts.

The insulated direct buried 50 core copper signal cable could potentially be impacted by mining. The consequence of impacts on the signal cable can be extreme if it results in wrong side failure. Wrong side failure could occur if the insulation around the cables breaks, thereby exposing the copper cables and allowing them to cross over.

Signal cables have been inspected and tested near Appin Longwalls 703 and 704, where the magnitude of strains required to break the cables was 100 mm/m, or greater. It was found by signalling consultant Signal Support Services, however, that when the cables failed, the copper cables remained in their extended state, while in the majority of cases, the insulation sheaths around the cables returned to their near-normal unstrained state, thereby exposing the copper cables. It is therefore possible that Wrong Side Failure could occur as a result of extreme tensile strain.

As documented in the management plan for Longwalls 703 and 704, telecommunications expert Colin Dove advised that the signal cable is roughly equivalent to direct buried copper cables that have previously experienced subsidence movements without impacts in the Southern Coalfield during the mining of Appin Longwalls 301 and 302, Appin Longwalls 405 to 409, West Cliff Longwalls 31 to 34 and Tahmoor Longwalls 20 and 21. These longwalls are of comparable widths and depths of cover to the proposed Longwalls 901 to 904.

A similar direct buried copper cable also experienced subsidence movements without adverse impacts in the Hunter Coalfield during the mining of Beltana Whybrow Longwalls 1 to 5, at depths of cover of approximately 100 metres, and the maximum observed strains were in excess of 10 mm/m over a 10 metre bay length. The subsidence movements at Beltana are substantially greater than those that are expected to generally occur above the proposed longwalls.

Based on the above information, the probability of Wrong Side Failure as a result of the mining of the proposed longwalls is considered to be extremely low for the reasons listed below:-

- The strains required to break the cables are orders of magnitude greater than the normal range of strains that are expected to occur during the mining of the proposed longwalls,
- Nearby cables above Appin Longwalls 703 and 704 have been inspected and tested and are currently in good condition, and
- Direct buried copper cables of similar construction have performed satisfactorily during similar and more extreme subsidence events than those expected to occur during the mining of the proposed longwalls.

It is possible, however, that cable breakages could develop if severe ground deformations occur in the vicinity of the cables, such as ground stepping at a fault, even when the overall ground strains are compressive.

In such situations, however, it is possible to relieve the stress in the cables by exposing them to the surface. This will allow the cables to drape over the ground deformation.

A plan for managing potential impacts on signalling and communications systems has been developed by the Rail Technical Committee during the mining of Appin Longwalls 703 and 704. A management plan using similar management measures will likely be adopted during the mining of the proposed Longwalls 901 to 902 and will likely include:-

- Conduct an audit and assessment of the pre-mining condition of signalling and communications systems,
- Brief ARTC personnel, who continuously monitor the condition of the signalling and communication systems,
- Install a monitoring system, which includes, among other things, the monitoring of ground movements,
- Regularly review and assess the monitoring data,
- Conduct regular visual inspections of the surface along the route of the buried cables, and
- Expose and inspect the condition of the cables in response to monitoring results during mining if required.

It is considered that with the adoption of appropriate management measures, the potential impacts on the signalling and communications systems can be managed, even if actual subsidence movements are greater than the predictions or substantial non-conventional movements occur.

6.1.16. Potential Impacts on Communications Tower

An ARTC owned communications tower is located near the Camden Road level crossing at Douglas Park, just beyond the end of Longwall 901. A photograph is shown in Fig. 6.22.

Fig. 6.22 Photograph of Communications Tower near Camden Road Level Crossing

A summary of the maximum predicted total conventional subsidence parameters at the tower, resulting from the extraction of the proposed longwalls, is provided in Table 6.16.

Table 6.16 Maximum Predicted Total Conventional Subsidence Parameters at the Douglas Park Communications Tower after the Extraction of the Proposed Longwalls

Maximum Predicted Subsidence (mm)	Maximum Predicted Tilt Along in Any Direction (mm/m)	Maximum Predicted Hogging Curvature in Any Direction (km^{-1})	Maximum Predicted Sagging Curvature in Any Direction (km^{-1})
50	0.5	< 0.01	< 0.01

Mining-induced strains are unlikely to affect the isolated single pole structure. Mining-induced tilts could, however, affect the communications system if the signal strength is sensitive to small changes in height and orientation.

The Rail Technical Committee will introduce consider management measures prior to the tower experiencing subsidence movements. It is likely that the following management measures will be used to manage potential impacts:-

- Assess pre-mining condition of the tower and sensitivity of the communications system,
- Consider and implement mitigation measures to reduce or avoid loss of deterioration of signal strength,
- Install a monitoring system, which includes, among other things, the monitoring of ground movements around the tower, and if the communications system is sensitive to small changes, the tilt of the tower and/or signal strength,
- Regularly review and assess the monitoring data,
- Conduct regular visual inspections of the tower, and
- Adjust the antennae if required in response to actual measurements and observations during mining.

It is considered that with the adoption of appropriate management measures, the potential impacts on the communications tower can be managed, even if actual subsidence movements are greater than the predictions or substantial non-conventional movements occur.

6.1.17. Potential Impacts on Powerline Crossing

An 11 kV powerline crosses the railway near the Camden Road level crossing at Douglas Park, just beyond the end of Longwall 901. A photograph is shown in Fig. 6.22. The potential impacts on the electrical infrastructure are discussed in Section 6.13.

Given that the powerline crossing is located beyond the end of Longwall 901, it is unlikely that clearance heights will be reduced as a result of the proposed mining.

A plan for managing potential impacts on powerline crossings have been developed by the Rail Technical Committee during the mining of Appin Longwalls 703 and 704. A management plan using similar management measures will likely be adopted during the mining of the proposed Longwalls 901 to 902 and will likely include:-

- Conduct an audit and assessment of the clearance height of the powerline crossing,
- Install a monitoring system, which includes, among other things, the monitoring of differential movements at power poles,
- Regularly review and assess the monitoring data,
- Conduct regular visual inspections of the powerline clearance, and
- Adjust the clearance height of cables in response to monitoring results during mining in the unlikely that adjustment is required.

It is considered that with the adoption of appropriate management measures, the potential impacts on the powerline crossing can be managed, even if actual subsidence movements are greater than the predictions or substantial non-conventional movements occur.

6.2. The HW2 Hume Highway

The location of the HW2 Hume Highway is shown in Drawing No. MSEC448-14. The descriptions, predictions and impact assessments for the highway are provided in the following sections.

6.2.1. Description of the HW2 Hume Highway

The HW2 Hume Highway is located at a distance of 750 metres south-east of Longwall 901, at its closest point to the proposed longwalls. Although the highway is located outside the Study Area, it is likely to experience far-field movements, as a result of the extraction of the proposed longwalls, and could be sensitive to these movements. The highway and associated infrastructure, therefore, have been included in the assessments provided in this report.

The HW2 Hume Highway is an important road corridor, linking Sydney with Canberra and Melbourne. The highway currently carries in excess of 20 million tonnes of road freight annually and current traffic volumes are in excess of 37,000 vehicles per day. The accident, fatal and serious injury crash rates for this section of the highway are, at present, one of the lowest in the state. The dual carriageway highway has been constructed with an asphaltic pavement on a slag road base and stabilised crushed sandstone sub-base.

The HW2 Hume Highway crosses the Nepean River at a distance of 1 kilometre south of the proposed Longwall 901. The description, predictions and impact assessments for the Twin Bridges over the Nepean River are provided in Section 6.3.

Moreton Park Road crosses over the HW2 Hume Highway at a distance of 1 kilometre east of the proposed longwalls. The description, predictions and impact assessments for this local road bridge are provided in Section 6.5. There are no interchanges with local roads in the vicinity of the Study Area.

In addition to the major structures described above, there are also a number of smaller structures associated with the highway in the vicinity of the Study Area, which include drainage culverts, cuttings, embankments, emergency phone system and road signage.

6.2.2. Predictions and Impact Assessments for the HW2 Hume Highway

The HW2 Hume Highway is located well outside the 35 degree angle of draw limit. At this distance, the highway is predicted to experience less than 20 mm of vertical subsidence. While it is possible that the highway could experience subsidence slightly greater than 20 mm, it would not be expected to experience any significant conventional tilts, curvatures or strains.

The highway is likely to experience far-field horizontal movements, which are described in Sections 3.3 and 4.6. It can be seen from Fig. 4.7, that incremental far-field horizontal movements around 50 mm have been observed at distances of 1 kilometre from previously extracted longwalls, such as the case as the highway. These movements tend to be bodily movements, towards the extracted goaf area, and are accompanied by very low levels of strain, which are generally less than the order of survey tolerance (i.e. < 0.3 mm/m).

It is unlikely, therefore, that the HW2 Hume Highway pavement would experience any adverse impacts resulting from the extraction of the proposed longwalls. Similarly, it is not expected that the drainage culverts, cuttings, embankments, emergency phone system and road signage would experience any adverse impacts resulting from the extraction of the proposed longwalls.

The Twin Bridges over the Nepean River and Moreton Park Road Bridge (South) could be sensitive to the far-field movements resulting from the extraction of the proposed longwalls. More detailed predictions and impact assessments for these structures are provided in Sections 6.3 and 6.5.

6.2.3. Impact Assessments for the HW2 Hume Highway Based on Increased Predictions

If the actual mine subsidence movements exceeded those predicted by a factor of 5 times, the maximum subsidence at the highway would still be less than 20 mm and, therefore, unlikely to result in any adverse impacts. Even if the subsidence at the highway was slightly greater than 20 mm, it would not be expected to experience any significant conventional tilts, curvatures or strains.

If the actual far-field horizontal movements exceeded those predicted by a factor of 2 times, the strain associated with these movements would still be expected to be small, in the order of survey tolerance (i.e. < 0.3 mm/m).

6.2.4. Recommendations for the HW2 Hume Highway

IC has developed management strategies for HW2 Hume Highway for the longwalls in Appin Area 7 which are being extracted directly beneath the road. It is recommended that these existing management strategies are reviewed, in consultation with the Roads and Maritime Services (RMS), based on the potential movements resulting from the extraction of the proposed longwalls.

6.3. The Twin Bridges over the Nepean River

The location of the Twin Bridges over the Nepean River is shown in Drawing No. MSEC448-14. The descriptions, prediction and impact assessments for these bridges are provided in the following sections.

6.3.1. Description of the Twin Bridges over the Nepean River

The Twin Bridges over the Nepean River at Douglas Park are located at a distance of 1 kilometre south of the proposed Longwall 901. The bridges have an overall length of approximately 235 metres for the southbound carriageway and 285 metres for the northbound carriageway. Both bridges consist of reinforced concrete bridge decks and piers. A photograph of these bridges is provided in Fig. 6.23.

Fig. 6.23 Twin Bridges over the Nepean River at Douglas Park

An indicative elevation of the bridges is provided in Fig. 6.24 (courtesy of IC), which shows the relative locations of the supporting columns, which are spaced at around 50 metres. The figure also shows the locations of the 3D relative monitoring points which were surveyed during the extraction of Appin Longwalls 701 to 704. The marks at the bases of the column were also measured during the extraction of Tower Longwalls 16 and 17.

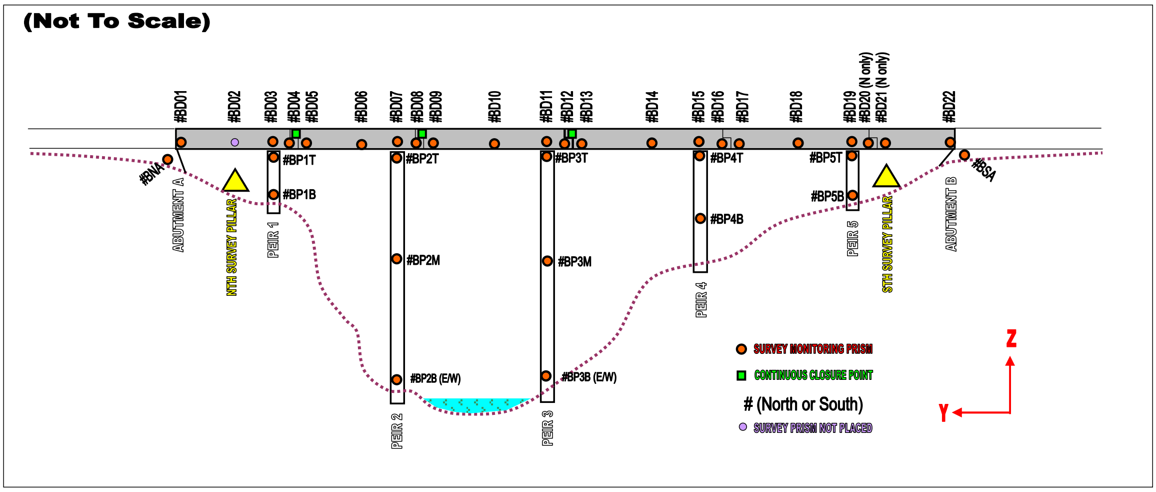

Fig. 6.24 Indicative Elevation of the Twin Bridges (Courtesy of IC)

As part of the management strategies of the Nepean Twin Bridges for the longwalls in Appin Area 7, the north and south carriageways were re-aligned, which was completed around the commencement of Appin Longwall 701.

A summary of the maximum observed relative longitudinal movements (i.e. horizontal movements along the bridge alignments), relative transverse movements (i.e. horizontal movements across the bridge alignments) and relative vertical movements for the Northbound and Southbound Carriageways, after the completion of Appin Longwalls 701 to 703, are provided in Table 6.17 and Table 6.18, respectively.

Table 6.17 Maximum Observed Relative Movements for the Northbound Carriageway after the Completion of Appin Longwalls 701 to 703

Location	Maximum Observed Longitudinal Movement Relative to Local Datum (mm)	Maximum Observed Transverse Movement Relative to Local Datum (mm)	Maximum Observed Vertical Movement Relative to Local Datum (mm)
Underside of Carriageway (NBD01 to NBD22)	5	2	5 (Down)
Carriageway Upper Supports (NBNA, NBSA, NBP1T to NBP5T and NBP2M to NBP3M)	4	2	2 (Down)
Lower Supports (NBP2B E&W and NBP3B E&W)	3	1	4 (Up)

Table 6.18 Maximum Observed Relative Movements for the Southbound Carriageway after the Completion of Appin Longwalls 701 to 703

Location	Maximum Observed Longitudinal Movement Relative to Local Datum (mm)	Maximum Observed Transverse Movement Relative to Local Datum (mm)	Maximum Observed Vertical Movement Relative to Local Datum (mm)
Underside of Carriageway (SBD01 to SBD22)	3	1	4 (Down)
Carriageway Upper Supports (SBNA, SBSA, SBP1T to SBP5T and SBP2M to SBP3M)	3	1	1 (Up and down)
Lower Supports (SBP2B E&W and SBP3B E&W)	3	3	4 (Up)

The accuracies of the measured longitudinal, transverse and levels at the relative 3D monitoring points on the Nepean Twin Bridges are in the order of ±3 to ±5 mm. It can be seen from Table 6.17 and Table 6.18, that the observed movements for both the Northbound and Southbound Carriageways were in the order of survey tolerance.

6.3.2. Predictions for the Twin Bridges over the Nepean River

The Twin Bridges could experience small far-field horizontal movements resulting from the extraction of the proposed longwalls. It can be seen from Fig. 4.7, that incremental far-field horizontal movements around 50 mm have been observed at distances of 1 kilometre from extracted longwalls, such as the case for the bridges.

The Twin Bridges are sensitive to the relative horizontal movements between the supporting columns, rather than the absolute horizontal movements of the entire bridge structure. Horizontal mid-ordinate deviation is a measure of relative horizontal movement, which is the change in perpendicular horizontal distance from a point to a chord formed by joining points on either side. A schematic sketch showing the horizontal mid-ordinate deviation of a mark compared to its adjacent survey marks is provided in Fig. 6.25.

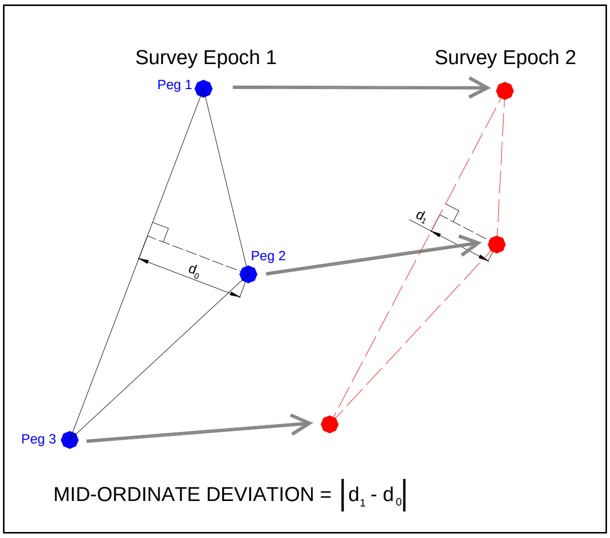

Fig. 6.25 Schematic Representation of Horizontal Mid-Ordinate Deviation

The bridge supporting columns are spaced at around 50 metres. The incremental horizontal mid-ordinate deviations were then calculated from the available 3D monitoring data in the Southern Coalfield, where the survey marks were spaced at 60 metres ±10 metres, and the results are shown as the grey diamonds in Fig. 6.26. The incremental horizontal mid-ordinate deviations at the base of the Twin Bridge column structures, measured during the extraction of Tower Longwalls 16 and 17 and Appin Longwalls 701 to 703, are shown as the coloured diamonds in this figure.

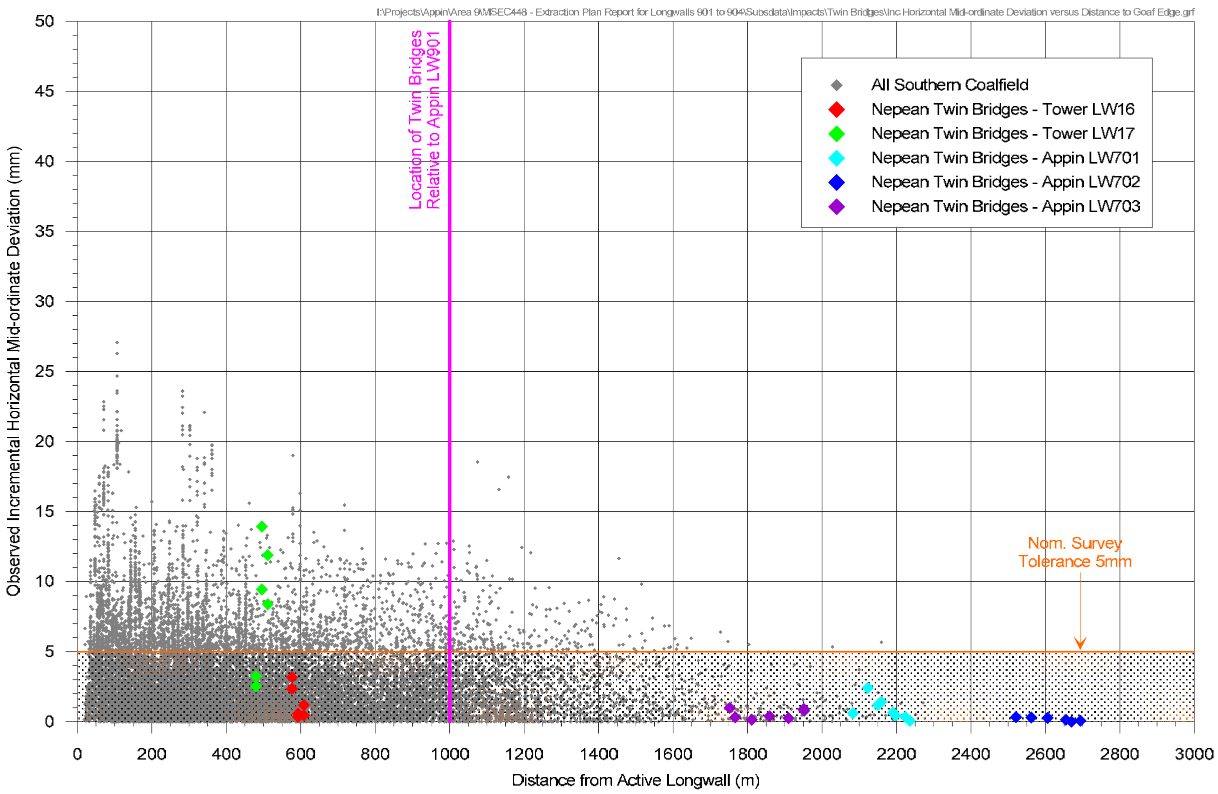

Fig. 6.26 Observed Incremental Horizontal Mid-Ordinate Deviation for 3D Survey Marks in the Southern Coalfield Spaced at 60 metres ± 10 metres

It can be seen from the above figure, that the Twin Bridges have experienced incremental horizontal mid-ordinate deviations up to 15 mm, over three adjacent supporting columns, resulting from the extraction of Tower Longwall 17. The incremental horizontal mid-ordinate deviations resulting from the extraction of the other longwalls at Tower and Appin Collieries were less than 5 mm (i.e. in the order of survey tolerance).

It can also be seen, that incremental horizontal mid-ordinate deviations around 15 mm have also been measured elsewhere in the Southern Coalfield, for survey marks spaced at 60 metres ±10 metres, at similar distances from extracted longwalls as the Twin Bridges are from the proposed Appin Longwall 901.

6.3.3. Impact Assessments for the Twin Bridges

IC has developed management strategies for the Twin Bridges for the previously extracted Longwalls 16 and 17 at Tower Colliery and Longwalls 701 to 704 at Appin Colliery. It is recommended that these existing management strategies are reviewed, in consultation with the Roads and Maritime Services (RMS), based on the potential movements resulting from the extraction of the proposed longwalls.

The study would require input from structural and geotechnical engineers, and subsidence engineers. The management measures may include a combination of:-

- Mitigation measures prior to mining,
- Installation of a monitoring system, which includes, among other things, the monitoring of ground movements, structure movements, sub-surface ground movements, bridge joint displacements and visual inspections,
- Implementation of a response plan, where actions are triggered by monitoring results, and
- Implementation of a reporting and communication plan.

It is expected, with the implementation of the appropriate management strategies, that the Twin Bridges over the Nepean River could be maintained in safe and serviceable conditions during and after the extraction of the proposed Longwalls 901 to 904.

6.4. The Local Roads

The locations of local roads within the Study Area are shown in Drawing No. MSEC448-14. The descriptions, prediction and impact assessments for the local roads within the Study Area are provided in the following sections.

The descriptions, predictions and impact assessments for the local road bridges and local road drainage culverts are provided in Sections 6.5 and 6.7, respectively. The descriptions, predictions and impact assessments for the HW2 Hume Highway and the Twin Bridges over the Nepean River are provided in Sections 6.2 and 6.3, respectively.

6.4.1. Descriptions of the Local Roads

The main local road within the Study Area is **Menangle Road** which crosses directly above the proposed Longwalls 902 to 904. The road provides a connection between the township of Campbelltown, which is located north-east of the Study Area, and Picton Road, to the south-west of the Study Area. There are also a number of local roads within the township of Douglas Park which are located directly above the eastern ends of the proposed longwalls.

A summary of the local roads within the Study Area is provided in Table 6.19.

Table 6.19 Summary of Major Local Roads within the Study Area

Local Road	Location	Total Length of Road within Study Area (km)	Total Length of Road Located Directly above Proposed Longwalls (km)
Menangle Road	Above LW902 to LW904	4.0	3.0
Other Local Roads	Above LW901 to LW904	12.0	2.4

The local roads have single carriageways with bitumen seals. The local roads within the township of Douglas Park also have concrete kerb and guttering. The local roads are owned and maintained by the Wollondilly Shire Council. A photograph of Menangle Road is provided in Fig. 6.27.

Fig. 6.27 Photograph of Menangle Road

Moreton Park Road crosses the HW2 Hume Highway at a distance of 1 kilometre east of the proposed longwalls. The descriptions, predictions and impact assessments for Moreton Park Road Bridge (South) are provided in Section 6.5.

6.4.2. Predictions for the Local Roads

The predicted profiles conventional subsidence, tilt and curvature along the alignment of Menangle Road, resulting from the extraction of the proposed longwalls, are shown in Fig. E.08, in Appendix E. The predicted incremental profiles along the alignment of the road, due to the extraction of each of the proposed longwalls, are shown as dashed black lines. The predicted total profiles along the alignment of the road, after the extraction of each of the proposed longwalls, are shown as solid blue lines. The range of predicted curvatures in any direction to the road, at any time during or after the extraction of the proposed longwalls, is shown by the grey shading.

A summary of the maximum predicted total conventional subsidence parameters for Menangle Road, after the extraction of each of the proposed longwalls, is provided in Table 6.20.

Table 6.20 Maximum Predicted Total Conventional Subsidence Parameters for Menangle Road after the Extraction of Each of the Proposed Longwalls

Location	Longwall	Maximum Predicted Subsidence (mm)	Maximum Predicted Tilt Along Alignment (mm/m)	Maximum Predicted Hogging Curvature in Any Direction (km^{-1})	Maximum Predicted Sagging Curvature in Any Direction (km^{-1})
Menangle Road	After LW901	< 20	< 0.5	< 0.01	< 0.01
	After LW902	500	3.0	0.03	0.03
	After LW903	850	3.5	0.05	0.11
	After LW904	1125	3.5	0.06	0.11

The predicted tilts provided in the above table are the maxima along the alignment of the road after the completion of each of the proposed longwalls. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each of the proposed longwalls.

The remaining local roads are located directly above the proposed longwalls and, therefore, could experience the full range of predicted subsidence movements. A summary of the maximum predicted conventional subsidence movements within the Study Area is provided in Chapter 4.

The local roads are linear features and, therefore, the most relevant distribution of strain is the maximum strains measured along whole monitoring lines above previous longwall mining. The analysis of strains along whole monitoring lines during the mining of previous longwalls in the Southern Coalfield is discussed in Section 4.4 and the results are provided in Fig. 4.4.

Non-conventional movements can also occur and have occurred in the NSW Coalfields as a result of, among other things, anomalous movements. The analysis of strains provided in Chapter 4 includes those resulting from both conventional and non-conventional anomalous movements.

The maximum predicted conventional strains for the local roads, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 1 mm/m tensile and 2 mm/m compressive.

6.4.3. Comparison of Predictions for the Roads with those provided in the Part 3A Application

The comparison of the maximum predicted subsidence parameters for Menangle Road with those provided in the Part 3A Application is provided in Table 6.21.

Table 6.21 Comparison of the Maximum Predicted Conventional Subsidence Parameters for Menangle Road Based on the Part 3A and Extraction Plan Layouts

Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt Along Alignment (mm/m)	Maximum Predicted Total Conventional Hogging Curvature in Any Direction (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature in Any Direction (km^{-1})
Part 3A Layout (Report No. MSEC404)	1150	4.0	0.05	0.08
Extraction Plan Layout (Report No. MSEC448)	1125	3.5	0.06	0.11

It can be seen from the above table, that the maximum predicted subsidence and tilt for Menangle Road, based on the Extraction Plan Layout, are slightly less than those predicted based on the Part 3A Layout. The maximum predicted hogging and sagging curvatures, based on the Extraction Plan Layout, are similar to but slightly greater than those predicted based on the Part 3A Layout.

6.4.4. Impact Assessments for the Local Roads

The maximum predicted conventional tilt along the alignment of Menangle Road, resulting from the extraction of the proposed longwalls, is 3.5 mm/m (i.e. 0.4 %), which represents a change in grade of 1 in 285. The maximum predicted conventional tilts for the remaining roads, resulting from the extraction of the proposed longwalls, is 6.5 mm/m (i.e. 0.7 %), which represents a change in grade of 1 in 155.

The predicted tilts are less than 1 % and are unlikely, therefore, to result in any adverse impacts on the serviceability or surface water drainage for the local roads. If any additional localised ponding or adverse changes in surface water drainage were to occur as the result of mining, the roads could be repaired using normal road maintenance techniques.

The maximum predicted conventional curvatures for Menangle Road, resulting from the extraction of the proposed longwalls, are 0.06 km^{-1} hogging and 0.11 km^{-1} sagging, which equate to minimum radii of curvatures of 17 kilometres and 9 kilometres, respectively. The maximum predicted conventional curvatures for the remaining roads, resulting from the extraction of the proposed longwalls, are 0.07 km^{-1} hogging and 0.12 km^{-1} sagging, which equate to minimum radii of curvatures of 14 kilometres and 8 kilometres, respectively.

The maximum predicted curvatures and the range of potential strains for the local roads, resulting from the extraction of the proposed longwalls, are similar to those typically experienced elsewhere in the Southern Coalfield. Longwalls in the Southern Coalfield have been successfully mined directly beneath local roads in the past, and some of these cases are provided in Table 6.22.

Table 6.22 Examples of Previous Experience of Mining Beneath Local Roads in the Southern Coalfield

Road	Distance and Longwalls	Observed Movements	Observed Impacts
Appin Road	2.8 km mined beneath by Appin LW1 and West Cliff LW5A3, LW5A4 and LW29 to LW34	1100 mm Subsidence 10 mm/m Tilt 1 mm/m Tensile Strain 5.5 mm/m Comp. Strain (Measured B-Line)	Localised depression above LW5A3. Bumps up to 100 mm and cracking up to 10 mm in pavement above LW32 to LW34
Brooks Point Road	2.4 km mined beneath by Appin LW1, LW2 & LW405 to LW409	700 mm Subsidence 5 mm/m Tilt 1 mm/m Tensile Strain 2 mm/m Comp. Strain (Measured A6000-Line)	Bump approximately 100 mm in pavement above LW408
Moreton Park Road	2.2 km mined beneath by Appin LW702 to LW704	1100 mm Subsidence 7.5 mm/m Tilt 1 mm/m Tensile Strain 3 mm/m Comp. Strain (Measured MPR-Line)	Minor cracking and localised bumps in pavement
Wilton Road	2.6 km mined beneath by Appin LW1, LW2, LW15, LW16, LW301 and LW302	650 mm Subsidence 4.5 mm/m Tilt 1 mm/m Tensile Strain 3 mm/m Comp. Strain (Measured M & N-Lines)	Some minor impacts to the road surface were observed above Appin LW301 and 302

The impacts on these local roads did not present a public safety risk and were remediated using normal road maintenance techniques. Photographs of the impacts observed along Appin Road are provided in Fig. 6.28 and Fig. 6.29.

Fig. 6.28 Bump in Slip Lane along Appin Road above West Cliff Longwall 32 (Courtesy of Colin Dove)

Fig. 6.29 Tension Crack in Appin Road above West Cliff Longwall 32 (Courtesy of Colin Dove)

The predicted mine subsidence movements at the local roads within the Study Area are similar to those observed and predicted at the local roads which have been directly mined beneath by previously extracted longwalls in the Southern Coalfield. The overall levels of impact on the local roads in the Study Area are, therefore, expected to be similar to those observed in the past. It is expected, therefore, that the local roads can be maintained in a safe and serviceable condition throughout the mining period using normal road maintenance techniques.

Menangle Road crosses the foothills of Razorback Range which has areas comprising steep slopes. The road crosses the range through a saddle feature above the eastern end of the proposed Longwall 904. The surface level and natural grade along the alignment of the road are illustrated in Fig. 6.30. The surface level and natural grade across the alignment of the road, in the location of the saddle, are illustrated in Fig. 6.31.

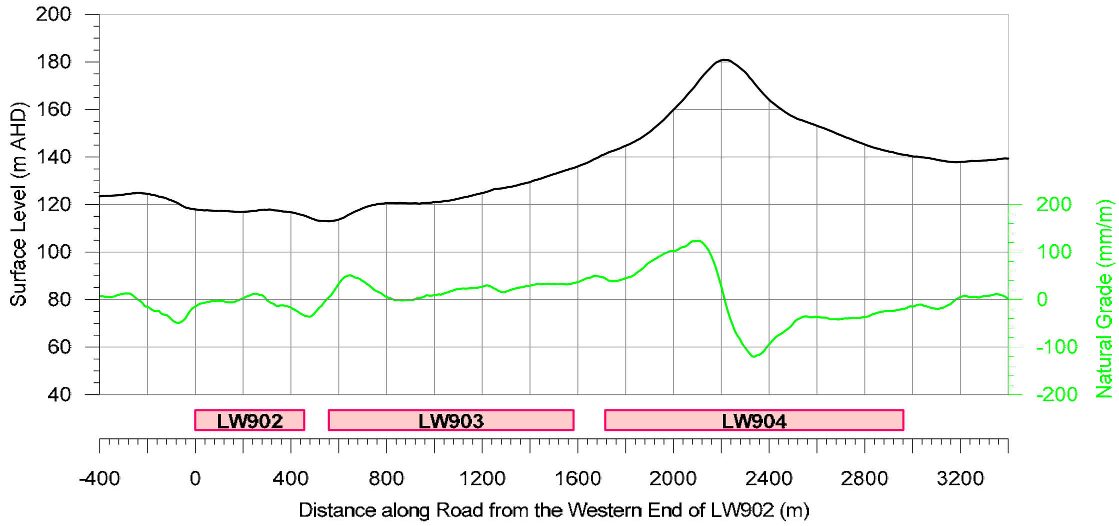

Fig. 6.30 Surface Level and Natural Grade Along the Alignment of Menangle Road

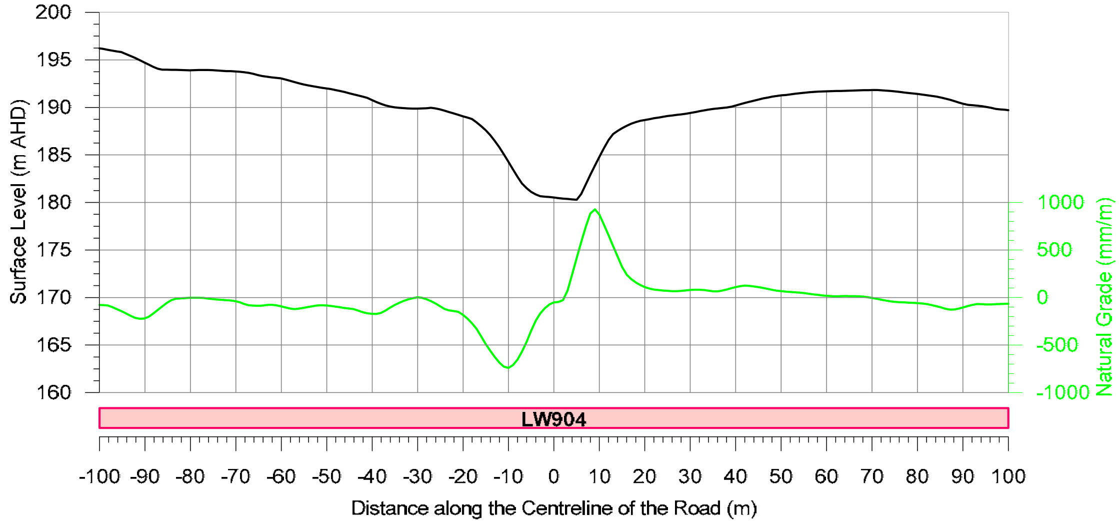

Fig. 6.31 Surface Level and Natural Grade Across the Alignment of Menangle Road

It can be seen from the above figures, that the maximum natural grades along and across the alignment of the road are 150 mm/m (i.e. 15 %) and 900 mm/m (i.e. 90 %), respectively, which represent natural gradients of around 1 in 7 and 1 in 1.1, respectively. The maximum natural grades across the alignment are associated with the road cutting through the saddle topographic feature.

Down slope soil movements and rock falls have been observed to occur naturally along this road. It is possible, therefore, that mining beneath the steep slopes could increase the potential for the down slope movement of the surface soils and for rock falls. It is recommended that IC develop management strategies, in consultation with the local council, to manage these risks.

Further discussions on the potential impacts on the steep slopes are provided in the reports by *Coffey* (2012) and *UoW* (2012).

6.4.5. Impact Assessments for the Local Roads Based on Increased Predictions

If the actual tilts exceeded those predicted by a factor of 2 times, the maximum tilt at the local roads would be 13 mm/m (i.e. 1.3 %), or a change in grade of 1 in 75. The potential impacts on the serviceability and surface water drainage of the roads would not be expected to significantly increase, as the maximum change in grade would still be small, in the order of 1 %. If any additional ponding or adverse changes in surface water drainage were to occur as the result of mining, the local roads could be repaired using normal road maintenance techniques.

If the actual curvatures exceeded those predicted by a factor of 2 times, the maximum curvature at the local roads would be 0.24 km^{-1}, which represents a minimum radius of curvature of 4 kilometres. In this case, the incidence of cracking, stepping and heaving of the local road surfaces would increase directly above the proposed longwalls. It would still be expected that any impacts could be repaired using normal road maintenance techniques.

While the predicted ground movements are important parameters when assessing the potential impacts on the local roads, it is noted that the impact assessments were primarily based on historical observations from previous longwall mining in the Southern Coalfield. The overall levels of impact on the local roads, resulting from the extraction of the proposed longwalls, are expected to be similar to those observed where longwalls have previously mined directly beneath roads in the Southern Coalfield.

6.4.6. Recommendations for the Roads

IC has developed a *Public Road Management Plan* for the longwalls at West Cliff and Appin Area 7 so as to manage the potential impacts on public roads. The Management Plan was developed in consultation with the Wollondilly Shire Council, the Roads and Maritime Services and the Mine Subsidence Board.

It is recommended that the Management Plan be reviewed and, where required, revised to include the local roads within the Study Area. Specific management strategies developed from the Razorback Range Steep Slope Assessment should also be included in the Public Road Management Plan. With the implementation of these management strategies, it would be expected that the local roads could be maintained in safe and serviceable conditions during and after the extraction of the proposed longwalls.

6.5. Local Road Bridges

The locations of local road bridges in the vicinity of the proposed longwalls are shown in Drawing No. MSEC448-14. The descriptions, prediction and impact assessments for the local road bridges are provided in the following sections. The descriptions, predictions and impact assessments for the Twin Bridges over the Nepean River are provided in Section 6.3.

6.5.1. Descriptions of the Local Road Bridges

Moreton Park Road Bridge (South) is located at a distance of 1 kilometre east of the Longwall 902, at its closest point to the proposed longwalls. The concrete bridge crosses over the HW2 Hume Highway and has overall length of 98 metres. The bridge is supported on three single piers, spaced at approximately 30 metres, with abutments at each end. A photograph of this bridge is provided in Fig. 6.32.

Fig. 6.32 Moreton Park Road Bridge (South)

Blades Bridge is located at a distance of 650 metres south-east of the proposed Longwall 901. The bridge crosses Harris Creek and connects Moreton Park Road with Douglas Park Drive. The original bridge has recently been replaced with a *Bailey* type bridge, simply supported on concrete abutments, a photograph of which is shown in Fig. 6.33.

Photograph courtesy of Wollondilly Shire Council

Fig. 6.33 The Newly Constructed Blades Bridge

The new Blades Bridge was designed to accommodate the following mine subsidence movements that were approved by the Mine Subsidence Board:-

- Subsidence of 1850 mm,
- Tilt either along or across the bridge of 10 mm/m,
- Opening between the abutments of 100 mm,
- Closure between the abutments of 700 mm, and
- Horizontal ground shear of 150 mm between abutments.

6.5.2. Predictions for the Local Road Bridges

Moreton Park Road Bridge (South) and Blades Bridge are located at minimum distances of 1 kilometre and 650 metres, respectively, from the proposed longwalls. At these distances, the bridges are predicted to experience less than 20 mm of vertical subsidence.

Blades Bridge crosses Harris Creek and, therefore, could experience valley related movements. The effective valley height within a half-depth of cover from the bridge, which is used to calculate the valley related movements, is 30 metres. The maximum predicted upsidence and closure at Blades Bridge, resulting from the extraction of the proposed longwalls, are both less than 20 mm.

6.5.3. Comparison of Predictions for the Local Road Bridges with those provided in the Part 3A Application

The comparison of the maximum predicted subsidence parameters for Moreton Park Road Bridge (South) and Blades Bridge with those provided in the Part 3A Application are provided in Table 6.23 and Table 6.24, respectively.

Table 6.23 Comparison of the Maximum Predicted Conventional Subsidence Parameters for Moreton Park Road Bridge (South) Based on the Part 3A and Extraction Plan Layouts

Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt Along Alignment (mm/m)	Maximum Predicted Total Conventional Hogging Curvature in Any Direction (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature in Any Direction (km^{-1})
Part 3A Layout (Report No. MSEC404)	< 20	< 0.5	< 0.01	< 0.01
Extraction Plan Layout (Report No. MSEC448)	< 20	< 0.5	< 0.01	< 0.01

Table 6.24 Comparison of the Maximum Predicted Conventional Subsidence Parameters for Blades Bridge Based on the Part 3A and Extraction Plan Layouts

Layout	Maximum Predicted Total Subsidence (mm)	Maximum Predicted Total Tilt Along Alignment (mm/m)	Maximum Predicted Total Hogging Curvature in Any Direction (km^{-1})	Maximum Predicted Total Sagging Curvature in Any Direction (km^{-1})	Maximum Predicted Total Upsidence (mm)	Maximum Predicted Total Closure (mm)
Part 3A Layout (Report No. MSEC404)	35	< 0.5	< 0.01	< 0.01	90	200
Extraction Plan Layout (Report No. MSEC448)	< 20	< 0.5	< 0.01	< 0.01	< 20	< 20

It can be seen from the above table, that the maximum predicted mine subsidence movements at Moreton Park Road Bridge (South) and Blades Bridge, based on the Extraction Plan Layout, are similar to or less than those predicted based on the Part 3A Layout.

6.5.4. Impact Assessments for the Local Road Bridges

The predicted subsidence, upsidence and closure at Moreton Park Road Bridge (South) and Blades Bridge are all less than 20 mm. Even if the bridges were to experience subsidence movements slightly greater than 20 mm, they would not be expected to experience any significant conventional tilts, curvatures or strains. In addition to this, the new Blades Bridge was designed to accommodate mine subsidence movements which are significantly greater than those predicted.

The bridges are also likely to experience far-field horizontal movements, which are described in Sections 3.3 and 4.6. It can be seen from Fig. 4.7, that incremental far-field horizontal movements around 100 mm have been observed at distances between 500 metres and 1000 metres from previously extracted longwalls, such as the case as the bridges.

The Moreton Park Road Bridge (South) could be sensitive to the relative horizontal movements between the supporting piers and abutments, resulting from the far-field movements. The mine subsidence movements were measured at this bridge, during the extraction of Appin Longwalls 701 to 703, which are both located approximately 1.1 kilometres to 1.4 kilometres from the bridge. The maximum observed relative horizontal movement of the bridge structure was around 3 mm, which is similar to the order of survey tolerance. It is expected, therefore, that the relative horizontal movements at the Moreton Park Road Bridge (South), resulting from the extracting of the proposed longwalls, would also expected to be small.

It is unlikely, therefore, that the Moreton Park Road Bridge (South) and Blades Bridge would experience any adverse impacts resulting from the extraction of the proposed longwalls.

6.5.5. Impact Assessments for the Local Road Bridges Based on Increased Predictions

If the actual conventional subsidence movements exceeded those predicted by a factor of 2 times, the maximum tilts, curvatures and strains at the bridges would still be extremely small, in the order of survey tolerance and, therefore, unlikely to result in any adverse impacts.

If the actual valley related movements exceeded those predicted by a factor of 2 times, the upsidence and closure movements at the new Blades Bridge would still be less than the minimum design requirements of the bridge. The Moreton Park Road Bridge (South) is not located in a valley and, therefore, this bridge is not anticipated to experience valley related movements.

6.5.6. Recommendations for the Local Road Bridges

The Moreton Park Road Bridge (South) is managed as part of the Roads and Traffic Authority assets including the HW2 Hume Highway and the Nepean Twin Bridges. The Hume Highway Technical Committee has undertaken detailed investigations and assessments of potential impacts on the Moreton Park Road Bridge (South) resulting from the extraction of the Appin Area 7 longwalls. A management plan has been developed for the bridge, which includes the following management measures:-

- Installation of a monitoring system, which includes, among other things, the monitoring of ground movements, structure movements, bridge joint displacements and visual inspections,
- Implementation of a response plan, where actions are triggered by monitoring results. This includes the ability to provide additional structural support to the bridge if triggered by monitoring results. IC and the RMS have already installed additional footings at the bridge and fabricated structural frames, which are stored on standby for swift installation if required, and
- Implementation of a reporting and communication plan.

It is recommended that the existing management plan for the Moreton Park Road Bridge (South) is updated to incorporate the proposed Longwalls 901 to 904.

The new Blades Bridge is a Wollondilly Shire Council Asset and should be incorporated into the revised Public Road Management Plan. It is not expected that any substantial management strategies would be required for Blades Bridge, given the recent reconstruction, large subsidence design criteria and the small predicted subsidence movements at the bridge.

6.6. Tunnels

There are no tunnels within the Study Area.

6.7. Local Road Drainage Culverts

The descriptions, predictions and impact assessments for the local road drainage culverts are provided in the following sections.

6.7.1. Descriptions of the Drainage Culverts

The locations of the drainage culverts along Menangle Road and Wrightson Way are shown in Drawing No. MSEC448-14. A summary of these culverts are provided in Table 6.25.

Table 6.25 Drainage Culverts along Menangle Road and Wrightson Way

Culvert Ref.	Type	Location
MR-A9-C01	1 x ϕ350 Culvert	500 metres west of LW902
MR-A9-C02	1 x ϕ450 Culvert	350 metres west of LW902
MR-A9-C03	1 x ϕ800 Culvert	Above western end of LW902
MR-A9-C04	2 x ϕ450 Culvert	Above western end of LW902
MR-A9-C05	2 x ϕ1800 Culvert	Above tailgate of LW903
MR-A9-C06	1 x 1500W x 1200H Box Culvert	Above LW903
MR-A9-C07	2 x 2000W x 1200H Box Culvert	Above LW903
MR-A9-C08	1 x ϕ900 Culvert	Above eastern end of LW904
MR-A9-C09	1 x ϕ700 Culvert	500 metres east of LW904
WW-A9-C01	2 x 2800W x 950H Box Culvert	50 metres east of LW904

Photographs of some of these culverts are provided in Fig. 6.34 and Fig. 6.35.

Fig. 6.34 Photographs of Culverts MR-A9-C05 (Left) and MR-A9-C08 (Right)

Fig. 6.35 Photographs of Box Culverts MR-A9-C07 (Left) and WW-C01 (Right)

In addition to this, there are also drainage culverts beneath the driveways to the private properties off Menangle Road and Wrightson Way, which are typically 300 mm to 450 mm diameter concrete culverts.

6.7.2. Predictions for the Drainage Culverts

A summary of the maximum predicted total conventional subsidence parameters for the local road drainage culverts, resulting from the extraction of the proposed longwalls, is provided in Table 6.26.

Table 6.26 Maximum Predicted Total Conventional Subsidence Parameters at the Local Road Drainage Culverts Resulting from the Extraction of the Proposed Longwalls

Road	Culvert	Maximum Predicted Subsidence (mm)	Maximum Predicted Tilt in Any Direction (mm/m)	Maximum Predicted Hogging Curvature in Any Direction (km^{-1})	Maximum Predicted Sagging Curvature in Any Direction (km^{-1})
Menangle Road	MR-A9-C1	< 20	< 0.5	< 0.01	< 0.01
	MR-A9-C2	< 20	< 0.5	< 0.01	< 0.01
	MR-A9-C3	250	3.0	0.03	0.01
	MR-A9-C4	675	3.5	< 0.01	0.03
	MR-A9-C5	925	1.5	0.03	0.01
	MR-A9-C6	1050	1.5	0.02	0.02
	MR-A9-C7	1125	4.0	0.02	0.11
	MR-A9-C8	150	2.0	0.02	< 0.01
	MR-A9-C9	< 20	< 0.5	< 0.01	< 0.01
Wrightson Way	MR-A9-WW01	75	0.5	< 0.01	< 0.01

The predicted tilts provided in the above table are the maxima in any direction after the completion of any or all of the proposed longwalls. The predicted curvatures are the maxima in any direction at any time during or after the extraction of the proposed longwalls.

The remaining local road drainage culverts are across the Study Area and, therefore, could experience the full range of predicted subsidence movements. A summary of the maximum predicted conventional subsidence movements within the Study Area is provided in Chapter 4.

The local road drainage culverts are at discrete locations and, therefore, the most relevant distributions of strain are the maximum strains measured in individual survey bays from previous longwall mining. The analysis of strains in survey bays during the mining of previous longwalls in the Southern Coalfield is discussed in Section 4.4.1. The results for survey bays above goaf are provided in Fig. 4.1 and Table 4.5. The results for survey bays above solid coal are provided in Fig. 4.3 and Table 4.6.

Non-conventional movements can also occur and have occurred in the NSW Coalfields as a result of, among other things, valley related upsidence and closure movements and anomalous movements. The analysis of strains provided in Chapter 4 includes those resulting from both conventional and non-conventional anomalous movements.

The maximum predicted conventional strains for the drainage culverts anywhere across the Study Area, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 1 mm/m tensile and 2 mm/m compressive. The strains resulting from valley related movements are discussed separately in the following sections.

6.7.3. Comparison of Predictions for the Local Road Drainage Culverts with those provided in the Part 3A Application

Comparisons of the maximum predicted subsidence parameters for the drainage culverts, based on the Modified Layout, with those predicted based on the Previous Layout, are provided in Table 6.27.

Table 6.27 Comparison of the Maximum Predicted Conventional Subsidence Parameters for Local Road Drainage Culverts Based on the Part 3A and Extraction Plan Layouts

Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt Along Alignment (mm/m)	Maximum Predicted Total Conventional Hogging Curvature in Any Direction (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature in Any Direction (km^{-1})
Part 3A Layout (Report No. MSEC404)	1400	6.5	0.07	0.12
Extraction Plan Layout (Report No. MSEC448)	1200	6.5	0.07	0.12

It can be seen from the above table, that the maximum predicted mine subsidence movements at the local road drainage culverts, based on the Extraction Plan Layout, are similar or slightly less than those predicted based on the Part 3A Layout.

6.7.4. Impact Assessments for the Local Road Drainage Culverts

The maximum predicted tilt within the Study Area is 6.5 mm/m (i.e. 0.7 %), which represents a change in grade of 1 in 155. It is expected that the local road drainage culverts will generally experience tilts less than this maximum, as the result of the variations in the predicted tilts across the Study Area and the orientations of the culverts relative to the subsidence trough.

The predicted changes in grade are small, less than 1 % and, therefore, are unlikely to result in any adverse impacts on the serviceability of the local road drainage culverts. If the flow of water through any drainage culverts were to be adversely affected, as a result of the extraction of the proposed longwalls, this could be easily remediated by relevelling the affected culverts.

The maximum predicted conventional curvatures within the Study Area, resulting from the extraction of the proposed longwalls, are 0.07 km^{-1} hogging and 0.12 km^{-1} sagging, which represent minimum radii of curvature of 14 kilometres and 8 kilometres, respectively. It is expected that the local road drainage culverts will generally experience curvatures less than these maxima, as the result of variations in the predicted curvatures across the Study Area and the orientations of the culverts relative to the subsidence trough.

The drainage culverts are located along drainage lines and could, therefore, experience valley related upsidence and closure movements. The drainage culverts are orientated along the alignments of the drainage lines and, therefore, the upsidence and closure movements are orientated perpendicular the main axes of the culverts and unlikely to result in any adverse impacts.

Longwalls have been previously extracted directly beneath drainage culverts in the NSW Coalfields. The incidence of impacts on drainage culverts has been found to be low, where the depths of cover were greater than 400 metres, such as the case within the Study Area. Impacts have generally been limited to cracking in the concrete headwalls which can be readily remediated. In some cases, however, cracking in the culvert pipes occurred which required the culverts to be replaced.

With remedial measures implemented, it is expected that the drainage culverts within the Study Area could be maintained in serviceable conditions throughout the mining period.

6.7.5. Impact Assessments for the Local Road Drainage Culverts Based on Increased Predictions

If the actual tilts exceeded those predicted by a factor of 2 times, the maximum tilt at the local road drainage culverts would be 13 mm/m (i.e. 1.3 %), or a change in grade of 1 in 75. The potential impacts on the serviceability and surface water drainage through the culverts would not be expected to significantly increase, as the maximum change in grade would still be small, in the order of 1 %. If any ponding or adverse changes in surface water drainage were to occur as the result of mining, the affected culverts could be replaced.

If the actual curvatures exceeded those predicted by a factor of 2 times, the maximum curvature at the local road drainage culverts would be 0.24 km^{-1}, which represents a minimum radius of curvature of 4 kilometres. In this case, the incidence of cracking in the culverts would increase, however, it would not be expected to affect the structural capacity or stability of the culverts. If any culverts were aversely impacts were to occur as the result of mining, the affected culverts could be replaced.

6.7.6. Recommendations for the Local Road Drainage Culverts

IC has developed a *Public Road Management Plan* for the longwalls at West Cliff and Appin Area 7 so as to manage the potential impacts on road drainage culverts. The potential impacts on the drainage culverts within the Study Area can be managed by periodic visual monitoring and the implementation of any necessary remedial measures. The ground movements will occur gradually as mining progresses, which will provide adequate time to repair or replace the culverts at the appropriate time, should these works be required.

It is recommended that the existing Public Road Management Plan be reviewed and, where required, revised to incorporate the culverts in within the Study Area. With the implementation of these management strategies, it would be expected that the local road drainage culverts could be maintained in safe and serviceable conditions during and after the extraction of the proposed longwalls.

6.8. Sydney Water Infrastructure

The locations of the Sydney Water owned infrastructure within the Study Area are shown in Drawing No. MSEC448-15. The descriptions, predictions and impact assessments for the water infrastructure are provided in the following sections.

6.8.1. Descriptions of the Sydney Water Infrastructure

The Sydney Water infrastructure within the Study Area comprises potable water pipelines which supply the township of Douglas Park. There are no sewage pipelines within the Study Area. A summary of the potable water pipelines within the Study Area is provided in Table 6.28.

Table 6.28 Potable Water Pipelines within the Study Area

Type	Location	Total Length of Pipeline within Study Area (km)	Total Length of Pipeline Located Directly above Proposed Longwalls (km)
100 DICL	Partially above LW901	3.8	0.5
100 uPVC	Above Solid Coal	0.2	-
150 DICL	Above Solid Coal	0.3	-
150 SCL	Above Solid Coal	0.1	-
200 DICL	Above Solid Coal	0.4	-
200 SCL	Above Solid Coal	0.1	-

The types of pipeline include Ductile Iron Cement Lined (DICL), Steel Cement Lined (SCL) and Polyvinyl Chloride (uPVC). The water pipelines are owned and operated by Sydney Water.

6.8.2. Predictions for the Sydney Water Infrastructure

A 100 mm DICL water pipeline is located directly above the proposed Longwall 901. The remaining water pipelines are located outside the extents of the proposed longwalls. A summary of the maximum predicted total conventional subsidence parameters for the water infrastructure, after the extraction of each of the proposed longwalls, is provided in Table 6.29.

Table 6.29 Maximum Predicted Total Conventional Subsidence Parameters for the Sydney Water Infrastructure after the Extraction of Each of the Proposed Longwalls

Location	Longwall	Maximum Predicted Subsidence (mm)	Maximum Predicted Tilt Along Alignment (mm/m)	Maximum Predicted Hogging Curvature Along Alignment (km^{-1})	Maximum Predicted Sagging Along Alignment (km^{-1})
100 mm DICL Water Pipeline Above LW901	After LW901	400	1.5	0.02	0.01
	After LW902	450	2.0	0.02	0.01
	After LW903	450	2.0	0.02	0.01
	After LW904	450	2.0	0.02	0.01
Remaining Water Pipelines	After LW901	150	< 0.5	< 0.01	< 0.01
	After LW902	150	< 0.5	< 0.01	< 0.01
	After LW903	150	< 0.5	< 0.01	< 0.01
	After LW904	150	< 0.5	< 0.01	< 0.01

The predicted tilts provided in the above table are the maxima along the alignments of the pipelines after the completion of each of the proposed longwalls. The predicted curvatures are the maxima along the alignments of the pipelines at any time during or after the extraction of each of the proposed longwalls.

The water pipelines cross tributaries in three locations in the vicinity of the proposed longwalls. The tributary crossings are indicated in Drawing No. MSEC448-15. A summary of the maximum predicted total upsidence and closure at these tributary crossings, resulting from the extraction of the proposed longwalls, is provided in Table 6.30.

Table 6.30 Maximum Predicted Total Upsidence and Closure at the Tributary Crossings after the Extraction of Each of the Proposed Longwalls

Location	Longwall	Maximum Predicted Upsidence (mm)	Maximum Predicted Closure (mm)
Crossing A (South of LW901)	After LW901	25	50
	After LW902	50	50
	After LW903	50	75
	After LW904	50	75
Crossing B (East of LW902)	After LW901	25	20
	After LW902	50	25
	After LW903	75	50
	After LW904	75	50
Crossing C (East of LW903)	After LW901	< 20	< 20
	After LW902	< 20	< 20
	After LW903	20	< 20
	After LW904	20	< 20

The water pipelines are linear features and, therefore, the most relevant distribution of strain is the maximum strains measured along whole monitoring lines above previous longwall mining. The analysis of strains along whole monitoring lines during the mining of previous longwalls in the Southern Coalfield is discussed in Section 4.4 and the results are provided in Fig. 4.4.

Non-conventional movements can also occur and have occurred in the NSW Coalfields as a result of, among other things, anomalous movements. The analysis of strains provided in Chapter 4 includes those resulting from both conventional and non-conventional anomalous movements.

The maximum predicted conventional strains for the water pipelines, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 0.3 mm/m tensile and less than 0.3 mm/m compressive. The strains resulting from valley related movements are discussed separately in the following sections.

6.8.3. Comparison of Predictions for the Sydney Water Infrastructure with those provided in the Part 3A Application

The comparison of the maximum predicted subsidence parameters for the Sydney Water infrastructure with those provided in the Part 3A Application is provided in Table 6.31.

Table 6.31 Comparison of the Maximum Predicted Conventional Subsidence Parameters for the Sydney Water Infrastructure Based on the Part 3A and Extraction Plan Layouts

Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
Part 3A Layout (Report No. MSEC404)	1400	6.5	0.07	0.12
Extraction Plan Layout (Report No. MSEC448)	450	2.0	0.02	0.01

It can be seen from the above table, that the maximum predicted mine subsidence movements at the Sydney Water infrastructure, based on the Extraction Plan Layout, are less than those predicted based on the Part 3A Layout.

6.8.4. Impact Assessments for the Sydney Water Infrastructure

The water pipelines are pressure mains and are unlikely, therefore, to be affected to any great extent by changes in gradient due to subsidence or tilt.

The maximum predicted conventional curvatures for the water infrastructure, resulting from the extraction of the proposed longwalls, are 0.02 km^{-1} hogging and 0.01 km^{-1} sagging, which represent minimum radii of curvatures of 50 kilometres and 100 kilometres, respectively.

The maximum predicted curvatures and the range of potential strains at the water infrastructure, resulting from the extraction of the proposed longwalls, are similar to those typically experienced elsewhere in the Southern Coalfield. Longwalls in the Southern Coalfield have been successfully mined directly beneath water pipelines in the past, and some of these cases are provided in Table 6.22.

Table 6.32 Examples of Previous Experience of Mining Beneath Water Pipelines in the Southern Coalfield

Colliery and LWs	Pipelines	Observed Movements	Observed Impacts
Appin LW301 and LW302	0.6 km of 150 dia DICL 0.6 km of 300 dia CICL 0.6 km of 1200 dia SCL	650 mm Subsidence 4.5 mm/m Tilt 1 mm/m Tensile Strain 3 mm/m Comp. Strain (Measured M & N-Lines)	Leakage of the 150 mm and 300 mm CICL pipelines at a creek crossing, elsewhere no other reported impacts
Tahmoor LW22 to LW25	2.7 km DICL pipes 7.3 km CICL pipes	1200 mm Subsidence 6 mm/m Tilt 1.5 mm Tensile Strain 2 mm (typ.) and up to 5 mm/m Comp. Strain (Extensive street monitoring)	One reported impact to the distribution network and a very small number of minor leaks in the consumer connection pipes
West Cliff LW5A3, LW5A4 & LW29 to LW34	2.8 km of 100 dia CICL pipe directly mined beneath	1100 mm Subsidence 10 mm/m Tilt 1 mm/m Tensile Strain 5.5 mm/m Comp. Strain (Measured B-Line)	No reported impacts

It can be seen from the above table, that the incidence of impacts on water pipelines is small.

One leak occurred in the water pipeline where it crossed a small creek south-west of Longwall 301. Observed compressive ground strain at this location was 1.8 mm/m, coupled with upsidence of approximately 100 mm.

One impact has occurred in a cast iron water main which had been directly mined beneath by the longwalls at Tahmoor Colliery. While there was no ground survey data to quantify the ground movements, the leak coincided with damage to the road pavement and damage to a fence. It is concluded that non-conventional movements had developed at this location. A very small number of minor leaks have also been observed to consumer connection pipes on private properties. Remedial works were undertaken and the leaks were repaired by the Mine Subsidence Board.

A water leak was also observed on York Street opposite the Tahmoor Town Centre during the mining of Tahmoor Longwall 25. The cause of the leak is currently unknown. While no impacts were reported to the road pavement and no elevated ground strain was observed at the leak, a bump was observed in the subsidence profile near the location of the leak.

The predicted mine subsidence movements for the water infrastructure within the Study Area are less than those observed at the water infrastructure which have been mined directly beneath by previously extracted longwalls in the Southern Coalfield. The overall levels of impact on the water infrastructure in the Study Area are, therefore, expected to be similar to or less than those observed in the past.

Based on this experience, it is expected that some minor leakages of the water pipelines could occur, as the result of the extraction of the proposed longwalls, however, the incidence of impacts is expected to be low. Impacts are more likely to occur in the locations of non-conventional movements or at the creek crossings. Any impacts are expected to be of a minor nature which could be readily remediated.

6.8.5. Impact Assessments for the Sydney Water Infrastructure Based on Increased Predictions

If the conventional subsidence movements exceeded those predicted by a factor of 2 times, the maximum tilt at the water infrastructure would be 4.0 mm/m (i.e. 0.4 %), or a change in grade of 1 in 250. The water pipelines are pressure mains and, therefore, are unlikely to be affected to any great extent by changes in gradient due to subsidence or tilt.

If the conventional subsidence movements exceeded those predicted by a factor of 2 times, the maximum curvature at the water infrastructure would be 0.04 km^{-1}, which represents a minimum radius of curvature of 25 kilometres. The curvatures at the water infrastructure would still be less than those experienced where water infrastructure was directly mined beneath by the previously extracted longwalls at Appin, West Cliff and Tahmoor Collieries. Based on this experience, it would be expected that some minor leakages could occur, but the incidence of impact would still be expected to be low.

6.8.6. Recommendations for the Sydney Water Infrastructure

Management strategies have already been developed by IC, in consultation with Sydney Water, to manage the impacts on water infrastructure in Appin Areas 3 and 7 and at West Cliff Colliery. It is recommended that these management strategies are extended to include the proposed Longwalls 901 to 904.

6.9. Sydney Catchment Authority Infrastructure

The locations of the Sydney Catchment Authority (SCA) owned infrastructure within the Study Area are shown in Drawing No. MSEC448-15. The descriptions, predictions and impact assessments for the infrastructure are provided in the following sections.

6.9.1. Descriptions of the Sydney Catchment Authority Infrastructure

The SCA infrastructure within the Study Area comprises the Douglas Park Weir, causeway and Fish Passage, which are all located approximately 900 metres south of the proposed Longwall 901. A photograph of the weir and causeway is provided in Fig. 6.36.

Fig. 6.36 Photograph of the Douglas Park Weir and Causeway

In July 2010, the SCA completed construction of a Fish Passage around the Douglas Park Weir. This structure provides a channel for the fish to swim around the weir in the river. The passage has been constructed from reinforced concrete supported on piers into the bedrock and has been approved by the Mine Subsidence Board.

The Mine Subsidence Board provided the SCA with the following minimum design parameters for the fish passages:-

- Subsidence of 1200 mm,
- Tilt of 6 mm/m,
- Strains of 2.5 mm/m, and
- Radius of curvature of 10 kilometres.

6.9.2. Predictions for the Sydney Catchment Authority Infrastructure

A summary of the maximum predicted total subsidence, upsidence and closure at the SCA infrastructure, resulting from the extraction of the proposed longwalls, is provided in Table 6.33.

Table 6.33 Maximum Predicted Total Subsidence, Upsidence and Closure for the SCA Infrastructure Resulting from the Extraction of the Proposed Longwalls

Location	Maximum Predicted Subsidence (mm)	Maximum Predicted Upsidence (mm)	Maximum Predicted Closure (mm)
SCA Infrastructure	< 20	< 20	< 20

The predicted mine subsidence movements provided in the above table are the maxima at any time during or after the extraction of the proposed longwalls.

6.9.3. Comparison of Predictions for the Sydney Catchment Authority Infrastructure with those provided in the Part 3A Application

The comparison of the maximum predicted subsidence parameters for the Sydney Catchment Authority infrastructure with those provided in the Part 3A Application is provided in Table 6.34.

Table 6.34 Comparison of the Maximum Predicted Conventional Subsidence Parameters for the Sydney Catchment Authority Infrastructure Based on the Part 3A and Extraction Plan Layouts

Layout	Maximum Predicted Subsidence (mm)	Maximum Predicted Upsidence (mm)	Maximum Predicted Closure (mm)
Part 3A Layout (Report No. MSEC404)	< 20	< 20	< 20
Extraction Plan Layout (Report No. MSEC448)	< 20	< 20	< 20

It can be seen from the above table, that the maximum predicted mine subsidence movements at the SCA infrastructure, based on the Extraction Plan Layout, are similar to those predicted based on the Part 3A Layout.

6.9.4. Impact Assessments for the Sydney Catchment Authority Infrastructure

The predicted mine subsidence movements at the SCA infrastructure are small, in the order of survey tolerance and, therefore, are unlikely to result in any adverse impacts, even if the predicted movements were exceeded by a factor of 2 times.

The SCA infrastructure could also experience small far-field horizontal movements as a result of the extraction of the proposed longwalls. At this distance from the proposed longwalls, the far-field horizontal movements are expected to be bodily movements associated with very low levels of strain which are unlikely to result in any adverse impacts, even if the predicted movements were exceeded by a factor of 2 times.

6.9.5. Recommendations for the Sydney Catchment Authority Infrastructure

It is recommended that the SCA infrastructure is visually inspected before and after the extraction of each of the proposed longwalls.

6.10. Sewerage Pipelines and Sewage Treatment Works

There are no sewerage pipelines, or sewage treatment works within the Study Area. The properties within the Study Area have local sewer connections to septic tanks, or package treatment plants.

6.11. Gas Pipelines

There are no gas pipelines within the Study Area.

6.12. Liquid Fuel Pipelines

There are no liquid fuel pipelines within the Study Area.

6.13. Electrical Infrastructure

The locations of the electrical infrastructure within the Study Area are shown in Drawing No. MSEC448-16. The descriptions, predictions and impact assessments for the electrical infrastructure are provided in the following sections.

6.13.1. Descriptions of the Electrical Infrastructure

The electrical infrastructure within the Study Area comprises a 66 kV powerline, which follows the alignment of Menangle Road, and 11 kV and low voltage powerlines, which follow the local roads within the township of Douglas Park.

A summary of the local roads within the Study Area is provided in Table 6.35.

Table 6.35   Summary of the Electrical Infrastructure within the Study Area

Type	Location	Total Length of Road within Study Area (km)	Total Length of Road Located Directly above Proposed Longwalls (km)
66 kV Powerline	Partially above LW902 to LW904	3.4	2.2
11 kV Powerlines	Partially above LW901 to LW904	13.2	5.5
Low Voltage Powerlines	Partially above LW901 to LW904	12.1	3.7

The powerlines consist of aerial copper cables supported on timber poles. The powerlines are owned and operated by Integral Energy.

6.13.2. Predictions for the Electrical Infrastructure

The aerial powerlines will not be directly affected by the ground strains, as the cables are supported by poles above ground level. The cables may, however, be affected by changes in the bay lengths, i.e. the distances between the poles at the levels of the cables, resulting from differential subsidence, horizontal movements, and tilt at the pole locations. The stabilities of the poles may also be affected by conventional tilt, and by changes in the catenary profiles of the cables.

The predicted profiles of conventional subsidence, tilt along and tilt across the alignment of the 66 kV powerline, resulting from the extraction of the proposed longwalls, are shown in Fig. E.09, in Appendix E. The predicted incremental profiles along and across the alignment of the powerline, due to the extraction of each of the proposed longwalls, are shown as dashed black lines. The predicted total profiles along and across the alignment of the powerline, after the extraction of each of the proposed longwalls, are shown as solid blue lines.

A summary of the maximum predicted cumulative conventional subsidence parameters for the 66 kV powerline, after the extraction of each of the proposed longwalls, is provided in Table 6.36.

Table 6.36   Maximum Predicted Cumulative Conventional Subsidence Parameters for the 66 kV Powerline after the Extraction of Each of the Proposed Longwalls

Powerline	Longwall	Maximum Predicted Subsidence (mm)	Maximum Predicted Tilt Along Alignment (mm/m)	Maximum Predicted Tilt Across Alignment (mm/m)
66 kV Powerline	After LW901	< 20	< 0.5	< 0.5
	After LW902	425	2.5	2.5
	After LW903	850	3.5	5.5
	After LW904	1125	3.5	5.0

The 11 kV and low voltage powerlines are located across the Study Area and, therefore, could experience the full range of predicted subsidence movements. A summary of the maximum predicted conventional subsidence movements within the Study Area is provided in Chapter 4.

6.13.3. Comparison of Predictions for the Electrical Infrastructure with those provided in the Part 3A Application

The comparison of the maximum predicted subsidence parameters for the 66kV powerline with those provided in the Part 3A Application is provided in Table 6.37. The comparison of the maximum predicted subsidence parameters for the 11 kV and low voltage powerlines with those provided in the Part 3A Application is provided in Table 6.38.

Table 6.37 Comparison of the Maximum Predicted Conventional Subsidence Parameters for the 66 kV Powerline

Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Tilt Along Alignment (mm/m)	Maximum Predicted Tilt Across Alignment (mm/m)
Part 3A Layout (Report No. MSEC404)	1300	4.0	2.5
Extraction Plan Layout (Report No. MSEC448)	1125	3.5	5.5

Table 6.38 Comparison of the Maximum Predicted Conventional Subsidence Parameters for the 11 kV and Low Voltage Powerlines

Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Tilt in Any Direction (mm/m)
Part 3A Layout (Report No. MSEC404)	1400	6.5
Extraction Plan Layout (Report No. MSEC448)	1200	6.5

It can be seen from the above tables, that the maximum predicted mine subsidence movements at the electrical infrastructure, based on the Extraction Plan Layout, are generally similar to or slightly less than those predicted based on the Part 3A Layout. The predicted tilt across the alignment of the 66 kV powerline, however, has increased as a result of the rotation of the proposed longwalls.

6.13.4. Impact Assessments for the Electrical Infrastructure

The maximum predicted tilt at the powerlines is 6.5 mm/m (i.e. 0.7 %), which represents a change in verticality of 1 in 155. It is expected that the power poles within the Study Area will generally experience tilts less than this maximum, as the result of the variations in the predicted tilts across the Study Area.

The maximum predicted subsidence and tilts at the powerlines, resulting from the extraction of the proposed longwalls, are similar to those typically experienced elsewhere in the Southern Coalfield. Longwalls in the Southern Coalfield have been successfully mined directly beneath powerlines in the past, and some of these cases are provided Table 6.39.

Table 6.39 Examples of Previous Experience of Mining Beneath Powerlines in the Southern Coalfield

Colliery and LWs	Length of Powerlines Directly Mined Beneath (km)	Observed Maximum Movements at Powerlines	Observed Impacts
Appin LW1 to LW12	5.2 km of 11 kV 104 power poles	850 mm Subsidence 6 mm/m Tilt (Measured WX-Line)	Minor impacts only including adjustment of cable catenaries, pole tilts and to consumer cables which connect between the powerlines and houses.
Appin LW14 to LW29	1.0 km of 66 kV 4.6 km of 11 kV 76 power poles	1200 mm Subsidence 7 mm/m Tilt (Measured A-Line)	
Appin LW301 and LW302	0.6 km of 66 kV 0.2 km of 11 kV 14 power poles	650 mm Subsidence 4.5 mm/m Tilt (Measured M & N-Lines)	
Appin LW401 to LW409	3.6 km of 66 kV 0.6 km of 33 kV 3.2 km of 11 kV 109 power poles	700 mm Subsidence 5 mm/m Tilt (Measured A6000-Line)	
Appin LW702 to LW704	2.1 km of 11 kV 54 power poles	1100 mm Subsidence 7.5 mm/m Tilt (Measured MPR-Line)	
Dendrobium LW3 and LW5	1.2 km of 33 kV powerline	1100 mm Subsidence 40 mm/m Tilt (Measured D2000-Line)	
Tower LW1 to LW10	6.0 km of 66 kV 4.3 km of 11 kV 112 power poles	400 mm Subsidence 3 mm/m Tilt (Measured T & TE-Lines)	
West Cliff LW5A3 to LW5A4 & LW29 to LW34	1.0 km of a 66 kV 4.8 km of 11 kV 128 power poles	1100 mm Subsidence 10 mm/m Tilt (Measured B-Line)	

It can be seen from the above table, that there have only been minor impacts on powerlines which have been directly mined beneath by previously extracted longwalls in the Southern Coalfield. Some remedial measures were required, which included adjustments to cable catenaries, pole tilts and to consumer cables which connect between the powerlines and houses. The incidence of these impacts was very low.

Based on this experience, it is likely that the extraction of the proposed longwalls would result in only minor impacts on the powerlines within the Study Area. It is expected that the remedial measures would include some adjustments of the cable catenaries, pole tilts and the consumer cables, as has been undertaken in the past, but any other impacts are expected to be relatively infrequent.

6.13.5. Impact Assessments for the Electrical Infrastructure Based on Increased Predictions

If the actual subsidence movements exceeded those predicted by a factor of 2 times, the maximum tilt at the powerlines would be 13 mm/m (i.e. 1.3 %), or a change in verticality of 1 in 75. In this case, the incidence of impacts would increase in the locations of greatest tilt, such as adjacent to the active longwall maingate and adjacent to the ends of the proposed longwalls. It would still be expected that any impacts could remediated, including some adjustments of the cable catenaries, pole tilts and the consumer cables, as has been undertaken in the past.

While the predicted ground movements are important parameters when assessing the potential impacts on the powerlines, it is noted that the impact assessments were primarily based on historical observations from previous longwall mining in the Southern Coalfield. The overall levels of impact on the powerlines, resulting from the extraction of the proposed longwalls, are expected to be similar to those observed where longwalls have previously mined directly beneath powerlines in the Southern Coalfield.

6.13.6. Recommendations for the Electrical Infrastructure

IC has developed an *Integral Energy Transmission Structure Monitoring and Management Plan* for the longwalls at Appin Area 7, West Cliff and Dendrobium so as to manage the potential impacts on the electrical infrastructure. The Management Plan was developed in consultation with Integral Energy. It is recommended that the plan be reviewed and, where required, revised to incorporate the powerlines within the Study Area. With the implementation of these management strategies, it would be expected that the powerlines could be maintained in safe and serviceable conditions during and after the extraction of the proposed longwalls.

6.14. Telecommunications Infrastructure

The locations of the telecommunications infrastructure within the Study Area are shown in Drawing No. MSEC448-17. The descriptions, predictions and impact assessments for the telecommunications infrastructure are provided in the following sections.

6.14.1. Description of the Telecommunications Infrastructure

The telecommunications infrastructure within the Study Area comprises a direct buried optical fibre cables, aerial and direct buried copper cables and a mobile phone telecommunications tower. A summary of the telecommunications cables within the Study Area is provided in Table 6.40.

Table 6.40 Summary of Telecommunications Infrastructure within the Study Area

Type	Location	Total Length of Cable within Study Area (km)	Total Length of Cable Located Directly above Proposed Longwalls (km)
Optical Fibre Cables	Above LW901 to LW904	11.2	3.9
Copper Cables	Above LW901 to LW904	32.6	13.0

The telecommunications cables within the Study Area are owned and maintained by Telstra.

There is also a telecommunications tower within the Study Area, which is located 380 metres north of the maingate of the proposed Longwall 904. A photograph of the tower is provided in Fig. 6.37. There are also light-weight shed structures associated with the telecommunications tower.

Fig. 6.37 Mobile Phone Telecommunications Tower

The tower supports GSM antennae and microwave dishes owned by Telstra and Optus which are used for mobile telephone communications.

6.14.2. Predictions for the Telecommunications Infrastructure

The predicted profiles of conventional subsidence, tilt and curvature along the alignment of the optical fibre cable which crosses directly above the proposed Longwalls 901 to 903 (i.e. generally follows the alignments of Menangle Road and the Main Southern Railway) are shown in Fig. E.10, in Appendix E. The predicted incremental profiles along the alignment of the cable, due to the extraction of each of the proposed longwalls, are shown as dashed black lines. The predicted total profiles along the alignment of the cable, after the extraction of each of the proposed longwalls, are shown as solid blue lines. The range of predicted curvatures in any direction to the cable, at any time during or after the extraction of the proposed longwalls, is shown by the grey shading.

A summary of the maximum predicted total conventional subsidence parameters for the optical fibre cable, after the extraction of each of the proposed longwalls, is provided in Table 6.41. The predicted conventional movements at the other optical fibre cables within the Study Area are less than those provided in the table below.

Table 6.41 Maximum Predicted Total Conventional Subsidence Parameters for the Optical Fibre Cable after the Extraction of Each of the Proposed Longwalls

Location	Longwall	Maximum Predicted Subsidence (mm)	Maximum Predicted Tilt (mm/m)	Maximum Predicted Hogging Curvature (km^{-1})	Maximum Predicted Sagging Curvature (km^{-1})
Optical Fibre Cable above LW901 to LW903	After LW901	575	2.0	0.02	0.03
	After LW902	925	6.5	0.06	0.12
	After LW903	1125	4.5	0.06	0.12
	After LW904	1175	4.0	0.07	0.12

The predicted tilts provided in the above table are the maxima along the alignment of the cable after the completion of each of the proposed longwalls. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each of the proposed longwalls.

The optical fibre cable crosses a number of drainage lines within the Study Area and could experience valley related movements in these locations. A summary of the maximum predicted upsidence and closure movements at the drainage line crossings, after the extraction of each of the proposed longwalls, is provided in Table 6.42. The locations of the drainage line crossings are shown in Drawing No. MSEC448-17.

Table 6.42 Maximum Predicted Upsidence and Closure Movements at the Drainage Line Crossings for the Optical Fibre Cable Resulting from the Extraction of the Proposed Longwalls

Location	Longwall	Maximum Predicted Upsidence (mm)	Maximum Predicted Closure (mm)
Point A (Above LW902)	After LW901	< 20	< 20
	After LW902	50	20
	After LW903	100	50
	After LW904	125	50
Point B (Above LW902)	After LW901	< 20	< 20
	After LW902	75	25
	After LW903	150	75
	After LW904	175	75
Points C1 and C2 (Above LW903)	After LW901	< 20	< 20
	After LW902	50	75
	After LW903	175	175
	After LW904	225	200
Point D (Above LW902)	After LW901	25	25
	After LW902	150	100
	After LW903	250	150
	After LW904	275	175
Point E (Above chain pillar between LW901 and LW902)	After LW901	50	50
	After LW902	125	125
	After LW903	150	150
	After LW904	150	150

The copper telecommunications cables are located across the Study Area and, therefore, could experience the full range of predicted subsidence movements. A summary of the maximum predicted conventional subsidence movements within the Study Area is provided in Chapter 4.

The telecommunications cables are linear features and, therefore, the most relevant distribution of strain is the maximum strains measured along whole monitoring lines above previous longwall mining. The analysis of strains along whole monitoring lines during the mining of previous longwalls in the Southern Coalfield is discussed in Section 4.4 and the results are provided in Fig. 4.4.

Non-conventional movements can also occur and have occurred in the NSW Coalfields as a result of, among other things, anomalous movements. The analysis of strains provided in Chapter 4 includes those resulting from both conventional and non-conventional anomalous movements.

The maximum predicted conventional strains for the optical fibre cables, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 1 mm/m tensile and 2 mm/m compressive. The maximum predicted conventional strains for the copper cables, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 1 mm/m tensile and 2 mm/m compressive. The compressive strains resulting from valley related movements could be in the order of 7 mm/m at the creek crossings.

A summary of the maximum predicted total conventional subsidence parameters for the telecommunications tower, after the extraction of each of the proposed longwalls, is provided in Table 6.43.

Table 6.43 Maximum Predicted Total Conventional Subsidence Parameters for the Telecommunications Tower after the Extraction of Each of the Proposed Longwalls

Location	Longwall	Maximum Predicted Subsidence (mm)	Maximum Predicted Tilt (mm/m)	Maximum Predicted Hogging Curvature (km^{-1})	Maximum Predicted Sagging Curvature (km^{-1})
Tower	LW901 to LW904	20	< 0.5	< 0.01	< 0.01

The predicted movements provided in the above table are the maxima in any direction at any time during or after the extraction of the proposed longwalls.

6.14.3. Comparison of Predictions for the Telecommunications Cables with those provided in the Part 3A Application

The comparison of the maximum predicted subsidence parameters for optical fibre cables with those provided in the Part 3A Application is provided in Table 6.44. The comparison of the maximum predicted subsidence parameters for copper telecommunications cables with those provided in the Part 3A Application is provided in Table 6.45

Table 6.44 Comparison of the Maximum Predicted Conventional Subsidence Parameters for the Optical Fibre Cable on the Part 3A and Extraction Plan Layouts

Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt Along Alignment (mm/m)	Maximum Predicted Total Conventional Hogging Curvature in Any Direction (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature in Any Direction (km^{-1})
Part 3A Layout (Report No. MSEC404)	1225	4.0	0.03	0.05
Extraction Plan Layout (Report No. MSEC448)	1175	6.5	0.07	0.12

Table 6.45 Comparison of the Maximum Predicted Conventional Subsidence Parameters for Copper Telecommunications Cables Based on the Part 3A and Extraction Plan Layouts

Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt Along Alignment (mm/m)	Maximum Predicted Total Conventional Hogging Curvature in Any Direction (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature in Any Direction (km^{-1})
Part 3A Layout (Report No. MSEC404)	1400	6.5	0.07	0.12
Extraction Plan Layout (Report No. MSEC448)	1200	6.5	0.07	0.12

It can be seen from the above tables, that the maximum predicted mine subsidence parameters for the optical fibre cables, based on the Extraction Plan Layout, are greater than those predicted based on the Part 3A Layout. The predicted parameters along the alignment of the optical fibre cables have increased primarily as the result of the rotation of the longwalls. The predictions for the copper cables, based on the Extraction Plan Layout, are similar to or slightly less than those predicted based on the Part 3A Layout.

6.14.4. Impact Assessments for the Optical Fibre Cable

The optical fibre cables are direct buried and, therefore, are unlikely to be impacted by tilt. The cables are also unlikely to be impacted by curvature, as the cable are flexible and would be expected to tolerate the predicted minimum radius of curvature within the Study Area of 8 kilometres.

The optical fibre cables could, however, be affected by the ground strains resulting from the extraction of the proposed longwalls. The greatest potential for impacts will occur as a result of localised ground strains due to non-conventional ground movements or valley related movements.

The tensile strains in the optical fibre cables could be higher than predicted, where the cables connect to the support structures, which may act as anchor points, preventing any differential movements that may have been allowed to occur with the ground. Tree roots have also been known to anchor cables to the ground. The extent to which the anchor points affect the ability of the cables to tolerate the mine subsidence movements depends on the cable size, type, age, installation method and ground conditions.

In addition to this, optical fibre cables contain additional fibre lengths over the sheath lengths, where the individual fibres are loosely contained within tubes. Compression of the sheaths can transfer to the loose tubes and fibres and result in "micro-bending" of the fibres constrained within the tubes, leading to higher attenuation of the transmitted signal. If the maximum predicted compressive strains were to be fully transferred into the optical fibre cables, the strains could be of sufficient magnitude to result in the reduction in capacities of the cables or transmission loss.

The strains transferred into the optical fibre cables can be monitored using Optical Time Domain Reflectometry (OTDR), which can be used to notify the infrastructure owners of strain concentrations due to non-conventional ground movements or valley related movements.

Longwalls in the Southern Coalfield have been successfully mined directly beneath optical fibre cables in the past. A summary of some of these cases is provided in Table 6.46.

Table 6.46 Examples of Mining Beneath Optical Fibre Cables

Colliery and LWs	Length of Optical Fibre Cables Directly Mined Beneath (km)	Observed Maximum Movements at Optical Fibre Cables	Pre-Mining Mitigation, Monitoring and Observed Impacts
Appin LW301 and LW302	0.8	650 mm Subsidence 1 mm/m Tensile Strain 3 mm/m Comp. Strain (Measured M & N-Lines)	600 metre aerial cable on standby. Ground survey, visual, OTDR. No reported impacts.
Appin LW703 and LW704	6.2 total for five cables	900 mm Subsidence 1.5 mm/m Tensile Strain 4 mm/m Comp. Strain (Measured HW2 and ARTC Lines)	Ground survey, visual, OTDR. Strain concentrations detected in three cables, attenuation losses were relieved by locally exposing the cables or by building a bypass cable.
Tower LW1 to LW10	1.7	400 mm Subsidence 3 mm/m Tilt 0.5 mm/m Tensile Strain 1 mm/m Comp. Strain	No reported impacts
West Cliff LW5A3, LW5A4 and LW29 to LW34	2.8	1100 mm Subsidence 1 mm/m Tensile Strain 5.5 mm/m Comp. Strain (Measured B-Line)	Survey, visual, OTDR, SBS. No reported impacts.

It can be seen from the above table, that optical fibre cables have been successfully directly mined beneath by previously extracted longwalls in the Southern Coalfield, with the implementation of suitable management strategies. It is recommended that the predicted movements are reviewed by the infrastructure owners, to assess the potential impacts and to develop the appropriate management strategies.

6.14.5. Impact Assessments for the Copper Telecommunications Cables

The direct buried copper telecommunications cables are unlikely to be impacted by tilt. The cables are also unlikely to be impacted by curvature, as the cables are flexible and would be expected to tolerate the predicted minimum radius of curvature within the Study Area of 8 kilometres.

The direct buried copper cables could, however, be affected by the ground strains resulting from the extraction of the proposed longwalls. The copper cables are more likely to be impacted by tensile strains rather than compressive strains. It is possible, that the direct buried cables could experience higher tensile strains where they are anchored to the ground by associated infrastructure, or by tree roots. The cables could also experience higher compressive strains at the creek crossings as the result of valley related movements.

Aerial copper telecommunications cables are generally not affected by ground strains, as they are supported by the poles above ground level. The aerial cables, however, could be affected by the changes in bay lengths, i.e. the distances between the poles at the levels of the cables, which result from mining induced differential subsidence, horizontal ground movements and lateral movements at the tops of the poles due to tilting of the poles. The stabilities of the poles can also be affected by mining induced tilts and by changes in the catenary profiles of the cables.

Longwalls in the Southern Coalfield have been successfully mined directly beneath copper telecommunications cables in the past, where the magnitudes of the predicted mine subsidence movements were similar to those predicted within the Study Area. Some of these cases have been summarised in Table 6.47.

Table 6.47 Examples of Mining Beneath Copper Telecommunications Cables

Colliery and LWs	Length of Copper Cables Directly Mined Beneath (km)	Observed Maximum Movements at the Copper Cables	Observed Impacts
Appin LW301 and LW302	0.8	650 mm Subsidence 1 mm/m Tensile Strain 3 mm/m Comp. Strain (Measured M & N-Lines)	No adverse impacts
Appin LW401 to LW409	4 km of underground cables and 0.8 km of aerial cables	700 mm Subsidence 5 mm/m Tilt 1 mm/m Tensile Strain 2 mm/m Comp. Strain (Measured A6000-Line)	No adverse impacts
Appin LW702 to LW704	5.8	1100 mm Subsidence 1.5 mm/m Tensile Strain 4 mm/m Comp. Strain (Measured HW2, ARTC and MPR Lines)	No adverse impacts
Tahmoor LW22 to LW25	19 km of underground cables and 2.5 km of aerial cables	1200 mm Subsidence 6 mm/m Tilt 1.5 mm Tensile Strain 2 mm (typ.) and up to 5 mm/m Comp. Strain (Extensive street monitoring)	No adverse impacts to underground cables. Some pole tilts and cable catenaries adjusted. Some consumer cables were re-tensioned as a precautionary measure
West Cliff LW29 to LW34	Longwalls have mined beneath 13 km of underground cables	1100 mm Subsidence 1 mm/m Tensile Strain 5.5 mm/m Comp. Strain (Measured B-Line)	No adverse impacts

It can be seen from the above table, that there were no reported impacts on the direct buried copper telecommunications cables in the above examples. It is also understood, that there have been no adverse impacts on direct buried copper telecommunications cables elsewhere in the NSW Coalfields, where the depths of cover were greater than 400 metres, such as the case above the proposed longwalls.

It can also be seen from the above table, that there have been only minor impacts on aerial copper telecommunications cables in the above examples. Some remedial measures were required, which included adjustments to cable catenaries, pole tilts and consumer cables which connect between the poles and houses. The incidence of these impacts, however, was very low.

Based on this experience, it is unlikely that the extraction of the proposed longwalls would result in any significant impacts on the direct buried or aerial copper telecommunications cables within the Study Area. Any minor impacts on these cables would be expected to be relatively infrequent and easily repaired.

6.14.6. Impact Assessments for the Telecommunications Tower

The telecommunications tower is located approximately 380 metres north of the maingate of the proposed Longwall 904. At this distance, the tower is predicted to experience around 20 mm of vertical subsidence. While it is possible that the tower could experience subsidence slightly greater than 20 mm, it would not be expected to experience any significant conventional tilts, curvatures or strains.

The tower is likely to experience far-field horizontal movements, which are described in Sections 3.3 and 4.6. It can be seen from Fig. 4.7, that incremental far-field horizontal movements around 100 mm have been observed at distances of 500 metres from previously extracted longwalls, such as the case as the tower. These movements tend to be bodily movements, towards the extracted goaf area, and are accompanied by very low levels of strain, which are generally less than the order of survey tolerance (i.e. less than 0.3 mm/m).

It is unlikely, therefore, that the telecommunications tower would experience any adverse impacts resulting from the extraction of the proposed longwalls. Similarly, it is not expected that the associated light-weight sheds would experience any adverse impacts resulting from the extraction of the proposed longwalls.

The tower is positioned on the top of the Razorback Range and is located near areas comprising steep slopes. A cross-section through the tower, perpendicular to the proposed longwalls, is provided Fig. 6.38. It can be seen from this figure, that the tower is located just outside the 26.5 degree angle of draw.

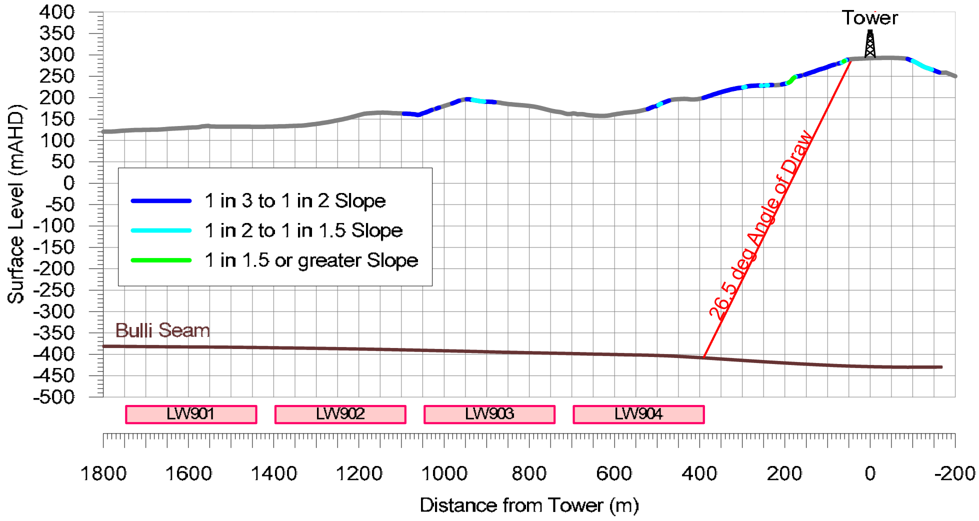

Fig. 6.38 Cross-section through the Telecommunications Tower

The natural ground slopes are indicated on the above figure, which are the maxima in any direction relative to the cross-section. A detailed investigation of the steep slopes within the Study Area and discussions on the potential impacts resulting from the extraction of the proposed longwalls are provided in the reports by *Coffey* (2012) and *UoW* (2012).

6.14.7. Impact Assessments for Telecommunications Infrastructure Based on Increased Predictions

If the actual mine subsidence movements exceeded those predicted by a factor of 2 times, the maximum curvature at the telecommunications cables would be 0.24 km^{-1}, which represents a minimum radius of curvature of 4 kilometres. In this case, the predicted conventional strains for the telecommunications cables would be 4 mm/m. It can be seen from Table 6.46 and Table 6.47, that longwalls have been successfully mined beneath optical fibre cables and copper telecommunications cables where, in some cases, the measured strains were greater than 4 mm/m.

It would still be expected, that the potential for elevated ground strains along the optical fibre cables could be managed using OTDR monitoring. Mitigation measures can be undertaken, such as excavating and exposing the cable, if strain concentrations are detected during the mining period.

If the actual mine subsidence movements exceeded those predicted by a factor of 5 times, the maximum subsidence at the telecommunications tower would be approximately 100 mm. In this case, the tilts and strains would still be expected to be small, similar to the order of survey tolerance and, therefore, unlikely to result in any adverse impacts.

If the actual far-field horizontal movements exceeded those predicted by a factor of 2 times, the strain associated with these movements would still be expected to be small, in the order of survey tolerance.

6.14.8. Recommendations for Telecommunications Infrastructure

IC has developed specific telecommunication infrastructure management plans for the longwalls at Appin Area 7 and West Cliff so as to manage the potential impacts on copper and optical fibre cables owned by Telstra, Optus, NextGen and PowerTel. The Management Plans were developed in consultation with telecommunications experts and the infrastructure owners. It is recommended that these plans are reviewed and, where required, revised to incorporate the telecommunications infrastructure within the Study Area. With the implementation of these management strategies, it would be expected that the telecommunications infrastructure can be maintained in serviceable conditions during and after the extraction of the proposed longwalls.

6.15. Water Tanks, Water and Sewage Treatment Works

There are no public water or sewage treatment works within the Study Area.

6.16. Dams, Reservoirs or Associated Works

There are no public dams, reservoirs, nor associated works within the Study Area.

6.17. Air Strips

There are no air strips within the Study Area.

6.18. Survey Control Marks

The locations of the survey control marks in the vicinity of the proposed longwalls are shown in Drawing No. MSEC448-32. The locations and details of the survey control marks were obtained from the *Land and Property Management Authority* using the *SCIMS Online* website (SCIMS, 2010).

The survey control marks are located across the Study Area and, therefore, are expected to experience the full range of predicted subsidence movements. A summary of the maximum predicted conventional subsidence movements within the Study Area is provided in Chapter 4.

The survey control marks located outside and in the vicinity of the Study Area are also expected to experience small amounts of subsidence and small far-field horizontal movements. It is possible that other survey control marks outside the immediate area could also be affected by far-field horizontal movements, up to 3 kilometres outside the Study Area. Far-field horizontal movements and the methods used to predict such movements are described further in Sections 3.3 and 4.6.

It will be necessary on the completion of the longwalls, when the ground has stabilised, to re-establish any survey control marks that are required for future use. Consultation between the IC and the Department of Lands will be required to ensure that these survey control marks are reinstated at the appropriate time, as required.

6.19. Any Other Public Utilities

There are no other public utilities within the Study Area.

The following sections provide the descriptions, predictions and impact assessments for the Public Amenities within the Study Area. The public amenities located outside the Study Area, which may be subjected to far-field movements or valley related movements and may be sensitive to these movements, have also been included as part of these assessments.

7.1. Hospitals

There are no hospitals within the Study Area.

7.2. Places of Worship

There are no places of worship within the Study Area.

7.3. Schools

Douglas Park Primary School (Property Ref. H31) is located 200 metres east of the finishing (eastern) end of the proposed Longwall 902. At this distance, the school is predicted to experience around 35 mm of vertical subsidence. While it is possible that the school could experience subsidence slightly greater than this, it would not be expected to experience any significant conventional tilts, curvatures or strains. The school is not expected to experience any adverse impacts resulting from the extraction of the proposed longwalls.

7.4. Shopping Centres

There are no shopping centres within the Study Area. There are, however, a number of small shops in the township of Douglas Park, which are located within the Study Area, but outside the extents of the proposed longwalls.

The locations of the shops are shown in are shown in Drawing No. MSEC448-18. A summary of the shops within the Study Area is provided in Table 7.1.

Table 7.1 Shops within the Study Area

Shop	Address	Description
Arctic Seals	135 Camden Road, Douglas Park	Services and repairs of fridge door seals
Douglas Park Cellars and Service Station	145A Camden Road, Douglas Park	General store, bottle shop and service station
Douglas Park General Store	145A Camden Road, Douglas Park	General store, bottle shop and take-away
The Dugout Café	139 Camden Road, Douglas Park	Closed and untenanted
The Pot Works	Corner of Camden Road and Railway Parade, Douglas Park	Pots, pavers and garden accessories

The predictions and impact assessments for these establishments are provided in Section 9.3.

7.5. Community Centres

There are no community centres located within the Study Area.

The Douglas Park Community Hall (Building Ref. K90PA01) is located just outside the Study Area. The hall is a single-storey weatherboard structure on brick piers. A photograph of the structure is shown in Fig. 7.1.

Fig. 7.1 Douglas Park Community Hall

The Douglas Park Community Hall is located 400 metres south-east of the finishing (eastern) end of the proposed Longwall 901. At this distance, the hall is predicted to experience less than 20 mm of vertical subsidence.

While it is possible that the hall could experience subsidence slightly greater than 20 mm, it would not be expected to experience any significant conventional tilts, curvatures or strains. The hall is not expected to experience any adverse impacts resulting from the extraction of the proposed longwalls.

7.6. Office Buildings

There are no office buildings within the Study Area.

7.7. Swimming Pools

There are no public swimming pools within the Study Area.

7.8. Bowling Greens

There are no bowling greens within the Study Area.

7.9. Ovals or Cricket Grounds

There are no ovals or cricket grounds located within the Study Area.

There is an oval south-east of the Study Area, which is located 475 metres from the finishing (eastern) end of the proposed Longwall 901. At this distance, the oval is predicted to experience less than 20 mm of vertical subsidence.

While it is possible that the facility could experience subsidence slightly greater than 20 mm, it would not be expected to experience any significant conventional tilts, curvatures or strains. The oval is not expected to experience any adverse impacts resulting from the extraction of the proposed longwalls.

7.10. Racecourses

There are no racecourses within the Study Area.

7.11. Golf Courses

There are no golf courses within the Study Area.

7.12. Tennis Courts

There are no public tennis courts within the Study Area.

There is a public tennis court facility south-east of the Study Area, which located 400 metres from the finishing (eastern) end of the proposed Longwall 901. At this distance, the facility is predicted to experience less than 20 mm of vertical subsidence.

While it is possible that the facility could experience subsidence slightly greater than 20 mm, it would not be expected to experience any significant conventional tilts, curvatures or strains. The tennis court facility is not expected to experience any adverse impacts resulting from the extraction of the proposed longwalls.

7.13. Any Other Public Amenities

The Douglas Park Train Station is located east of the proposed Longwall 901. The descriptions, predictions and impact assessments for the station is provided in Section 6.1.

The *Fidgety Frogs Long Day Care Centre* is located in Douglas Park, east of the proposed longwalls. The descriptions, predictions and impact assessments for this establishment are provided in Section 9.3.

There are no other public amenities identified within the Study Area.

8.0 DESCRIPTIONS, PREDICTIONS AND IMPACT ASSESSMENTS FOR THE FARM LAND AND FARM FACILITIES

The following sections provide the descriptions, predictions and impact assessments for the farm land and farm facilities within the Study Area. The farm facilities located outside the Study Area, which may be subjected to far-field movements or valley related movements and may be sensitive to these movements, have also been included as part of these assessments.

8.1. Agricultural Utilisation

The agricultural land classification types within the Study Area are illustrated in Fig. 8.1.

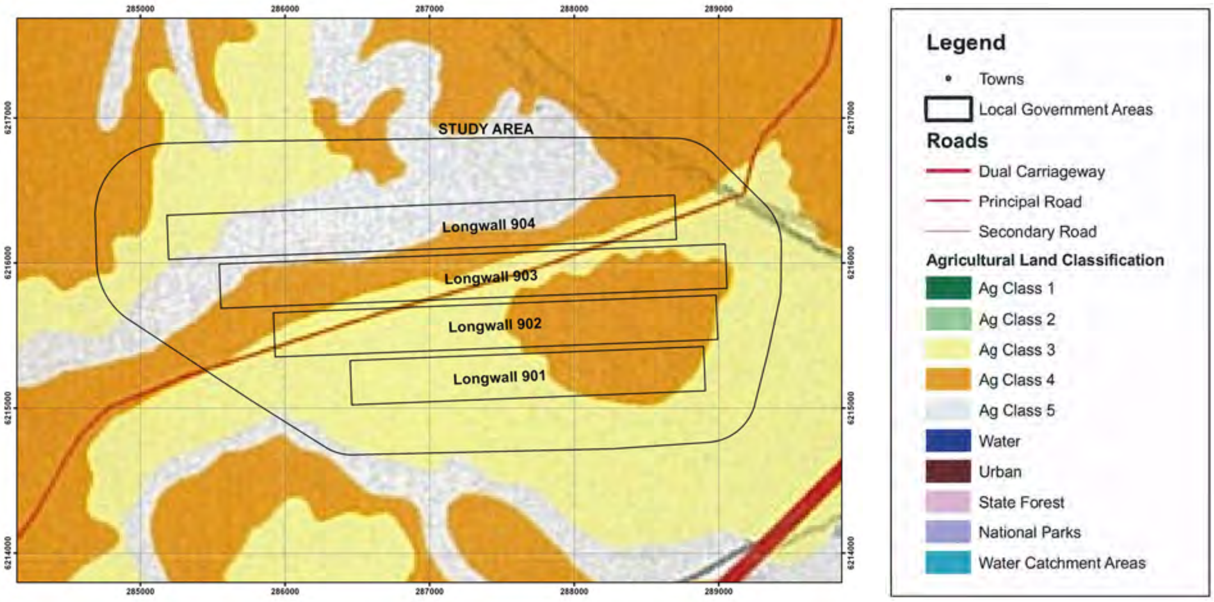

Fig. 8.1 Agricultural Land Classification within the Study Area (Source DTIRIS, November 2008)

It can be seen from the above figure, that there are three main agricultural land classification types within the Study Area, which are:-

- Class 3 – Grazing land or land well suited to pasture improvement,
- Class 4 – Land suitable for grazing but not for cultivation, and
- Class 5 – Land unsuitable for agriculture, or at best suited only to light grazing.

The flatter areas of land within the Study Area have been predominately cleared and are used for light agricultural and residential purposes. The more hilly areas within the Study Area, including the Razorback Range, have not been cleared of the natural vegetation.

8.2. Rural Building Structures

The locations of the rural building structures within the Study Area are shown in Drawing Nos. MSEC448-19 to MSEC448-31. The descriptions, predictions and impact assessments for these structures are provided in the following sections.

8.2.1. Descriptions of the Rural Building Structures

There are 652 rural building structures (Structure Type R) which have been identified within the Study Area, which includes sheds, garages, gazebos, pergolas, greenhouses, playhouses, shade structures and other non-residential building structures.

The locations of the rural building structures are shown in Drawing Nos. MSEC448-19 to MSEC448-31 and details are provided in Table D.03, in Appendix D. The locations, sizes, and details of the rural building structures were determined from an aerial photograph of the area and from kerb side inspections.

8.2.2. Predictions for the Rural Building Structures

Predictions of conventional subsidence, tilt and curvature have been made at the centroid and at the vertices of each rural building structure, as well as at eight equally spaced points placed radially around the centroid and vertices at a distance of 20 metres. In the case of a rectangular shaped structure, predictions have been made at a minimum of 45 points within and around the structure.

A summary of the maximum predicted values of conventional subsidence, tilt and curvature for each rural building structure within the Study Area, resulting from the extraction of the proposed longwalls, is provided in Table D.03, in Appendix D. The predicted tilts provided in this table are the maxima in any direction after the completion of each of the proposed longwalls. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each of the proposed longwalls.

The distributions of the maximum predicted conventional subsidence, tilt and curvature for the rural building structures within the Study Area, resulting from the extraction of the proposed longwalls, are illustrated in Fig. 8.2 and Fig. 8.3.

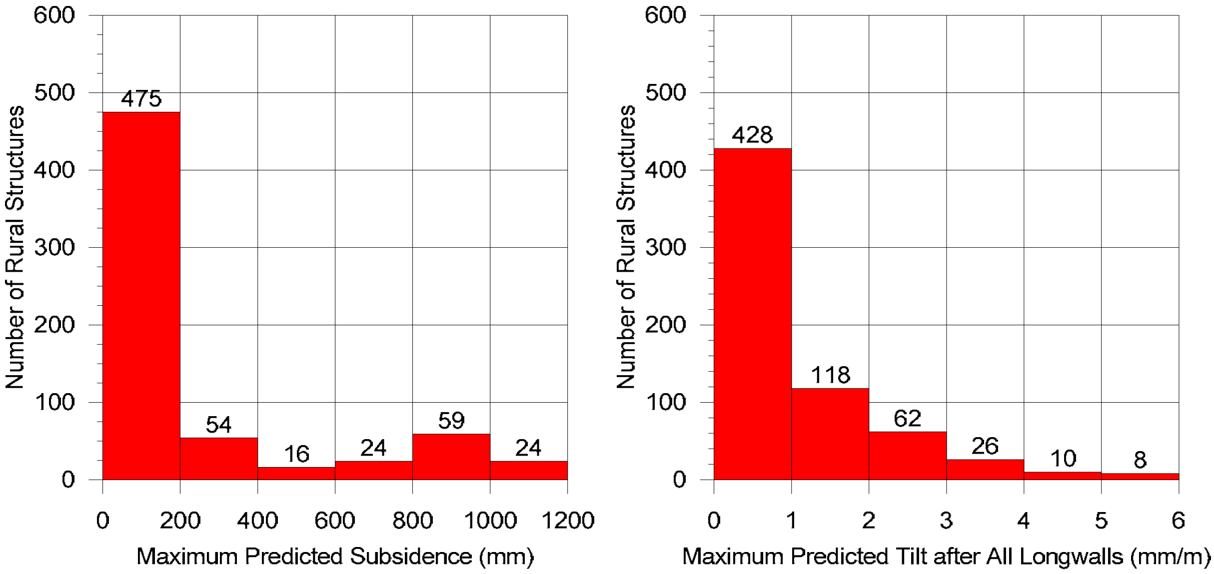

Fig. 8.2 Maximum Predicted Conventional Subsidence and Tilt for the Rural Building Structures within the Study Area Resulting from the Extraction of the Proposed Longwalls

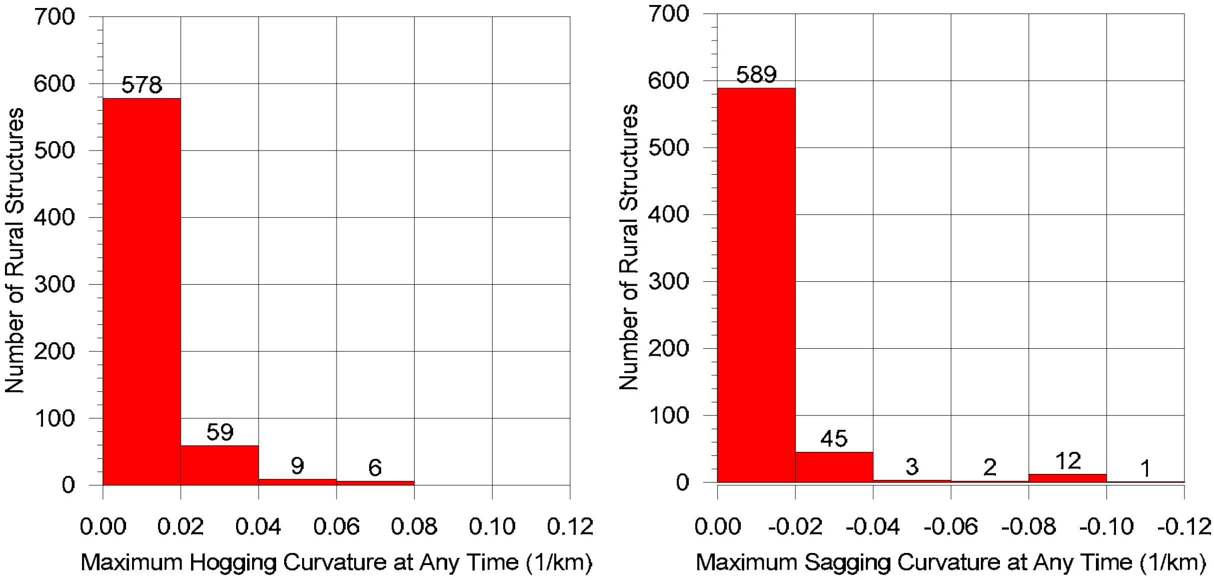

Fig. 8.3 Maximum Predicted Conventional Hogging Curvature (Left) and Sagging Curvature (Right) for the Rural Structures Resulting from the Extraction of the Proposed Longwalls

The rural building structures are at discrete locations and, therefore, the most relevant distributions of strain are the maximum strains measured in individual survey bays from previous longwall mining. The analysis of strains in survey bays during the mining of previous longwalls in the Southern Coalfield is discussed in Section 4.4.1. The results for survey bays above goaf are provided in Fig. 4.1 and Table 4.5. The results for survey bays above solid coal are provided in Fig. 4.3 and Table 4.6.

Non-conventional movements can also occur and have occurred in the NSW Coalfields as a result of, among other things, anomalous ground movements. The analysis of strains provided in Chapter 4 includes those resulting from both conventional and non-conventional anomalous movements.

The maximum predicted conventional strains for the rural building structures, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 1 mm/m tensile and 2 mm/m compressive.

8.2.3. Comparison of Predictions for the Rural Building Structures with those provided in the Part 3A Application

The comparison of the maximum predicted subsidence parameters for the rural building structures with those provided in the Part 3A Application is provided in Table 8.1.

Table 8.1 Comparison of the Maximum Predicted Conventional Subsidence Parameters for the Rural Building Structures Based on the Part 3A and Extraction Plan Layouts

Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging (km^{-1})
Part 3A Layout (Report No. MSEC404)	1400	6.5	0.07	0.12
Extraction Plan Layout (Report No. MSEC448)	1175	6.5	0.07	0.11

It can be seen from the above table, that the maximum predicted mine subsidence movements for the rural building structures, based on the Extraction Plan Layout, are similar to or slightly less than those predicted based on the Part 3A Layout.

8.2.4. Impact Assessments for the Rural Building Structures

The maximum predicted tilt for the rural building structures, resulting from the extraction of the proposed longwalls, is 6.5 mm/m (i.e. 0.7 %), which represents a change in grade of 1 in 155. The majority of the rural building structures within the Study Area are of lightweight construction. It has been found from past longwall mining experience, that tilts of the magnitudes predicted within the Study Area generally do not result in adverse impacts on rural building structures. Some minor serviceability impacts could occur at the higher levels of predicted tilt, including door swings and issues with roof and pavement drainage, all of which can be remediated using normal building maintenance techniques.

The maximum predicted conventional curvatures for the rural building structures, resulting from the extraction of the proposed longwalls, are 0.07 km^{-1} hogging and 0.11 km^{-1} sagging, which equate to minimum radii of curvature of 14 kilometres and 9 kilometres, respectively.

The maximum predicted curvatures and the range of potential strains at the rural building structures, resulting from the extraction of the proposed longwalls, are similar to those typically experienced elsewhere in the Southern Coalfield. Longwalls in the Southern Coalfield have been successfully mined directly beneath rural building structures in the past, and some of these cases are provided in Table 8.2.

Table 8.2 Examples of Previous Experience of Mining Beneath Rural Building Structures in the Southern Coalfield

Colliery and LWs	Rural Building Structures	Maximum Predicted Movements at the Structures	Observed Impacts
Appin LW301 and LW302	4	650 mm Subsidence 4.5 mm/m Tilt 1 mm/m Tensile Strain 3 mm/m Comp. Strain	No reported impacts
Appin LW401 to LW409	100	1200 mm Subsidence 5 mm/m Tilt 1 mm/m Tensile Strain 2 mm/m Comp. Strain	No reported impacts
Appin LW701 to LW704	55	1100 mm Subsidence 7.5 mm/m Tilt 1.5 mm/m Tensile Strain 4 mm/m Comp. Strain	No reported impacts
Tahmoor LW22 to LW25	716	1200 mm Subsidence 6 mm/m Tilt 1.5 mm/m Tensile Strain 2 mm (typ.) and up to 5 mm/m Comp. Strain	Impacts reported at three rural building structures
West Cliff LW29 to LW34	196	1100 mm Subsidence 10 mm/m Tilt 1 mm/m Tensile Strain 5.5 mm/m Comp. Strain	Impacts to four large chicken sheds due to non-conventional movements.

There is extensive experience of mining directly beneath rural building structures in the Southern Coalfield which indicates that the incidence of impacts on these structures is very low. This is not surprising as rural building structures are generally small in size and of light-weight construction, which makes them less susceptible to impact than houses which are typically more rigid. In all cases, the rural building structures remained in safe and serviceable conditions.

It is expected, therefore, that all the rural building structures within the Study Area would remain safe and serviceable during the mining period, provided that they are in sound existing condition. The risk of impact is clearly greater if the structures are in poor condition, though the chances of there being a public safety risk remains very low. A number of rural building structures which were in poor existing conditions have been directly mined beneath and these structures have not experienced impacts during mining.

Any impacts on the rural building structures that occur as the result of the extraction of the proposed longwalls are expected to be remediated using well established building techniques. With these remediation measures available, it is unlikely that there would be any significant long term impacts on rural building structures resulting from the extraction of the proposed longwalls.

There are some rural building structures which have been built on the top of the Razorback Range and, therefore, are located closer to areas comprising steep slopes. An example of this is illustrated in Fig. 11.7, which provides a cross-section through the range above the commencing (western) end of the proposed Longwall 904. A detailed investigation of the steep slopes within the Study Area and discussions on the potential impacts resulting from the extraction of the proposed longwalls are provided in the reports by *Coffey* (2012) and *UoW* (2012).

8.2.5. Impact Assessments for the Rural Building Structures Based on Increased Predictions

If the actual tilts exceeded those predicted by a factor of 2 times, the maximum tilt at the rural building structures would be 13 mm/m (i.e. 1.3 %), or a change in grade of 1 in 75. In this case, the incidence of serviceability impacts, such as door swings and issues with gutter and pavement drainage, would increase in the locations of greatest tilt, such as adjacent to the active longwall maingate and adjacent to the ends of the proposed longwalls. It would still be unlikely that stabilities of these rural building structures would be affected by tilts of these magnitudes.

If the actual curvatures exceeded those predicted by a factor of 2 times, the incidence of impacts would increase for the rural building structures located directly above the longwalls. Since rural building structures are generally small in size and of light-weight construction, they would still be expected to remain safe, serviceable and repairable using normal building maintenance techniques. With the implementation of any necessary remediation measures, it is unlikely that there would be any significant long term impacts on the rural building structures.

While the predicted ground movements are important parameters when assessing the potential impacts on the rural building structures, it is noted that the impact assessments were primarily based on historical observations from previous longwall mining in the Southern Coalfield. The overall levels of impact on the rural building structures, resulting from the extraction of the proposed longwalls, are expected to be similar to those observed where longwalls have previously mined directly beneath rural building structures in the Southern Coalfield.

8.2.6. Recommendations for the Rural Building Structures

The assessed impacts on the rural building structures within the Study Area, resulting from the extraction of the proposed longwalls, can be managed with the implementation of suitable management strategies.

IC will prepare Property Subsidence Management Plans (PSMP) for all landholders within the Study Area, similar to those which have been prepared for the properties at Appin Area 7 and West Cliff Colliery. The PSMPs will address the management of all surface infrastructure including rural building structures. With the implementation of these management strategies, it would be expected that the rural building structures could be maintained in safe and serviceable conditions during and after the extraction of the proposed longwalls.

8.3. Tanks

The locations of the water tanks within the Study Area are shown in Drawing Nos. MSEC448-11 to MSEC448-15. The descriptions, predictions and impact assessments for the tanks are provided in the following sections.

8.3.1. Descriptions of the Tanks

There are 257 water tanks (Structure Type T) which have been identified within the Study Area. The locations of the tanks are shown in Drawing No. MSEC448-19 to MSEC448-31 and details are provided in Table D.05, in Appendix D. The locations and sizes of the tanks were determined from an aerial photograph of the area and kerb side inspections. There are also a number of smaller rainwater tanks associated with the houses which are not shown in these drawings.

8.3.2. Predictions for the Tanks

Predictions of conventional subsidence, tilt and curvature have been made at the centroid and at points located around the perimeter of each tank, as well as at points located at a distance of 20 metres from the perimeter of each tank.

A summary of the maximum predicted values of conventional subsidence, tilt and curvature for each tank within the Study Area, resulting from the extraction of the proposed longwalls, is provided in Table D.05, in Appendix D. The predicted tilts provided in this table are the maxima in any direction after the completion of each of the proposed longwalls. The predicted curvatures provided in this table are the maxima in any direction at any time during or after the extraction of each of the proposed longwalls.

The distributions of the maximum predicted conventional subsidence, tilt and curvature for the tanks within the Study Area, resulting from the extraction of the proposed longwalls, are illustrated in Fig. 8.4 and Fig. 8.5.

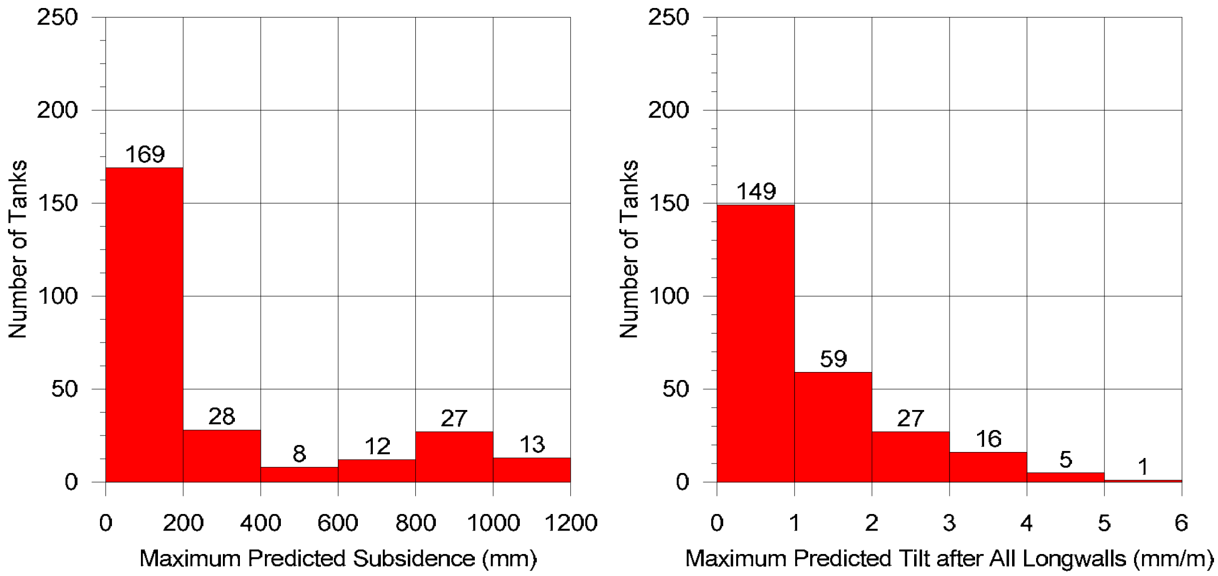

Fig. 8.4 Maximum Predicted Conventional Subsidence and Tilt for the Tanks within the Study Area Resulting from the Extraction of the Proposed Longwalls

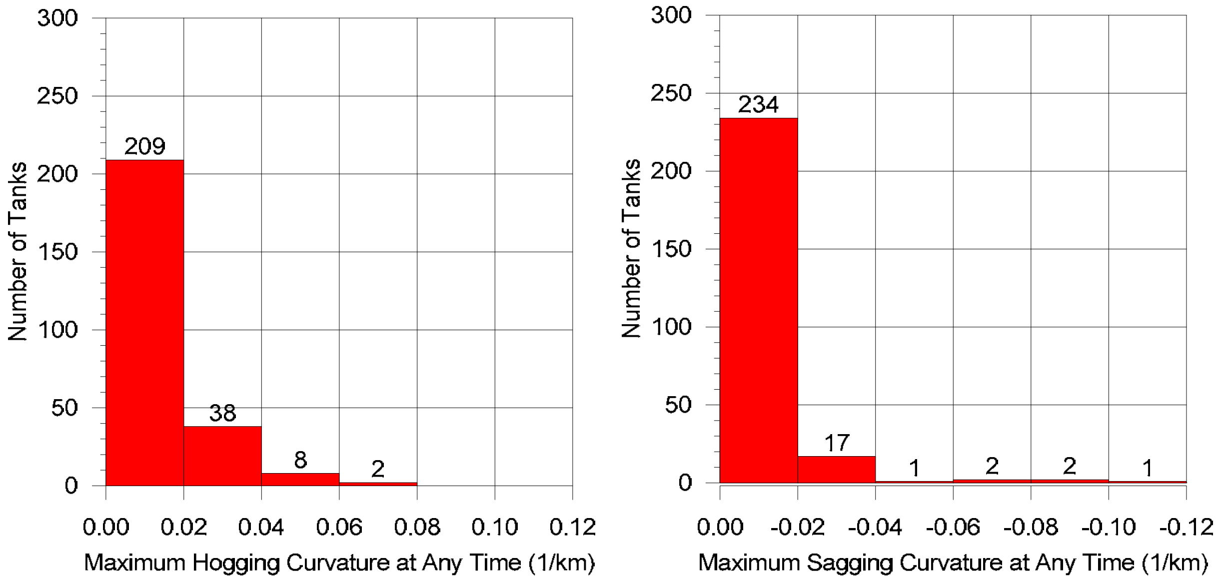

Fig. 8.5 Maximum Predicted Conventional Hogging Curvature (Left) and Sagging Curvature (Right) for the Tanks Resulting from the Extraction of the Proposed Longwalls

The tanks are at discrete locations and, therefore, the most relevant distributions of strain are the maximum strains measured in individual survey bays from previous longwall mining. The analysis of strains in survey bays during the mining of previous longwalls in the Southern Coalfield is discussed in Section 4.4.1. The results for survey bays above goaf are provided in Fig. 4.1 and Table 4.5. The results for survey bays above solid coal are provided in Fig. 4.3 and Table 4.6.

Non-conventional movements can also occur and have occurred in the NSW Coalfields as a result of, among other things, anomalous movements. The analysis of strains provided in Chapter 4 includes those resulting from both conventional and non-conventional anomalous movements.

The maximum predicted conventional strains for the tanks, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 1 mm/m tensile and 2 mm/m compressive.

8.3.3. Comparison of Predictions for the Tanks with those provided in the Part 3A Application

The comparison of the maximum predicted subsidence parameters for the tanks with those provided in the Part 3A Application is provided in Table 8.3.

Table 8.3 Comparison of the Maximum Predicted Conventional Subsidence Parameters for the Tanks Based on the Part 3A and Extraction Plan Layouts

Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging (km^{-1})
Part 3A Layout (Report No. MSEC404)	1400	6.5	0.07	0.12
Extraction Plan Layout (Report No. MSEC448)	1125	5.5	0.07	0.11

It can be seen from the above table, that the maximum predicted mine subsidence movements for the tanks, based on the Extraction Plan Layout, are similar to or slightly less than those predicted based on the Part 3A Layout.

8.3.4. Impact Assessments for the Tanks

Tilt can potentially affect the serviceability of tanks by altering the water levels in the tanks, which can in turn affect the minimum level of water which can be released from the outlets. The maximum predicted conventional tilt for the tanks within the Study Area is 5.5 mm/m (i.e. 0.6 %), which represents a change in grade of 1 in 180. The predicted changes in grade are small, less than 1 % and unlikely, therefore, to result in any adverse impacts on the serviceability of the tanks.

The tanks structures are typically constructed above ground level and, therefore, are unlikely to experience the curvatures and ground strains resulting from the extraction of the proposed longwalls. It is possible, that any buried water pipelines associated with the tanks within the Study Area could be impacted by the ground strains, if they are anchored by the tanks, or by other structures in the ground.

Any impacts are expected to be of a minor nature, including leaking pipe joints, and could be easily repaired. With these remedial measures in place, it would be unlikely that there would be any adverse impacts on the pipelines associated with the tanks.

8.3.5. Impact Assessments for the Tanks Based on Increased Predictions

If the actual tilts exceeded those predicted by a factor of 2 times, the maximum tilt at the tanks would be 11 mm/m (i.e. 1.1 %), or a change in grade of 1 in 90. In this case, the incidence of serviceability impacts, such as changes in the minimum water levels which can be released from the outlets, could increase in the locations of greatest tilt, such as adjacent to the active longwall maingate and adjacent to the ends of the proposed longwalls. Any such impacts would be expected to be easily remediated by relevelling the tanks.

If the actual curvatures exceeded those predicted by a factor of 2 times, the incidence of impacts on the tank structures would not be expected to change significantly, as they are not expected to experience these ground movements. The incidence of impacts on the buried pipelines would, however, be expected to increase in the locations directly above the proposed longwalls. Any impacts would still be expected to be of a minor nature which could be easily repaired. With these remediation measures in place, it would be unlikely that there would be any significant long term impacts on the pipelines associated with the tanks.

8.3.6. Recommendations for the Tanks

The assessed impacts on the tanks and associated infrastructure resulting from the extraction of the proposed longwalls are not significant. In any case, the management strategies for the tanks within the Study Area will be covered in the Property Subsidence Management Plans (PSMPs).

8.4. Gas and Fuel Storages

A number of the residences within the Study Area have gas or fuel storages.

The domestic gas and fuel storages are located across the Study Area and, therefore, are expected to experience the full range of predicted subsidence movements. A summary of the maximum predicted conventional subsidence movements within the Study Area is provided in Chapter 4.

The storage tanks are generally elevated above ground level and, therefore, are not susceptible to mine subsidence movements. It is possible, however, that any buried gas pipelines associated with the storage tanks within the Study Area could be impacted by the curvatures and ground strains, if they are anchored by the storage tanks, or by other structures in the ground.

Any impacts are expected to be of a minor nature, including minor gas leaks, which could be easily repaired. It is unlikely that there would be any adverse impacts on the pipelines associated with the gas and fuel storage tanks, even if the actual movements exceeded the predictions by a factor of 2 times.

8.5. Poultry Sheds

No poultry sheds have been identified within the Study Area.

8.5.1. Glass Houses

No glass houses have been identified within the Study Area.

8.5.2. Hydroponic Systems

No hydroponic systems have been identified within the Study Area.

8.5.3. Irrigation Systems

No irrigation systems have been identified within the Study Area.

8.6. Farm Fences

The fences are located across the Study Area and, therefore, are expected to experience the full range of predicted subsidence movements. A summary of the maximum predicted conventional subsidence movements within the Study Area is provided in Chapter 4.

The fences are linear features and, therefore, the most relevant distribution of strain is the maximum strains measured along whole monitoring lines above previous longwall mining. The analysis of strains along whole monitoring lines during the mining of previous longwalls in the Southern Coalfield is discussed in Section 4.4 and the results are provided in Fig. 4.4.

Non-conventional movements can also occur and have occurred in the NSW Coalfields as a result of, among other things, anomalous movements. The analysis of strains provided in Chapter 4 includes those resulting from both conventional and non-conventional anomalous movements.

The fences within the Study Area are constructed in a variety of ways, generally using either timber or metal materials.

Wire fences can be affected by tilting of the fence posts and by changes of tension in the fence wires due to strain as mining occurs. These types of fences are generally flexible in construction and can usually tolerate tilts of up to 10 mm/m and strains of up to 5 mm/m without adverse impacts. It is possible, that some of the wire fences within the Study Area could be impacted as the result of the extraction of the proposed longwalls. Any impacts on the wire fences are likely to be of a minor nature and relatively easy to remediate by re-tensioning the fencing wire, straightening the fence posts, and if necessary, replacing some sections of fencing.

Colorbond and timber paling fences are more rigid than wire fences and, therefore, are more susceptible to impacts resulting from mine subsidence movements. It is possible that these types of fences could be impacted as the result of the extraction of the proposed longwalls. Any impacts on Colorbond or timber paling fences can be remediated or, where necessary, affected sections of the fences replaced.

The management strategies for the fences within the Study Area will be covered in the Property Subsidence Management Plans (PSMPs).

8.7. Farm Dams

The locations of the farm dams within the Study Area are shown in Drawing Nos. MSEC448-19 to MSEC448-31. The descriptions, predictions and impact assessments for these features are provided in the following sections.

8.7.1. Descriptions of the Farm Dams

There are 149 farm dams (Structure Type D) which have been identified within the Study Area. The locations of the farm dams are shown in Drawing Nos. MSEC448-19 to MSEC448-31 and details are provided in Table D.04, in Appendix D. The locations and sizes of the farm dams were determined from an aerial photograph of the area.

The dams are typically of earthen construction and have been established by localised cut and fill operations within the natural drainage lines. The farm dams are generally shallow, with the dam wall heights generally being less than 3 metres. The distributions of the longest lengths and surface areas of the farm dams within the Study Area are shown in Fig. 8.6.

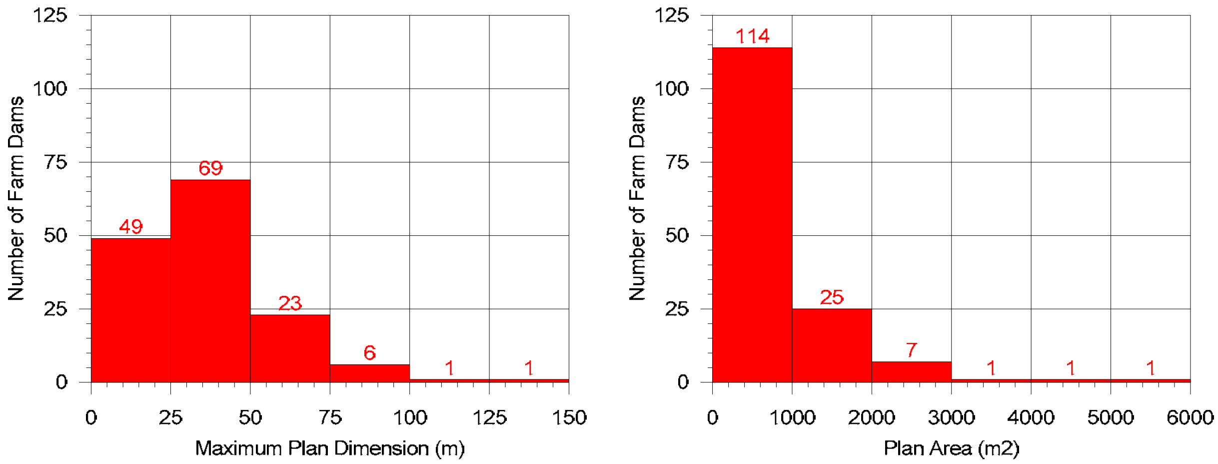

Fig. 8.6 Distributions of Longest Lengths and Surface Areas of the Farm Dams

The longest lengths of the farm dams within the Study Area vary between 5 metres and 130 metres and the plan areas vary between 10 m^2 and 5,300 m^2.

8.7.2. Predictions for the Farm Dams

Predictions of conventional subsidence, tilt and curvature have been made at the centroid and around the perimeters of each farm dam. A summary of the maximum predicted values of conventional subsidence, tilt and curvature for each farm dam within the Study Area, resulting from the extraction of the proposed longwalls, is provided in Table D.04, in Appendix D.

The distributions of the maximum predicted conventional subsidence, tilt and curvature for the farm dams within the Study Area, resulting from the extraction of the proposed longwalls, are illustrated in Fig. 8.7, Fig. 8.8 and Fig. 8.9.

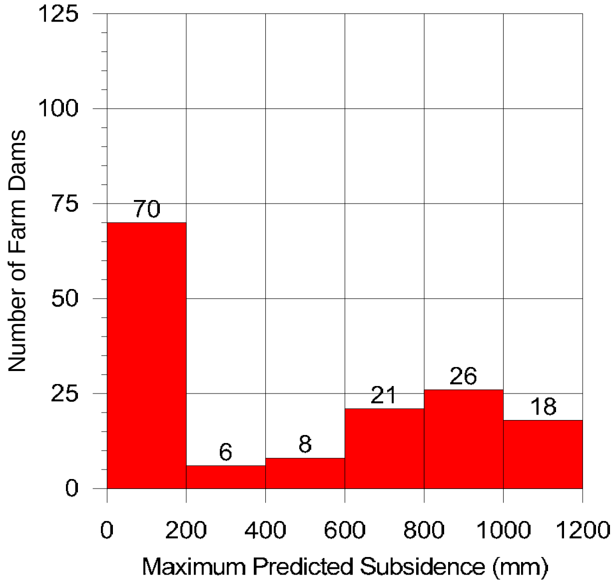

Fig. 8.7 Maximum Predicted Conventional Subsidence for the Farm Dams within the Study Area

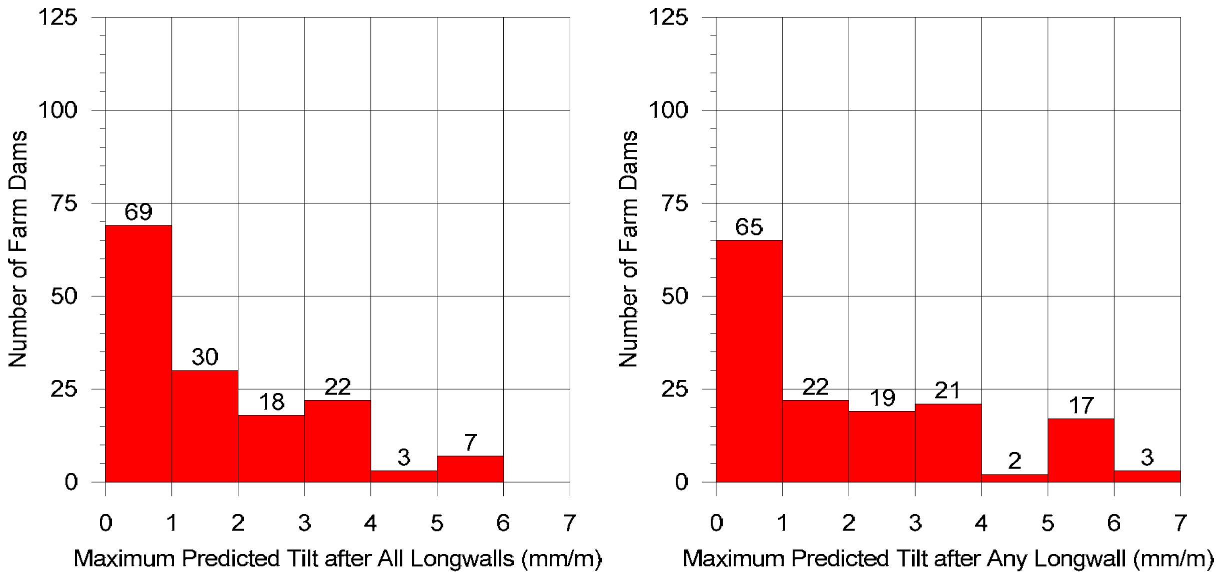

Fig. 8.8 Maximum Predicted Conventional Tilt after the Extraction of All Longwalls (Left) and after the Extraction of Any Longwall (Right) for the Farm Dams within the Study Area

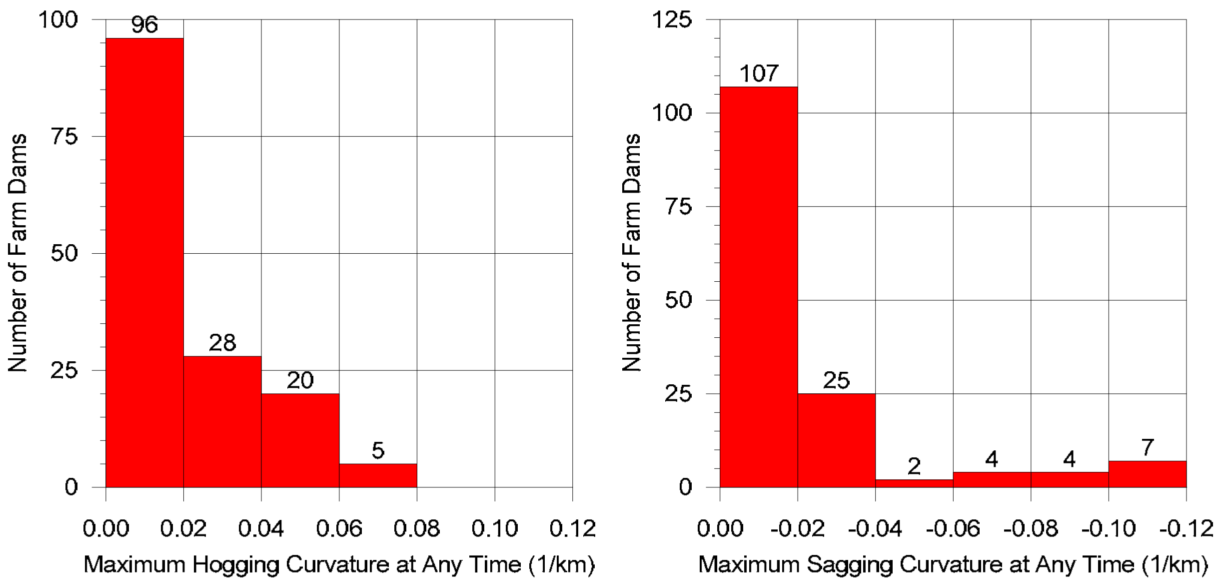

Fig. 8.9 Maximum Predicted Conventional Hogging Curvature (Left) and Sagging Curvature (Right) for the Farm Dams within the Study Area

The dams have typically been constructed within the drainage lines and, therefore, may be subjected to valley related movements resulting from the extraction of the proposed longwalls. The equivalent valley heights at the dams are very small and it is expected, therefore, that the predicted valley related upsidence and closure movements at the dam walls would be much less than the predicted conventional subsidence movements and would not be significant.

The farm dams are at discrete locations and, therefore, the most relevant distributions of strain are the maximum strains measured in individual survey bays from previous longwall mining. The analysis of strains in survey bays during the mining of previous longwalls in the Southern Coalfield is discussed in Section 4.4.1. The results for survey bays above goaf are provided in Fig. 4.1 and Table 4.5. The results for survey bays above solid coal are provided in Fig. 4.3 and Table 4.6.

Non-conventional movements can also occur and have occurred in the NSW Coalfields as a result of, among other things, anomalous ground movements. The analysis of strains provided in Chapter 4 includes those resulting from both conventional and non-conventional anomalous movements.

The maximum predicted conventional strains for the farm dams, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 1 mm/m tensile and 2 mm/m compressive. The compressive strains resulting from valley related movements could be in the order of 7 mm/m.

8.7.3. Comparison of Predictions for the Farm Dams with those provided in the Part 3A Application

The comparison of the maximum predicted subsidence parameters for the farm dams with those provided in the Part 3A Application is provided in Table 8.4.

Table 8.4 Comparison of the Maximum Predicted Conventional Subsidence Parameters for the Farm Dams Based on the Part 3A and Extraction Plan Layouts

Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging (km^{-1})
Part 3A Layout (Report No. MSEC404)	1400	6.5	0.07	0.12
Extraction Plan Layout (Report No. MSEC448)	1175	6.5	0.07	0.11

It can be seen from the above table, that the maximum predicted mine subsidence movements for the farm dams, based on the Extraction Plan Layout, are similar to or slightly less than those predicted based on the Part 3A Layout.

8.7.4. Impact Assessments for the Farm Dams

The maximum predicted tilt for the farm dams within the Study Area, at the completion of mining, is 6.0 mm/m (i.e. 0.6 %), which represents a change in grade of 1 in 165. The maximum predicted tilt for the farm dams within the Study Area, at any time during the extraction of the proposed longwalls, is 6.5 mm/m (i.e. 0.7 %), which represents a change in grade of 1 in 155.

Mining induced tilts can affect the water levels around the perimeters of farm dams, with the freeboard increasing on one side, and decreasing on the other. Tilt can potentially reduce the storage capacity of farm dams, by causing them to overflow, or can affect the stability of the dam walls.

The predicted changes in freeboard at the farm dams within the Study Area were determined by taking the difference between the maximum predicted subsidence and the minimum predicted subsidence anywhere around the perimeter of each farm dam. The predicted maximum changes in freeboard at the farm dams within the Study Area, after the completion of the proposed longwalls, are provided in Table D.04, in Appendix D, and are illustrated in Fig. 8.10.

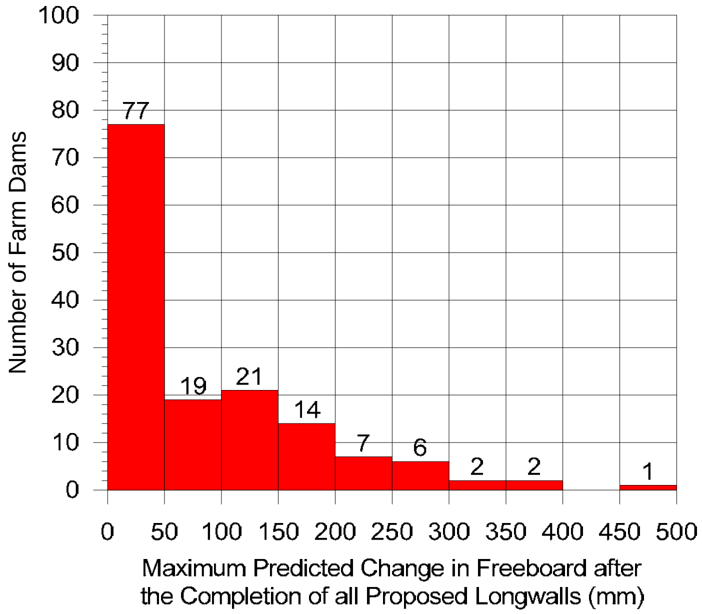

Fig. 8.10 Predicted Changes in Freeboards for the Farm Dams within the Study Area

It can be seen from the above figure, that the predicted maximum changes in freeboard at the farm dams within the Study Area are all less than 500 mm and are unlikely, therefore, to have adverse impacts on the storage capacities or the stability of the dam walls.

The maximum predicted conventional curvatures for farm dams, resulting from the extraction of the proposed longwalls, are 0.07 km^{-1} hogging and 0.11 km^{-1} sagging, which represent minimum radii of curvature of 14 kilometres and 9 kilometres, respectively.

The maximum predicted curvatures and the range of potential strains at the farm dams, resulting from the extraction of the proposed longwalls, are similar to those typically experienced elsewhere in the Southern Coalfield. Longwalls in the Southern Coalfield have been successfully mined directly beneath farm dams in the past, and some of these cases are provided in Table 8.5.

Table 8.5 Examples of Previous Experience of Mining Beneath Farm Dams in the Southern Coalfield

Colliery and LWs	Number of Farm Dams Directly Mined Beneath	Predicted Maximum Movements at Dams	Observed Impacts
Appin LW301 and LW302	3	650 mm Subsidence 4.5 mm/m Tilt 1 mm/m Tensile Strain 3 mm/m Comp. Strain	No reported impacts
Appin LW401 to LW409	52	1200 mm Subsidence 5 mm/m Tilt 1 mm/m Tensile Strain 2 mm/m Comp. Strain	No reported impacts
Appin LW701 to LW704	30	1100 mm Subsidence 7.5 mm/m Tilt 1.5 mm/m Tensile Strain 4 mm/m Comp. Strain	One farm dam reported to drain
Tahmoor LW22 to LW25	36	1200 mm Subsidence 6 mm/m Tilt 1.5 mm/m Tensile Strain 2 mm (typ.) and up to 5 mm/m Comp. Strain	No reported impacts
West Cliff LW29 to LW34	49	1100 mm Subsidence 10 mm/m Tilt 1 mm/m Tensile Strain 5.5 mm/m Comp. Strain	No reported impacts

It can be seen from the above table, that the incidence of impacts on farm dams in the Southern Coalfield is extremely low. The farm dam reported to drain during the extraction of Appin Longwall 702 was of poor, shallow construction and seepage was observed at the base of the dam wall prior to mining. While no impacts were observed on the dam wall itself, the dam was observed to drain following mining of Appin Longwall 702.

It is expected, therefore, that the incidence of impacts on the farm dams within the Study Area, resulting from the extraction of the proposed longwalls, will be extremely low. If cracking or leakage of water were to occur in the farm dam walls, it is expected that this could be readily identified and repaired as required. It is not expected that any significant loss of water will occur from the farm dams, and any loss that did occur would flow into the tributary in which the dam was formed.

8.7.5. Impact Assessments for the Farm Dams Based on Increased Predictions

If the actual tilts exceeded those predicted by a factor of 2 times, the maximum tilt at the farm dams, at the completion of mining, would be 12 mm/m (i.e. 1.2 %), or a change in grade of 1 in 85. In this case, the maximum change in freeboard would be around 1000 mm, which could be sufficient to reduce the capacities of the farm dams below acceptable levels in the locations of greatest tilt, such as adjacent to the active longwall maingate and adjacent to the ends of the proposed longwalls. It may be necessary to restore the capacities of these farm dams at the completion of mining.

If the actual curvatures exceeded those predicted by a factor of 2 times, the likelihood and extent of cracking would increase for the farm dams located directly above the longwalls. Any surface cracking would still be expected to be of a minor nature and could be readily repaired. With any necessary remedial measures implemented, it is unlikely that any adverse impacts on the farm dams would occur resulting from the extraction of the proposed longwalls.

8.7.6. Recommendations for the Farm Dams

The assessed impacts on the farm dams, resulting from the extraction of the proposed longwalls, can be managed by the implementation of suitable management strategies. It is recommended that all water retaining structures be periodically visually monitored during the extraction of the proposed longwalls, to ensure that they remain in serviceable conditions.

The management strategies for the farm dams within the Study Area will be covered in the Property Subsidence Management Plans (PSMPs). With these management strategies in place, it is unlikely that there would be any significant long term impacts on the farm dams resulting from the extraction of the proposed longwalls.

8.8. Groundwater Bores

The locations of the groundwater bores within the Study Area are shown in Drawing No. MSEC448-32. The descriptions, predictions and impact assessments for the bores are provided in the following sections.

8.8.1. Descriptions of the Groundwater Bores

There are six registered groundwater bores within the Study Area, the details of which are provided in Table 8.6.

Table 8.6 Details of the Groundwater Bore within the General Study Area

Ref.	Approximate Easting (m)	Approximate Northing (m)	Diameter (mm)	Depth (m)	Authorised Use
GW034425	289175	6215600	152	70	Waste Disposal
GW035033	288050	6214950	152	131	Stock
GW072249	288100	6215550	165	98	Domestic / Stock
GW100673	286225	6216150	170	104	Stock
GW104602	289050	6216350	200	231	Stock
GW110671	288725	6216350	200	240	Domestic / Stock

The locations and details of the registered groundwater bores were obtained from the Department of Natural Resources using the *Natural Resource Atlas* website (NRAtlas, 2010).

The work summary sheet for GW104602, which is located 200 metres north of the finishing (eastern) end of the proposed Longwall 903, indicates that the bore has a yield of 0.75 L/sec and a salinity of 2500 ppm. The work summary sheet for GW110671, which is located directly above the finishing (eastern) end of the proposed Longwall 904, indicates that the bore has a yield of 0.15 L/sec and a salinity of 400 ppm.

Further details on the groundwater bores are provided in the report by *Geoterra* (2012).

8.8.2. Predictions and Impact Assessments for the Groundwater Bores

A summary of the maximum predicted total conventional subsidence parameters for the groundwater bores, resulting from the extraction of the proposed longwalls, is provided in Table 8.7.

Table 8.7 Maximum Predicted Total Conventional Subsidence Parameters at the Groundwater Bores Resulting from the Extraction of the Proposed Longwalls

Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
GW034425	50	< 0.5	< 0.01	< 0.01
GW035033	150	1.0	< 0.01	< 0.01
GW072249	1150	1.5	0.02	0.02
GW100673	825	< 0.5	0.02	0.01
GW104602	< 20	< 0.5	< 0.01	< 0.01
GW110671	150	1.5	0.02	0.01

The predicted tilts provided in the above table are the maxima in any direction after the completion of any or all of the proposed longwalls. The predicted curvatures are the maxima in any direction at any time during or after the extraction of the proposed longwalls.

The bores are at discrete locations and, therefore, the most relevant distributions of strain are the maximum strains measured in individual survey bays from previous longwall mining. The analysis of strains in survey bays during the mining of previous longwalls in the Southern Coalfield is discussed in Section 4.4.1. The results for survey bays above goaf are provided in Fig. 4.1 and Table 4.5. The results for survey bays above solid coal are provided in Fig. 4.3 and Table 4.6.

Non-conventional movements can also occur and have occurred in the NSW Coalfields as a result of, amongst other things, anomalous movements. The analysis of strains provided in Chapter 4 includes those resulting from both conventional and non-conventional anomalous movements.

The maximum predicted conventional ground strains for the bores, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 0.3 mm/m tensile and compressive.

It is likely that the groundwater bores will experience some impacts as the result of mining of the longwalls, particularly those directly above the proposed longwalls. Impacts may include temporary lowering of the piezometric surface, blockage of the bore due to differential horizontal displacements at different horizons within the strata and changes to groundwater quality. Such impacts on the groundwater bores can be readily managed.

Further discussions on the potential impacts on the groundwater regime, resulting from the extraction of the proposed longwalls, are provided in the report by *Geoterra* (2012).

8.8.3. Recommendations for the Groundwater Bores

The management strategies for the groundwater bores within the Study Area will be covered in the Property Subsidence Management Plans (PSMPs).

The following sections provide the descriptions, predictions and impact assessments for the industrial, commercial and business establishments within the Study Area. The infrastructure located outside the Study Area, which may be subjected to far-field movements or valley related movements and may be sensitive to these movements, have also been included as part of these assessments.

9.1. Factories

There are no factories within the Study Area.

9.2. Workshops

There are no commercial workshops within the Study Area.

9.3. Business or Commercial Establishments or Improvements

There are a number of business and commercial establishments in the township of Douglas Park, which are located within the Study Area, but outside the extents of the proposed longwalls. The locations of the business and commercial establishments are shown in are shown in Drawing No. MSEC448-18. The descriptions, predictions and impact assessments for these establishments are provided in the following sections.

9.3.1. Descriptions of the Business and Commercial Establishments

The establishment **Arctic Seals** (135 Camden Road) services and repairs fridge door seals. The business is located 200 metres east of the finishing (eastern) end of the proposed Longwall 901. The main building (Ref. J48C01) is a single-storey brick structure. There is also one small associated building structure on the property (Ref. J48C02).

The **Douglas Park Cellars and Service Station** (145A Camden Road) comprises a general store, bottle shop and service station. The business is located 150 metres east of the finishing (eastern) end of the proposed Longwall 901. The structures on the property include a single-storey brick structure (Ref. J43C01), a tank (Ref. J43C02) and a cantilevered steel awning. A photograph of the business is shown in Fig. 9.1.

Fig. 9.1 Douglas Park Cellars and Service Station

The **Douglas Park General Store** (145A Camden Road) is a general store and take-away shop. The business is located 150 metres east of the finishing (eastern) end of the proposed Longwall 901. The building (Ref. J42C01) is a double-storey brick structure.

The **Douglas Park Physical Culture Club** (32 Station Street) is located approximately 50 metres east of the finishing (eastern) end of the proposed Longwall 901. The main building (Ref. K48C01) is a single-storey weatherboard structure on brick piers. There are also two small associated building structures on the property (Refs. K48C02 and K48C03).

The **Dugout Café** (139 Camden Road) has been closed and is currently untenanted. The structure is located 200 metres east of the finishing (eastern) end of the proposed Longwall 901. The building (Ref. J46C01) is a single-storey brick structure.

The **Pots Works** (Corner of Camden Road and Railway Parade) sells pots, pavers and garden accessories. The business is located 150 metres east of the finishing (eastern) end of the proposed Longwall 901. The main building (Ref. J41C01) is a single-storey brick structure. There are also two small associated building structures on the property (Refs. J41C02 and J41C03).

The **Fidgety Frogs Long Day Care Centre** (148 Camden Road) is a child care centre. The business is located 75 metres east of the finishing (eastern) end of the proposed Longwall 901. The main building (Ref. J34C01) is a single-storey brick structure. There are also three small associated building structures on the property (Refs. J34C02, J34C03 and J34C04).

A fabrication workshop is also located on Railway Parade.

9.3.2. Predictions for the Business and Commercial Establishments

A summary of the maximum predicted conventional subsidence parameters at the business and commercial establishments, resulting from the extraction of the proposed longwalls, is provided in Table 9.1. The predicted movements are the maxima at the building structures on the properties, which have been made at the centroid and at the vertices of each structure, as well as at eight equally spaced points placed radially around the centroid and vertices at a distance of 20 metres.

Table 9.1 Maximum Predicted Conventional Subsidence Parameters at the Building Structure Resulting from the Extraction of the Proposed Longwalls

Location	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
Arctic Seals	50	< 0.5	< 0.01	< 0.01
Douglas Park Cellars and Service Station	50	< 0.5	< 0.01	< 0.01
Douglas Park General Store	50	< 0.5	< 0.01	< 0.01
Douglas Park Physical Culture Club	50	0.5	< 0.01	< 0.01
The Dugout Café (Closed)	50	< 0.5	< 0.01	< 0.01
The Pots Works	50	< 0.5	< 0.01	< 0.01
Fidgety Frogs Long Day Care Centre	100	1.0	0.01	< 0.01
Fabrication Workshop	< 20	< 0.5	< 0.01	< 0.01

The building structures on the business and commercial properties are at discrete locations outside the extents of the proposed longwalls and, therefore, the most relevant distributions of strain are the maximum strains measured in individual survey bays above solid coal from previous longwall mining. The results for survey bays above solid coal are provided in Fig. 4.3 and Table 4.6.

9.3.3. Impact Assessments for the Business and Commercial Establishments

The building structures on the business and commercial properties are predicted to generally experience subsidence of 50 mm or less, as a result of the extraction of the proposed longwalls. The smaller structures at the Fidgety Frogs Long Day Care Centre are predicted to experience subsidence up to 100 mm. All the building structures are located outside the extents of the proposed longwalls and, therefore, are not expected to experience any significant conventional tilts, curvatures or strains. The business and commercial establishments are not expected to experience any adverse impacts resulting from the proposed mining.

9.3.4. Impact Assessments for the Business and Commercial Establishments Based on Increased Predictions

If the actual tilts exceeded those predicted by a factor of 5 times, the maximum tilt at the commercial building structures would be 5 mm/m (i.e. 0.5 %), or a change in grade of 1 in 200. In this case, it is possible that the incidence of serviceability impacts, such as door swings and issues with gutter and pavement drainage, could increase for the commercial buildings in the locations of greatest tilt, such Ref. J34C01. It would still be unlikely that stabilities of these commercial building structures would be affected by tilts of these magnitudes.

If the actual curvatures exceeded those predicted by a factor of 5 times, the maximum curvatures would be 0.05 km^{-1} hogging and 0.01 km^{-1} sagging, which equate to minimum radii of curvature of 20 kilometres and 100 kilometres, respectively. In this case, only minor impacts on the commercial building structures would still be anticipated. With the implementation of any necessary remediation measures, it is unlikely that there would be any significant long term impacts on the commercial building structures.

9.3.5. Recommendations for the Business and Commercial Establishments

It is recommended that the commercial building structures are periodically visually monitored during the extraction of the proposed longwalls.

9.4. Gas or Fuel Storages and Associated Plant

There are fuel storages associated with the petrol station in Douglas Park. The descriptions, predictions and impact assessments for the petrol station are provided in Section 9.3. IC is undertaking a separate assessment of the petrol station and a specific Management Plan will be developed.

There are no other known commercial gas or fuel storages, or associated plant within the Study Area.

9.5. Waste Storages and Associated Plant

There are no commercial waste storages, or associated plant within the Study Area.

9.6. Buildings, Equipment or Operations that are Sensitive to Surface Movements

There are no known buildings, equipment or operations that are sensitive to surface movements within the Study Area.

9.7. Surface Mining (Open Cut) Voids and Rehabilitated Areas

There are no surface mining, or rehabilitation areas within the Study Area.

9.8. Mine Infrastructure Including Tailings Dams or Emplacement Areas

There are a number of exploration drill holes within the Study Area, the locations of which are shown in Drawing No. MSEC448-32. There is no other mine infrastructure within the Study Area.

9.9. Any Other Industrial, Commercial or Business Features

There are no other industrial, or commercial, or business features within the Study Area.

10.0 DESCRIPTIONS, PREDICTIONS AND IMPACT ASSESSMENTS FOR AREAS OF ARCHAEOLOGICAL AND HERITAGE SIGNIFICANCE

The descriptions, predictions and impact assessments for the archaeological and heritage sites within the Study Area are provided in the following sections. The sites located outside the Study Area, which may be subjected to far-field movements or valley related movements and may be sensitive to these movements, have also been included as part of these assessments.

10.1. Archaeological Sites

There are no lands within the Study Area declared as an Aboriginal Place under the *National Parks and Wildlife Act 1974*. There are also no identified Aboriginal Sites within the Study Area. There is one Shelter with Art (Site BDC1) which has been identified just outside the Study Area, the location of which is shown in Drawing No. MSEC448-33. Further details on this site are provided in the report by *Biosis* (2012b).

The shelter is located 350 metres south of the commencing (western) end of the proposed Longwall 901. At this distance, the site is predicted to experience less than 20 mm of subsidence as the result of the extraction of the proposed longwalls. While it is possible that the site could experience subsidence slightly greater than 20 mm, it would not be expected to experience any significant conventional tilts, curvatures or strains.

It is not expected, therefore, that the site would experience any adverse impacts resulting from the extraction of the proposed longwalls, even if the predictions were exceeded by a factor of 5 times.

10.2. Heritage Sites

There are no items within the Study Area which are listed on the State Heritage Register. The Railway Cottage at Douglas Park Station (Site 30) is listed on the new Wollondilly LEP 2011 (local significance), the location of which is shown in Drawing No. MSEC448-33. The descriptions, predictions and impact assessments for the structures at the station are provided in Section 6.1.13. Further discussions are provided in the report by *Biosis* (2012b).

Warragunyah and the Mountbatten Group are situated well outside the Study Area, the locations of which are also shown in Drawing No.MSEC448-33. It is not expected that these sites would experience any adverse impacts resulting from the extraction of the proposed longwalls, even if the predictions were increased by a factor of 5 times.

10.3. Items on the Register of the National Estate

There are no items on the Register of National Estate within the Study Area.

10.4. Items of Architectural Significance

There are no items of architectural significance within the Study Area.

11.1. Houses

The locations of the houses within the Study Area are shown in Drawing Nos. MSEC448-19 to MSEC448-31. The descriptions, predictions and impact assessments for these structures are provided in the following sections.

11.1.1. Descriptions of the Houses

There are 251 houses that have been identified within the Study Area. The locations of the houses are shown in Drawing No. MSEC448-19 to MSEC448-31 and details are provided in Table D.01, in Appendix D. The locations, sizes, and details of the houses were determined from an aerial photograph of the area and from kerb side inspections. It is likely that additional houses will be constructed prior to the commencement of mining.

The distributions of the maximum plan dimensions and areas of the houses within the Study Area are provided in Fig. 11.1. The distributions of the wall and footing constructions of the houses within the Study Area are provided in Fig. 11.2.

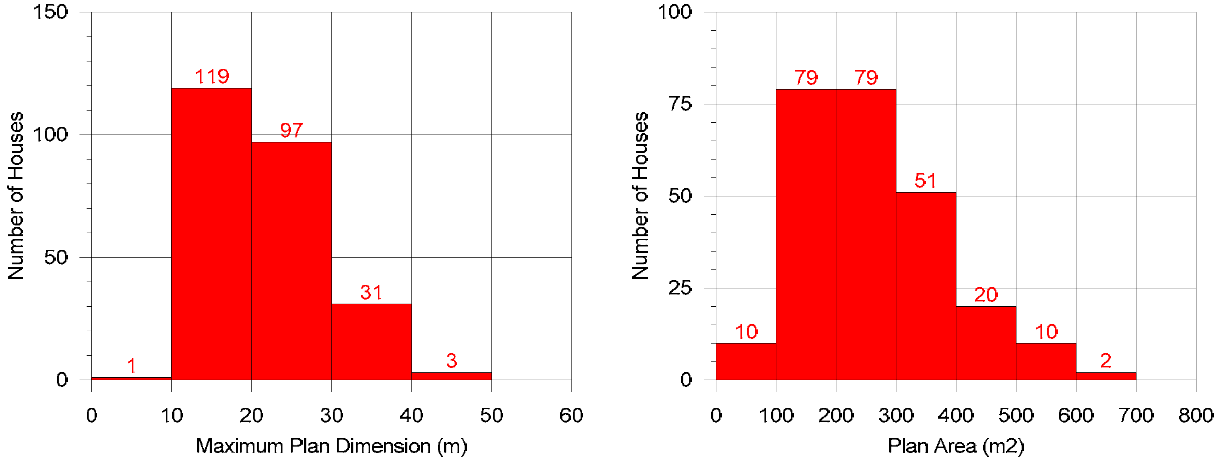

Fig. 11.1 Distributions of the Maximum Plan Dimensions and Areas of Houses within the Study Area

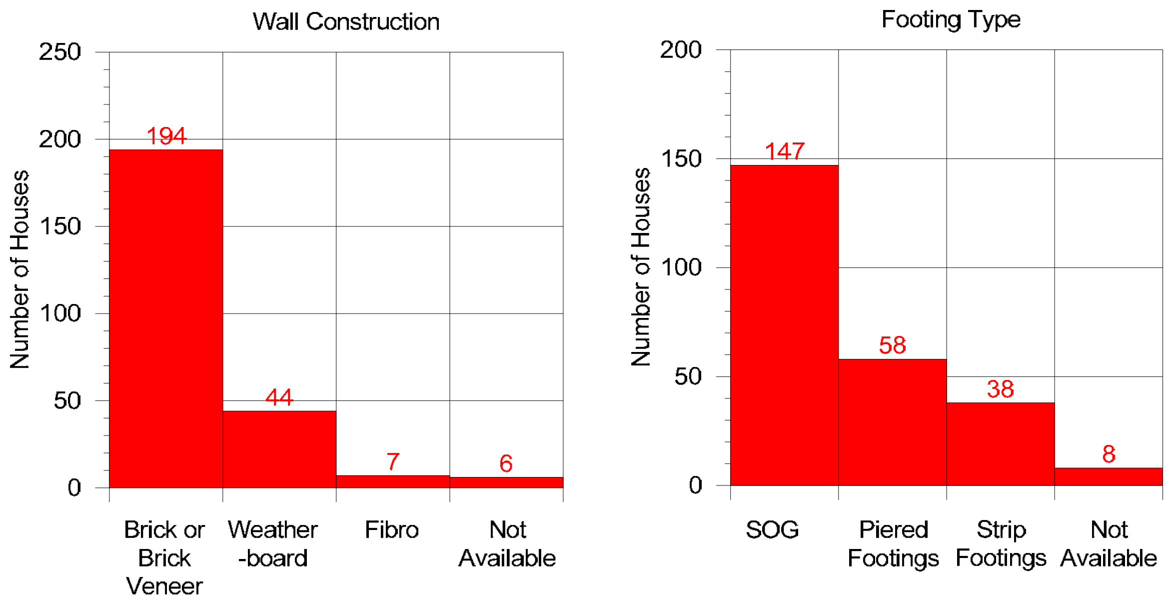

Fig. 11.2 Distributions of Wall and Footing Construction for the Houses within the Study Area

The houses within the Study Area are located within the *Wilton* and the *South Campbelltown* Mine Subsidence Districts, which are shown in Drawing No. MSEC428-19. There are a total of 177 houses identified within the Wilton Mine Subsidence District, which was proclaimed on the 7th November 1979 and notified on the 23rd November 1979. There are a total of 74 houses identified within the South Campbelltown Mine Subsidence District, which was proclaimed on the 30th June 1976 and notified on the 30th July 1976.

The ages of the houses within the Study Area were determined from the series of aerial photographs of the area taken in 1955, 1966, 1975, 1984, 1994, 2002, 2004, 2007 and 2009. It was found that 49 houses were constructed during or prior to 1975 and 202 houses were constructed after 1975. It is estimated, therefore, that approximately 20 % of the houses within the Study Area were constructed prior to the declarations of the mine subsidence districts.

11.1.2. Predictions for the Houses

Predictions of conventional subsidence, tilt and curvature have been made at the centroid and at the vertices of each house, as well as eight equally spaced points placed radially around the centroid and vertices at a distance of 20 metres. In the case of a rectangular shaped structure, predictions have been made at a minimum of 45 points within and around the structure.

A summary of the maximum predicted values of conventional subsidence, tilt and curvature for each house within the Study Area, resulting from the extraction of the proposed longwalls, is provided in Table D.02, in Appendix D. The predicted tilts provided in this table are the maxima in any direction after the completion of each of the proposed longwalls. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each of the proposed longwalls.

The distribution of the predicted conventional subsidence parameters for the houses within the Study Area are illustrated in Fig. 11.3, Fig. 11.4 and Fig. 11.5 below.

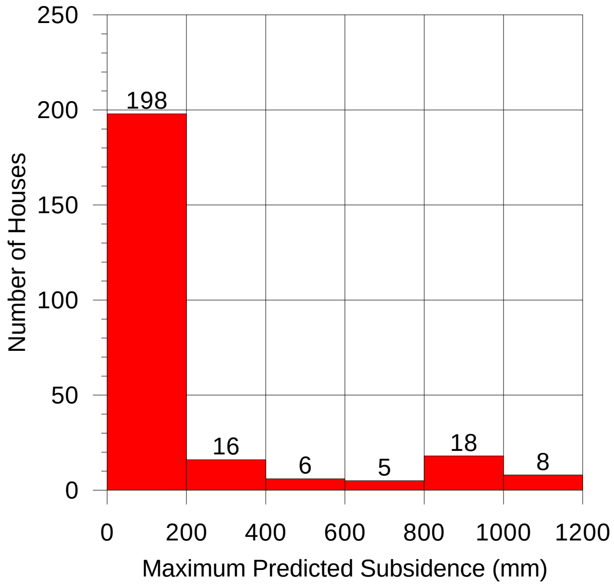

Fig. 11.3 Maximum Predicted Conventional Subsidence for the Houses within the Study Area

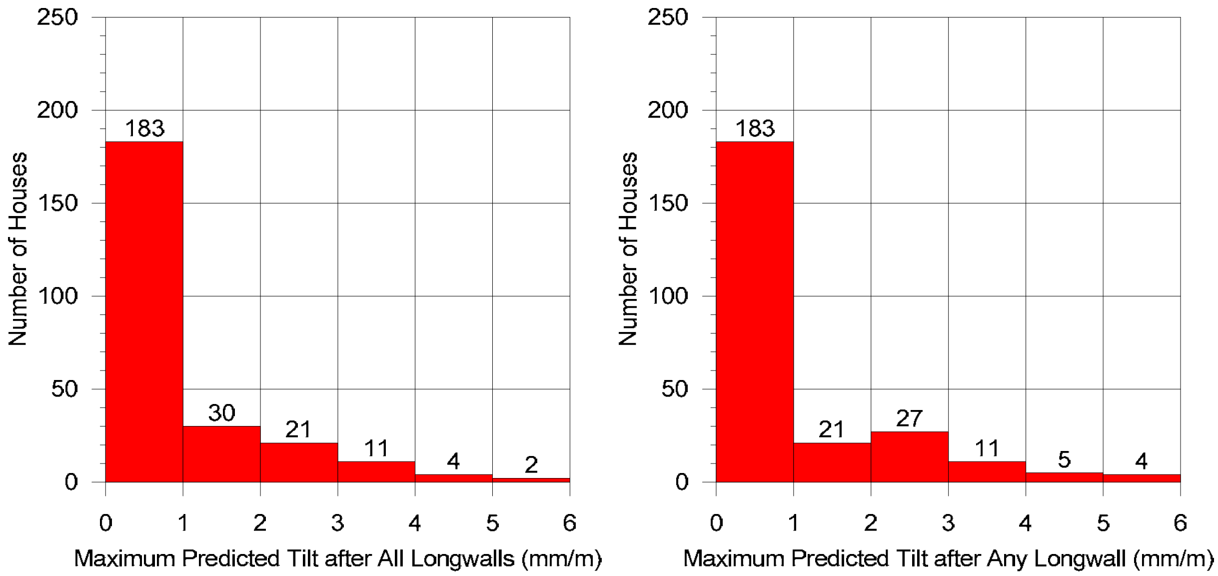

Fig. 11.4 Maximum Predicted Conventional Tilts After the Extraction of All Longwalls (Left) and Maximum Predicted Conventional Tilts After the Extraction of Any Longwall (Right)

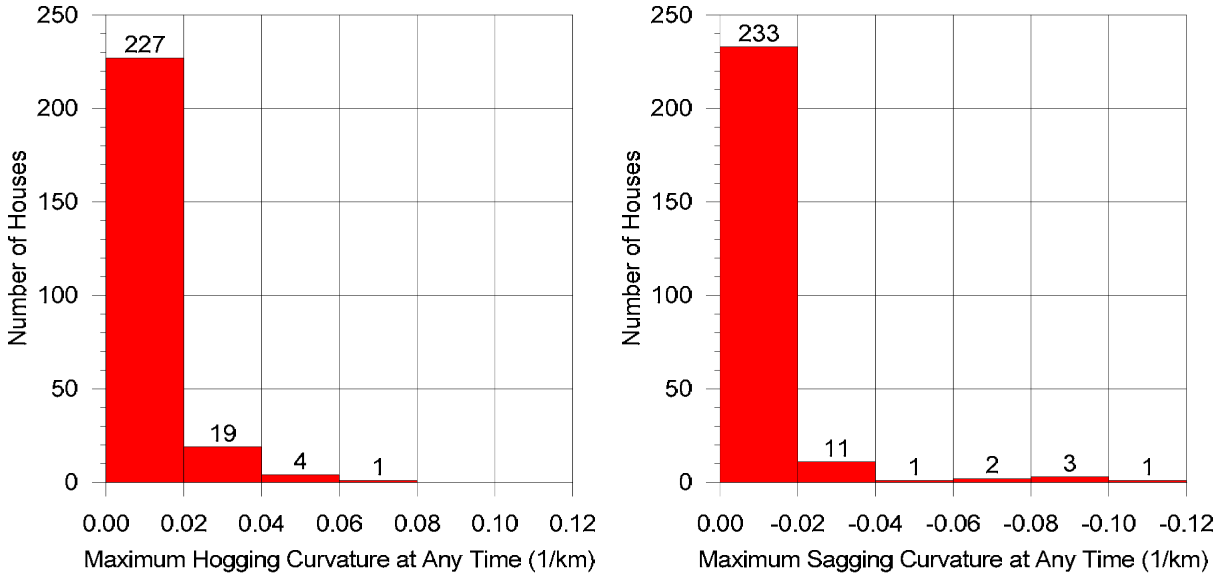

Fig. 11.5 Maximum Predicted Conventional Hogging Curvature (Left) and Sagging Curvature (Right) for the Houses within the Study Area

The houses are at discrete locations and, therefore, the most relevant distributions of strain are the maximum strains measured in individual survey bays from previous longwall mining. The analysis of strains in survey bays during the mining of previous longwalls in the Southern Coalfield is discussed in Section 4.4.1. The results for survey bays above goaf are provided in Fig. 4.1 and Table 4.5. The results for survey bays above solid coal are provided in Fig. 4.3 and Table 4.6.

Non-conventional movements can also occur and have occurred in the NSW Coalfields as a result of, amongst other things, anomalous movements. The analysis of strains provided in Chapter 4 includes those resulting from both conventional and non-conventional anomalous movements.

The maximum predicted conventional strains for the houses, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 1 mm/m tensile and 1.5 mm/m compressive.

11.1.3. Comparison of Predictions for the Houses with those provided in the Part 3A Application

The comparison of the maximum predicted subsidence parameters for the houses with those provided in the Part 3A Application is provided in Table 11.1.

Table 11.1 Comparison of the Maximum Predicted Conventional Subsidence Parameters for the Houses Based on the Part 3A and Extraction Plan Layouts

Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging (km^{-1})
Part 3A Layout (Report No. MSEC404)	1350	6.0	0.07	0.12
Extraction Plan Layout (Report No. MSEC448)	1175	6.0	0.07	0.10

It can be seen from the above table, that the maximum predicted mine subsidence movements for the houses, based on the Extraction Plan Layout, are similar to or slightly less than those predicted based on the Part 3A Layout.

11.1.4. Impact Assessments for the Houses

The following sections provide the impact assessments for the houses within the Study Area.

Potential Impacts Resulting from Vertical Subsidence

Vertical subsidence does not directly affect the stability or serviceability of houses. The potential for impacts on houses are affected by differential subsidence, which includes tilt, curvature and strain, and the impact assessments based on these parameters are described in the following sections.

Potential Impacts Resulting from Tilt

It has been found from past longwall mining experience that tilts of less than 7 mm/m generally do not result in any significant impacts on houses. Some minor serviceability impacts can occur at these levels of tilt, including door swings and issues with roof gutter and wet area drainage, all of which can be remediated using normal building maintenance techniques. Tilts greater than 7 mm/m can result in greater serviceability impacts which may require more substantial remediation measures, including the relevelling of wet areas or, in some cases, the relevelling of the building structure.

The maximum predicted tilt for the houses, resulting from the extraction of the proposed longwalls, is 6.0 mm/m (i.e. 0.6 %), which represents a change in grade of 1 in 165. It is expected, therefore, that only minor serviceability impacts would occur for the houses within the Study Area, as the result of tilt, which could be remediated using normal building techniques. It is expected that the houses within the Study Area will remain in safe conditions as the result of the mining induced tilts.

Potential Impacts Resulting from Curvature and Strain

The methods for predicting and assessing impacts on building structures have developed over time as knowledge and experience has grown. MSEC has provided predictions and impact assessments for the houses within the Study Area using the latest methods available at the time.

The maximum predicted conventional curvatures for the houses, resulting from the extraction of the proposed longwalls, are 0.07 km^{-1} hogging and 0.10 km^{-1} sagging, which equate to minimum radii of curvature of 14 kilometres and 10 kilometres, respectively. It can be seen from Fig. 11.5, that more than 95 % of the houses within the Study Area are predicted to experience hogging and sagging curvatures no greater than 0.04 km^{-1}, which represents a minimum radius of curvature of 25 kilometres.

The maximum predicted curvatures and the range of potential strains for the houses, resulting from the extraction of the proposed longwalls, are similar to those typically experienced elsewhere in the Southern Coalfield. It is expected, therefore, that the houses within the Study Area will collectively experience a similar range of impacts as has been observed during previous longwall mining in the Southern Coalfield.

The probabilities of impacts for each house within the Study Area have been assessed using the method developed as part of ACARP Research Project C12015, which is described in Appendix C. This method uses the primary parameters of ground curvature and type of construction. A summary of the predicted movements and the assessed impacts for each house within the Study Area is provided in Table D.02 in Appendix D. The overall distribution of the assessed impacts for the houses within the Study Area is provided in Table 11.2.

Table 11.2 **Assessed Impacts for the Houses within the Study Area**

Group	Repair Category			
	No Claim or R0	R1 or R2	R3 or R4	R5
All houses (total of 251)	231 (92 %)	15 (6 %)	4 (2 %)	≈ 1 (< 0.5 %)
Houses Directly Above Longwalls (total of 49)	42 (85 %)	5 ~ 6 (9 %)	2 (3 %)	≈ 1
Houses Directly Above Solid Coal (total of 202)	189 (93 %)	11 (5 %)	2 ~ 3 (1 %)	≈ 0

The repair categories R0 to R5 are described in Table C.4 in Appendix C.

Trend analyses following the mining of Tahmoor Longwalls 22 to 25 indicate that the likelihoods of impact are higher for the following houses:-

- Houses predicted to experience higher strains and curvatures,
- Houses with masonry walls,
- Masonry walled houses that are constructed on strip footings,
- Larger houses, and
- Houses with variable foundations, such as those with extensions added.

The primary risk associated with mining beneath houses is public safety. Residents have not been exposed to immediate and sudden safety hazards as a result of impacts that occur due to mine subsidence movements in the NSW Coalfields, where the depths of cover were greater than 400 metres, such as the case above the proposed longwalls. This includes the recent experience at Tahmoor Colliery, which has affected more than 1,000 houses, and the experiences at Teralba, West Cliff and West Wallsend Collieries, which have affected around 500 houses.

Emphasis is placed on the words "immediate and sudden" as in rare cases, some structures have experienced severe impacts, but the impacts did not present an immediate risk to public safety as they developed gradually with ample time to relocate residents.

All houses within the Study Area are expected to remain safe and serviceable throughout the mining period, provided that they are in sound structural condition prior to mining. It should be noted, however, that the assessments indicate that the impact to approximately one house within the Study Area may be such that the cost of repair may exceed the cost of replacement.

Potential Impacts Resulting from Downslope Movements

Longwall mining can result in downslope movements, in the locations where the natural surface grades are high, which can result in increased tensile strains at the tops and along the sides of the slopes and, hence, increased potential for impacts on the houses. The natural surface grades in the locations of each house within the Study Area are provided in Table D.01, in Appendix D, and is illustrated in Fig. 11.6.

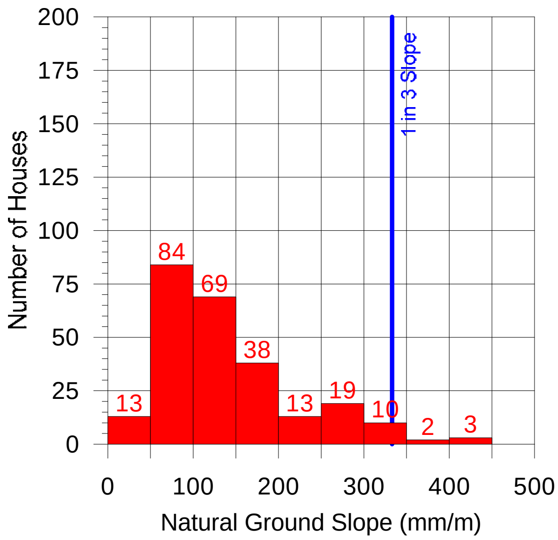

Fig. 11.6 Distribution of the Natural Surface Grades at the Houses within the Study Area

It can be seen from this table and figure, that the natural surface grades in the locations of the houses are generally less than 1 in 3 (i.e. 333 mm/m, or 3.3 %), which is the grade which has been used to define a steep slope in this report. The natural grades exceed 1 in 3 in the locations of nine houses within the Study Area. The maximum natural grade in the locations of the houses within the Study Area is 1 in 2.2 (i.e. 450 mm/m, or 4.5 %).

The method of assessment for houses developed as part of ACARP Research Project C12015 included the experience of mining beneath houses having a similar range of natural surface grades in the locations of the houses. The range of natural surface grades in the locations of the houses within the Study Area is unlikely, therefore, to affect the probabilities of impact for the houses which have been obtained using this method.

There are some houses, however, which have been built on the top of the Razorback Range and, therefore, are located in close proximity to areas comprising steep slopes. An example of this is illustrated in Fig. 11.7, which provides a cross-section through the range above the western end of the proposed Longwall 904. Similarly, houses have also been built near the top of the Nepean River valley, however, the proposed longwalls do not mine directly beneath these houses or the valley.

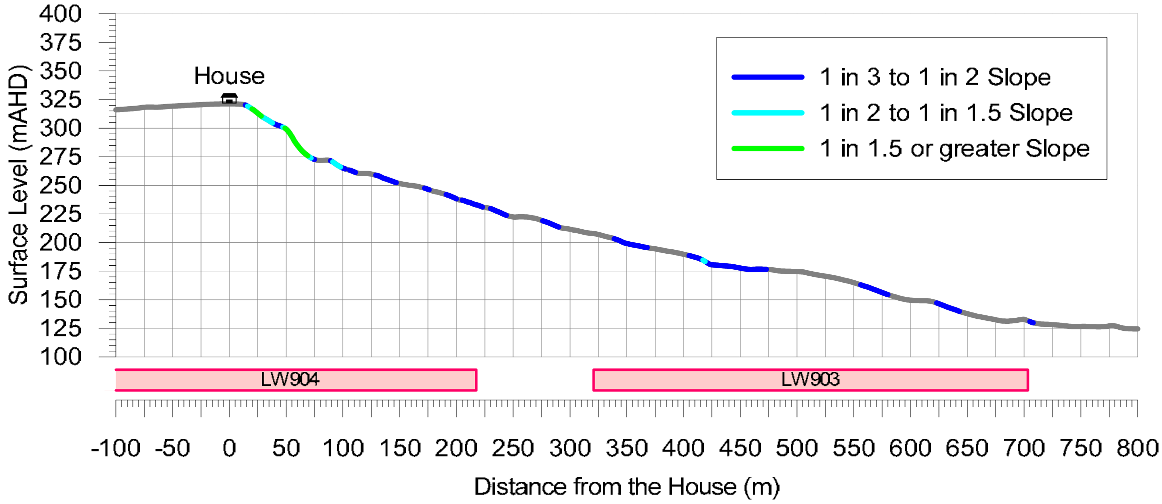

Fig. 11.7 Cross-section through the Razorback Range Above the Western End of Longwall 904

It can be seen from the above figure, that some of the houses which have been built on the top of the Razorback Range, directly above the proposed Longwall 904, are located in close proximity to steep slopes. The maximum natural surface grades within 25 metres and within 50 metres of each house within the Study Area are provided in Table D.01, in Appendix D, and are illustrated in Fig. 11.8.

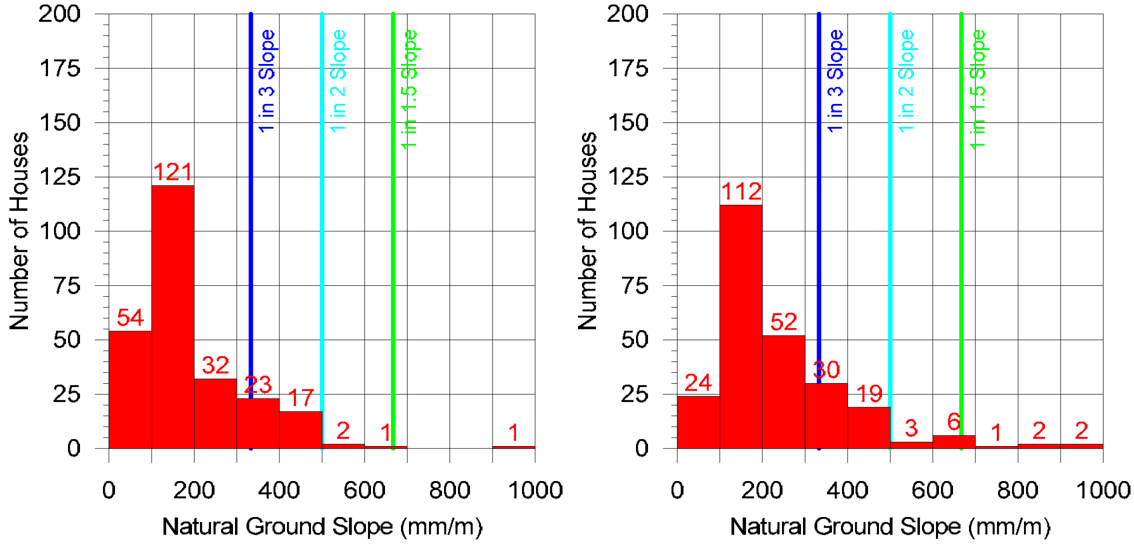

Fig. 11.8 Distribution of the Maximum Natural Surface Grades within 25 metres (Left) and within 50 metres (Right) of the Houses within the Study Area

A summary of the maximum natural surface grades at the houses and within 25 metres and 50 metres of the houses within the Study Area is provided in Table 11.3.

Table 11.3 Maximum Natural Surface Grades at and near the Houses within the Study Area

Location	Maximum Natural Grade less than 1 in 3	Maximum Natural Grade between 1 in 3 ~ 1 in 2	Maximum Natural Grade between 1 in 2 ~ 1 in 1.5	Maximum Natural Grade greater than 1 in 1.5
In the locations of the houses	242	9	0	0
Within 25 metres of the houses	219	28	2	2
Within 50 metres of the houses	200	37	6	8

Detailed site investigations and studies of the potential impacts on the steep slopes along the Razorback Range have been undertaken and are described in the reports by *Coffey* (2012) and the *UoW* (2012). As described in these reports, it is recommended that the properties in close proximity of the steep slopes along the Razorback Range are inspected prior to and after the proposed longwalls mine directly beneath them.

11.1.5. Impact Assessments for the Houses Based on Increased Predictions

If the actual tilts exceeded those predicted by a factor of 2 times, the tilts would still be less than 7 mm/m at 242 of the houses (i.e. 96 %) at the completion of mining. It would still be expected that only minor serviceability impacts would occur at these houses, as the result of tilt, which could be remediated using normal building techniques.

The tilts would be between 7 mm/m and 10 mm/m at 7 houses (i.e. 3 %) and would be slightly greater than 10 mm/m at 2 houses (i.e. 1 %) at the completion of mining. It would be expected that greater serviceability impacts would occur at these houses which would require more substantial remediation measures possibly including, in some cases, relevelling of the building structures.

A summary of the houses with tilts greater than 7 mm/m, based on a 2 times predicted case, is provided in Table 11.4. The maximum tilt at the completion of mining, based on the 2 times predicted case, is 11 mm/m at House Ref. N16h01, which is located directly above Longwall 904.

Table 11.4 Houses with Tilts Greater than 7 mm/m Based on a 2 Times Predicted Case

Tilt Based on a 2 Times Predicted Case (mm/m)	Number of Houses	House References
7 ~ 10	7	H10h01, H11h01, H12h01, J01h01, J20h01, N14h01 and N17h01
> 10	2	N15h01 and N16h01

It is expected, in all cases, that the houses within the Study Area would remain in safe conditions as the result of the mining induced tilts.

If the actual curvatures exceeded those predicted by a factor of 2 times, the maximum curvatures at the houses would be 0.14 km^{-1} hogging and 0.20 km^{-1} sagging, which represent minimum radii of curvature of 7 kilometres and 5 kilometres, respectively. The distributions of hogging and sagging curvature, based on a 2 times predicted case, are illustrated in Fig. 11.9.

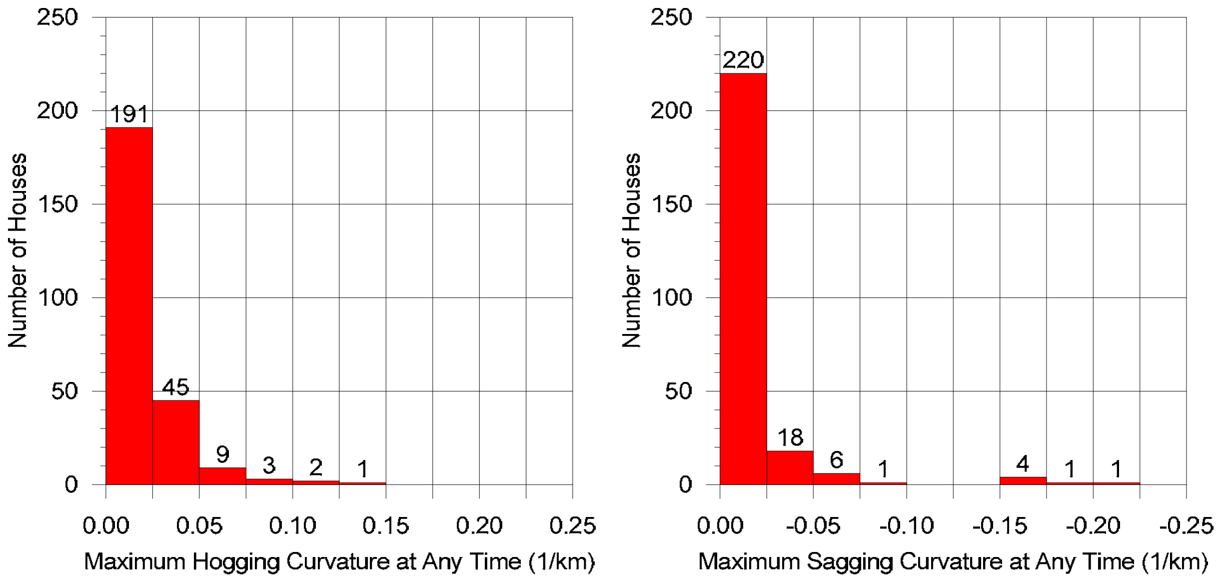

Fig. 11.9 Distributions of Hogging Curvature (Left) and Sagging Curvature (Right) for the Houses Based on a 2 Times Predicted Case

The ranges and distributions of hogging and sagging curvature, based on the 2 times predicted case, are similar to those predicted to have occurred for the houses above Teralba Longwalls 9 and 10, West Cliff Longwalls 5A1 to 5A4 and West Wallsend Longwalls 1 to 10. The overall levels of impact on the houses within the Study Area would, therefore, be expected to be similar to those experienced at Teralba, West Cliff and West Wallsend, which is summarised in Table 11.5.

Table 11.5 Observed Frequency of Impacts for Houses Resulting from the Extraction of Teralba Longwalls 9 and 10, West Cliff Longwalls 5A1 to 5A4 and West Wallsend Longwalls 1 to 10

Group	Repair Category			
	No Claim or R0	R1 or R2	R3 or R4	R5
All houses (total of 494)	415 (84.0 %)	51 (10.3 %)	26 (5.3 %)	2 (0.4 %)

The repair categories R0 to R5 are described in Table C.4 in Appendix C.

Based on previous experience, it would still be expected that the houses would remain in safe conditions. The impacts would develop slowly, allowing preventive measures to be undertaken and, where required, relocation of residence if any structures were deemed to become unsafe.

11.1.6. Recommendations for the Houses

IC has developed a number of management strategies for houses which have been directly mined beneath by previously extracted longwalls at Appin, Tower and West Cliff Collieries. It is recommended that similar management strategies are developed for the houses within the Study Area.

IC will prepare Property Subsidence Management Plans (PSMP) for the houses within the predicted limit of vertical subsidence, similar to those which have been prepared for the properties at Appin Area 7 and West Cliff Colliery. The PSMPs will address the management of all surface infrastructure including the houses. With the implementation of these management strategies, it would be expected that the houses could be maintained in safe and serviceable conditions during and after the extraction of the proposed longwalls.

The management strategies should include the recommendations from the steep slopes assessment and structural assessments of the houses. The management strategies could also include the following where access is provided to the property:-

- Inspection of the houses considered to be at higher risk by a structural engineer or a suitably qualified building inspector prior to the longwall mining directly beneath them,
- Consideration of implementing any mitigation measures, where necessary to address specific identified risks to public safety,
- Consideration of undertaking detailed monitoring of ground movements at or around structures, where necessary to address specific identified risks to public safety,

- Periodic inspections of structures that are considered to be at higher risk. These may include:-
  - Structures in close proximity to steep slopes where recommended by a geotechnical or subsidence engineer,
  - Structures identified as being potentially unstable where recommended by a structural or subsidence engineer, and
  - Pool fences.
- Co-ordination and communication with landowners and the Mine Subsidence Board during mining.

It is recommended that the houses are periodically visually monitored during the extraction of the proposed longwalls. With these strategies in place, it is expected that the houses would remain safe and serviceable throughout the mining period.

11.2. Flats or Units

There are no flats or units within the Study Area.

11.3. Caravan Parks

There are no caravan parks within the Study Area.

11.4. Retirement or Aged Care Villages

There are no retirement or aged care villages within the Study Area.

11.5. Swimming Pools

The locations of the private swimming pools within the Study Area are shown in Drawing Nos. MSEC448-19 to MSEC448-31. The predictions and impact assessments for the privately owned pools are provided in the following sections. There are no public swimming pools identified within the Study Area.

11.5.1. Descriptions of the Swimming Pools

There are 78 privately owned swimming pools which have been identified within the Study Area, of which 68 are in-ground pools and 10 are above ground pools. The locations, sizes, and details of the pools were determined from an aerial photograph of the area.

11.5.2. Predictions for the Swimming Pools

Predictions of conventional subsidence, tilt and curvature have been made at the centroid and at points located around the perimeter of each pool, as well as at points located at a distance of 20 metres from the perimeter of each pool.

A summary of the maximum predicted values of conventional subsidence, tilt and curvature for each pools within the Study Area, resulting from the extraction of the proposed longwalls, is provided in Table D.06, in Appendix D. The predicted tilts provided in this table are the maxima in any direction after the completion of each of the proposed longwalls. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each of the proposed longwalls.

The distributions of the maximum predicted conventional subsidence, tilt and curvature for the pools within the Study Area, resulting from the extraction of the proposed longwalls, are illustrated in Fig. 11.10 and Fig. 11.11.

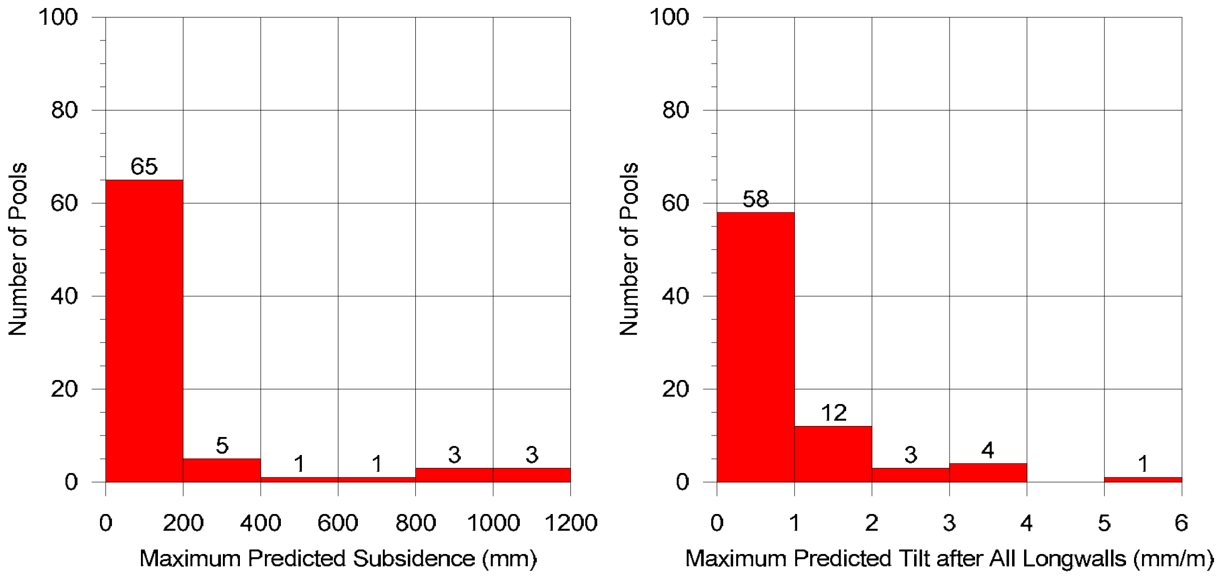

Fig. 11.10 Maximum Predicted Conventional Subsidence and Tilt for Pools within the Study Area

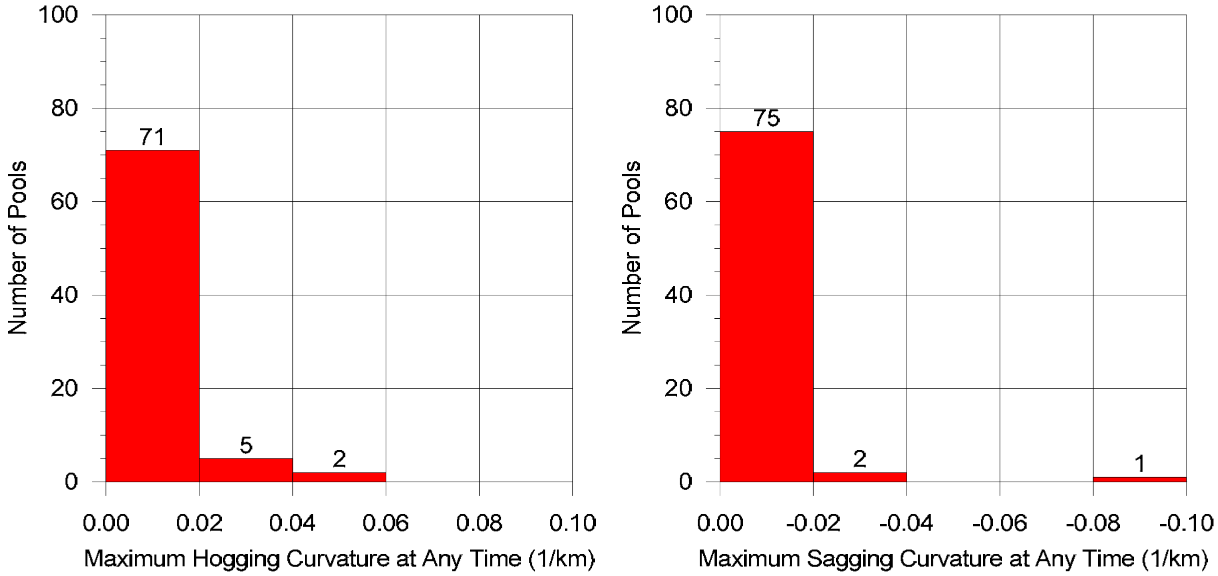

Fig. 11.11 Maximum Predicted Conventional Hogging Curvature (Left) and Sagging Curvature (Right) for the Pools within the Study Area

The pools are at discrete locations and, therefore, the most relevant distributions of strain are the maximum strains measured in individual survey bays from previous longwall mining. The analysis of strains in survey bays during the mining of previous longwalls in the Southern Coalfield is discussed in Section 4.4.1. The results for survey bays above goaf are provided in Fig. 4.1 and Table 4.5. The results for survey bays above solid coal are provided in Fig. 4.3 and Table 4.6.

Non-conventional movements can also occur and have occurred in the NSW Coalfields as a result of, among other things, anomalous movements. The analysis of strains provided in Chapter 4 includes those resulting from both conventional and non-conventional anomalous movements.

The maximum predicted conventional strains for the pools, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 1 mm/m tensile and 1.5 mm/m compressive.

11.5.3. Comparison of Predictions for the Pools with those provided in the Part 3A Application

The comparison of the maximum predicted subsidence parameters for the pools with those provided in the Part 3A Application is provided in Table 11.6.

Table 11.6 Comparison of the Maximum Predicted Conventional Subsidence Parameters for the Pools Based on the Part 3A and Extraction Plan Layouts

Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging (km^{-1})
Part 3A Layout (Report No. MSEC404)	1400	6.5	0.07	0.12
Extraction Plan Layout (Report No. MSEC448)	1150	5.0	0.05	0.09

It can be seen from the above table, that the maximum predicted mine subsidence movements for the pools, based on the Extraction Plan Layout, are similar to but less than those predicted based on the Part 3A Layout.

11.5.4. Impact Assessments for the Swimming Pools

Mining-induced tilts are more noticeable in pools than other structures due to the presence of the water line and the small gap to the edge coping, particularly when the pool lining has been tiled. Skimmer boxes are also susceptible of being lifted above the water line due to mining tilt.

The Australian Standard AS2783-1992 (Use of reinforced concrete for small swimming pools) requires that pools be constructed level ± 15 mm from one end to the other. This represents a tilt of approximately 3.3 mm/m for pools that are 10 metres in length. Australian Standard AS/NZS 1839:1994 (Swimming pools – Pre-moulded fibre-reinforced plastics – Installation) also requires that pools be constructed with a tilt of 3 mm/m or less.

It can be seen from Fig. 11.10, that 75 of the 78 pools within the Study Area (i.e. 96 %) are predicted to experience tilts of 3 mm/m or less, at the completion of the proposed longwalls, which is similar to or less than the Australian Standard. There are three pools (Refs. J01p01, N14p01 and N15p01) within the Study Area (i.e. 4 %) which is predicted to experience tilts greater than 3 mm/m, at the completion of the proposed longwalls, which may require some remediation of the pool copings. The maximum predicted tilt at these pools, at the completion of mining, is 5.0 mm/m (i.e. 0.5 %).

The maximum predicted conventional curvatures for the pools within the Study Area, resulting from the extraction of the proposed longwalls, are 0.05 km^{-1} hogging and 0.09 km^{-1} sagging, which represent minimum radii of curvature of 20 kilometres and 11 kilometres, respectively. The ranges of conventional curvatures for the pools within the Study Area are similar to or less than those predicted to have occurred for the houses and, hence, the pools above Tahmoor Longwalls 22 to 25. The incidence and levels of impacts on the pools in the Study Area, therefore, are expected to be similar to or less than those experienced at Tahmoor Colliery.

Observations during the mining of Tahmoor Colliery Longwalls 22 to 25 have shown that pools, particularly in-ground pools, are more susceptible to severe impacts than houses and other structures. Pools cannot be easily repaired and most of the impacted pools need to be replaced in order to restore them to pre-mining condition or better.

As of Feb 2011, a total of 130 pools have experienced mine subsidence movements during the mining of Tahmoor Colliery Longwalls 22 to 25, of which 118 were located directly above the extracted longwalls. A total of 18 pools have reported impacts, all of which were located directly above the extracted longwalls. This represents an impact rate of approximately 15 %. A higher proportion of impacts have been observed for in-ground pools, particularly fibreglass pools. The majority of the impacts related to tilt or cracking, though in a small number of cases the impacts were limited to damage to skimmer boxes or the edge coping.

The observed levels of impact on the pools at Tahmoor should provide a reasonable guide to the potential levels of impact on the pools within the Study Area.

11.5.5. Impact Assessments for the Swimming Pools Based on Increased Predictions

If the actual tilts exceeded those predicted by a factor of 2 times, the tilts would still be 3 mm/m or less at 70 of the 78 pools within the Study Area (i.e. 89 %) at the completion of mining. The tilts would exceed 3 mm/m at eight pools at the completion of mining, being Pool Refs. J01p01, J17p01, J20p01, L08p01, M03p01, M05p01, N14p01 and N15p01, which may require some remediation of the pool copings.

If the actual curvatures exceeded those predicted by a factor of 2 times, the maximum conventional curvatures for the pools would be 0.10 km^{-1} hogging and 0.18 km^{-1} sagging, which represent minimum radii of curvature of 10 kilometres and 6 kilometres, respectively. The ranges of conventional curvatures, based on the 2 times predicted case, are still similar to but slightly greater than those predicted to have occurred for the houses and, hence, the pools above Tahmoor Longwalls 22 to 25. In this case, the potential impacts on the pools within the Study Area would be expected to be similar to but slightly greater than those experienced at Tahmoor Colliery.

11.5.6. Recommendations for the Swimming Pools

While not strictly related to the pool structure, a number of pool gates have been impacted as the result of the previous extraction of longwalls beneath pools. While the gates can be easily repaired, the consequence of breaching pool fence integrity is considered to be severe. As a result, it is recommended that regular inspections of the integrity of pool fences during the active subsidence period be included in the development of any Management Plan for properties that have pools or are planning to construct a pool during the mining period.

IC will prepare Property Subsidence Management Plans (PSMP) for all landholders within the Study Area, similar to those which have been prepared for the properties at Appin Area 7 and West Cliff Colliery. The PSMPs will address the management of all surface infrastructure including the pools and pool fences.

11.6. Tennis Courts

The locations of the tennis courts within the Study Area are shown in Drawing Nos. MSEC448-19 to MSEC448-31. The descriptions, predictions and impact assessments for the tennis courts are provided in the following sections.

11.6.1. Descriptions of the Tennis Courts

There are four privately owned tennis courts which have been identified within the Study Area, of which three have concrete or Astroturf surfaces and one has a grass or clay surface. The locations and sizes of the tennis courts were determined from an aerial photograph of the area.

11.6.2. Predictions for the Tennis Courts

Predictions of conventional subsidence, tilt and curvature have been made at the centroid and at points located around the perimeter of each tennis court, as well as at points located at a distance of 20 metres from the perimeter of each tennis court.

A summary of the maximum predicted values of conventional subsidence, tilt and curvatures for the tennis courts within the Study Area, resulting from the extraction of the proposed longwalls, is provided in Table 11.7.

Table 11.7 Maximum Predicted Conventional Subsidence, Tilt and Curvatures for the Tennis Courts within the Study Area Resulting from the Extraction of the Proposed Longwalls

Ref.	Maximum Predicted Conventional Subsidence (mm)	Maximum Predicted Conventional Tilt (mm/m)	Maximum Predicted Conventional Hogging Curvature (km^{-1})	Maximum Predicted Conventional Sagging Curvature (km^{-1})
H13tc	150	1.0	0.01	< 0.01
J01tc	225	2.5	0.02	0.01
M07tc	100	1.0	< 0.01	< 0.01
P13tc	< 20	< 0.5	< 0.01	< 0.01

The predicted tilts provided in the above table are the maxima in any direction after the completion of the proposed longwalls. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each of the proposed longwalls.

The tennis courts are at discrete locations and, therefore, the most relevant distributions of strain are the maximum strains measured in individual survey bays from previous longwall mining. The analysis of strains in survey bays during the mining of previous longwalls in the Southern Coalfield is discussed in Section 4.4.1. The results for survey bays above goaf are provided in Fig. 4.1 and Table 4.5. The results for survey bays above solid coal are provided in Fig. 4.3 and Table 4.6.

Non-conventional movements can also occur and have occurred in the NSW Coalfields as a result of, amongst other things, anomalous movements. The analysis of strains provided in Chapter 4 includes those resulting from both conventional and non-conventional anomalous movements.

The maximum predicted conventional strains for the tennis courts, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 0.3 mm/m tensile and less than 0.3 mm/m compressive.

11.6.3. Impact Assessments for the Tennis Courts

The maximum predicted tilt for the tennis courts, resulting from the extraction of the proposed longwalls, is 2.5 mm/m (i.e. 0.3 %), which represents a change in grade of 1 in 400. The predicted tilts are small, less than 1 % and unlikely, therefore, to result in any adverse impacts on the serviceability of the tennis courts.

The maximum predicted conventional curvatures for the tennis courts, resulting from the extraction of the proposed longwalls, are 0.02 km^{-1} hogging and 0.01 km^{-1} sagging, which represent minimum radii of curvature of 50 kilometres and 100 kilometres, respectively. The maximum predicted curvatures are less than those typically experienced in the Southern Coalfield.

It is possible that the maximum predicted curvatures and strains could result in minor cracking or heaving in the tennis courts with grass or clay surfaces, however, any impacts would be expected to be minor and readily repairable. It is possible, that some minor surface cracking could also occur in the concrete tennis court surfaces, but any cracking would be expected to be of a minor nature and readily repairable.

11.6.4. Impact Assessments for the Tennis Courts Based on Increased Predictions

If the actual tilts exceeded those predicted by a factor of 2 times, the maximum tilt at the tennis courts would be 5 mm/m (i.e. 0.5 %), which is still small, less than 1 % and unlikely, therefore, to result any adverse impacts on the serviceability of the tennis courts.

If the actual curvatures exceeded those predicted by a factor of 2 times, the maximum curvatures at the tennis courts would be 0.04 km^{-1} hogging and 0.02 km^{-1} sagging, which represent minimum radii of curvatures of 25 kilometres and 50 kilometres, respectively. The curvatures for these tennis courts, therefore, would still be less than those typically experienced in the Southern Coalfield. The increased curvatures would result in a greater incidence of cracking or heaving in the tennis court surfaces. Any impacts would still be expected to be of a minor natural which could be readily repaired

11.6.5. Recommendations for the Tennis Courts

IC will prepare Property Subsidence Management Plans (PSMP) for all landholders within the Study Area, similar to those which have been prepared for the properties at Appin Area 7 and West Cliff Colliery. The PSMPs will address the management of all surface infrastructure including the tennis courts.

11.7. On-Site Waste Water Systems

The residences on the rural properties within the Study Area have on-site waste water systems.

The on-site waste systems are located across the Study Area and, therefore, are expected to experience the full range of predicted subsidence movements. A summary of the maximum predicted conventional subsidence movements within the Study Area is provided in Chapter 4.

The on-site waste water systems are at discrete locations and, therefore, the most relevant distributions of strain are the maximum strains measured in individual survey bays from previous longwall mining. The analysis of strains in survey bays during the mining of previous longwalls in the Southern Coalfield is discussed in Section 4.4.1. The results for survey bays above goaf are provided in Fig. 4.1 and Table 4.5. The results for survey bays above solid coal are provided in Fig. 4.3 and Table 4.6.

Non-conventional movements can also occur and have occurred in the NSW Coalfields as a result of, among other things, anomalous ground movements. The analysis of strains provided in Chapter 4 includes those resulting from both conventional and non-conventional anomalous movements.

The maximum predicted change in grade for the on-site waste water systems within the Study Area are less than 1 %. It is unlikely, therefore, that the maximum predicted tilts would result in any adverse impacts on the systems. The maximum predicted conventional tilts could, however, be of sufficient magnitude to affect the serviceability of the buried pipes between the houses and the on-site waste water systems, if the existing grades of these pipes are very small, say less than 1 %.

The maximum predicted conventional strains for the on-site waste water systems, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 1 mm/m tensile and 2 mm/m compressive.

The on-site waste water system tanks are generally small, typically less than 3 metres in diameter, are constructed from reinforced concrete, and are usually bedded in sand and backfilled. It is unlikely, therefore, that the maximum predicted curvatures and strains would be fully transferred into the tank structures.

It is possible, however, that the buried pipelines associated with the on-site waste water tanks could be impacted by the strains if they are anchored by the tanks or other structures in the ground. Any impacts are expected to be of a minor nature, including leaking pipe joints, and could be readily repaired. With the implementation of these remedial measures, it would be unlikely that there would be any adverse impacts on the pipelines associated with the on-site waste water systems.

IC will prepare Property Subsidence Management Plans (PSMP) for all landholders within the Study Area, similar to those which have been prepared for the properties at Appin Area 7 and West Cliff Colliery. The PSMPs will address the management of all surface infrastructure including the on-site waste water systems.

11.8. Rigid External Pavements

Adverse impacts on rigid external pavements are often reported to the Mine Subsidence Board in the NSW Coalfields. This is because pavements are typically thin relative to their length and width. The design of external pavements is also not regulated by Council or the Mine Subsidence Board.

A study by MSEC of 120 properties at Tahmoor and Thirlmere indicated that 98 % of the properties with external concrete pavements demonstrated some form of cracking prior to mining. These cracks are sometimes difficult to distinguish from cracks caused by mine subsidence. It is therefore uncertain how many claims for damage can be genuinely attributed to mine subsidence impacts.

Residential concrete pavements are typically constructed with tooled joints which do not have the capacity to absorb compressive movements. It is possible that some of the smaller concrete footpaths or pavements within the Study Area, in the locations of the larger compressive strains, could buckle upwards if there are insufficient movement joints in the pavements. It is expected, however, that the buckling of footpaths and pavements would not be common, given the magnitudes of the predicted ground strains, and could be easily repaired.

IC will prepare Property Subsidence Management Plans (PSMP) for all landholders within the Study Area, similar to those which have been prepared for the properties at Appin Area 7 and West Cliff Colliery. The PSMPs will address the management of all surface infrastructure including the rigid external pavements.

11.9. Fences

The predictions and impact assessments for fences are provided in Section 8.3.

11.10. Any Other Residential Feature

There are no other significant residential features within the Study Area.

APPENDIX A. GLOSSARY OF TERMS AND DEFINITIONS

Glossary of Terms and Definitions

Some of the more common mining terms used in the report are defined below:-

Angle of draw	The angle of inclination from the vertical of the line connecting the goaf edge of the workings and the limit of subsidence (which is usually taken as 20 mm of subsidence).
Chain pillar	A block of coal left unmined between the longwall extraction panels.
Cover depth (H)	The depth from the surface to the top of the seam. Cover depth is normally provided as an average over the area of the panel.
Closure	**T**he reduction in the horizontal distance between the valley sides. The magnitude of closure, which is typically expressed in the units of *millimetres (mm)*, is the greatest reduction in distance between any two points on the opposing valley sides. It should be noted that the observed closure movement across a valley is the total movement resulting from various mechanisms, including conventional mining induced movements, valley closure movements, far-field effects, downhill movements and other possible strata mechanisms.
Critical area	The area of extraction at which the maximum possible subsidence of one point on the surface occurs.
Curvature	The change in tilt between two adjacent sections of the tilt profile divided by the average horizontal length of those sections, i.e. curvature is the second derivative of subsidence. Curvature is usually expressed as the inverse of the **Radius of Curvature** with the units of *1/kilometres (km-1)*, but the value of curvature can be inverted, if required, to obtain the radius of curvature, which is usually expressed in *kilometres (km)*. Curvature can be either **hogging** (i.e. convex) or **sagging** (i.e. concave).
Extracted seam thickness	The thickness of coal that is extracted. The extracted seam thickness is normally given as an average over the area of the panel.
Effective extracted seam thickness (T)	The extracted seam thickness modified to account for the percentage of coal left as pillars within the panel.
Face length	The width of the coalface measured across the longwall panel.
Far-field movements	The measured horizontal movements at pegs that are located beyond the longwall panel edges and over solid unmined coal areas. Far-field horizontal movements tend to be bodily movements towards the extracted goaf area and are accompanied by very low levels of strain.
Goaf	The void created by the extraction of the coal into which the immediate roof layers collapse.
Goaf end factor	A factor applied to reduce the predicted incremental subsidence at points lying close to the commencing or finishing ribs of a panel.
Horizontal displacement	The horizontal movement of a point on the surface of the ground as it settles above an extracted panel.
Inflection point	The point on the subsidence profile where the profile changes from a convex curvature to a concave curvature. At this point the strain changes sign and subsidence is approximately one half of S max.
Incremental subsidence	The difference between the subsidence at a point before and after a panel is mined. It is therefore the additional subsidence at a point resulting from the excavation of a panel.
Panel	The plan area of coal extraction.
Panel length (L)	The longitudinal distance along a panel measured in the direction of (mining from the commencing rib to the finishing rib.
Panel width (Wv)	The transverse distance across a panel, usually equal to the face length plus the widths of the roadways on each side.
Panel centre line	An imaginary line drawn down the middle of the panel.
Pillar	A block of coal left unmined.
Pillar width (Wpi)	The shortest dimension of a pillar measured from the vertical edges of the coal pillar, i.e. from rib to rib.

Shear deformations	The horizontal displacements that are measured across monitoring lines and these can be described by various parameters including; horizontal tilt, horizontal curvature, mid-ordinate deviation, angular distortion and shear index.
Strain	The change in the horizontal distance between two points divided by the original horizontal distance between the points, i.e. strain is the relative differential displacement of the ground along or across a subsidence monitoring line. Strain is dimensionless and can be expressed as a decimal, a percentage or in parts per notation. **Tensile Strains** are measured where the distance between two points or survey pegs increases and **Compressive Strains** where the distance between two points decreases. Whilst mining induced **strains** are measured **along** monitoring lines, ground **shearing** can occur both vertically, and horizontally **across** the directions of the monitoring lines.
Sub-critical area	An area of panel smaller than the critical area.
Subsidence	The vertical movement of a point on the surface of the ground as it settles above an extracted panel, but, 'subsidence of the ground' in some references can include both a vertical and horizontal movement component. The vertical component of subsidence is measured by determining the change in surface level of a peg that is fixed in the ground before mining commenced and this vertical subsidence is usually expressed in units of *millimetres (mm)*. Sometimes the horizontal component of a peg's movement is not measured, but in these cases, the horizontal distances between a particular peg and the adjacent pegs are measured.
Super-critical area	An area of panel greater than the critical area.
Tilt	The change in the slope of the ground as a result of differential subsidence, and is calculated as the change in subsidence between two points divided by the horizontal distance between those points. Tilt is, therefore, the first derivative of the subsidence profile. Tilt is usually expressed in units of *millimetres per metre (mm/m)*. A tilt of 1 mm/m is equivalent to a change in grade of 0.1 %, or 1 in 1000.
Uplift	An increase in the level of a point relative to its original position.
Upsidence	Upsidence results from the dilation or buckling of near surface strata at or near the base of the valley. The magnitude of upsidence, which is typically expressed in the units of *millimetres (mm)*, is the difference between the observed subsidence profile within the valley and the conventional subsidence profile which would have otherwise been expected in flat terrain.

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APPENDIX C. METHOD OF IMPACT ASSESSMENTS FOR HOUSES

APPENDIX C METHOD OF IMPACT ASSESSMENT FOR HOUSES

C.1. Introduction

The methods for predicting and assessing impacts on building structures have developed over time as knowledge and experience has grown. MSEC has provided predictions and impact assessments for the building structures within the Study Area using the latest methods available at this time.

Longwall mining has occurred directly beneath building structures at a number of Collieries in the Southern Coalfield, including Appin, West Cliff, Tower and Tahmoor Collieries. The most extensive data has come from extraction of Tahmoor Colliery Longwalls 22 to 24A, where more than 1000 residential and significant civil structures have experienced subsidence movements. The experiences gained during the mining of these longwalls, as well as longwalls at other Collieries in the Southern and Newcastle Coalfields, have provided substantial additional information that has been used to further develop the methods.

The information collected during the mining of Tahmoor Colliery Longwalls 22 to 24A has been reviewed in two parallel studies, one as part of a funded ACARP Research Project C12015, and the other at the request of Industry and Investment NSW (I&I).

The outcomes of these studies include:-

- Review of the performance of the previous method,
- Recommendations for improving the method of Impact Classification, and
- Recommendations for improving the method of Impact Assessment.

A summary is provided in the following sections.

C.2. Review of the Performance of the Previous Method

The most extensive data on house impacts has come from extraction of Tahmoor Colliery Longwalls 22 to 25 and a comparison between predicted and observed impacts is provided in Table C.1. The comparison is based on pre-mining predictions that were provided in SMP Applications for these longwalls and the observations of impacts using the previous method of impact classification. The comparison is based on information up to 30 November 2008. At this point in time, the length of extraction of Longwall 25 was 611 metres.

A total of 1037 houses and civil structures were affected by subsidence due to the mining of Tahmoor Colliery Longwalls 22 to 25 at this time. A total of 175 claims have been received by the Mine Subsidence Board (not including claims that have been refused) of which 14 claims do not relate to the main residence or civil structure.

Table C.1 Summary of Comparison between Observed and Predicted Impacts for each Structure

Strain Impact Category	Total No. of Observed Impacts for Structures predicted to be Strain Impact Category 0	Total No. of Observed Impacts for Structures predicted to be Strain Impact Category 1	Total No. of Observed Impacts for Structures predicted to be Strain Impact Category 2	Total
No impact	483	373	20	876
Cat 0	31	70	6	107
Cat 1	8	9	1	18
Cat 2	7	11	2	20
Cat 3	2	2	0	4
Cat 4	3	5	0	8
Cat 5	3	1	0	4
Total	537	471	29	1037
% claim	**10 %**	**21 %**	**31 %**	16 %
% Obs > Pred	**4 %**	**4 %**	**0 %**	-
% Obs <= Pred	**96 %**	**96 %**	**100 %**	-

Note: Predicted impacts due to conventional subsidence only, as described in the SMP Application.

Given that observed impacts are less than or equal to predicted impacts in 96 % of cases, it is considered that the previous methods are generally conservative even though non-conventional movements were not taken into account in the predictions and assessments. However, when compared on a house by house basis, the predictions have been substantially exceeded in a small proportion of cases.

The majority, if not all, of the houses that have experienced Category 3, 4 or 5 impacts are considered to have experienced substantial non-conventional subsidence movements. The consideration is based on nearby ground survey results, where upsidence bumps are observed in subsidence profiles and high localised strain is observed. The potential for impact from non-conventional movements were discussed generally and not included in the specific impact assessments for each structure.

The inability to specify the number or probability of impacts due to the potential for non-conventional movements is a shortcoming of the previous method. It is considered that there is significant room for improvement in this area and recommendations are provided later in this report.

The comparison shows a favourable observation that the overall proportion of claims increased for increasing predicted impact categories. This suggests that the main parameters currently used to make impact assessments (namely predicted conventional curvature and maximum plan dimension of each structure) are credible. Please note that we have stated predicted conventional curvature rather than strain, as predictions of strain were directly based on predictions of conventional curvature.

A significant over-prediction is observed at the low end of the spectrum of impacts (Category 0 and 1). A number of causes and/or possible causes for the deviations have been identified:

- Construction methods and standards may mitigate against small differential ground movements.
- The impacts may have occurred but the residents have not made a claim for the following reasons:-
  - All structures contain some existing, pre-mining defects. A pre-mining field investigation of 119 structures showed that it is very rare for all elements of a building to be free of cracks. Cracks up to 3 mm in width are commonly found in buildings. Cracks up to 1 mm in width are very common. There is a higher incidence of cracking in brittle forms of construction such as masonry walls and tiled surfaces.
  - In light of the above, additional very slight Category 0 and 1 impacts may not have been noticed by residents. A forensic investigation of all structures before or after mining may reveal that the number of actual impacts is greater than currently known.
  - Similarly, impacts have been noticed but some residents may consider them to be too trivial to make a claim. While difficult to prove statistically, it is considered that the frequency of claims from tenanted properties is less than the frequency of claims from owner-occupied properties.
- The impacts have been noticed but some residents are yet to make a claim at this stage. It has been observed that there is a noticeable time lag between the moment of impact and the moment of making a claim. More claims are therefore expected to be received in the future within areas that have already been directly mined beneath.
- The predictive method is deliberately conservative in a number of ways.
  - Predicted subsidence movements for each structure are based on the maximum predicted subsidence movements within 20 metres of the structure.
  - An additional 0.2 mm/m of strain was added
  - Maximum strains were applied to the maximum plan dimension, regardless of the maximum predicted strain orientation.
  - The method of impact assessment does not provide for “nil impacts”. The minimum assessed level of impact is Category 0.
  - The impact data was based on double-storey full masonry structures in the UK.

Finally, it is considered that the previous method impact classification has masked the true nature and extent of impacts. It is recommended that an improved method of classification be adopted before embarking on any further analysis. This is discussed in the next chapter of this report.

C.3. Method of Impact Classification

C.3.1. Previous Method

The impacts to structures were previously classified in accordance with Table C1 of Australian Standard 2870-1996, but the Table has been extended by the addition of Category 5 and is reproduced below.

Table C.2 Classification of Damage with Reference to Strain

Impact Category	Description of typical damage to walls and required repair	Approximate crack width limit
0	Hairline cracks.	< 0.1 mm
1	Fine cracks which do not need repair.	0.1 mm to 1.0 mm
2	Cracks noticeable but easily filled. Doors and windows stick slightly	1 mm to 5 mm
3	Cracks can be repaired and possibly a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weather-tightness often impaired	5 mm to 15 mm, or a number of cracks 3 mm to 5 mm in one group
4	Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Window or door frames distort. Walls lean or bulge noticeably. Some loss of bearing in beams. Service pipes disrupted.	15 mm to 25 mm but also depends on number of cracks
5	As above but worse, and requiring partial or complete rebuilding. Roof and floor beams lose bearing and need shoring up. Windows broken with distortion. If compressive damage, severe buckling and bulging of the roof and walls.	> 25 mm

Note 1 of Table C1 states that *"Crack width is the main factor by which damage to walls is categorized. The width may be supplemented by other factors, including serviceability, in assessing category of damage.*

Impacts relating to tilt were classified according to matching impacts with the description in Table C.3, not the observed actual tilt. This is because many houses that have experience tilts greater than 5 mm have not made a claim to the MSB.

Table C.3 Classification of Damage with Reference to Tilt

Impact Category	Tilt (mm/m)	Description
A	< 5	Unlikely that remedial work will be required.
B	5 to 7	Adjustment to roof drainage and wet area floors might be required.
C	7 to 10	Minor structural work might be required to rectify tilt. Adjustments to roof drainage and wet area floors will probably be required and remedial work to surface water drainage and sewerage systems might be necessary.
D	> 10	Considerable structural work might be required to rectify tilt. Jacking to level or rebuilding could be necessary in the worst cases. Remedial work to surface water drainage and sewerage systems might be necessary.

C.3.2. Need for Improvement to the Previous Method of Impact Classification

It is very difficult to design a method of impact classification that covers all possible scenarios and permutations. The application of any method is likely to find some instances that do not quite fit within the classification criteria.

Exposure to a large number of affected structures has allowed the mining industry to appreciate where improvements can be made to all aspects including the identification of areas for improvement in the previous method of impact classification.

A number of difficulties have been experienced with the previous method during the mining period. The difficulty centres on the use of crack width as the main classifying factor, as specified in Table C1 of Australian Standard 2870-1996.

A benefit of using crack width as the main factor is that it provides a clear objective measure by which to classify impact. However, experience has shown that crack width is a poor measure of the overall impact and extent of repair to a structure. The previous method of impact classification may be useful for assessing impact to newly built structures in a non-subsidence environment but further improvement and clarification is recommended before it can be effectively applied to houses impacted by mine subsidence.

The following aspects highlight areas where the previous classification system could be improved.-

- *Slippage on Damp Proof Course*

  Approximately 30 houses have experienced slippage along the damp proof course in Tahmoor. Slippage on some houses is relatively small (less than 10 mm) though substantial slippage has been observed in a number of cases, such as shown in Fig. C.1 below.

Fig. C.1 Example of slippage on damp proof course

  Under the previous classification method, the “crack” width of the slippage may be very small (Category 1) but the distortion in the brickwork is substantial. Moreover, the extent of work required to repair the impact is substantial as it usually involves re-lining the whole external skin of the structure. Such impacts would be considered Category 4 based on extent of repair but only Category 1 or 2 based on maximum crack width.

  There is no reference to slippage of damp proof course in the previous method of impact classification. However, if the extent of repair was used instead of using crack width as the main factor, the impact category would be properly classified as either Category 4 or Category 5.

  It was recommended that slippage of damp proof courses be added to the previous impact classification table.

- *Cracks to brickwork*

  In some cases, cracks are observed in mortar only. For example, movement joints in some structures have been improperly filled with mortar instead of a flexible sealant, as shown in Fig. C.2. In these situations, the measured crack width may be significant but the impact is relatively simple to repair regardless of the crack width.

Fig. C.2 Example of crack in mortar only

In other cases, a small number of isolated bricks have been observed to crack or become loose. This is usually straightforward to repair. Under the previous impact classification method, a completely loose brick could be strictly classified as Category 5 as the crack width is infinitely large. This is clearly not the intention of the previous method but clarification is recommended to avoid confusion.

If a panel of brickwork is cracked, the method of repair is the same regardless of the width. While it is considered reasonable to classify large and severe cracks by its width, it is recommended that cracks less than 5 mm in width be treated the same rather than spread across Categories 0, 1 and 2.

If a brick lined structure contains many cracks of width less than 3 mm, the impact would be classified as no more than Category 2 under the previous method of impact classification. The extent of repair may be substantially more than a house that has experienced only one single 5 mm crack. However, it is recognised that it is very difficult to develop a simple method of classifying impacts based on multiple cracks in wall panels. How many cracks are needed to justify an increase in impact category?

- *Structures without masonry walls*

  Timber framed structures with lightweight external linings such weatherboard panels and fibro sheeting are not referenced in the previous classification table. If crack widths were strictly adopted to classify impacts, it may be possible to classify movement in external wall linings beyond Category 3 when in reality the repairs are usually minor.

  It was recommended that the impact classification table be extended to include structures with other types of external linings.

- *Minor impacts such as door swings*

  Experience has shown that one of the earliest signs of impact is the report of a sticking door. In some instances, the only observed impact is one or two sticking doors. It takes less than half an hour to repair a sticking door and impact is considered negligible.

  Such an impact would be rightly classified as Category 0 based on the previous method of impact classification as there is no observed crack. However, the previous classification table suggests that sticking doors and windows occur when Category 2 crack widths develop. It was recommended that the impact classification table be amended in this respect.

C.3.3. Broad Recommendations for Improvement of Previous Method of Impact Classification

It was recommended that crack width no longer be used as the main factor for classifying impacts. This does not mean that the use of crack width should be abandoned altogether. Crack width remains a good indicator of the severity of impacts and should be used to assist classification, particularly for impacts that are moderate or greater.

By focussing on crack width, the previous impact classification table appears to be classifying impacts from a structural stability perspective. It was recommended that a revised impact classification table be more closely aligned with all aspects of a building, including its finishes and services. Residents who are affected by impacts are concerned as much about impacts to internal linings, finishes and services as they are about cracks to their external walls and a revised impact classification method should reflect this.

With crack width no longer used as the main factor, it was recommended that the wording of the descriptions of impact in the classification table be extended to cover impacts to more elements of buildings. In keeping with the previous method of assessment, the level of impact should distinguish between cosmetic, serviceability and stability related impacts:-

- Low impact levels should relate to cosmetic impacts that do affect the structural integrity of the building and are relatively straight-forward to repair,
- Mid-level impact categories should relate to impacts to serviceability and minor structural issues, and
- High level impacts should be reserved for structural stability issues and impacts requiring extensive repairs.

C.3.4. Revised Method of Impact Classification

The following revised method of impact classification has been developed.

Table C.4 Revised Classification based on the Extent of Repairs

Repair Category	Extent of Repairs
Nil	No repairs required
R0 **Adjustment**	One or more of the following, where the damage does not require the removal or replacement of any external or internal claddings or linings:- - **Door** or **window** jams or swings, or - Movement of **cornices**, or - Movement at external or internal **expansion joints**.
R1 **Very Minor Repair**	One or more of the following, where the damage can be repaired by filling, patching or painting without the removal or replacement of any external or internal brickwork, claddings or linings:- - Cracks in **brick mortar** only, or isolated cracked, broken, or loose **bricks** in the external façade, or - Cracks or movement < 5 mm in width in any external or internal wall **claddings**, **linings**, or **finish**, or - Isolated cracked, loose, or drummy floor or wall **tiles**, or - Minor repairs to any **services** or **gutters**.
R2 **Minor Repair**	One or more of the following, where the damage affects a small proportion of external or internal claddings or linings, but does not affect the integrity of external brickwork or structural elements:- - Continuous cracking in **bricks** < 5 mm in width in one or more locations in the total external façade, or - Slippage along the **damp proof course** of 2 to 5 mm anywhere in the total external façade, or - Cracks or movement ≥ 5 mm in width in any external or internal wall **claddings**, **linings**, **finish**, or - Several cracked, loose or drummy floor or wall **tiles**, or - Replacement of any **services**.
R3 **Substantial Repair**	One or more of the following, where the damage requires the removal or replacement of a large proportion of external brickwork, or affects the stability of isolated structural elements:- - Continuous cracking in **bricks** of 5 to 15 mm in width in one or more locations in the total external façade, or - Slippage along the **damp proof course** of 5 to 15 mm anywhere in the total external façade, or - Loss of bearing to isolated walls, piers, columns, or other load-bearing elements, or - Loss of stability of isolated structural elements.
R4 **Extensive Repair**	One or more of the following, where the damage requires the removal or replacement of a large proportion of external brickwork, or the replacement or repair of several structural elements:- - Continuous cracking in **bricks** > 15 mm in width in one or more locations in the total external façade, or - Slippage along the damp proof course of 15 mm or greater anywhere in the total external façade, or - Relevelling of building, or - Loss of stability of several structural elements.
R5 **Re-build**	Extensive damage to house where the MSB and the owner have agreed to rebuild as the cost of repair is greater than the cost of replacement.

As discussed at the start of this chapter, it is very difficult to design a method of impact classification that covers all possible scenarios and permutations. While the method has been floated among some members of the mining industry, it is recommended that this table be reviewed broadly.

The recommended method has attempted to follow the current Australian Standard in terms of the number of impact categories and crack widths for Categories 3 and 4. The method is based on the extent of repairs required to repair the physical damage that has occurred, and does not include additional work that is occasionally required because replacement finishes cannot match existing damaged ones. It is therefore likely that the actual cost of repairs will vary greatly between houses depending on the nature of the existing level and type of finishes used.

The impacts experienced at Tahmoor Colliery have been classified in accordance with the revised method of classification with good results. The method allowed clearer trends to be found when undertaking statistical analyses.

A comparison between the previous and revised methods is shown in Fig. C.3.

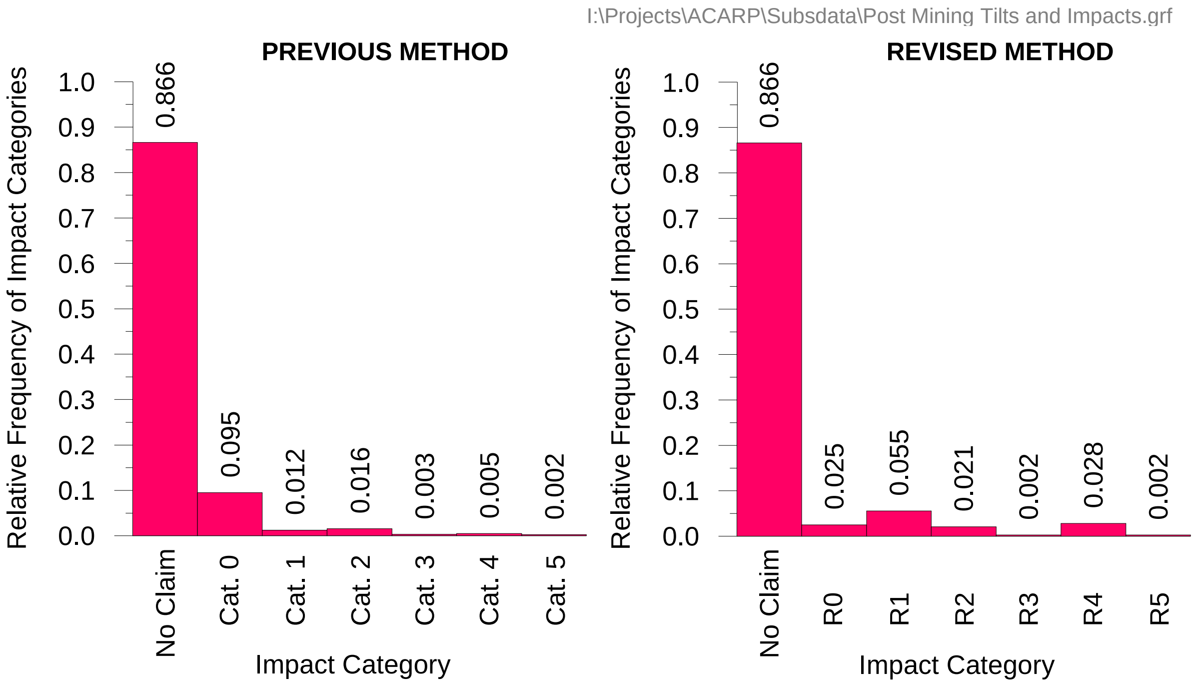


Fig. C.3 Comparison between Previous and Revised Methods of Impact Classification

It can be seen that there was an increased proportion in the higher impact categories using the revised method. This is brought about mainly by the recorded slippage on damp proof courses, which are classified as either Category 3 or Category 4 when they were previously classified as Category 1 or 2.

There was also a noticeable reduction in proportion of Category 0 impacts and noticeable increase in proportion of Category 1 impacts using the revised method. This is because the revised method reserves Category 0 impacts for impacts that did not result in cracking any linings, while the previous method allows hairline cracking to occur.

The consistent low proportion of Category 3 impacts under both the previous and current methods raises questions as to whether this category should be merged with Category 4.

C.4. Method of Impact Assessment

C.4.1. Need for Improvement of the Previous Method

The previous method of impact assessment provided specific quantitative predictions based on predicted conventional subsidence movements and general qualitative statements concerning the potential for impacts due to non-conventional movements. These non-conventional movements are additional to the predicted conventional movements.

This message was quite complex and created the potential for confusion and misunderstanding among members of the community who may easily focus on numbers and letters in a table that deal specifically with their house and misunderstand the message contained in the accompanying words of caution about the low level of reliability concerning predictions of conventional strain and potential for non-conventional movements.

This was unfortunately a necessary shortcoming of the previous method at the time as there was very little statistical information available to quantify the potential for impacts due to non-conventional movement. However, a great deal of statistical information is now available following the mining of Tahmoor Colliery Longwalls 22 to 24A and the method and message to the community can be improved.

While additional statistical information is now available, there remains limited knowledge at this point in time to accurately predict the locations of non-conventional movement. Substantial gains are still to be made in this area.

In the meantime, therefore, a probabilistic method of impact assessment has been developed. The method combines the potential for impacts from both conventional and non-conventional subsidence movement.

C.4.2. Factors that Could be Used to Develop a Probabilistic Method of Prediction

Trend analyses have highlighted a number of factors that could be used to develop a probabilistic method. The trends examined were:-

- *Ground tilt*

  This was found to be an ineffective parameter at Tahmoor Colliery as ground tilts have been relatively benign and a low number of claims have been made in relation to tilt.

- *Ground strain*

  There appears to be a clear link between ground strain and impacts, particularly compressive strain. The difficulty with adopting ground strain as a predictive factor lies in the ability to accurately predict ground strain at a point.

  Another challenge with using strain to develop a probabilistic method is that there is limited information that links maximum observed strains with observed impacts at a structure. Horizontal strain is a two-dimensional parameter and it has been measured along survey lines that are oriented in one direction only.

  The above issues are less problematic for curvature and the statistical analysis on the relationship between strain and curvature shows that the observed frequency of high strains increased with increasing observed curvature.

- *Ground curvature*

  Curvature appears to be the most effective subsidence parameter to develop a probabilistic method. The trend analysis showed that the frequency of impacts increased with increasing observed curvature.

  It should be noted that we are referring to conventional curvature and not curvatures that have developed as a result of non-conventional subsidence behaviour. This is because conventional curvature can be readily predicted with reasonable correlation with observations. It is also a relatively straight-forward exercise to estimate the observed smoothed or “conventional” curvature provided some ground monitoring is undertaken across and along extracted longwalls.

  Non-conventional curvature cannot be predicted prior to mining and is accounted for by using a probabilistic method of impact assessment.

  It has also been shown that the observed frequency of high strains increased with increasing observed curvature.

- *Position of structure relative to longwall*

  A clear trend was understandably found that structures located directly above goaf were substantially more likely to experience impact. The calculated probabilities may be applicable for mining conditions that are similar to those experienced at Tahmoor Colliery but will be less applicable for other mining conditions. An effective probabilistic method should create a link between the magnitude of differential subsidence movements and impact.

- *Construction type*

  Two trends have been observed. Not surprisingly, structures constructed with lightweight flexible external linings are able to accommodate a far greater range of subsidence movements than brittle inflexible linings such as masonry. The analyses merely quantified what was already well known. The second observation was that houses constructed with strip footings were noticeably more likely to experience impacts than houses constructed with a ground slab, particularly in relation to higher levels of impact. This is because houses with strip footings are more susceptible to slippage along the damp proof course.

- *Structure size*

  Trend analysis showed that larger structures attract a higher likelihood of impact. This is understandable as the chance of impacts increases with increasing footprint area. However, it is noted that the probability of severe impacts was not substantially greater for larger structures even though this would be expected if considering probabilities theoretically rather than empirically. It may be worthwhile including structure size as a factor in the development of a probabilistic method, though it is considered that it is a third order effect behind subsidence movements and construction type.

- *Structure age*

  The trend analysis for structure age did not reveal any noticeable trends.

- *Extensions, variable foundations and building joints*

  There is a clear trend of a higher frequency of impacts for structures that include extensions, variable foundations and building joints. The increased frequency appears to be related mainly to lower impact categories.

- *Urban or rural setting*

  While trends were observed, it is considered that they can be explained by other factors. However, consideration can be made to provide a more conservative estimate of probabilities in rural areas if structure size has not been taken into account.

C.4.3. Revised Method of Impact Assessment

A revised method of impact assessment has been developed. The method is probabilistic and currently includes conventional ground curvature and construction type as input factors.

Because of the relatively low number of buildings that suffered damage, the trends in the data were difficult to determine within small ranges of curvature. A decision was therefore taken to analyse the data in a limited number of curvature ranges, so that where possible a reasonable sample size would be available in each range. The ranges of curvature chosen were 5 to 15 kilometres, 15 to 50 kilometres and greater than 50 kilometres.

Because the incidence of damage for different construction types showed strong trends and because the sample size was reasonable for each type of structure, the data were analysed to determine the effect of radius of curvature on the incidence of damage for each of the three structure types and for each of the three curvature ranges.

The following probabilities are proposed in Table C.5.

Table C.5 Probabilities of Impact based on Curvature and Construction Type based on the Revised Method of Impact Classification

R (km)	Repair Category			
	No Repair or R0	R1 or R2	R3 or R4	R5
Brick or brick-veneer houses with Slab on Ground				
> 50	90 ~ 95 %	3 ~ 10 %	1 %	< 0.1 %
15 to 50	80 ~ 85 %	12 ~ 17 %	2 ~ 5 %	< 0.5 %
5 to 15	70 ~ 75 %	17 ~ 22 %	5 ~ 8 %	< 0.5 %
Brick or brick-veneer houses with Strip Footing				
> 50	90 ~ 95 %	3 ~ 10 %	1 %	< 0.1 %
15 to 50	80 ~ 85 %	7 ~ 12 %	2 ~ 7 %	< 0.5 %
5 to 15	70 ~ 75 %	15 ~ 20 %	7 ~ 12 %	< 0.5 %
Timber-framed houses with flexible external linings of any foundation type				
> 50	90 ~ 95 %	3 ~ 10 %	1 %	< 0.1 %
15 to 50	85 ~ 90 %	7 ~ 13 %	1 ~ 3 %	< 0.5 %
5 to 15	80 ~ 85 %	10 ~ 15 %	3 ~ 5 %	< 0.5 %

The results have been expressed as a range of values rather than a single number, recognising that the data had considerable scatter within each curvature range. While structure size and building extensions have not been included in the predictive tables, it is recommended to adopt percentages at the higher end of the range for larger structures or those with building extensions.

The percentages stated in each table are the percentages of building structures of that type that would be likely to be damaged to the level indicated within each curvature range. The levels of damage in the tables are indicated with reference to the repair categories described in the damage classification given in Table C.4.

To place these values in context, Table C.6 shows the actual percentages recorded at Tahmoor Colliery for all buildings within the sample.

Table C.6 Observed Frequency of Impacts observed for all buildings at Tahmoor Colliery

R (km)	Repair Category			
	No Claim or R0	R1 or R2	R3 or R4	R5
> 50	94%	4%	1%	0%
15 to 50	86%	9%	4%	0.7%
5 to 15	76%	17%	7%	0%

It can be seen that the proposed probabilities for the higher impact categories have been increased compared to those observed to date. These have been deliberately increased, because it has been noticed that some of the claims for damage have been submitted well after the event and it is possible that the numbers damaged in this category could be increased as further claims are received and investigated. These numbers are particularly sensitive to change because the sample size is very small. In light of the above, it is recommended that the probabilities be revisited in the future as mining progresses.

The ranges provided in Table C.5 have been converted into a set of probability curves to remove artificial discontinuities that are formed by dividing curvatures into three categories. These are shown in Fig. C.4. The probability curves are applicable for all houses and civil structures.

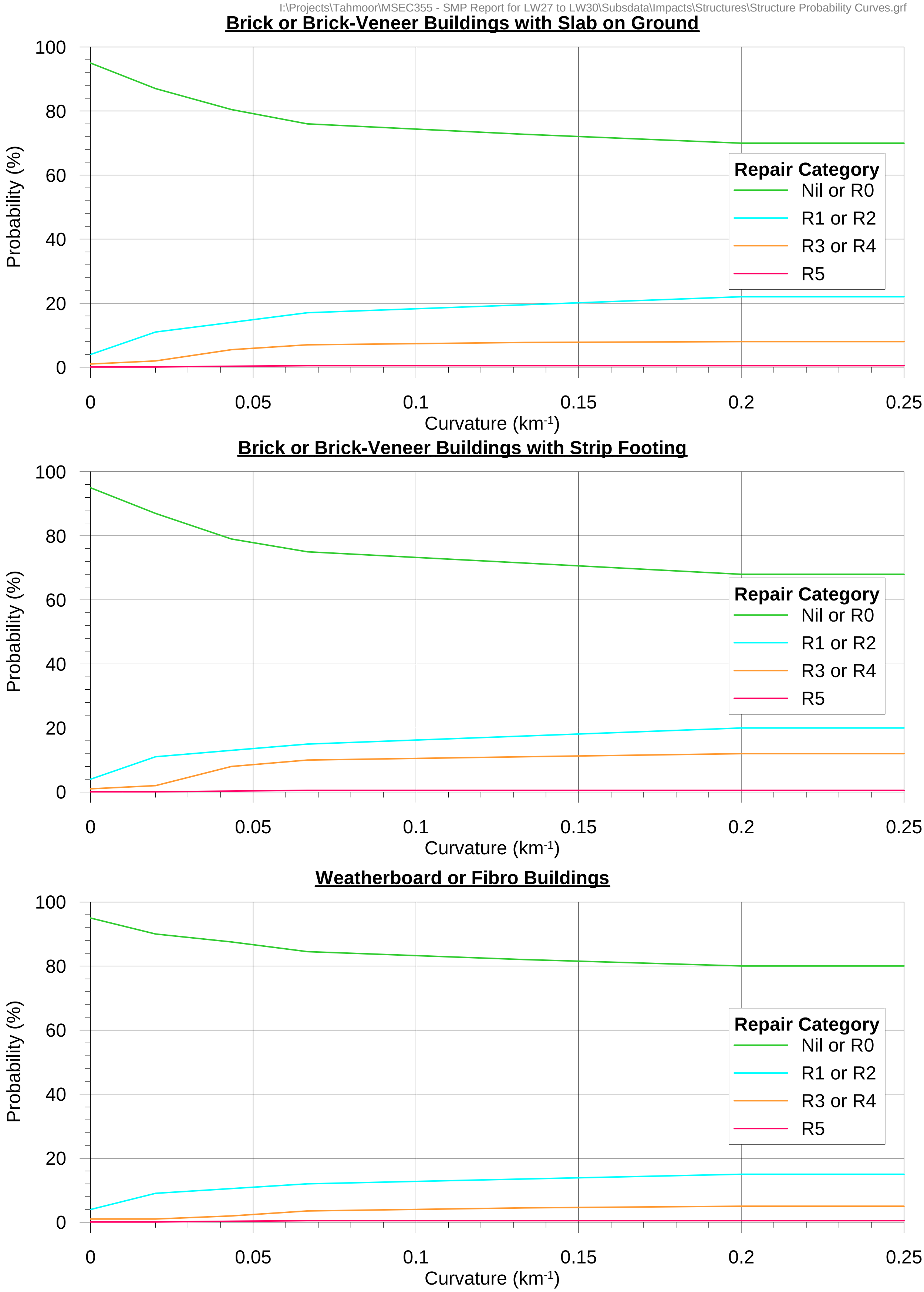


Fig. C.4 Probability Curves for Impacts to Buildings

APPENDIX D. TABLES

Table D.01 - Details of the Houses within the Study Area

House Ref.	Mine Subsidence District	Maximum Plan Dimension (m)	Planar Area (m2)	Number of Stories	Wall Construction	Footing Construction	Wall and Footing Construction	Roof Construcftion	Age (Years)	Extension (Year)
A29h01	Sth Camp.	17.2	180	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	50 to 60	
A30h01	Sth Camp.	29.94	468	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
A32h01	Sth Camp.	20.85	338	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	20 to 30	
D54h01	Wilton	21.31	290	1	Weatherboard	Piers	Weatherboard or Fibro	Metal	50 to 60	
E01h01	Sth Camp.	22.62	274	1	Weatherboard	Slab on Ground	Weatherboard or Fibro	Metal	< 10	
E01h02	Sth Camp.	38.38	461	1	Weatherboard	Piers	Weatherboard or Fibro	Metal	< 10	
E02h01	Wilton	21.47	293	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	10 to 20	
E03h01	Wilton	27.46	294	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	10 to 20	
E04h01	Wilton	30.52	350	1	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Metal	10 to 20	2007
E05h01	Wilton	28.11	355	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	10 to 20	
E06h01	Wilton	19.95	253	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	10 to 20	
E07h01	Wilton	22	263	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	10 to 20	
E08h01	Wilton	33.27	438	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	10 to 20	
E09h01	Wilton	23.94	312	1	Weatherboard	Piers	Weatherboard or Fibro	Metal	< 10	
E10h01	Wilton	19.99	191	1	Fibro	Slab on Ground	Weatherboard or Fibro	Tiled	40 to 50	
E11h01	Wilton	18.6	231	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	20 to 30	
E12h01	Wilton	31.47	325	1	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Tiled	10 to 20	
E12h02	Wilton	23.99	307	1	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Tiled	10 to 20	
F01h01	Wilton	19.89	222	1	Weatherboard	Piers	Weatherboard or Fibro	Metal	50 to 60	1984
F02h01	Wilton	22.41	316	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	20 to 30	2002
F03h01	Wilton	22.2	411	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	
F04h01	Wilton	25.18	294	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	10 to 20	
F05h01	Wilton	36.51	468	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	
H01h01	Sth Camp.	22.34	292	2	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
H01h02	Sth Camp.	17.05	97	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	< 10	
H01h03	Sth Camp.	17.06	100	2	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	< 10	
H02h01	Sth Camp.	32.82	385	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	10 to 20	
H03h01	Sth Camp.	24.6	363	1	Weatherboard	Piers	Weatherboard or Fibro	Metal	10 to 20	2007
H04h01	Sth Camp.	21.56	257	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
H05h01	Sth Camp.	17.44	217	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
H06h01	Sth Camp.	25.66	277	1	Weatherboard	Piers	Weatherboard or Fibro	Metal	10 to 20	
H07h01	Wilton	17.63	210	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
H08h01	Wilton	23.99	373	1	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Tiled	10 to 20	
H09h01	Wilton	26.77	292	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
H10h01	Wilton	37.58	521	1	Brick or Brick-Veneer	Unknown	Other	Metal	10 to 20	
H11h01	Wilton	12.15	143	1	Weatherboard	Piers	Weatherboard or Fibro	Metal	10 to 20	
H12h01	Wilton	17.78	208	2	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
H13h01	Wilton	25.84	347	1	Weatherboard	Piers	Weatherboard or Fibro	Metal	10 to 20	
H14h01	Wilton	37.67	527	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
H16h01	Wilton	31.99	380	1	Other	Unknown	Other	Metal	10 to 20	2007
H17h01	Wilton	16.21	152	2	Other	Slab on Ground	Other	Other	10 to 20	
H18h01	Wilton	18.47	247	2	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	

Table D.01 - Details of the Houses within the Study Area

House Ref.	Mine Subsidence District	Maximum Plan Dimension (m)	Planar Area (m2)	Number of Stories	Wall Construction	Footing Construction	Wall and Footing Construction	Roof Construcftion	Age (Years)	Extension (Year)
H19h01	Wilton	22.51	353	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	20 to 30	
H22h01	Wilton	13.27	126	2	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	< 10	
H23h01	Wilton	19.49	235	1	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Tiled	20 to 30	
H24h01	Wilton	23.43	440	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	1994
H25h01	Wilton	23.37	317	1	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Metal	10 to 20	
H26h01	Sth Camp.	17.73	137	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	
H27h01	Sth Camp.	17.18	193	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	20 to 30	
H28h01	Sth Camp.	17.4	178	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	2002
H29h01	Sth Camp.	15.68	142	1	Fibro	Piers	Weatherboard or Fibro	Metal	50 to 60	
H30h01	Sth Camp.	16.6	143	1	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Tiled	40 to 50	
H33h01	Sth Camp.	16.53	182	1	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Tiled	20 to 30	1994
H34h01	Sth Camp.	21.76	227	1	Weatherboard	Piers	Weatherboard or Fibro	Metal	50 to 60	2002
H35h01	Sth Camp.	12.94	130	1	Weatherboard	Piers	Weatherboard or Fibro	Tiled	40 to 50	
H36h01	Sth Camp.	14.32	180	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	
H37h01	Sth Camp.	16.93	233	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	2007
H38h01	Sth Camp.	15.52	157	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	2009
H39h01	Sth Camp.	15.18	167	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	
H40h01	Sth Camp.	16.19	216	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	2009
H41h01	Sth Camp.	14.16	192	1	Weatherboard	Piers	Weatherboard or Fibro	Metal	20 to 30	
H42h01	Sth Camp.	13.13	97	1	Weatherboard	Piers	Weatherboard or Fibro	Metal	50 to 60	
H43h01	Sth Camp.	15.52	158	2	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Metal	20 to 30	
H44h01	Sth Camp.	15.43	153	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	
J01h01	Wilton	26.9	214	2	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
J02h01	Wilton	13.16	149	2	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
J03h01	Wilton	34.75	372	1	Weatherboard	Piers	Weatherboard or Fibro	Metal	10 to 20	
J04h01	Wilton	18.61	286	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	10 to 20	2002
J05h01	Wilton	22.92	233	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
J06h01	Wilton	15.47	141	1	Weatherboard	Piers	Weatherboard or Fibro	Metal	10 to 20	
J07h01	Wilton	18.63	255	2	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Metal	10 to 20	
J08h01	Wilton	27.49	282	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
J09h01	Wilton	29.85	354	1	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Tiled	10 to 20	
J10h01	Wilton	28.63	399	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	10 to 20	
J11h01	Wilton	27.6	488	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
J13h01	Wilton	36.68	533	2	Brick or Brick-Veneer	Piers	Brick on Piers	Metal	< 10	
J14h01	Wilton	29.95	420	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	10 to 20	2002
J15h01	Wilton	14.9	139	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	10 to 20	
J16h01	Wilton	28.88	378	1	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Metal	10 to 20	
J17h01	Wilton	33.43	410	1	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Metal	10 to 20	
J18h01	Wilton	29.26	325	1	Weatherboard	Piers	Weatherboard or Fibro	Metal	10 to 20	
J19h01	Wilton	22.67	349	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	10 to 20	
J20h01	Wilton	28.08	393	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	< 10	
J21h01	Wilton	18.99	209	1	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Tiled	10 to 20	

Table D.01 - Details of the Houses within the Study Area

House Ref.	Mine Subsidence District	Maximum Plan Dimension (m)	Planar Area (m2)	Number of Stories	Wall Construction	Footing Construction	Wall and Footing Construction	Roof Construcftion	Age (Years)	Extension (Year)
J22h01	Wilton	19.56	266	1	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Tiled	20 to 30	
J23h01	Wilton	16.86	126	1	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Tiled	20 to 30	
J24h01	Wilton	25.23	272	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	10 to 20	2004
J25h01	Wilton	27.67	306	1	Brick or Brick-Veneer	Piers	Brick on Piers	Tiled	20 to 30	2002
J26h01	Wilton	21.29	274	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	2007
J27h01	Wilton	28.46	320	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	10 to 20	
J28h01	Wilton	19.95	261	1	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Tiled	10 to 20	
J29h01	Wilton	16.57	212	1	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Tiled	20 to 30	
J30h01	Wilton	16.66	171	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
J31h01	Wilton	14.67	133	1	Brick or Brick-Veneer	Piers	Brick on Piers	Metal	10 to 20	
J32h01	Wilton	15.36	177	1	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Tiled	10 to 20	
J44h01	Sth Camp.	18.01	173	1	Fibro	Piers	Weatherboard or Fibro	Metal	50 to 60	
J47h01	Sth Camp.	12.58	95	1	Fibro	Piers	Weatherboard or Fibro	Tiled	40 to 50	
J49h01	Sth Camp.	17.66	224	1	Weatherboard	Piers	Weatherboard or Fibro	Metal	40 to 50	
J50h01	Sth Camp.	28.48	254	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	30 to 40	1984
J51h01	Sth Camp.	11.39	125	1	Fibro	Slab on Ground	Weatherboard or Fibro	Metal	10 to 20	
J52h01	Sth Camp.	13.18	162	1	Weatherboard	Piers	Weatherboard or Fibro	Metal	50 to 60	
J53h01	Sth Camp.	16.09	174	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	
J54h01	Sth Camp.	28.85	310	1	Weatherboard	Slab on Ground	Weatherboard or Fibro	Metal	20 to 30	2004
J55h01	Sth Camp.	29.54	382	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	2004
J56h01	Sth Camp.	23.66	284	1	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Metal	10 to 20	
J57h01	Sth Camp.	19.52	212	1	Weatherboard	Unknown	Weatherboard or Fibro	Metal	10 to 20	
J57h02	Sth Camp.	13.72	123	1	Weatherboard	Unknown	Weatherboard or Fibro	Metal	< 10	
J59h01	Sth Camp.	17.52	157	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	50 to 60	2004
J60h01	Sth Camp.	14.67	115	1	Weatherboard	Piers	Weatherboard or Fibro	Metal	50 to 60	
J61h01	Sth Camp.	11.57	105	1	Fibro	Slab on Ground	Weatherboard or Fibro	Metal	50 to 60	
J64h01	Sth Camp.	11.53	79	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	40 to 50	
J67h01	Sth Camp.	20.99	251	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	< 10	
J68h01	Sth Camp.	21.57	243	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
J69h01	Sth Camp.	17.61	110	1	Weatherboard	Piers	Weatherboard or Fibro	Metal	50 to 60	
K01h01	Wilton	18.36	212	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
K02h01	Wilton	20.08	262	2	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
K03h01	Wilton	13.67	118	2	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	30 to 40	
K04h01	Wilton	20.16	333	1	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Metal	30 to 40	2002
K05h01	Wilton	23	278	2	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
K06h01	Wilton	22.11	217	2	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
K07h01	Wilton	16.85	189	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
K08h01	Wilton	17.93	191	1	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Tiled	20 to 30	
K10h01	Wilton	16.48	175	2	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Tiled	30 to 40	
K10h02	Wilton	9.72	62	1	Weatherboard	Piers	Weatherboard or Fibro	Tiled	10 to 20	
K11h01	Wilton	23.68	362	1	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Metal	< 10	
K12h01	Wilton	31.69	439	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	2007

Table D.01 - Details of the Houses within the Study Area

House Ref.	Mine Subsidence District	Maximum Plan Dimension (m)	Planar Area (m2)	Number of Stories	Wall Construction	Footing Construction	Wall and Footing Construction	Roof Construcftion	Age (Years)	Extension (Year)
K12h02	Wilton	22.6	159	1	Weatherboard	Piers	Weatherboard or Fibro	Metal	20 to 30	2002
K13h01	Wilton	17.73	149	1	Brick or Brick-Veneer	Piers	Brick on Piers	Tiled	20 to 30	
K32h01	Wilton	22.73	213	1	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Metal	10 to 20	
K33h01	Wilton	19.71	249	1	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Tiled	10 to 20	
K34h01	Wilton	16.14	153	2	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	
K35h01	Wilton	18.65	259	1	Brick or Brick-Veneer	Piers	Brick on Piers	Tiled	20 to 30	
K36h01	Wilton	21.29	262	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	
K37h01	Wilton	20.8	368	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	2002
K38h01	Wilton	14.66	149	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	
K39h01	Wilton	14.14	145	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	
K40h01	Wilton	20.97	237	1	Brick or Brick-Veneer	Piers	Brick on Piers	Tiled	10 to 20	
K41h01	Wilton	30.59	363	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
K42h01	Wilton	19.98	194	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	30 to 40	2004
K43h01	Wilton	19.74	226	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
K44h01	Wilton	16.3	221	1	Weatherboard	Piers	Weatherboard or Fibro	Metal	30 to 40	1994
K45h01	Wilton	27.12	269	2	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	2002
K46h01	Wilton	15.16	153	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	
K47h01	Wilton	11.02	84	1	Weatherboard	Piers	Weatherboard or Fibro	Metal	50 to 60	
K49h01	Wilton	14.62	194	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	2002
K50h01	Sth Camp.	10.46	107	1	Brick or Brick-Veneer	Piers	Brick on Piers	Tiled	10 to 20	
K50h02	Sth Camp.	16.18	150	1	Brick or Brick-Veneer	Piers	Brick on Piers	Tiled	10 to 20	
K50h03	Sth Camp.	13.36	115	1	Brick or Brick-Veneer	Piers	Brick on Piers	Tiled	10 to 20	
K50h04	Sth Camp.	15.91	148	1	Brick or Brick-Veneer	Piers	Brick on Piers	Tiled	10 to 20	
K50h05	Sth Camp.	26.33	254	1	Brick or Brick-Veneer	Piers	Brick on Piers	Tiled	10 to 20	
K50h06	Sth Camp.	39.95	363	1	Brick or Brick-Veneer	Piers	Brick on Piers	Tiled	10 to 20	
K50h07	Sth Camp.	26.55	247	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
K51h01	Sth Camp.	17.27	214	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	2007
K52h01	Sth Camp.	13.25	129	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	
K52h02	Sth Camp.	11.7	96	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
K53h01	Sth Camp.	20.16	170	1	Weatherboard	Slab on Ground	Weatherboard or Fibro	Metal	10 to 20	
K54h01	Sth Camp.	16.21	168	1	Weatherboard	Piers	Weatherboard or Fibro	Tiled	40 to 50	1994
K55h01	Sth Camp.	13.94	180	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
K56h01	Sth Camp.	20.74	206	1	Weatherboard	Piers	Weatherboard or Fibro	Metal	30 to 40	2002
K57h01	Sth Camp.	14.94	139	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	10 to 20	
K58h01	Sth Camp.	16.96	198	1	Brick or Brick-Veneer	Piers	Brick on Piers	Metal	40 to 50	2002
K66h01	Sth Camp.	23.97	262	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	2004
K67h01	Sth Camp.	15.43	224	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	2004
K68h01	Sth Camp.	16.19	162	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	
K69h01	Sth Camp.	15.96	150	1	Weatherboard	Piers	Weatherboard or Fibro	Tiled	30 to 40	
K70h01	Sth Camp.	17.67	157	1	Weatherboard	Piers	Weatherboard or Fibro	Metal	40 to 50	1994
K71h01	Sth Camp.	16.28	168	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	
K72h01	Sth Camp.	17.42	188	1	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Tiled	30 to 40	

Table D.01 - Details of the Houses within the Study Area

House Ref.	Mine Subsidence District	Maximum Plan Dimension (m)	Planar Area (m2)	Number of Stories	Wall Construction	Footing Construction	Wall and Footing Construction	Roof Construcftion	Age (Years)	Extension (Year)
K73h01	Sth Camp.	20.46	306	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
K86h01	Sth Camp.	26.83	199	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
L01h01	Wilton	17.75	181	2	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
L02h01	Wilton	20.78	215	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	20 to 30	
L05h01	Wilton	24.94	291	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	30 to 40	1994
L06h01	Wilton	31.21	469	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	10 to 20	
L07h01	Wilton	24.21	342	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	2004
L08h01	Wilton	18.74	294	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	2002
L09h01	Wilton	28.53	416	1	Weatherboard	Slab on Ground	Weatherboard or Fibro	Metal	10 to 20	2004
L10h01	Wilton	25.79	385	1	Brick or Brick-Veneer	Piers	Brick on Piers	Metal	10 to 20	2009
L12h01	Wilton	24.74	301	1	Brick or Brick-Veneer	Piers	Brick on Piers	Tiled	10 to 20	
L13h01	Wilton	29.27	331	1	Brick or Brick-Veneer	Piers	Brick on Piers	Tiled	50 to 60	1984
L14h01	Wilton	26.01	510	1	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Tiled	10 to 20	2002
L15h01	Wilton	13.25	155	1	Weatherboard	Piers	Weatherboard or Fibro	Metal	30 to 40	
L16h01	Wilton	16.04	247	2	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	2002
L17h01	Wilton	18.05	184	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
L18h01	Wilton	11.17	119	2	Weatherboard	Piers	Weatherboard or Fibro	Metal	30 to 40	
L19h01	Wilton	24.47	297	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	10 to 20	
L20h01	Wilton	12.73	94	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	30 to 40	
L21h01	Wilton	17.08	127	1	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Tiled	30 to 40	
L21h02	Wilton	12.38	97	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	30 to 40	
L22h01	Wilton	16	210	2	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	
L23h01	Wilton	16.23	184	1	Weatherboard	Strip Footings	Weatherboard or Fibro	Metal	30 to 40	1994
L24h01	Wilton	24.45	289	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	2002
L25h01	Wilton	16.36	190	1	Weatherboard	Piers	Weatherboard or Fibro	Metal	30 to 40	
L27h01	Wilton	26.47	292	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	
L28h01	Wilton	16.56	129	2	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	
L29h01	Wilton	18.67	217	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	
M01h01	Wilton	20.39	297	1	Brick or Brick-Veneer	Piers	Brick on Piers	Metal	40 to 50	1975
M02h01	Wilton	21.71	264	1	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Tiled	20 to 30	
M03h01	Wilton	23.43	253	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	20 to 30	
M04h01	Wilton	35.26	489	1	Weatherboard	Piers	Weatherboard or Fibro	Metal	10 to 20	
M05h01	Wilton	15.9	177	2	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Tiled	20 to 30	2007
M06h01	Wilton	29.97	407	1	Other	Unknown	Other	Tiled	20 to 30	
M07h01	Wilton	33.67	432	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	1994
M07h02	Wilton	18.39	113	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	2004
M08h01	Wilton	31.28	380	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	10 to 20	
M09h01	Wilton	29	256	1	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Tiled	30 to 40	1984
M10h01	Wilton	33.44	334	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	< 10	
M10h02	Wilton	17.7	131	1	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Tiled	30 to 40	
M11h01	Wilton	27.12	233	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
M12h01	Wilton	17.84	208	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	

Table D.01 - Details of the Houses within the Study Area

House Ref.	Mine Subsidence District	Maximum Plan Dimension (m)	Planar Area (m2)	Number of Stories	Wall Construction	Footing Construction	Wall and Footing Construction	Roof Construcftion	Age (Years)	Extension (Year)
M12h02	Wilton	21.89	167	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	30 to 40	
M13h01	Wilton	25.33	386	1	Weatherboard	Piers	Weatherboard or Fibro	Metal	30 to 40	2004
M13h02	Wilton	29.01	311	1	Weatherboard	Piers	Weatherboard or Fibro	Metal	20 to 30	
M14h01	Wilton	15.88	168	1	Fibro	Piers	Weatherboard or Fibro	Metal	20 to 30	
N01h01	Wilton	21.5	239	2	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	< 10	
N02h01	Wilton	17.28	244	1	Weatherboard	Piers	Weatherboard or Fibro	Metal	50 to 60	2002
N04d01	Wilton	15.1	208	1	Weatherboard	Piers	Weatherboard or Fibro	Metal	50 to 60	
N06h01	Wilton	17.68	298	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	20 to 30	
N11h01	Wilton	25.14	425	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	< 10	
N11h02	Wilton	23.48	345	1	Other	Unknown	Other	Other	< 10	
N13h01	Wilton	28.81	430	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	< 10	
N14h01	Wilton	16.39	230	1	Brick or Brick-Veneer	Piers	Brick on Piers	Tiled	20 to 30	
N15h01	Wilton	17.36	194	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	
N16h01	Wilton	29.73	400	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	
N17h01	Wilton	23.24	257	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	20 to 30	
N18h01	Wilton	19.1	177	1	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Tiled	30 to 40	1994
N20h01	Wilton	22.42	394	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	< 10	
N21h01	Wilton	13.81	133	1	Weatherboard	Strip Footings	Weatherboard or Fibro	Tiled	40 to 50	
N22h01	Wilton	33.87	408	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	10 to 20	
O01h01	Wilton	31.34	334	2	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
O02h01	Wilton	29.65	309	1	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Metal	10 to 20	
P01h01	Wilton	29	332	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	< 10	
P02h01	Wilton	34.51	696	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	< 10	
P04h01	Wilton	29.98	470	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
P05h01	Wilton	37.39	529	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	10 to 20	
P06h01	Wilton	32.27	320	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	10 to 20	
P07h01	Wilton	41.15	513	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	10 to 20	
P08h01	Wilton	26.97	374	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	10 to 20	
P09h01	Wilton	18.68	233	1	Weatherboard	Piers	Weatherboard or Fibro	Metal	10 to 20	
P10h01	Wilton	43.27	608	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	< 10	
P11h01	Wilton	11.83	119	0	Other	Unknown	Other	Other	10 to 20	
P12h01	Wilton	36.68	279	0	Other	Unknown	Other	Other	< 10	
P13h01	Wilton	32.13	388	2	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	< 10	
P14h01	Wilton	24.95	315	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	< 10	
P15h01	Wilton	29.19	558	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	< 10	
P16h01	Wilton	28.18	380	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	< 10	
P19h01	Wilton	32.35	504	2	Brick or Brick-Veneer	Strip Footings	Brick on Strip	Tiled	< 10	2009
P20h01	Wilton	31.69	585	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	10 to 20	
P23h01	Wilton	32.02	484	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	< 10	
P25h01	Wilton	33.32	329	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Tiled	< 10	
P40h01	Wilton	42.37	566	1	Brick or Brick-Veneer	Slab on Ground	Brick on SOG	Metal	10 to 20	

Table D.01 - Details of the Houses within the Study Area

House Ref.	House Located Above Goaf after LW901	House Located Above Goaf after LW902	House Located Above Goaf after LW903	House Located Above Goaf after LW904	Natural Surface Grade at Structure	Natural Surface Grade within 25m of Structure	Natural Surface Grade within 50m of Structure	House on a Steep Slope	House within 25 metres of a Steep Slope	House within 50 metres of a Steep Slope
A29h01					1 in 12	1 in 5	1 in 5			
A30h01					1 in 7	1 in 6	1 in 6			
A32h01					1 in 9	1 in 6	1 in 6			
D54h01					1 in 7	1 in 3	1 in 3			
E01h01					1 in 6	1 in 5	1 in 5			
E01h02					1 in 10	1 in 8	1 in 6			
E02h01					1 in 4	1 in 4	1 in 4			
E03h01					1 in 3	1 in 2.2	1 in 2.2		1	1
E04h01					1 in 5	1 in 3	1 in 3			
E05h01			1	1	1 in 7	1 in 2.9	1 in 2.5		1	1
E06h01					1 in 7	1 in 6	1 in 6			
E07h01					1 in 7	1 in 7	1 in 6			
E08h01					1 in 7	1 in 4	1 in 4			
E09h01					1 in 9	1 in 5	1 in 4			
E10h01					1 in 12	1 in 6	1 in 4			
E11h01					1 in 6	1 in 6	1 in 4			
E12h01					1 in 14	1 in 14	1 in 10			
E12h02					1 in 21	1 in 16	1 in 11			
F01h01					1 in 6	1 in 3	1 in 2.8			1
F02h01					1 in 3	1 in 3	1 in 2.3			1
F03h01					1 in 4	1 in 3	1 in 3			
F04h01					1 in 6	1 in 2.6	1 in 2.6		1	1
F05h01					1 in 8	1 in 3	1 in 3		1	1
H01h01					1 in 7	1 in 7	1 in 7			
H01h02					1 in 8	1 in 8	1 in 8			
H01h03					1 in 9	1 in 7	1 in 7			
H02h01					1 in 8	1 in 8	1 in 8			
H03h01					1 in 8	1 in 6	1 in 1.7			1
H04h01					1 in 15	1 in 8	1 in 8			
H05h01					1 in 7	1 in 7	1 in 7			
H06h01					1 in 12	1 in 9	1 in 8			
H07h01					1 in 14	1 in 12	1 in 7			
H08h01					1 in 6	1 in 5	1 in 5			
H09h01					1 in 4	1 in 3	1 in 3			
H10h01			1	1	1 in 5	1 in 2.8	1 in 2.2		1	1
H11h01			1	1	1 in 5	1 in 4	1 in 2.8			1
H12h01			1	1	1 in 4	1 in 3	1 in 3			
H13h01					1 in 5	1 in 4	1 in 4			
H14h01					1 in 5	1 in 5	1 in 4			
H16h01			1	1	1 in 4	1 in 2.2	1 in 2.2		1	1
H17h01			1	1	1 in 2.4	1 in 2.4	1 in 2.4	1	1	1
H18h01		1	1	1	1 in 2.5	1 in 2.2	1 in 2.2	1	1	1

Table D.01 - Details of the Houses within the Study Area

House Ref.	House Located Above Goaf after LW901	House Located Above Goaf after LW902	House Located Above Goaf after LW903	House Located Above Goaf after LW904	Natural Surface Grade at Structure	Natural Surface Grade within 25m of Structure	Natural Surface Grade within 50m of Structure	House on a Steep Slope	House within 25 metres of a Steep Slope	House within 50 metres of a Steep Slope
H19h01					1 in 12	1 in 11	1 in 8			
H22h01					1 in 8	1 in 8	1 in 8			
H23h01					1 in 11	1 in 8	1 in 7			
H24h01					1 in 8	1 in 6	1 in 6			
H25h01					1 in 10	1 in 7	1 in 7			
H26h01					1 in 17	1 in 16	1 in 12			
H27h01					1 in 16	1 in 14	1 in 14			
H28h01					1 in 16	1 in 15	1 in 13			
H29h01					1 in 19	1 in 14	1 in 12			
H30h01					1 in 14	1 in 11	1 in 10			
H33h01					1 in 18	1 in 18	1 in 15			
H34h01					1 in 17	1 in 17	1 in 13			
H35h01					1 in 20	1 in 15	1 in 7			
H36h01					1 in 13	1 in 10	1 in 7			
H37h01					1 in 8	1 in 6	1 in 5			
H38h01					1 in 7	1 in 7	1 in 5			
H39h01					1 in 15	1 in 8	1 in 8			
H40h01					1 in 14	1 in 14	1 in 9			
H41h01					1 in 25	1 in 16	1 in 9			
H42h01					1 in 25	1 in 18	1 in 8			
H43h01					1 in 19	1 in 8	1 in 5			
H44h01					1 in 13	1 in 7	1 in 4			
J01h01		1	1	1	1 in 2.4	1 in 2.4	1 in 1.5	1	1	1
J02h01		1	1	1	1 in 3	1 in 3	1 in 2.6			1
J03h01		1	1	1	1 in 2.9	1 in 1.8	1 in 1.7	1	1	1
J04h01	1	1	1	1	1 in 4	1 in 3	1 in 3			
J05h01		1	1	1	1 in 3	1 in 2.8	1 in 2.8		1	1
J06h01		1	1	1	1 in 4	1 in 3	1 in 3			
J07h01		1	1	1	1 in 4	1 in 3	1 in 3			
J08h01		1	1	1	1 in 5	1 in 2.7	1 in 2.2		1	1
J09h01		1	1	1	1 in 4	1 in 2.3	1 in 2.3		1	1
J10h01		1	1	1	1 in 6	1 in 2.8	1 in 2.1		1	1
J11h01	1	1	1	1	1 in 5	1 in 5	1 in 5			
J13h01	1	1	1	1	1 in 6	1 in 5	1 in 4			
J14h01	1	1	1	1	1 in 4	1 in 4	1 in 4			
J15h01	1	1	1	1	1 in 6	1 in 6	1 in 4			
J16h01	1	1	1	1	1 in 6	1 in 5	1 in 4			
J17h01	1	1	1	1	1 in 7	1 in 7	1 in 6			
J18h01	1	1	1	1	1 in 9	1 in 8	1 in 4			
J19h01	1	1	1	1	1 in 5	1 in 3	1 in 3			
J20h01		1	1	1	1 in 3	1 in 3	1 in 3			
J21h01					1 in 10	1 in 9	1 in 9			

Table D.01 - Details of the Houses within the Study Area

House Ref.	House Located Above Goaf after LW901	House Located Above Goaf after LW902	House Located Above Goaf after LW903	House Located Above Goaf after LW904	Natural Surface Grade at Structure	Natural Surface Grade within 25m of Structure	Natural Surface Grade within 50m of Structure	House on a Steep Slope	House within 25 metres of a Steep Slope	House within 50 metres of a Steep Slope
J22h01					1 in 12	1 in 12	1 in 8			
J23h01					1 in 12	1 in 8	1 in 6			
J24h01					1 in 7	1 in 6	1 in 6			
J25h01					1 in 5	1 in 5	1 in 5			
J26h01					1 in 9	1 in 6	1 in 6			
J27h01					1 in 6	1 in 6	1 in 6			
J28h01					1 in 19	1 in 6	1 in 6			
J29h01					1 in 8	1 in 8	1 in 6			
J30h01					1 in 8	1 in 8	1 in 8			
J31h01					1 in 16	1 in 9	1 in 9			
J32h01					1 in 15	1 in 13	1 in 9			
J44h01					1 in 9	1 in 9	1 in 7			
J47h01					1 in 7	1 in 7	1 in 7			
J49h01					1 in 11	1 in 8	1 in 8			
J50h01					1 in 6	1 in 6	1 in 4			
J51h01					1 in 7	1 in 7	1 in 7			
J52h01					1 in 9	1 in 8	1 in 8			
J53h01					1 in 14	1 in 8	1 in 8			
J54h01					1 in 8	1 in 6	1 in 4			
J55h01					1 in 5	1 in 4	1 in 2.6			1
J56h01					1 in 3	1 in 2.4	1 in 2.4		1	1
J57h01					1 in 5	1 in 3	1 in 2.6			1
J57h02					1 in 4	1 in 2.4	1 in 2.1		1	1
J59h01					1 in 12	1 in 11	1 in 4			
J60h01					1 in 25	1 in 11	1 in 4			
J61h01					1 in 23	1 in 6	1 in 4			
J64h01					1 in 11	1 in 5	1 in 5			
J67h01					1 in 12	1 in 8	1 in 5			
J68h01					1 in 12	1 in 11	1 in 6			
J69h01					1 in 9	1 in 8	1 in 5			
K01h01					1 in 11	1 in 9	1 in 6			
K02h01					1 in 9	1 in 8	1 in 4			
K03h01					1 in 8	1 in 8	1 in 4			
K04h01					1 in 11	1 in 9	1 in 6			
K05h01					1 in 8	1 in 7	1 in 6			
K06h01					1 in 7	1 in 5	1 in 5			
K07h01					1 in 6	1 in 5	1 in 5			
K08h01					1 in 5	1 in 5	1 in 5			
K10h01					1 in 5	1 in 5	1 in 4			
K10h02					1 in 7	1 in 6	1 in 4			
K11h01					1 in 6	1 in 6	1 in 4			
K12h01					1 in 4	1 in 4	1 in 4			

Table D.01 - Details of the Houses within the Study Area

House Ref.	House Located Above Goaf after LW901	House Located Above Goaf after LW902	House Located Above Goaf after LW903	House Located Above Goaf after LW904	Natural Surface Grade at Structure	Natural Surface Grade within 25m of Structure	Natural Surface Grade within 50m of Structure	House on a Steep Slope	House within 25 metres of a Steep Slope	House within 50 metres of a Steep Slope
K12h02					1 in 12	1 in 10	1 in 4			
K13h01					1 in 11	1 in 7	1 in 4			
K32h01					1 in 5	1 in 5	1 in 5			
K33h01					1 in 9	1 in 9	1 in 6			
K34h01					1 in 9	1 in 8	1 in 6			
K35h01					1 in 12	1 in 6	1 in 6			
K36h01					1 in 9	1 in 9	1 in 6			
K37h01					1 in 10	1 in 10	1 in 10			
K38h01					1 in 11	1 in 9	1 in 9			
K39h01					1 in 9	1 in 9	1 in 9			
K40h01					1 in 8	1 in 8	1 in 8			
K41h01					1 in 9	1 in 8	1 in 8			
K42h01					1 in 10	1 in 10	1 in 8			
K43h01					1 in 9	1 in 9	1 in 8			
K44h01					1 in 14	1 in 8	1 in 8			
K45h01					1 in 8	1 in 8	1 in 8			
K46h01					1 in 8	1 in 8	1 in 8			
K47h01					1 in 11	1 in 7	1 in 7			
K49h01					1 in 14	1 in 11	1 in 4			
K50h01					1 in 19	1 in 14	1 in 10			
K50h02					1 in 18	1 in 18	1 in 10			
K50h03					1 in 20	1 in 19	1 in 11			
K50h04					1 in 26	1 in 17	1 in 11			
K50h05					1 in 13	1 in 11	1 in 11			
K50h06					1 in 27	1 in 15	1 in 10			
K50h07					1 in 24	1 in 21	1 in 9			
K51h01					1 in 17	1 in 15	1 in 8			
K52h01					1 in 21	1 in 14	1 in 10			
K52h02					1 in 14	1 in 10	1 in 10			
K53h01					1 in 19	1 in 13	1 in 10			
K54h01					1 in 19	1 in 10	1 in 7			
K55h01					1 in 19	1 in 19	1 in 7			
K56h01					1 in 23	1 in 14	1 in 7			
K57h01					1 in 24	1 in 20	1 in 7			
K58h01					1 in 15	1 in 15	1 in 5			
K66h01					1 in 11	1 in 11	1 in 11			
K67h01					1 in 13	1 in 13	1 in 11			
K68h01					1 in 11	1 in 11	1 in 11			
K69h01					1 in 13	1 in 11	1 in 8			
K70h01					1 in 11	1 in 9	1 in 9			
K71h01					1 in 11	1 in 10	1 in 9			
K72h01					1 in 16	1 in 8	1 in 8			

Table D.01 - Details of the Houses within the Study Area

House Ref.	House Located Above Goaf after LW901	House Located Above Goaf after LW902	House Located Above Goaf after LW903	House Located Above Goaf after LW904	Natural Surface Grade at Structure	Natural Surface Grade within 25m of Structure	Natural Surface Grade within 50m of Structure	House on a Steep Slope	House within 25 metres of a Steep Slope	House within 50 metres of a Steep Slope
K73h01					1 in 9	1 in 9	1 in 9			
K86h01					1 in 8	1 in 8	1 in 8			
L01h01					1 in 3	1 in 2.8	1 in 2.8		1	1
L02h01					1 in 2.7	1 in 2.3	1 in 1.5	1	1	1
L05h01					1 in 4	1 in 4	1 in 2.9			1
L06h01	1	1	1	1	1 in 3	1 in 3	1 in 3			
L07h01					1 in 7	1 in 7	1 in 4			
L08h01					1 in 6	1 in 5	1 in 5			
L09h01					1 in 8	1 in 5	1 in 5			
L10h01	1	1	1	1	1 in 6	1 in 6	1 in 6			
L12h01					1 in 7	1 in 7	1 in 5			
L13h01					1 in 5	1 in 5	1 in 5			
L14h01					1 in 3	1 in 3	1 in 3			1
L15h01					1 in 5	1 in 4	1 in 3			
L16h01					1 in 3	1 in 2.3	1 in 2.3		1	1
L17h01					1 in 2.9	1 in 2	1 in 2	1	1	1
L18h01					1 in 5	1 in 3	1 in 2.5			1
L19h01					1 in 6	1 in 6	1 in 4			
L20h01					1 in 9	1 in 7	1 in 7			
L21h01					1 in 9	1 in 9	1 in 7			
L21h02					1 in 11	1 in 9	1 in 7			
L22h01					1 in 5	1 in 4	1 in 4			
L23h01					1 in 7	1 in 6	1 in 3			
L24h01					1 in 4	1 in 4	1 in 4			
L25h01					1 in 5	1 in 3	1 in 3			1
L27h01					1 in 4	1 in 4	1 in 4			
L28h01					1 in 7	1 in 7	1 in 5			
L29h01					1 in 7	1 in 6	1 in 6			
M01h01	1	1	1	1	1 in 10	1 in 7	1 in 4			
M02h01					1 in 9	1 in 8	1 in 8			
M03h01					1 in 16	1 in 12	1 in 11			
M04h01	1	1	1	1	1 in 8	1 in 4	1 in 3			
M05h01	1	1	1	1	1 in 15	1 in 15	1 in 12			
M06h01	1	1	1	1	1 in 9	1 in 9	1 in 9			
M07h01					1 in 12	1 in 10	1 in 6			
M07h02					1 in 17	1 in 10	1 in 6			
M08h01					1 in 14	1 in 7	1 in 5			
M09h01	1	1	1	1	1 in 9	1 in 6	1 in 1.6			1
M10h01					1 in 7	1 in 7	1 in 5			
M10h02					1 in 7	1 in 6	1 in 5			
M11h01					1 in 13	1 in 13	1 in 7			
M12h01					1 in 12	1 in 12	1 in 10			

Table D.01 - Details of the Houses within the Study Area

House Ref.	House Located Above Goaf after LW901	House Located Above Goaf after LW902	House Located Above Goaf after LW903	House Located Above Goaf after LW904	Natural Surface Grade at Structure	Natural Surface Grade within 25m of Structure	Natural Surface Grade within 50m of Structure	House on a Steep Slope	House within 25 metres of a Steep Slope	House within 50 metres of a Steep Slope
M12h02					1 in 19	1 in 13	1 in 9			
M13h01					1 in 12	1 in 12	1 in 8			
M13h02					1 in 15	1 in 12	1 in 12			
M14h01					1 in 12	1 in 11	1 in 9			
N01h01					1 in 5	1 in 5	1 in 5			
N02h01		1	1	1	1 in 25	1 in 19	1 in 15			
N04d01		1	1	1	1 in 7	1 in 7	1 in 4			
N06h01			1	1	1 in 11	1 in 2.5	1 in 2.5		1	1
N11h01				1	1 in 4	1 in 2.4	1 in 2.2		1	1
N11h02			1	1	1 in 3	1 in 2.3	1 in 2.1	1	1	1
N13h01					1 in 3	1 in 2.8	1 in 2.1	1	1	1
N14h01				1	1 in 9	1 in 5	1 in 3			
N15h01				1	1 in 6	1 in 2.1	1 in 1.5		1	1
N16h01				1	1 in 6	1 in 1.4	1 in 1.4		1	1
N17h01				1	1 in 5	1 in 2.1	1 in 2		1	1
N18h01				1	1 in 5	1 in 2.7	1 in 2.7		1	1
N20h01			1	1	1 in 12	1 in 10	1 in 5			
N21h01		1	1	1	1 in 14	1 in 6	1 in 3			
N22h01					1 in 4	1 in 3	1 in 2.4			1
O01h01					1 in 18	1 in 6	1 in 3			
O02h01					1 in 6	1 in 5	1 in 2.9			1
P01h01					1 in 12	1 in 7	1 in 2.6			1
P02h01					1 in 8	1 in 8	1 in 8			
P04h01					1 in 6	1 in 5	1 in 5			
P05h01				1	1 in 14	1 in 10	1 in 1			1
P06h01				1	1 in 10	1 in 7	1 in 1.2			1
P07h01				1	1 in 14	1 in 1.1	1 in 1.1		1	1
P08h01				1	1 in 10	1 in 4	1 in 1.2			1
P09h01					1 in 8	1 in 1.7	1 in 1.6		1	1
P10h01					1 in 7	1 in 4	1 in 1.3			1
P11h01					1 in 15	1 in 7	1 in 7			
P12h01					1 in 2.3	1 in 2.3	1 in 2.3	1	1	1
P13h01					1 in 4	1 in 4	1 in 4			
P14h01					1 in 8	1 in 8	1 in 5			
P15h01					1 in 6	1 in 6	1 in 6			
P16h01					1 in 9	1 in 4	1 in 4			
P19h01					1 in 6	1 in 3	1 in 3		1	1
P20h01					1 in 14	1 in 11	1 in 11			
P23h01					1 in 6	1 in 6	1 in 6			
P25h01					1 in 25	1 in 14	1 in 10			
P40h01					1 in 8	1 in 8	1 in 8			

Table D.02 - Predictions and Impact Assessments for Houses within the Study Area

House Ref.	Predicted Total Subsidence after LW901 (mm)	Predicted Total Subsidence after LW902 (mm)	Predicted Total Subsidence after LW903 (mm)	Predicted Total Subsidence after LW904 (mm)	Predicted Total Tilt after LW901 (mm/m)	Predicted Total Tilt after LW902 (mm/m)	Predicted Total Tilt after LW903 (mm/m)	Predicted Total Tilt after LW904 (mm/m)	Maximum Predicted Tilt at the Completion of Any or All the Longwalls (mm/m)
A29h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
A30h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
A32h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
D54h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
E01h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
E01h02	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
E02h01	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
E03h01	< 20	< 20	75	75	< 0.5	< 0.5	1.0	1.0	1.0
E04h01	< 20	< 20	50	50	< 0.5	< 0.5	0.5	1.0	1.0
E05h01	< 20	< 20	175	200	< 0.5	< 0.5	2.5	2.5	2.5
E06h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
E07h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
E08h01	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
E09h01	< 20	< 20	25	50	< 0.5	< 0.5	< 0.5	0.5	0.5
E10h01	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
E11h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
E12h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
E12h02	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
F01h01	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	0.5	0.5
F02h01	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
F03h01	< 20	< 20	< 20	250	< 0.5	< 0.5	< 0.5	3.0	3.0
F04h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
F05h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
H01h01	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
H01h02	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
H01h03	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
H02h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
H03h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
H04h01	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
H05h01	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
H06h01	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
H07h01	< 20	< 20	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
H08h01	< 20	< 20	75	75	< 0.5	< 0.5	0.5	0.5	0.5
H09h01	< 20	< 20	75	75	< 0.5	< 0.5	< 0.5	0.5	0.5
H10h01	< 20	< 20	425	450	< 0.5	< 0.5	3.5	4.0	4.0
H11h01	< 20	< 20	375	425	< 0.5	< 0.5	4.5	5.0	5.0
H12h01	< 20	< 20	325	450	< 0.5	< 0.5	4.0	4.0	4.0
H13h01	< 20	< 20	100	200	< 0.5	< 0.5	1.0	1.0	1.0
H14h01	< 20	< 20	50	150	< 0.5	< 0.5	< 0.5	1.0	1.0
H16h01	< 20	75	725	775	< 0.5	1.0	2.5	2.5	2.5
H17h01	< 20	< 20	175	200	< 0.5	< 0.5	2.0	2.0	2.0
H18h01	< 20	150	350	375	< 0.5	2.5	3.5	3.5	3.5
H19h01	< 20	25	75	75	< 0.5	< 0.5	0.5	0.5	0.5
H22h01	< 20	50	75	75	< 0.5	< 0.5	0.5	0.5	0.5
H23h01	< 20	50	75	75	< 0.5	< 0.5	0.5	0.5	0.5

Table D.02 - Predictions and Impact Assessments for Houses within the Study Area

House Ref.	Predicted Total Subsidence after LW901 (mm)	Predicted Total Subsidence after LW902 (mm)	Predicted Total Subsidence after LW903 (mm)	Predicted Total Subsidence after LW904 (mm)	Predicted Total Tilt after LW901 (mm/m)	Predicted Total Tilt after LW902 (mm/m)	Predicted Total Tilt after LW903 (mm/m)	Predicted Total Tilt after LW904 (mm/m)	Maximum Predicted Tilt at the Completion of Any or All the Longwalls (mm/m)
H24h01	< 20	50	100	100	< 0.5	< 0.5	1.0	1.0	1.0
H25h01	< 20	75	100	100	< 0.5	0.5	1.0	1.0	1.0
H26h01	< 20	25	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
H27h01	< 20	25	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
H28h01	< 20	25	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
H29h01	< 20	25	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
H30h01	< 20	25	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
H33h01	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
H34h01	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
H35h01	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
H36h01	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
H37h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
H38h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
H39h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
H40h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
H41h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
H42h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
H43h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
H44h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
J01h01	< 20	275	400	425	< 0.5	3.0	4.0	4.0	4.0
J02h01	150	750	900	925	1.5	2.0	2.5	2.5	2.5
J03h01	150	825	1000	1025	1.0	1.0	1.5	1.5	1.5
J04h01	350	800	900	925	2.5	< 0.5	1.0	1.0	2.5
J05h01	300	825	950	1000	2.0	0.5	1.0	1.5	2.0
J06h01	175	875	1050	1100	1.0	0.5	1.0	1.5	1.5
J07h01	150	875	1050	1125	1.0	0.5	1.5	1.5	1.5
J08h01	75	750	1050	1125	< 0.5	6.0	3.5	3.0	6.0
J09h01	100	900	1100	1175	0.5	3.5	1.5	1.0	3.5
J10h01	175	900	1075	1150	1.0	0.5	1.5	1.5	1.5
J11h01	425	800	900	925	2.5	< 0.5	1.0	1.0	2.5
J13h01	375	825	925	975	2.5	0.5	1.5	1.5	2.5
J14h01	375	825	925	950	2.5	< 0.5	1.0	1.5	2.5
J15h01	400	800	900	925	2.5	< 0.5	1.0	1.0	2.5
J16h01	525	800	850	850	2.5	1.0	1.5	1.5	2.5
J17h01	525	775	800	825	2.0	1.5	2.0	2.0	2.0
J18h01	375	675	750	750	2.5	3.0	3.0	3.5	3.5
J19h01	250	650	725	725	2.5	3.0	3.0	3.5	3.5
J20h01	25	300	375	375	< 0.5	3.0	3.5	4.0	4.0
J21h01	< 20	75	100	100	< 0.5	0.5	1.0	1.0	1.0
J22h01	< 20	75	100	100	< 0.5	0.5	1.0	1.0	1.0
J23h01	< 20	75	100	100	< 0.5	0.5	1.0	1.0	1.0
J24h01	< 20	75	100	125	< 0.5	1.0	1.0	1.0	1.0
J25h01	25	75	100	100	< 0.5	1.0	1.0	1.0	1.0
J26h01	25	100	125	125	< 0.5	1.0	1.5	1.5	1.5
J27h01	25	125	150	150	< 0.5	1.0	1.5	1.5	1.5

Table D.02 - Predictions and Impact Assessments for Houses within the Study Area

House Ref.	Predicted Total Subsidence after LW901 (mm)	Predicted Total Subsidence after LW902 (mm)	Predicted Total Subsidence after LW903 (mm)	Predicted Total Subsidence after LW904 (mm)	Predicted Total Tilt after LW901 (mm/m)	Predicted Total Tilt after LW902 (mm/m)	Predicted Total Tilt after LW903 (mm/m)	Predicted Total Tilt after LW904 (mm/m)	Maximum Predicted Tilt at the Completion of Any or All the Longwalls (mm/m)
J28h01	25	75	75	100	< 0.5	0.5	1.0	1.0	1.0
J29h01	25	75	75	75	< 0.5	0.5	1.0	1.0	1.0
J30h01	25	75	75	75	< 0.5	0.5	1.0	1.0	1.0
J31h01	25	75	75	75	< 0.5	0.5	1.0	1.0	1.0
J32h01	25	75	75	75	< 0.5	0.5	1.0	1.0	1.0
J44h01	25	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
J47h01	< 20	25	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
J49h01	< 20	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
J50h01	< 20	25	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
J51h01	< 20	25	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
J52h01	< 20	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
J53h01	< 20	25	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
J54h01	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
J55h01	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
J56h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
J57h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
J57h02	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
J59h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
J60h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
J61h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
J64h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
J67h01	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
J68h01	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
J69h01	25	25	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K01h01	100	100	125	125	1.5	1.5	1.5	1.5	1.5
K02h01	75	100	100	100	1.0	1.5	1.5	1.5	1.5
K03h01	50	75	75	75	0.5	1.0	1.0	1.0	1.0
K04h01	50	50	50	50	0.5	1.0	1.0	1.0	1.0
K05h01	25	50	50	50	< 0.5	0.5	0.5	0.5	0.5
K06h01	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K07h01	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K08h01	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K10h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K10h02	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K11h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K12h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K12h02	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K13h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K32h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K33h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K34h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K35h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K36h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K37h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K38h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5

Table D.02 - Predictions and Impact Assessments for Houses within the Study Area

House Ref.	Predicted Total Subsidence after LW901 (mm)	Predicted Total Subsidence after LW902 (mm)	Predicted Total Subsidence after LW903 (mm)	Predicted Total Subsidence after LW904 (mm)	Predicted Total Tilt after LW901 (mm/m)	Predicted Total Tilt after LW902 (mm/m)	Predicted Total Tilt after LW903 (mm/m)	Predicted Total Tilt after LW904 (mm/m)	Maximum Predicted Tilt at the Completion of Any or All the Longwalls (mm/m)
K39h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K40h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K41h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K42h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K43h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K44h01	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K45h01	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K46h01	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K47h01	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K49h01	50	50	50	50	< 0.5	0.5	0.5	0.5	0.5
K50h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K50h02	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K50h03	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K50h04	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K50h05	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K50h06	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K50h07	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K51h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K52h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K52h02	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K53h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K54h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K55h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K56h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K57h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K58h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K66h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K67h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K68h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K69h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K70h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K71h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K72h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K73h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
K86h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
L01h01	300	325	325	325	2.0	2.5	2.5	2.5	2.5
L02h01	275	300	300	300	2.0	2.0	2.0	2.0	2.0
L05h01	250	275	275	275	2.0	2.0	2.0	2.0	2.0
L06h01	325	375	375	375	2.5	2.5	2.5	2.5	2.5
L07h01	300	350	350	350	2.0	2.5	2.5	2.5	2.5
L08h01	275	300	300	300	2.0	2.5	2.5	2.5	2.5
L09h01	225	250	250	250	2.0	2.0	2.0	2.0	2.0
L10h01	225	275	275	275	2.0	2.5	2.5	2.5	2.5
L12h01	150	175	175	175	1.5	2.0	2.0	2.0	2.0
L13h01	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5

Table D.02 - Predictions and Impact Assessments for Houses within the Study Area

House Ref.	Predicted Total Subsidence after LW901 (mm)	Predicted Total Subsidence after LW902 (mm)	Predicted Total Subsidence after LW903 (mm)	Predicted Total Subsidence after LW904 (mm)	Predicted Total Tilt after LW901 (mm/m)	Predicted Total Tilt after LW902 (mm/m)	Predicted Total Tilt after LW903 (mm/m)	Predicted Total Tilt after LW904 (mm/m)	Maximum Predicted Tilt at the Completion of Any or All the Longwalls (mm/m)
L14h01	100	100	100	100	0.5	0.5	0.5	0.5	0.5
L15h01	100	100	100	100	0.5	0.5	0.5	0.5	0.5
L16h01	150	175	175	175	1.0	1.0	1.0	1.0	1.0
L17h01	100	125	125	125	0.5	1.0	1.0	1.0	1.0
L18h01	125	125	125	125	1.0	1.0	1.0	1.0	1.0
L19h01	125	150	150	150	1.0	1.0	1.0	1.0	1.0
L20h01	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
L21h01	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
L21h02	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
L22h01	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
L23h01	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
L24h01	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
L25h01	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
L27h01	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
L28h01	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
L29h01	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
M01h01	550	625	650	650	2.5	3.0	3.0	3.0	3.0
M02h01	125	125	125	125	1.0	1.0	1.0	1.0	1.0
M03h01	325	350	350	350	2.5	3.0	3.0	3.0	3.0
M04h01	600	775	800	800	2.0	3.0	3.0	3.0	3.0
M05h01	375	425	425	425	2.5	3.0	3.0	3.0	3.0
M06h01	525	625	625	625	2.5	3.0	3.0	3.0	3.0
M07h01	150	175	175	175	1.5	1.5	1.5	1.5	1.5
M07h02	125	125	125	125	1.0	1.0	1.0	1.0	1.0
M08h01	100	125	125	125	1.0	1.0	1.0	1.0	1.0
M09h01	375	425	425	425	2.5	3.0	3.0	3.0	3.0
M10h01	250	275	275	275	2.0	2.0	2.0	2.0	2.0
M10h02	275	325	325	325	2.5	2.5	2.5	2.5	2.5
M11h01	75	100	100	100	0.5	0.5	0.5	0.5	0.5
M12h01	100	100	100	100	0.5	1.0	1.0	1.0	1.0
M12h02	75	100	100	100	0.5	0.5	0.5	0.5	0.5
M13h01	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
M13h02	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
M14h01	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
N01h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
N02h01	< 20	600	800	800	< 0.5	1.0	2.5	2.5	2.5
N04d01	50	425	800	900	< 0.5	5.0	3.0	2.5	5.0
N06h01	25	225	775	925	< 0.5	2.5	1.0	1.5	2.5
N11h01	< 20	< 20	150	850	< 0.5	< 0.5	1.5	1.5	1.5
N11h02	< 20	125	825	1050	< 0.5	1.0	< 0.5	1.0	1.0
N13h01	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
N14h01	< 20	< 20	25	350	< 0.5	< 0.5	< 0.5	4.0	4.0
N15h01	< 20	< 20	50	875	< 0.5	< 0.5	< 0.5	5.0	5.0
N16h01	< 20	< 20	25	825	< 0.5	< 0.5	< 0.5	5.5	5.5
N17h01	< 20	< 20	50	875	< 0.5	< 0.5	< 0.5	5.0	5.0

Table D.02 - Predictions and Impact Assessments for Houses within the Study Area

House Ref.	Predicted Total Subsidence after LW901 (mm)	Predicted Total Subsidence after LW902 (mm)	Predicted Total Subsidence after LW903 (mm)	Predicted Total Subsidence after LW904 (mm)	Predicted Total Tilt after LW901 (mm/m)	Predicted Total Tilt after LW902 (mm/m)	Predicted Total Tilt after LW903 (mm/m)	Predicted Total Tilt after LW904 (mm/m)	Maximum Predicted Tilt at the Completion of Any or All the Longwalls (mm/m)
N18h01	< 20	< 20	75	875	< 0.5	< 0.5	0.5	< 0.5	0.5
N20h01	< 20	75	850	1100	< 0.5	0.5	1.0	1.5	1.5
N21h01	< 20	100	325	350	< 0.5	1.5	2.0	2.5	2.5
N22h01	< 20	< 20	25	50	< 0.5	< 0.5	< 0.5	0.5	0.5
O01h01	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
O02h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
P01h01	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
P02h01	< 20	< 20	< 20	100	< 0.5	< 0.5	< 0.5	1.0	1.0
P04h01	< 20	< 20	< 20	125	< 0.5	< 0.5	< 0.5	1.0	1.0
P05h01	< 20	< 20	< 20	175	< 0.5	< 0.5	< 0.5	1.0	1.0
P06h01	< 20	< 20	< 20	125	< 0.5	< 0.5	< 0.5	0.5	0.5
P07h01	< 20	< 20	< 20	100	< 0.5	< 0.5	< 0.5	0.5	0.5
P08h01	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
P09h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
P10h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
P11h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
P12h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
P13h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
P14h01	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
P15h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
P16h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
P19h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
P20h01	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
P23h01	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
P25h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
P40h01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5

Table D.02 - Predictions and Impact Assessments for Houses within the Study Area

House Ref.	Predicted Total or Travelling Hogging Curvature after LW901 (1/km)	Predicted Total or Travelling Hogging Curvature after LW902 (1/km)	Predicted Total or Travelling Hogging Curvature after LW903 (1/km)	Predicted Total or Travelling Hogging Curvature after LW904 (1/km)	Predicted Total or Travelling Sagging Curvature after LW901 (1/km)	Predicted Total or Travelling Sagging Curvature after LW902 (1/km)	Predicted Total or Travelling Sagging Curvature after LW903 (1/km)	Predicted Total or Travelling Sagging Curvature after LW904 (1/km)	Predicted Probability of Nil or Category R0 Impact due to Proposed Longwalls (%)	Predicted Probability of Category R1 or R2 Impact due to Proposed Longwalls (%)	Predicted Probability of Category R3 or R4 Impact due to Proposed Longwalls (%)	Predicted Probability of Category R5 Impact due to Proposed Longwalls (%)
A29h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.8	4.2	1.0	< 0.1
A30h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.7	4.2	1.0	< 0.1
A32h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.7	4.3	1.0	< 0.1
D54h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.9	4.1	1.0	< 0.1
E01h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.9	4.1	1.0	< 0.1
E01h02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	95.0	4.0	1.0	< 0.1
E02h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.0	4.9	1.1	< 0.1
E03h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	92.2	6.4	1.3	< 0.1
E04h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	91.6	6.9	1.4	< 0.1
E05h01	< 0.01	< 0.01	0.03	0.03	< 0.01	< 0.01	0.02	0.02	84.9	12.0	3.1	< 0.2
E06h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	93.8	5.1	1.2	< 0.1
E07h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	93.7	5.1	1.2	< 0.1
E08h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	93.6	5.3	1.2	< 0.1
E09h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.2	4.8	1.0	< 0.1
E10h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.6	4.4	1.0	< 0.1
E11h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.8	4.1	1.0	< 0.1
E12h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.0	4.9	1.1	< 0.1
E12h02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.1	4.7	1.1	< 0.1
F01h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	93.8	5.2	1.0	< 0.1
F02h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	93.7	5.1	1.2	< 0.1
F03h01	< 0.01	< 0.01	< 0.01	0.04	< 0.01	< 0.01	< 0.01	< 0.01	81.8	13.4	4.8	< 0.3
F04h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.6	4.4	1.1	< 0.1
F05h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.7	4.3	1.0	< 0.1
H01h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.0	4.9	1.1	< 0.1
H01h02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.2	4.7	1.1	< 0.1
H01h03	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.5	4.4	1.1	< 0.1
H02h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.1	4.8	1.1	< 0.1
H03h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.8	4.2	1.0	< 0.1
H04h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.2	4.7	1.1	< 0.1
H05h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.2	4.7	1.1	< 0.1
H06h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.5	4.5	1.0	< 0.1
H07h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	93.6	5.3	1.2	< 0.1
H08h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	92.6	6.1	1.3	< 0.1
H09h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	93.3	5.5	1.2	< 0.1
H10h01	< 0.01	< 0.01	0.03	0.03	< 0.01	< 0.01	0.05	0.05	78.3	13.4	8.4	< 0.3
H11h01	< 0.01	< 0.01	0.05	0.05	< 0.01	< 0.01	0.01	0.01	86.7	10.9	2.4	< 0.4
H12h01	< 0.01	< 0.01	0.05	0.05	< 0.01	< 0.01	< 0.01	< 0.01	78.6	15.3	6.1	< 0.4
H13h01	< 0.01	< 0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	91.5	7.5	1.0	< 0.1
H14h01	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	89.9	8.5	1.6	< 0.1
H16h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.02	0.02	87.1	10.9	2.0	< 0.1
H17h01	< 0.01	< 0.01	0.03	0.03	< 0.01	< 0.01	< 0.01	< 0.01	84.2	11.7	4.1	< 0.2
H18h01	< 0.01	0.03	0.03	0.03	< 0.01	0.01	0.01	0.01	85.0	11.9	3.1	< 0.2
H19h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	93.0	5.7	1.2	< 0.1
H22h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	92.8	5.9	1.3	< 0.1
H23h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	92.5	6.2	1.3	< 0.1

Table D.02 - Predictions and Impact Assessments for Houses within the Study Area

House Ref.	Predicted Total or Travelling Hogging Curvature after LW901 (1/km)	Predicted Total or Travelling Hogging Curvature after LW902 (1/km)	Predicted Total or Travelling Hogging Curvature after LW903 (1/km)	Predicted Total or Travelling Hogging Curvature after LW904 (1/km)	Predicted Total or Travelling Sagging Curvature after LW901 (1/km)	Predicted Total or Travelling Sagging Curvature after LW902 (1/km)	Predicted Total or Travelling Sagging Curvature after LW903 (1/km)	Predicted Total or Travelling Sagging Curvature after LW904 (1/km)	Predicted Probability of Nil or Category R0 Impact due to Proposed Longwalls (%)	Predicted Probability of Category R1 or R2 Impact due to Proposed Longwalls (%)	Predicted Probability of Category R3 or R4 Impact due to Proposed Longwalls (%)	Predicted Probability of Category R5 Impact due to Proposed Longwalls (%)
H24h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	91.6	6.9	1.4	< 0.1
H25h01	< 0.01	< 0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	90.7	7.8	1.5	< 0.1
H26h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	93.7	5.2	1.2	< 0.1
H27h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	93.7	5.2	1.2	< 0.1
H28h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	93.7	5.1	1.2	< 0.1
H29h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.3	4.7	1.0	< 0.1
H30h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	93.7	5.1	1.2	< 0.1
H33h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.4	4.6	1.1	< 0.1
H34h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.6	4.4	1.0	< 0.1
H35h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.6	4.4	1.0	< 0.1
H36h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.3	4.6	1.1	< 0.1
H37h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.5	4.4	1.1	< 0.1
H38h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.5	4.4	1.1	< 0.1
H39h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.5	4.4	1.1	< 0.1
H40h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.5	4.4	1.1	< 0.1
H41h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.7	4.3	1.0	< 0.1
H42h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.6	4.4	1.0	< 0.1
H43h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.4	4.5	1.1	< 0.1
H44h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.5	4.4	1.1	< 0.1
J01h01	< 0.01	0.03	0.03	0.03	< 0.01	0.02	0.02	0.02	83.3	12.7	4.0	< 0.2
J02h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.02	0.02	0.02	86.4	11.3	2.3	< 0.1
J03h01	< 0.01	0.02	0.02	0.02	< 0.01	0.02	0.02	0.02	90.0	9.0	1.0	< 0.1
J04h01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	88.6	9.6	1.8	< 0.1
J05h01	0.01	0.02	0.02	0.02	< 0.01	0.01	0.01	0.01	87.9	10.2	1.9	< 0.1
J06h01	0.01	0.02	0.02	0.02	< 0.01	0.02	0.02	0.02	89.9	9.0	1.0	< 0.1
J07h01	0.01	0.02	0.02	0.02	< 0.01	0.02	0.02	0.02	86.6	11.1	2.3	< 0.1
J08h01	< 0.01	0.05	0.05	0.05	< 0.01	0.08	0.08	0.08	75.5	17.4	7.1	< 0.5
J09h01	< 0.01	0.02	0.02	0.02	< 0.01	0.10	0.10	0.10	73.2	16.3	10.5	< 0.5
J10h01	0.01	0.02	0.02	0.02	< 0.01	0.02	0.02	0.02	86.4	11.3	2.3	< 0.1
J11h01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	89.1	9.2	1.7	< 0.1
J13h01	0.01	0.02	0.02	0.02	< 0.01	0.01	0.01	0.01	88.2	9.9	1.8	< 0.1
J14h01	0.01	0.02	0.02	0.02	< 0.01	0.01	0.01	0.01	88.6	9.6	1.8	< 0.1
J15h01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	89.0	9.2	1.7	< 0.1
J16h01	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	83.9	11.8	4.4	< 0.2
J17h01	0.01	0.01	0.01	0.01	0.03	0.03	0.03	0.03	84.1	11.7	4.2	< 0.2
J18h01	< 0.01	< 0.01	< 0.01	< 0.01	0.02	0.02	0.02	0.02	89.5	9.3	1.2	< 0.1
J19h01	< 0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	85.9	11.5	2.6	< 0.1
J20h01	< 0.01	0.03	0.03	0.03	< 0.01	< 0.01	< 0.01	< 0.01	84.2	12.3	3.5	< 0.2
J21h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	91.0	7.5	1.5	< 0.1
J22h01	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	90.9	7.6	1.5	< 0.1
J23h01	< 0.01	< 0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	90.9	7.6	1.5	< 0.1
J24h01	< 0.01	< 0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	89.9	8.4	1.6	< 0.1
J25h01	< 0.01	< 0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	90.1	8.3	1.6	< 0.1
J26h01	< 0.01	0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01	88.6	9.6	1.8	< 0.1
J27h01	< 0.01	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01	88.2	10.0	1.9	< 0.1

Table D.02 - Predictions and Impact Assessments for Houses within the Study Area

House Ref.	Predicted Total or Travelling Hogging Curvature after LW901 (1/km)	Predicted Total or Travelling Hogging Curvature after LW902 (1/km)	Predicted Total or Travelling Hogging Curvature after LW903 (1/km)	Predicted Total or Travelling Hogging Curvature after LW904 (1/km)	Predicted Total or Travelling Sagging Curvature after LW901 (1/km)	Predicted Total or Travelling Sagging Curvature after LW902 (1/km)	Predicted Total or Travelling Sagging Curvature after LW903 (1/km)	Predicted Total or Travelling Sagging Curvature after LW904 (1/km)	Predicted Probability of Nil or Category R0 Impact due to Proposed Longwalls (%)	Predicted Probability of Category R1 or R2 Impact due to Proposed Longwalls (%)	Predicted Probability of Category R3 or R4 Impact due to Proposed Longwalls (%)	Predicted Probability of Category R5 Impact due to Proposed Longwalls (%)
J28h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	91.3	7.2	1.5	< 0.1
J29h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	91.5	7.1	1.4	< 0.1
J30h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	91.4	7.1	1.4	< 0.1
J31h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	91.7	6.9	1.4	< 0.1
J32h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	91.6	6.9	1.4	< 0.1
J44h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	93.9	5.1	1.0	< 0.1
J47h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.2	4.8	1.0	< 0.1
J49h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.0	5.0	1.0	< 0.1
J50h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	93.9	4.9	1.1	< 0.1
J51h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.2	4.8	1.0	< 0.1
J52h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.1	4.9	1.0	< 0.1
J53h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	93.7	5.2	1.2	< 0.1
J54h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.4	4.6	1.0	< 0.1
J55h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.4	4.5	1.1	< 0.1
J56h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.6	4.4	1.1	< 0.1
J57h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.8	4.2	1.0	< 0.1
J57h02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.8	4.2	1.0	< 0.1
J59h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.8	4.2	1.0	< 0.1
J60h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.8	4.2	1.0	< 0.1
J61h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.8	4.2	1.0	< 0.1
J64h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.6	4.3	1.0	< 0.1
J67h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.1	4.8	1.1	< 0.1
J68h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	93.9	5.0	1.1	< 0.1
J69h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.2	4.8	1.0	< 0.1
K01h01	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	89.4	8.9	1.7	< 0.1
K02h01	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	89.2	9.1	1.7	< 0.1
K03h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	91.1	7.4	1.5	< 0.1
K04h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	91.9	6.7	1.4	< 0.1
K05h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	92.6	6.1	1.3	< 0.1
K06h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	93.1	5.7	1.2	< 0.1
K07h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	93.4	5.4	1.2	< 0.1
K08h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	93.5	5.3	1.2	< 0.1
K10h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.0	4.9	1.1	< 0.1
K10h02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.5	4.5	1.0	< 0.1
K11h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.3	4.6	1.1	< 0.1
K12h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.4	4.5	1.1	< 0.1
K12h02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.8	4.2	1.0	< 0.1
K13h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.6	4.4	1.1	< 0.1
K32h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.9	4.1	1.0	< 0.1
K33h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.9	4.1	1.0	< 0.1
K34h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.9	4.1	1.0	< 0.1
K35h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.9	4.1	1.0	< 0.1
K36h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.8	4.2	1.0	< 0.1
K37h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.8	4.2	1.0	< 0.1
K38h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.7	4.2	1.0	< 0.1

Table D.02 - Predictions and Impact Assessments for Houses within the Study Area

House Ref.	Predicted Total or Travelling Hogging Curvature after LW901 (1/km)	Predicted Total or Travelling Hogging Curvature after LW902 (1/km)	Predicted Total or Travelling Hogging Curvature after LW903 (1/km)	Predicted Total or Travelling Hogging Curvature after LW904 (1/km)	Predicted Total or Travelling Sagging Curvature after LW901 (1/km)	Predicted Total or Travelling Sagging Curvature after LW902 (1/km)	Predicted Total or Travelling Sagging Curvature after LW903 (1/km)	Predicted Total or Travelling Sagging Curvature after LW904 (1/km)	Predicted Probability of Nil or Category R0 Impact due to Proposed Longwalls (%)	Predicted Probability of Category R1 or R2 Impact due to Proposed Longwalls (%)	Predicted Probability of Category R3 or R4 Impact due to Proposed Longwalls (%)	Predicted Probability of Category R5 Impact due to Proposed Longwalls (%)
K39h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.6	4.4	1.1	< 0.1
K40h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.6	4.3	1.0	< 0.1
K41h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.5	4.4	1.1	< 0.1
K42h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.5	4.5	1.1	< 0.1
K43h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.4	4.5	1.1	< 0.1
K44h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.5	4.5	1.0	< 0.1
K45h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.0	4.9	1.1	< 0.1
K46h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.0	4.9	1.1	< 0.1
K47h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.3	4.7	1.0	< 0.1
K49h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	92.5	6.2	1.3	< 0.1
K50h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.4	4.5	1.1	< 0.1
K50h02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.5	4.4	1.1	< 0.1
K50h03	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.5	4.4	1.1	< 0.1
K50h04	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.6	4.3	1.0	< 0.1
K50h05	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.7	4.3	1.0	< 0.1
K50h06	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.6	4.3	1.0	< 0.1
K50h07	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.5	4.4	1.1	< 0.1
K51h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.6	4.3	1.0	< 0.1
K52h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.7	4.3	1.0	< 0.1
K52h02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.8	4.2	1.0	< 0.1
K53h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.8	4.2	1.0	< 0.1
K54h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.9	4.1	1.0	< 0.1
K55h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.8	4.2	1.0	< 0.1
K56h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.9	4.1	1.0	< 0.1
K57h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.8	4.1	1.0	< 0.1
K58h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.9	4.1	1.0	< 0.1
K66h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.9	4.1	1.0	< 0.1
K67h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.9	4.1	1.0	< 0.1
K68h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.9	4.1	1.0	< 0.1
K69h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.9	4.1	1.0	< 0.1
K70h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.9	4.1	1.0	< 0.1
K71h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.9	4.1	1.0	< 0.1
K72h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.8	4.2	1.0	< 0.1
K73h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.8	4.2	1.0	< 0.1
K86h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.9	4.1	1.0	< 0.1
L01h01	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	89.0	9.2	1.7	< 0.1
L02h01	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	89.2	9.1	1.7	< 0.1
L05h01	0.01	0.01	0.01	0.02	< 0.01	< 0.01	< 0.01	< 0.01	88.9	9.3	1.8	< 0.1
L06h01	0.01	0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01	88.8	9.5	1.8	< 0.1
L07h01	0.01	0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01	88.8	9.5	1.8	< 0.1
L08h01	0.01	0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01	88.8	9.4	1.8	< 0.1
L09h01	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	91.3	7.7	1.0	< 0.1
L10h01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	89.6	8.8	1.7	< 0.1
L12h01	< 0.01	< 0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	90.6	7.9	1.6	< 0.1
L13h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	93.8	5.0	1.1	< 0.1

Table D.02 - Predictions and Impact Assessments for Houses within the Study Area

House Ref.	Predicted Total or Travelling Hogging Curvature after LW901 (1/km)	Predicted Total or Travelling Hogging Curvature after LW902 (1/km)	Predicted Total or Travelling Hogging Curvature after LW903 (1/km)	Predicted Total or Travelling Hogging Curvature after LW904 (1/km)	Predicted Total or Travelling Sagging Curvature after LW901 (1/km)	Predicted Total or Travelling Sagging Curvature after LW902 (1/km)	Predicted Total or Travelling Sagging Curvature after LW903 (1/km)	Predicted Total or Travelling Sagging Curvature after LW904 (1/km)	Predicted Probability of Nil or Category R0 Impact due to Proposed Longwalls (%)	Predicted Probability of Category R1 or R2 Impact due to Proposed Longwalls (%)	Predicted Probability of Category R3 or R4 Impact due to Proposed Longwalls (%)	Predicted Probability of Category R5 Impact due to Proposed Longwalls (%)
L14h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	92.6	6.1	1.3	< 0.1
L15h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	93.5	5.5	1.0	< 0.1
L16h01	< 0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	90.9	7.6	1.5	< 0.1
L17h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	92.3	6.4	1.3	< 0.1
L18h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	93.1	5.9	1.0	< 0.1
L19h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	91.6	6.9	1.4	< 0.1
L20h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.5	4.5	1.1	< 0.1
L21h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.1	4.7	1.1	< 0.1
L21h02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.3	4.6	1.1	< 0.1
L22h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.3	4.6	1.1	< 0.1
L23h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.5	4.5	1.0	< 0.1
L24h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.4	4.5	1.1	< 0.1
L25h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.7	4.3	1.0	< 0.1
L27h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.6	4.4	1.1	< 0.1
L28h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.6	4.4	1.1	< 0.1
L29h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.6	4.4	1.1	< 0.1
M01h01	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	83.5	11.9	4.6	< 0.2
M02h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	91.5	7.0	1.4	< 0.1
M03h01	0.02	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01	87.9	10.2	1.9	< 0.1
M04h01	0.02	0.02	0.02	0.02	0.04	0.04	0.04	0.04	88.3	10.0	1.7	< 0.2
M05h01	0.01	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01	88.2	9.9	1.8	< 0.1
M06h01	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	83.2	12.0	4.9	< 0.2
M07h01	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	89.7	8.6	1.7	< 0.1
M07h02	< 0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	90.7	7.7	1.5	< 0.1
M08h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	92.0	6.6	1.4	< 0.1
M09h01	0.02	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01	87.7	10.4	1.9	< 0.1
M10h01	0.02	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01	87.8	10.3	1.9	< 0.1
M10h02	0.02	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01	87.6	10.5	1.9	< 0.1
M11h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	92.8	5.9	1.3	< 0.1
M12h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	92.2	6.4	1.3	< 0.1
M12h02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	92.7	6.0	1.3	< 0.1
M13h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.7	4.3	1.0	< 0.1
M13h02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.6	4.4	1.0	< 0.1
M14h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.7	4.3	1.0	< 0.1
N01h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.5	4.4	1.1	< 0.1
N02h01	< 0.01	0.02	0.02	0.02	< 0.01	0.04	0.04	0.04	88.3	10.0	1.7	< 0.2
N04d01	< 0.01	0.06	0.07	0.07	< 0.01	< 0.01	0.01	0.01	84.4	12.0	3.5	< 0.5
N06h01	< 0.01	0.03	0.03	0.03	< 0.01	< 0.01	0.01	0.01	83.0	12.8	4.1	< 0.2
N11h01	< 0.01	< 0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	0.02	86.5	11.2	2.3	< 0.1
N11h02	< 0.01	0.01	0.02	0.02	< 0.01	< 0.01	0.01	0.01	88.0	10.1	1.9	< 0.1
N13h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.1	4.8	1.1	< 0.1
N14h01	< 0.01	< 0.01	< 0.01	0.05	< 0.01	< 0.01	< 0.01	< 0.01	77.9	13.6	8.6	< 0.4
N15h01	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.09	75.0	17.8	7.2	< 0.5
N16h01	< 0.01	< 0.01	< 0.01	0.03	< 0.01	< 0.01	< 0.01	0.09	75.0	17.8	7.2	< 0.5
N17h01	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.09	75.1	17.7	7.2	< 0.5

Table D.02 - Predictions and Impact Assessments for Houses within the Study Area

House Ref.	Predicted Total or Travelling Hogging Curvature after LW901 (1/km)	Predicted Total or Travelling Hogging Curvature after LW902 (1/km)	Predicted Total or Travelling Hogging Curvature after LW903 (1/km)	Predicted Total or Travelling Hogging Curvature after LW904 (1/km)	Predicted Total or Travelling Sagging Curvature after LW901 (1/km)	Predicted Total or Travelling Sagging Curvature after LW902 (1/km)	Predicted Total or Travelling Sagging Curvature after LW903 (1/km)	Predicted Total or Travelling Sagging Curvature after LW904 (1/km)	Predicted Probability of Nil or Category R0 Impact due to Proposed Longwalls (%)	Predicted Probability of Category R1 or R2 Impact due to Proposed Longwalls (%)	Predicted Probability of Category R3 or R4 Impact due to Proposed Longwalls (%)	Predicted Probability of Category R5 Impact due to Proposed Longwalls (%)
N18h01	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.02	86.9	11.0	2.1	< 0.1
N20h01	< 0.01	< 0.01	0.02	0.02	< 0.01	< 0.01	0.08	0.08	75.4	17.5	7.1	< 0.5
N21h01	< 0.01	0.02	0.03	0.03	< 0.01	< 0.01	< 0.01	< 0.01	88.6	9.8	1.5	< 0.2
N22h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	92.8	6.0	1.3	< 0.1
O01h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.7	4.3	1.0	< 0.1
O02h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.9	4.1	1.0	< 0.1
P01h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.5	4.5	1.1	< 0.1
P02h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	92.6	6.1	1.3	< 0.1
P04h01	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	< 0.01	86.9	11.1	2.1	< 0.1
P05h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	91.0	7.5	1.5	< 0.1
P06h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	92.7	6.0	1.3	< 0.1
P07h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	93.3	5.5	1.2	< 0.1
P08h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	93.4	5.4	1.2	< 0.1
P09h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.7	4.3	1.0	< 0.1
P10h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.4	4.5	1.1	< 0.1
P11h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	95.0	4.0	1.0	< 0.1
P12h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	95.0	4.0	1.0	< 0.1
P13h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.8	4.2	1.0	< 0.1
P14h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.2	4.7	1.1	< 0.1
P15h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.8	4.1	1.0	< 0.1
P16h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.8	4.1	1.0	< 0.1
P19h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.5	4.5	1.1	< 0.1
P20h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.3	4.6	1.1	< 0.1
P23h01	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	90.9	7.6	1.5	< 0.1
P25h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	95.0	4.0	1.0	< 0.1
P40h01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	94.8	4.2	1.0	< 0.1

Table D.03 - Predictions for the Rural Building Structures within the Study Area

Structure Ref.	Maximum Length (m)	Predicted Total Subsidence after LW901 (mm)	Predicted Total Subsidence after LW902 (mm)	Predicted Total Subsidence after LW903 (mm)	Predicted Total Subsidence after LW904 (mm)	Predicted Total Tilt after LW901 (mm/m)	Predicted Total Tilt after LW902 (mm/m)	Predicted Total Tilt after LW903 (mm/m)	Predicted Total Tilt after LW904 (mm/m)	Predicted Total or Travelling Hogging Curvature after LW901 (1/km)	Predicted Total or Travelling Hogging Curvature after LW902 (1/km)	Predicted Total or Travelling Hogging Curvature after LW903 (1/km)	Predicted Total or Travelling Hogging Curvature after LW904 (1/km)	Predicted Total or Travelling Sagging Curvature after LW901 (1/km)	Predicted Total or Travelling Sagging Curvature after LW902 (1/km)	Predicted Total or Travelling Sagging Curvature after LW903 (1/km)	Predicted Total or Travelling Sagging Curvature after LW904 (1/km)
A29r01	17.83	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A29r02	9.71	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A29r03	3.17	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A29r04	4.95	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A29r05	14.56	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A30r01	6.92	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A30r02	17.82	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A30r05	4.24	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A32r01	12.58	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
D54r01	13.75	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
D54r02	11.3	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
D54r03	11.49	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
D54r04	10.67	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
D54r05	3.07	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E01r02	4.51	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E01r03	3.03	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E01r04	2.7	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E02r01	12.83	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E02r02	6.13	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E03r01	7.44	< 20	< 20	50	50	< 0.5	< 0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E03r02	9.94	< 20	< 20	50	75	< 0.5	< 0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E03r03	7.4	< 20	< 20	75	75	< 0.5	< 0.5	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E03r04	3.46	< 20	< 20	50	50	< 0.5	< 0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E04r01	9.4	< 20	< 20	50	75	< 0.5	< 0.5	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E04r02	4.45	< 20	< 20	50	50	< 0.5	< 0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E05r01	12.29	< 20	< 20	200	225	< 0.5	< 0.5	3.0	3.0	< 0.01	< 0.01	0.03	0.03	< 0.01	< 0.01	0.02	0.02
E05r02	12.29	< 20	< 20	200	225	< 0.5	< 0.5	2.5	3.0	< 0.01	< 0.01	0.03	0.03	< 0.01	< 0.01	0.02	0.02
E06r01	10.06	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E06r02	16.94	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E06r03	5.28	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E06r04	3.73	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E06r05	4.08	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E07r01	14.41	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E08r01	14.88	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E08r02	6.29	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E08r03	10.53	< 20	< 20	25	50	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E09r01	10.31	< 20	< 20	50	75	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E10r01	9.52	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E10r02	4.81	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E10r03	14.26	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E10r04	4.03	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E10r05	2.45	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E10r06	3.68	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E11r01	11.2	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E11r02	9.35	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E11r03	5.43	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E11r04	5.64	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E11r05	1.87	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E11r06	2.26	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E11r07	1.75	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E12r01	8.27	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E12r02	3.32	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E12r03	6.21	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E12r04	8.18	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E12r06	6.33	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E12r07	3.45	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
F01r01	13.36	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
F02r01	3.33	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

Table D.03 - Predictions for the Rural Building Structures within the Study Area

Structure Ref.	Maximum Length (m)	Predicted Total Subsidence after LW901 (mm)	Predicted Total Subsidence after LW902 (mm)	Predicted Total Subsidence after LW903 (mm)	Predicted Total Subsidence after LW904 (mm)	Predicted Total Tilt after LW901 (mm/m)	Predicted Total Tilt after LW902 (mm/m)	Predicted Total Tilt after LW903 (mm/m)	Predicted Total Tilt after LW904 (mm/m)	Predicted Total or Travelling Hogging Curvature after LW901 (1/km)	Predicted Total or Travelling Hogging Curvature after LW902 (1/km)	Predicted Total or Travelling Hogging Curvature after LW903 (1/km)	Predicted Total or Travelling Hogging Curvature after LW904 (1/km)	Predicted Total or Travelling Sagging Curvature after LW901 (1/km)	Predicted Total or Travelling Sagging Curvature after LW902 (1/km)	Predicted Total or Travelling Sagging Curvature after LW903 (1/km)	Predicted Total or Travelling Sagging Curvature after LW904 (1/km)
F02r02	16.51	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
F02r03	2.88	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
F03r01	9.08	< 20	< 20	< 20	175	< 0.5	< 0.5	< 0.5	2.0	< 0.01	< 0.01	< 0.01	0.03	< 0.01	< 0.01	< 0.01	< 0.01
F03r02	13.98	< 20	< 20	< 20	175	< 0.5	< 0.5	< 0.5	2.0	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	< 0.01
F03r03	17.58	< 20	< 20	< 20	175	< 0.5	< 0.5	< 0.5	1.5	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	< 0.01
F03r04	5.93	< 20	< 20	< 20	275	< 0.5	< 0.5	< 0.5	3.0	< 0.01	< 0.01	< 0.01	0.04	< 0.01	< 0.01	< 0.01	< 0.01
F03r05	4.8	< 20	< 20	< 20	225	< 0.5	< 0.5	< 0.5	2.5	< 0.01	< 0.01	< 0.01	0.04	< 0.01	< 0.01	< 0.01	< 0.01
F03r06	2.77	< 20	< 20	< 20	400	< 0.5	< 0.5	< 0.5	5.0	< 0.01	< 0.01	< 0.01	0.05	< 0.01	< 0.01	< 0.01	0.01
F04r01	12.39	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
F04r02	3.01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
F05r01	9.1	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
F05r02	12.58	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
F05r03	18.28	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
F05r04	5.8	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
F15r01	3.58	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H01r01	23.39	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H01r02	6.05	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H01r03	3.15	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H01r04	4.23	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H01r05	4.34	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H02r01	9.1	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H03r01	7.24	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H03r02	16.4	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H03r03	4.7	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H04r01	8.59	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H04r02	3.6	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H04r03	7.01	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H04r04	6.27	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H04r05	2.84	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H06r01	10.23	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H06r02	2.33	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H07r01	8.06	< 20	< 20	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H08r01	4.69	< 20	< 20	75	75	< 0.5	< 0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H08r02	4.8	< 20	< 20	75	75	< 0.5	< 0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H08r03	5.37	< 20	< 20	100	125	< 0.5	< 0.5	1.0	1.0	< 0.01	< 0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
H09r01	6.9	< 20	< 20	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H09r02	2.51	< 20	< 20	50	75	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H09r03	1.72	< 20	< 20	75	75	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H10r01	3.11	< 20	< 20	250	275	< 0.5	< 0.5	3.0	3.0	< 0.01	< 0.01	0.03	0.03	< 0.01	< 0.01	0.02	0.03
H10r02	2.63	< 20	25	650	675	< 0.5	< 0.5	3.0	3.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.02	0.02
H11r01	5.8	< 20	< 20	350	425	< 0.5	< 0.5	4.5	4.5	< 0.01	< 0.01	0.05	0.05	< 0.01	< 0.01	< 0.01	< 0.01
H11r02	12.57	< 20	< 20	350	425	< 0.5	< 0.5	4.5	4.5	< 0.01	< 0.01	0.05	0.05	< 0.01	< 0.01	< 0.01	< 0.01
H12r01	10.33	< 20	< 20	200	250	< 0.5	< 0.5	2.5	2.5	< 0.01	< 0.01	0.03	0.03	< 0.01	< 0.01	< 0.01	< 0.01
H12r02	5.77	< 20	< 20	375	525	< 0.5	< 0.5	4.5	4.5	< 0.01	< 0.01	0.05	0.05	< 0.01	< 0.01	< 0.01	< 0.01
H12r03	1.91	< 20	25	450	600	< 0.5	< 0.5	5.5	5.0	< 0.01	< 0.01	0.05	0.05	< 0.01	< 0.01	< 0.01	< 0.01
H13r01	4.55	< 20	< 20	125	200	< 0.5	< 0.5	1.0	1.5	< 0.01	< 0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
H13r02	12.26	< 20	< 20	100	300	< 0.5	< 0.5	1.0	2.5	< 0.01	< 0.01	< 0.01	0.03	< 0.01	< 0.01	< 0.01	< 0.01
H13r03	2.8	< 20	< 20	100	275	< 0.5	< 0.5	1.0	2.5	< 0.01	< 0.01	< 0.01	0.03	< 0.01	< 0.01	< 0.01	< 0.01
H13r04	8.06	< 20	< 20	100	125	< 0.5	< 0.5	1.0	1.0	< 0.01	< 0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
H13r05	4.07	< 20	< 20	100	150	< 0.5	< 0.5	1.0	1.0	< 0.01	< 0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
H13r06	2.97	< 20	< 20	125	200	< 0.5	< 0.5	1.0	1.5	< 0.01	< 0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
H14r01	6.88	< 20	< 20	50	200	< 0.5	< 0.5	< 0.5	1.5	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	< 0.01
H14r02	23.95	< 20	< 20	25	175	< 0.5	< 0.5	< 0.5	1.5	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.01
H16r01	7.86	< 20	75	750	800	< 0.5	1.0	2.0	2.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.02	0.02
H16r02	7.87	< 20	50	775	850	< 0.5	< 0.5	2.0	2.5	< 0.01	< 0.01	0.01	0.01	< 0.01	< 0.01	0.09	0.09
H16r03	7.49	< 20	50	675	725	< 0.5	0.5	3.0	3.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.02	0.02
H16r04	6.36	< 20	75	700	750	< 0.5	1.0	2.0	2.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.02	0.02
H16r05	5.05	< 20	100	750	800	< 0.5	1.0	1.5	2.0	< 0.01	0.01	0.01	0.01	< 0.01	< 0.01	0.02	0.02

Table D.03 - Predictions for the Rural Building Structures within the Study Area

Structure Ref.	Maximum Length (m)	Predicted Total Subsidence after LW901 (mm)	Predicted Total Subsidence after LW902 (mm)	Predicted Total Subsidence after LW903 (mm)	Predicted Total Subsidence after LW904 (mm)	Predicted Total Tilt after LW901 (mm/m)	Predicted Total Tilt after LW902 (mm/m)	Predicted Total Tilt after LW903 (mm/m)	Predicted Total Tilt after LW904 (mm/m)	Predicted Total or Travelling Hogging Curvature after LW901 (1/km)	Predicted Total or Travelling Hogging Curvature after LW902 (1/km)	Predicted Total or Travelling Hogging Curvature after LW903 (1/km)	Predicted Total or Travelling Hogging Curvature after LW904 (1/km)	Predicted Total or Travelling Sagging Curvature after LW901 (1/km)	Predicted Total or Travelling Sagging Curvature after LW902 (1/km)	Predicted Total or Travelling Sagging Curvature after LW903 (1/km)	Predicted Total or Travelling Sagging Curvature after LW904 (1/km)
H16r06	11.81	< 20	100	750	800	< 0.5	1.0	1.5	2.0	< 0.01	0.01	0.01	0.01	< 0.01	< 0.01	0.02	0.02
H16r07	6.49	< 20	100	800	850	< 0.5	1.0	1.0	1.5	< 0.01	< 0.01	0.01	0.01	< 0.01	< 0.01	0.02	0.02
H16r08	4.28	< 20	50	775	850	< 0.5	0.5	1.5	1.5	< 0.01	< 0.01	0.01	0.01	< 0.01	< 0.01	0.02	0.02
H17r01	11.87	< 20	< 20	175	200	< 0.5	< 0.5	2.0	2.0	< 0.01	< 0.01	0.03	0.03	< 0.01	< 0.01	< 0.01	< 0.01
H17r02	1.88	< 20	< 20	225	225	< 0.5	< 0.5	2.5	2.5	< 0.01	< 0.01	0.03	0.03	< 0.01	< 0.01	< 0.01	< 0.01
H18r01	10.09	< 20	125	350	375	< 0.5	2.0	3.0	3.0	< 0.01	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
H18r02	5.15	< 20	125	375	375	< 0.5	2.0	3.0	3.5	< 0.01	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
H18r03	3.6	< 20	125	375	400	< 0.5	2.0	3.0	3.5	< 0.01	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
H18r04	2.48	< 20	175	350	375	< 0.5	2.5	3.5	3.5	< 0.01	0.03	0.03	0.03	< 0.01	0.01	0.01	0.01
H22r01	10.34	< 20	50	75	100	< 0.5	< 0.5	0.5	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H23r01	6.73	< 20	50	75	75	< 0.5	< 0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H23r02	5.17	< 20	50	100	100	< 0.5	< 0.5	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H23r03	12.47	< 20	50	100	100	< 0.5	< 0.5	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H23r04	15.54	< 20	75	100	125	< 0.5	0.5	1.0	1.0	< 0.01	< 0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
H24r01	11.46	< 20	75	125	125	< 0.5	0.5	1.0	1.0	< 0.01	< 0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
H24r02	5.77	< 20	100	125	150	< 0.5	0.5	1.5	1.5	< 0.01	< 0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
H24r03	3.38	< 20	100	150	150	< 0.5	1.0	1.5	1.5	< 0.01	< 0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
H24r04	5.58	< 20	75	125	150	< 0.5	0.5	1.5	1.5	< 0.01	< 0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
H24r05	4.77	< 20	75	125	125	< 0.5	0.5	1.0	1.5	< 0.01	< 0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
H25r01	17.17	< 20	100	125	150	< 0.5	1.0	1.5	1.5	< 0.01	< 0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
H25r02	2.89	< 20	75	125	125	< 0.5	0.5	1.0	1.0	< 0.01	< 0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
H25r03	3.06	< 20	75	125	125	< 0.5	0.5	1.5	1.5	< 0.01	< 0.01	0.01	0.02	< 0.01	< 0.01	< 0.01	< 0.01
H25r04	2.38	< 20	75	125	125	< 0.5	0.5	1.5	1.5	< 0.01	< 0.01	0.01	0.02	< 0.01	< 0.01	< 0.01	< 0.01
H26r01	12.38	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H26r02	4.13	< 20	25	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H27r01	17.34	< 20	25	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H27r02	2.56	< 20	25	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H27r03	2.43	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H28r01	2.95	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H28r02	2.78	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H29r01	6.05	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H29r02	1.92	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H30r01	6.52	< 20	25	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H33r01	11.21	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H33r02	10.45	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H34r01	9.36	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H35r01	10.97	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H35r02	8.98	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H35r03	7.02	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H35r04	6.97	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H36r01	9.7	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H36r02	4.6	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H36r03	7.86	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H36r04	2.8	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H37r01	9.98	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H37r02	5.18	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H38r01	8.76	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H38r02	5.88	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H38r03	4.02	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H39r01	4.71	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H39r02	7.62	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H39r03	3.26	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H41r01	9.13	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H41r02	3.54	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H41r03	3.21	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H42r01	11.01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H43r01	5.54	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H43r02	11	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

Table D.03 - Predictions for the Rural Building Structures within the Study Area

Structure Ref.	Maximum Length (m)	Predicted Total Subsidence after LW901 (mm)	Predicted Total Subsidence after LW902 (mm)	Predicted Total Subsidence after LW903 (mm)	Predicted Total Subsidence after LW904 (mm)	Predicted Total Tilt after LW901 (mm/m)	Predicted Total Tilt after LW902 (mm/m)	Predicted Total Tilt after LW903 (mm/m)	Predicted Total Tilt after LW904 (mm/m)	Predicted Total or Travelling Hogging Curvature after LW901 (1/km)	Predicted Total or Travelling Hogging Curvature after LW902 (1/km)	Predicted Total or Travelling Hogging Curvature after LW903 (1/km)	Predicted Total or Travelling Hogging Curvature after LW904 (1/km)	Predicted Total or Travelling Sagging Curvature after LW901 (1/km)	Predicted Total or Travelling Sagging Curvature after LW902 (1/km)	Predicted Total or Travelling Sagging Curvature after LW903 (1/km)	Predicted Total or Travelling Sagging Curvature after LW904 (1/km)
H43r03	3.86	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H44r01	11.59	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H44r02	12.29	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H44r03	2.5	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J01r01	2.97	< 20	150	275	275	< 0.5	1.5	3.0	3.0	< 0.01	0.02	0.03	0.03	< 0.01	0.02	0.02	0.02
J02r01	4.98	100	700	850	875	1.0	2.5	3.0	3.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.02	0.02	0.02
J02r02	5.58	100	700	850	875	1.0	2.5	3.0	3.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.02	0.02	0.02
J02r03	2.84	100	700	850	850	1.0	2.5	3.0	3.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.02	0.02	0.02
J02r04	2.08	75	650	800	800	1.0	3.0	3.5	3.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.02	0.02	0.02
J02r05	2.47	125	775	925	950	1.0	1.5	2.0	2.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.02	0.02	0.02
J02r06	2.76	125	750	900	925	1.0	2.0	2.5	2.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.02	0.02	0.02
J02r07	1.72	150	750	900	925	1.5	1.5	2.0	2.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.02	0.02	0.02
J02r08	1.72	150	750	875	900	1.5	2.0	2.0	2.5	0.01	0.01	0.01	0.01	< 0.01	0.02	0.02	0.02
J02r09	2.67	175	725	850	850	1.5	2.0	2.5	2.5	0.01	0.01	0.01	0.01	< 0.01	0.02	0.02	0.02
J02r10	1.37	175	700	825	825	1.5	2.0	2.5	2.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.02	0.02	0.02
J02r11	3.21	50	700	975	1000	< 0.5	5.5	3.0	3.0	< 0.01	0.01	0.01	0.01	< 0.01	0.09	0.09	0.09
J03r01	2.96	150	825	1000	1025	1.0	0.5	1.0	1.5	< 0.01	0.02	0.02	0.02	< 0.01	0.02	0.02	0.02
J03r02	4.74	100	825	1025	1075	0.5	1.5	1.0	1.5	< 0.01	0.02	0.02	0.02	< 0.01	0.08	0.08	0.08
J03r03	5.98	75	800	1025	1075	< 0.5	5.0	3.0	3.0	< 0.01	0.02	0.02	0.02	< 0.01	0.10	0.10	0.10
J04r01	8.61	325	800	900	925	2.5	< 0.5	1.0	1.0	0.01	0.01	0.01	0.01	< 0.01	0.01	0.01	0.01
J04r02	13.3	250	825	950	975	2.0	0.5	1.0	1.5	0.01	0.02	0.02	0.02	< 0.01	0.02	0.02	0.02
J04r03	11.33	150	850	1025	1075	1.0	0.5	1.0	1.5	0.01	0.02	0.02	0.02	< 0.01	0.02	0.02	0.02
J05r01	9.13	225	850	1000	1025	1.5	0.5	1.0	1.5	0.01	0.02	0.02	0.02	< 0.01	0.02	0.02	0.02
J05r02	3.66	175	850	1000	1050	1.5	0.5	1.0	1.5	0.01	0.02	0.02	0.02	< 0.01	0.02	0.02	0.02
J06r01	14.48	175	875	1050	1100	1.5	0.5	1.5	1.5	0.01	0.02	0.02	0.02	< 0.01	0.02	0.02	0.02
J06r02	6.19	175	850	1025	1075	1.5	0.5	1.5	1.5	0.01	0.02	0.02	0.02	< 0.01	0.02	0.02	0.02
J06r03	5.56	125	875	1075	1125	1.0	< 0.5	1.0	1.0	< 0.01	0.02	0.02	0.02	< 0.01	0.03	0.03	0.03
J06r04	2.94	200	850	1000	1050	1.5	0.5	1.5	1.5	0.01	0.02	0.02	0.02	< 0.01	0.01	0.01	0.01
J07r01	11.73	150	875	1075	1125	1.0	0.5	1.5	1.5	< 0.01	0.02	0.02	0.02	< 0.01	0.02	0.02	0.02
J07r02	8	125	875	1075	1150	1.0	0.5	1.0	1.0	< 0.01	0.02	0.02	0.02	< 0.01	0.04	0.04	0.04
J08r01	6.65	50	450	875	1000	< 0.5	5.0	2.5	2.0	< 0.01	0.05	0.05	0.05	< 0.01	< 0.01	< 0.01	< 0.01
J10r01	11.01	200	875	1025	1075	1.5	0.5	1.5	1.5	0.01	0.02	0.02	0.02	< 0.01	0.02	0.02	0.02
J10r02	6.57	100	900	1100	1175	0.5	2.0	1.0	1.0	< 0.01	0.02	0.02	0.02	< 0.01	0.09	0.09	0.09
J10r03	3.75	225	850	1000	1050	1.5	0.5	1.5	1.5	0.01	0.02	0.02	0.02	< 0.01	0.01	0.01	0.01
J10r04	2.39	250	850	975	1025	2.0	0.5	1.5	1.5	0.01	0.02	0.02	0.02	< 0.01	0.01	0.01	0.01
J11r01	20.64	325	825	950	975	2.0	0.5	1.5	1.5	0.01	0.02	0.02	0.02	< 0.01	0.01	0.01	0.01
J11r02	12.59	225	850	1000	1050	1.5	0.5	1.5	1.5	0.01	0.02	0.02	0.02	< 0.01	0.01	0.01	0.01
J11r03	10.59	225	850	1000	1050	1.5	0.5	1.5	1.5	0.01	0.02	0.02	0.02	< 0.01	0.01	0.01	0.01
J11r04	5.72	350	825	925	950	2.5	< 0.5	1.0	1.5	0.01	0.02	0.02	0.02	< 0.01	0.01	0.01	0.01
J13r01	11.51	550	725	750	775	1.0	2.0	2.5	2.5	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03
J13r02	5.49	550	725	750	750	1.0	2.0	2.5	2.5	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03
J13r03	3.15	425	800	875	900	2.5	< 0.5	1.0	1.0	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
J14r01	13.62	325	825	950	975	2.0	0.5	1.0	1.5	0.01	0.02	0.02	0.02	< 0.01	0.01	0.01	0.01
J14r02	7.92	400	800	900	925	2.5	< 0.5	1.0	1.0	0.01	0.01	0.01	0.01	< 0.01	0.01	0.01	0.01
J14r03	11.69	500	800	875	900	2.5	0.5	1.0	1.0	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
J14r04	3.32	425	800	875	900	2.5	< 0.5	1.0	1.0	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
J14r05	5.05	425	800	900	925	2.5	< 0.5	1.0	1.0	0.01	0.01	0.01	0.01	< 0.01	0.01	0.01	0.01
J14r06	4.03	425	800	875	900	2.5	< 0.5	1.0	1.0	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
J15r01	9.12	475	800	875	900	2.5	< 0.5	1.0	1.0	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
J15r02	5.73	425	800	875	900	2.5	< 0.5	1.0	1.0	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
J15r03	3.13	475	800	875	875	2.5	< 0.5	1.0	1.0	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
J16r01	14.67	550	800	850	850	2.0	1.0	1.5	1.5	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03
J16r02	11.72	550	775	825	825	2.0	1.5	1.5	2.0	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03
J17r01	16.41	450	725	750	775	2.0	2.5	2.5	2.5	< 0.01	< 0.01	< 0.01	< 0.01	0.03	0.03	0.03	0.03
J17r02	6.52	525	725	775	775	1.5	2.0	2.0	2.0	0.01	0.01	0.01	0.01	0.03	0.03	0.03	0.03
J18r01	13.27	425	700	750	750	2.5	2.5	3.0	3.0	< 0.01	< 0.01	< 0.01	< 0.01	0.02	0.02	0.02	0.02
J19r01	17.36	225	525	600	600	2.5	3.5	3.5	3.5	0.02	0.02	0.02	0.02	< 0.01	0.01	0.01	0.01
J19r02	7.92	200	525	575	575	2.5	3.0	3.5	3.5	0.02	0.02	0.02	0.02	< 0.01	0.01	0.01	0.01

Table D.03 - Predictions for the Rural Building Structures within the Study Area

Structure Ref.	Maximum Length (m)	Predicted Total Subsidence after LW901 (mm)	Predicted Total Subsidence after LW902 (mm)	Predicted Total Subsidence after LW903 (mm)	Predicted Total Subsidence after LW904 (mm)	Predicted Total Tilt after LW901 (mm/m)	Predicted Total Tilt after LW902 (mm/m)	Predicted Total Tilt after LW903 (mm/m)	Predicted Total Tilt after LW904 (mm/m)	Predicted Total or Travelling Hogging Curvature after LW901 (1/km)	Predicted Total or Travelling Hogging Curvature after LW902 (1/km)	Predicted Total or Travelling Hogging Curvature after LW903 (1/km)	Predicted Total or Travelling Hogging Curvature after LW904 (1/km)	Predicted Total or Travelling Sagging Curvature after LW901 (1/km)	Predicted Total or Travelling Sagging Curvature after LW902 (1/km)	Predicted Total or Travelling Sagging Curvature after LW903 (1/km)	Predicted Total or Travelling Sagging Curvature after LW904 (1/km)
J19r03	2.8	250	625	675	675	2.5	3.0	3.0	3.5	< 0.01	< 0.01	< 0.01	< 0.01	0.01	0.02	0.02	0.02
J19r04	2.67	250	600	675	675	2.5	3.0	3.0	3.5	< 0.01	< 0.01	< 0.01	< 0.01	0.01	0.02	0.02	0.02
J19r05	1.81	200	550	625	625	2.5	3.0	3.5	3.5	0.02	0.02	0.02	0.02	< 0.01	0.01	0.01	0.01
J20r01	13.43	50	300	375	375	0.5	3.0	3.5	3.5	< 0.01	0.03	0.03	0.03	< 0.01	< 0.01	< 0.01	< 0.01
J21r01	7.84	< 20	75	100	100	< 0.5	0.5	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J21r02	9.73	< 20	100	150	150	< 0.5	1.0	1.5	1.5	< 0.01	0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
J22r01	3.39	< 20	100	150	150	< 0.5	1.0	1.5	1.5	< 0.01	0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
J23r01	5.81	< 20	50	75	75	< 0.5	0.5	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J23r02	7.94	< 20	75	100	100	< 0.5	0.5	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J23r03	5.56	< 20	75	100	100	< 0.5	0.5	1.0	1.0	< 0.01	< 0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
J23r04	5.85	< 20	100	125	125	< 0.5	1.0	1.5	1.5	< 0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
J24r01	13.33	25	100	125	125	< 0.5	1.0	1.5	1.5	< 0.01	0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
J25r01	7.99	25	125	150	150	< 0.5	1.0	1.5	1.5	< 0.01	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
J26r01	8.07	25	125	150	150	< 0.5	1.5	1.5	1.5	< 0.01	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
J27r01	3.82	25	125	150	150	< 0.5	1.5	1.5	1.5	< 0.01	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
J28r01	8.21	50	125	150	150	< 0.5	1.5	1.5	1.5	< 0.01	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
J28r02	2.81	50	125	150	150	< 0.5	1.5	1.5	1.5	< 0.01	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
J29r01	11.82	50	100	125	125	< 0.5	1.0	1.5	1.5	< 0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
J29r02	2.92	25	100	100	100	< 0.5	1.0	1.0	1.0	< 0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
J30r01	8.01	25	75	75	75	< 0.5	0.5	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J30r02	9.01	25	75	75	75	< 0.5	0.5	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J30r03	5.17	50	100	125	125	< 0.5	1.0	1.5	1.5	< 0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
J31r01	16.31	50	100	125	125	< 0.5	1.0	1.5	1.5	< 0.01	0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
J31r02	2.93	50	125	125	125	< 0.5	1.5	1.5	1.5	< 0.01	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
J31r03	7.84	50	125	150	150	< 0.5	1.5	1.5	1.5	< 0.01	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
J32r01	5.98	25	75	75	75	< 0.5	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J32r02	4.79	25	75	75	75	< 0.5	0.5	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J32r03	5.49	50	75	75	75	< 0.5	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J32r04	3.19	50	75	100	100	< 0.5	1.0	1.0	1.0	< 0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
J32r05	17.35	50	100	100	100	< 0.5	1.0	1.0	1.0	< 0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
J32r06	7.11	50	100	100	100	< 0.5	1.0	1.0	1.0	< 0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
J32r07	18.19	50	125	125	125	< 0.5	1.5	1.5	1.5	< 0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
J32r08	6.46	50	125	150	150	0.5	1.5	1.5	1.5	< 0.01	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
J44r01	7.12	< 20	25	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J44r02	7.88	< 20	25	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J44r03	4.09	< 20	25	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J44r04	2.9	< 20	25	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J47r01	2.84	< 20	25	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J49r01	15.57	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J50r01	5.15	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J50r02	6.21	< 20	25	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J51r01	7.99	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J52r01	7.46	< 20	25	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J52r02	15.99	< 20	25	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J52r03	5.65	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J53r01	3.07	< 20	25	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J53r02	5.43	< 20	25	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J53r03	2.62	< 20	25	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J54r01	4.37	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J55r01	11.68	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J56r01	9.55	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J56r02	2.15	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J57r01	7.11	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J59r01	14.59	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J59r02	5.77	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J59r03	3.56	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J59r04	8.4	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J60r01	2.64	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

Table D.03 - Predictions for the Rural Building Structures within the Study Area

Structure Ref.	Maximum Length (m)	Predicted Total Subsidence after LW901 (mm)	Predicted Total Subsidence after LW902 (mm)	Predicted Total Subsidence after LW903 (mm)	Predicted Total Subsidence after LW904 (mm)	Predicted Total Tilt after LW901 (mm/m)	Predicted Total Tilt after LW902 (mm/m)	Predicted Total Tilt after LW903 (mm/m)	Predicted Total Tilt after LW904 (mm/m)	Predicted Total or Travelling Hogging Curvature after LW901 (1/km)	Predicted Total or Travelling Hogging Curvature after LW902 (1/km)	Predicted Total or Travelling Hogging Curvature after LW903 (1/km)	Predicted Total or Travelling Hogging Curvature after LW904 (1/km)	Predicted Total or Travelling Sagging Curvature after LW901 (1/km)	Predicted Total or Travelling Sagging Curvature after LW902 (1/km)	Predicted Total or Travelling Sagging Curvature after LW903 (1/km)	Predicted Total or Travelling Sagging Curvature after LW904 (1/km)
J60r02	2.19	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J61r01	6.91	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J63r01	22.54	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J63r02	4.45	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J63r03	4.45	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J65r01	24.59	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J65r02	7.31	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J67r01	3.03	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J69r01	4.72	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K01r01	5.83	50	75	75	75	1.0	1.0	1.0	1.0	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
K01r02	9.73	75	100	100	100	1.0	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K01r03	4.01	50	75	75	75	1.0	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K01r04	5.65	50	75	75	75	1.0	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K01r05	9.44	50	75	75	75	1.0	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K01r06	3.69	50	50	50	50	0.5	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K03r01	11.99	50	50	50	50	0.5	0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K04r01	5.54	50	50	50	50	0.5	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K04r02	11.45	50	50	50	50	0.5	0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K04r03	2.6	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K05r01	14.58	25	50	50	50	< 0.5	0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K05r02	12.33	25	50	50	50	0.5	0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K05r03	10.29	25	50	50	50	< 0.5	0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K05r04	1.24	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K05r05	2.07	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K05r06	2.26	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K05r07	4.3	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K05r08	4.93	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K05r09	3.22	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K06r01	5.68	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K06r02	8.42	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K06r03	2.42	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K06r04	2.72	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K07r01	15.19	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K08r01	10.94	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K08r02	10.95	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K08r03	2.84	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K10r01	9.72	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K11r01	10	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K12r01	8.66	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K12r02	6.42	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K13r04	2.87	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K33r01	5.21	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K33r02	2.84	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K34r01	2.54	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K34r02	4.28	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K34r03	5.64	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K35r01	12.1	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K35r02	7.96	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K35r03	5.54	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K35r04	2.71	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K36r01	9.81	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K36r02	9.16	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K37r01	7.61	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K38r01	6.01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K38r02	2.52	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K38r03	3.39	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K38r04	5.13	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K38r05	2.79	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

Table D.03 - Predictions for the Rural Building Structures within the Study Area

Structure Ref.	Maximum Length (m)	Predicted Total Subsidence after LW901 (mm)	Predicted Total Subsidence after LW902 (mm)	Predicted Total Subsidence after LW903 (mm)	Predicted Total Subsidence after LW904 (mm)	Predicted Total Tilt after LW901 (mm/m)	Predicted Total Tilt after LW902 (mm/m)	Predicted Total Tilt after LW903 (mm/m)	Predicted Total Tilt after LW904 (mm/m)	Predicted Total or Travelling Hogging Curvature after LW901 (1/km)	Predicted Total or Travelling Hogging Curvature after LW902 (1/km)	Predicted Total or Travelling Hogging Curvature after LW903 (1/km)	Predicted Total or Travelling Hogging Curvature after LW904 (1/km)	Predicted Total or Travelling Sagging Curvature after LW901 (1/km)	Predicted Total or Travelling Sagging Curvature after LW902 (1/km)	Predicted Total or Travelling Sagging Curvature after LW903 (1/km)	Predicted Total or Travelling Sagging Curvature after LW904 (1/km)
K38r06	5.58	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K38r07	8.67	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K38r08	13.99	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K38r09	3.28	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K38r10	3.66	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K39r01	6.92	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K40r01	6.94	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K40r02	9.5	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K41r01	6.69	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K42r01	13.15	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K42r02	3.12	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K42r03	3.75	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K42r04	2.98	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K43r01	6.12	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K44r01	4.14	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K45r01	11.13	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K46r01	7.55	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K46r02	6.3	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K47r01	6.92	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K49r01	4.76	25	50	50	50	< 0.5	0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K50r01	7.38	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K50r02	6.59	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K50r03	2.25	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K51r01	9.38	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K51r02	3.09	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K51r03	5.53	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K51r04	2.86	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K51r05	2.4	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K52r01	11.56	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K52r02	16.58	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K52r03	4.64	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K52r04	4.06	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K53r01	4.1	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K54r01	5.63	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K54r02	2.53	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K55r01	11.98	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K55r02	3.04	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K55r03	15.79	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K56r01	4.97	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K56r02	5.28	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K56r03	3.64	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K56r04	5.72	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K56r05	3.77	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K57r01	8.76	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K57r02	8.79	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K57r03	10.15	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K57r04	2.18	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K57r05	2.4	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K58r01	5.78	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K65r01	13.11	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K65r02	11.58	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K65r03	2.97	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K66r01	6.37	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K67r01	5.65	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K67r02	2.86	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K68r01	5.86	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K68r02	7.4	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K68r03	10.42	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

Table D.03 - Predictions for the Rural Building Structures within the Study Area

Structure Ref.	Maximum Length (m)	Predicted Total Subsidence after LW901 (mm)	Predicted Total Subsidence after LW902 (mm)	Predicted Total Subsidence after LW903 (mm)	Predicted Total Subsidence after LW904 (mm)	Predicted Total Tilt after LW901 (mm/m)	Predicted Total Tilt after LW902 (mm/m)	Predicted Total Tilt after LW903 (mm/m)	Predicted Total Tilt after LW904 (mm/m)	Predicted Total or Travelling Hogging Curvature after LW901 (1/km)	Predicted Total or Travelling Hogging Curvature after LW902 (1/km)	Predicted Total or Travelling Hogging Curvature after LW903 (1/km)	Predicted Total or Travelling Hogging Curvature after LW904 (1/km)	Predicted Total or Travelling Sagging Curvature after LW901 (1/km)	Predicted Total or Travelling Sagging Curvature after LW902 (1/km)	Predicted Total or Travelling Sagging Curvature after LW903 (1/km)	Predicted Total or Travelling Sagging Curvature after LW904 (1/km)
K69r01	3.62	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K69r02	4.73	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K69r03	2.02	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K69r04	5.57	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K69r05	8.6	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K69r06	4.89	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K69r07	4.89	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K69r08	2.66	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K70r01	5.96	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K71r01	7.86	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K71r02	8.64	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K71r03	5.71	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K71r04	2.6	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K72r01	11.88	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K72r02	3.23	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K72r03	2.25	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K73r01	3.38	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K86r01	6.68	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K86r02	2.64	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L01r01	15.81	225	250	250	250	2.0	2.0	2.0	2.0	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
L01r02	5.45	200	225	225	225	1.5	1.5	1.5	2.0	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
L01r03	4.77	200	225	225	225	1.5	1.5	1.5	2.0	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
L02r01	9.14	275	325	325	325	2.0	2.5	2.5	2.5	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
L02r02	4.07	225	250	250	250	1.5	2.0	2.0	2.0	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
L05r01	11.36	275	300	300	300	2.0	2.5	2.5	2.5	0.01	0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
L05r02	3.63	225	250	250	250	1.5	2.0	2.0	2.0	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
L05r03	1.92	250	300	300	300	2.0	2.0	2.0	2.0	0.01	0.01	0.01	0.02	< 0.01	< 0.01	< 0.01	< 0.01
L06r01	16.52	275	300	300	300	2.0	2.0	2.5	2.5	0.01	0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
L06r02	3.19	325	350	350	350	2.5	2.5	2.5	2.5	0.01	0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
L06r03	2.13	275	300	300	300	2.0	2.0	2.5	2.5	0.01	0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
L06r04	5.24	225	250	250	250	2.0	2.0	2.0	2.0	0.01	0.01	0.01	0.02	< 0.01	< 0.01	< 0.01	< 0.01
L06r05	2.88	225	250	250	250	2.0	2.0	2.0	2.0	0.01	0.01	0.01	0.02	< 0.01	< 0.01	< 0.01	< 0.01
L06r06	5.68	200	225	225	225	1.5	2.0	2.0	2.0	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
L06r07	3.46	225	250	250	250	2.0	2.0	2.0	2.0	0.01	0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
L07r01	17.43	225	250	250	250	1.5	2.0	2.0	2.0	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
L08r01	7.9	225	250	250	250	2.0	2.0	2.0	2.0	0.01	0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
L08r02	9.58	200	200	200	200	1.5	1.5	1.5	1.5	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
L08r03	11.64	200	225	225	225	1.5	1.5	1.5	1.5	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
L08r04	4.46	200	200	200	200	1.5	1.5	1.5	1.5	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
L08r05	6.91	200	225	225	225	1.5	1.5	1.5	1.5	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
L09r01	11.75	175	175	175	175	1.5	1.5	1.5	1.5	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
L09r02	8.48	175	200	200	200	1.5	1.5	1.5	1.5	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
L10r01	13.75	175	200	200	200	1.5	1.5	1.5	1.5	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
L10r02	9.01	150	150	150	150	1.5	1.5	1.5	1.5	< 0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
L11r01	7.63	225	250	250	250	2.0	2.5	2.5	2.5	< 0.01	< 0.01	0.01	0.01	0.01	0.01	0.01	0.01
L11r02	5.7	200	250	250	250	2.0	2.5	2.5	2.5	< 0.01	< 0.01	0.01	0.01	0.01	0.01	0.01	0.01
L13r01	9.48	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L13r02	9.69	75	100	100	100	0.5	0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L13r03	13.42	50	75	75	75	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L13r04	9.53	75	75	75	75	< 0.5	0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L14r01	5.38	100	100	100	100	0.5	0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L14r02	13.37	125	150	150	150	1.0	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L14r03	2.22	100	100	100	100	0.5	0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L14r04	1.63	100	100	100	100	0.5	0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L14r05	3.62	75	100	100	100	0.5	0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L15r01	5.28	100	100	100	100	0.5	0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L15r02	8.88	100	100	100	100	0.5	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L15r03	6.3	100	100	100	100	0.5	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

Table D.03 - Predictions for the Rural Building Structures within the Study Area

Structure Ref.	Maximum Length (m)	Predicted Total Subsidence after LW901 (mm)	Predicted Total Subsidence after LW902 (mm)	Predicted Total Subsidence after LW903 (mm)	Predicted Total Subsidence after LW904 (mm)	Predicted Total Tilt after LW901 (mm/m)	Predicted Total Tilt after LW902 (mm/m)	Predicted Total Tilt after LW903 (mm/m)	Predicted Total Tilt after LW904 (mm/m)	Predicted Total or Travelling Hogging Curvature after LW901 (1/km)	Predicted Total or Travelling Hogging Curvature after LW902 (1/km)	Predicted Total or Travelling Hogging Curvature after LW903 (1/km)	Predicted Total or Travelling Hogging Curvature after LW904 (1/km)	Predicted Total or Travelling Sagging Curvature after LW901 (1/km)	Predicted Total or Travelling Sagging Curvature after LW902 (1/km)	Predicted Total or Travelling Sagging Curvature after LW903 (1/km)	Predicted Total or Travelling Sagging Curvature after LW904 (1/km)
L15r04	14.72	150	150	150	150	1.0	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L15r05	2.45	100	100	100	100	0.5	0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L15r06	2.02	75	75	75	75	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L17r01	8.4	100	100	100	100	0.5	0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L17r02	6.51	100	100	100	100	0.5	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L18r01	17.02	100	100	100	100	0.5	0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L18r02	9.64	150	175	175	175	1.0	1.5	1.5	1.5	< 0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
L18r03	3.16	125	150	150	150	1.0	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L18r04	1.91	100	100	100	100	0.5	0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L18r05	3.4	75	75	75	75	< 0.5	0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L18r06	4.08	125	150	150	150	1.0	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L19r01	13.5	100	125	125	125	0.5	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L19r02	8.99	125	150	150	150	1.0	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L19r03	5.64	150	150	150	150	1.0	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L19r04	2.62	125	125	125	125	1.0	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L20r01	8.13	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L21r01	7.74	50	75	75	75	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L21r02	5.22	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L21r03	5.02	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L21r04	16.49	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L21r05	6.79	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L22r01	7.22	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L22r02	4.46	25	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L23r01	9.33	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L23r02	15.65	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L23r03	2.79	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L23r04	2.18	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L23r05	4.52	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L24r01	6.36	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L25r01	22.54	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L26r02	3.05	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L27r01	8.39	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L28r01	15.92	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L28r02	11.92	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L29r01	7.5	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L29r02	9.67	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L29r03	5.91	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L29r04	4.47	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
M01r01	12.69	525	600	600	600	2.5	3.0	3.0	3.0	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03
M01r02	41.34	600	775	800	800	1.0	2.5	2.5	2.5	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03
M01r03	21.6	575	775	800	825	1.0	2.0	2.5	2.5	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03
M01r04	2.35	575	775	800	800	0.5	2.0	2.5	2.5	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03
M01r05	4.64	575	750	775	800	1.0	2.5	2.5	2.5	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03
M01r06	5.47	575	750	775	775	1.0	2.5	2.5	2.5	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03
M01r07	4.13	575	725	750	775	1.5	2.5	2.5	2.5	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03
M02r01	6.16	125	125	125	125	1.0	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
M02r02	16.61	125	150	150	150	1.0	1.0	1.0	1.0	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
M02r03	5.98	125	125	125	125	1.0	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
M02r04	6.43	100	125	125	125	1.0	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
M02r05	5.06	125	125	125	125	1.0	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
M03r01	11.22	325	350	350	350	2.5	3.0	3.0	3.0	0.02	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
M03r02	3.52	475	525	525	525	2.5	3.0	3.5	3.5	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01
M03r03	6.41	600	750	775	775	1.5	2.5	3.0	3.0	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03
M04r01	10.24	600	750	775	775	2.0	3.0	3.0	3.0	0.02	0.02	0.02	0.02	0.04	0.04	0.04	0.04
M04r02	20.53	600	800	825	825	1.0	2.5	2.5	2.5	0.02	0.02	0.02	0.02	0.04	0.04	0.04	0.04
M04r03	30.79	575	850	875	875	2.5	1.0	1.0	1.5	0.02	0.02	0.02	0.02	0.04	0.04	0.04	0.04
M04r04	4.61	600	825	850	850	1.5	2.0	2.0	2.0	0.02	0.02	0.02	0.02	0.04	0.04	0.04	0.04
M04r05	5.32	600	825	850	850	1.0	2.0	2.0	2.0	0.02	0.02	0.02	0.02	0.04	0.04	0.04	0.04

Table D.03 - Predictions for the Rural Building Structures within the Study Area

Structure Ref.	Maximum Length (m)	Predicted Total Subsidence after LW901 (mm)	Predicted Total Subsidence after LW902 (mm)	Predicted Total Subsidence after LW903 (mm)	Predicted Total Subsidence after LW904 (mm)	Predicted Total Tilt after LW901 (mm/m)	Predicted Total Tilt after LW902 (mm/m)	Predicted Total Tilt after LW903 (mm/m)	Predicted Total Tilt after LW904 (mm/m)	Predicted Total or Travelling Hogging Curvature after LW901 (1/km)	Predicted Total or Travelling Hogging Curvature after LW902 (1/km)	Predicted Total or Travelling Hogging Curvature after LW903 (1/km)	Predicted Total or Travelling Hogging Curvature after LW904 (1/km)	Predicted Total or Travelling Sagging Curvature after LW901 (1/km)	Predicted Total or Travelling Sagging Curvature after LW902 (1/km)	Predicted Total or Travelling Sagging Curvature after LW903 (1/km)	Predicted Total or Travelling Sagging Curvature after LW904 (1/km)
M05r01	8.31	325	375	375	375	2.5	3.0	3.0	3.0	0.01	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
M05r02	10.64	450	500	500	500	2.5	3.0	3.0	3.0	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
M05r03	17.1	500	550	575	575	2.5	3.0	3.0	3.0	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
M06r01	13.78	475	550	550	550	2.5	3.0	3.0	3.0	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
M07r01	8.26	125	150	150	150	1.0	1.0	1.0	1.0	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
M08r01	17.64	125	125	125	125	1.0	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
M08r02	8.31	100	125	125	125	1.0	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
M08r03	4.84	125	125	125	125	1.0	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
M08r04	8.45	125	125	125	125	1.0	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
M08r05	2.63	100	100	100	100	0.5	0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
M08r06	2.16	100	100	100	100	0.5	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
M08r07	1.94	100	125	125	125	1.0	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
M09r01	23.83	275	300	300	300	2.5	2.5	2.5	2.5	0.02	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
M09r02	7.62	325	350	350	350	2.5	3.0	3.0	3.0	0.02	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
M09r03	3.8	75	100	100	100	0.5	0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
M10r01	11.34	200	225	225	225	1.5	2.0	2.0	2.0	0.02	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
M11r01	8.29	75	75	75	75	0.5	0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
M11r02	4.58	75	75	75	75	< 0.5	0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
M12r01	18.95	75	75	75	75	< 0.5	0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
M12r02	11.55	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
M12r03	6.55	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
M13r01	4.42	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
M14r01	5.9	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
M14r02	7.7	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
M14r03	9.97	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
M14r04	4.95	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
N02r01	8.42	< 20	600	750	775	< 0.5	1.5	2.5	3.0	< 0.01	0.02	0.02	0.02	< 0.01	0.04	0.04	0.04
N02r02	19.96	< 20	575	675	675	< 0.5	2.5	3.0	3.0	< 0.01	0.02	0.02	0.02	< 0.01	0.03	0.03	0.03
N02r03	3.19	< 20	600	725	750	< 0.5	2.0	3.0	3.0	< 0.01	0.02	0.02	0.02	< 0.01	0.04	0.04	0.04
N02r04	4.32	< 20	500	550	550	< 0.5	2.5	3.0	3.0	< 0.01	0.02	0.02	0.02	< 0.01	0.02	0.02	0.02
N03r01	17.58	50	775	1050	1125	< 0.5	6.5	4.5	4.0	< 0.01	0.06	0.06	0.07	< 0.01	0.09	0.09	0.09
N03r02	12.99	50	675	1000	1075	< 0.5	6.5	4.5	4.0	< 0.01	0.06	0.07	0.07	< 0.01	0.04	0.04	0.04
N03r03	5.82	50	600	950	1000	< 0.5	6.5	4.5	4.0	< 0.01	0.06	0.07	0.07	< 0.01	0.01	0.01	0.01
N03r04	6.33	50	675	1000	1050	< 0.5	6.5	4.5	4.0	< 0.01	0.06	0.07	0.07	< 0.01	0.04	0.04	0.04
N04r01	15.5	50	425	800	900	< 0.5	5.0	3.0	2.5	< 0.01	0.06	0.07	0.07	< 0.01	< 0.01	0.01	0.01
N04r02	7.44	50	475	850	925	< 0.5	6.0	4.0	3.5	< 0.01	0.06	0.07	0.07	< 0.01	0.01	0.01	0.01
N05r01	29.71	25	175	775	950	< 0.5	2.0	1.0	1.5	< 0.01	0.02	0.02	0.02	< 0.01	< 0.01	0.01	0.01
N06r01	8.11	25	225	750	900	< 0.5	2.5	1.0	1.5	< 0.01	0.03	0.03	0.04	< 0.01	< 0.01	0.01	0.01
N11r01	16.77	< 20	< 20	175	775	< 0.5	< 0.5	2.0	2.0	< 0.01	< 0.01	0.03	0.03	< 0.01	< 0.01	< 0.01	0.02
N11r02	10.94	< 20	100	825	1075	< 0.5	1.0	< 0.5	1.0	< 0.01	< 0.01	0.02	0.02	< 0.01	< 0.01	0.01	0.01
N14r01	13.01	< 20	< 20	25	375	< 0.5	< 0.5	< 0.5	4.5	< 0.01	< 0.01	< 0.01	0.05	< 0.01	< 0.01	< 0.01	< 0.01
N14r02	6.76	< 20	< 20	< 20	250	< 0.5	< 0.5	< 0.5	2.5	< 0.01	< 0.01	< 0.01	0.04	< 0.01	< 0.01	< 0.01	< 0.01
N14r03	5.51	< 20	< 20	< 20	150	< 0.5	< 0.5	< 0.5	1.5	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	< 0.01
N15r01	13.88	< 20	< 20	50	900	< 0.5	< 0.5	< 0.5	2.0	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.08
N15r02	7.53	< 20	< 20	50	850	< 0.5	< 0.5	< 0.5	5.5	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.09
N15r03	7.38	< 20	< 20	50	825	< 0.5	< 0.5	< 0.5	5.5	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.09
N15r04	2.77	< 20	< 20	75	900	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.03
N16r01	11.95	< 20	< 20	25	800	< 0.5	< 0.5	< 0.5	5.5	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.09
N16r02	4.81	< 20	< 20	25	700	< 0.5	< 0.5	< 0.5	5.5	< 0.01	< 0.01	< 0.01	0.04	< 0.01	< 0.01	< 0.01	0.05
N17r01	9.32	< 20	< 20	25	850	< 0.5	< 0.5	< 0.5	5.0	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.08
N17r02	2.81	< 20	< 20	25	850	< 0.5	< 0.5	< 0.5	5.0	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.09
N17r03	2.68	< 20	< 20	25	825	< 0.5	< 0.5	< 0.5	5.5	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.09
N17r04	4.72	< 20	< 20	25	825	< 0.5	< 0.5	< 0.5	5.5	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.09
N18r01	13.16	< 20	< 20	100	875	< 0.5	< 0.5	1.0	0.5	< 0.01	< 0.01	0.01	0.02	< 0.01	< 0.01	< 0.01	0.02
N18r02	3.86	< 20	< 20	75	875	< 0.5	< 0.5	0.5	< 0.5	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.02
N18r03	13.02	< 20	< 20	75	875	< 0.5	< 0.5	0.5	< 0.5	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.02
N18r04	8.76	< 20	< 20	75	875	< 0.5	< 0.5	0.5	< 0.5	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.02
N18r05	5.38	< 20	< 20	75	875	< 0.5	< 0.5	0.5	< 0.5	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.02

Table D.03 - Predictions for the Rural Building Structures within the Study Area

Structure Ref.	Maximum Length (m)	Predicted Total Subsidence after LW901 (mm)	Predicted Total Subsidence after LW902 (mm)	Predicted Total Subsidence after LW903 (mm)	Predicted Total Subsidence after LW904 (mm)	Predicted Total Tilt after LW901 (mm/m)	Predicted Total Tilt after LW902 (mm/m)	Predicted Total Tilt after LW903 (mm/m)	Predicted Total Tilt after LW904 (mm/m)	Predicted Total or Travelling Hogging Curvature after LW901 (1/km)	Predicted Total or Travelling Hogging Curvature after LW902 (1/km)	Predicted Total or Travelling Hogging Curvature after LW903 (1/km)	Predicted Total or Travelling Hogging Curvature after LW904 (1/km)	Predicted Total or Travelling Sagging Curvature after LW901 (1/km)	Predicted Total or Travelling Sagging Curvature after LW902 (1/km)	Predicted Total or Travelling Sagging Curvature after LW903 (1/km)	Predicted Total or Travelling Sagging Curvature after LW904 (1/km)
N18r06	5.06	< 20	< 20	75	875	< 0.5	< 0.5	0.5	< 0.5	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.02
N19r01	3.89	< 20	< 20	175	800	< 0.5	< 0.5	2.0	0.5	< 0.01	< 0.01	0.03	0.03	< 0.01	< 0.01	< 0.01	0.01
N20r01	10.4	< 20	50	850	1100	< 0.5	< 0.5	2.5	1.5	< 0.01	< 0.01	0.02	0.02	< 0.01	< 0.01	0.11	0.11
N21r01	4.12	< 20	100	300	350	< 0.5	1.0	2.0	2.0	< 0.01	0.02	0.03	0.03	< 0.01	< 0.01	< 0.01	< 0.01
N21r02	8.44	< 20	75	300	325	< 0.5	1.0	2.0	2.0	< 0.01	0.02	0.03	0.03	< 0.01	< 0.01	< 0.01	< 0.01
N21r03	20.32	< 20	75	275	300	< 0.5	0.5	1.5	1.5	< 0.01	< 0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
N21r04	43.57	< 20	50	375	425	< 0.5	0.5	2.0	2.5	< 0.01	< 0.01	0.03	0.03	< 0.01	< 0.01	< 0.01	< 0.01
N21r05	17.35	< 20	50	375	450	< 0.5	0.5	2.0	2.5	< 0.01	< 0.01	0.03	0.04	< 0.01	< 0.01	< 0.01	< 0.01
N21r06	5.8	< 20	50	300	325	< 0.5	0.5	1.5	2.0	< 0.01	< 0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
N21r07	11.7	< 20	50	275	325	< 0.5	0.5	1.5	2.0	< 0.01	< 0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
N21r08	8.32	< 20	100	375	425	< 0.5	1.5	2.5	3.0	< 0.01	0.02	0.03	0.03	< 0.01	< 0.01	< 0.01	< 0.01
N21r09	3.96	< 20	75	400	450	< 0.5	1.0	2.5	3.0	< 0.01	0.02	0.03	0.03	< 0.01	< 0.01	< 0.01	< 0.01
N21r10	4.72	< 20	75	225	250	< 0.5	1.0	1.5	1.5	< 0.01	0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
N22r01	15.37	< 20	< 20	50	75	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
N22r02	11.29	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
N22r03	2.32	< 20	< 20	25	50	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
N22r04	2.32	< 20	< 20	25	50	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
N22r05	1.85	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
N23r09	1.68	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
O01r01	5.85	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
O01r02	6.41	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
O01r03	2.09	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
O01r04	3.44	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
O02r01	19.92	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
O02r02	11.36	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
O02r03	3.64	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
O02r04	4.92	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
O02r05	3.93	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P01r01	5.38	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P02r01	16.59	< 20	< 20	< 20	75	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P04r01	26.39	< 20	< 20	< 20	125	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	< 0.01
P05r01	18.49	< 20	< 20	< 20	150	< 0.5	< 0.5	< 0.5	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P05r02	8.69	< 20	< 20	< 20	150	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P06r01	20.17	< 20	< 20	< 20	125	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P06r02	5.45	< 20	< 20	< 20	150	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P07r01	17.73	< 20	< 20	< 20	75	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P08r01	8.15	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P08r02	5.79	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P09r01	11.75	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P09r02	7.34	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P09r03	2.74	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P09r04	8.14	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P09t05	5.69	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P10r01	13.29	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P10r02	11.61	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P10r03	4.45	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P10r04	3.05	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P10r05	5.05	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P10r06	4.92	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P10r07	2.53	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P11r01	23.07	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P13r01	21.02	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P14r01	20.76	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P14r02	9.25	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P14r03	10.4	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P15r01	9.58	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P16r01	23.25	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P18r01	19.08	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

Table D.03 - Predictions for the Rural Building Structures within the Study Area

Structure Ref.	Maximum Length (m)	Predicted Total Subsidence after LW901 (mm)	Predicted Total Subsidence after LW902 (mm)	Predicted Total Subsidence after LW903 (mm)	Predicted Total Subsidence after LW904 (mm)	Predicted Total Tilt after LW901 (mm/m)	Predicted Total Tilt after LW902 (mm/m)	Predicted Total Tilt after LW903 (mm/m)	Predicted Total Tilt after LW904 (mm/m)	Predicted Total or Travelling Hogging Curvature after LW901 (1/km)	Predicted Total or Travelling Hogging Curvature after LW902 (1/km)	Predicted Total or Travelling Hogging Curvature after LW903 (1/km)	Predicted Total or Travelling Hogging Curvature after LW904 (1/km)	Predicted Total or Travelling Sagging Curvature after LW901 (1/km)	Predicted Total or Travelling Sagging Curvature after LW902 (1/km)	Predicted Total or Travelling Sagging Curvature after LW903 (1/km)	Predicted Total or Travelling Sagging Curvature after LW904 (1/km)
P19r01	11.16	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P19r02	2.73	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P20r01	16.69	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P20r02	11.88	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P20r03	7.45	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P20r04	5.95	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P22r01	16.6	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P23r01	19.28	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
P23r02	8.22	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P23r03	4.31	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P25r01	2.11	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P39r01	16.72	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P40r01	6.45	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P40r02	1.85	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

Table D.04 - Predictions for the Farm Dams within the Study Area

Dam Ref.	Maximum Length (m)	Plannar Area (m2)	Predicted Total Subsidence after LW901 (mm)	Predicted Total Subsidence after LW902 (mm)	Predicted Total Subsidence after LW903 (mm)	Predicted Total Subsidence after LW904 (mm)	Predicted Total Tilt after LW901 (mm/m)	Predicted Total Tilt after LW902 (mm/m)	Predicted Total Tilt after LW903 (mm/m)	Predicted Total Tilt after LW904 (mm/m)
A29d01	40	809	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5
D53d01	26	348	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5
D54d01	34	315	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5
E07d01	24	184	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5
E07d02	17	134	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5
E09d01	91	2302	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.5
E10d01	18	170	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5
F01d01	34	738	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5
F02d01	52	1200	< 20	< 20	< 20	100	< 0.5	< 0.5	< 0.5	1.0
F02d02	59	1634	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5
F03d01	34	493	< 20	< 20	< 20	350	< 0.5	< 0.5	< 0.5	4.0
F03d02	86	1186	< 20	< 20	25	600	< 0.5	< 0.5	< 0.5	6.0
F05d01	56	1379	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.5
F05d02	33	434	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5
F20d10	34	603	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5
H04d01	33	457	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5
H11d01	17	204	< 20	25	575	675	< 0.5	< 0.5	5.5	5.5
H14d01	23	283	< 20	< 20	25	100	< 0.5	< 0.5	< 0.5	1.0
H16d01	29	303	< 20	25	725	775	< 0.5	< 0.5	2.5	3.0
H16d02	11	53	< 20	225	625	675	< 0.5	3.0	2.5	2.5
J03d01	21	260	50	675	975	1025	< 0.5	5.5	3.5	3.0
J03d02	25	337	275	775	875	900	2.0	1.5	2.0	2.0
J07d01	27	407	75	825	1075	1150	< 0.5	6.0	3.5	3.0
J08d01	63	1143	150	875	1075	1150	1.0	0.5	1.5	1.5
J09d01	29	431	75	850	1075	1175	< 0.5	6.0	3.5	3.0
J13d01	45	1213	250	850	1000	1050	2.0	0.5	1.5	1.5
J14d01	37	551	550	750	800	800	1.0	2.5	2.5	2.5
J15d01	46	1002	550	800	850	875	2.5	1.5	2.0	2.0
J16d01	25	189	550	750	775	775	1.0	2.5	2.5	2.5
J16d02	22	163	550	725	750	750	1.5	2.5	2.5	2.5
J17d01	94	2282	550	675	700	700	2.0	2.5	3.0	3.0
J19d01	36	464	125	575	675	675	1.5	3.0	3.5	3.5
J19d02	6	21	200	625	725	725	2.0	3.0	3.0	3.0
J55d01	17	141	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5
J57d01	14	132	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5
L01d01	42	746	425	475	475	475	2.5	3.0	3.0	3.0
L13d01	25	273	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5
L14d01	16	121	125	150	150	150	1.0	1.0	1.0	1.0
L15d01	15	133	75	75	75	75	< 0.5	< 0.5	< 0.5	< 0.5
L18d01	26	305	100	125	125	125	0.5	1.0	1.0	1.0
L19d01	21	273	150	175	175	175	1.0	1.5	1.5	1.5
L20d01	51	1112	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5

Table D.04 - Predictions for the Farm Dams within the Study Area

Dam Ref.	Maximum Length (m)	Plannar Area (m2)	Predicted Total Subsidence after LW901 (mm)	Predicted Total Subsidence after LW902 (mm)	Predicted Total Subsidence after LW903 (mm)	Predicted Total Subsidence after LW904 (mm)	Predicted Total Tilt after LW901 (mm/m)	Predicted Total Tilt after LW902 (mm/m)	Predicted Total Tilt after LW903 (mm/m)	Predicted Total Tilt after LW904 (mm/m)
L21d01	49	961	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5
L22d01	11	60	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5
L25d01	18	197	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5
L27d01	23	308	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5
M01d01	31	575	575	750	750	750	2.0	3.0	3.0	3.0
M01d02	57	2222	500	575	575	575	2.5	3.0	3.0	3.0
M01d03	42	832	375	425	425	425	2.5	3.0	3.0	3.0
M02d01	43	1348	200	225	225	225	1.5	2.0	2.0	2.0
M03d01	59	1160	600	825	850	875	2.0	2.5	2.5	2.5
M03d02	19	123	550	825	875	875	2.5	1.0	1.0	1.0
M04d01	50	1490	575	850	875	875	3.0	1.0	1.5	1.5
M05d01	47	942	575	775	800	800	1.5	2.5	3.0	3.0
M05d02	7	25	550	650	650	650	2.5	3.0	3.0	3.0
M05d03	5	15	550	675	675	675	2.0	3.0	3.0	3.0
M06d01	22	348	375	725	750	775	2.5	1.5	1.5	1.5
M07d01	33	740	225	250	250	250	2.0	2.0	2.0	2.0
M08h02	38	740	75	100	100	100	0.5	0.5	0.5	0.5
M09d01	17	175	75	100	100	100	0.5	0.5	0.5	0.5
M11d01	31	484	150	175	175	175	1.5	1.5	1.5	1.5
M12d01	52	1082	125	125	125	125	1.0	1.0	1.0	1.0
M14d01	26	310	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5
M16d01	12	89	100	550	600	625	1.5	3.0	3.5	3.5
N02d01	59	1619	< 20	125	175	175	< 0.5	2.0	2.0	2.0
N02d02	12	64	< 20	500	600	600	< 0.5	2.5	3.0	3.5
N02d03	31	183	< 20	525	850	875	< 0.5	3.5	1.5	1.0
N03d01	82	2916	25	300	800	950	< 0.5	3.5	1.5	2.0
N03d02	83	3116	50	825	1100	1150	< 0.5	6.5	4.5	4.5
N03d03	28	464	50	525	875	950	< 0.5	6.0	4.0	4.0
N03d04	25	316	275	825	925	950	2.0	1.0	2.0	2.0
N03d05	30	524	250	875	1000	1025	2.0	0.5	1.5	2.0
N03d06	33	502	< 20	50	825	1100	< 0.5	< 0.5	4.0	2.0
N05d01	50	1050	< 20	25	750	1100	< 0.5	< 0.5	6.0	4.0
N05d02	29	436	< 20	75	825	1100	< 0.5	0.5	1.0	1.5
N05d03	28	342	< 20	100	825	1050	< 0.5	1.0	1.0	1.5
N06d01	58	1699	300	875	1000	1025	2.5	1.0	1.5	2.0
N06d02	61	1845	175	925	1100	1150	1.5	1.0	1.5	2.0
N06d03	27	275	75	925	1125	1175	0.5	5.5	3.5	3.5
N07d01	19	179	< 20	< 20	175	875	< 0.5	< 0.5	2.0	< 0.5
N08d01	28	413	25	325	800	950	< 0.5	4.0	1.5	1.0
N09d01	19	236	525	800	875	900	2.5	0.5	1.0	1.0
N10d01	39	748	50	450	875	1000	< 0.5	5.0	2.5	2.0
N11d01	28	457	< 20	< 20	100	625	< 0.5	< 0.5	1.0	4.0

Table D.04 - Predictions for the Farm Dams within the Study Area

Dam Ref.	Maximum Length (m)	Plannar Area (m2)	Predicted Total Subsidence after LW901 (mm)	Predicted Total Subsidence after LW902 (mm)	Predicted Total Subsidence after LW903 (mm)	Predicted Total Subsidence after LW904 (mm)	Predicted Total Tilt after LW901 (mm/m)	Predicted Total Tilt after LW902 (mm/m)	Predicted Total Tilt after LW903 (mm/m)	Predicted Total Tilt after LW904 (mm/m)
N11d02	22	288	< 20	< 20	50	900	< 0.5	< 0.5	< 0.5	1.0
N11d03	21	251	< 20	< 20	275	850	< 0.5	< 0.5	3.0	0.5
N13d01	61	1418	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5
N14d01	65	2311	< 20	< 20	25	800	< 0.5	< 0.5	< 0.5	6.0
N15d01	37	872	< 20	< 20	25	475	< 0.5	< 0.5	< 0.5	5.5
N15d02	30	485	< 20	< 20	25	525	< 0.5	< 0.5	< 0.5	5.5
N16d01	39	968	< 20	< 20	100	875	< 0.5	< 0.5	1.0	< 0.5
N17d01	51	862	< 20	< 20	50	875	< 0.5	< 0.5	< 0.5	1.0
N17d02	36	419	< 20	< 20	25	725	< 0.5	< 0.5	< 0.5	5.5
N18d01	21	273	< 20	< 20	75	875	< 0.5	< 0.5	0.5	< 0.5
N19d01	73	2939	< 20	25	600	975	< 0.5	< 0.5	6.0	4.0
N19d02	32	519	< 20	< 20	150	850	< 0.5	< 0.5	1.5	1.0
N19d03	23	284	< 20	< 20	< 20	425	< 0.5	< 0.5	< 0.5	5.0
N19d04	15	146	< 20	25	775	1075	< 0.5	< 0.5	6.0	4.0
N19d05	5	9	< 20	< 20	325	800	< 0.5	< 0.5	4.0	1.5
N21d01	36	639	< 20	25	125	125	< 0.5	< 0.5	0.5	1.0
N21d02	24	333	< 20	50	150	175	< 0.5	< 0.5	1.0	1.0
N21d03	55	1855	< 20	50	275	300	< 0.5	< 0.5	1.5	2.0
N21d04	14	52	< 20	25	275	325	< 0.5	< 0.5	1.5	2.0
N21d05	39	841	< 20	< 20	450	600	< 0.5	< 0.5	1.5	2.5
N21d06	19	195	< 20	< 20	525	750	< 0.5	< 0.5	1.5	2.0
N21d07	37	654	< 20	50	650	775	< 0.5	1.0	3.5	4.0
N21d08	13	64	< 20	50	475	550	< 0.5	0.5	3.0	3.0
N21d09	65	1929	< 20	150	700	800	< 0.5	2.0	3.5	4.0
N21d10	24	325	< 20	200	875	1000	< 0.5	1.5	1.0	2.0
N21d11	34	729	< 20	100	875	1075	< 0.5	1.0	2.5	1.5
N21d12	129	5289	< 20	100	875	1100	< 0.5	1.0	6.0	4.0
N21d13	46	1090	< 20	50	500	875	< 0.5	< 0.5	5.5	3.0
N21d14	56	2063	< 20	25	425	850	< 0.5	< 0.5	5.0	3.0
N21d15	27	352	< 20	< 20	< 20	125	< 0.5	< 0.5	< 0.5	1.0
N21d16	24	186	< 20	< 20	25	675	< 0.5	< 0.5	< 0.5	5.5
N22d01	66	1322	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5
N22d02	27	296	< 20	< 20	25	50	< 0.5	< 0.5	< 0.5	0.5
N23d02	50	1221	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5
O01d01	52	942	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5
O01d02	22	314	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5
O11d01	103	4755	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5
P01d01	52	839	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5
P02d01	46	1345	< 20	< 20	< 20	75	< 0.5	< 0.5	< 0.5	< 0.5
P03d01	29	424	< 20	< 20	< 20	150	< 0.5	< 0.5	< 0.5	1.5
P04d01	30	645	< 20	< 20	25	250	< 0.5	< 0.5	< 0.5	2.0
P05d01	32	552	< 20	< 20	< 20	125	< 0.5	< 0.5	< 0.5	0.5

Table D.04 - Predictions for the Farm Dams within the Study Area

Dam Ref.	Maximum Length (m)	Plannar Area (m2)	Predicted Total Subsidence after LW901 (mm)	Predicted Total Subsidence after LW902 (mm)	Predicted Total Subsidence after LW903 (mm)	Predicted Total Subsidence after LW904 (mm)	Predicted Total Tilt after LW901 (mm/m)	Predicted Total Tilt after LW902 (mm/m)	Predicted Total Tilt after LW903 (mm/m)	Predicted Total Tilt after LW904 (mm/m)
P05d02	29	503	< 20	< 20	< 20	125	< 0.5	< 0.5	< 0.5	0.5
P06d01	30	321	< 20	< 20	< 20	100	< 0.5	< 0.5	< 0.5	0.5
P08d01	22	237	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.5
P09d01	23	207	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5
P10d01	86	1454	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5
P10d02	29	502	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5
P11d01	41	659	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5
P13d01	34	644	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5
P13d02	35	656	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5
P14d01	23	344	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5
P14d02	21	305	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5
P15d01	42	719	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5
P15d02	11	70	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5
P16d01	64	1781	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5
P16d02	31	428	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5
P16d03	41	562	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5
P19d01	34	351	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5
P20d01	20	282	< 20	< 20	< 20	75	< 0.5	< 0.5	< 0.5	< 0.5
P20d02	32	497	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.5
P21d01	39	846	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5
P21d02	16	144	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5
P22d01	32	408	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5
P23d01	30	464	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.5

Table D.04 - Predictions for the Farm Dams within the Study Area

Dam Ref.	Predicted Total or Travelling Hogging Curvature after LW901 (1/km)	Predicted Total or Travelling Hogging Curvature after LW902 (1/km)	Predicted Total or Travelling Hogging Curvature after LW903 (1/km)	Predicted Total or Travelling Hogging Curvature after LW904 (1/km)	Predicted Total or Travelling Sagging Curvature after LW901 (1/km)	Predicted Total or Travelling Sagging Curvature after LW902 (1/km)	Predicted Total or Travelling Sagging Curvature after LW903 (1/km)	Predicted Total or Travelling Sagging Curvature after LW904 (1/km)	Predicted Change in Freeboard after LW901 (mm)	Predicted Change in Freeboard after LW902 (mm)	Predicted Change in Freeboard after LW903 (mm)	Predicted Change in Freeboard after LW904 (mm)
A29d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
D53d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
D54d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
E07d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
E07d02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
E09d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
E10d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
F01d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
F02d01	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	50
F02d02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
F03d01	< 0.01	< 0.01	< 0.01	0.05	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	150
F03d02	< 0.01	< 0.01	< 0.01	0.05	< 0.01	< 0.01	< 0.01	0.01	< 50	< 50	< 50	350
F05d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
F05d02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
F20d10	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
H04d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
H11d01	< 0.01	< 0.01	0.05	0.05	< 0.01	< 0.01	0.03	0.03	< 50	< 50	300	300
H14d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
H16d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.08	0.08	< 50	< 50	100	100
H16d02	< 0.01	0.04	0.04	0.04	< 0.01	< 0.01	0.02	0.02	< 50	100	100	100
J03d01	< 0.01	0.05	0.05	0.05	< 0.01	0.07	0.07	0.07	< 50	300	200	150
J03d02	0.01	0.01	0.01	0.01	< 0.01	0.02	0.02	0.02	100	100	100	100
J07d01	< 0.01	0.04	0.04	0.04	< 0.01	0.10	0.10	0.10	< 50	350	200	150
J08d01	< 0.01	0.02	0.02	0.02	< 0.01	0.02	0.02	0.02	50	< 50	50	100
J09d01	< 0.01	0.03	0.03	0.03	< 0.01	0.10	0.10	0.10	< 50	300	150	150
J13d01	0.01	0.02	0.02	0.02	< 0.01	0.01	0.01	0.01	100	< 50	100	100
J14d01	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	< 50	150	150	150
J15d01	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	100	50	100	100
J16d01	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	< 50	100	100	100
J16d02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	< 50	100	150	150
J17d01	0.01	0.01	0.01	0.01	0.03	0.03	0.03	0.03	150	250	250	250
J19d01	0.01	0.01	0.01	0.01	< 0.01	0.01	0.01	0.01	100	200	200	200
J19d02	< 0.01	< 0.01	< 0.01	< 0.01	0.01	0.02	0.02	0.02	100	100	150	150
J55d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
J57d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
L01d01	0.01	0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01	200	200	200	200
L13d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
L14d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
L15d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
L18d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
L19d01	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	50	50	50	50
L20d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50

Table D.04 - Predictions for the Farm Dams within the Study Area

Dam Ref.	Predicted Total or Travelling Hogging Curvature after LW901 (1/km)	Predicted Total or Travelling Hogging Curvature after LW902 (1/km)	Predicted Total or Travelling Hogging Curvature after LW903 (1/km)	Predicted Total or Travelling Hogging Curvature after LW904 (1/km)	Predicted Total or Travelling Sagging Curvature after LW901 (1/km)	Predicted Total or Travelling Sagging Curvature after LW902 (1/km)	Predicted Total or Travelling Sagging Curvature after LW903 (1/km)	Predicted Total or Travelling Sagging Curvature after LW904 (1/km)	Predicted Change in Freeboard after LW901 (mm)	Predicted Change in Freeboard after LW902 (mm)	Predicted Change in Freeboard after LW903 (mm)	Predicted Change in Freeboard after LW904 (mm)
L21d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
L22d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
L25d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
L27d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
M01d01	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	50	150	150	150
M01d02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	250	250	250	250
M01d03	0.01	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01	150	200	200	200
M02d01	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	100	100	100	100
M03d01	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	50	150	150	150
M03d02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	100	< 50	< 50	< 50
M04d01	0.02	0.02	0.02	0.02	0.04	0.04	0.04	0.04	200	< 50	< 50	< 50
M05d01	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	< 50	150	150	150
M05d02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	100	150	150	150
M05d03	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	50	100	100	100
M06d01	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.03	150	100	100	100
M07d01	0.01	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01	100	100	100	100
M08h02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
M09d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
M11d01	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	50	50	50	50
M12d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	50	50	50
M14d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
M16d01	0.02	0.03	0.03	0.03	< 0.01	0.01	0.01	0.01	50	150	200	200
N02d01	< 0.01	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01	< 50	100	100	100
N02d02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.03	0.03	0.03	< 50	100	150	150
N02d03	< 0.01	0.03	0.04	0.04	< 0.01	0.01	0.02	0.02	< 50	200	50	< 50
N03d01	< 0.01	0.05	0.06	0.06	< 0.01	< 0.01	0.02	0.02	< 50	200	50	100
N03d02	< 0.01	0.06	0.07	0.07	< 0.01	0.11	0.11	0.11	< 50	600	350	300
N03d03	< 0.01	0.06	0.07	0.07	< 0.01	0.01	0.01	0.01	< 50	300	150	100
N03d04	0.01	0.02	0.02	0.02	< 0.01	0.02	0.02	0.02	100	50	100	100
N03d05	0.02	0.02	0.02	0.02	< 0.01	0.02	0.02	0.02	100	< 50	100	100
N03d06	< 0.01	< 0.01	0.02	0.02	< 0.01	< 0.01	0.10	0.10	< 50	< 50	100	< 50
N05d01	< 0.01	< 0.01	0.05	0.06	< 0.01	< 0.01	0.10	0.10	< 50	< 50	400	250
N05d02	< 0.01	< 0.01	0.02	0.02	< 0.01	< 0.01	0.02	0.02	< 50	< 50	< 50	100
N05d03	< 0.01	0.01	0.02	0.02	< 0.01	< 0.01	0.02	0.02	< 50	< 50	< 50	100
N06d01	0.02	0.02	0.02	0.02	< 0.01	0.02	0.02	0.02	150	50	100	100
N06d02	0.01	0.03	0.03	0.03	< 0.01	0.04	0.04	0.04	100	50	150	150
N06d03	< 0.01	0.03	0.03	0.03	< 0.01	0.11	0.11	0.11	< 50	150	100	50
N07d01	< 0.01	< 0.01	0.03	0.03	< 0.01	< 0.01	< 0.01	0.01	< 50	< 50	50	< 50
N08d01	< 0.01	0.05	0.05	0.05	< 0.01	< 0.01	0.01	0.01	< 50	150	< 50	< 50
N09d01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	150	< 50	< 50	< 50
N10d01	< 0.01	0.05	0.05	0.05	< 0.01	< 0.01	< 0.01	< 0.01	< 50	250	100	50
N11d01	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.02	< 50	< 50	< 50	250

Table D.04 - Predictions for the Farm Dams within the Study Area

Dam Ref.	Predicted Total or Travelling Hogging Curvature after LW901 (1/km)	Predicted Total or Travelling Hogging Curvature after LW902 (1/km)	Predicted Total or Travelling Hogging Curvature after LW903 (1/km)	Predicted Total or Travelling Hogging Curvature after LW904 (1/km)	Predicted Total or Travelling Sagging Curvature after LW901 (1/km)	Predicted Total or Travelling Sagging Curvature after LW902 (1/km)	Predicted Total or Travelling Sagging Curvature after LW903 (1/km)	Predicted Total or Travelling Sagging Curvature after LW904 (1/km)	Predicted Change in Freeboard after LW901 (mm)	Predicted Change in Freeboard after LW902 (mm)	Predicted Change in Freeboard after LW903 (mm)	Predicted Change in Freeboard after LW904 (mm)
N11d02	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.06	< 50	< 50	< 50	< 50
N11d03	< 0.01	< 0.01	0.05	0.05	< 0.01	< 0.01	< 0.01	0.01	< 50	< 50	100	< 50
N13d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
N14d01	< 0.01	< 0.01	< 0.01	0.05	< 0.01	< 0.01	< 0.01	0.09	< 50	< 50	< 50	450
N15d01	< 0.01	< 0.01	< 0.01	0.05	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	300
N15d02	< 0.01	< 0.01	< 0.01	0.05	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	250
N16d01	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.01	< 50	< 50	< 50	< 50
N17d01	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.06	< 50	< 50	< 50	< 50
N17d02	< 0.01	< 0.01	< 0.01	0.04	< 0.01	< 0.01	< 0.01	0.06	< 50	< 50	< 50	350
N18d01	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.02	< 50	< 50	< 50	< 50
N19d01	< 0.01	< 0.01	0.05	0.06	< 0.01	< 0.01	0.01	0.01	< 50	< 50	400	200
N19d02	< 0.01	< 0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	0.02	< 50	< 50	50	< 50
N19d03	< 0.01	< 0.01	< 0.01	0.05	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	200
N19d04	< 0.01	< 0.01	0.03	0.04	< 0.01	< 0.01	0.10	0.10	< 50	< 50	300	200
N19d05	< 0.01	< 0.01	0.05	0.06	< 0.01	< 0.01	< 0.01	0.01	< 50	< 50	150	< 50
N21d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
N21d02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	50
N21d03	< 0.01	< 0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	100	150
N21d04	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	50	100
N21d05	< 0.01	< 0.01	0.01	0.01	< 0.01	< 0.01	0.02	0.02	< 50	< 50	100	150
N21d06	< 0.01	< 0.01	0.04	0.05	< 0.01	< 0.01	0.04	0.04	< 50	< 50	50	100
N21d07	< 0.01	0.01	0.04	0.04	< 0.01	< 0.01	0.02	0.02	< 50	< 50	200	250
N21d08	< 0.01	0.01	0.04	0.04	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	150	150
N21d09	< 0.01	0.02	0.03	0.04	< 0.01	< 0.01	0.03	0.03	< 50	100	350	400
N21d10	< 0.01	0.01	0.02	0.02	< 0.01	< 0.01	0.02	0.02	< 50	100	50	100
N21d11	< 0.01	< 0.01	0.03	0.03	< 0.01	< 0.01	0.11	0.11	< 50	< 50	< 50	50
N21d12	< 0.01	< 0.01	0.05	0.05	< 0.01	< 0.01	0.11	0.11	< 50	50	500	250
N21d13	< 0.01	< 0.01	0.05	0.06	< 0.01	< 0.01	0.01	0.01	< 50	< 50	300	100
N21d14	< 0.01	< 0.01	0.05	0.06	< 0.01	< 0.01	< 0.01	0.01	< 50	< 50	250	100
N21d15	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	50
N21d16	< 0.01	< 0.01	< 0.01	0.04	< 0.01	< 0.01	< 0.01	0.05	< 50	< 50	< 50	250
N22d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
N22d02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
N23d02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
O01d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
O01d02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
O11d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
P01d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
P02d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
P03d01	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
P04d01	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.01	< 50	< 50	< 50	100
P05d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50

Table D.04 - Predictions for the Farm Dams within the Study Area

Dam Ref.	Predicted Total or Travelling Hogging Curvature after LW901 (1/km)	Predicted Total or Travelling Hogging Curvature after LW902 (1/km)	Predicted Total or Travelling Hogging Curvature after LW903 (1/km)	Predicted Total or Travelling Hogging Curvature after LW904 (1/km)	Predicted Total or Travelling Sagging Curvature after LW901 (1/km)	Predicted Total or Travelling Sagging Curvature after LW902 (1/km)	Predicted Total or Travelling Sagging Curvature after LW903 (1/km)	Predicted Total or Travelling Sagging Curvature after LW904 (1/km)	Predicted Change in Freeboard after LW901 (mm)	Predicted Change in Freeboard after LW902 (mm)	Predicted Change in Freeboard after LW903 (mm)	Predicted Change in Freeboard after LW904 (mm)
P05d02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
P06d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
P08d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
P09d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
P10d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
P10d02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
P11d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
P13d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
P13d02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
P14d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
P14d02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
P15d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
P15d02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
P16d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
P16d02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
P16d03	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
P19d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
P20d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
P20d02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
P21d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
P21d02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
P22d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50
P23d01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 50	< 50	< 50	< 50

Table D.05 - Predictions for the Tanks within the Study Area

Structure Ref.	Maximum Length (m)	Predicted Total Subsidence after LW901 (mm)	Predicted Total Subsidence after LW902 (mm)	Predicted Total Subsidence after LW903 (mm)	Predicted Total Subsidence after LW904 (mm)	Predicted Total Tilt after LW901 (mm/m)	Predicted Total Tilt after LW902 (mm/m)	Predicted Total Tilt after LW903 (mm/m)	Predicted Total Tilt after LW904 (mm/m)	Predicted Total or Travelling Hogging Curvature after LW901 (1/km)	Predicted Total or Travelling Hogging Curvature after LW902 (1/km)	Predicted Total or Travelling Hogging Curvature after LW903 (1/km)	Predicted Total or Travelling Hogging Curvature after LW904 (1/km)	Predicted Total or Travelling Sagging Curvature after LW901 (1/km)	Predicted Total or Travelling Sagging Curvature after LW902 (1/km)	Predicted Total or Travelling Sagging Curvature after LW903 (1/km)	Predicted Total or Travelling Sagging Curvature after LW904 (1/km)
A30t02	1.86	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A30t03	1.61	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
D54t01	8.44	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
D54t02	3.25	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
D54t03	4.35	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
D54t04	5.38	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E01t01	2.02	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E01t02	2.02	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E02t01	2	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E03t01	7.95	< 20	< 20	50	50	< 0.5	< 0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E03t02	1.77	< 20	< 20	50	50	< 0.5	< 0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E03t03	1.77	< 20	< 20	50	50	< 0.5	< 0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E04t01	3.62	< 20	< 20	50	50	< 0.5	< 0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E04t02	2.61	< 20	< 20	50	50	< 0.5	< 0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E04t03	1.87	< 20	< 20	25	50	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E05t01	2.57	< 20	< 20	100	125	< 0.5	< 0.5	1.5	1.5	< 0.01	< 0.01	0.01	0.02	< 0.01	< 0.01	< 0.01	< 0.01
E06t01	3.02	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E06t02	1.82	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E07t01	1.57	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E07t02	3.3	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E08t01	8.51	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E08t02	3.6	< 20	< 20	25	50	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E09t01	9.26	< 20	< 20	25	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E09t02	2.66	< 20	< 20	25	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E10t01	5.45	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E10t02	3.44	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E10t03	3.87	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E11t01	3.48	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E11t02	4.03	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E11t03	1.26	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
F01t01	7.35	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
F01t02	6.82	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
F02t01	3.73	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
F02t02	3.48	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
F03t01	7.32	< 20	< 20	< 20	275	< 0.5	< 0.5	< 0.5	3.0	< 0.01	< 0.01	< 0.01	0.04	< 0.01	< 0.01	< 0.01	< 0.01
F03t02	2	< 20	< 20	< 20	200	< 0.5	< 0.5	< 0.5	2.0	< 0.01	< 0.01	< 0.01	0.03	< 0.01	< 0.01	< 0.01	< 0.01
F03t03	2.05	< 20	< 20	< 20	175	< 0.5	< 0.5	< 0.5	2.0	< 0.01	< 0.01	< 0.01	0.03	< 0.01	< 0.01	< 0.01	< 0.01
F03t04	3.5	< 20	< 20	< 20	175	< 0.5	< 0.5	< 0.5	1.5	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	< 0.01
F03t05	3.09	< 20	< 20	< 20	150	< 0.5	< 0.5	< 0.5	1.5	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	< 0.01
F04t01	7.97	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
F04t02	2.63	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
F05t01	1.32	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
F05t02	1.33	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H01t01	1.86	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H01t02	1.85	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H01t03	1.04	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H01t04	1.04	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H02t01	2.49	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H02t02	1.72	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H02t03	2.02	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H04t01	2.57	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H04t02	2	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H06t01	4.01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H06t02	1.51	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H09t01	1.79	< 20	< 20	50	75	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H09t02	1.92	< 20	< 20	75	75	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H09t03	1.93	< 20	< 20	75	75	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H10t01	4.84	< 20	< 20	400	425	< 0.5	< 0.5	3.5	4.0	< 0.01	< 0.01	0.03	0.03	< 0.01	< 0.01	0.02	0.02
H11t01	3.32	< 20	< 20	275	325	< 0.5	< 0.5	3.5	3.5	< 0.01	< 0.01	0.05	0.05	< 0.01	< 0.01	< 0.01	< 0.01

Table D.05 - Predictions for the Tanks within the Study Area

Structure Ref.	Maximum Length (m)	Predicted Total Subsidence after LW901 (mm)	Predicted Total Subsidence after LW902 (mm)	Predicted Total Subsidence after LW903 (mm)	Predicted Total Subsidence after LW904 (mm)	Predicted Total Tilt after LW901 (mm/m)	Predicted Total Tilt after LW902 (mm/m)	Predicted Total Tilt after LW903 (mm/m)	Predicted Total Tilt after LW904 (mm/m)	Predicted Total or Travelling Hogging Curvature after LW901 (1/km)	Predicted Total or Travelling Hogging Curvature after LW902 (1/km)	Predicted Total or Travelling Hogging Curvature after LW903 (1/km)	Predicted Total or Travelling Hogging Curvature after LW904 (1/km)	Predicted Total or Travelling Sagging Curvature after LW901 (1/km)	Predicted Total or Travelling Sagging Curvature after LW902 (1/km)	Predicted Total or Travelling Sagging Curvature after LW903 (1/km)	Predicted Total or Travelling Sagging Curvature after LW904 (1/km)
H11t02	2.68	< 20	< 20	350	400	< 0.5	< 0.5	4.5	4.5	< 0.01	< 0.01	0.05	0.05	< 0.01	< 0.01	0.01	0.01
H12t01	8.5	< 20	< 20	200	350	< 0.5	< 0.5	2.5	2.5	< 0.01	< 0.01	0.03	0.03	< 0.01	< 0.01	< 0.01	< 0.01
H12t02	2.6	< 20	< 20	375	525	< 0.5	< 0.5	5.0	4.5	< 0.01	< 0.01	0.05	0.05	< 0.01	< 0.01	< 0.01	< 0.01
H12t03	2.27	< 20	< 20	400	525	< 0.5	< 0.5	5.0	4.5	< 0.01	< 0.01	0.05	0.05	< 0.01	< 0.01	< 0.01	< 0.01
H13t01	7.74	< 20	< 20	100	175	< 0.5	< 0.5	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H13t02	3.6	< 20	< 20	75	300	< 0.5	< 0.5	0.5	2.5	< 0.01	< 0.01	< 0.01	0.03	< 0.01	< 0.01	< 0.01	< 0.01
H13t03	1.74	< 20	< 20	100	150	< 0.5	< 0.5	1.0	1.0	< 0.01	< 0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
H13t04	1.82	< 20	< 20	100	175	< 0.5	< 0.5	1.0	1.0	< 0.01	< 0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
H13t05	1.88	< 20	< 20	75	125	< 0.5	< 0.5	1.0	1.0	< 0.01	< 0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
H13t06	1.35	< 20	< 20	75	125	< 0.5	< 0.5	1.0	1.0	< 0.01	< 0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
H14t01	7.67	< 20	< 20	50	200	< 0.5	< 0.5	< 0.5	1.5	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.01
H14t02	4.54	< 20	< 20	25	175	< 0.5	< 0.5	< 0.5	1.5	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.01
H16t01	1.17	< 20	50	650	700	< 0.5	0.5	3.0	3.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.02	0.02
H17t01	1.85	< 20	< 20	175	200	< 0.5	< 0.5	2.0	2.0	< 0.01	< 0.01	0.03	0.03	< 0.01	< 0.01	< 0.01	< 0.01
H17t02	1.96	< 20	< 20	175	200	< 0.5	< 0.5	2.0	2.0	< 0.01	< 0.01	0.03	0.03	< 0.01	< 0.01	< 0.01	< 0.01
H18t01	1.66	< 20	125	275	275	< 0.5	1.5	2.5	3.0	< 0.01	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
H18t02	1.67	< 20	125	275	275	< 0.5	1.5	2.5	3.0	< 0.01	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
H18t03	1.67	< 20	100	250	275	< 0.5	1.5	2.5	3.0	< 0.01	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
H18t04	2.03	< 20	125	375	400	< 0.5	2.0	3.0	3.5	< 0.01	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
H25t01	2.06	< 20	75	125	125	< 0.5	1.0	1.0	1.5	< 0.01	< 0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
H37t01	1.42	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H41t01	1.86	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H42t01	3.77	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H44t01	1.98	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J01t01	5.03	< 20	250	400	425	< 0.5	3.0	4.0	4.0	< 0.01	0.03	0.03	0.03	< 0.01	0.03	0.03	0.03
J02t01	6.15	150	725	875	875	1.5	2.0	2.5	2.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.02	0.02	0.02
J03t01	2.13	100	825	1025	1075	0.5	1.0	1.0	1.5	< 0.01	0.02	0.02	0.02	< 0.01	0.07	0.07	0.07
J04t01	3.18	325	800	900	925	2.5	< 0.5	1.0	1.0	0.01	0.01	0.01	0.01	< 0.01	0.01	0.01	0.01
J04t02	7.88	275	825	925	950	2.0	< 0.5	1.0	1.5	0.01	0.02	0.02	0.02	< 0.01	0.01	0.01	0.01
J04t03	3.41	300	800	925	950	2.0	< 0.5	1.0	1.5	0.01	0.01	0.01	0.01	< 0.01	0.01	0.01	0.01
J04t04	2.07	300	800	925	950	2.0	< 0.5	1.0	1.0	0.01	0.01	0.01	0.01	< 0.01	0.01	0.01	0.01
J05t01	7.53	250	825	975	1000	2.0	0.5	1.0	1.5	0.01	0.02	0.02	0.02	< 0.01	0.01	0.01	0.01
J05t02	1.8	275	825	950	975	2.0	< 0.5	1.0	1.5	0.01	0.02	0.02	0.02	< 0.01	0.01	0.01	0.01
J06t01	3.4	175	850	1025	1075	1.5	0.5	1.5	1.5	0.01	0.02	0.02	0.02	< 0.01	0.01	0.01	0.01
J06t02	1.48	125	875	1075	1125	1.0	< 0.5	1.0	1.0	< 0.01	0.02	0.02	0.02	< 0.01	0.04	0.04	0.04
J11t01	1.6	275	825	950	975	2.0	0.5	1.5	1.5	0.01	0.02	0.02	0.02	< 0.01	0.01	0.01	0.01
J11t02	2.05	225	850	975	1025	2.0	0.5	1.5	1.5	0.01	0.02	0.02	0.02	< 0.01	0.01	0.01	0.01
J11t03	2.05	225	850	975	1025	2.0	0.5	1.5	1.5	0.01	0.02	0.02	0.02	< 0.01	0.01	0.01	0.01
J13t01	7.74	375	800	900	925	2.5	< 0.5	1.0	1.0	0.01	0.01	0.01	0.01	< 0.01	0.01	0.01	0.01
J13t02	2.24	350	825	900	950	2.5	< 0.5	1.0	1.5	0.01	0.02	0.02	0.02	< 0.01	0.01	0.01	0.01
J14t01	3.32	325	825	925	950	2.0	< 0.5	1.0	1.5	0.01	0.02	0.02	0.02	< 0.01	0.01	0.01	0.01
J14t02	2.7	475	800	875	900	2.5	< 0.5	1.0	1.0	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
J14t03	3.6	475	800	875	875	2.5	0.5	1.0	1.0	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
J15t01	3.2	450	800	875	900	2.5	< 0.5	1.0	1.0	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
J16t01	7.73	550	775	825	825	2.0	1.5	1.5	2.0	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03
J17t01	8.42	475	675	725	725	2.0	2.5	2.5	2.5	< 0.01	< 0.01	< 0.01	< 0.01	0.03	0.03	0.03	0.03
J17t02	2.32	475	700	725	725	1.5	2.0	2.5	2.5	< 0.01	< 0.01	< 0.01	< 0.01	0.03	0.03	0.03	0.03
J18t01	3.19	425	675	700	725	2.5	2.5	3.0	3.0	< 0.01	< 0.01	< 0.01	< 0.01	0.02	0.02	0.02	0.02
J19t01	7	250	600	650	675	2.5	3.0	3.5	3.5	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02
J19t02	1.71	225	475	525	525	2.5	3.5	3.5	3.5	0.02	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
J20t01	8.4	50	300	375	375	< 0.5	3.0	3.5	3.5	< 0.01	0.03	0.03	0.03	< 0.01	< 0.01	< 0.01	< 0.01
J20t02	1.8	25	250	325	325	< 0.5	3.0	3.5	3.5	< 0.01	0.03	0.03	0.03	< 0.01	< 0.01	< 0.01	< 0.01
J20t03	1.8	25	250	325	325	< 0.5	3.0	3.5	3.5	< 0.01	0.03	0.03	0.03	< 0.01	< 0.01	< 0.01	< 0.01
J21t01	1.78	< 20	100	150	150	< 0.5	1.0	1.5	1.5	< 0.01	0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
J24t01	2.11	< 20	75	100	100	< 0.5	0.5	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J30t01	2.42	25	75	75	100	< 0.5	0.5	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J30t02	1.47	50	100	125	125	< 0.5	1.0	1.5	1.5	< 0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
J31t01	2.27	50	125	125	125	< 0.5	1.5	1.5	1.5	< 0.01	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
J32t01	1.78	50	100	100	100	< 0.5	1.0	1.0	1.0	< 0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01

Table D.05 - Predictions for the Tanks within the Study Area

Structure Ref.	Maximum Length (m)	Predicted Total Subsidence after LW901 (mm)	Predicted Total Subsidence after LW902 (mm)	Predicted Total Subsidence after LW903 (mm)	Predicted Total Subsidence after LW904 (mm)	Predicted Total Tilt after LW901 (mm/m)	Predicted Total Tilt after LW902 (mm/m)	Predicted Total Tilt after LW903 (mm/m)	Predicted Total Tilt after LW904 (mm/m)	Predicted Total or Travelling Hogging Curvature after LW901 (1/km)	Predicted Total or Travelling Hogging Curvature after LW902 (1/km)	Predicted Total or Travelling Hogging Curvature after LW903 (1/km)	Predicted Total or Travelling Hogging Curvature after LW904 (1/km)	Predicted Total or Travelling Sagging Curvature after LW901 (1/km)	Predicted Total or Travelling Sagging Curvature after LW902 (1/km)	Predicted Total or Travelling Sagging Curvature after LW903 (1/km)	Predicted Total or Travelling Sagging Curvature after LW904 (1/km)
J44t01	1.29	< 20	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J49t01	1.93	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J54t01	2.82	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J56t01	1.93	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J59t01	2.45	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K01t01	2.1	75	100	100	100	1.0	1.5	1.5	1.5	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
K10t01	2.72	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K34t01	1.8	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K41t01	1.94	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K41t02	2.75	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K43t01	1.94	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K43t02	1.93	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K45t01	1.77	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K52t01	2.17	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K52t02	2.17	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K56t01	1.82	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K86t01	1.36	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L01t01	2.51	200	225	225	225	1.5	2.0	2.0	2.0	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
L01t02	1.65	200	225	225	225	1.5	1.5	1.5	2.0	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
L07t01	1.36	275	300	300	300	2.0	2.5	2.5	2.5	0.01	0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
L07t02	1.85	300	325	325	325	2.0	2.5	2.5	2.5	0.01	0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
L08t01	1.98	275	300	300	300	2.0	2.5	2.5	2.5	0.01	0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
L09t01	1.36	175	175	175	175	1.5	1.5	1.5	1.5	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
L12t01	2.42	150	175	175	175	1.5	2.0	2.0	2.0	< 0.01	< 0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
L13t01	8.11	100	100	100	100	0.5	0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L13t02	1.59	75	75	75	75	< 0.5	0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L18t01	2.4	100	125	125	125	0.5	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L23t01	3.6	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L24t01	2.38	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
M02t01	1.77	125	125	125	125	1.0	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
M02t02	1.41	125	125	125	125	1.0	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
M03t01	3.33	350	375	375	375	2.5	3.0	3.0	3.0	0.02	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
M04t01	2.23	600	750	775	775	2.0	3.0	3.0	3.0	0.02	0.02	0.02	0.02	0.04	0.04	0.04	0.04
M04t02	2.24	600	775	800	800	1.5	2.5	3.0	3.0	0.02	0.02	0.02	0.02	0.04	0.04	0.04	0.04
M05t01	2.7	450	525	525	525	2.5	3.0	3.0	3.0	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01
M05t02	1.82	450	500	500	500	2.5	3.0	3.0	3.0	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
M05t03	3.27	525	800	825	825	2.5	< 0.5	0.5	0.5	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03
M06t01	4.13	500	550	575	575	2.5	3.0	3.0	3.0	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
M08t01	3.29	100	125	125	125	0.5	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
M08t02	3.23	100	100	100	100	0.5	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
M10t01	2.73	275	300	325	325	2.5	2.5	2.5	2.5	0.02	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
M12t01	1.45	75	75	75	75	< 0.5	0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
M12t02	5.48	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
M13t01	1.85	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
N01t01	3.48	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
N01t02	1.77	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
N02t01	5.77	< 20	600	750	750	< 0.5	1.5	2.5	3.0	< 0.01	0.02	0.02	0.02	< 0.01	0.04	0.04	0.04
N02t02	1.71	< 20	575	775	775	< 0.5	1.0	2.5	2.5	< 0.01	0.02	0.02	0.02	< 0.01	0.03	0.03	0.03
N04t01	2.57	50	450	825	900	< 0.5	5.5	3.5	3.0	< 0.01	0.06	0.07	0.07	< 0.01	< 0.01	0.01	0.01
N04t02	2.57	50	425	825	900	< 0.5	5.0	3.5	3.0	< 0.01	0.06	0.07	0.07	< 0.01	< 0.01	0.01	0.01
N05t01	2.67	< 20	175	775	950	< 0.5	1.5	1.0	1.5	< 0.01	0.02	0.02	0.02	< 0.01	< 0.01	0.01	0.01
N06t01	6.54	25	250	750	875	< 0.5	3.0	0.5	1.5	< 0.01	0.04	0.04	0.04	< 0.01	< 0.01	0.01	0.01
N06t02	3.33	25	200	750	900	< 0.5	2.0	1.0	1.5	< 0.01	0.03	0.03	0.03	< 0.01	< 0.01	0.01	0.01
N06t03	2.65	25	275	725	850	< 0.5	3.5	1.0	1.0	< 0.01	0.04	0.05	0.05	< 0.01	< 0.01	0.01	0.01
N11t01	7.63	< 20	< 20	175	800	< 0.5	< 0.5	2.0	1.5	< 0.01	< 0.01	0.03	0.03	< 0.01	< 0.01	< 0.01	0.02
N11t02	3.15	< 20	< 20	150	775	< 0.5	< 0.5	1.5	2.0	< 0.01	< 0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	0.02
N11t03	2.72	< 20	< 20	75	875	< 0.5	< 0.5	0.5	1.0	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01	0.02
N11t04	7.88	< 20	100	825	1050	< 0.5	1.0	< 0.5	1.0	< 0.01	< 0.01	0.02	0.02	< 0.01	< 0.01	0.01	0.01
N11t05	1.7	< 20	125	825	1025	< 0.5	1.0	< 0.5	1.0	< 0.01	0.01	0.02	0.02	< 0.01	< 0.01	0.01	0.01

Table D.05 - Predictions for the Tanks within the Study Area

Structure Ref.	Maximum Length (m)	Predicted Total Subsidence after LW901 (mm)	Predicted Total Subsidence after LW902 (mm)	Predicted Total Subsidence after LW903 (mm)	Predicted Total Subsidence after LW904 (mm)	Predicted Total Tilt after LW901 (mm/m)	Predicted Total Tilt after LW902 (mm/m)	Predicted Total Tilt after LW903 (mm/m)	Predicted Total Tilt after LW904 (mm/m)	Predicted Total or Travelling Hogging Curvature after LW901 (1/km)	Predicted Total or Travelling Hogging Curvature after LW902 (1/km)	Predicted Total or Travelling Hogging Curvature after LW903 (1/km)	Predicted Total or Travelling Hogging Curvature after LW904 (1/km)	Predicted Total or Travelling Sagging Curvature after LW901 (1/km)	Predicted Total or Travelling Sagging Curvature after LW902 (1/km)	Predicted Total or Travelling Sagging Curvature after LW903 (1/km)	Predicted Total or Travelling Sagging Curvature after LW904 (1/km)
N11t06	2.51	< 20	100	825	1050	< 0.5	1.0	< 0.5	1.0	< 0.01	< 0.01	0.02	0.02	< 0.01	< 0.01	0.01	0.01
N11t07	3.83	< 20	100	825	1075	< 0.5	1.0	< 0.5	1.0	< 0.01	< 0.01	0.02	0.02	< 0.01	< 0.01	0.01	0.01
N11t08	1.65	< 20	125	825	1025	< 0.5	1.0	< 0.5	1.0	< 0.01	0.01	0.02	0.02	< 0.01	< 0.01	0.01	0.01
N13t01	8.2	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
N14t01	4.75	< 20	< 20	25	375	< 0.5	< 0.5	< 0.5	4.5	< 0.01	< 0.01	< 0.01	0.05	< 0.01	< 0.01	< 0.01	< 0.01
N14t02	1.41	< 20	< 20	< 20	225	< 0.5	< 0.5	< 0.5	2.5	< 0.01	< 0.01	< 0.01	0.03	< 0.01	< 0.01	< 0.01	< 0.01
N15t01	5.21	< 20	< 20	50	875	< 0.5	< 0.5	< 0.5	3.0	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.09
N15t02	3.25	< 20	< 20	50	900	< 0.5	< 0.5	< 0.5	1.0	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.06
N16t01	3	< 20	< 20	25	725	< 0.5	< 0.5	< 0.5	5.5	< 0.01	< 0.01	< 0.01	0.03	< 0.01	< 0.01	< 0.01	0.06
N17t01	2.6	< 20	< 20	25	850	< 0.5	< 0.5	< 0.5	5.0	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.08
N18t01	4.36	< 20	< 20	75	875	< 0.5	< 0.5	0.5	< 0.5	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.02
N20t01	8.06	< 20	75	825	1050	< 0.5	1.0	1.0	1.5	< 0.01	< 0.01	0.02	0.02	< 0.01	< 0.01	0.02	0.02
N20t02	2.36	< 20	75	825	1050	< 0.5	1.0	1.0	1.5	< 0.01	< 0.01	0.02	0.02	< 0.01	< 0.01	0.02	0.02
N20t03	3.08	< 20	50	850	1100	< 0.5	< 0.5	2.5	1.0	< 0.01	< 0.01	0.02	0.02	< 0.01	< 0.01	0.11	0.11
N21t01	4.61	< 20	100	325	350	< 0.5	1.0	2.0	2.5	< 0.01	0.02	0.03	0.03	< 0.01	< 0.01	< 0.01	< 0.01
N21t02	1.36	< 20	100	350	375	< 0.5	1.5	2.5	2.5	< 0.01	0.02	0.03	0.03	< 0.01	< 0.01	< 0.01	< 0.01
N21t03	3.67	< 20	50	350	375	< 0.5	1.0	2.0	2.0	< 0.01	0.01	0.03	0.03	< 0.01	< 0.01	< 0.01	< 0.01
N21t04	4.11	< 20	50	325	375	< 0.5	0.5	2.0	2.0	< 0.01	0.01	0.03	0.03	< 0.01	< 0.01	< 0.01	< 0.01
N21t05	4.1	< 20	50	275	325	< 0.5	0.5	1.5	2.0	< 0.01	< 0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
N21t06	2.22	< 20	50	275	325	< 0.5	0.5	1.5	2.0	< 0.01	< 0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
N21t07	3.44	< 20	75	200	225	< 0.5	0.5	1.0	1.5	< 0.01	< 0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
N22t01	8.34	< 20	< 20	50	75	< 0.5	< 0.5	0.5	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
N22t02	2.47	< 20	< 20	50	75	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
O01t01	2.76	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
O02t02	1.97	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P01t01	8.03	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P01t02	2.04	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P01t03	1.66	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P02t01	8.03	< 20	< 20	< 20	75	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P02t02	2.77	< 20	< 20	< 20	100	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P02t03	2.77	< 20	< 20	< 20	100	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P02t04	8.04	< 20	< 20	< 20	100	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P04t01	7.36	< 20	< 20	< 20	125	< 0.5	< 0.5	< 0.5	1.0	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	< 0.01
P05t01	7.8	< 20	< 20	< 20	175	< 0.5	< 0.5	< 0.5	1.0	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	< 0.01
P06t01	4.25	< 20	< 20	< 20	125	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P06t02	4.25	< 20	< 20	< 20	125	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P06t03	1.9	< 20	< 20	< 20	100	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P06t04	1.9	< 20	< 20	< 20	100	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P07t01	7.66	< 20	< 20	< 20	100	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P07t02	2.56	< 20	< 20	< 20	100	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P07t03	3.36	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P07t04	3.36	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P09t01	1.74	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P09t02	1.74	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P09t03	1.53	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P10t01	3.46	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P10t02	3.45	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P10t03	2.75	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P10t04	1.56	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P10t05	1.56	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P11t01	7.99	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P11t02	2.24	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P12t01	7.85	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P12t02	2.61	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P13t01	8.37	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P13t02	8.39	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P13t03	2.68	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P14t01	7.8	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P14t02	2.47	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

Table D.05 - Predictions for the Tanks within the Study Area

Structure Ref.	Maximum Length (m)	Predicted Total Subsidence after LW901 (mm)	Predicted Total Subsidence after LW902 (mm)	Predicted Total Subsidence after LW903 (mm)	Predicted Total Subsidence after LW904 (mm)	Predicted Total Tilt after LW901 (mm/m)	Predicted Total Tilt after LW902 (mm/m)	Predicted Total Tilt after LW903 (mm/m)	Predicted Total Tilt after LW904 (mm/m)	Predicted Total or Travelling Hogging Curvature after LW901 (1/km)	Predicted Total or Travelling Hogging Curvature after LW902 (1/km)	Predicted Total or Travelling Hogging Curvature after LW903 (1/km)	Predicted Total or Travelling Hogging Curvature after LW904 (1/km)	Predicted Total or Travelling Sagging Curvature after LW901 (1/km)	Predicted Total or Travelling Sagging Curvature after LW902 (1/km)	Predicted Total or Travelling Sagging Curvature after LW903 (1/km)	Predicted Total or Travelling Sagging Curvature after LW904 (1/km)
P14t03	2.47	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P14t04	2.47	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P15t01	8.49	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P15t02	2.66	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P16t01	8.29	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P16t02	2.55	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P18t01	8.78	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P18t02	2.53	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P19t01	8.17	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P19t02	2.8	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P19t03	2.48	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P20t01	7.82	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P22t01	8.22	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P22t02	2.21	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P23t01	8	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P23t02	2.2	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P23t03	1.8	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P23t04	1.81	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P25t01	8.01	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P25t02	1.86	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P25t03	1.85	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

Table D.06 - Predictions for the Pools within the Study Area

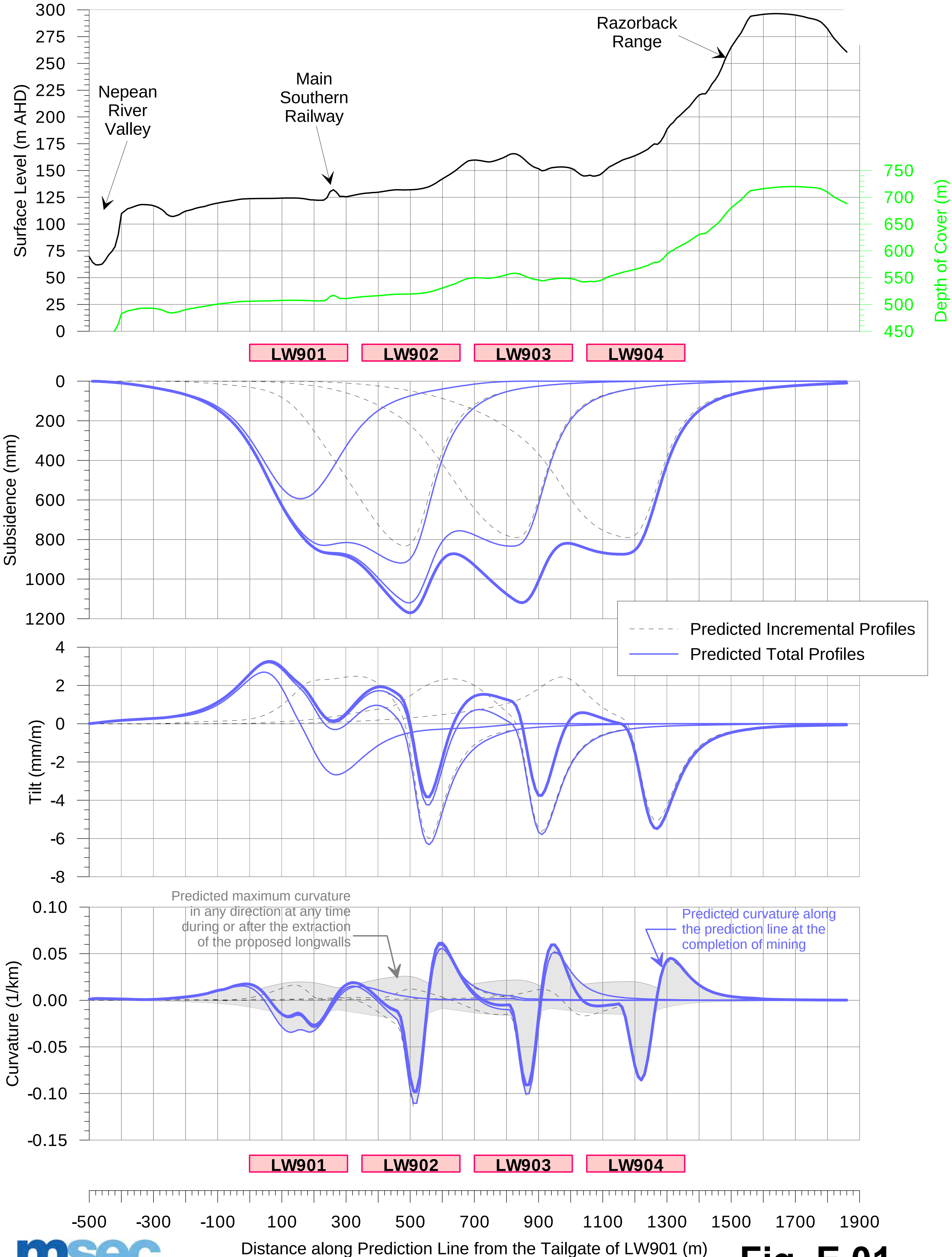
Pool Ref.	Maximum Length (m)	Predicted Total Subsidence after LW901 (mm)	Predicted Total Subsidence after LW902 (mm)	Predicted Total Subsidence after LW903 (mm)	Predicted Total Subsidence after LW904 (mm)	Predicted Total Tilt after LW901 (mm/m)	Predicted Total Tilt after LW902 (mm/m)	Predicted Total Tilt after LW903 (mm/m)	Predicted Total Tilt after LW904 (mm/m)	Predicted Total or Travelling Hogging Curvature after LW901 (1/km)	Predicted Total or Travelling Hogging Curvature after LW902 (1/km)	Predicted Total or Travelling Hogging Curvature after LW903 (1/km)	Predicted Total or Travelling Hogging Curvature after LW904 (1/km)	Predicted Total or Travelling Sagging Curvature after LW901 (1/km)	Predicted Total or Travelling Sagging Curvature after LW902 (1/km)	Predicted Total or Travelling Sagging Curvature after LW903 (1/km)	Predicted Total or Travelling Sagging Curvature after LW904 (1/km)
A30p01	9.86	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
D54p01	7.03	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E03p01	9.94	< 20	< 20	75	100	< 0.5	< 0.5	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E04p01	10.18	< 20	< 20	50	50	< 0.5	< 0.5	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E08p01	10.7	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E09p01	7.92	< 20	< 20	25	50	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
E12p01	8.65	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H01p01	12.31	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H03p01	7.97	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H07p01	7.36	< 20	< 20	50	75	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H14p01	8.62	< 20	< 20	50	175	< 0.5	< 0.5	< 0.5	1.5	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.01
H24p01	9.63	< 20	75	100	100	< 0.5	0.5	1.0	1.0	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
H25p01	8.92	< 20	75	125	125	< 0.5	0.5	1.0	1.0	< 0.01	< 0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
H26p01	9.18	< 20	25	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H34p01	7.41	< 20	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H36p01	8.31	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H37p01	8	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H38p01	9.53	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H39p01	8.76	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H42p01	9.62	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
H44p01	11.59	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J01p01	9.1	< 20	175	325	325	< 0.5	2.0	3.0	3.5	< 0.01	0.03	0.03	0.03	< 0.01	0.02	0.02	0.02
J03p01	11.06	150	850	1025	1050	1.0	0.5	1.0	1.5	< 0.01	0.02	0.02	0.02	< 0.01	0.02	0.02	0.02
J06p01	9.59	125	875	1075	1125	1.0	< 0.5	1.0	1.5	< 0.01	0.02	0.02	0.02	< 0.01	0.03	0.03	0.03
J10p01	8.11	150	900	1075	1150	1.0	0.5	1.5	1.5	< 0.01	0.02	0.02	0.02	< 0.01	0.02	0.02	0.02
J14p01	12.02	425	800	875	900	2.5	< 0.5	1.0	1.0	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
J17p01	11.11	525	725	775	775	1.5	2.0	2.0	2.0	0.01	0.01	0.01	0.01	0.03	0.03	0.03	0.03
J20p01	11.35	25	225	300	300	< 0.5	2.5	3.0	3.0	< 0.01	0.03	0.03	0.03	< 0.01	< 0.01	< 0.01	< 0.01
J23p01	9.93	< 20	75	100	125	< 0.5	0.5	1.0	1.0	< 0.01	< 0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
J24p01	10.97	25	100	125	125	< 0.5	1.0	1.5	1.5	< 0.01	0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
J25p01	6.1	25	100	125	125	< 0.5	1.0	1.0	1.0	< 0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
J27p01	8.45	25	75	100	100	< 0.5	0.5	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J29p01	10.27	25	75	100	100	< 0.5	1.0	1.0	1.0	< 0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
J49p01	7.17	< 20	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J50p01	9.66	< 20	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J53p01	8.25	< 20	25	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J55p01	7.75	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J57p01	8.17	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J60p01	5.22	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
J67p01	7.97	< 20	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K02p01	6.48	50	75	75	75	1.0	1.0	1.0	1.0	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
K03p01	6.13	50	50	50	50	0.5	0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K04p01	7.19	25	50	50	50	< 0.5	0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K05p01	8.72	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K34p01	7.43	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K35p01	7.96	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K38p01	8.24	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K42p01	8.99	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K53p01	7.95	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K57p01	5.25	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K66p01	8.86	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K67p01	4.25	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K71p01	6.74	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L08p01	8.79	225	250	250	250	2.0	2.0	2.0	2.0	0.01	0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
L13p01	10.4	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L14p01	10.45	100	100	100	100	0.5	0.5	0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L18p01	9.32	150	150	150	150	1.0	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

Table D.06 - Predictions for the Pools within the Study Area

Pool Ref.	Maximum Length (m)	Predicted Total Subsidence after LW901 (mm)	Predicted Total Subsidence after LW902 (mm)	Predicted Total Subsidence after LW903 (mm)	Predicted Total Subsidence after LW904 (mm)	Predicted Total Tilt after LW901 (mm/m)	Predicted Total Tilt after LW902 (mm/m)	Predicted Total Tilt after LW903 (mm/m)	Predicted Total Tilt after LW904 (mm/m)	Predicted Total or Travelling Hogging Curvature after LW901 (1/km)	Predicted Total or Travelling Hogging Curvature after LW902 (1/km)	Predicted Total or Travelling Hogging Curvature after LW903 (1/km)	Predicted Total or Travelling Hogging Curvature after LW904 (1/km)	Predicted Total or Travelling Sagging Curvature after LW901 (1/km)	Predicted Total or Travelling Sagging Curvature after LW902 (1/km)	Predicted Total or Travelling Sagging Curvature after LW903 (1/km)	Predicted Total or Travelling Sagging Curvature after LW904 (1/km)
L21p01	8.91	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L23p01	9.77	50	50	50	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L28p01	10.6	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
L29p01	9.02	25	25	25	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
M03p01	9.19	325	350	375	375	2.5	3.0	3.0	3.0	0.02	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
M05p01	9.63	375	425	425	425	2.5	3.0	3.0	3.0	0.01	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
M07p01	10.27	125	150	150	150	1.0	1.0	1.0	1.0	< 0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
M11p01	9.45	100	100	100	100	0.5	1.0	1.0	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
N06p01	8.47	25	250	750	875	< 0.5	3.0	0.5	1.5	< 0.01	0.04	0.04	0.04	< 0.01	< 0.01	0.01	0.01
N14p01	10.77	< 20	< 20	< 20	300	< 0.5	< 0.5	< 0.5	3.5	< 0.01	< 0.01	< 0.01	0.05	< 0.01	< 0.01	< 0.01	< 0.01
N15p01	8.52	< 20	< 20	50	875	< 0.5	< 0.5	< 0.5	5.0	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.09
O01p01	14.12	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P01p01	7.87	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P06p01	8.43	< 20	< 20	< 20	150	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P07p01	13.7	< 20	< 20	< 20	100	< 0.5	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P09p01	10.17	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P10p01	14	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P14p01	11.36	< 20	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P19p01	5.19	< 20	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P20p01	7.6	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
P23p01	9.51	< 20	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

APPENDIX E. FIGURES

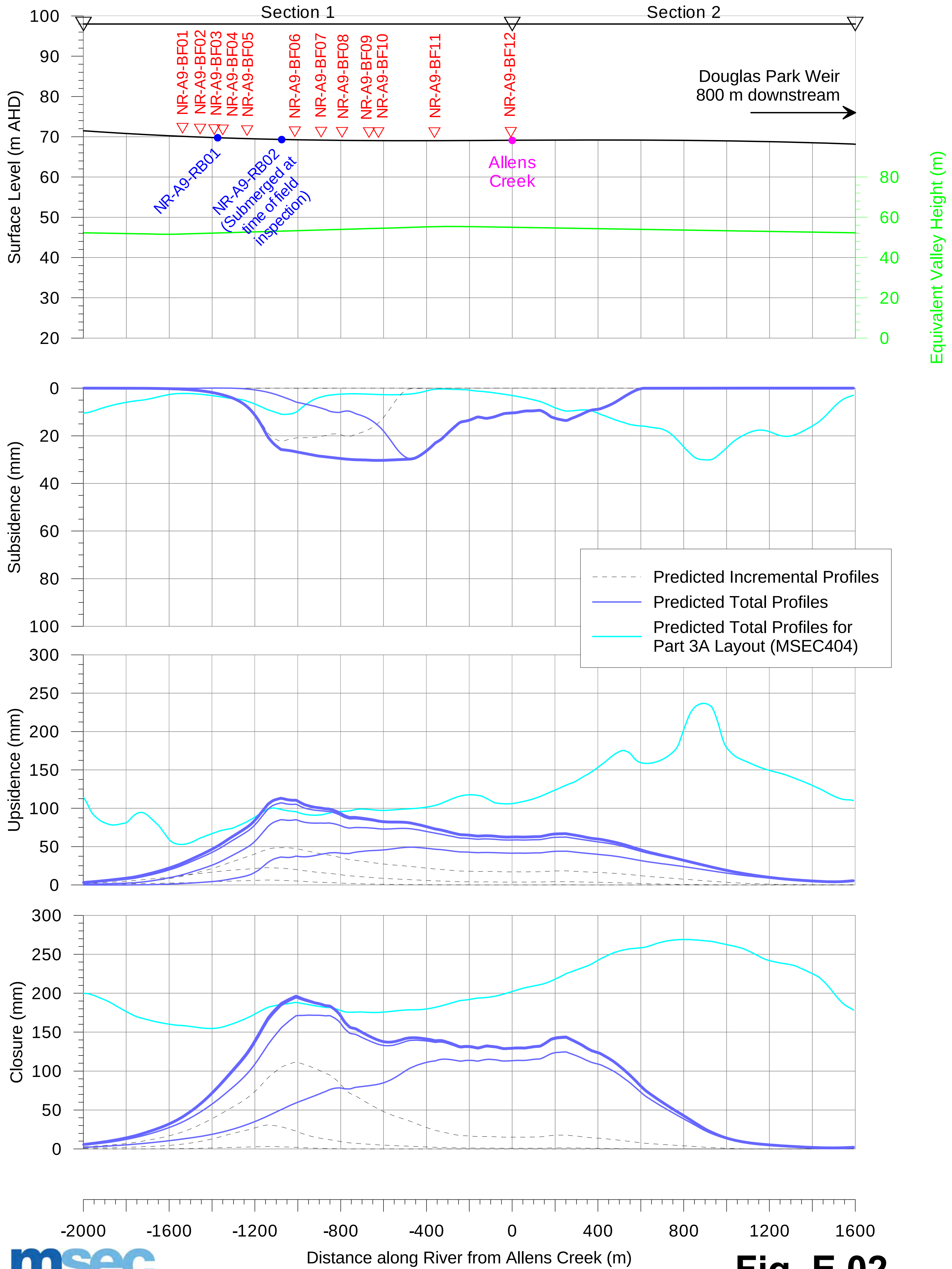
Predicted Profiles of Conventional Subsidence, Tilt and Curvature along Prediction Line 1 Resulting from the Extraction of Longwalls 901 to 904



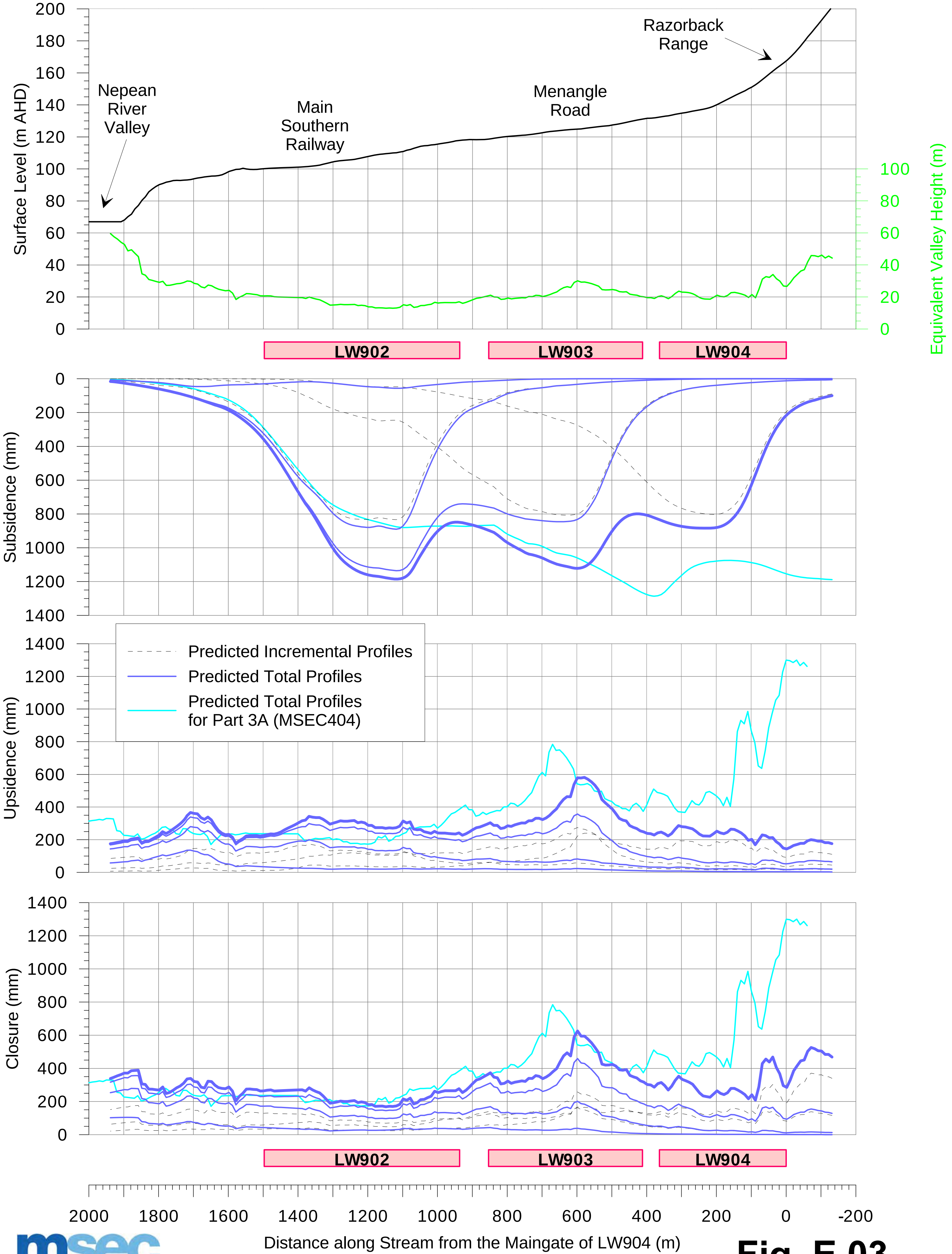
msec

Fig. E.01

Predicted Profiles of Subsidence, Upsidence and Closure along the Nepean River Resulting from the Extraction of Longwalls 901 to 904



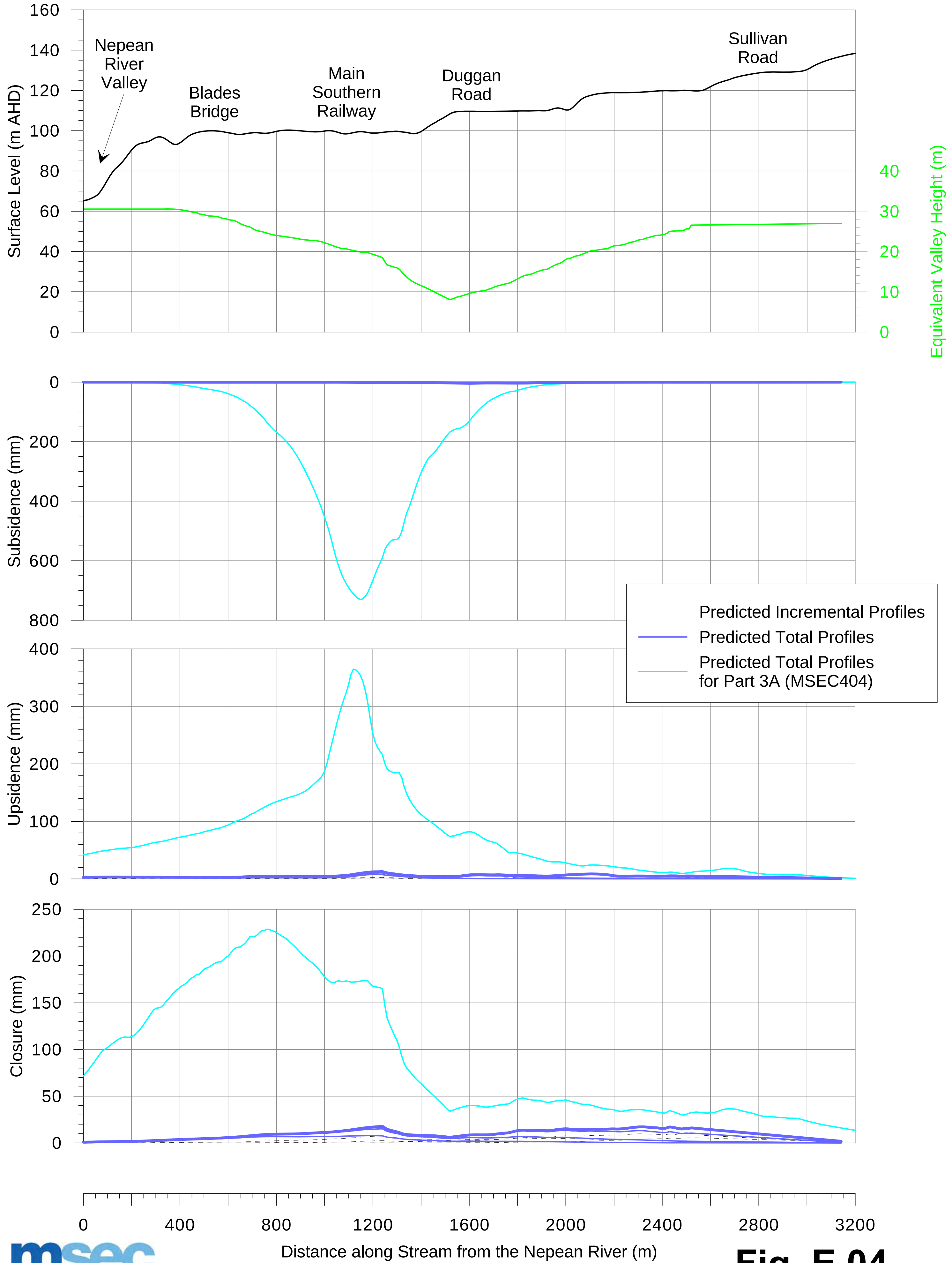
Predicted Profiles of Subsidence, Upsidence and Closure along the Nepean River Tributary 1 Resulting from the Extraction of Longwalls 901 to 904



msec

Fig. E.03

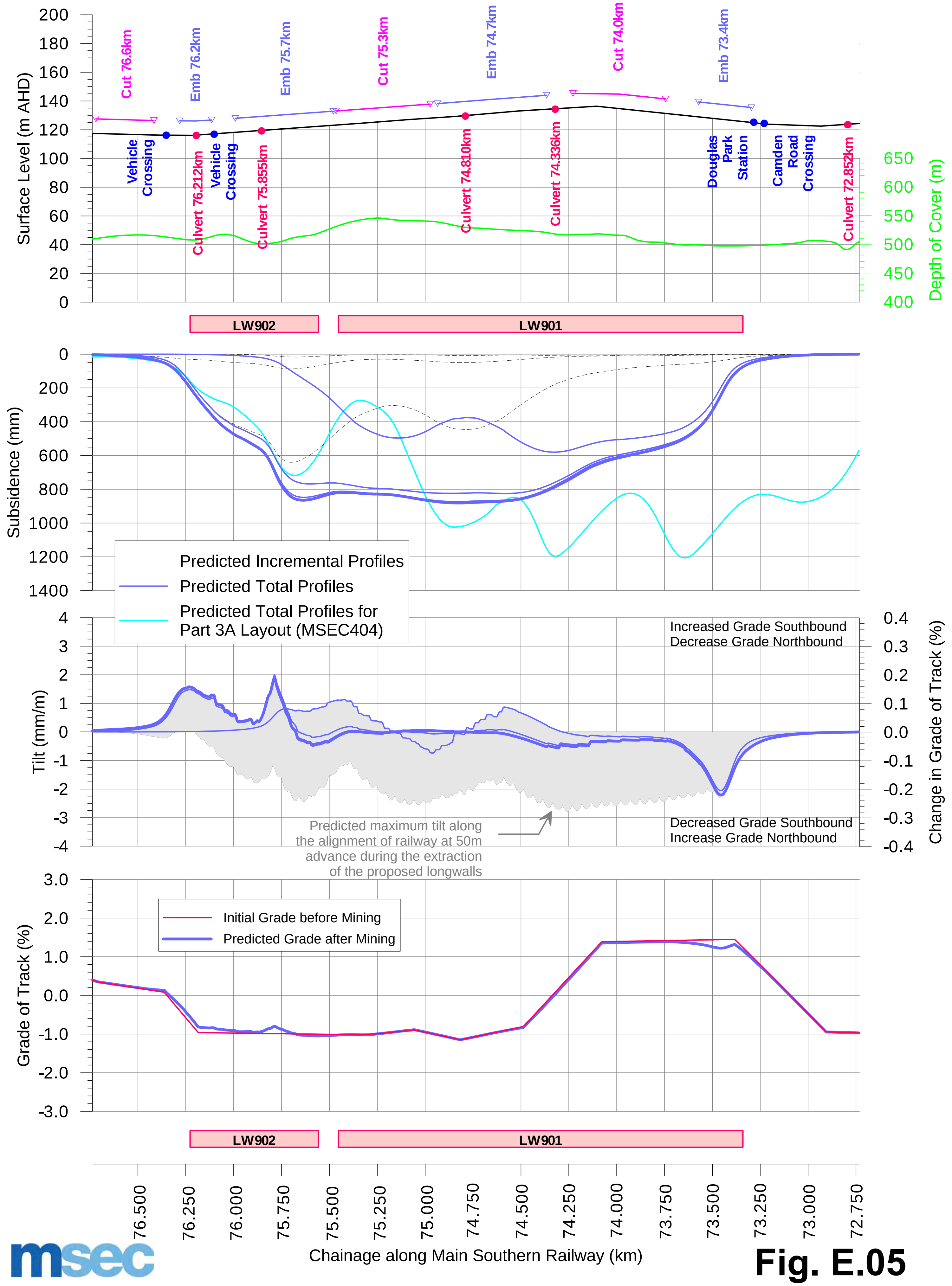
Predicted Profiles of Subsidence, Upsidence and Closure along Harris Creek Resulting from the Extraction of Longwalls 901 to 904



msec

Fig. E.04

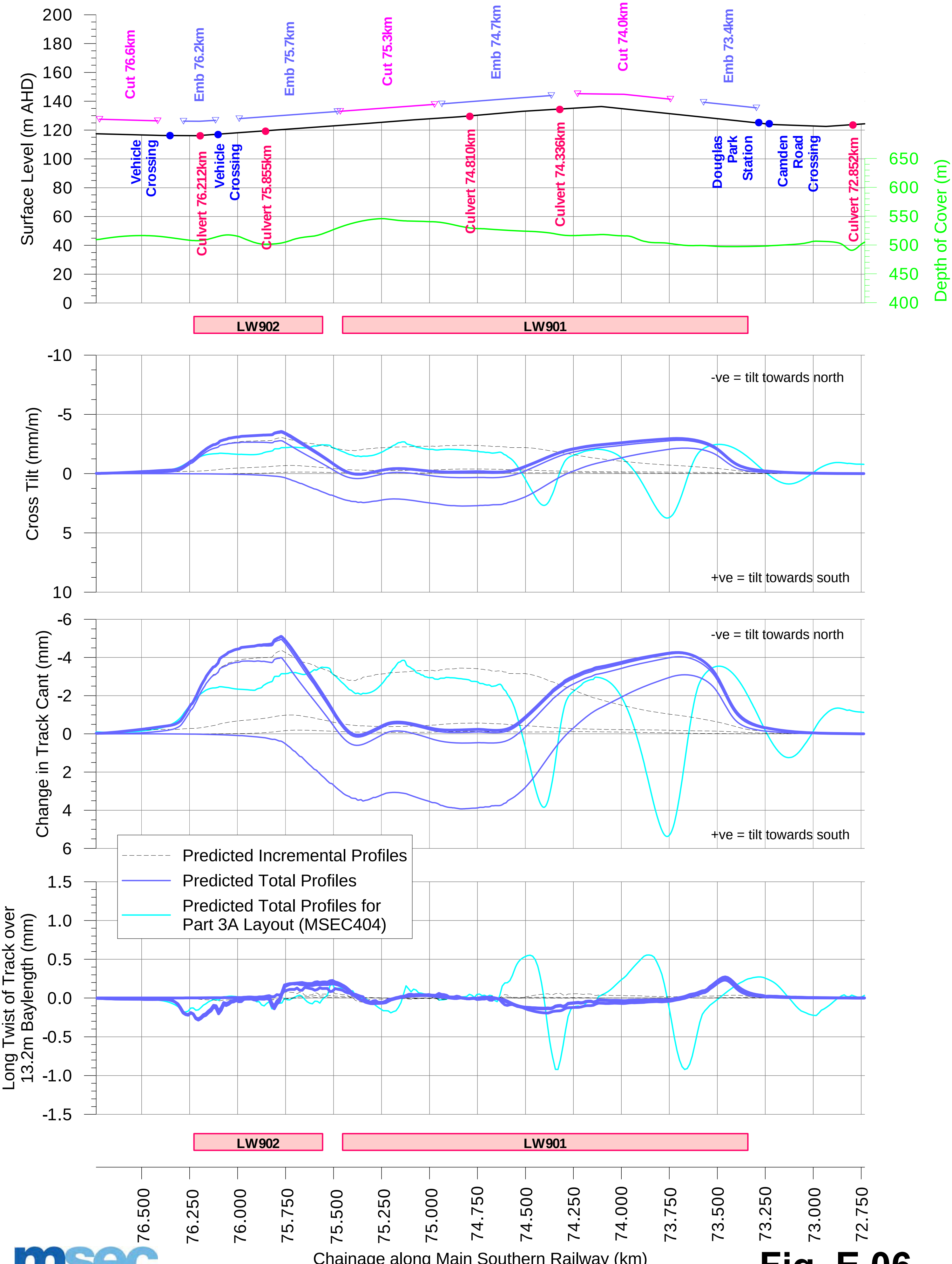
Predicted Profiles of Conventional Subsidence, Tilt and Change in Grade along the Main Southern Railway Resulting from the Extraction of Longwalls 901 to 904



msec

Fig. E.05

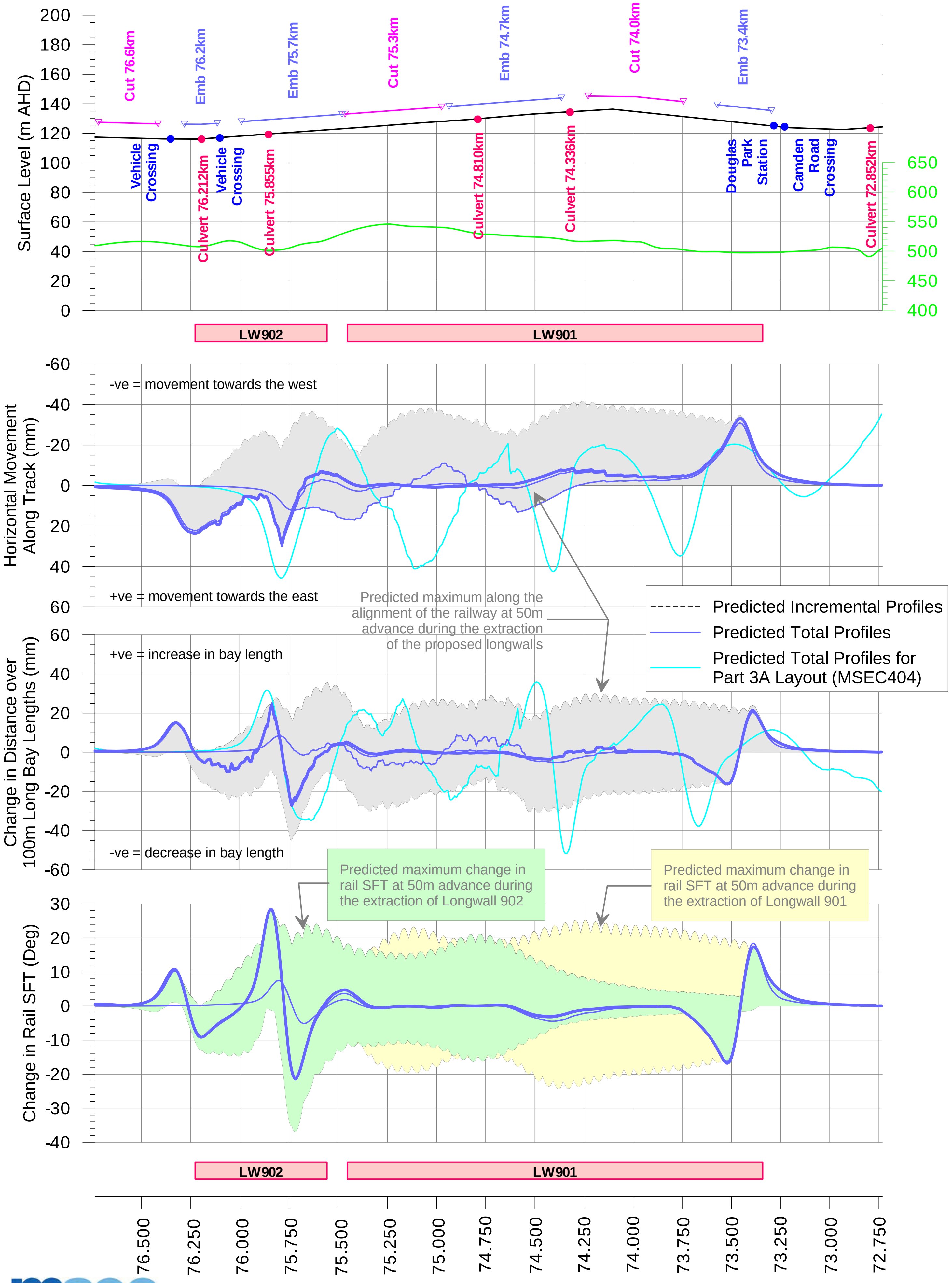
Predicted Profiles of Conventional Cross Tilt, Change in Track Cant and Long Twist along the Main Southern Railway Resulting from the Extraction of Longwalls 901 to 904



msec

Fig. E.06

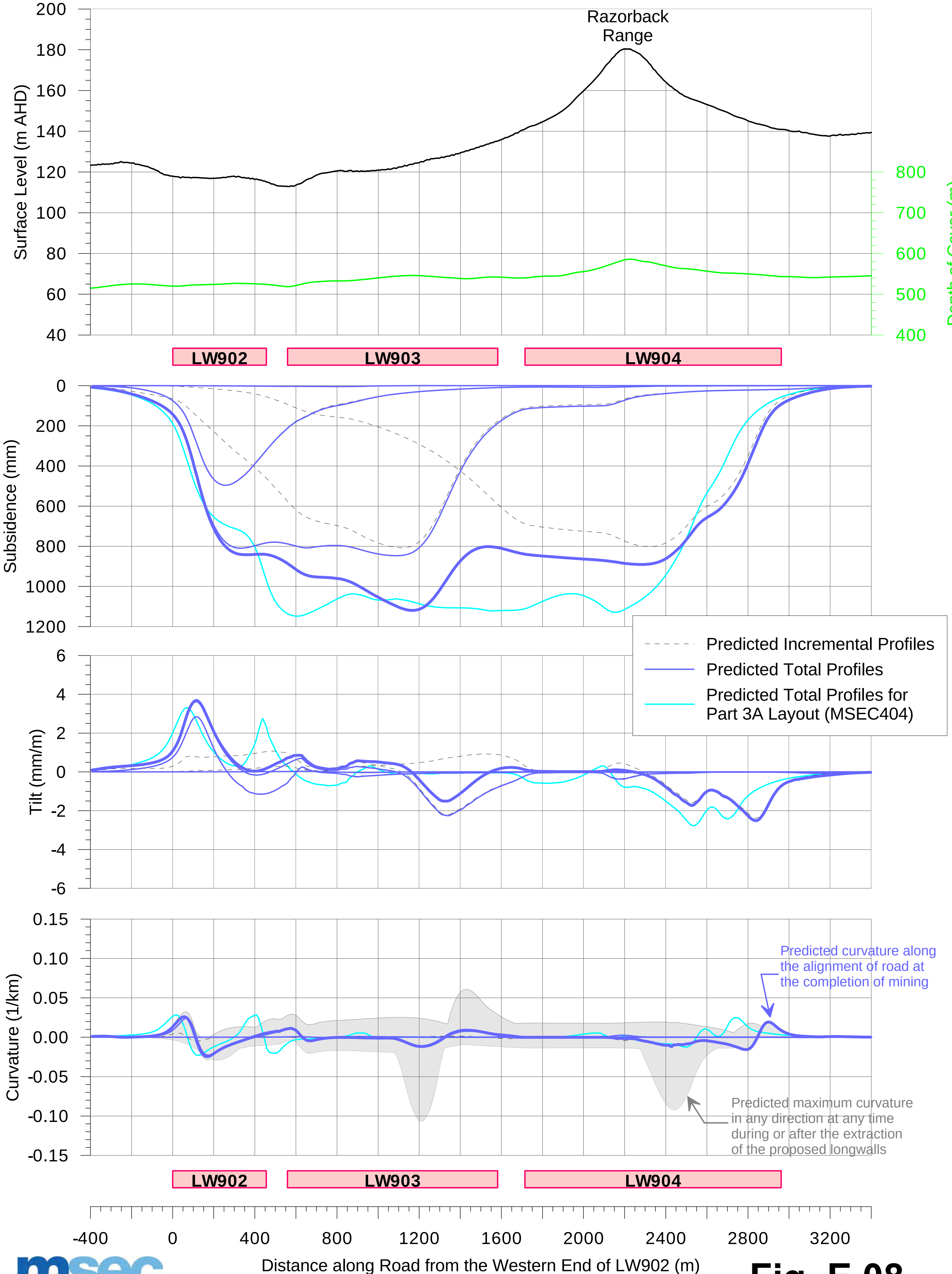
Predicted Profiles of Conventional Horizontal Movement Along Track, Change in Long Bay Length and Change in SFT for the Main Southern Railway Resulting from the Extraction of LWs 901 to 904



msec

Fig. E.07

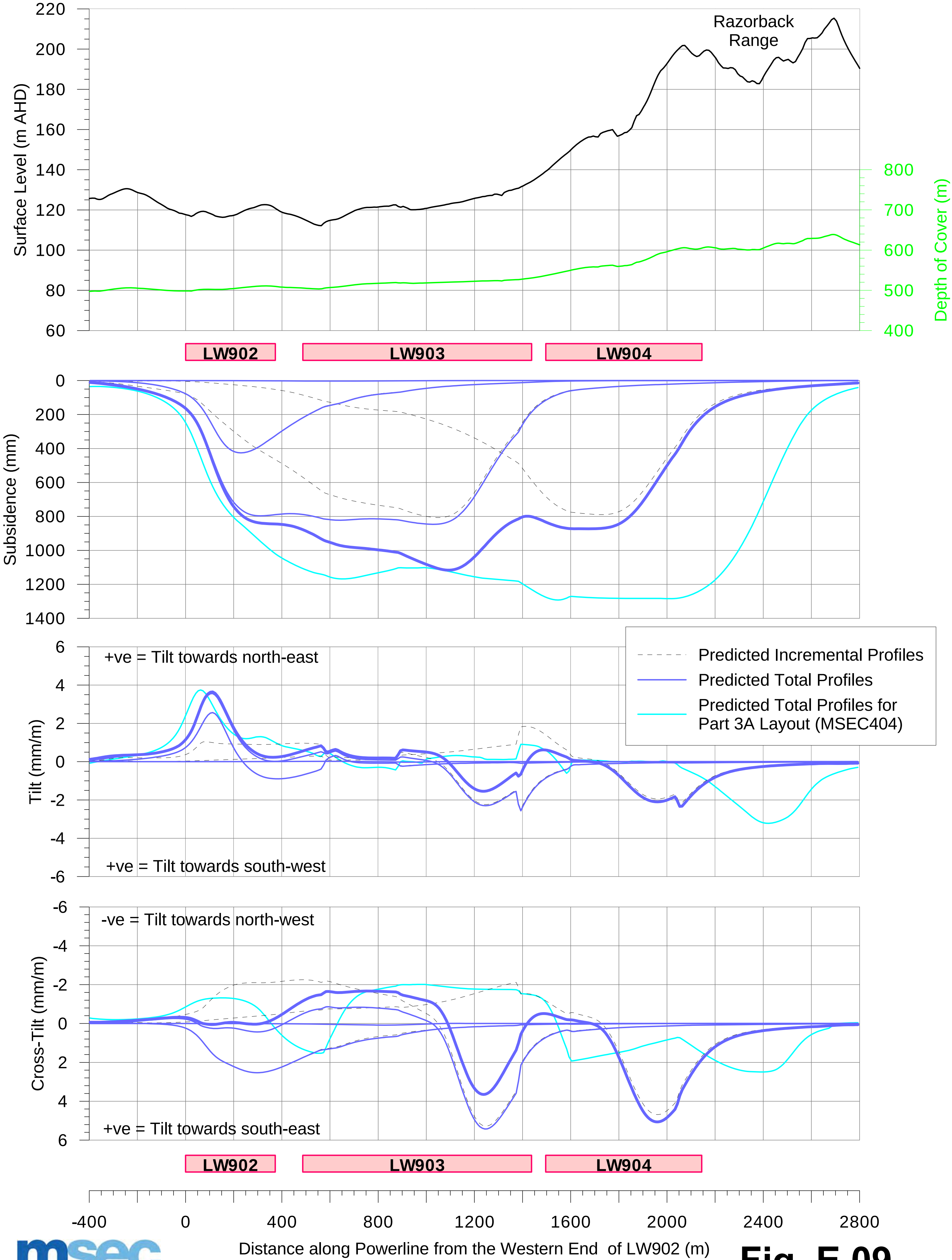
Predicted Profiles of Conventional Subsidence, Tilt and Curvature along Menangle Road Resulting from the Extraction of Longwalls 901 to 904



msec

Fig. E.08

Predicted Profiles of Conventional Subsidence, Tilt Along and Tilt Across the Alignment of the 66kV Powerline Resulting from the Extraction of LWs 901 to 904



msec

Fig. E.09

Predicted Profiles of Systematic Subsidence, Tilt and Curvature along the Optical Fibre Cable Resulting from the Extraction of Longwalls 901 to 904

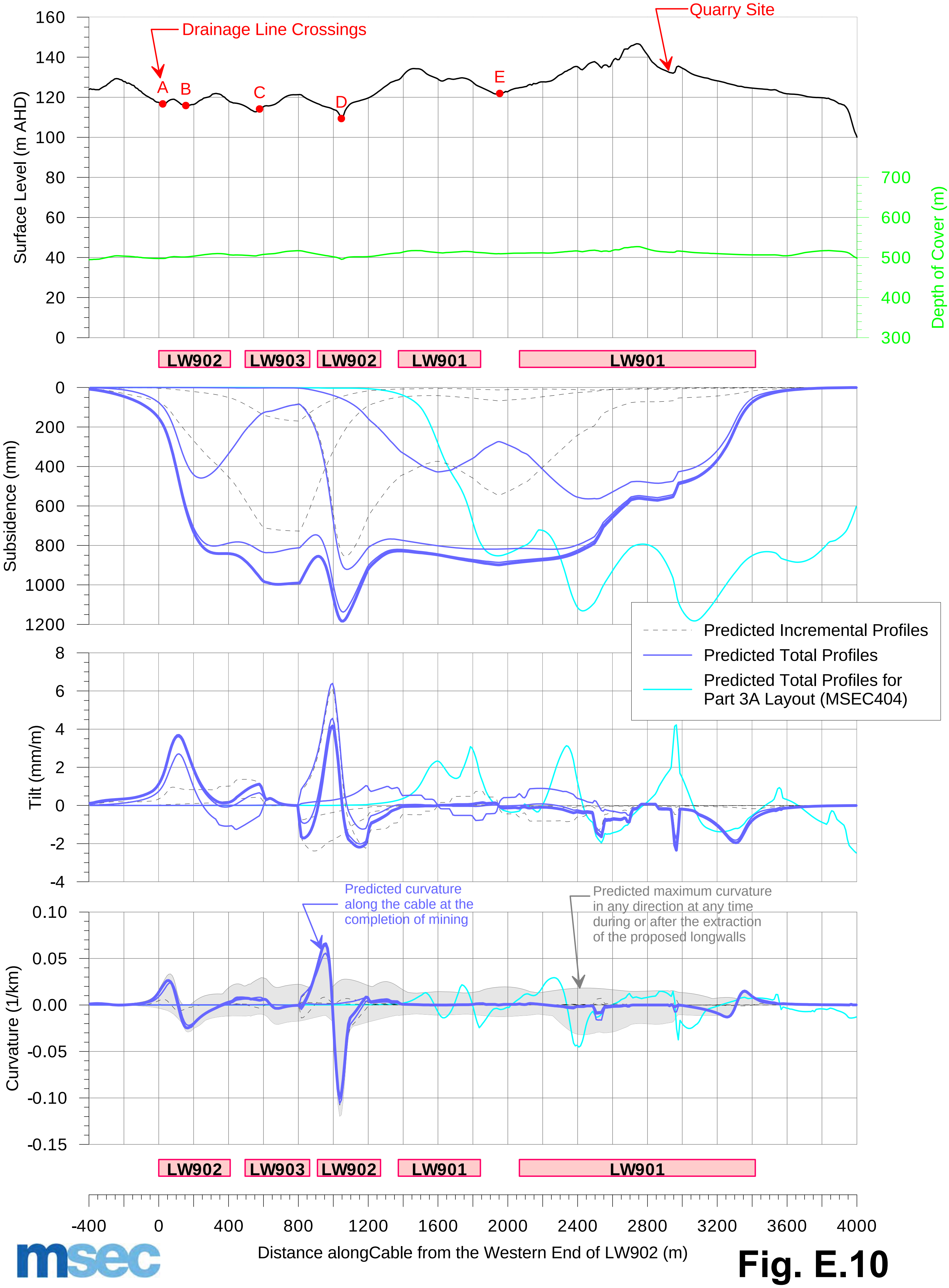


Fig. E.10

APPENDIX F. DRAWINGS

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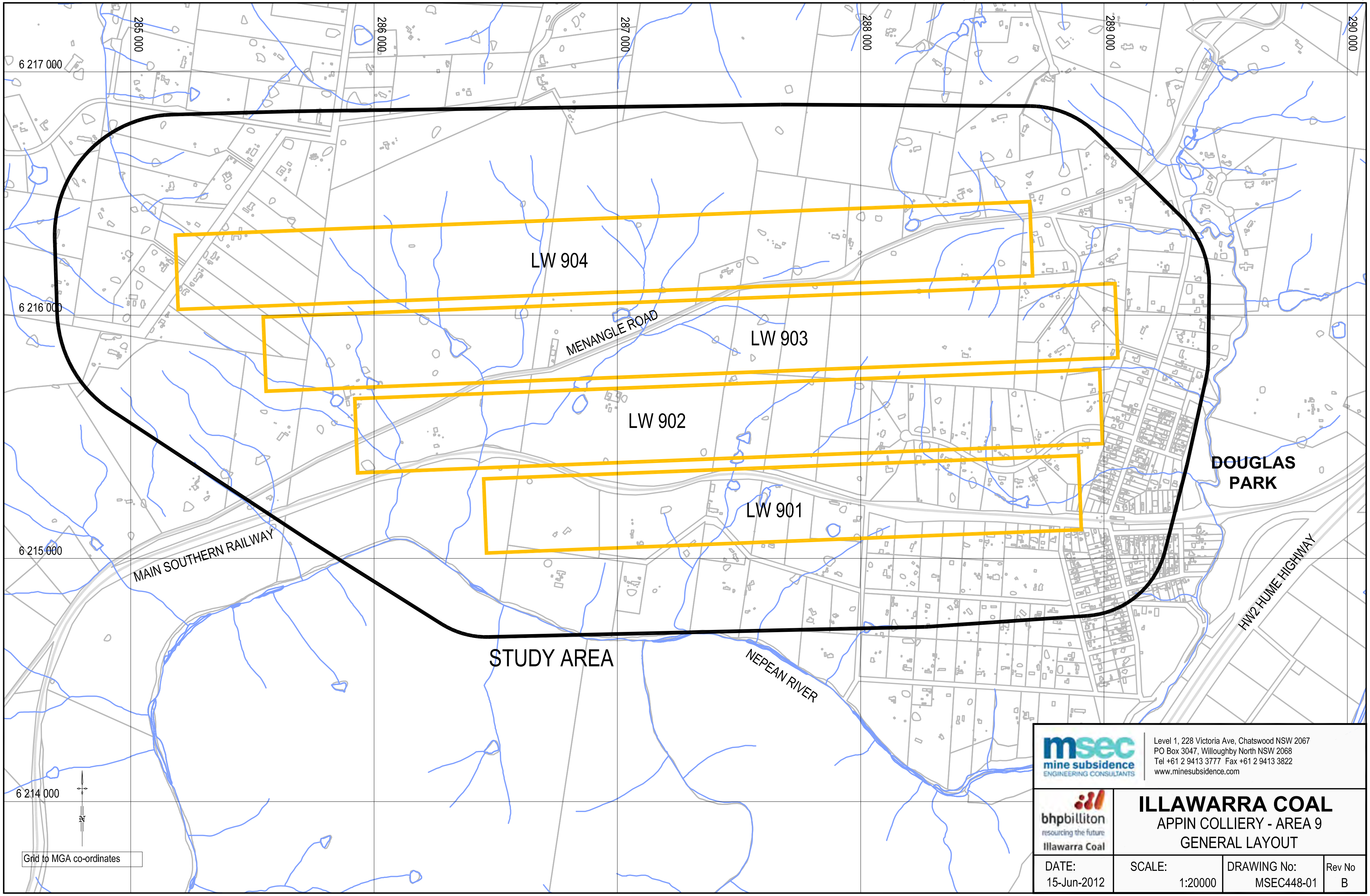

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GENERAL LAYOUT

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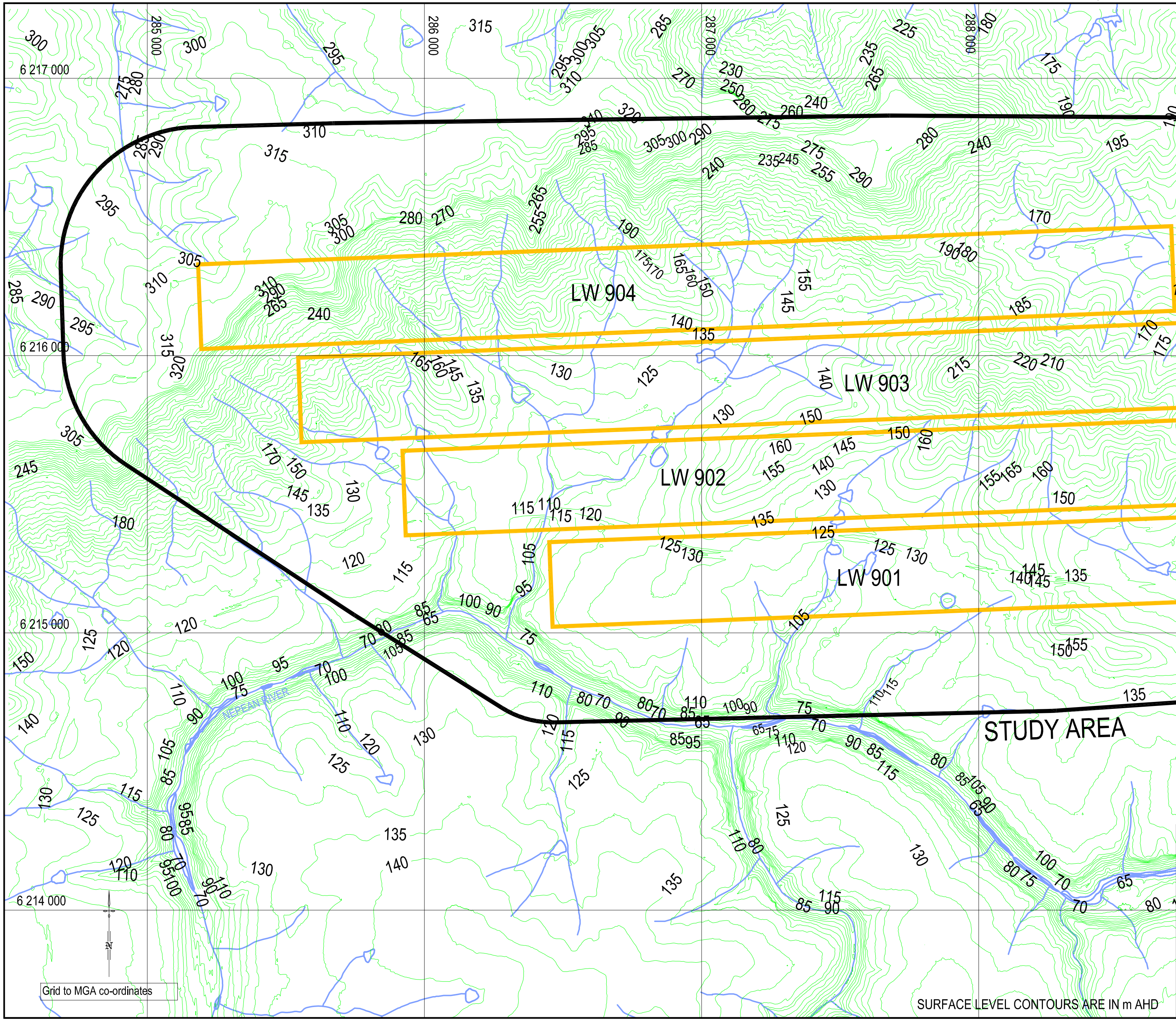

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SURFACE LEVEL CONTOURS

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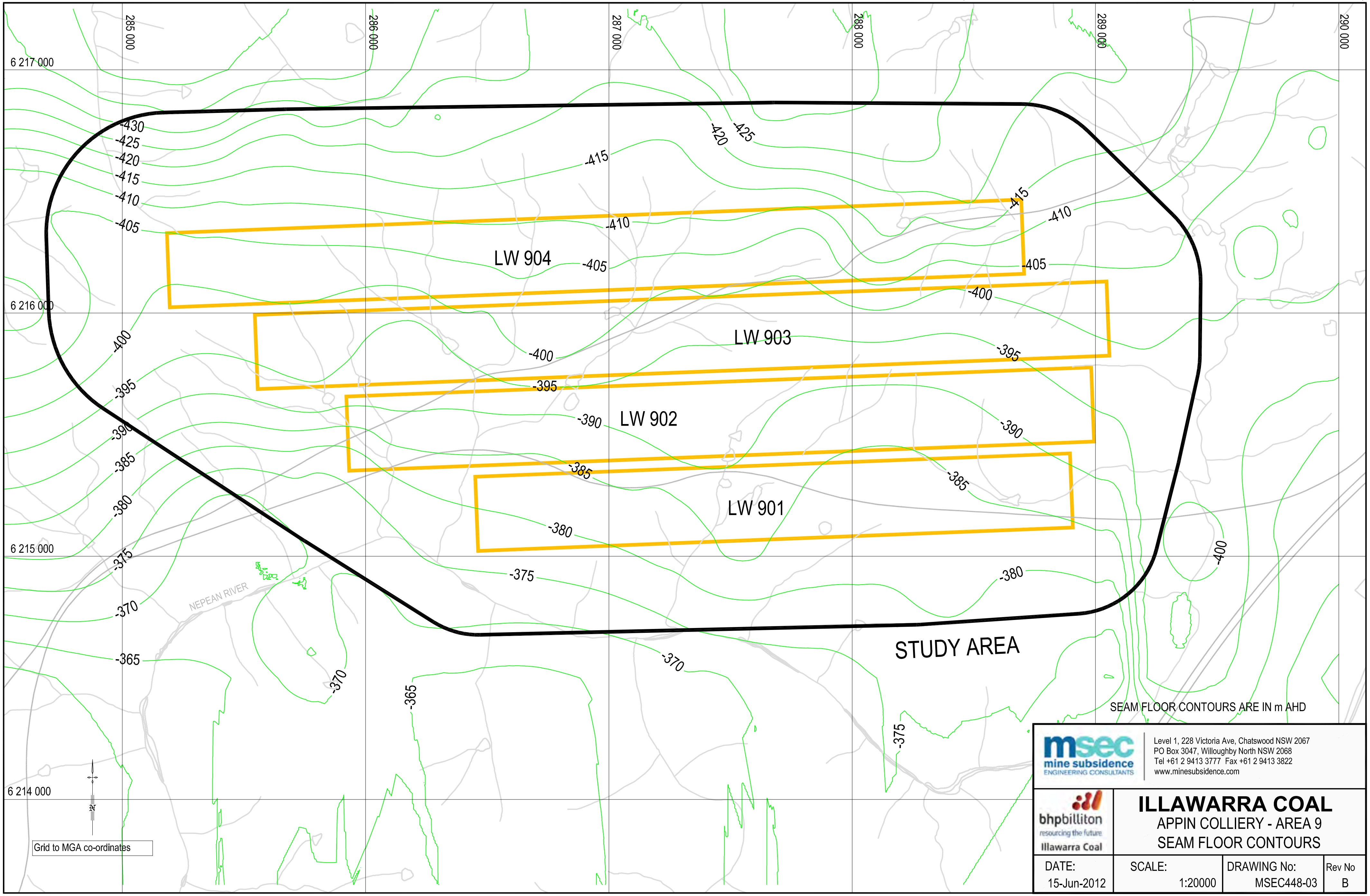

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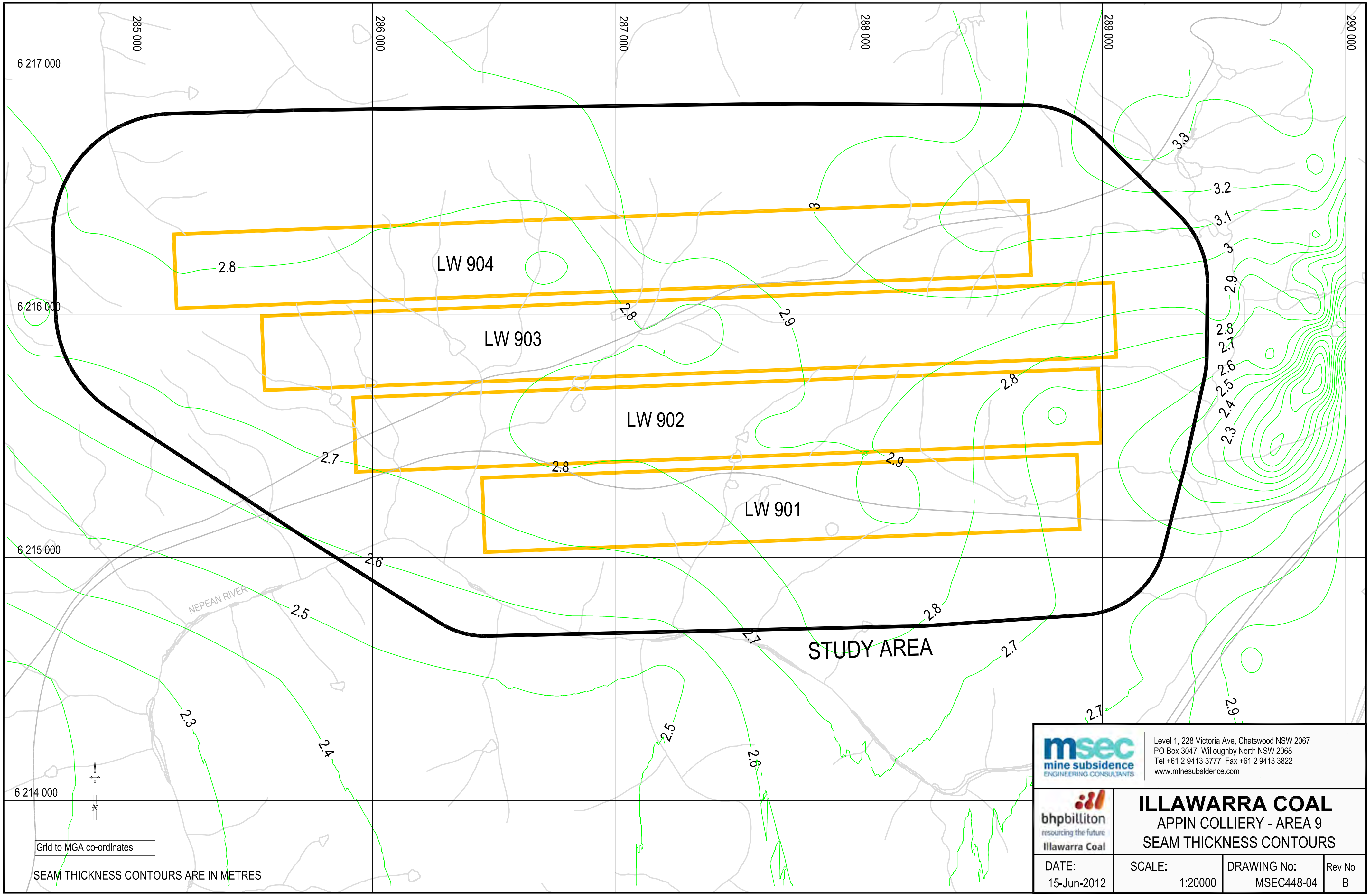

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SEAM THICKNESS CONTOURS

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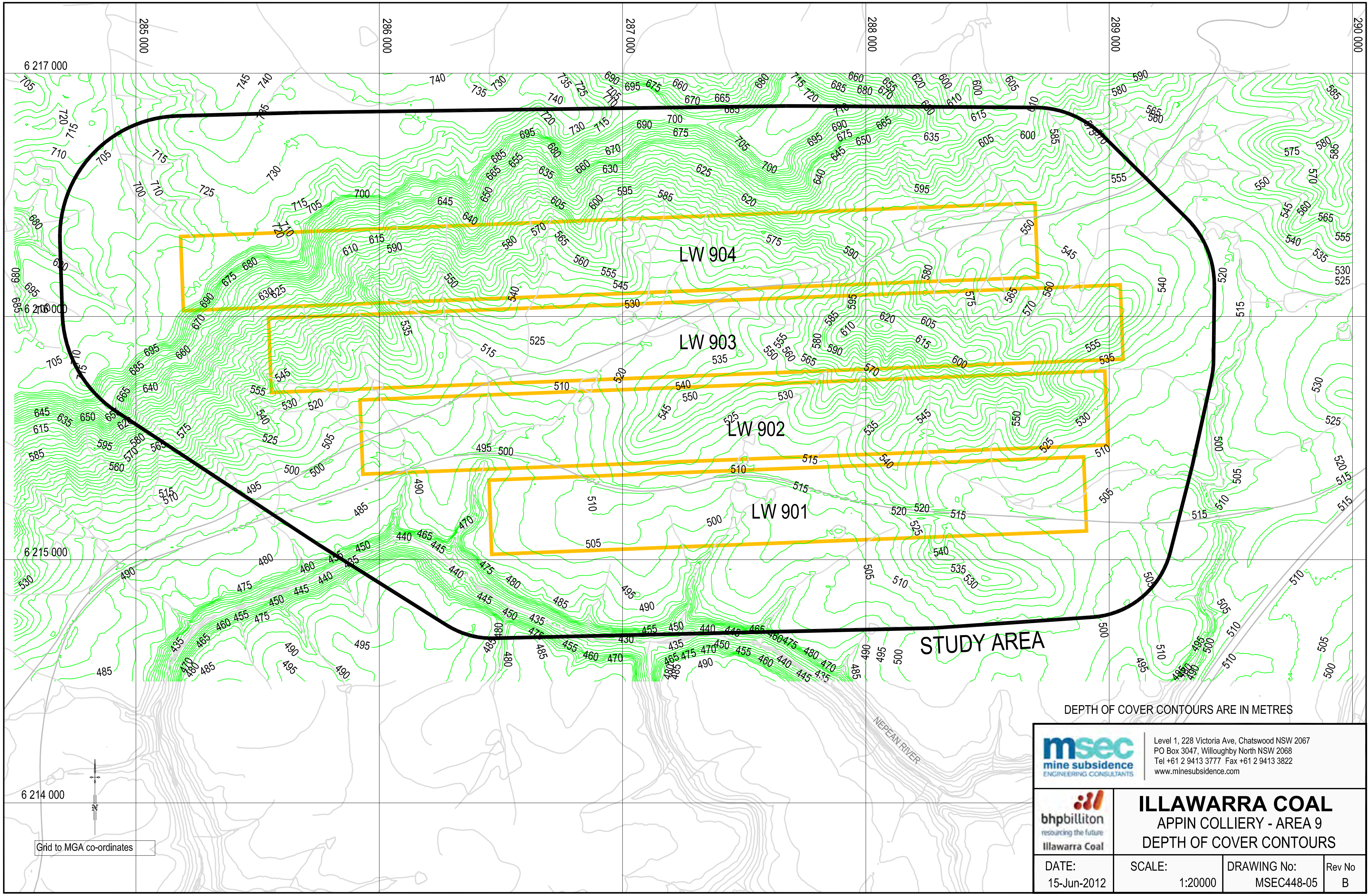

DEPTH OF COVER CONTOURS ARE IN METRES

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DEPTH OF COVER CONTOURS

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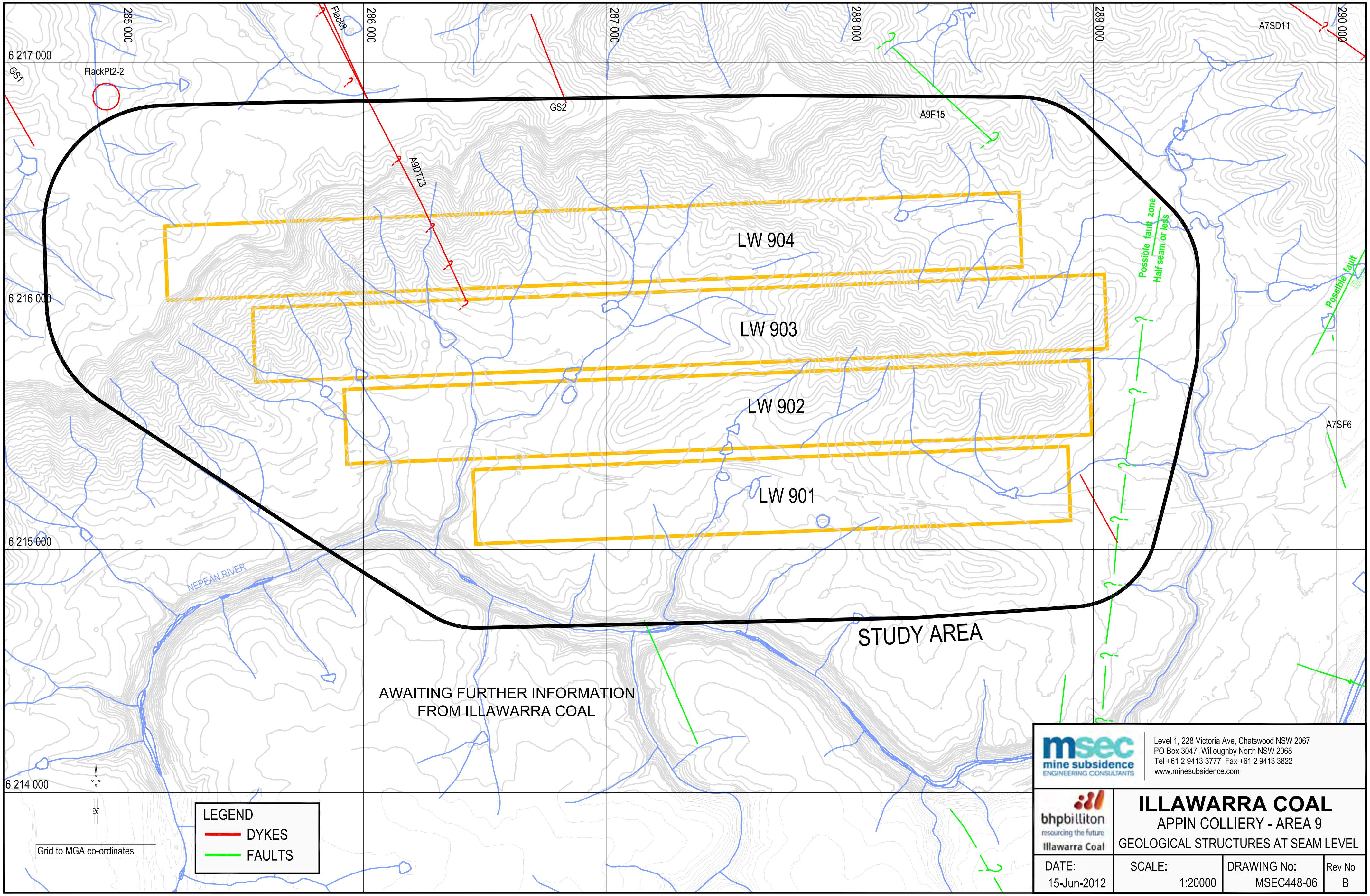

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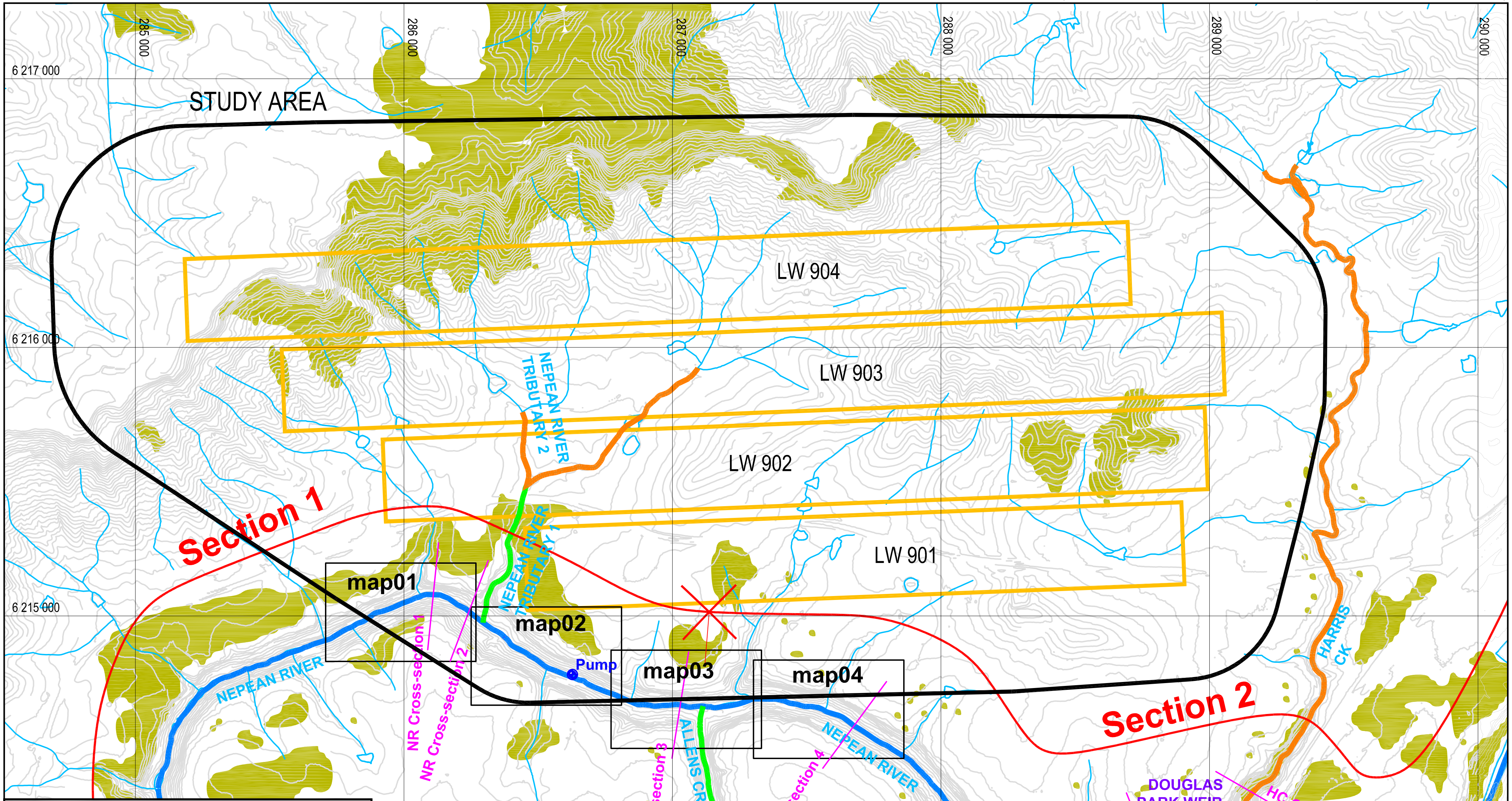

LEGEND

- WATERCOURSES
- 3rd ORDER STREAMS
- 4th ORDER STREAMS
- 6th ORDER STREAMS
- 7th ORDER STREAMS
- ENDANGERED ECOLOGICAL COMMUNITIES
- VALLEY CROSS-SECTIONS

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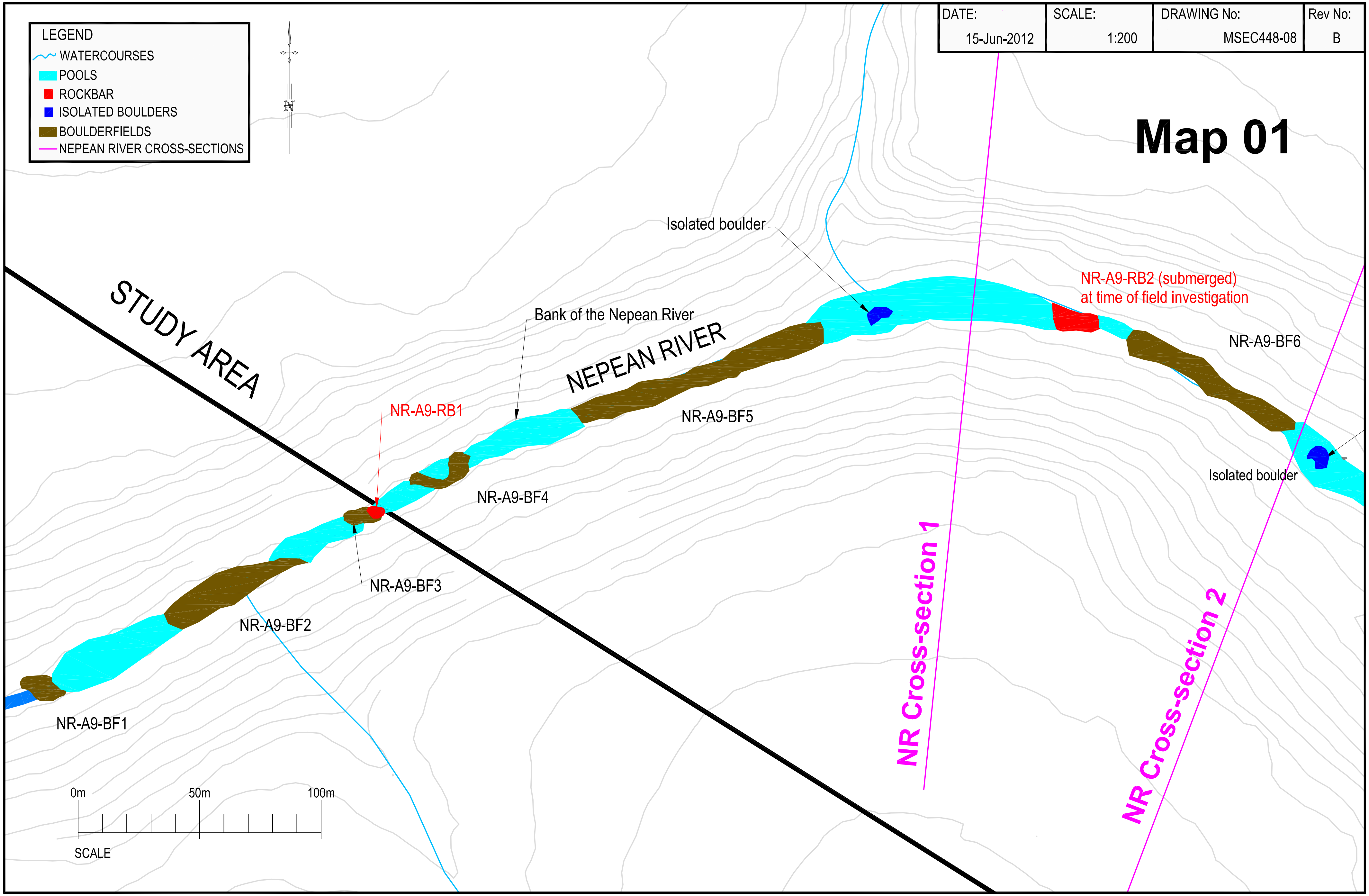
Map 01



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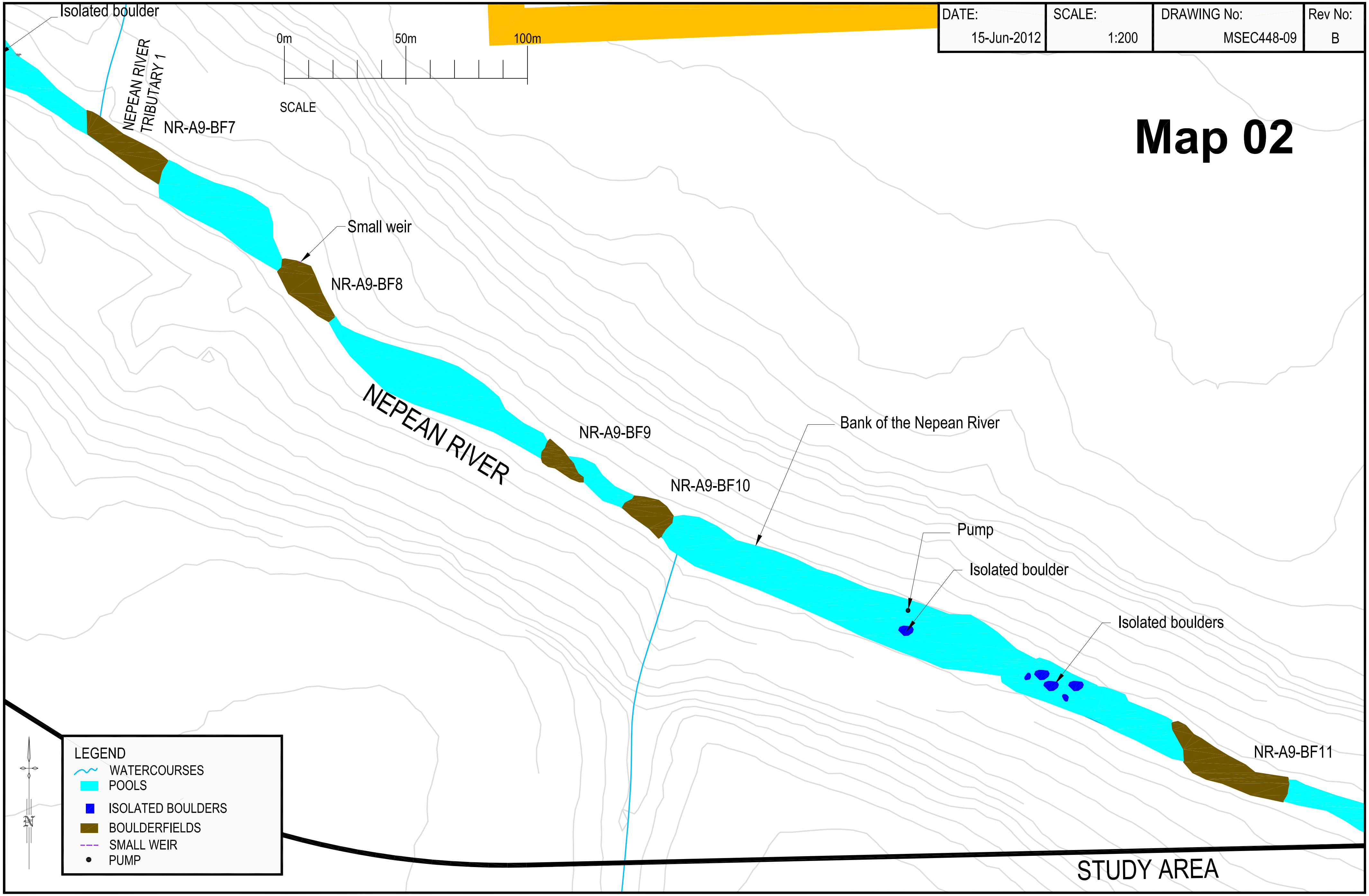
Map 02



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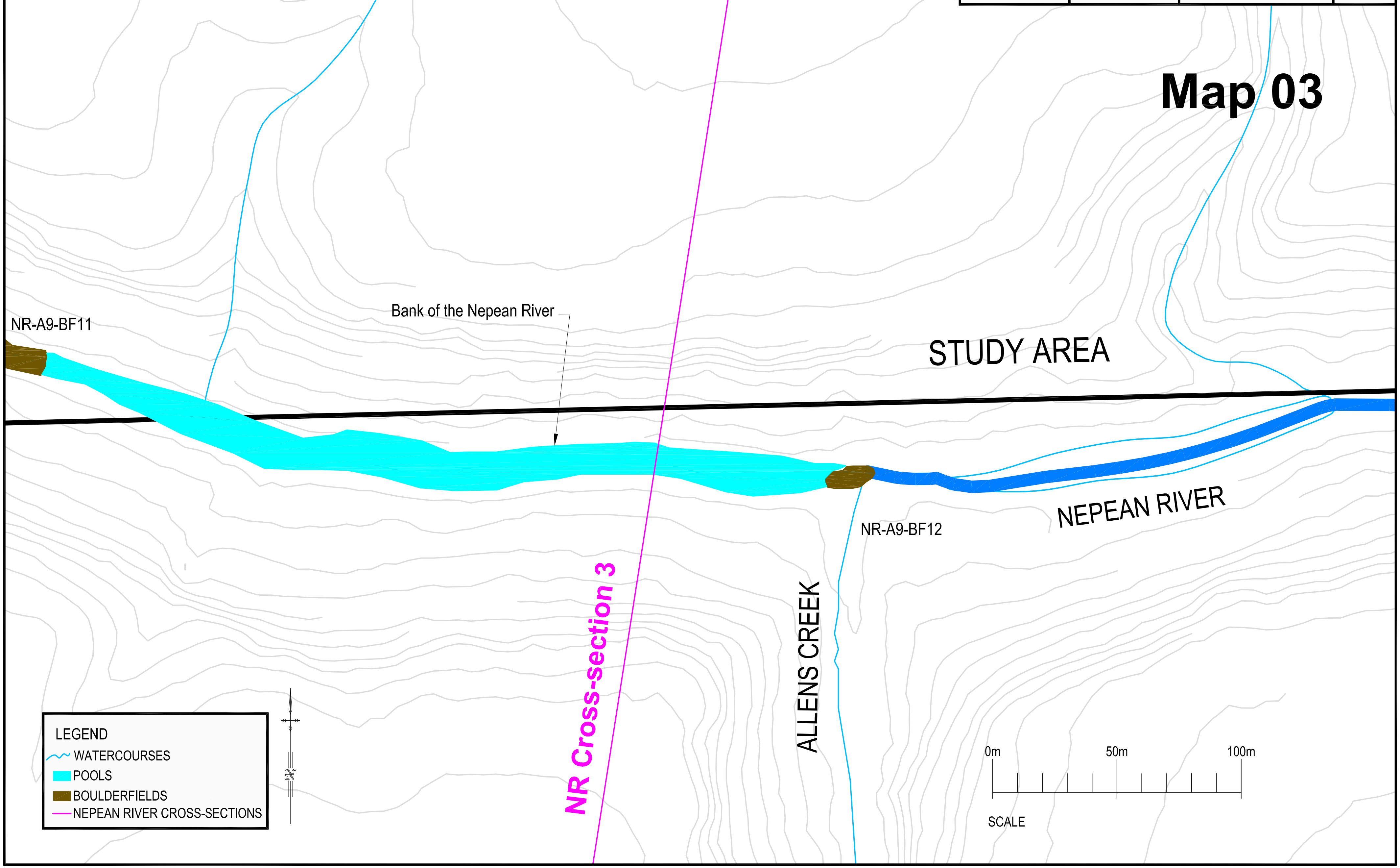

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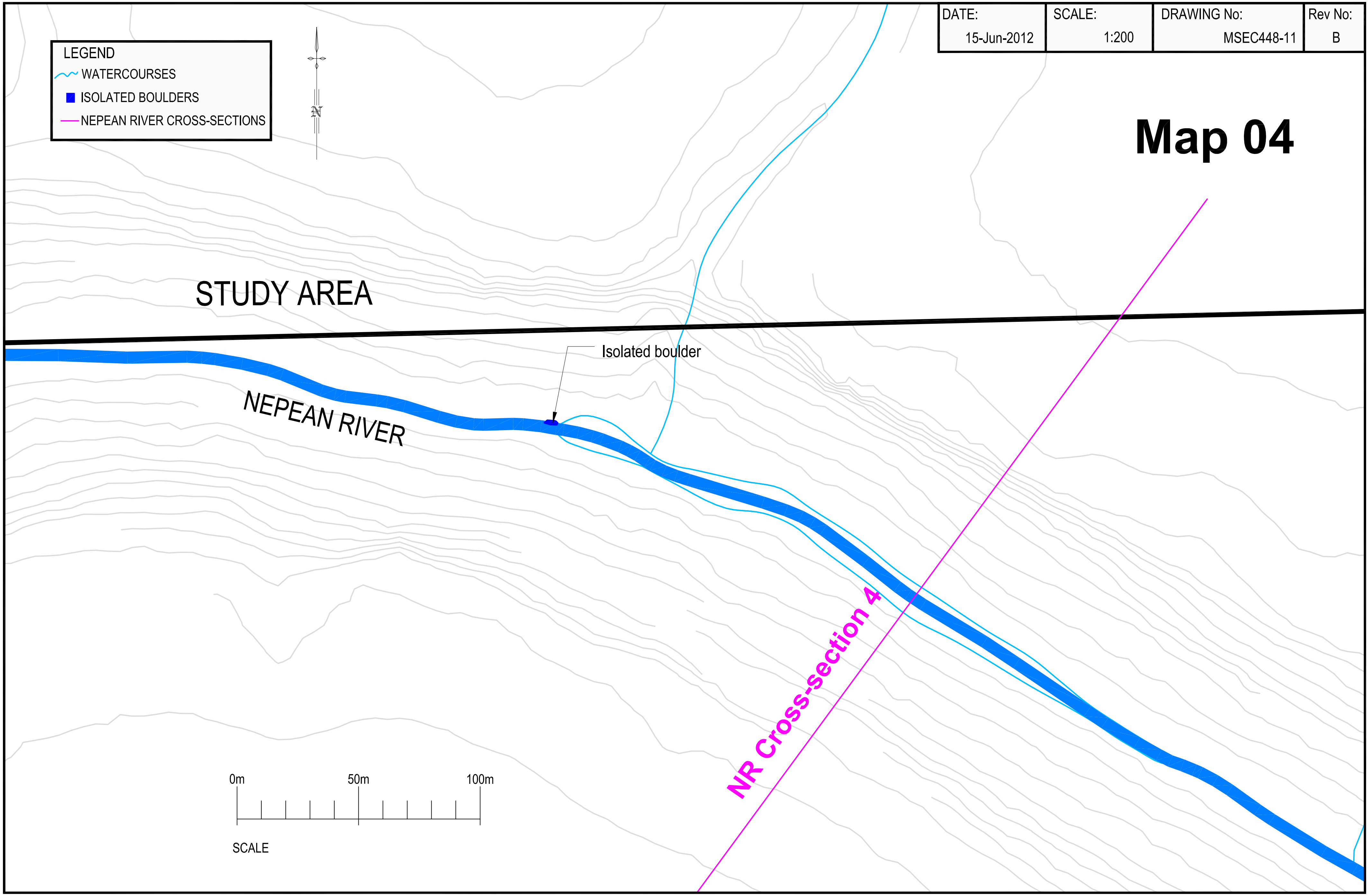
Map 04



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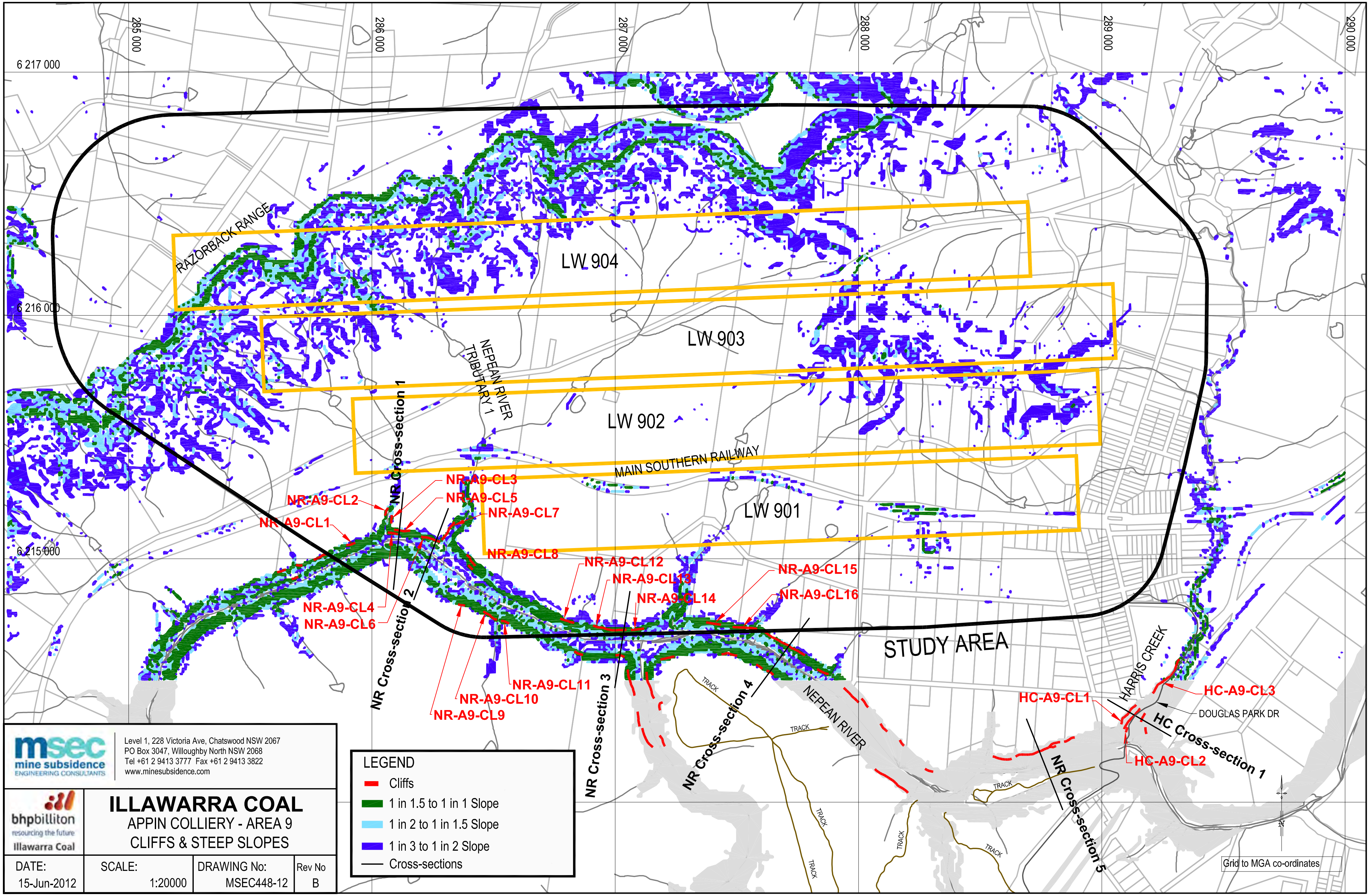

LEGEND

- Cliffs
- 1 in 1.5 to 1 in 1 Slope
- 1 in 2 to 1 in 1.5 Slope
- 1 in 3 to 1 in 2 Slope
- Cross-sections

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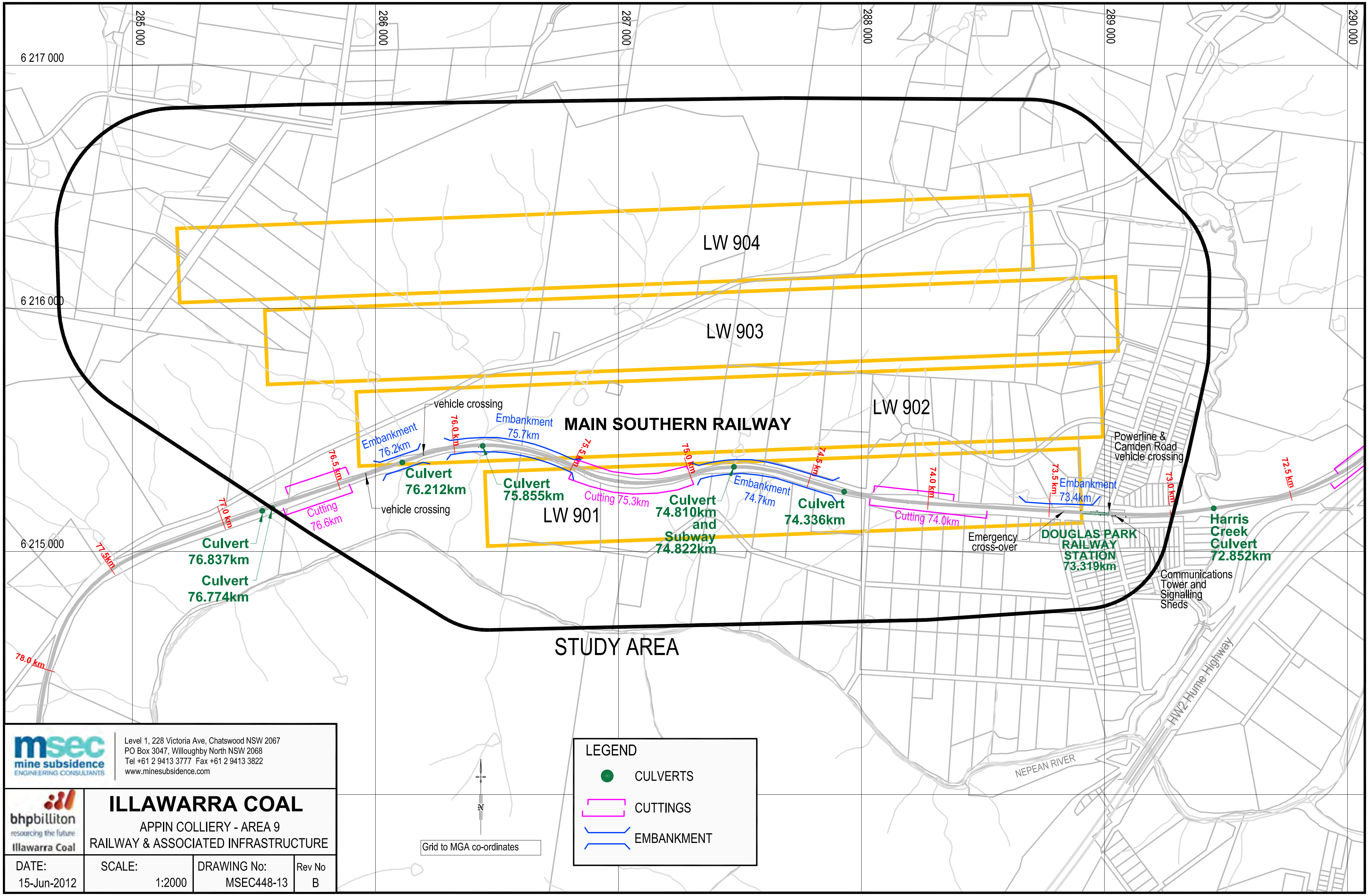

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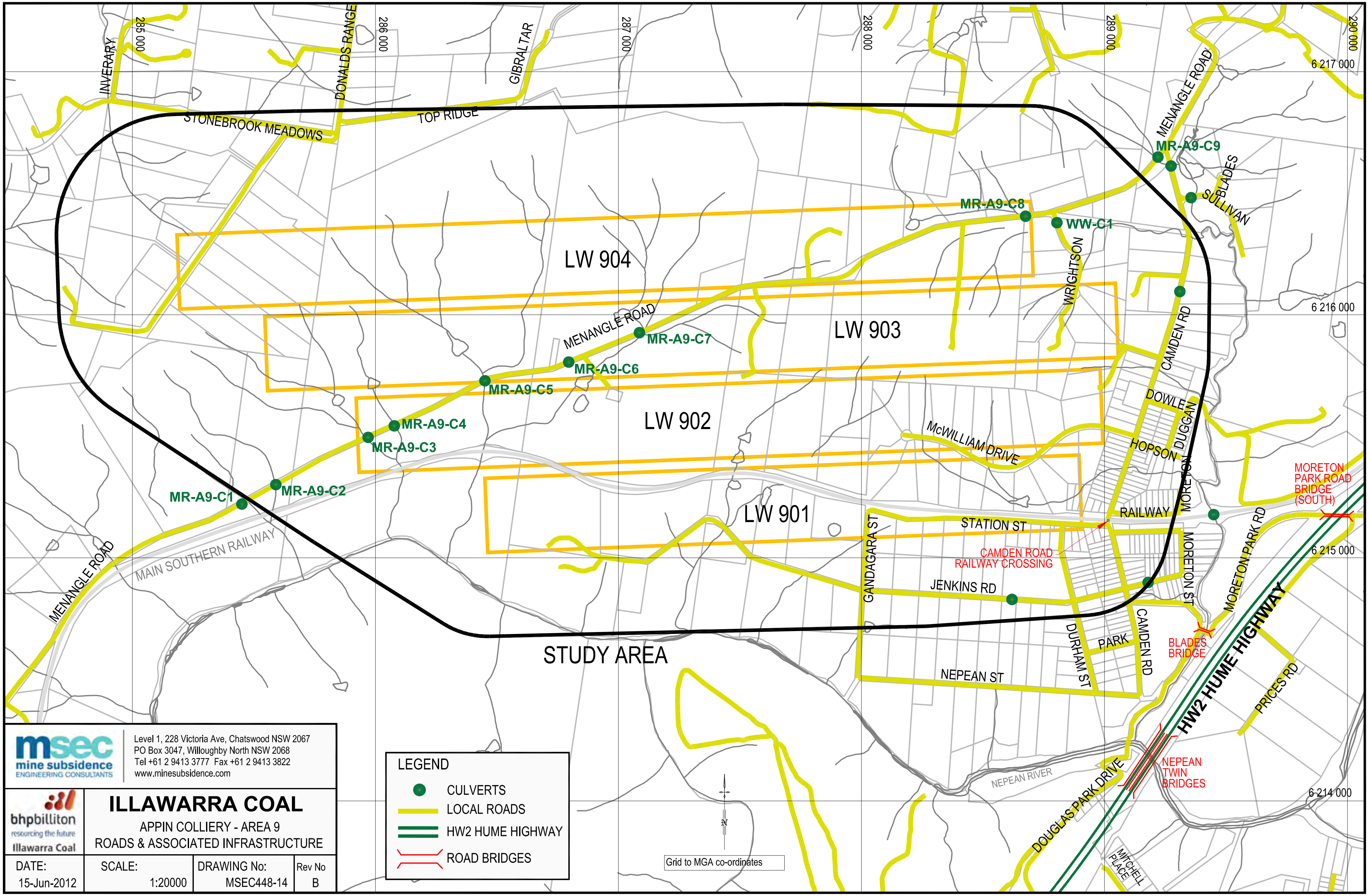

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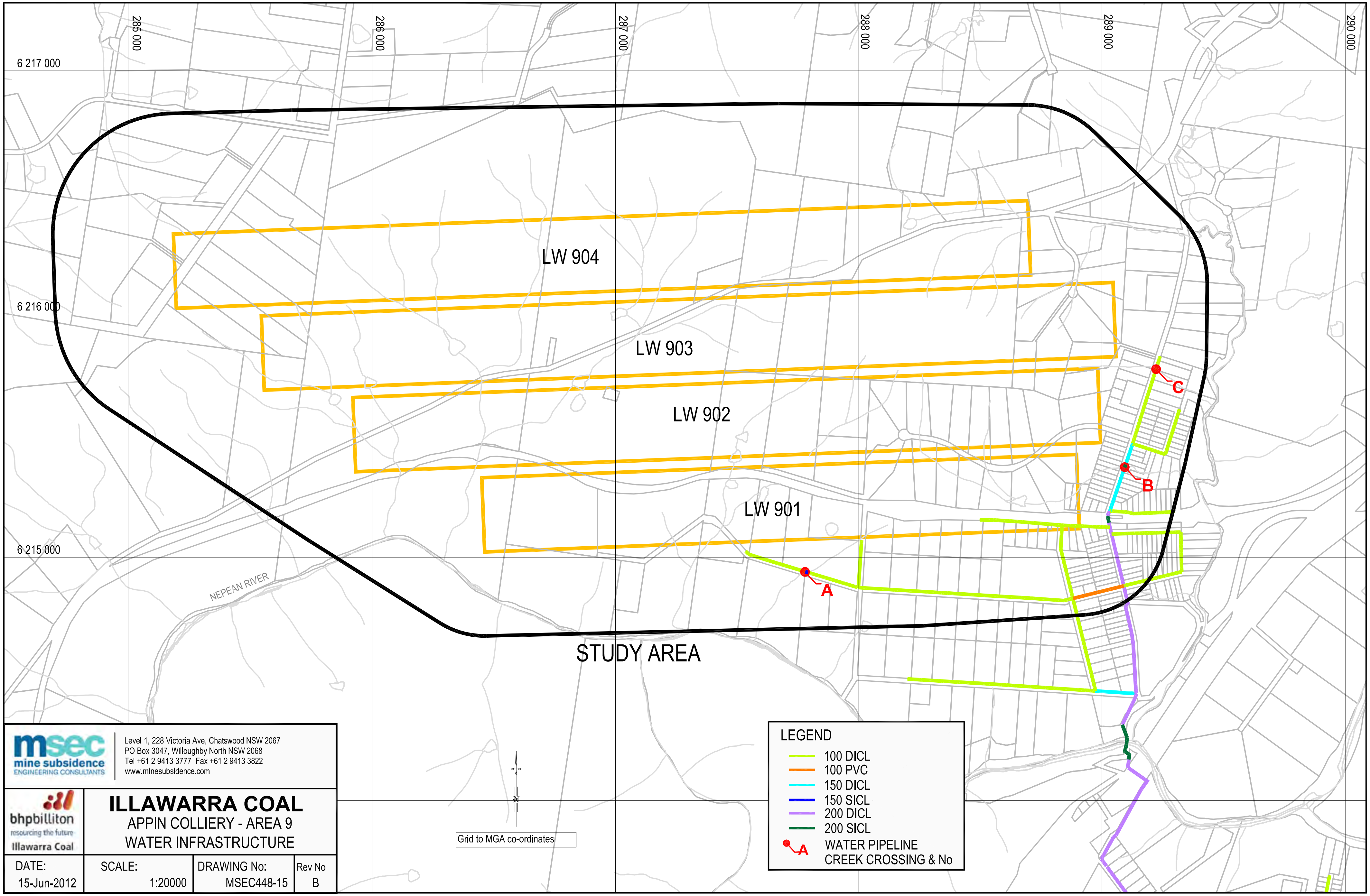

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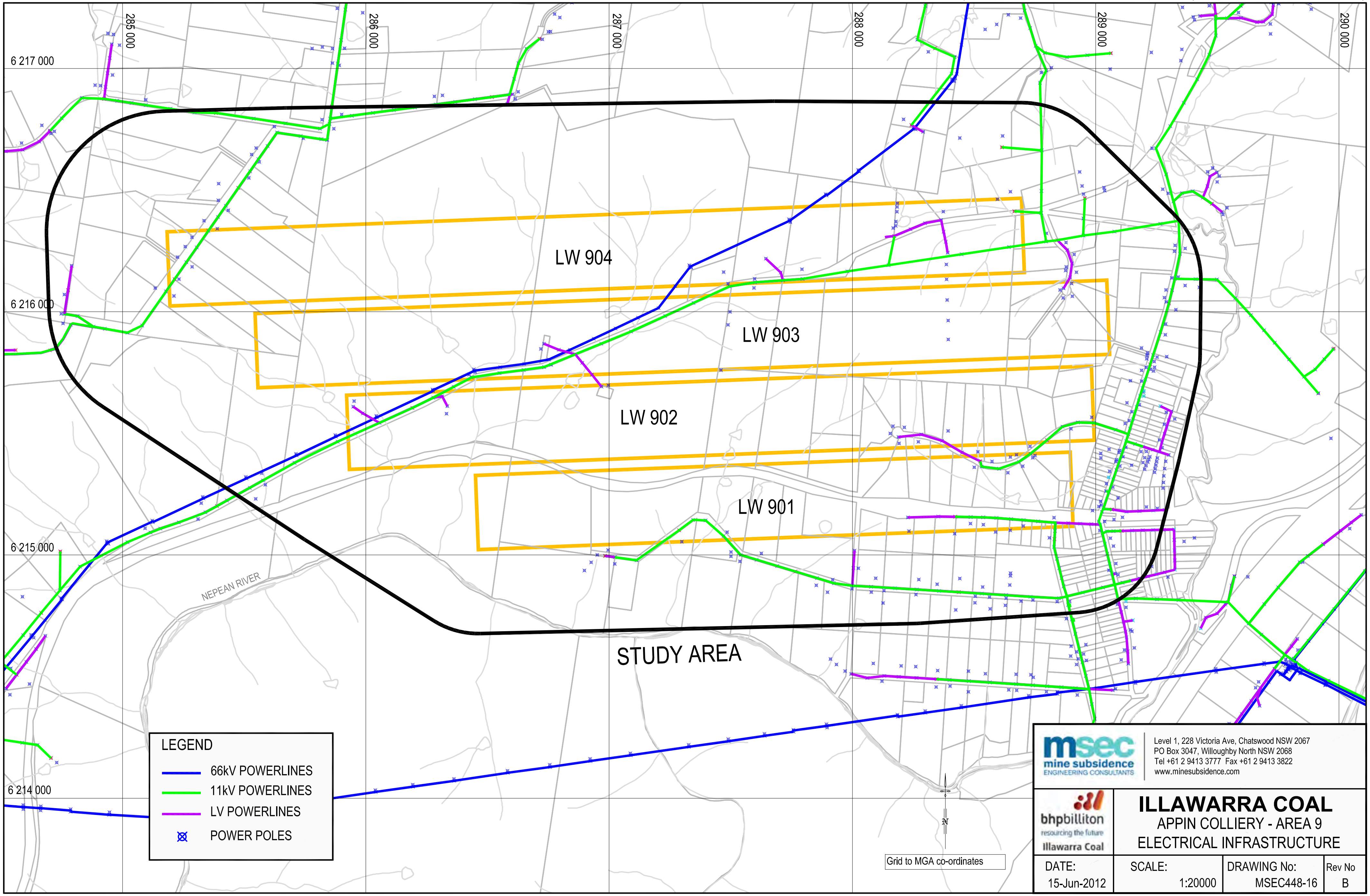

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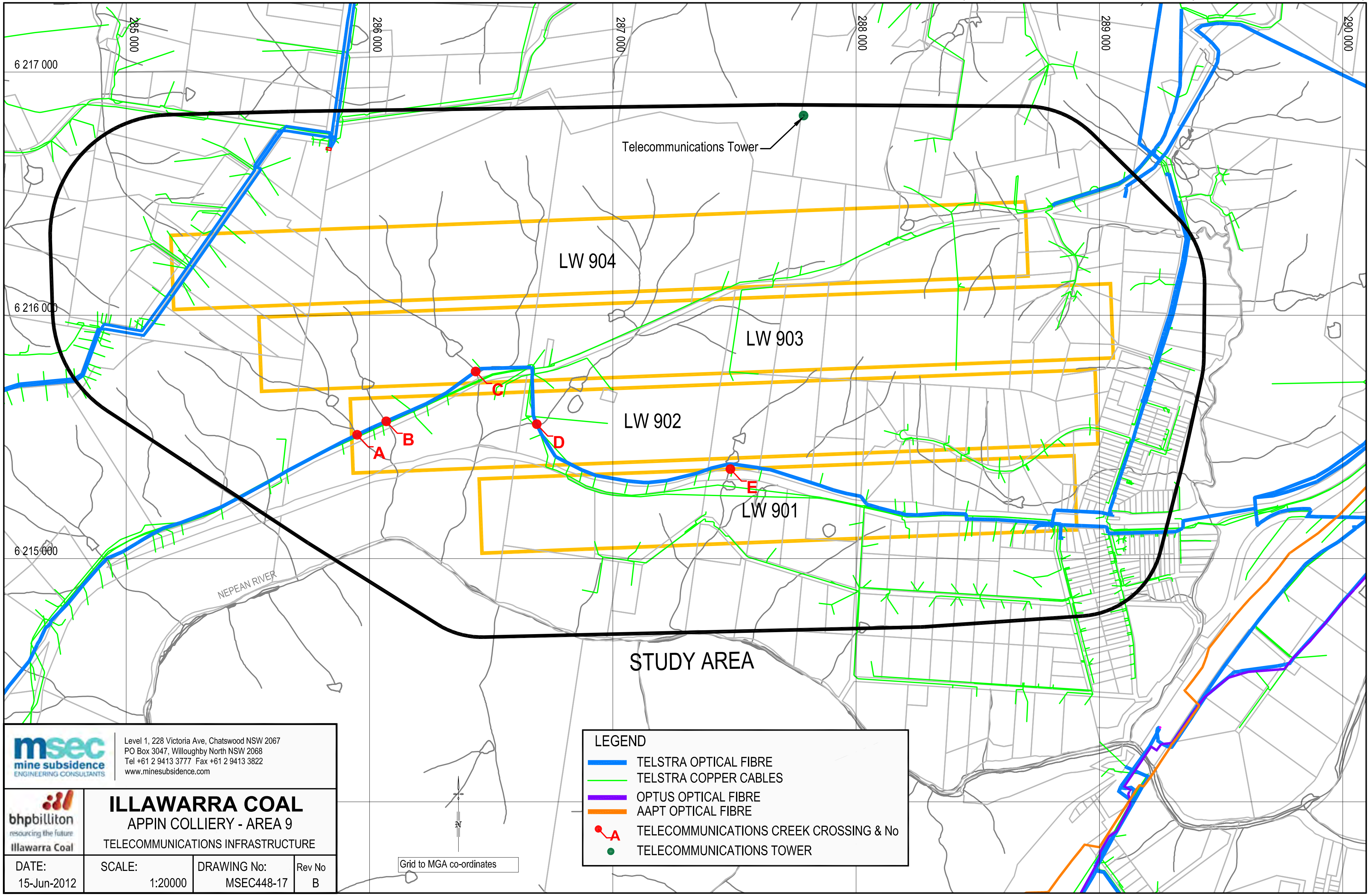

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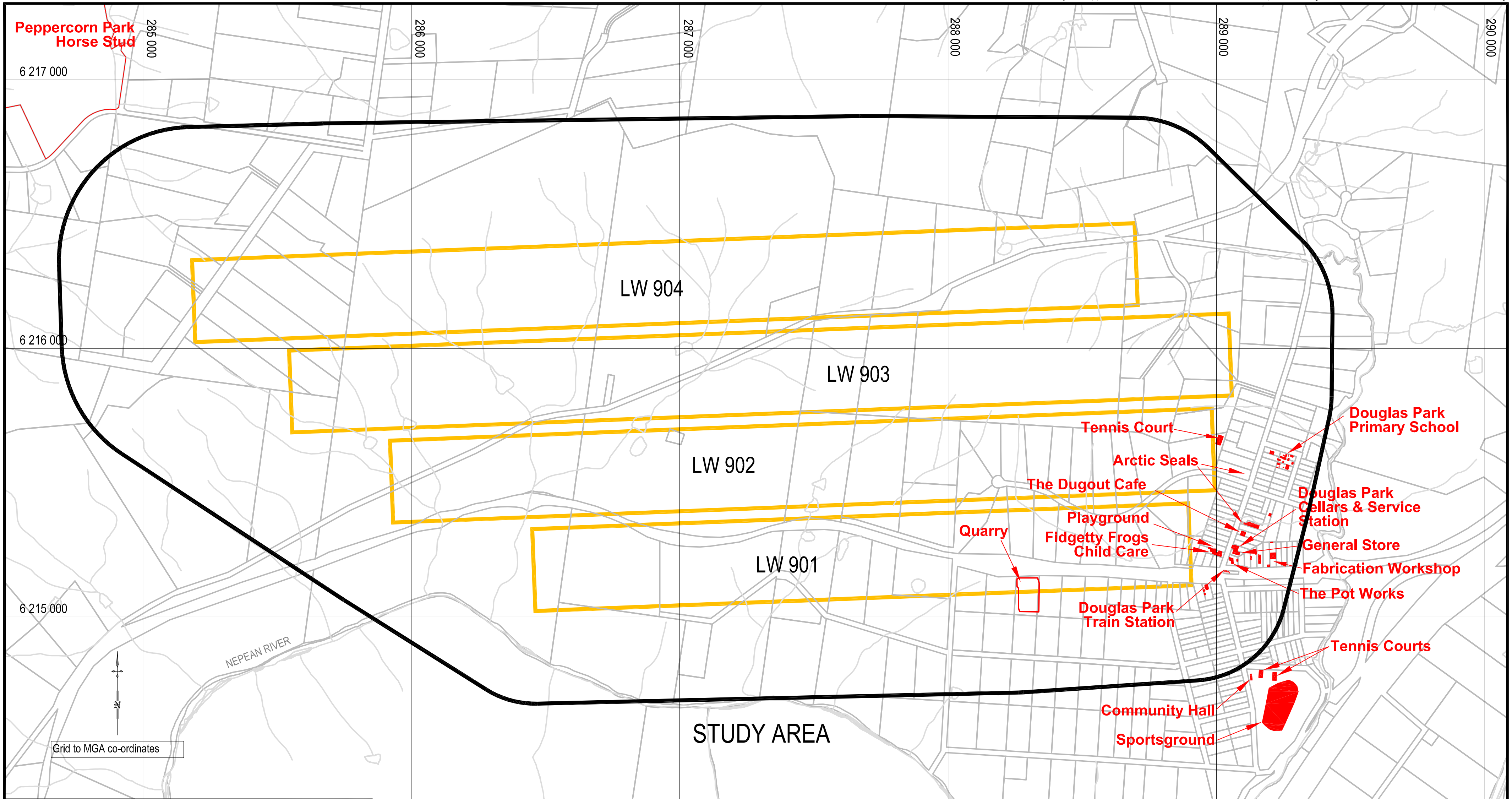

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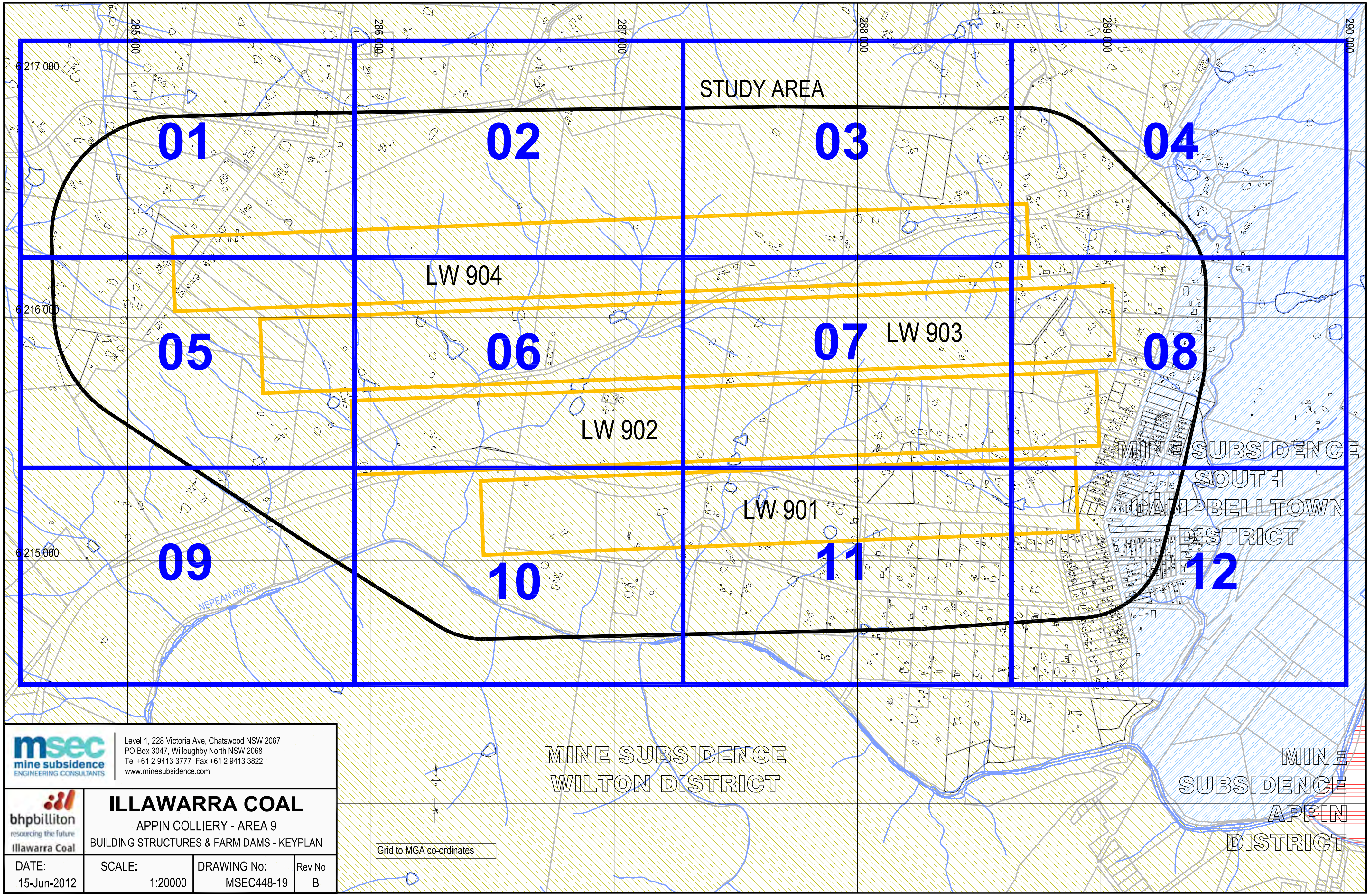

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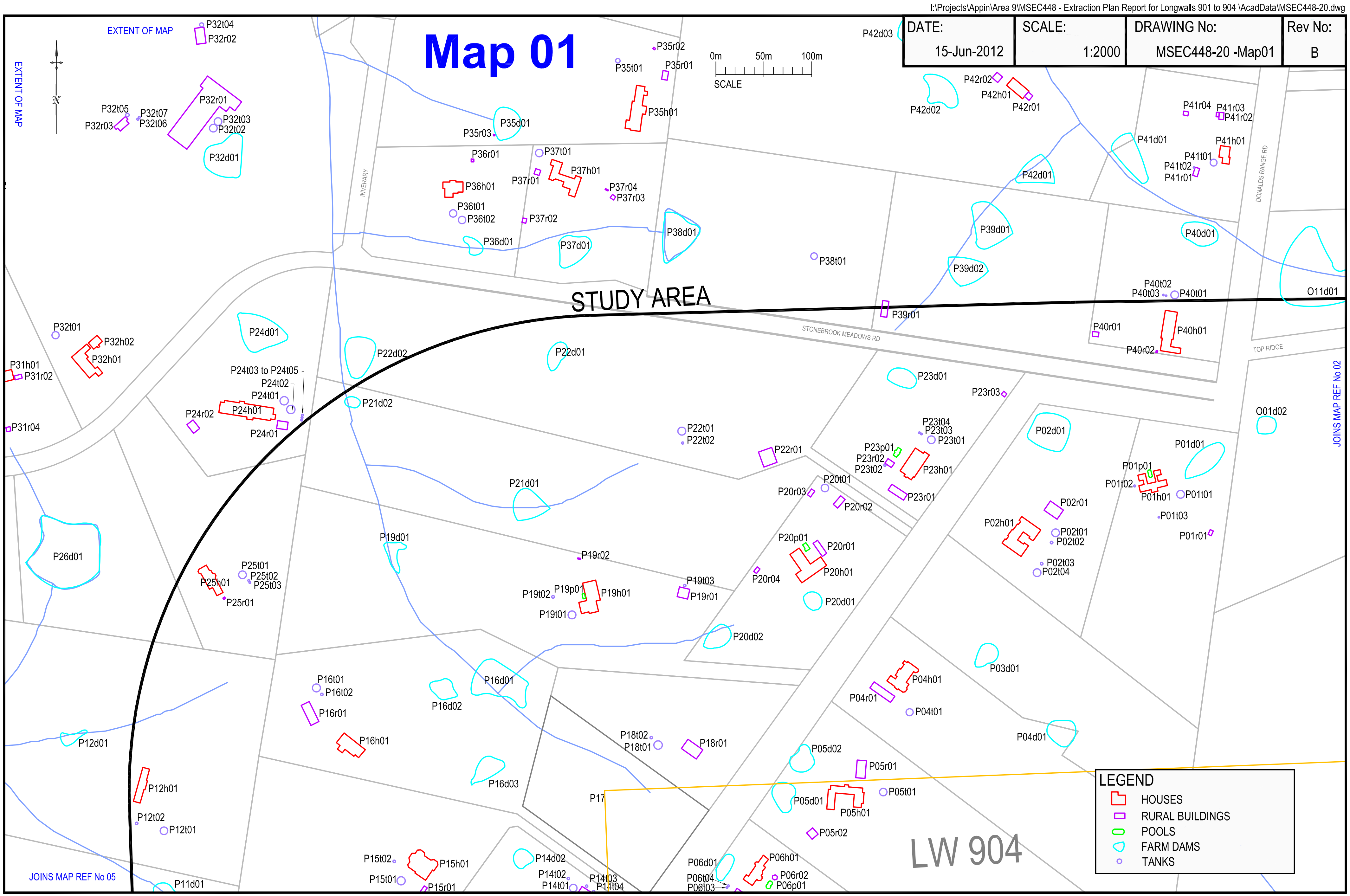

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Map 01
DATE: 15-Jun-2012
SCALE: 1:2000
DRAWING No: MSEC448-20 -Map01
Rev No: B
0m 50m 100m
SCALE
EXTENT OF MAP
JOINS MAP REF No 02
JOINS MAP REF No 05
STUDY AREA
LW 904
STONEBROOK MEADOWS RD
INVERARY
DONALDS RANGE RD
TOP RIDGE
LEGEND
HOUSES
RURAL BUILDINGS
POOLS
FARM DAMS
TANKS

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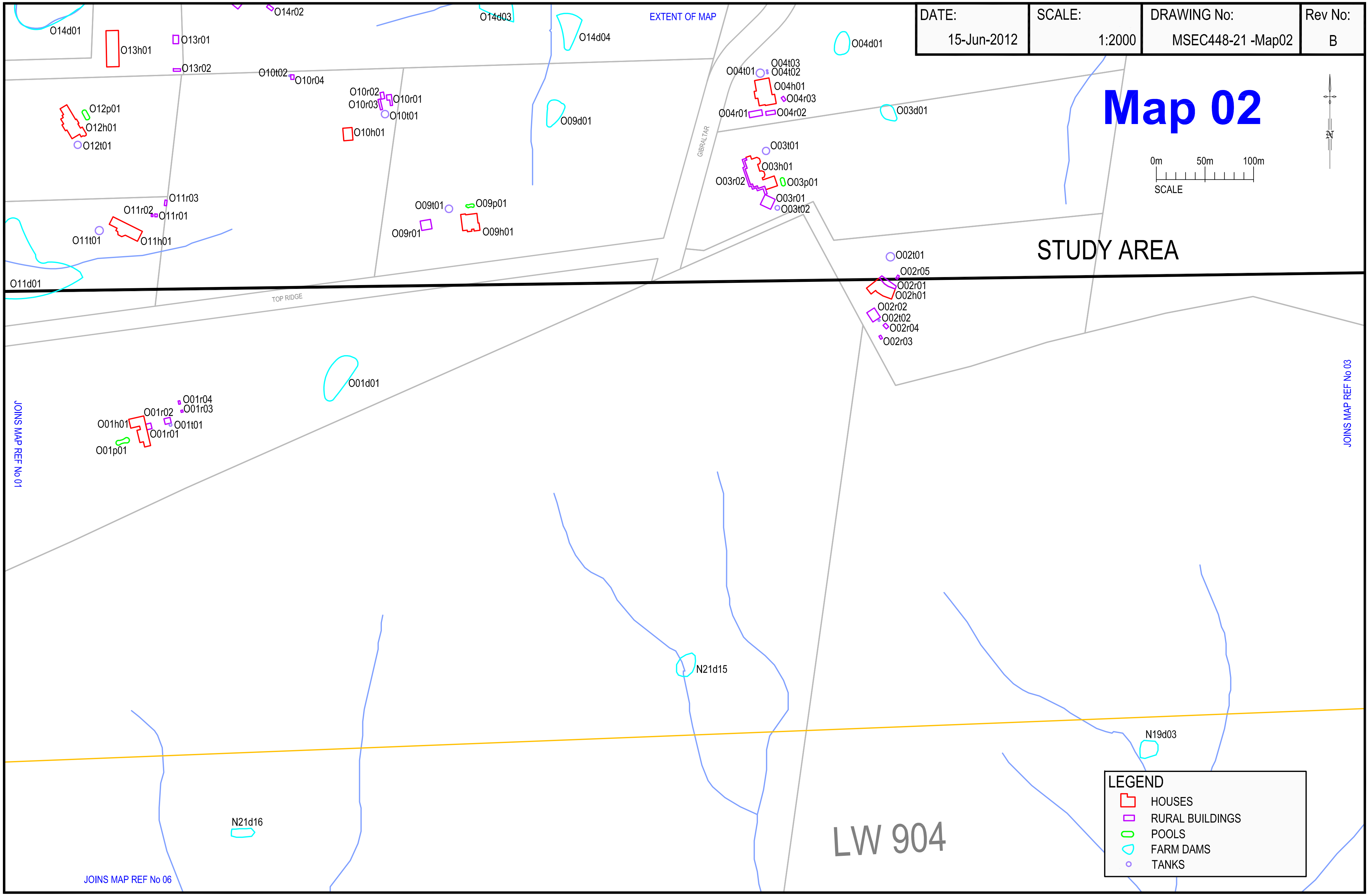
Map 02



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Map 03

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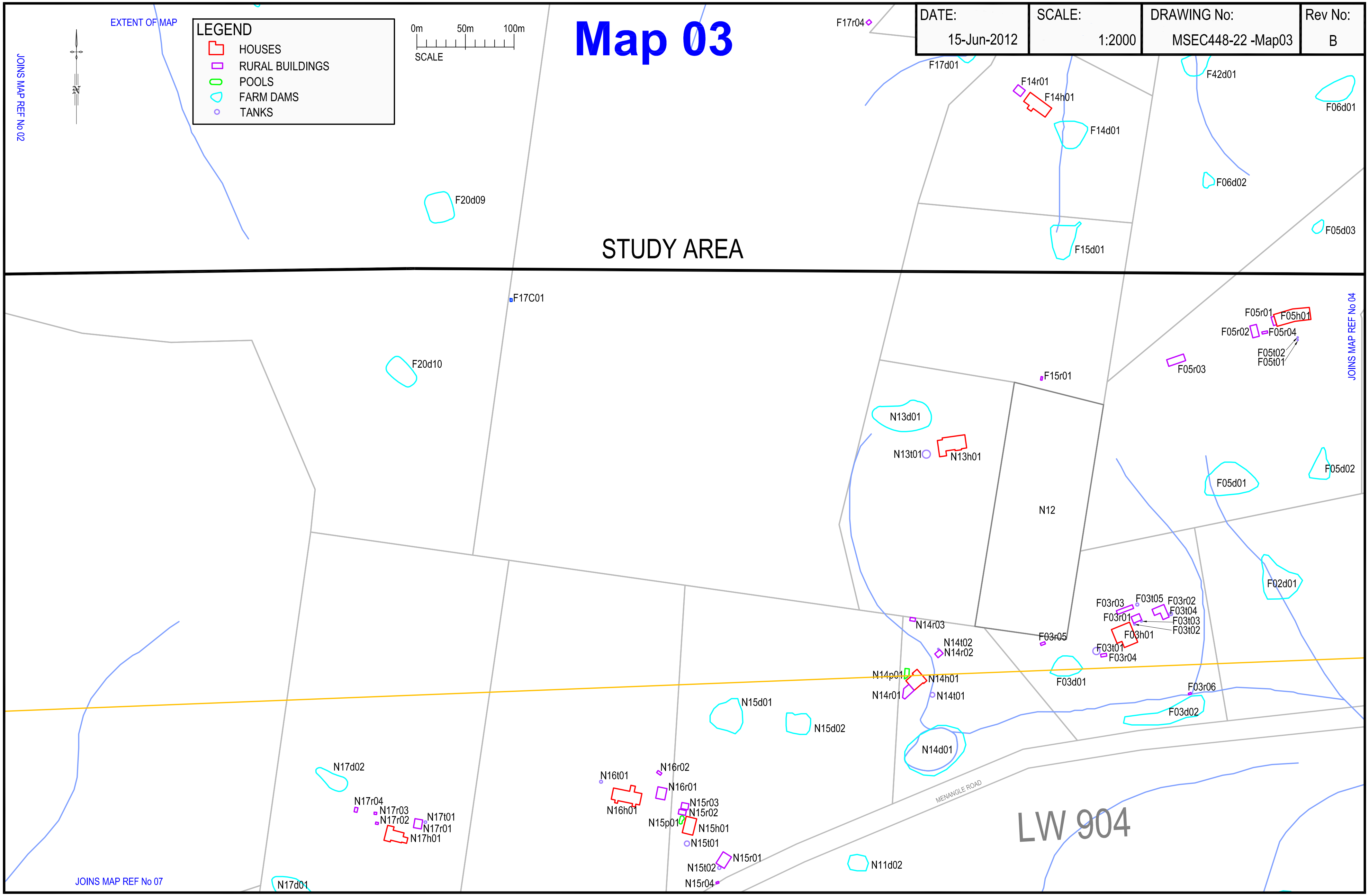

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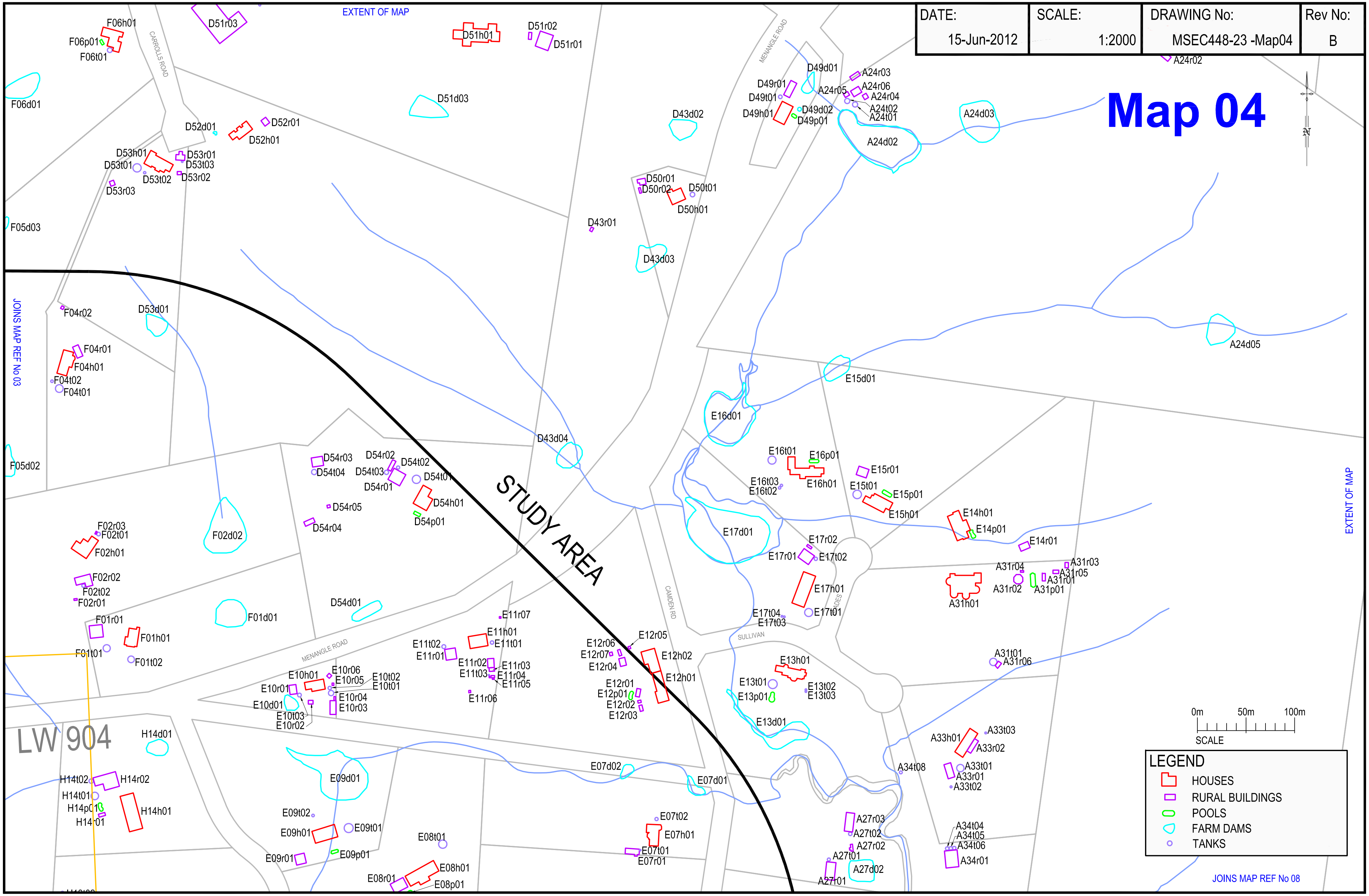
Map 04



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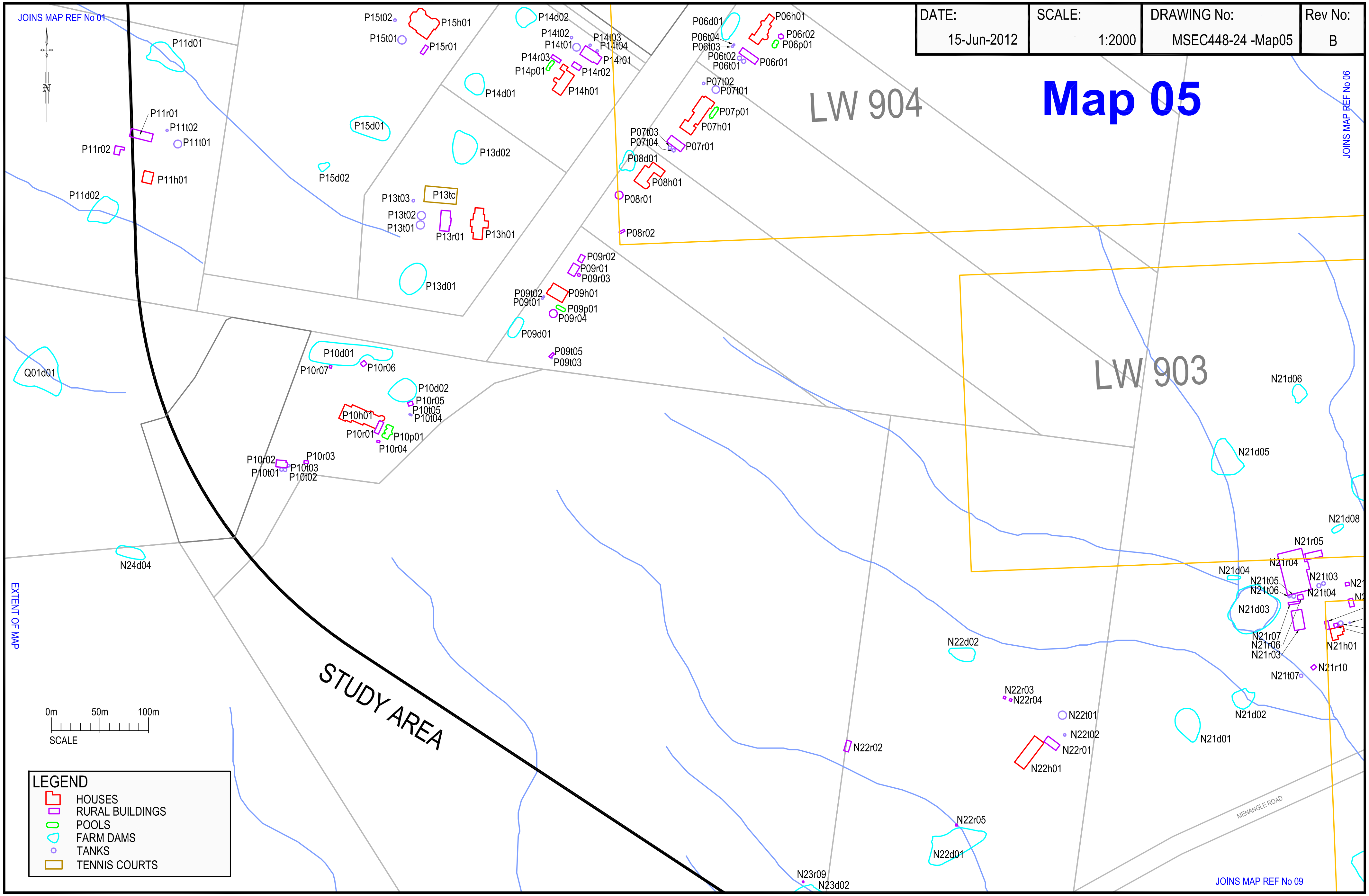
Map 05



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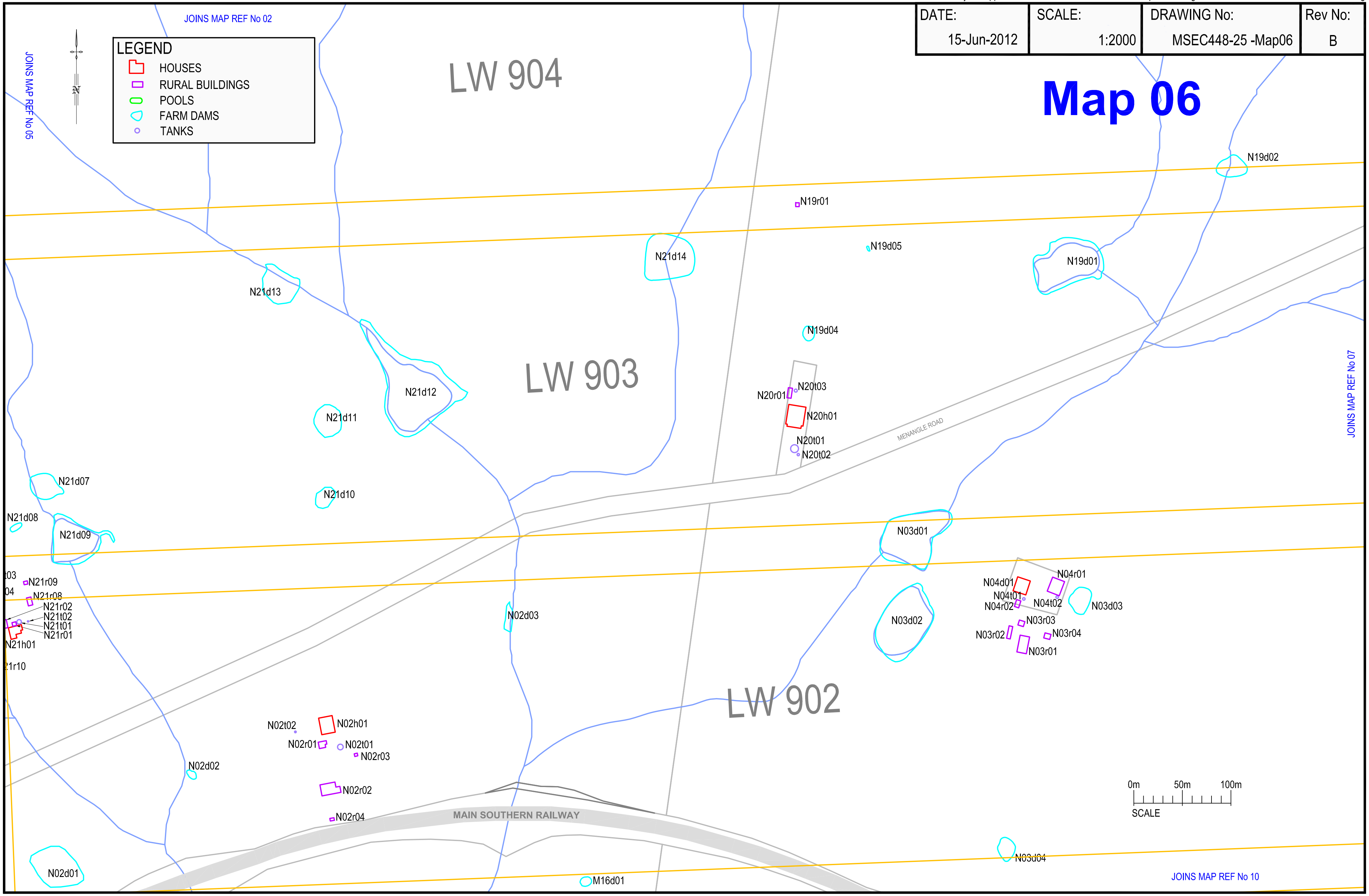
Map 06



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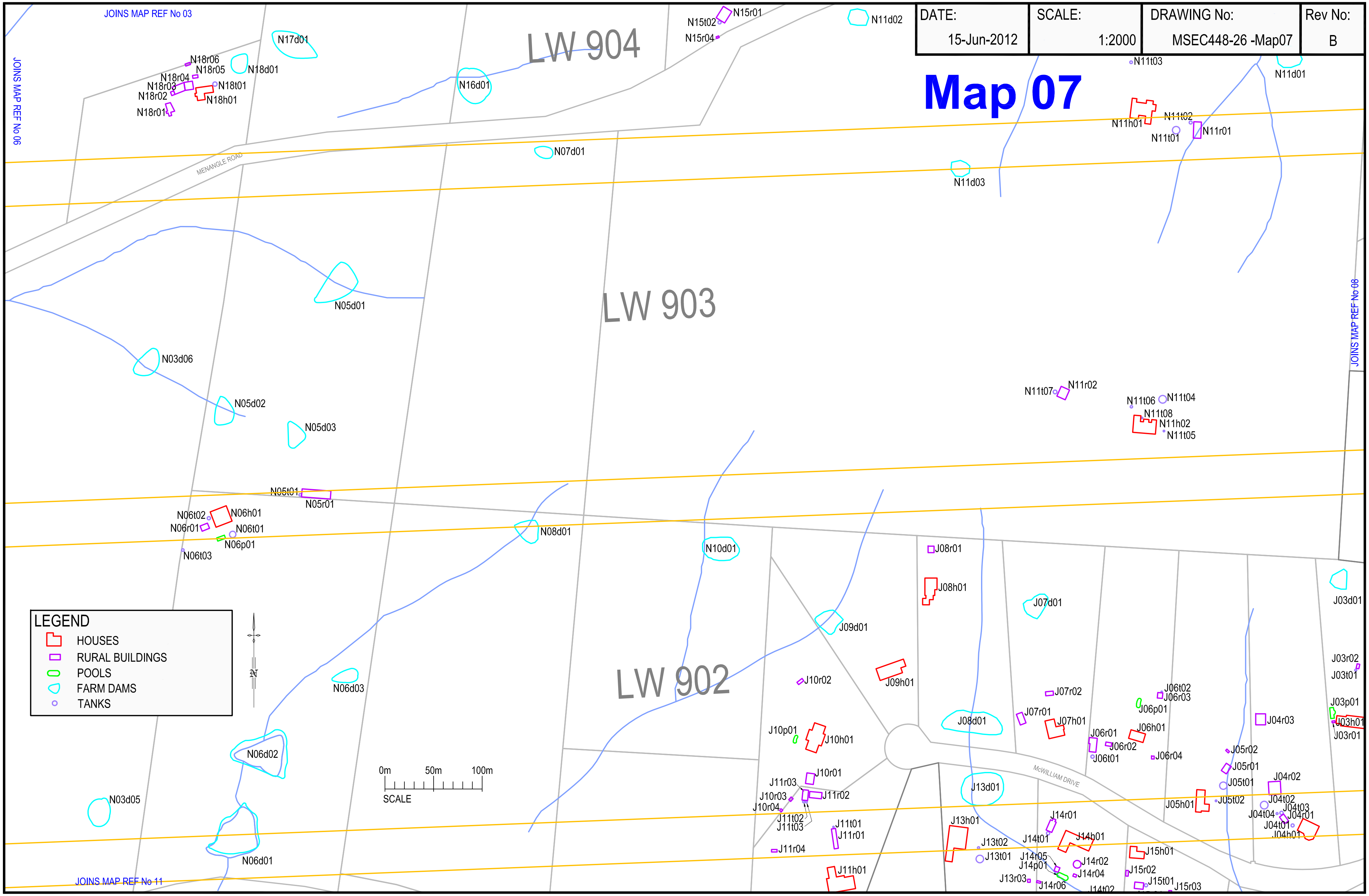
Map 07



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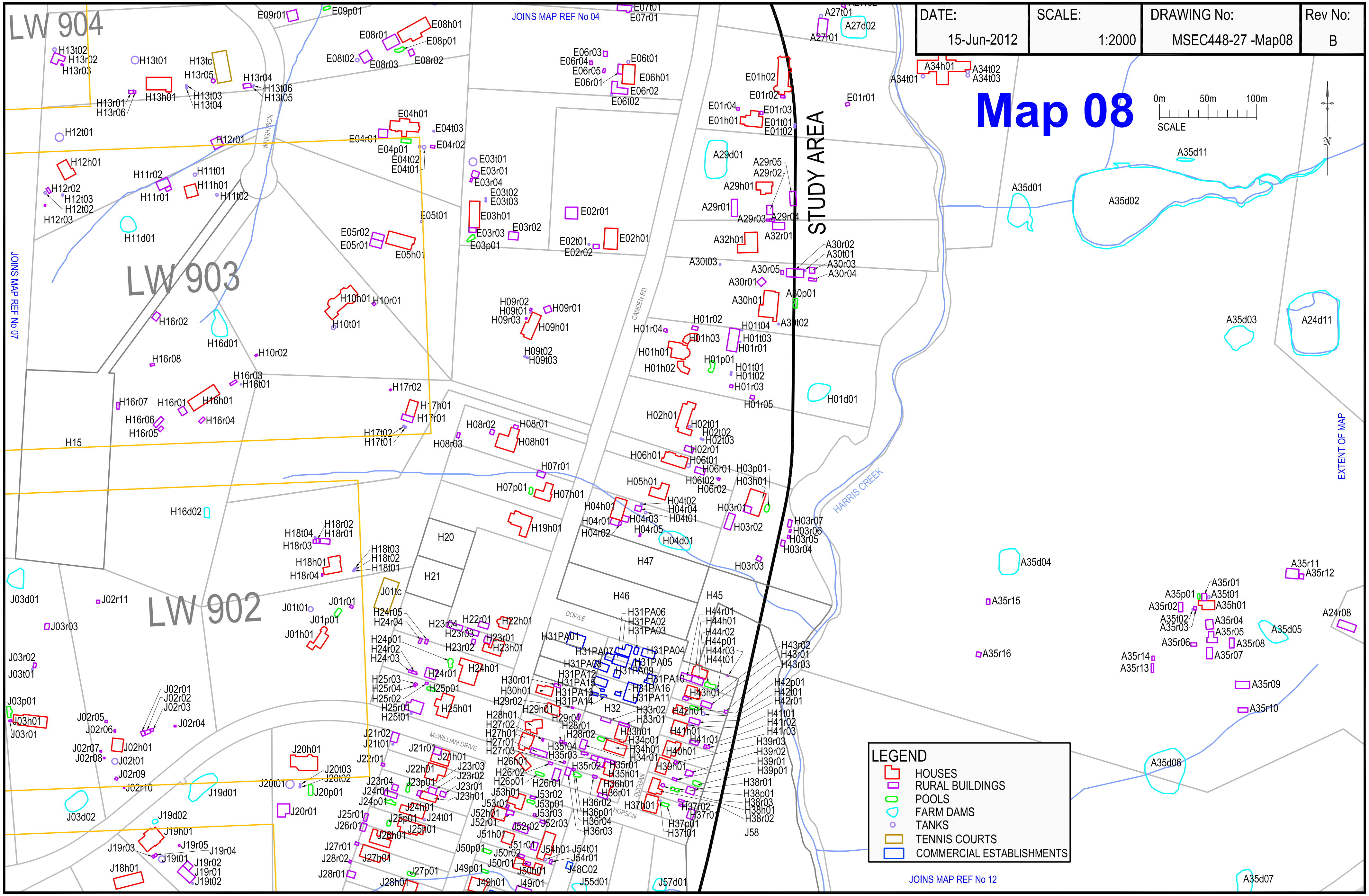

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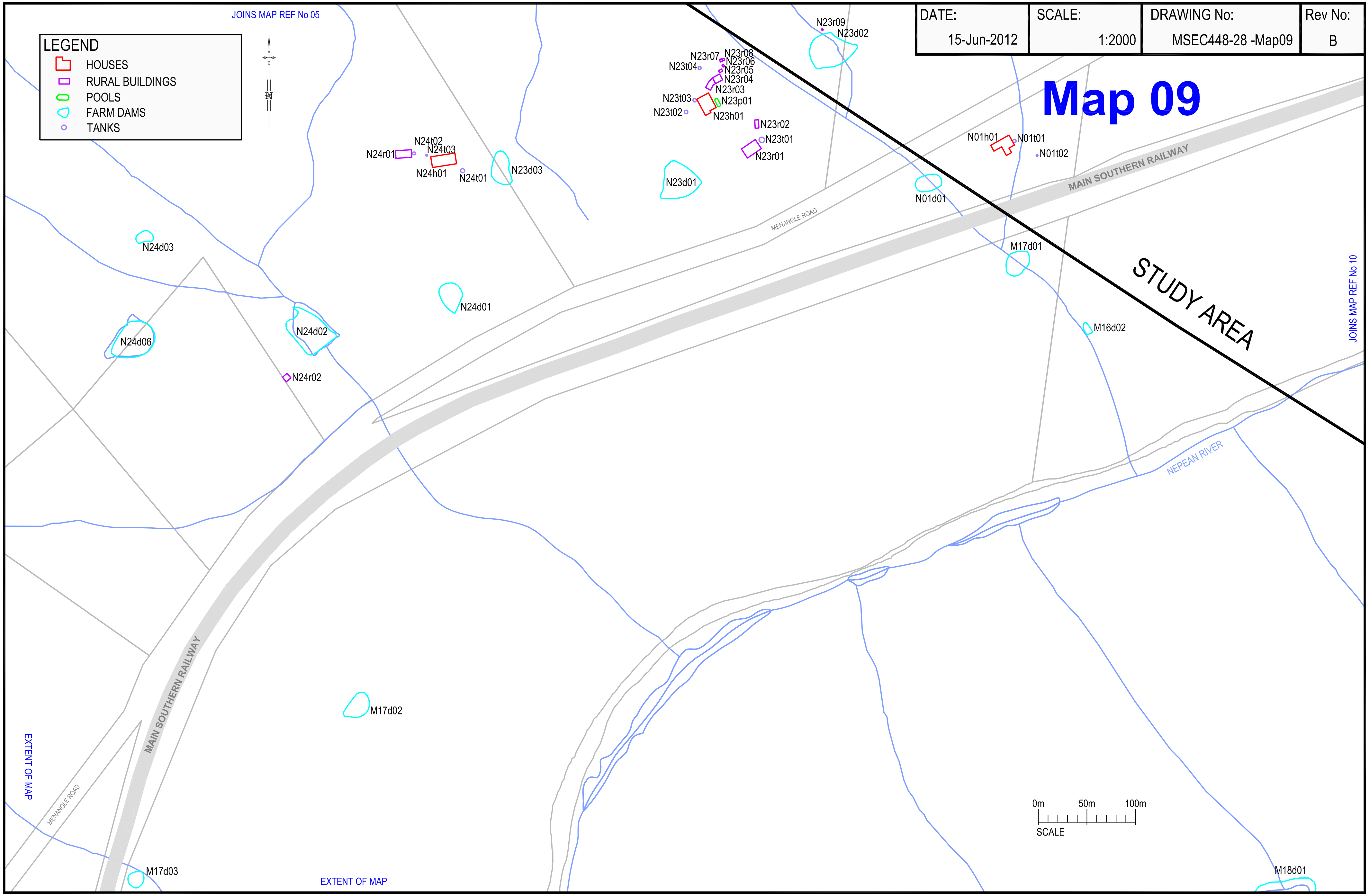
Map 09



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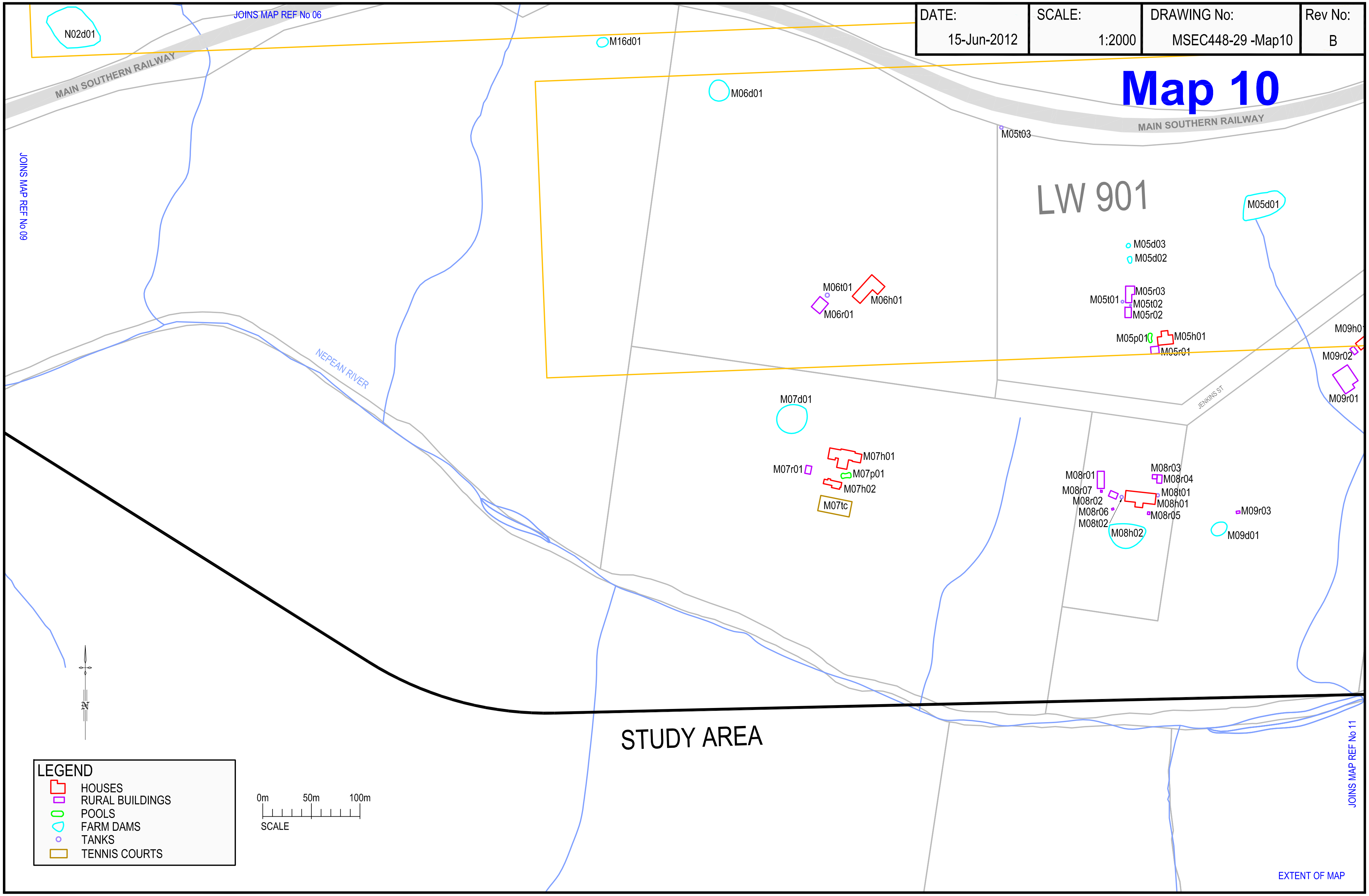
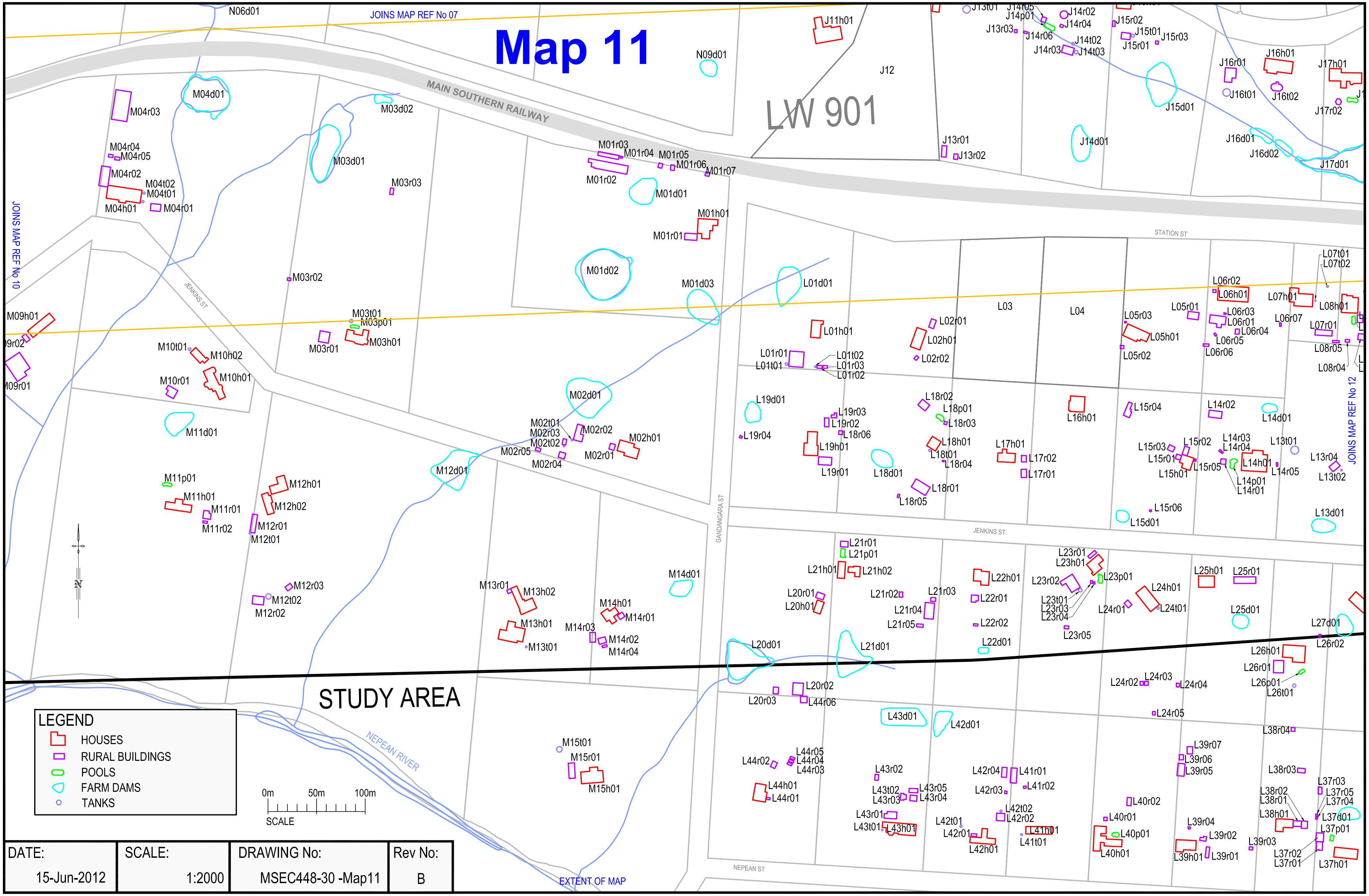
Map 10




Map 11
LW 901
MAIN SOUTHERN RAILWAY
JOINS MAP REF No 07
JOINS MAP REF No 10
JOINS MAP REF No 12
STATION ST
JENKINS ST
GANDANGARA ST
NEPEAN ST
NEPEAN RIVER
EXTENT OF MAP
STUDY AREA
LEGEND
HOUSES
RURAL BUILDINGS
POOLS
FARM DAMS
TANKS
0m
50m
100m
SCALE
DATE:
15-Jun-2012
SCALE:
1:2000
DRAWING No:
MSEC448-30 -Map11
Rev No:
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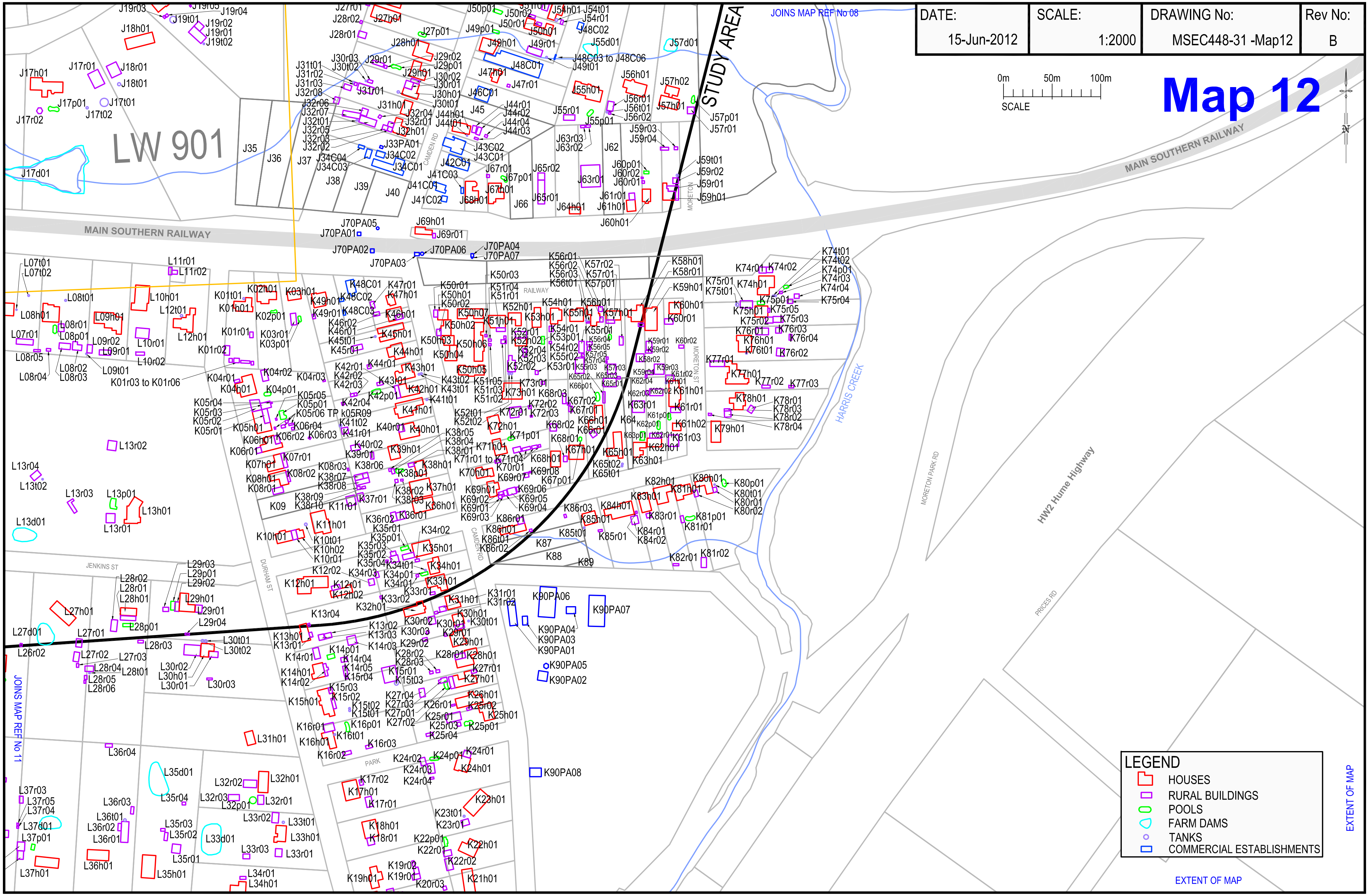
Map 12



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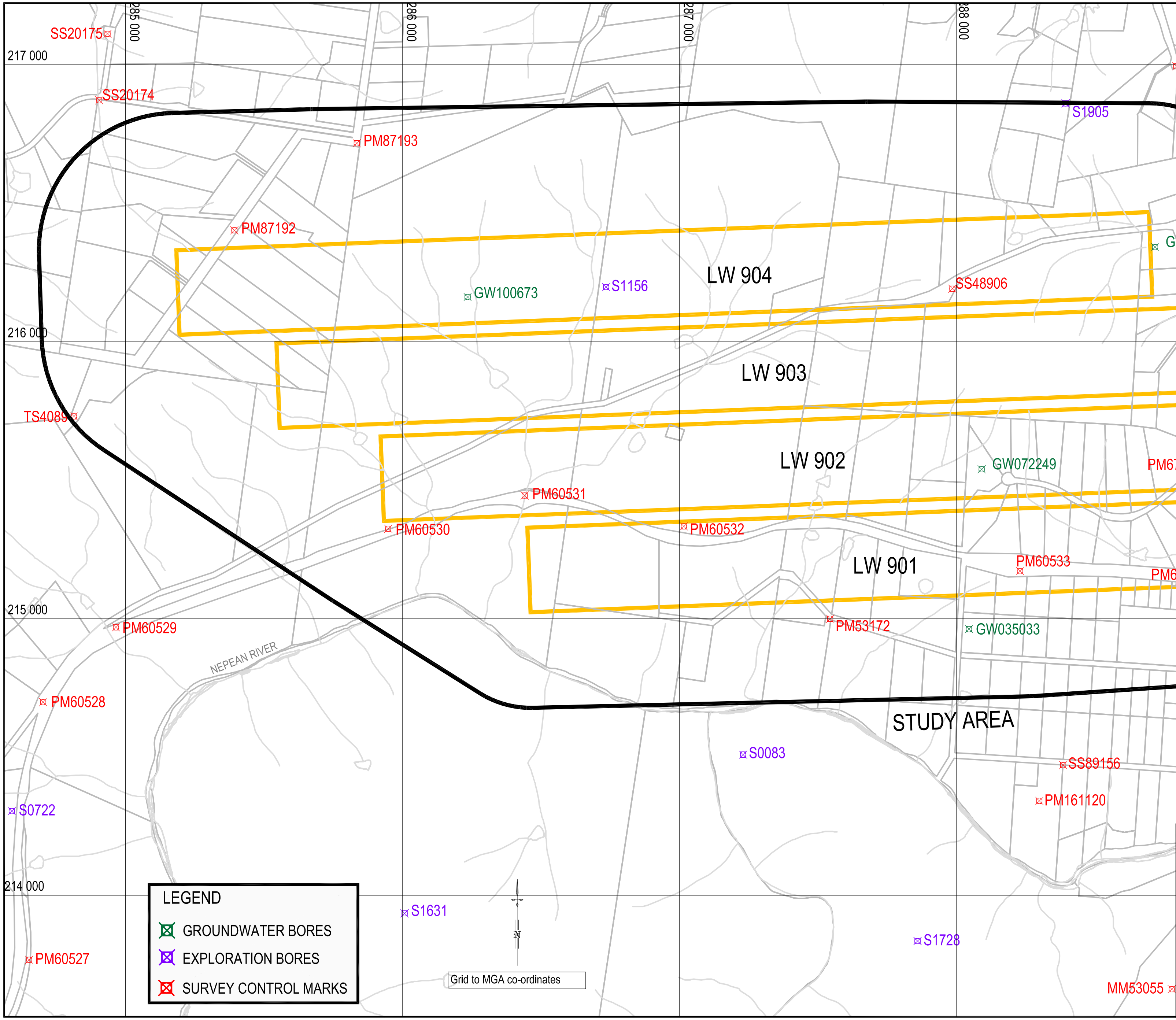

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APPIN COLLIERY - AREA 9
WATER BORE HOLES, EXPLORATION DRILL HOLES & SURVEY CONTROL MARKS

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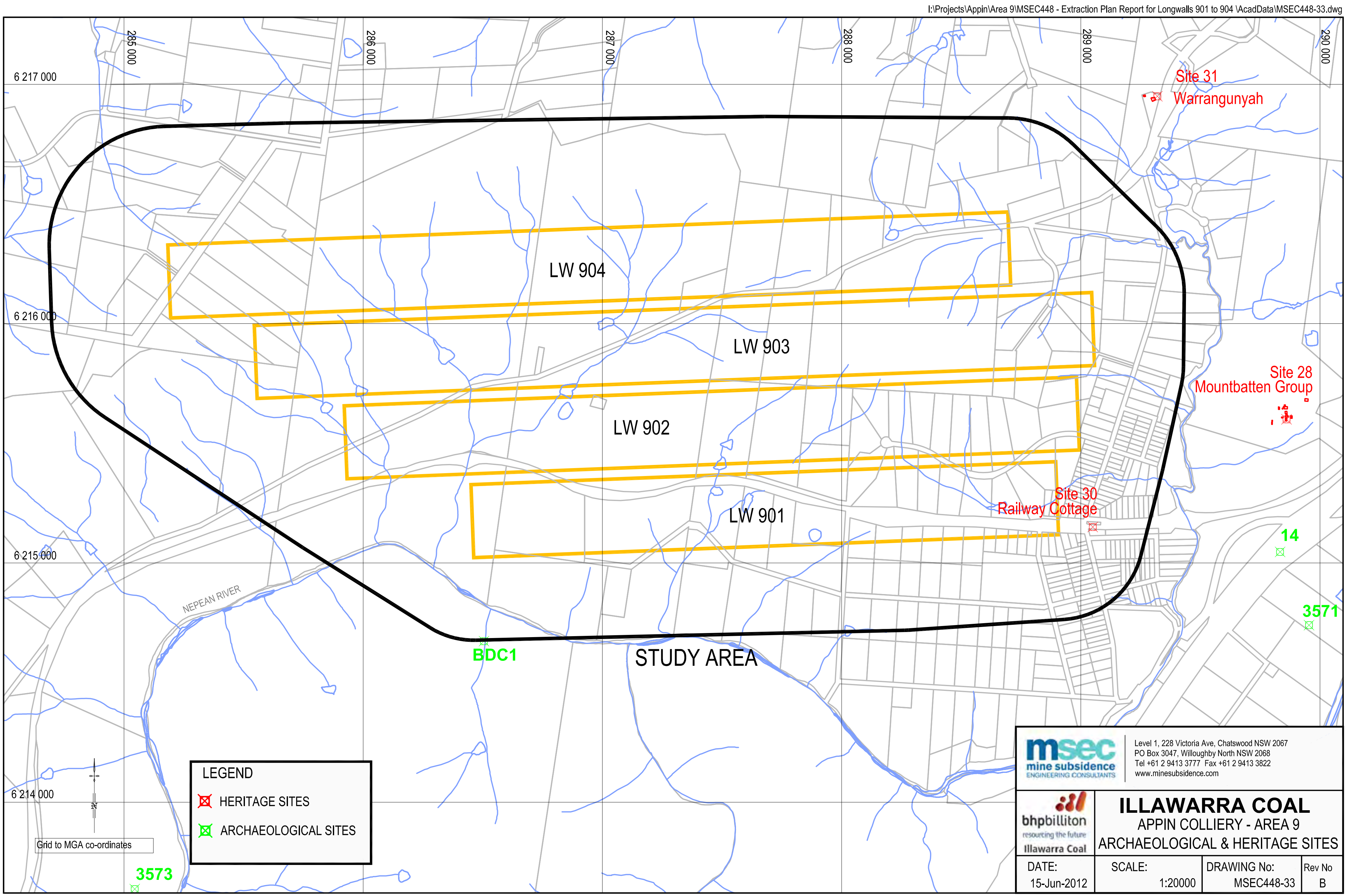
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285 000
286 000
287 000
288 000
289 000
290 000
6 217 000
6 216 000
6 215 000
6 214 000
Site 31
Warrangunyah
Site 28
Mountbatten Group
Site 30
Railway Cottage
14
3571
3573
BDC1
LW 904
LW 903
LW 902
LW 901
STUDY AREA
NEPEAN RIVER
LEGEND
HERITAGE SITES
ARCHAEOLOGICAL SITES
Grid to MGA co-ordinates
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Rev No
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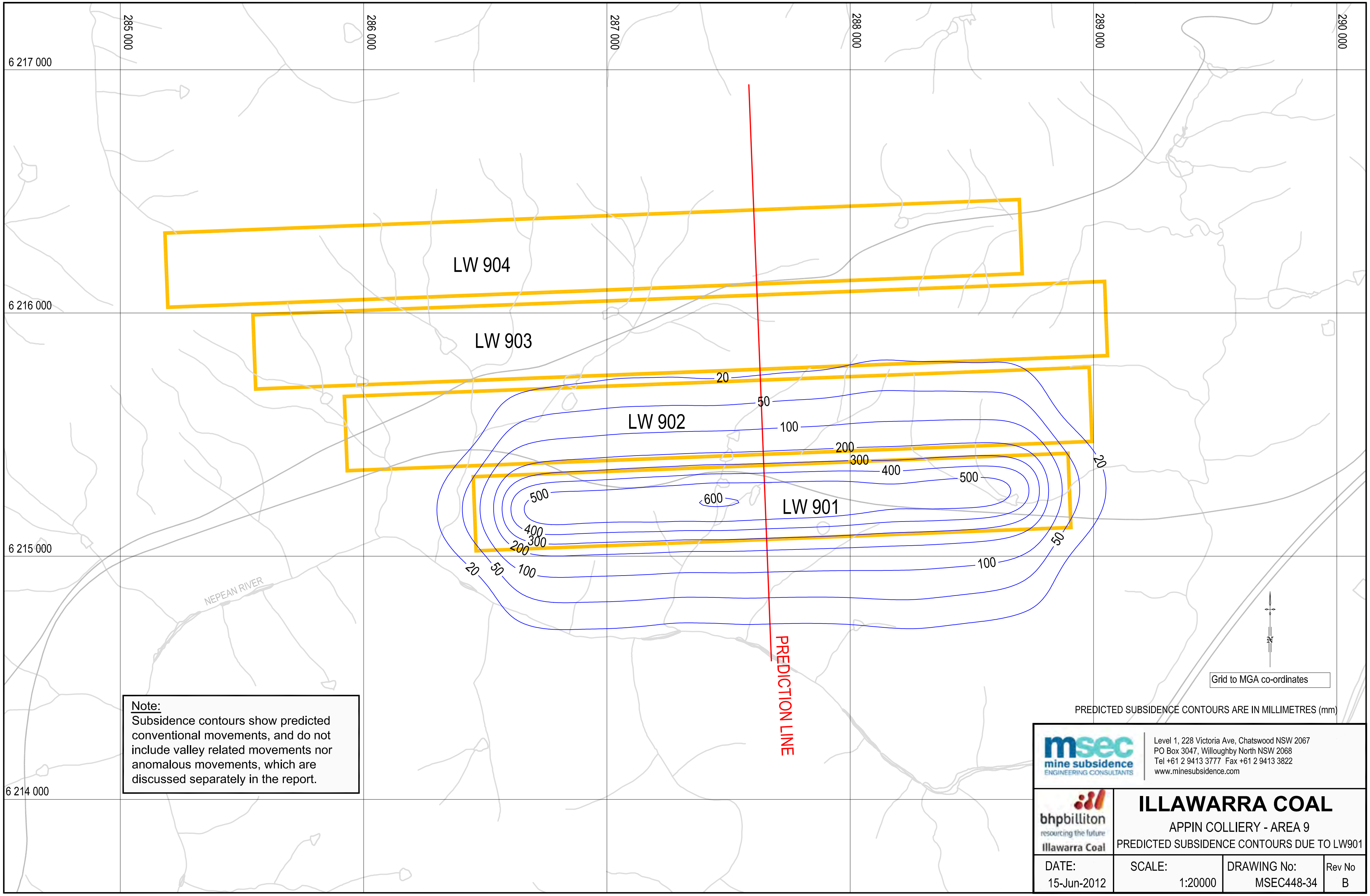

Note:
Subsidence contours show predicted conventional movements, and do not include valley related movements nor anomalous movements, which are discussed separately in the report.

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PREDICTED SUBSIDENCE CONTOURS DUE TO LW901

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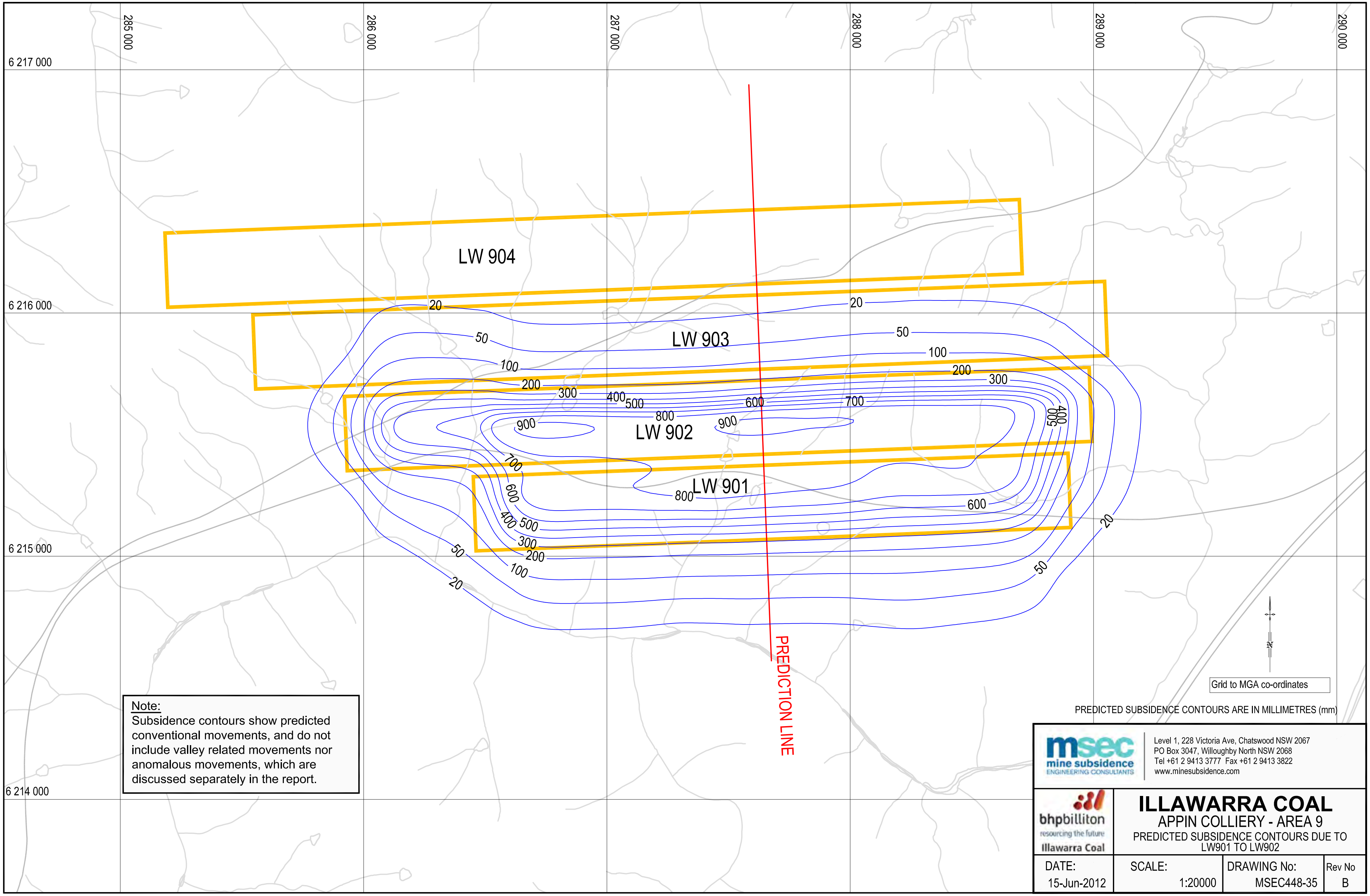

Note:
Subsidence contours show predicted conventional movements, and do not include valley related movements nor anomalous movements, which are discussed separately in the report.

PREDICTED SUBSIDENCE CONTOURS ARE IN MILLIMETRES (mm)

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APPIN COLLIERY - AREA 9
PREDICTED SUBSIDENCE CONTOURS DUE TO LW901 TO LW902

DATE:	SCALE:	DRAWING No:	Rev No
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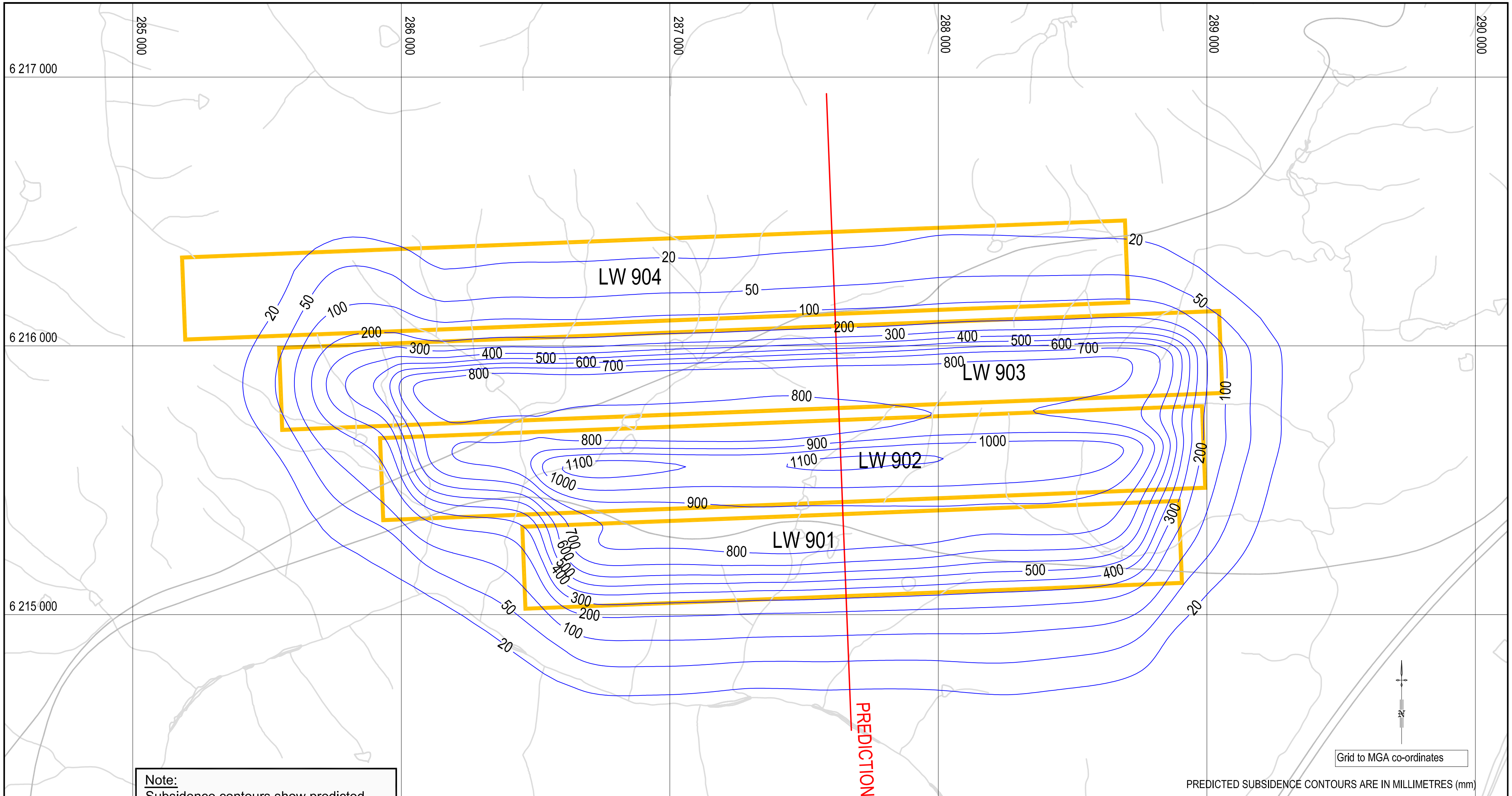

Note:
Subsidence contours show predicted conventional movements, and do not include valley related movements nor anomalous movements, which are discussed separately in the report.

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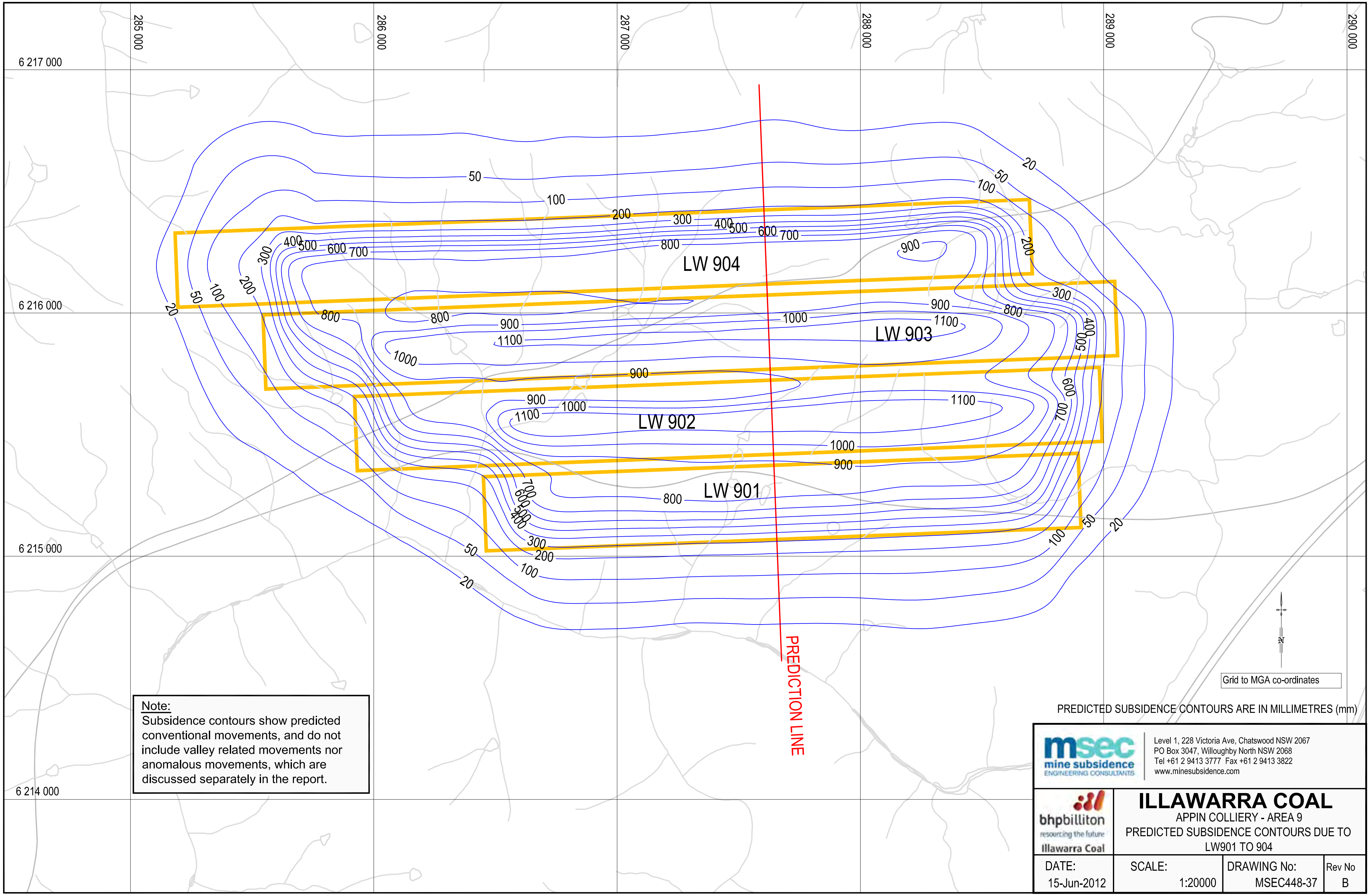

PREDICTED SUBSIDENCE CONTOURS ARE IN MILLIMETRES (mm)

Note:
Subsidence contours show predicted conventional movements, and do not include valley related movements nor anomalous movements, which are discussed separately in the report.

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DATE:	SCALE:	DRAWING No:	Rev No
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