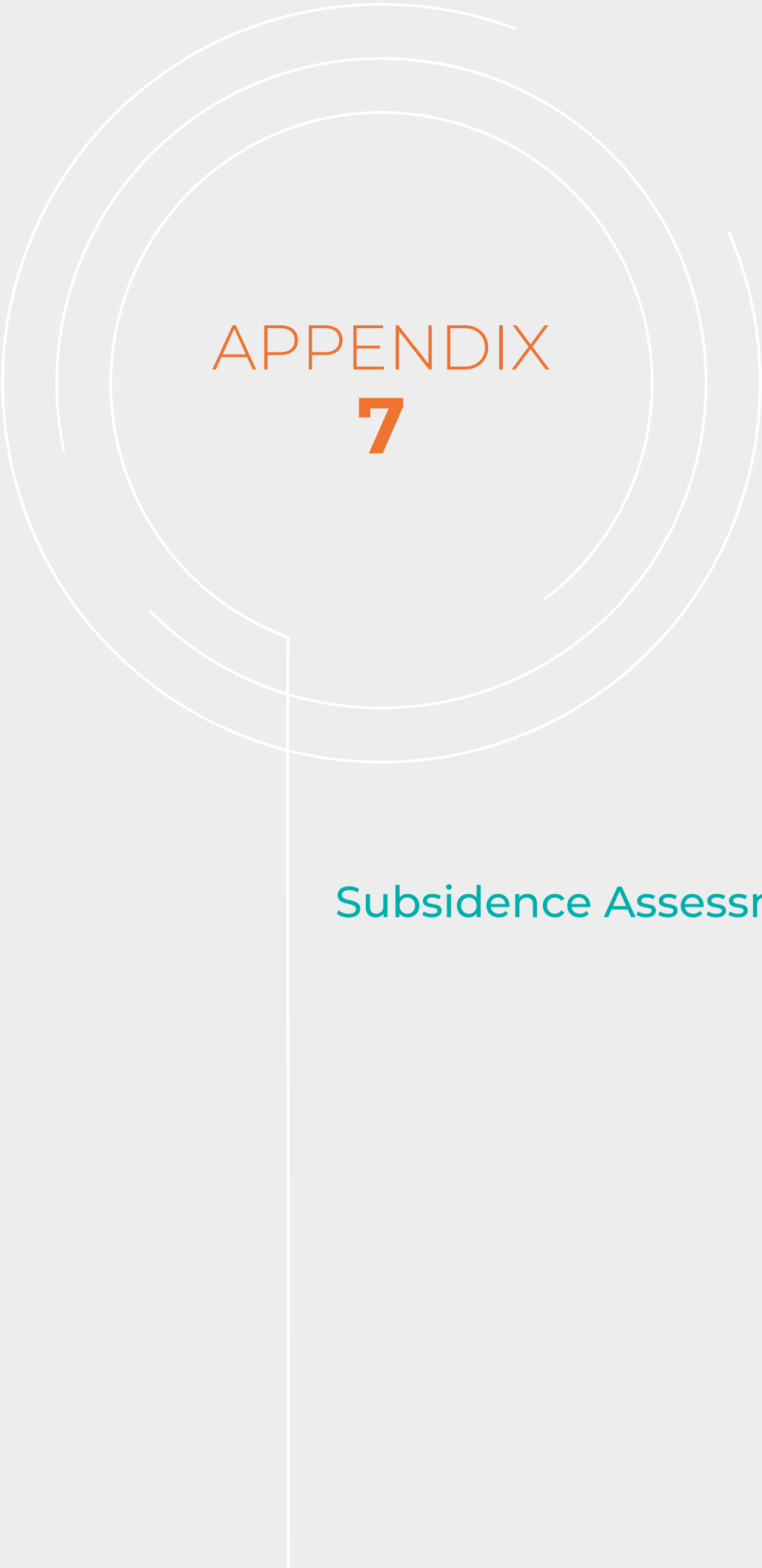




APPENDIX **7**

Subsidence Assessment



Strata Control Technology

ULAN COAL MINES PTY LTD

Subsidence Assessment for Proposed Modification 6

UMW5220_REV2



RESEARCH



CONSULTING



FIELD SERVICES



INSTRUMENTATION



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TITLE Subsidence Assessment for Proposed
Modification 6

REPORT No UMW5220_Rev2

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EXECUTIVE SUMMARY

Ulan Coal Mines Pty Ltd (UCMPL) operates the Ulan Underground (UUG) mine and Ulan West (UWO) mine within the Ulan Coal Complex (UCC) approximately 19km northeast of Gulgong in the Central West of New South Wales. UCMPL is proposing to modify the current project approval, PA08_0184 for the Ulan Coal Continued Operations (UCCO) Project, to optimise coal recovery from within existing mining lease (ML) areas and an adjacent exploration licence (EL) area by increasing the length and width of some longwall panels at UUG and UWO. Umwelt (Australia) Pty Ltd (Umwelt) as lead consultant to UCMPL commissioned SCT Operations Pty Ltd (SCT) to forecast the likely subsidence effects and assess the impacts for the proposed additions to the underground mining areas at UUG and UWO (Proposed Modification) in two layouts. This report presents our forecast of the subsidence effects and impact assessment for longwall mining in the Proposed Modification extension areas.

Our assessment of both layout options indicates:

Subsidence effects, impacts and consequences for longwall mining in the Proposed Modification extension areas are expected to be:

- Similar to those previously forecast and subsequently observed at UCC.
- Compliant with the subsidence performance measures of the UCCO Project Approval conditions.

Estimates of conventional subsidence effects are consistent with the range of values previously forecast at similar overburden depths for the original UCCO Project Environmental Assessment (EA) or subsequent updates for modifications and subsidence management / extraction plan assessments at the UCC.

Maximum vertical subsidence of 2.1m is forecast for the shallower areas where the overburden depth is 130m and 1.7m for the deeper areas where the overburden depth is 250m.

Subsidence impacts are expected to be consistent with or less than the predictions for the original UCCO Project EA and subsequent modifications, subsidence performance measures in PA08_0184, and the monitoring experience since PA08_0184 was granted.

The majority of the surface is undeveloped bushland owned by UCMPL or Crown Land leased by UCMPL. The remainder is Crown Land, Crown Land leased privately or private property. Most of the areas of cleared or semi-cleared land suitable for grazing are owned by UCMPL. There are no significant surface improvements on the areas of private property and privately leased Crown Land.

Impacts to natural or built surface and sub-surface features, including those on privately owned or privately leased land, are expected to be manageable via provisions of subsidence management plans for private property, public safety, built features and water.

Ongoing subsidence monitoring and risk control measures or hazard management strategies for managing subsidence impacts are recommended.

TABLE OF CONTENTS

	PAGE No
EXECUTIVE SUMMARY	I
TABLE OF CONTENTS	II
1. INTRODUCTION	1
2. CONCLUSIONS AND RECOMMENDATIONS	4
3. SITE DESCRIPTION	6
3.1 Site Overview	7
3.2 Assessment Area	7
3.3 Approvals Context	10
3.4 Land Ownership and Land Use	10
3.5 Proposed Mining Geometry	12
3.6 Stratigraphy, Overburden Depth and Seam Thickness	13
3.7 Surface Features and Surface Infrastructure	13
3.7.1 Natural Features	18
3.7.2 Man-made or Built Features	19
4. FORECAST SUBSIDENCE BEHAVIOUR	20
4.1 Forecast of Subsidence Effects	20
4.1.1 Vertical Subsidence	21
4.1.2 Tilt	24
4.1.3 Strain and Surface Cracking	24
4.1.4 Horizontal Movements	25
4.1.5 Unconventional Subsidence	25
4.2 Reliability and Accuracy of Subsidence Predictions	26
4.3 Subsidence Monitoring	27
5. SUBSIDENCE IMPACT ASSESSMENT	27
5.1 Subsidence Impact Assessment by Feature	27
5.1.1 Landform	28
5.1.2 Steep Slopes, Sandstone and Cliff Formations	28
5.1.3 Surface Water - Creeks and Dams	30
5.1.4 Groundwater	32
5.1.5 Aboriginal Heritage Sites	33
5.1.6 Powerline and Telecommunications Cable	40
5.1.7 Survey Control Stations	40
5.1.8 Private Property, Privately Leased Crown Land or Crown Land	41
5.1.9 Agricultural Infrastructure	42
5.1.10 Mining Related Infrastructure	43
5.1.11 Public Safety	43

5.2	Subsidence Impact Assessment by Location – Option 1 (Base case) ..	43
5.2.1	UUG - Longwall W9	44
5.2.2	UUG - Longwall W10	45
5.2.3	UUG - Longwall W11	46
5.2.4	UWO - Longwall 9A	47
5.2.5	UWO - Longwall 10A.....	48
5.2.6	UWO - Longwall 11A.....	49
5.2.7	UWO - Longwall 12A (238m Wide).....	50
5.3	Subsidence Impact Assessment by Location – Option 2 (Flexibility) ...	51
5.3.1	UUG - Longwall W9	51
5.3.2	UUG - Longwall W10	52
5.3.3	UUG - Longwall W11	53
5.3.4	UWO - Longwall 9A	55
5.3.5	UWO - Longwall 10A.....	55
5.3.6	UWO - Longwall 11A.....	56
5.3.7	UWO - Longwall 12A (238m Wide).....	57
6.	REFERENCES	58

1. INTRODUCTION

Ulan Coal Mines Pty Ltd (UCMPL) owns and operates the Ulan Underground (UUG) mine and Ulan West (UWO) mine within the Ulan Coal Complex (UCC) approximately 19km northeast of Gulgong in the Central West of New South Wales. UCMPL is proposing to modify the current project approval, PA08_0184 (as modified) for the Ulan Coal Continued Operations (UCCO) Project, to optimise coal recovery from within existing mining lease (ML) areas and an adjacent exploration licence (EL) area by increasing the length, and in one case the width, of some longwall panels at UUG and UWO. Umwelt (Australia) Pty Ltd (Umwelt), the lead environmental consultant for the Proposed Modification commissioned SCT Operations Pty Ltd (SCT) to forecast the likely subsidence effects and assess impacts for the Proposed Modification areas. This report presents our forecast of the subsidence effects and impacts from the proposed mining in two layout options within the same footprint.

The scope for the Proposed Modification includes:

- An extension of the length of Longwalls W9-W11 at UUG.
- A slight increase in the width of Longwall W11 to be consistent with the current longwall panels.
- An extension of Longwalls 9-12 at UWO.

There is an area within EL 7542 which may be accessed by either UWO or UUG depending on timing of operations and mining conditions. The area referred to as the 'Longwall Option Area'. Both options have been considered in this assessment, being:

- Option 1 - referred to as the 'Base case' layout has shorter extensions to Longwalls W9-W11 at UUG and a longer extension of Longwall 9 at UWO.
- Option 2 - the 'Flexibility' layout option is the opposite to Option 1 with longer extensions to Longwalls W9-W11 and a shorter extension to Longwall 9.

Figure 1 shows an overview of the longwall extension areas for the Proposed Modification in the Option 1 (Base case) layout, relative to the existing and approved longwall panels, superimposed on a 1:25,000 topographic series map of the area. Mining Leases, Exploration Licence areas, the UCCO Project boundary and the Assessment Area used for the Proposed Modification areas are also shown. Figure 2 shows the same detail with the Option 2 (Flexibility) layout.

This report is structured to provide:

- Conclusions and recommendations based on our assessment.
- An overview of the site, including a general description of significant surface features above or within the vicinity of the Proposed Modification extension areas.
- Estimates of the subsidence effects expected in the Proposed Modification areas based on previous subsidence experience at the UCC and understanding gained since the original UCCO Project Approval was granted.
- A description of the subsidence impacts expected for the various surface, sub-surface features and infrastructure or built features identified within the Assessment Area for the Proposed Modification areas. Expected impacts are discussed for each type of feature and then on a longwall by longwall basis for both layout options.

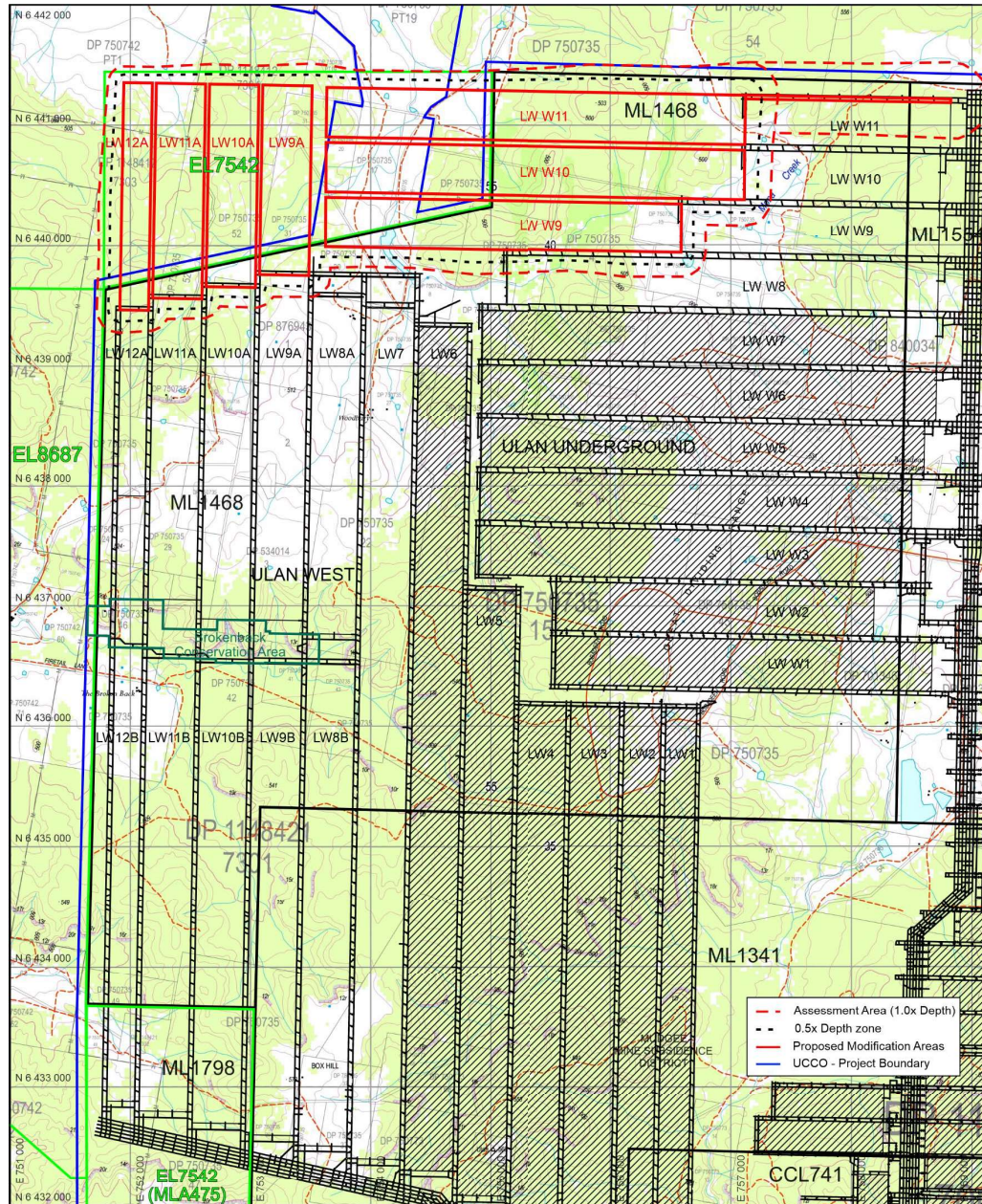


Figure 1: Site plan of Proposed Modification Areas for Option 1 (Base case) layout superimposed on 1:25,000 topographic map with mining leases.

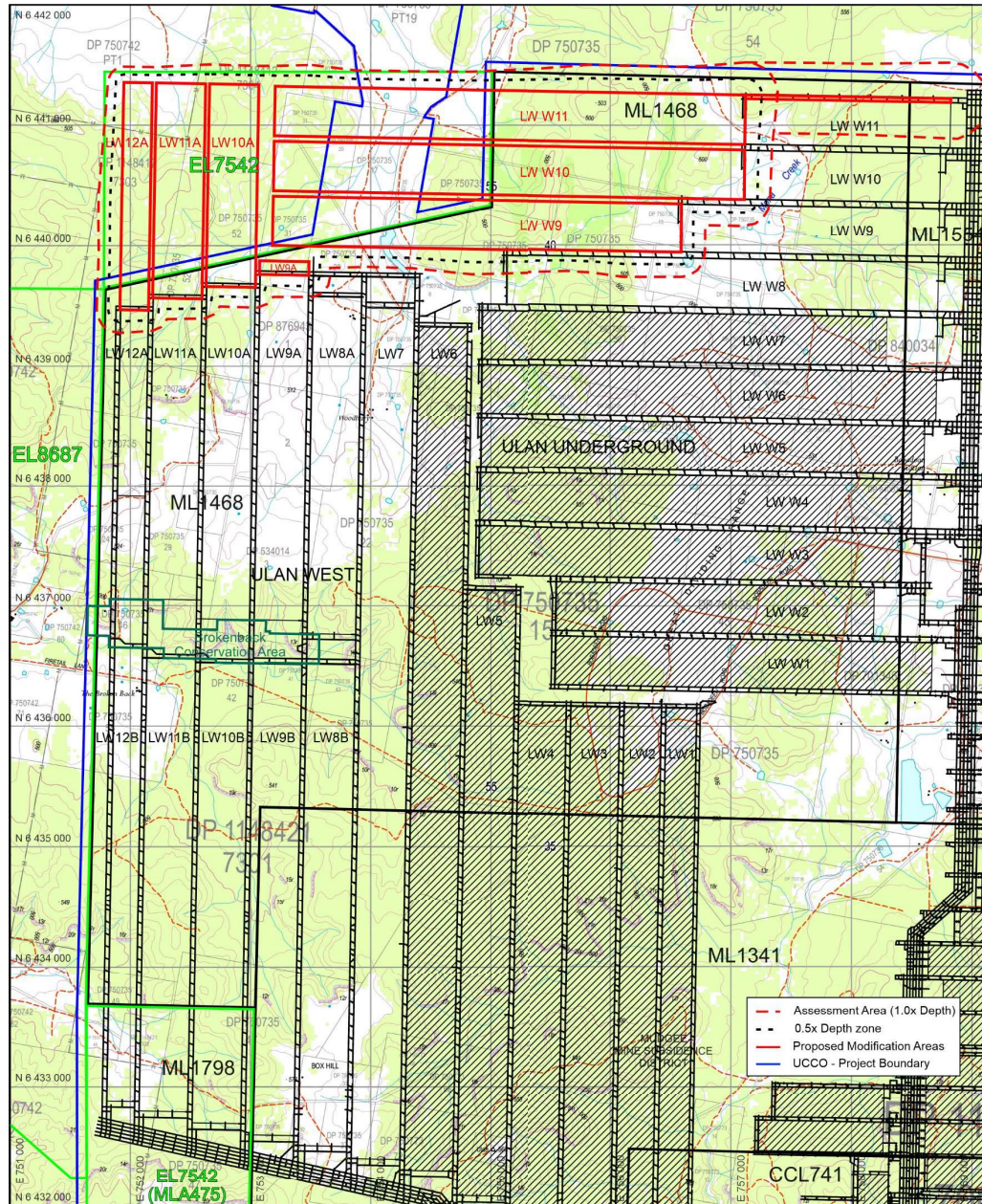


Figure 2: Site plan of Proposed Modification Areas for Option 2 (Flexibility) layout superimposed on 1:25,000 topographic map with mining leases.

2. CONCLUSIONS AND RECOMMENDATIONS

The Proposed Modification layouts with extensions to the current longwall panels are considered to be generally in accordance with the approved mine plan.

Subsidence effects, impacts and consequences for longwall mining in the Proposed Modification extension areas for both the Base case and Flexibility layout options are expected to be:

- Similar to those previously forecast and subsequently measured or observed at UCC.
- Compliant with the subsidence performance measures of the UCCO Project Approval conditions.

Estimates of conventional subsidence effects for the proposed longwall extension areas are consistent with the range of values previously forecast at similar overburden depths. These forecasts are from the original UCCO Project EA or subsequent updates for modifications and subsidence management/extraction plan assessments at the UCC. The estimates incorporate the improved understanding of subsidence behaviour from the monitoring conducted since the original UCCO Project EA was prepared.

The forecast of maximum subsidence effects for conventional subsidence behaviour are shown in Table 1.

Table 1: Primary Subsidence Parameters for Representative Overburden Depths over the Proposed Modification Areas

Overburden Depth	130m	250m
Vertical Subsidence (m)	2.1	1.7
Tilt (mm/m)	85	40
Compression Strain (mm/m)	35	20
Tensile Strain (mm/m)	25	15

The subsidence impacts forecast for the Proposed Modification longwall extraction areas are not greater than those for original UCCO Project EA and subsequent modifications and not greater than in the adjacent areas that have already been approved.

The majority of the surface within the Assessment Area is freehold land owned by UCMPL or Crown Land leased and controlled by UCMPL. The remainder is Crown Land, privately leased Crown Land or private property. There are no significant surface improvements on the areas of private property and privately leased Crown Land.

The majority of the surface is undeveloped bushland with small areas of cleared or semi-cleared land suitable for grazing. Most of the cleared or semi-cleared areas are on land owned by UCMPL.

Impacts to the areas of land not owned or leased by UCMPL above the Proposed Modification extension areas, are expected to be minor and generally imperceptible. Any impacts to natural or built surface and sub-surface features on privately owned or privately leased Crown Land, are expected to be minor and manageable via provisions in subsidence management plans for private property, public safety, built features and water. Private Property Subsidence Management Plans (PPSMP) for each individual property are required to be developed through consultation and agreement with the affected landholders.

The frequency of sandstone outcrop formations and Aboriginal heritage rock shelters above the Proposed Modification extension areas are generally less than previously mined areas at the UCC.

Overall subsidence impacts are expected to be consistent with or less than the predictions for the original UCCO Project EA and subsequent modifications, subsidence performance measures in PA08_0184, and the monitoring experience since PA08_0184 was granted.

Table 2 summarises the subsidence performance measures for the UCCO Project, as outlined in Table 14 of Condition 24 from Schedule 3 of PA08_0184, and the expected compliance from mining the Proposed Modification extension areas.

Table 2: Subsidence Performance Measures

<i>Subsidence Performance Measure</i>		<i>Status of compliance expected during proposed mining</i>
Water		
Ulan, Mona & Cockabutta Creeks	No greater environmental consequences than predicted in the EA	Compliance expected. Proposed mining is remote from Ulan and Cockabutta Creeks No change to forecast of impacts or consequences for Mona Creek expected from additional underground mining associated with the Proposed Modification. (refer to water resource assessments).
Biodiversity		
Threatened species, populations, habitat or ecological communities	Negligible impact	Compliance expected. No change to forecast of maximum effects or impacts expected from additional underground mining associated with the Proposed Modification.
Land		
Cliffs in the Brokenback Conservation Area (BBCA)	Nil environmental consequences	Compliance expected. Proposed mining is remote from BBCA No change to forecast of impacts or environmental consequences to BBCA expected from additional underground mining associated with the Proposed Modification
Other Cliffs	Minor environmental consequences	Compliance expected. No change to forecast of impacts or consequences expected from additional underground mining associated with the Proposed Modification.

<i>Subsidence Performance Measure</i>		<i>Status of compliance expected during proposed mining</i>
Heritage		
Aboriginal Sites	Nil impact in the Brokenback Conservation Area, Grinding Groove Conservation Areas; and on Mona Creek Rock Shelter sites	Compliance expected. Proposed mining is remote from areas and sites. Mona Creek Rock Shelter sites protected by barrier. No change to forecast of maximum effects or impacts expected from additional underground mining associated with the Proposed Modification.
Talbragar Fish Fossil Reserve (TFFR)	Negligible impact	Compliance expected. Proposed mining is remote from TFFR No change to forecast of maximum effects or impacts expected from additional underground mining associated with the Proposed Modification.
Other Heritage Sites	No greater impact than predicted in EA	Compliance expected. No change to forecast of maximum effects or impacts expected from additional underground mining associated with the Proposed Modification.
Built Features		
All built features	Safe, serviceable and repairable unless the owner agrees otherwise in writing	Compliance expected (impacts managed via provisions of Built Features Management Plan (BFMP) and following development of a Private Property Subsidence Management Plan in consultation with the landholder (PPSMP)).
Public Safety		
Public Safety	No additional risk due to mining	Compliance expected (impacts managed via Public Safety Management Plan (PSMP) and PPSMP).

Maintaining the existing subsidence monitoring line arrangements at UCC is expected to be satisfactory for monitoring the Proposed Modification extension areas unless the recommended monitoring line over Longwalls 7-12 at UWO is not able to be implemented. If agreement with the private landowner for this additional line is not able to be reached, then a new east-west line over the proposed extension areas on UCML and Crown Land is recommended.

Risk control measures or hazard management strategies for managing subsidence impacts are also recommended. These measures are included in Section 5.1.

3. SITE DESCRIPTION

This section presents a description of the surface and sub-surface features within the Assessment Area for the Proposed Modification extension areas as well as other parameters of relevance to this subsidence assessment.

3.1 Site Overview

The surface topography above the Assessment Area is characterised by the series of ephemeral drainage lines or tributaries and the main channel of Mona Creek that flow from the ridge of the Great Dividing Range generally to the north into the Talbragar River. Sandstone outcrop formations that form steep slopes and short sections of cliff line are prominent along the sides of some of these drainage channels. Aboriginal heritage sites are located at some of the sandstone outcrop formations.

The majority of the surface within the Assessment Area is undeveloped bushland with areas of cleared or semi-cleared land suitable for grazing, predominately in the valley formed by the main channel of Mona Creek. Most of the land above the Proposed Modification extension areas is owned by UCMPL or Crown Land leased by UCMPL. The remainder is Crown Land, privately leased Crown Land or private property.

Figures 3 and 4 shows the Proposed Modification extension areas for each options with the Assessment Area superimposed onto a high resolution image of the surface from August 2018. Bushland, watercourses and dams, sandstone outcrop formations and land ownership details are also shown.

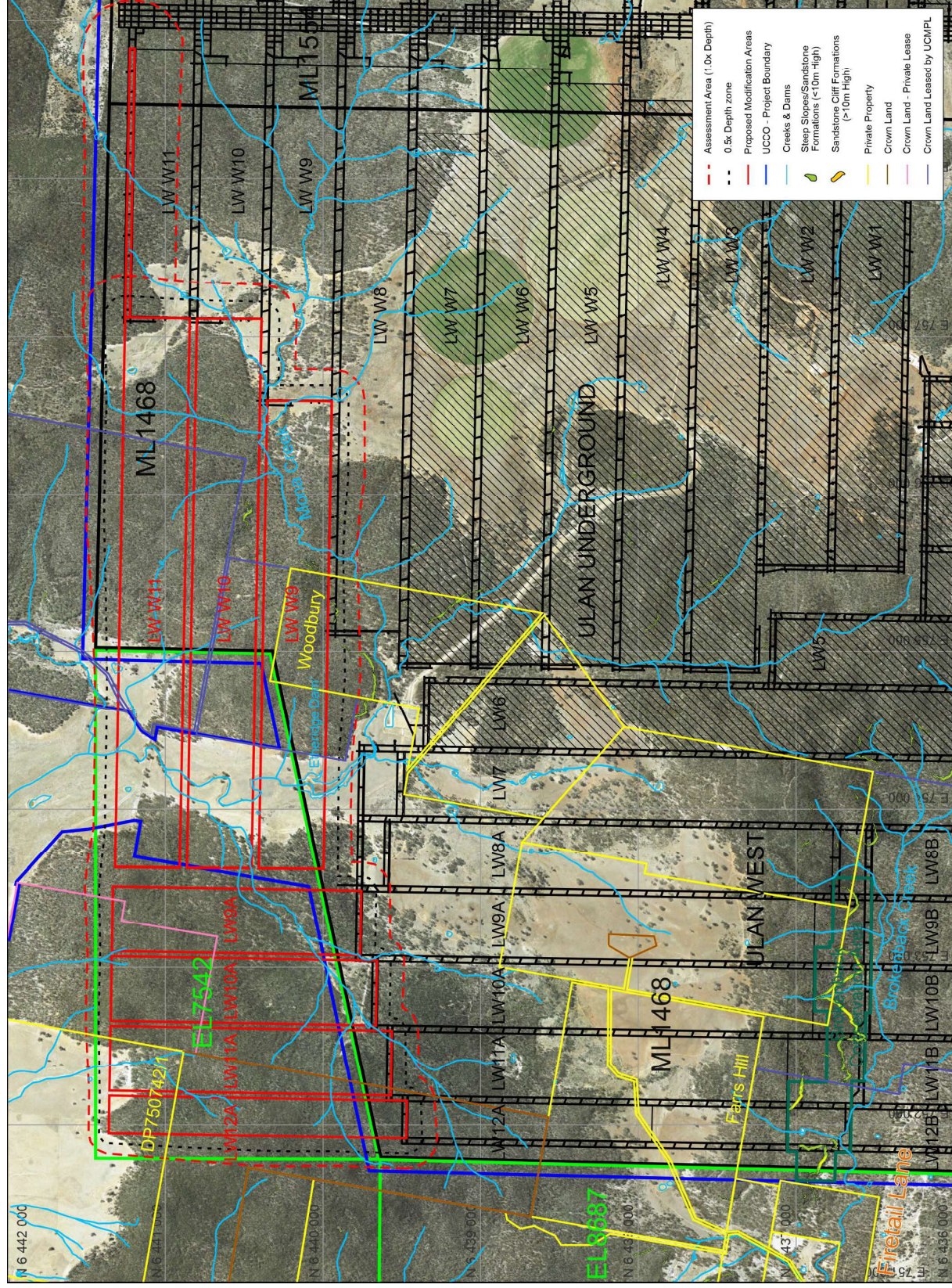
3.2 Assessment Area

The Assessment Area for Proposed Modification extension areas for each option is shown in figures including Figures 1 and 2. This Assessment Area is based on a distance equal to the depth to the mining horizon from the edges of the proposed extensions to the longwall panels to which the Proposed Modification applies. A distance equal to the overburden depth is equivalent of a 45° angle of draw and is considered to be conservative for impact assessment purposes.

A distance equal to the overburden depth is used because this distance can be determined with confidence, is not subject to survey tolerance variations that can affect estimates of angle of draw and is expected to extend far enough to include all surface features that may be impacted by subsidence movements. A 20mm contour of vertical subsidence was historically used as the basis to determine the extent of subsidence movements. The concept of angle of draw was used to define this distance. An angle of draw of 26.5° (0.5 depth) was commonly accepted as a practical limit of subsidence movements. However, the angle of draw at any given site is not easily defined and is observed to vary with mining direction, depth, mining height and other parameters including survey tolerance.

Vertical ground movements are expected to be less than 20mm outside of the outermost edges of this Assessment Area. Horizontal ground movements may be as high as 250mm at the edge of the Assessment Area reducing to 20mm out to a horizontal distance of up to 2km from the edge of longwall panels. However, the differential or rate of change of these far-field horizontal movements is expected to be so small and so gradual that they are imperceptible for all practical purposes.

No perceptible impacts from subsidence movements are expected beyond a distance of 0.5 times depth (equal to a 26.5° angle of draw) from the longwall panel edges.



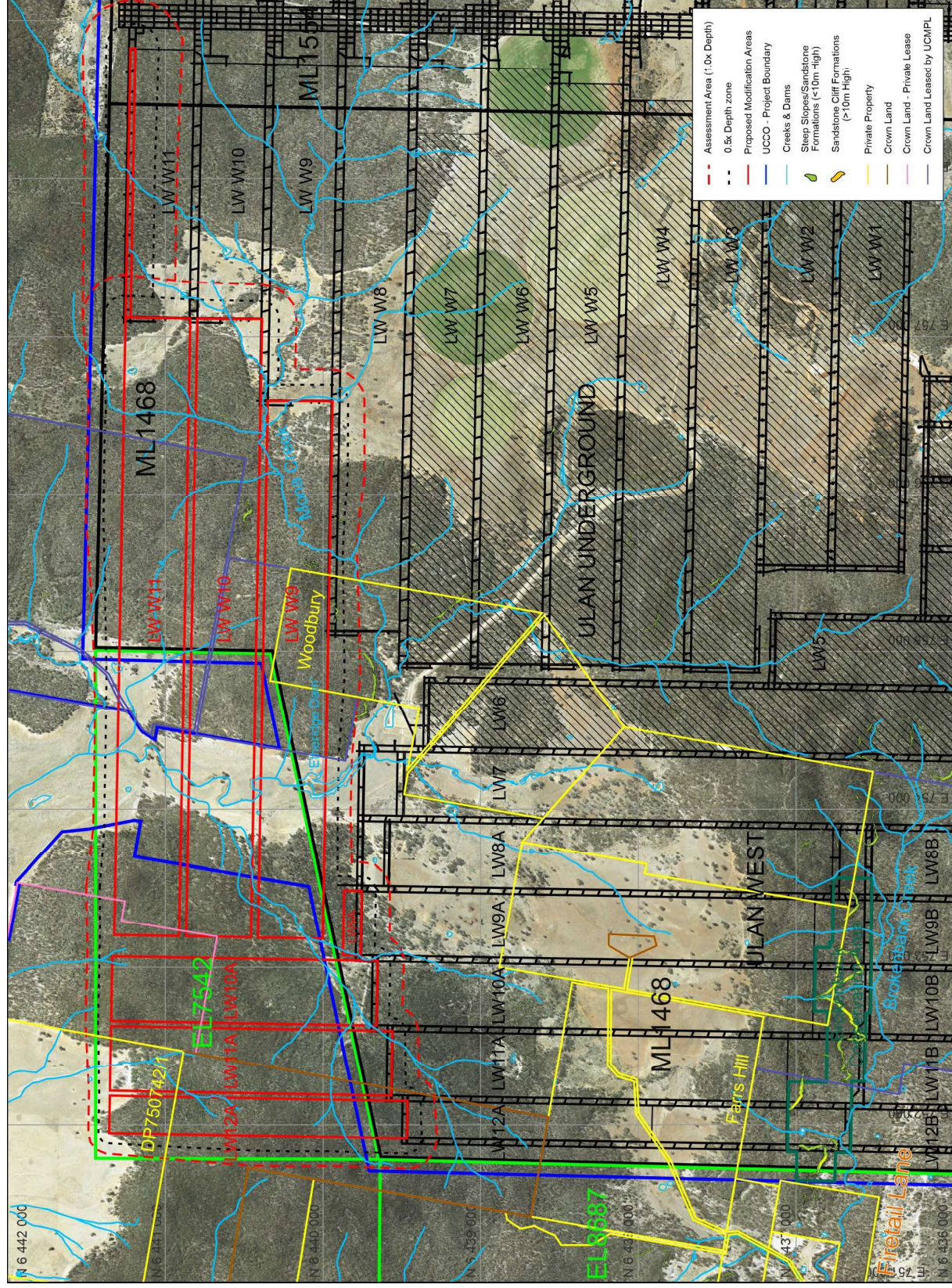


Figure 4: Site plan of Proposed Modification Areas for Option 2 (Flexibility) layout superimposed onto an aerial image with surface features and land ownership details.

The assessment presented in this report for the Proposed Modification extension areas is generally limited to a distance of one times the depth around each of the individual extension areas with the main focus on areas outside the previously approved panel boundaries. Features within previously approved areas are not generally reassessed in this report.

3.3 Approvals Context

As shown on Figures 1 and 2, the Proposed Modification extension areas are within mining leases ML1468, ML1554 and exploration licence area EL7542.

UCMPL was granted Project Approval 08_0184 (PA08_0184) under then Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) in November 2010 for the UCCO Project.

Since 2010, six modifications have been granted to the UCCO Project Approval to facilitate changes or corrections to the mining plan geometries at both UUG and UWO (MOD1, MOD2, MOD3, MOD4 and MOD5) and for other operational requirements (MOD7) at the UCC.

The potential environmental impacts of the UCC were assessed in the Ulan Coal - Continued Operations Environmental Assessment (Umwelt, 2009) and updated in subsequent modifications including the Ulan West Modification (MOD3) Environmental Assessment (Umwelt, 2015) and Modification 4 Longwall Optimisation Project (Eco Logical 2017). MOD5 was a minor modification to correct a misdescription of longwall recovery positions within Longwall 6-8 at UW. MOD 7 modified PA 08_0184 to permit use of an alternate biodiversity offset site (Bobadeen West Vegetation Offset) to replace the privately owned portion of Brokenback Conservation Area.

A number of other minor variations to the mine plan have also been facilitated through first workings applications under conditions of the UCCO Project Approval. These include extensions and reductions in longwall panel lengths, realignment of main headings and adjustment of or removal of internal coal barrier pillars with the consequence of reducing the mining footprint in some areas.

3.4 Land Ownership and Land Use

The majority of the surface within the Assessment Area is freehold land owned by UCMPL or Crown Land leased and controlled by UCMPL. The remainder is Crown Land, privately leased Crown Land or private property.

Land ownership details are shown in Figures 3 and 4. Areas not delineated are owned by UCMPL.

The mining footprint above the Proposed Modification extension areas for both layout options cover a surface area that totals 728Ha. Approximately 79% of this surface area is owned or leased by UCMPL, 6.5% is private property, 6.5% is privately leased Crown Land and 8% is Crown Land.

For Option 1 (Base case) layout –

- the Proposed Modification extension areas at UWO:
 - The undeveloped Crown Land is above sections of Longwall 11A and Longwall 12A.

- Privately leased Crown Land covers the northern sections of Longwalls 9A-11A.
 - Portions of privately owned land cover the northwest corner of Longwall 11A and Longwall 12A.
- the Proposed Modification extension areas at UUG:
 - Privately owned land overlies a section of the surface above Longwall W9.
 - A Crown Land 'paper road' overlies the western end of the proposed extensions to Longwall W9, W10 and W11. This 'paper road' provides a legal access to private properties to the south of the proposed extension of Longwall W9. The actual access road for these private properties also overlies the proposed extensions to Longwall W9, W10 and W11, although in a slightly different alignment to the Crown Road easement.

For Option 2 (Flexibility) layout -

- the Proposed Modification extension areas at UWO:
 - The undeveloped Crown Land is above sections of Longwall 11A and Longwall 12A.
 - Privately leased Crown Land covers the northern sections of Longwall 10A and Longwall 11A.
 - Portions of privately owned land cover the northwest corner of Longwall 11A and Longwall 12A.
- the Proposed Modification extension areas at UUG:
 - Privately owned land overlies a section of the surface above Longwall W9.
 - Privately leased Crown Land covers the far western part of Longwalls W10 and Longwall W11.

The majority of the surface within the Assessment Area is undeveloped bushland with smaller areas of cleared or semi-cleared land suitable for agricultural activities such as grazing.

The cleared or semi-cleared areas are predominately adjacent to the main channel or higher order tributaries of Mona Creek in areas owned by UCMPL. Other smaller, cleared or semi-cleared, areas on private property are located above the northwest corner of Longwall 11A and Longwall 12A.

The majority of the land over the Proposed Modification extension areas is within the Mudgee Mine Subsidence District (MMSD). Areas outside the MMSD are sections of private property above the northwest corner of Longwall 11A and Longwall 12A. There does not appear to be any significant surface improvements on this private property at this location other than fencing.

3.5 Proposed Mining Geometry

Current longwall panel voids at both mines are approximately 411m wide as measured between the remaining chain pillars. The block of coal mined by the longwall is 400m wide and the roadways on either side of each block are nominally 5.2m or 5.4m wide.

Table 3 summarises the geometry changes and overburden depth ranges associated with the Proposed Modification for UUG and UWO for both layout options.

Longwalls W9-W11 at UUG would be extended in a westerly direction within mining lease ML1468 and into the northern portion of EL7542. The width of Longwall W11 within ML1554 and ML1468 would be increased by approximately 30m to 411m to be consistent with the standard longwall equipment width.

Longwalls 9-12 at UWO would be extended in a northerly direction from within ML1468 towards the northern barrier in the northern portion of EL7542.

Table 3: Longwall Panel Extensions for the Proposed Modification

Mine and Longwall Panel	Approximate extension length (m)	Overburden Depth (m)
OPTION 1 (BASE CASE) LAYOUT		
Ulan Underground		
Longwall W9	2970	155-220
Longwall W10	3490	150-225
Longwall W11 (all 411m wide)	3495	145-250
Ulan West		
Longwall 9A	1580	150-180
Longwall 10A	1685	155-175
Longwall 11A	1790	130-180
Longwall 12A (238m wide)	1890	130-200
OPTION 2 (FLEXIBILITY) LAYOUT		
Ulan Underground		
Longwall W9	3410	155-220
Longwall W10	3925	150-225
Longwall W11 (all 411m wide)	3925	145-250
Ulan West		
Longwall 9A	120	160-180
Longwall 10A	1685	155-175
Longwall 11A	1790	130-180
Longwall 12A (238m wide)	1890	130-200

3.6 Stratigraphy, Overburden Depth and Seam Thickness

The overburden sequence above the Ulan Seam mining horizon comprises approximately 100m of Permian age strata, overlain by 100-120m of Triassic Sandstone. In limited areas of UWO and larger areas of UUG, where the overburden is thicker than about 200-220m, the Triassic Sandstone is overlain by Jurassic age siltstones and sandstones.

Figures 5 and 6 show the depth of cover to the Ulan Seam mining horizon and the thickness of the mining section which is located near the base of the seam for each layout option.

The Ulan Seam dips gently to the northeast across the Assessment Area causing a general increase in overburden depth in this direction. Most of the local variation in overburden depth is a result of topographic relief. Overburden depth varies from approximately 130m to 250m for the proposed longwall extension areas of the Proposed Modification. Table 3 details the range in overburden depth for each of the Proposed Modification extension areas.

The overall thickness of the Ulan Seam is nominally 7m in the Assessment Area. Longwall mining targets the base of the seam where the higher quality portion is located. This section is known as the D working section or DWS.

The thickness of the DWS varies from 2.4m to 3.1m within the Proposed Modification extension areas but is typically in the range of 2.6m to 3.1m. SCT understands that the minimum mining height would be 2.6m to suit the longwall equipment specifications. A mining height of 3.0m is used to estimate primary subsidence parameters.

3.7 Surface Features and Surface Infrastructure

In this section, surface features identified within the Assessment Area for Proposed Modification are described. Figures 7 and 8 shows the locations of most of these features relative to the layout options.

Surface features in the Assessment Area were identified based on:

- A site visit and walk-over inspection on 14 October 2020.
- LIDAR survey and high resolution imagery of the site from August 2018.
- Recent studies of features within the Assessment Area conducted by other specialists.
- Information presented in the EAs for the original UCCO Project (Umwelt 2009), MOD3 (Umwelt 2015) and MOD4 (Eco Logical 2017).

SCT Operations Pty Ltd – UMW5220_Rev2 – 1 November 2022

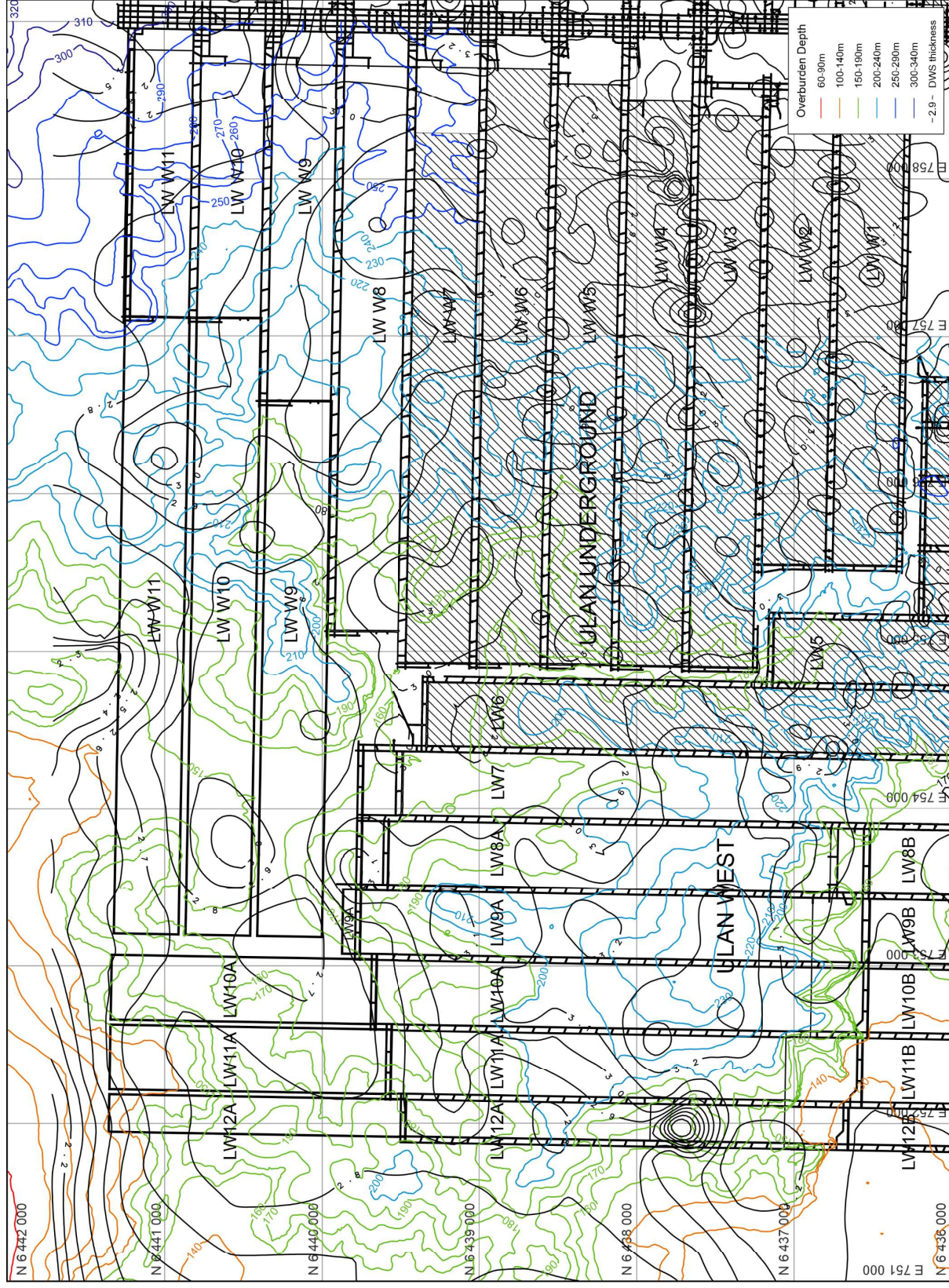


Figure 6: Overburden depths and DWS thickness of the Ulan Seam for Option 2 (Flexibility) layout.

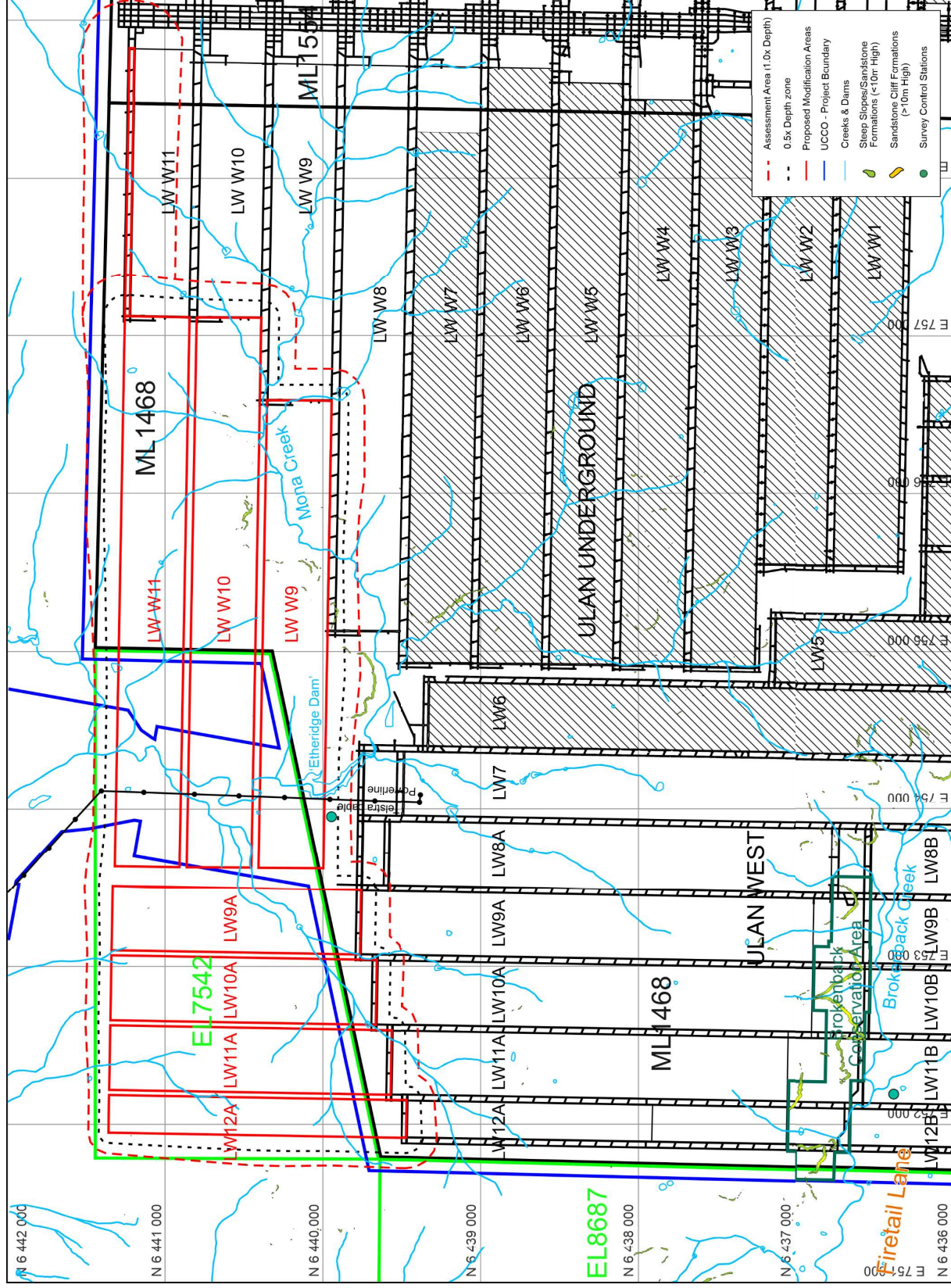


Figure 7: Site plan of Proposed Modification Areas for Option 1 (Base case) layout with surface features.

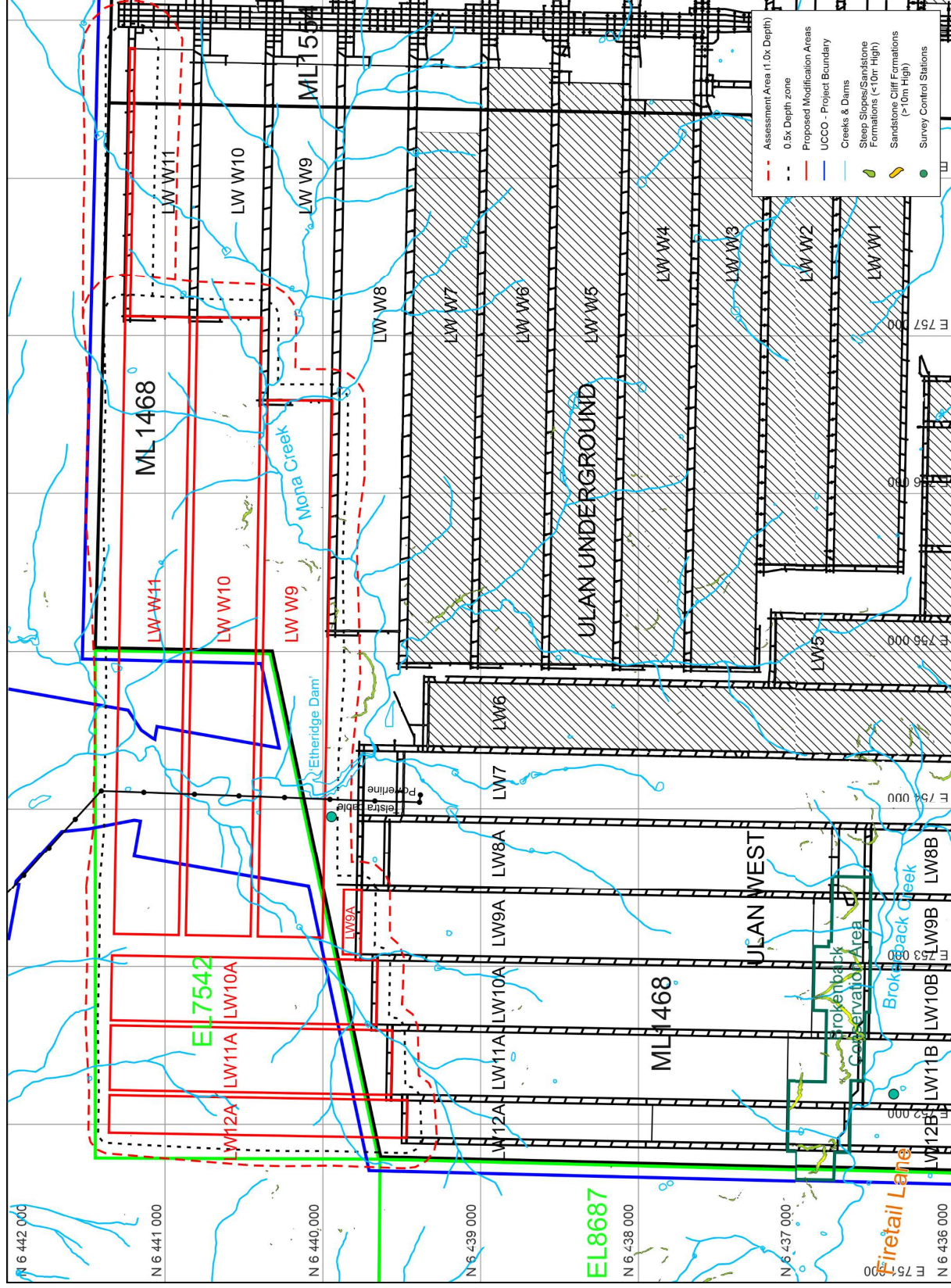


Figure 8: Site plan of Proposed Modification Areas for Option 2 (Flexibility) layout with surface features.

The majority of the surface above the proposed longwall extension areas has not been previously assessed for subsidence effects and impacts from longwall mining.

Risks associated with subsidence impacts to the features identified within the Assessment Area are considered in the context of the subsidence management requirements under the *Work Health and Safety (Mines and Petroleum Sites) Regulation 2014*.

The NSW Department of Mineral Resources "Guideline for Applications for Subsidence Management Approvals" provides a comprehensive list of surface and sub-surface features to be considered in a subsidence assessment for previous subsidence management plans (SMP). With no such equivalent list included in the Version 5 draft (unpublished) "Guidelines for the Preparations of Extraction Plans" issued by the Department of Planning & Environment, NSW Trade & Investment – Division of Resources and Energy, the SMP list has been used as a guide instead.

3.7.1 Natural Features

The majority of the surface within the Assessment Area is undeveloped bushland with small areas of cleared or semi-cleared land suitable for grazing.

The major natural features include a number of ephemeral watercourses and drainage lines that flow west from the Great Dividing Range into the Talbragar River and sandstone formations in the outcrops of the Triassic Sandstones.

The main channel, and tributaries of Mona Creek are located above the Proposed Modification extension areas to Longwalls W9-W11 at UUG and Longwalls 9A-12A at UWO. In the northwest corner of the Assessment Area above Longwalls 9A-12A, other lower order drainage lines flow directly into the Mona Creek floodplain and onto the broader Talbragar River floodplain.

Sandstone formation outcrops occur along the sides of the Mona Creek valley above the Proposed Modification extension areas. These formations host a variety of Aboriginal heritage rock shelter sites. Most of the sandstone formations are less than 5m high and defined as steep slopes but there are areas where formations are greater than 10m high and classified as a cliff. The UCCO Project Approval defines continuous formations with a height greater than 10m and a slope greater than 66°, as a cliff. Steep slopes are defined as an area of land having a natural gradient of between 33° and 66°.

The most prominent sandstone formations above the Proposed Modification extension areas are located on the northern side of Mona Creek over Longwall W9 and Longwall W10. The outcrop above Longwall W10 includes a short section of cliff on land owned by UCMPL.

The most substantial and significant sandstone formations in the vicinity of the Proposed Modification extension areas is the cliff line that hosts the Aboriginal heritage sites referred to as the Mona Creek Rock Shelter Sites. These significant rock shelter sites are outside the Assessment Area.

The steep slope/cliff formation is on land owned by UCMPL or Crown Land leased by UCMPL and private property. This sandstone formation and rock shelter sites are protected from subsidence impacts by a barrier of coal with a width greater than 0.5 depth from the approved and proposed longwall mining.

Other sandstone outcrops within the Assessment Area are, by definition, steep slopes. These steep slope formations occur on land owned by UCMPL or Crown Land leased by UCMPL, Crown Land, and on private property.

There are no private bores/wells for groundwater extraction within the Assessment Area, or within approximately 1km of the Proposed Modification extension areas.

3.7.2 Man-made or Built Features

There are 159 Aboriginal heritage sites within or in close proximity to the Assessment Area. The type of site includes rock shelter, grinding grooves, stone arrangement, ochre quarry, isolated find and artefact scatter sites. This total includes sites identified during additional ground surveys over the Proposed Modification extension areas and the area adjacent to Longwall 12 at UWO.

No European heritage sites have been identified within the Assessment Area.

Public utilities or public amenities identified within the Assessment Area are limited to a powerline, telecommunication cables and a state survey control station.

A single pole overhead powerline and a telecommunications cable that service private property dwelling sites traverse the surface south from Blue Springs Road and cross above the proposed extensions to Longwalls W9-W11.

One state survey permanent mark is located within the Assessment Area. A total of 18 survey marks are within 3km of the Assessment Area.

There are no residential buildings or outbuildings associated with dwellings on the sections of private property within the Assessment Area. Privately owned agricultural infrastructure is limited to access roads/four-wheel drive tracks, farm dams and fencing.

Private property owners to the south of the proposed extension of Longwall W9 access via a four-wheel drive track on UCMPL owned land that overlies the proposed extensions to Longwalls W9-W11.

Agricultural infrastructure owned by UCMPL within the Assessment Area consists of farm dams, (including the larger 'Etheridge Dam' above the proposed Longwall W9 extension area) fencing and access roads/four-wheel drive tracks.

Mining related infrastructure is currently limited to access roads/four wheel drive tracks that traverse the surface providing access to environmental monitoring installations within the Assessment Area and mining infrastructure outside the area. These tracks are owned and maintained by UCMPL.

4. FORECAST SUBSIDENCE BEHAVIOUR

In this section, the subsidence movements expected above the Proposed Modification extension areas and in the vicinity of the Assessment Area are estimated on the basis of the latest subsidence monitoring results at the UCC.

These estimates incorporate improved understanding of subsidence behaviour from the monitoring conducted since the original UCCO Project EA was prepared. A margin is provided in recognition of natural variation so that reporting processes are not triggered for inconsequential.

Estimates of conventional subsidence effects for the extension areas are consistent with the range of values previously forecast at similar overburden depths in the original UCCO Project EA and subsequent updates for modifications and subsidence management or extraction plan assessments at the UCC.

4.1 Forecast of Subsidence Effects

Table 1 shows the estimate of the primary subsidence parameters for conventional subsidence behaviour over the Proposed Modification extension areas for impact assessment purposes. These are provided for two overburden depths given the influence of overburden depth on these parameters.

It is recognised that unconventional subsidence movements associated with steps, compression overrides or ripples, and valley closure may locally exceed the values presented in Table 1. These phenomena are generally localised and can be easily identified. The impacts of any locally higher values of tilt and strain associated with these phenomena are not expected to be particularly significant in a bushland setting or in open grazing land.

Table 4 summarises secondary subsidence parameters that are provided as an indication of the likely ground behaviour. These estimates of subsidence effects are based on experience at the UCC. These parameters are provided as a general guide to the approximate values that can be expected. These parameters should not be used as performance indicators because the magnitudes can be heavily influenced by survey tolerances and consequences of exceedances are not significant in bushland or open grazing land environments.

Table 4: Estimates of Secondary Subsidence Parameters for the Proposed Modification Areas

Overburden Depth	130m	250m
Subsidence Over Chain Pillars (mm)	250	600
Goaf Edge Subsidence (mm)	150	300
Angle of Draw (°)	40-55	40-55
Horizontal Movement (mm)	600	600
Crack Width (Not Steps or Ripples) (mm)	300	150
Potential for Steps	Yes	Yes
Potential for Compression Overrides / Ripples	Yes	Yes

4.1.1 Vertical Subsidence

Figures 9 and 10 show contours of vertical subsidence that are expected for the panels with the Proposed Modification extension areas for each layout option. These subsidence contours are based on subsidence profiles measured previously at the UCC.

Maximum vertical subsidence of up to 2.1m is forecast for the shallower depth areas of the Proposed Modification extensions. The shallowest areas are located above the northern ends of Longwall 11A and Longwall 12A. Maximum vertical subsidence of up to 1.9m is forecast for the Mona Creek valley above Longwalls W9-W11 where the overburden thickness is approximately 145m and includes up to 20m of alluvium/colluvium at the surface along this fourth order section of Mona Creek.

Maximum vertical subsidence is expected to be controlled by the ability of the goaf to reconsolidate under the weight of overburden strata and bulking of the Triassic Sandstones. Where the overburden depth is greater than approximately 140m, the thickness of the Triassic Sandstone is nominally greater than 30-40m. This 30-40m thickness is expected to reduce the magnitude of vertical subsidence as a function of mining height relative to the behaviour in shallower areas where the overburden is made up completely of Permian strata.

Maximum vertical subsidence in a single seam situation is naturally variable by about 15% for any given panel geometry and overburden depth. Subsidence contours shown should be regarded as indicative of the general level of subsidence rather than as precise indications of subsidence at a point. Any variations in mining heights that may occur for a range of reasons are expected to proportionally influence the maximum vertical subsidence and other subsidence parameters.

Over most of the Proposed Modification extension areas, vertical subsidence is expected to be less than about 1.8m for a 3.0m mining height with maximum subsidence typically in the range 1.3-1.7m. The variable magnitude of subsidence appears to be a characteristic of the bulking behaviour of the Triassic Sandstones and cyclic nature of overburden caving. Maximum vertical subsidence of up to 1.7m is expected at the eastern end of the proposed Longwall W11 extension area where the overburden depth is 250m.

Based on the most recent experience at the UCC, angle of draw at the edges of panels is expected to be in the range 40°-55°. It should be recognised that angle of draw is very sensitive to small variations in survey tolerance. A greater or lesser angle of draw is not particularly significant because vertical subsidence outside the panel edges is small and considered to be insignificant for all practical purposes.

Subsidence over each panel is likely to be substantially complete once the panel has been mined, but additional vertical subsidence of up to few hundred millimetres is expected when the adjacent longwall panel is mined, mainly close to the inter-panel chain pillars.

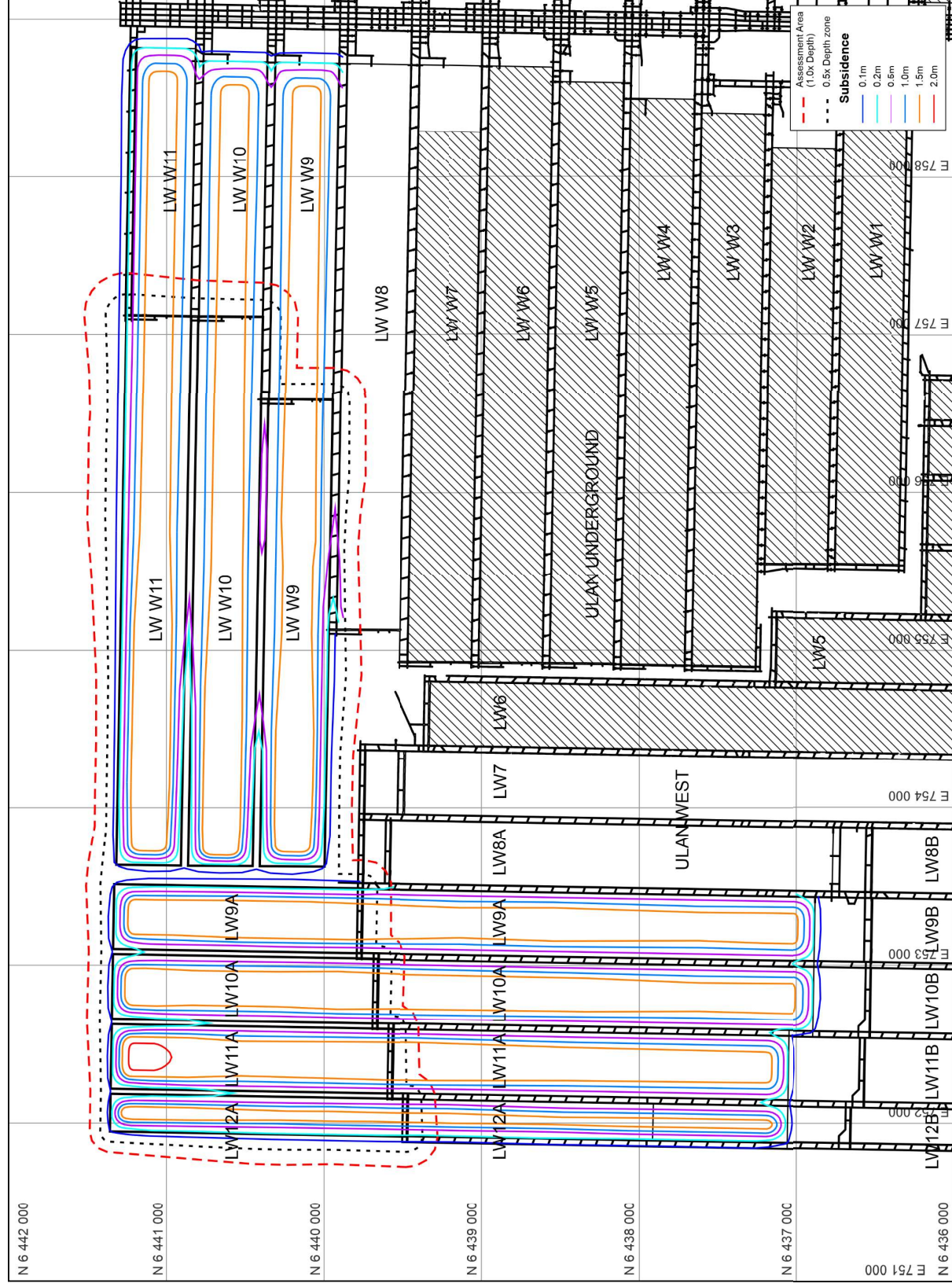


Figure 9: Contours of estimated vertical subsidence for the Proposed Modification Panels in the Option 1 (Base case) layout.

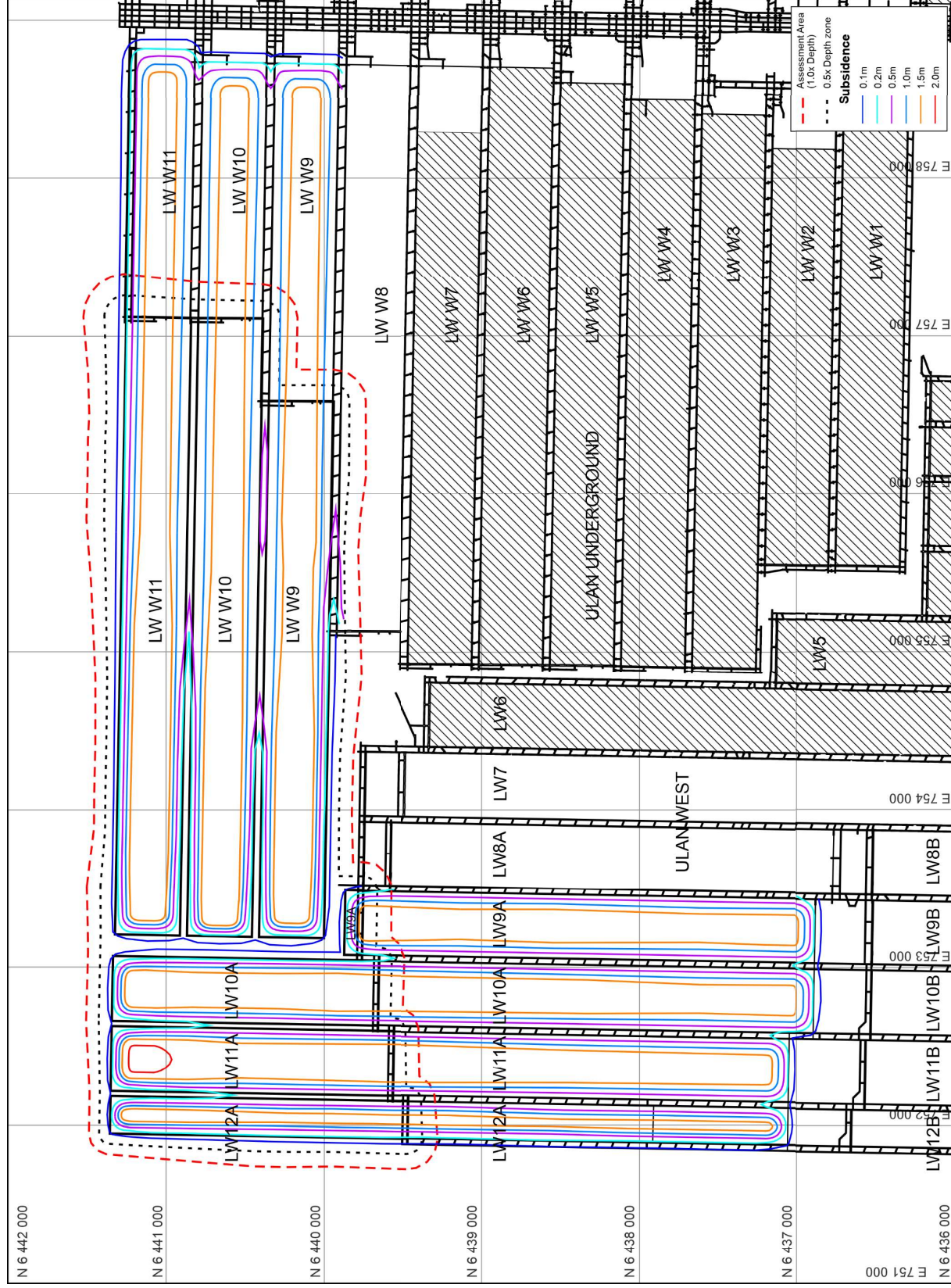


Figure 10: Contours of estimated vertical subsidence for the Proposed Modification Panels in the Option 2 (Flexibility) layout.

4.1.2 Tilt

The approach outlined by Holla (1991) has been successfully used to estimate tilt at the UCC. This approach is consistent with experience elsewhere in the Western Coalfield. The K factors are modified slightly to better reflect experience at the UCC.

The Holla (1991) approach, with the K factors derived from the UCC experience, indicates maximum tilts to be generally less than 60mm/m over most of the Proposed Modification extension areas but up to 85mm/m in the shallower areas including the northern ends of Longwall 11A and Longwall 12A.

Tilt is likely to be mainly transitory over the centre of each longwall panel and more permanent near the goaf edges.

4.1.3 Strain and Surface Cracking

The Holla method has also been used successfully at the UCC to estimate maximum tensile and compressive strains for conventional subsidence behaviour.

Estimates for maximum strain based on this approach, using K factors derived for the UCC, indicates the maximum strains are likely to be generally less than 25mm/m in compression and 20mm/m in tension above most of the Proposed Modification areas. Maximum compressive strain of up to 35mm/m and maximum tensile strain of up to 25mm/m are forecast for the shallower areas including the northern ends of Longwall 11A and Longwall 12A.

Cracks occur in areas of tensile strain where the ground is stretched. Tension cracking of the ground surfaces, both parallel and perpendicular to longwall panel direction, is expected over all the longwall extension areas of the Proposed Modification and potentially up to 0.4 times depth outside the panel edges. Tension cracks are expected to be most perceptible in the vicinity of goaf edges, at the start of each panel and at the top of steep slopes and sandstone cliff formations that are directly mined under. The majority of goaf edge positions for the Proposed Modification are beneath UCMP owned land. Longwall 11A and 12A have goaf edge positions beneath private land, and the overburden is shallower in this area.

A fourth-order section of Mona Creek crosses multiple goaf edges. Surface cracks are expected at these locations and there is potential for pothole erosion to occur following periods of heavy rainfall. First, second and third-order tributaries of Mona Creek also cross goaf edges at multiple locations.

Tension cracks typically align with natural joint directions in the rock mass and may form en-echelon type cracks along goaf edges. Transient tension cracks may also occur at regular intervals above the centre of the panel typically just behind the longwall face.

The magnitude of tensile strain at which surface cracking is detectable is sensitive to the nature of the surface terrain. Cracks are typically evident on hard surfaces such as roads and bare rock outcrops at strains of greater than 2-5mm/m and in bushland environments at strains greater than about 5-10mm/m.

Cracks are typically less than about 50mm wide in deeper areas where there is flat or gently undulating terrain but may be larger, up to 100mm wide in areas of lower overburden thickness. Cracks up to 300mm wide are considered possible in the shallower areas above the Proposed Modification areas or where there is a significant thickness of topsoil that can erode into a narrow crack in the rock causing the sides to collapse and the crack to widen. Potholes caused by piping erosion into surface cracks may occur in areas where there are dispersive soils and overland flow during and after heavy rainfall events.

4.1.4 Horizontal Movements

Horizontal ground movements occur at the surface in response to vertical subsidence movements within the overburden strata. These movements are a secondary subsidence effect. There are three recognised components of horizontal movement.

Systematic horizontal ground movements above longwall panels are expected to occur initially in a direction toward the approaching goaf, and then reverse to follow the direction of mining once the longwall face has passed. The magnitude of systematic horizontal movements is typically less than 200mm.

Horizontal movements associated with topography are expected to occur in a downslope direction with larger horizontal movements expected in areas where mining is in the same direction as the slope and the slope is steep. The magnitude and direction of the topographic component is strongly dependent on surface topography but is expected to be generally less than 500mm.

Horizontal movements associated with horizontal stress relief are observed to occur outside the mining area. The magnitude of these movements is generally expected to be less than 400mm at the goaf edge tapering to less than 20mm at a distance of approximately 1.8-2km ahead of longwall mining. The gradual rate of change outside the mining area is generally so small as to be imperceptible and of no practical significance.

The sum of these horizontal movement components can total more than 600mm over the goaf areas, more than 400mm at the panel edge and approximately 250mm at the edge of the Assessment Area gradually reducing to 20mm at 2km from the panel edge.

4.1.5 Unconventional Subsidence

Unconventional subsidence movements such as valley closure, steps and compression overrides or ripples are all possible in the Proposed Modification extension areas. These movements are more likely in the shallower areas where the ground disturbance is generally greater or near the top of the Triassic Sandstones. Permanent compression humps and fracturing may become apparent at topographic lows such as drainage channels, particularly where stream channels flow directly on bedrock.

The effects of these unconventional subsidence movements tend to be localised or along narrow zones so the impacts and consequences need to be considered in the context of sensitive features that may be in close proximity.

Recent experience at the UCC indicates that two different styles of unconventional subsidence may occur in the Assessment Area, but the likelihood of either is relatively low. These include step formation and bedding plane shears leading to compression overrides or ripples.

Formation of a step up to 0.8m high has been observed previously at the UCC and is therefore considered possible within the Assessment Area. Such a step is likely to be greatest in the centre of the panel and taper towards the chain pillars. The low side of any step is expected to be toward the start of the panel.

Horizontal shearing on bedding planes and compression overrides with local humps of up to about 0.5m high forming as a ripple on the surface may also occur within the Assessment Area. These are most likely to occur where low strength bedding plane horizons interact with the surface.

Valley closure and concentration of far field horizontal movements may also occur at topographic low points. The magnitude of valley closure is difficult to estimate with confidence. Horizontal closure of up to about 900mm has been measured at the UCC previously. This magnitude of valley closure is considered likely to be an upper limit of closure that could be expected for the Proposed Modification areas.

4.2 Reliability and Accuracy of Subsidence Predictions

Maximum vertical subsidence in a single seam situation is naturally variable by about 15% for any given panel geometry and overburden depth.

The approach to estimating subsidence effects used in this assessment is based on a review of previous experience over more than 40 longwall panels at the UCC. This method is an empirical approach suitable for providing a reasonable estimate of the upper limit of key subsidence parameters.

Although actual vertical subsidence is expected to be generally less than the upper limits, upper limit estimates of subsidence movements are considered appropriate to use for impact assessment purposes.

It is not credible that the magnitude of maximum vertical subsidence could exceed predicted maxima by 100% (or 200%) because of the nature of the mining process used and because double the predicted subsidence is greater than the planned mining height in this single seam situation.

The possibility of unusual, anomalous or unconventional subsidence behaviour such as steps, compression overrides or ripples and valley closure must be recognised. Higher values of strain and tilt, and sharp variations of vertical displacement are possible in the vicinity of these localised features.

In a bushland or agricultural environment such as exists within the Assessment Area, any variations in the maximum values of subsidence parameters measured from those forecast is unlikely to significantly affect the impacts observed.

4.3 Subsidence Monitoring

It is not considered necessary to add additional subsidence monitoring lines specifically for the Proposed Modification extension areas unless the recommended new monitoring line for Longwalls 7 and 8 at UWO is not able to be established and monitored.

Current subsidence monitoring for the western longwall panels at UUG includes H Line. This line has recently been extended to the northern lease boundary and the Proposed Modification extensions to Longwalls W10 and W11 would mine below this line.

Subsidence monitoring at UWO includes C and D Lines across the southern sections of the UWO longwall panels. It is expected that these lines will be extended to the west in due course to maintain a distance of 2km from active subsidence areas.

A recommendation to install a new cross-panel subsidence monitoring line over the current layout for Longwalls 7, 8A-12A is included in a recent subsidence assessment for the preparation of the extraction plan for Longwalls 7 and 8 at UWO. However, this suggestion is subject to reaching agreement with the private property landowner.

If agreed to, this additional line would provide site specific monitoring data for compliance reporting with insights into the subsidence behaviour and potential impacts to surface features from mining below the private property. A potential alignment for the line was suggested across the open terrain as this is more favourable to achieve high accuracy surveys.

If agreement for this additional line is not able to be reached, then a new east-west line over the centre of the proposed extension areas of Longwall W9 (or Longwall W10) and across Longwalls 9A-12A through the more difficult undeveloped bushland environment on UCMPL and Crown Land is recommended.

Ongoing subsidence monitoring, in a similar manner to the standards detailed in the subsidence monitoring programs required by extraction plans currently in place at UUG and UWO, is recommended.

5. SUBSIDENCE IMPACT ASSESSMENT

In this section, the potential subsidence impacts are assessed for the various surface, sub-surface features and infrastructure or built features identified within each of the Assessment Area for the Proposed Modification areas. Expected impacts are discussed initially on a feature by feature basis and then for each of the proposed longwall extension areas for both layout options.

5.1 Subsidence Impact Assessment by Feature

In this section, an assessment of subsidence impacts on each feature identified within the Assessment Area for Proposed Modification is presented. This includes a description of relevant parameters, assessment of expected impacts from the proposed mining and suggestions of risk control measures or hazard management strategies for likely impacts and consequences. Consideration of the consequences for public safety are also included.

The statement of commitments included in PA01_0184, requires UCMPL to prepare a Private Property Subsidence Management Plan (PPSMP) through consultation with each of the affected landholders. The PPSMP outlines the impacts of mining and the management and remediation measures to be implemented, by agreement with the landholder. It is expected PPSMP's for individual properties would reference the compensatory water supply provisions within the overall water management plan for any loss of surface and groundwater.

5.1.1 Landform

The general surface landform is expected to be affected by impacts from vertical subsidence, tilt and strain, horizontal movements and the unconventional effects discussed in Section 4.1. Impacts are expected to be mainly in the form of cracking and humps including compression overrides and ripples. Impacts are likely to be greater in magnitude in the areas of shallower depth and in the vicinity of steeper ground. Impacts are likely to be less perceptible in the undeveloped bushland areas than in open terrain.

Figure 11 shows examples of impacts to the general landform above or in close proximity to longwall panels previously observed at various depths at the UCC. Impacts of this nature are expected to be easily repairable where access is achievable including by agreement with private landholders.

5.1.2 Steep Slopes, Sandstone and Cliff Formations

The locations of steep slopes and cliff lines are shown in Figures 7 and 8. Sandstone formation outcrops occur along the sides of the Mona Creek valleys within the Assessment Area for the Proposed Modification. Most of these sandstone formations are less than 5m high and classified as steep slopes but there are areas where short sections of formations are greater than 10m high and defined as a cliff. In general, the frequency, height, and length of sandstone outcrop formations above the Proposed Modification extension areas are much less than some other areas previously mined at the UCC.

In some areas, sections of lower height sandstone outcrop extend off the main sandstone formation and degrade into a slope. There has been no evidence of this type of steeper ground becoming unstable and large scale spillage occurring as a result of subsidence movements from longwall mining.

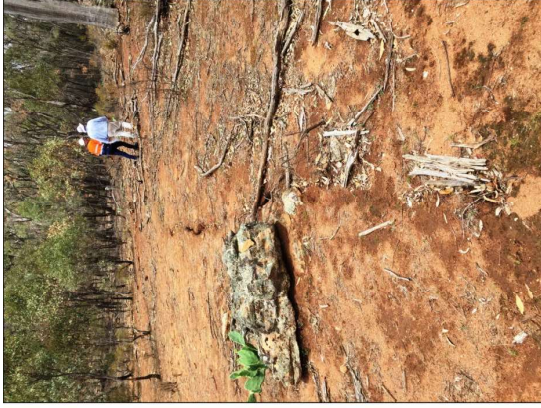
The most prominent sandstone formations within the Assessment Area are located on the northern side of the main channel of Mona Creek above the proposed extension areas of Longwall W9 and Longwall W10. The sandstone formation above Longwall W10 includes a 40m long section of cliff line on land owned by UCMPL. The formations above Longwall W9 are located on land owned by UCMPL and private property.

Other sandstone outcrops within the Assessment Area are by definition steep slopes. These steep slope formations occur over land owned by UCMPL, Crown Land leased by UCMPL, Crown Land and private property.

Impacts to sandstone formations are expected to be consistent with UCCO Project EA forecasts, subsidence performance measures outlined in the conditions of PA 01_0184 and the monitoring experience for mining since the UCCO Project was approved.



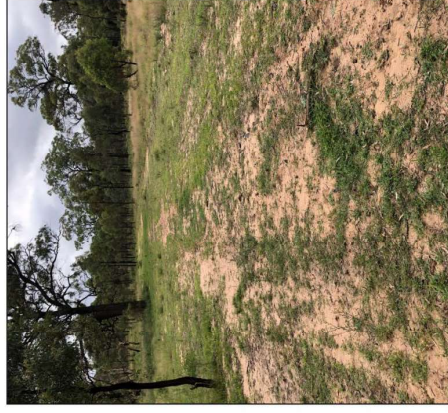
e) Wider crack near start line of longwall.



c) Looking South.

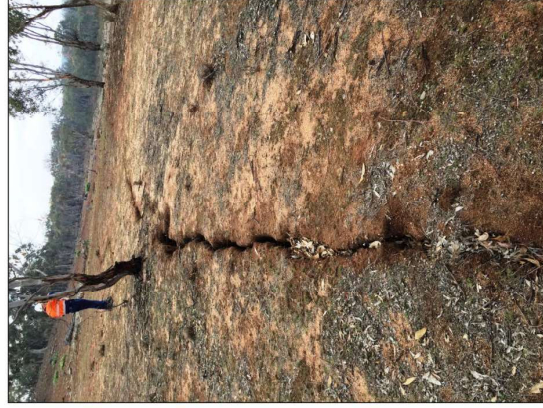


a) Cracking.

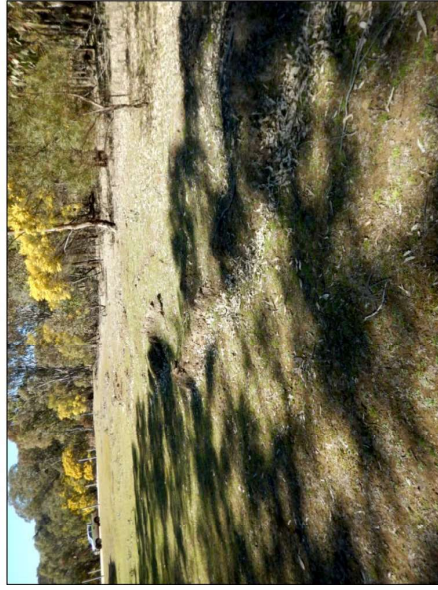


f) Area after remediation of surface cracks.

Example of cracking in flat terrain at 160m depth.



d) Looking North.



b) Compression override (ripple).

Example of surface impacts at 70m depth.

Cracking in sloping terrain just outside start line of longwall at 170m depth.

Figure 11: Examples of impacts to general landform.

Experience indicates the potential for impacts to sandstone cliff formations is dependent on a range of factors that include location relative to the longwall panels, overburden depth, the nature and geometry of the formation and the size of any overhangs. Site specific assessments are typically necessary to assess the potential for impacts to individual formations.

However, two types of impact to sandstone cliff formations are commonly observed: rock falls and perceptible cracking. On average, rock falls can be expected on up to 20% of the total length of sandstone formations located directly over longwall panels and the inter-panel chain pillar between extracted panels. In areas where sandstone formations are unfavourably oriented with respect to mining direction, this proportion may be locally increased. Mining induced rock falls are not typically observed outside the outermost goaf edge of longwall extraction. Perceptible cracking is expected at up to 50-70% of the length of sandstone formations located directly over extracted longwall panels or chain pillars and to a distance of up to about 0.4 times overburden depth outside the goaf edge.

Impacts to sandstone formations are expected to be more evident along outcrops where the overburden depth is less and the formations are higher, longer and more continuous in nature.

In addition to environmental consequences from subsidence impacts which may include loss of visual amenity, rock falls from sandstone formations (including Aboriginal heritage rock shelter sites) present an ongoing public safety hazard on private properties where access cannot easily be controlled, and the formations are relatively accessible. Considerations for managing this hazard for public safety are included in Section 5.1.11.

5.1.3 Surface Water - Creeks and Dams

The surface topography above the Assessment Area is characterised by the series of ephemeral drainage lines or tributaries of Mona Creek that flow generally west from the ridge of Great Dividing Range into the Talbragar River.

The main channel and tributaries of Mona Creek are located above the Proposed Modification extension areas to Longwalls W9-W11 and Longwalls 9-12. Over the northern ends of the Proposed Modification extension areas to Longwalls 9-12, lower order drainage lines flow directly into the Mona Creek floodplain and onto the broader Talbragar River floodplain.

The main channel over Longwalls W9-W11 includes a fourth order stream section in the broader Mona Creek valley where there is approximately 20m of alluvium/colluvium at the surface.

The local watercourses or drainage lines and dams within the Assessment Area are shown in Figures 7 and 8.

Subsidence impacts to these surface watercourses have so far been consistent with expectations presented in the original UCCO Project EA and subsequent modifications. Similar impacts are expected to watercourses located over the Assessment Area from the proposed mining of the Proposed Modification extension areas.

Watercourses in the Assessment Area are first, second, third and fourth order streams. Fourth order streams have not been mined under previously at UCC. These watercourses are all ephemeral in nature, only flowing during and immediately after heavy rain. Water is observed to pond in clay bottomed pools for a period after rain, but there are no known substantial, permanent, natural water holes within the Assessment Area.

Impacts from the proposed mining of the Proposed Modification extension areas are expected to include:

- diversion of overland flow into sub-surface strata through cracks and lowering of the groundwater possibly causing potholes on flow lines
- changes to the length of time that ephemeral streams and pools located directly above longwall panels hold water after periods of heavy rain
- vertical subsidence causing ponding in the flatter areas where the stream gradients are low
- potential to locally change the course of flow lines in flatter areas
- nick-point erosion on stream channels where the gradient is locally steepened on the upstream side of longwall panels
- compression fracturing and upsidence where sandstone rock strata is exposed in the valley floor.

There is potential for surface water to be diverted from the Mona Creek catchment downward into the underground mine workings. The planned mining in the Proposed Modification extension areas is located to the west of the Great Dividing Range. In accordance with approved operations, this inflow would be managed underground and ultimately discharged into the Goulburn River Catchment. SCT understands that UCMPL has appropriate infrastructure and licences in place to cover any potential flow redirection of this nature.

There are approximately 13 small dams within the Assessment Area. Most of these are farm dams constructed on or near drainage lines on land owned by UCMPL or Crown Land leased by UCMPL. The more substantial farm dam, known as the 'Etheridge Dam', is located on the main channel of Mona Creek above the proposed extension to Longwall W9 on land owned by UCMPL. The dam wall and storage are located on the colluvium deposited on the Mona Creek valley floodplain.

Minor impacts to the dams are expected with cracking and water loss during the period of active subsidence but are expected to be repairable with a small amount of remediation work. Any water flows into surface cracks is expected to migrate down through the overburden strata and eventually report to the underground mine workings. Loss of water from these dams is not expected to pose a significant operational risk to mining underground and is not considered to constitute an inrush hazard.

Impacts to the Etheridge Dam are expected to include water loss due to cracking of the dam and changes to the storage shape and holding capacity. Remediation work after the period of active subsidence is likely to be required to repair the dam and return the storage level to the pre-mining or an increased capacity. Although not expected to pose a significant operational or inrush hazard, removing the water from the dam prior to undermining by Longwall W9 is recommended to avoid any potential operational delays underground.

The potential for ponding in the main channel of Mona Creek is expected to increase at the northern edges of Longwalls W9-W11 as a result of proposed mining the in Proposed Modification extension areas of these panels.

5.1.4 Groundwater

Changes in groundwater behaviour are expected above the Proposed Modification extension areas consistent with experience above other longwall panels at the UCC and elsewhere in NSW.

All longwall panels are of supercritical width, in subsidence engineering terms. Mining subsidence is expected to cause fracturing of the sandstone strata through the full overburden section directly above each longwall panel. Caving of the overburden strata above each longwall is expected to result in a zone of large downward movement equal to panel width as discussed by Mills (2012). Vertical conductivity of the overburden strata is expected to increase through to the surface above each panel.

Full depressurisation of the groundwater within of the overburden sequence is expected above all panels, consistent with previous monitoring across the site and empirical experience presented in Tammetta (2012). The height of depressurisation in the overburden strata is also expected to extend through to the surface directly above each longwall panel. Monitoring experience at the UCC indicates that depressurisation may occur gradually, and full depressurisation of the overburden section may take some years. Draw down of the regional groundwater level is also expected to a distance of several kilometres around each longwall panel, consistent with monitoring experience.

These impacts are consistent with expectations presented in SCT (2009), SCT (2015) and SCT (2018) to inform Umwelt (2009), Umwelt (2015) and Eco Logical (2017) for the original UCCO Project EA, MOD3 EA and MOD4 EA. SCT (2015) provides detailed discussion on the impacts to groundwater.

The UCCO Project Approval conditions require UCMPL to prepare and implement a water management plan that includes, amongst other things, groundwater monitoring and compensatory water supply provisions for private landowners affected by loss of water supply. This management plan is expected to satisfactorily address the likely subsidence impacts to surface water and groundwater from the proposed mining.

It is expected PPSMP's for individual properties would reference the compensatory water supply provisions within the overall water management plan for any loss of surface and groundwater.

5.1.5 Aboriginal Heritage Sites

The database of Aboriginal archaeological sites for the UCC currently contains the details of more than 1650 sites. The database now includes more than 250 additional sites recorded since the original UCCO Project EA. Approximately 57 of these additional sites were identified during ground surveys over the Proposed Modification extension areas and the area adjacent to Longwall 12 at UWO. Of these 57 new sites, the majority are isolated finds and artefact scatters with three potential grinding grooves sites and 10 rock shelter sites.

A total of 159 Aboriginal heritage sites from this database have been identified within, or immediately adjacent to, the Assessment Area for the Proposed Modification. This total includes sites previously assessed for subsidence impacts in the UCCO Project EA and subsequent modifications and extraction plans as well as new sites identified for the Proposed Modification.

The total of 159 comprises 49 rock shelters, the three potential grinding grooves sites, one stone arrangement, one ochre quarry, 39 isolated finds and 66 artefact scatter sites, recognising that artefact scatters can extend over considerable distances to within or outside the Assessment Area. The potential grinding groove sites are assessed as confirmed grinding grooves sites. The location of all these sites is shown in Figures 12 and 13 for each layout option.

The rock shelter sites consist of:

- 27 with artefacts.
- 21 with potential archaeological deposits (PAD).
- One with art.

Table 5 provides an update of the estimated probabilities of impacts to all sites considered sensitive to the subsidence movements forecast for the Proposed Modification extension areas.

The significant rock shelter sites at Mona Creek (MC23-30 or Ulan ID#180-187) and those in the BBKA (Ulan ID#196-198) are located outside the Assessment Area and not likely to be impacted by the proposed mining of the Proposed Modification extension areas.

Table 6 shows the descriptive interpretation that can be placed on the probability categories in Table 5.

The probability of subsidence impacts to the ochre quarry, the stone arrangement, and artefact scatter and isolated find sites is expected to be low. Any impacts are expected to be negligible, consistent with forecasts presented in the UCCO Project EA and subsequent modifications and the monitoring experience since those assessments were prepared.

Rock shelter and grinding grooves sites are expected to be sensitive to subsidence movements. Impacts to these types of sites are expected to be consistent with or less than the maximum impacts forecast for these types of sites in the UCCO Project EA and subsequent modifications based on monitoring experience. The locations of the 52 sites with rock shelters and grinding grooves within the Assessment Area are shown in Figures 12 and 13.

Table 5: Estimated Probabilities of Impacts to Aboriginal Heritage Sites within the Assessment Area for the Proposed Modification extension areas

Ulan ID#	Site Name	OEH AHIMS #	Site Type	Probability of Perceptible Impact	Probability of Rock Fall or Significant Rock Fracturing with Potential for Fall
175	Mona Creek 18	36-3-1518	Rockshelter with Artefacts	50%	10%
176	Mona Creek 19	36-3-1519	Rockshelter with Artefacts	50%	10%
178	Mona Creek 21	36-3-1521	Rockshelter with Artefacts	70%	20%
179	Mona Creek 22	36-3-1522	Rockshelter with Artefacts	70%	20%
180	Mona Creek 23	36-3-1523	Rockshelter with Artefacts	0%	0%
549	MC65	36-3-1652	Rockshelter with PAD	50%	10%
550	MC66	36-3-1653	Rockshelter with PAD	50%	10%
722	MC234	36-3-1825	Rockshelter with PAD	70%	20%
723	MC235	36-3-1826	Rockshelter with PAD	70%	20%
724	MC236	36-3-1827	Rockshelter with PAD	20%	5%
725	MC237	36-3-1828	Rockshelter with PAD	70%	20%
726	MC238	36-3-1829	Rockshelter with PAD	70%	20%
727	MC239	36-3-1830	Rockshelter with PAD	50%	10%
728	MC240	36-3-1831	Rockshelter with Artefacts	50%	10%
730	MC242	36-3-1833	Rockshelter with Artefacts	70%	20%
731	MC243	36-3-1834	Rockshelter with PAD	70%	20%
732	MC244	36-3-1835	Rockshelter with PAD	50%	10%

Ulan ID#	Site Name	OEH AHIMS #	Site Type	Probability of Perceptible Impact	Probability of Rock Fall or Significant Rock Fracturing with Potential for Fall
733	MC245	36-3-1836	Rockshelter with PAD	50%	10%
734	MC246	36-3-1837	Rockshelter with Artefacts	50%	10%
735	MC247	36-3-1838	Rockshelter with Artefacts	70%	20%
738	MC250	36-3-1841	Rockshelter with Artefacts	70%	20%
741	MC253	36-3-1844	Rockshelter with Artefacts	20%	5%
742	MC254	36-3-1845	Rockshelter with PAD	70%	20%
743	MC255	36-3-1846	Rockshelter with PAD	70%	20%
744	MC256	36-3-1847	Rockshelter with Artefacts	70%	20%
749	MC261	36-3-1852	Rockshelter with Artefacts	70%	20%
750	MC262	36-3-1853	Rockshelter with Artefacts	70%	20%
751	MC263	36-3-1854	Rockshelter with Artefacts	70%	20%
775	MC287	36-3-1878	Rockshelter with PAD	50%	10%
776	MC288	36-3-1879	Rockshelter with PAD	50%	10%
777	MC289	36-3-1880	Rockshelter with Artefacts	50%	10%
778	MC290	36-3-1881	Rockshelter with PAD	50%	10%
779	MC291	36-3-1882	Rockshelter with PAD	50%	10%
787	MC299	36-3-1890	Rockshelter with PAD	50%	10%
788	MC300	36-3-1891	Rockshelter with Artefacts	50%	10%
789	MC301	36-3-1892	Rockshelter with Artefacts	50%	10%

Ulan ID#	Site Name	OEH AHIMS #	Site Type	Probability of Perceptible Impact	Probability of Rock Fall or Significant Rock Fracturing with Potential for Fall
790	MC302	36-3-1893	Rockshelter with Artefacts	50%	10%
806	MC318	36-3-1909	Rockshelter with PAD	70%	20%
1618	MC360	36-3-3311	Rockshelter with Artefacts	70%	20%
1668	MC410	pending	Rockshelter with Art	50%	10%
1669	MC411	pending	Rockshelter with Artefacts	50%	10%
1670	MC412	pending	Rockshelter with Artefacts	70%	20%
1671	MC413	pending	Rockshelter with Artefacts	20%	5%
1672	MC414	pending	Rockshelter with Artefacts	70%	20%
1673	MC415	pending	Rockshelter with Artefacts	50%	10%
1678	MC419	pending	Rockshelter with Artefacts	50%	10%
1679	MC420	pending	Rockshelter with PAD	50%	10%
1680	MC421	pending	Rockshelter with PAD	50%	10%
1681	MC422	pending	Rockshelter with Artefacts	70%	20%
1682	MM201110-2	pending	Grinding Grooves	50%	n/a
1683	MM221020-2	pending	Grinding Grooves	20%	n/a
1684	MM1510-3	pending	Grinding Grooves	20%	n/a

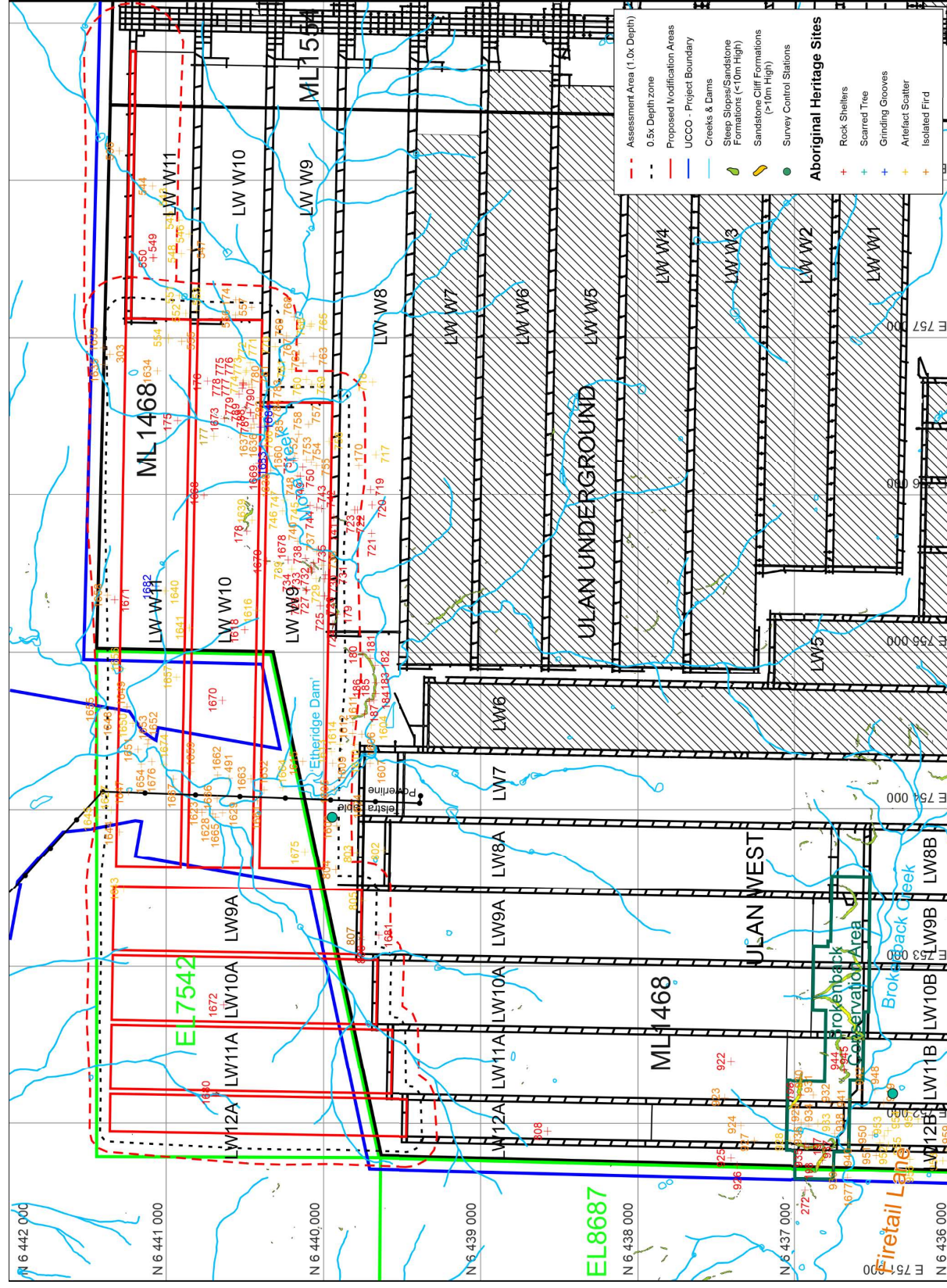


Figure 12: Site plan of Proposed Modification Areas for Option 1 (Base case) layout with surface features and heritage sites.

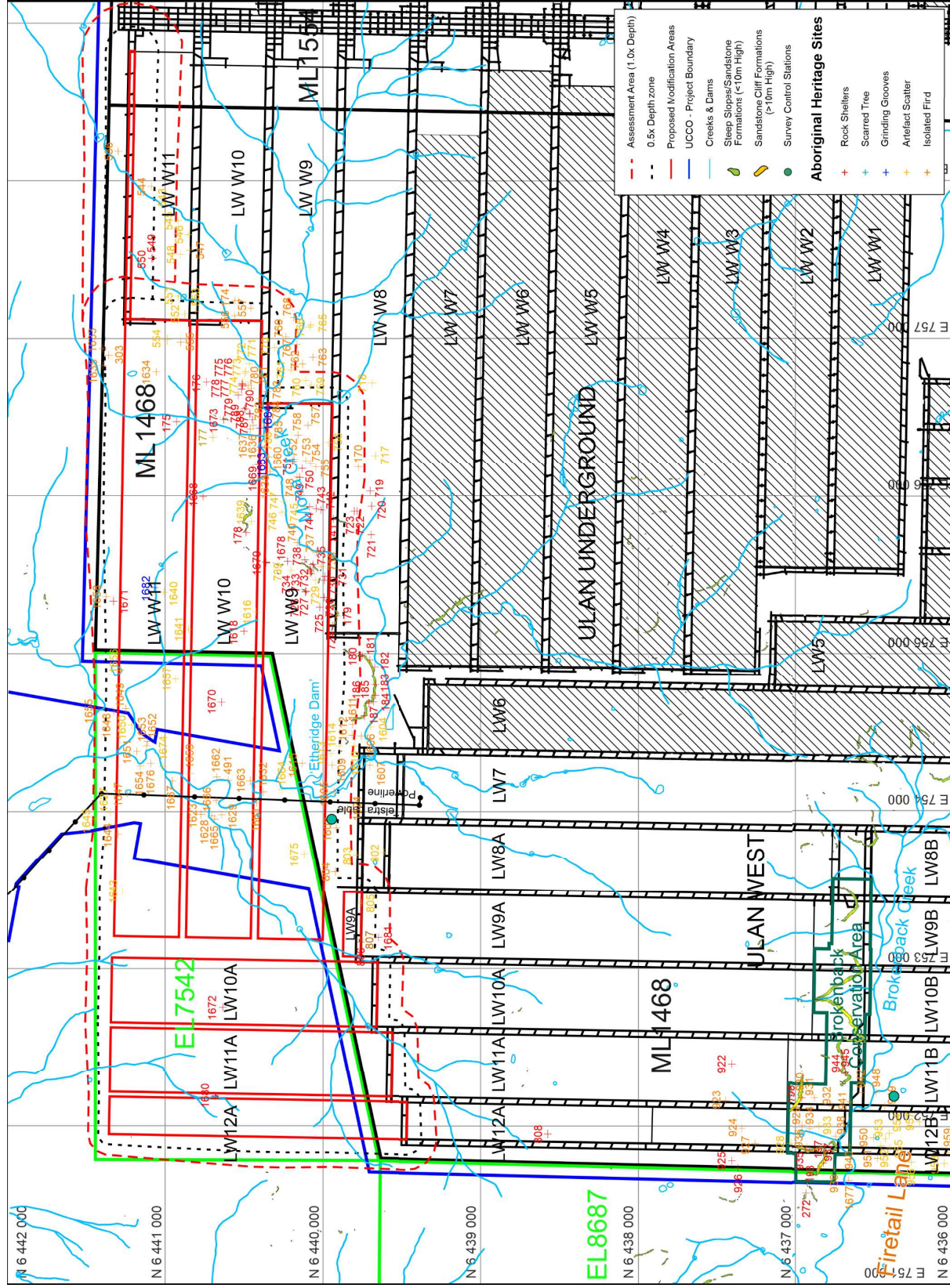


Figure 13: Site plan of Proposed Modification Areas for Option 2 (Flexibility) layout with surface features and heritage sites.

Table 6: Probability Rating for Subsidence Impacts on Sandstone Rock Formations used in Table 5

Descriptive Term	Probability
Almost Certainly	> 90%
Likely	50-90%
Possible	11-49%
Unlikely	1-10%
Most Unlikely	<1%

Assessments of the probabilities of impacts on all the archaeological sites identified by South East Archaeology (SEA) for the UCCO Project EA, MOD1, MOD3 or MOD4 and considered sensitive to subsidence movements are included in SCT (2009), SCT (2011), SCT (2015) or SCT (2018). Any changes to the probabilities of impacts at individual sites presented in these assessments are a result of changes to the mining geometry since the earlier assessments were prepared and not a result of any impacts exceeding predictions. Although the forecast level of impact at individual sites may have increased due to changes to the mining geometry, the probabilities of impact has not exceeded the maximum forecast generically for any one site.

Impacts to rock shelter sites are effectively the same as those for sandstone formations and cliffs. Rock falls can be expected on up to 20% of the length of sandstone formations located directly over longwall panels and the inter-panel chain pillar between extracted panels. No rock falls are expected outside the outermost goaf edge of longwall extraction. Perceptible cracking is expected at up to 50-70% of the length of sandstone formations located directly over extracted longwall panels or chain pillars and to a distance of up to about 0.4 times overburden depth outside the goaf edge.

Grinding grooves sites located on larger rock bars or shelves above longwall panels are expected to be sensitive to subsidence effects and impacts. Experience at the UCC indicate impacts to grinding groove sites can also occur outside the panel edge ahead of mining with stress relief or stretching (tensile) ground movements.

Of the three grinding groove sites identified, MM201110-2 (Ulan ID# 1682) is located over the centre of the proposed extension to Longwall W11 and MM221020-2 (Ulan ID# 1683) and MM1510-3 (Ulan ID# 1684) are located above the chain pillar between the proposed extensions to Longwalls W9 and W10. These sites are adjacent to the main channel or a tributary of Mona Creek. Site 1682 is expected to experience the full subsidence effects forecast with potential for cracking, which may intersect the grinding grooves, to occur on the rock outcrops at this location. Sites 1683 and 1684 are likely to experience much less vertical subsidence but impacts from tensile cracking or shearing of the rock outcrops at these sites is still possible. This provides an update for sites in the Assessment Area previously assessed for different mining geometries and the new sites recorded for the Proposed Modification considering the Proposed Modification areas cover almost all remaining areas of the existing mining leases and EL7542.

5.1.6 Powerline and Telecommunications Cable

A single pole overhead powerline, owned by Essential Energy, and a telecommunications (Telstra) cable that service the dwelling sites on the Woodbury and Billir (owned by UCMPL) properties traverse the surface and cross the Assessment Area above the Proposed Modification extensions to Longwalls W9-W11 as shown in Figures 7 and 8.

There are six poles within the Assessment Area located on land owned by UCMPL. Four of the six poles are positioned above the Proposed Modification extension areas in a straight section of the powerline alignment. One pole is positioned over Longwall W9, two poles over Longwall W10 and a single pole over Longwall W11.

The overhead section of the powerline terminates further south at the edge of Woodbury and Billir properties and does not extend to the Woodbury residence. The Billir property is now owned by UCMPL. The Telstra underground cable runs to the Woodbury and Billir dwellings but is not used. The Billir residence is currently not occupied.

The power poles and cable are expected to experience the full subsidence effects from longwall mining in the Proposed Modification extension areas. Single power pole structures are generally tolerant of subsidence movements as maximum ground strain and tilt movements do not necessarily transfer to the poles themselves. The two poles over the Longwall W10 extension area are located closer to the panel edges and expected to be more susceptible to permanent impacts from the forecast subsidence movements. However, the potential impacts to all poles are expected to be manageable with mitigation measures such as placing conductors in roller sheaves and reducing guy wire or stay tensions for the period of active subsidence.

Buried cables are likely to be impacted by the levels of strain expected near the panel edges but given the current period of no usage of these services the consequences from mining the proposed extensions to Longwalls W9-W11 are expected to be negligible. Uncovering buried cables for the period of active subsidence would reduce the likelihood of damage.

Visual monitoring during the period of active subsidence with testing and repairs post mining, if necessary, to the satisfaction of the utility owner, are considered to be appropriate measures to manage impacts to these built features.

A BFMP for these utilities that includes consultation with the asset owner and service user (landholder), and consideration of the suggested mitigation, monitoring and remediation measures is recommended.

Including the agreed measures in a PPSMP is also recommended.

5.1.7 Survey Control Stations

Only one state survey mark has been identified within the Assessment Area, but this are not directly above the Proposed Modification extension areas. Nevertheless, this mark is expected to be disturbed by the proposed mining. As shown in Figures 7 and 8, this permanent mark is PM189277 located adjacent to the access road to Woodbury, over solid coal just to the south of the proposed Longwall W9 extension area.

An additional 17 marks, likely to have been affected by the previous mining at the UCC or located within approximately 3km of the proposed mining, have potential to be affected by the far-field subsidence movements expected from the Proposed Modification extension areas.

A search for state survey marks within 3km of the reveals 10 marks located generally to the east and south of the Assessment Area and seven to the south, west and north.

The 10 marks to the east and south are: PM170454, TS5964 (Bobadeen), PM170452, PM170462, PM170453, PM170450, PM78729, PM113078, PM85671, PM189276.

The seven marks to the south, west and north are: PM170455, PM170456, PM174862, PM173945, TS12016 (Cockabutta), PM85632, PM170458.

State survey marks are expected to be stable reference points. Ground movements caused by mining subsidence have potential to impact this stability to the extent where continued reference to a mark displaced by mining could, in certain circumstances, have significant consequences.

A BFMP that includes a process to manage these impacts is recommended. This approach has been used in the past and is considered a practical way to manage subsidence impacts from longwall mining on survey control stations. The asset owner is notified and advised to temporarily decommission a mark that may be affected by removing its coordinates from the database during the period of active subsidence. Once the subsidence effects have taken place and stabilised, the horizontal and vertical positions of the mark are re-established, and the mark is returned to service with revised coordinates.

5.1.8 Private Property, Privately Leased Crown Land or Crown Land

As shown in Figures 3 and 4, most of the surface above the Assessment Area is land owned by UCMPL or Crown Land leased by UCMPL. The remainder is Crown Land, Crown Land privately leased or private property.

Impacts to the areas of land not owned or leased by UCMPL above the Proposed Modification extension areas, are expected to be minor and generally imperceptible. Any impacts requiring remediation are expected to be manageable through provision of a PPSMP for each property.

Impacts to the greater areas of undeveloped bushland are expected to be generally imperceptible over large areas with minor, permanent cracking around the panel edges likely to be the main impact evident. Impacts to sandstone outcrop formations within the undeveloped bushland areas are expected to be consistent with the forecast of impacts for steep slopes and sandstone formation discussed in Section 5.1.2. These impacts include the potential for rock falls and for perceptible cracking.

Any impacts to the smaller areas of cleared or semi-cleared grazing land are expected to be minor. Physical impacts to the ground surface, discussed in Section 5.1.1, including cracking along panel edges are expected to be generally repairable. Impacts to drainage lines and dams are expected to be consistent with the changes to these features and the potential remediation measures discussed in Section 5.1.3. There are no substantial steep slopes, sandstone formations or cliffs on or adjacent to the cleared or semi-cleared areas.

Potential impacts to groundwater are discussed in Section 5.1.4.

5.1.9 Agricultural Infrastructure

Mining of the Proposed Modification extension areas is not expected to have any greater impact on agricultural utilisation or agricultural suitability of farmland, to both privately owned or leased land and land owned or leased by UCMPL than impacts described in the original UCCO Project EA and subsequent updates for modifications and extraction plans.

The physical impacts to the surface terrain and farm infrastructure on the small areas suitable for agricultural activities such as grazing are expected to be generally minor and easily remediated.

Agricultural infrastructure on privately owned or leased land is limited to access roads/four-wheel drive tracks, fencing and farm dams.

Agricultural infrastructure owned by UCMPL consists of access roads/four-wheel drive tracks (including an access road with shared access to private properties from Blue Springs Road), fencing and farm dams.

Impacts to access roads and tracks are expected to be essentially similar to impacts previously observed over the UCC, all of which have been managed successfully in the past.

There is some potential for cracks and compression humps to form and a much lower probability of steps forming. These impacts are unlikely to be significantly out of context with the general character of the tracks and other hazards that might exist. Some minor repair work may be required to smooth out irregularities and close up open cracks. Any steps that form may require some greater effort to break up the sandstone overhang that has formed.

The use of warning signs, regular inspections, and timely remediation of any impacts are recommended as appropriate measures to manage potential impacts.

Fences may become affected in areas where the ground strain changes due to subsidence to the extent that they become ineffective for stock control. The operation of gates and cattle grids may also be affected depending on their specific location. In general, these impacts can most easily be managed as and when they occur.

A program of regular visual inspection and appropriate remediation as required is recommended as a satisfactory way to manage any impacts.

Including the mitigation, monitoring and remediation measures for these features in a BFMP and PPSMP is recommended.

Impacts to farm dams are expected to be minor and easily repairable as discussed in Section 5.1.3.

Potential impacts to groundwater resources for private landholders are discussed in Section 5.1.4. These impacts are managed under a comprehensive Water Management Plan with compensatory water supply arrangements as required under the UCCO Project Approval conditions.

5.1.10 Mining Related Infrastructure

Mining related infrastructure within the Assessment Area is currently limited to access roads/four-wheel drive tracks, owned and maintained by UCMPL, that traverse the surface providing access for environmental monitoring inside the area and major mining infrastructure outside the Assessment Area.

Impacts to and remediation of access roads/four-wheel drive tracks are expected to be the same as for tracks over agricultural land.

Groundwater monitoring installations are expected to be impacted in a manner similar to other water bores and wells across the site. They are likely to be physically impacted by shear movements in the rock strata several hundred metres ahead of longwall mining. Draw down of the regional groundwater level is also expected to a distance of several kilometres around each longwall panel.

The groundwater monitoring installations are not expected to remain serviceable in the long-term.

There is also potential for surface water monitoring installations to be impacted by subsidence movements including valley closure effects.

5.1.11 Public Safety

The Public Safety Management Plan (PSMP) required by PA08_0184 must safeguard members of the public from the hazards of mining induced subsidence impacts. These hazards include surface cracking or changes in grade that might affect traffic safety on public and private roads, the potential for falling trees and rock falls from sandstone outcrop formations that could cause personal injury. There are no public roads within the Assessment Area.

The UCCO Project Approval subsidence performance measure for public safety requires that there be no additional risk [to the public] due to mining. Current measures to manage the hazards include controlling access, the use of warning signage and prompt remediation of any impacts.

Current measures are expected to be effective where access can be controlled. Further measures may be required to ensure that there is no additional risk to the landholder (and authorised persons) from mining induced rock falls on privately owned or privately leased land recognising that cliffs are naturally in a continuous process of decay and become unstable from time to time

SCT understands that a PPSMP that includes strategies to mitigate and remediate hazards on private or privately leased property would be effective in managing the risk to public safety.

5.2 Subsidence Impact Assessment by Location – Option 1 (Base case)

In this section, a description and list of features above each proposed longwall extension area for the Option 1 (Baseline) layout are presented together with a general summary of the expectation of impacts. The suggested risk control measures or hazard management strategies for each of the features are provided in Section 5.1 and are not repeated here.

5.2.1 UUG - Longwall W9

The proposed extension to Longwall W9 is approximately 2970m long and 411m wide. Most of this area is within ML1468 but extends into EL7542. The overburden depth ranges from 155-220m. The private property 'Woodbury' overlies approximately 21 hectares of Longwall W9. This area is undeveloped bushland that includes several sandstone outcrop formations. The remainder of the surface above Longwall W9 is owned or leased by UCMPL.

This remaining area includes sections of undeveloped bushland and semi-cleared or cleared land on the Mona Creek valley floodplain.

Surface features above the proposed longwall extension area include:

- Two sections of the main channel and tributaries of Mona Creek.
- The dam wall and lower storage area of the 'Etheridge' dam owned by UCMPL.
- One small farm dam.
- Overhead powerline and Telstra cable.
- Access road on UCMPL land which is used by private land holders.
- Short sections of sandstone formations on Woodbury and land owned by UCMPL.
- Aboriginal heritage sites with 18 rock shelter sites including two new sites, eight isolated find sites including two new sites and 13 artefact scatter sites including three new sites.

Impacts to all these features are expected to be consistent with or less than the predictions for the original UCCO Project EA and subsequent modifications, subsidence performance measures in PA08_0184, and the monitoring experience since PA08_0184 was granted.

Any impacts to the general landform areas are expected to be generally repairable as discussed in Section 5.1.1.

Expected impacts to Mona Creek are assessed in Section 5.1.3 which are consistent with the predictions prepared for the original UCCO Project EA and subsequent modifications. Expected impacts to dams are assessed in Section 5.1.2 which indicates impacts are likely to be minor and easily repairable.

Expected impacts to groundwater and compensatory water supply arrangements as required are discussed in Section 5.1.4.

Expected impacts to the Powerline and Telstra cable are assessed in Section 5.1.6 which indicates impacts are likely to be minor with mitigation and remediation measures and any consequences from impacts are expected to be insignificant in the current circumstances.

Expected impacts to access roads or four-wheel drive tracks are assessed in Section 5.1.9 which indicates impacts are likely to be generally minor and repairable.

Expected impacts to sandstone outcrop formations are assessed in Section 5.1.2 which indicates the likely impacts include the potential of rock falls and perceptible cracking. The risk from instability at these features and the consequence for public safety is outlined in Section 5.1.11.

Expected impacts to Aboriginal heritage sites are assessed in Section 5.1.5 which indicates the likely impacts to rock shelter sites are effectively the same as those for sandstone formations and cliffs. Subsidence movements are not expected to have any practical effect on isolated finds and artefact scatters in open terrain.

A private bore is located approximately 1km to the south of the Longwall LW9 extension over the current Longwall 7 at UWO. The private bore is anticipated to be directly impacted by UWO Longwall 7 and is not expected to be operational when Longwall W9 is extracted.

5.2.2 UUG - Longwall W10

The proposed extension to Longwall W10 is approximately 3490m long and 411m wide. The majority of the area is within ML1468 but extends into EL7542. The overburden depth ranges from 150-230m. All of the surface above the area is owned or leased by UCMPL and includes sections of undeveloped bushland and semi-cleared or cleared land of the Mona Creek valley floodplain.

Surface features above the proposed longwall extension area include:

- Two sections of the main channel and numerous tributaries of Mona Creek.
- One small farm dam and access tracks.
- Powerline and Telstra cable.
- Access road on UCMPL land which is used by private land holders.
- Sandstone formations with a short section of cliff line on land owned by UCMPL.
- Aboriginal heritage sites with 16 rock shelter sites including four new sites, two grinding grooves sites, one stone arrangement, seven isolated find sites including two new sites and 14 artefact scatter sites including 10 new sites.

Impacts to all these features are expected to be consistent with or less than the predictions for the original UCCO Project EA and subsequent modifications, subsidence performance measures in PA08_0184, and the monitoring experience since PA08_0184 was granted.

Expected impacts to Mona Creek are assessed in Section 5.1.3 which are consistent with the predictions prepared for the original UCCO Project EA and subsequent modifications. Expected impacts to dams are assessed in Section 5.1.3 which indicates impacts are likely to be minor and easily repairable.

Expected impacts to groundwater are discussed in Section 5.1.4.

Expected impacts to the Powerline and Telstra cable are assessed in Section 5.1.8 which indicates impacts are likely to be minor with mitigation and remediation measures and any consequences of impacts in the current circumstances are expected to be insignificant.

Expected impacts to access roads or four-wheel drive tracks are assessed in Section 5.1.11 which indicates impacts are likely to be generally minor and repairable.

Expected impacts to sandstone outcrop formations are assessed in Section 5.1.2 which indicates the likely impacts include the potential of rock falls and perceptible cracking. The risk from instability at these features and any consequences for public safety is outlined in Section 5.1.11.

Expected impacts to Aboriginal heritage sites are assessed in Section 5.1.5 which indicates the likely impacts to rock shelter and grinding grooves sites are effectively the same as those for sandstone formations and cliffs. Subsidence movements are not expected to have any practical effect on the stone arrangement, isolated finds and artefact scatters.

5.2.3 UUG - Longwall W11

The proposed western extension to Longwall W11 is approximately 3495m long and 411m wide. Approximately 50% of this area is within ML1468 and 50% in EL7542. The overburden depth in this western section ranges from 145-250m.

It is also proposed to increase the width of the existing 1705m section of Longwall W11 within ML1554 and ML1468, from approximately 380m to the standard longwall equipment width of 411m. The overburden depth along this 30m wide section is approximately 265-295m.

All of the surface above these areas is owned or leased by UCMPL with the majority being undeveloped bushland with smaller areas of semi-cleared or cleared land including on the Mona Creek valley floodplain.

Surface features above the proposed longwall extension areas include:

- A section of the main channel and numerous tributaries of Mona Creek.
- Four small farm dams and access tracks.
- Powerline and Telstra cable.
- Access road on UCMPL land which is used by private land holders.
- Aboriginal heritage sites with one rock shelter site, one grinding grooves site, six isolated find sites including five new sites and 11 artefact scatter sites including 10 new sites.

Impacts to all these features are expected to be consistent with or less than the predictions for the original UCCO Project EA and subsequent modifications, subsidence performance measures in PA08_0184, and the monitoring experience since PA08_0184 was granted.

Expected impacts to Mona Creek are assessed in Section 5.1.3 which are consistent with the predictions prepared for the original UCCO Project EA and subsequent modifications. Expected impacts to dams are assessed in Section 5.1.3 which indicates impacts are likely to be minor and easily repairable.

Expected impacts to groundwater are discussed in Section 5.1.4.

Expected impacts to the Powerline and Telstra cable are assessed in Section 5.1.8 which indicates impacts are likely to be minor with mitigation and remediation measures and any consequences of impacts in the current circumstances are expected to be insignificant.

Expected impacts to access roads or four-wheel drive tracks are assessed in Section 5.1.11 which indicates impacts are likely to be generally minor and repairable.

Expected impacts to Aboriginal heritage sites are assessed in Section 5.1.5 which indicates the likely impacts and consequences at rock shelter and grinding grooves sites are effectively the same as those for sandstone formations and cliffs as detailed in Sections 5.1.2 and 5.1.11. Subsidence movements are not expected to have any practical effect to isolated finds and artefact scatters.

5.2.4 UWO - Longwall 9A

The proposed northern extension to Longwall 9A is approximately 1580m long and 411m wide. The large majority of the extension area is within EL7542. The overburden depth ranges from 150-180m. All the surface above the area is undeveloped bushland with the majority owned by UCMPL and a smaller section of Crown Land privately leased.

Surface features above the proposed longwall extension area include:

- A few tributaries of Mona Creek.
- One small farm dam and access tracks on UCMPL land.
- A few isolated sandstone outcrops forming small sections of steep slopes on land owned by UCMPL.
- Aboriginal heritage sites with an ochre quarry site and two isolated find sites including one new site.

Impacts to all these features are expected to be consistent with or less than the predictions for the original UCCO Project EA and subsequent modifications, subsidence performance measures in PA08_0184, and the monitoring experience since PA08_0184 was granted.

Impacts to the general landform areas are expected to be generally repairable as discussed in Section 5.1.1.

Expected impacts to Mona Creek are assessed in Section 5.1.3 which are consistent with the predictions prepared for the original UCCO Project EA and subsequent modifications. Expected impacts to dams are assessed in Section 5.1.2 which indicates impacts are likely to be minor and easily repairable.

Expected impacts to groundwater and compensatory water supply arrangements as required are discussed in Section 5.1.4.

Expected impacts to access roads or four-wheel drive tracks are assessed in Section 5.1.11 which indicates impacts are likely to be generally minor and repairable.

Expected impacts to sandstone outcrop formations are assessed in Section 5.1.2 which indicates the likely impacts include the potential of rock falls and perceptible cracking. The risk from instability at these features and any consequences for public safety is outlined in Section 5.1.11 which indicates these hazards are expected to be manageable.

Expected impacts to Aboriginal heritage sites are assessed in Section 5.1.5 which indicates that no practical impacts are expected at the ochre quarry and isolated find sites.

5.2.5 UWO - Longwall 10A

The proposed northern extension to Longwall 10A is approximately 1685m long and 411m wide. The large majority of the extension area is within EL7542. The overburden depth ranges from 155-175m. All the surface above the area is undeveloped bushland with a small semi-cleared section. The majority of the land is owned by UCMLP with a smaller portion of Crown Land privately leased.

Surface features above the proposed longwall extension area include:

- A few tributaries of Mona Creek.
- One small farm dam and access tracks on UCMLP land.
- A few isolated sandstone outcrops forming small sections of steep slopes on land owned by UCMLP.
- One new Aboriginal heritage rock shelter site.

Impacts to all these features are expected to be consistent with or less than the predictions for the original UCCO Project EA and subsequent modifications, subsidence performance measures in PA08_0184, and the monitoring experience since PA08_0184 was granted.

Impacts to the general landform areas are expected to be generally repairable as discussed in Section 5.1.1.

Expected impacts to Mona Creek are assessed in Section 5.1.3 which are consistent with the predictions prepared for the original UCCO Project EA and subsequent modifications. Expected impacts to dams are assessed in Section 5.1.3 which indicates impacts are likely to be minor and easily repairable.

Expected impacts to groundwater and compensatory water supply arrangements as required are discussed in Section 5.1.4.

Expected impacts to access roads or four-wheel drive tracks are assessed in Section 5.1.11 which indicates impacts are likely to be generally minor and repairable.

Expected impacts to sandstone outcrop formations are assessed in Section 5.1.2 which indicates the likely impacts include the potential of rock falls and perceptible cracking. The risk from instability at these features and any consequences for public safety is outlined in Section 5.1.11 which indicates these hazards are expected to be manageable.

Expected impacts to Aboriginal heritage sites are assessed in Section 5.1.5 which indicates the likely impacts to rock shelter sites are effectively the same as those for sandstone formations and cliffs.

5.2.6 UWO - Longwall 11A

The proposed northern extension to Longwall 11A is approximately 1790m long and 411m wide. The large majority of the extension area is within EL7542. The overburden depth ranges from 130-180m. The land above the area is either owned by UCMPL, Crown Land, Crown Land privately leased or private property. Almost all the surface is undeveloped bushland with a small northern section on private property (DP750742/1) cleared for grazing purposes.

Surface features above the proposed longwall extension area include:

- A few tributaries of Mona Creek including one located in private property.
- Access tracks on UCMPL land and minor farm infrastructure (fencing) on private property.
- A few isolated sandstone outcrops forming small sections of steep slopes on land owned by UCMPL.
- One new Aboriginal heritage isolated find site.

Impacts to all these features are expected to be consistent with or less than the predictions for the original UCCO Project EA and subsequent modifications, subsidence performance measures in PA08_0184, and the monitoring experience since PA08_0184 was granted.

Impacts to the general landform areas are expected to be generally repairable as discussed in Section 5.1.1.

Expected impacts to Mona Creek are assessed in Section 5.1.3 which are consistent with the predictions prepared for the original UCCO Project EA and subsequent modifications.

Expected impacts to groundwater and compensatory water supply arrangements as required are discussed in Section 5.1.4.

Expected impacts to access roads or four-wheel drive tracks and farm infrastructure are assessed in Section 5.1.11 which indicates impacts are likely to be generally minor and repairable.

Expected impacts to sandstone outcrop formations are assessed in Section 5.1.2 which indicates the likely impacts include the potential of rock falls and perceptible cracking. The risk from instability at these features and any consequences for public safety is outlined in Section 5.1.11 which indicates these hazards are expected to be manageable.

Expected impacts to Aboriginal heritage sites are assessed in Section 5.1.5 which indicates that no practical impacts are expected at isolated find sites.

5.2.7 UWO - Longwall 12A (238m Wide)

The proposed northern extension to Longwall 12A into EL7542 is approximately 1890m long and 238m wide. The overburden depth in this extension ranges from 130-200m. The majority of land above the area is Crown Land with a section of the private property (DP750742/1) in the north. Almost all the surface is undeveloped bushland with a small section of the private property cleared for grazing purposes.

Surface features above the proposed longwall extension area include:

- A few tributaries of Mona Creek.
- Minor farm infrastructure (fencing) on private property.
- A couple of isolated sandstone outcrops on the private property.
- One new Aboriginal heritage rock shelter site located above the chain pillar between Longwalls 11A and 12A.

Impacts to all these features are expected to be consistent with or less than the predictions for the original UCCO Project EA and subsequent modifications, subsidence performance measures in PA08_0184, and the monitoring experience since PA08_0184 was granted.

Impacts to the general landform areas are expected to be generally repairable as discussed in Section 5.1.1.

Expected impacts to Mona Creek are assessed in Section 5.1.3 which are consistent with the predictions prepared for the original UCCO Project EA and subsequent modifications.

Expected impacts to groundwater and compensatory water supply arrangements as required are discussed in Section 5.1.4.

Expected impacts to farm infrastructure are assessed in Section 5.1.9 which indicates impacts are likely to be generally minor and repairable.

Expected impacts to sandstone outcrop formations are assessed in Section 5.1.2 which indicates the likely impacts include the potential of rock falls and perceptible cracking. The risk from instability at these features and the consequence for public safety is outlined in Section 5.1.11 which indicates these hazards are expected to be manageable.

Expected impacts to Aboriginal heritage sites are assessed in Section 5.1.5 which indicates the likely impacts to rock shelter sites are effectively the same as those for sandstone formations and cliffs.

5.3 Subsidence Impact Assessment by Location – Option 2 (Flexibility)

In this section, a description and list of features above each proposed longwall extension area for the Option 2 (Flexibility) layout are presented together with a general summary of the expectation of impacts. The suggested risk control measures or hazard management strategies for each of the features are provided in Section 5.1 and are not repeated here. The assessment for Longwalls 10A-12A at UWO as the same as for the Option 1 (Baseline) layout.

5.3.1 UUG - Longwall W9

The proposed extension to Longwall W9 is approximately 3410m long and 411m wide. Approximately 45% of this area is within ML1468 and 55% extends into EL7542. The overburden depth ranges from 155-220m.

The private property 'Woodbury' overlies approximately 21 hectares of Longwall W9. This area is undeveloped bushland that includes several sandstone outcrop formations.

The remainder of the surface above Longwall W9 is owned or leased by UCMPL. This remaining area owned or leased by UCMPL includes sections of undeveloped bushland and semi-cleared or cleared land on the Mona Creek valley floodplain.

Surface features above the proposed longwall extension area include:

- Two sections of the main channel and tributaries of Mona Creek.
- The dam wall and lower storage area of the 'Etheridge' dam owned by UCMPL.
- Two small farm dams.
- Overhead powerline and Telstra cable.
- Access road on UCMPL land which is used by private land holders.
- Short sections of sandstone formations on Woodbury and land owned by UCMPL.
- Aboriginal heritage sites with 18 rock shelter sites including two new sites, eight isolated find sites including two new sites and 13 artefact scatter sites including three new sites.

Impacts to all these features are expected to be consistent with or less than the predictions for the original UCCO Project EA and subsequent modifications, subsidence performance measures in PA08_0184, and the monitoring experience since PA08_0184 was granted.

Any impacts to the general landform areas are expected to be generally repairable as discussed in Section 5.1.1.

Expected impacts to Mona Creek are assessed in Section 5.1.3 which are consistent with the predictions prepared for the original UCCO Project EA and subsequent modifications. Expected impacts to dams are assessed in Section 5.1.2 which indicates impacts are likely to be minor and easily repairable.

Expected impacts to groundwater and compensatory water supply arrangements as required are discussed in Section 5.1.4.

Expected impacts to the Powerline and Telstra cable are assessed in Section 5.1.6 which indicates impacts are likely to be minor with mitigation and remediation measures and any consequences from impacts are expected to be insignificant in the current circumstances.

Expected impacts to access roads or four-wheel drive tracks are assessed in Section 5.1.9 which indicates impacts are likely to be generally minor and repairable.

Expected impacts to sandstone outcrop formations are assessed in Section 5.1.2 which indicates the likely impacts include the potential of rock falls and perceptible cracking. The risk from instability at these features and the consequence for public safety is outlined in Section 5.1.11.

Expected impacts to Aboriginal heritage sites are assessed in Section 5.1.5 which indicates the likely impacts to rock shelter sites are effectively the same as those for sandstone formations and cliffs. Subsidence movements are not expected to have any practical effect on isolated finds and artefact scatters in open terrain.

A private bore is located approximately 1km to the south of the Longwall LW9 extension over the current Longwall 7 at UWO. The private bore is anticipated to be directly impacted by the current mining of Longwall 7 at UWO and is not expected to be operational when Longwall W9 is extracted.

5.3.2 UUG - Longwall W10

The proposed extension to Longwall W10 is approximately 3925m long and 411m wide. Approximately 50% of this area is within ML1468 and 50% extends into EL7542. The overburden depth ranges from 150-230m. Almost all of the surface above the area is owned or leased by UCMLPL excepting a small portion at the far western end which is privately leased Crown Land. The surface terrain includes sections of undeveloped bushland and semi-cleared or cleared land of the Mona Creek valley floodplain.

Surface features above the proposed longwall extension area include:

- Two sections of the main channel and numerous tributaries of Mona Creek.
- One small farm dam and access tracks.
- Powerline and Telstra cable.
- Access road on UCMPL land which is used by private land holders.
- Sandstone formations with a short section of cliff line on land owned by UCMPL.
- Aboriginal heritage sites with 16 rock shelter sites including four new sites, two grinding grooves sites, one stone arrangement, seven isolated find sites including two new sites and 14 artefact scatter sites including 10 new sites.

Impacts to all these features are expected to be consistent with or less than the predictions for the original UCCO Project EA and subsequent modifications, subsidence performance measures in PA08_0184, and the monitoring experience since PA08_0184 was granted.

Expected impacts to Mona Creek are assessed in Section 5.1.3 which are consistent with the predictions prepared for the original UCCO Project EA and subsequent modifications. Expected impacts to dams are assessed in Section 5.1.3 which indicates impacts are likely to be minor and easily repairable.

Expected impacts to groundwater are discussed in Section 5.1.4.

Expected impacts to the Powerline and Telstra cable are assessed in Section 5.1.6 which indicates impacts are likely to be minor with mitigation and remediation measures and any consequences of impacts in the current circumstances are expected to be insignificant.

Expected impacts to access roads or four-wheel drive tracks are assessed in Section 5.1.9 which indicates impacts are likely to be generally minor and repairable.

Expected impacts to sandstone outcrop formations are assessed in Section 5.1.2 which indicates the likely impacts include the potential of rock falls and perceptible cracking. The risk from instability at these features and any consequences for public safety is outlined in Section 5.1.11.

Expected impacts to Aboriginal heritage sites are assessed in Section 5.1.5 which indicates the likely impacts to rock shelter and grinding grooves sites are effectively the same as those for sandstone formations and cliffs. Subsidence movements are not expected to have any practical effect on the stone arrangement, isolated finds and artefact scatters.

5.3.3 UUG - Longwall W11

The proposed western extension to Longwall W11 is approximately 3925m long and 411m wide. Approximately 50% of this area is within ML1468 and 50% in EL7542. The overburden depth in this western section ranges from 145-250m.

It is also proposed to increase the width of the existing 1705m section of Longwall W11 within ML1554 and ML1468, from approximately 380m to the standard longwall equipment width of 411m. The overburden depth along this 30m wide section is approximately 265-295m.

Almost all of the surface above these areas is owned or leased by UCMPL with a small section of privately leased Crown Land at the far western end of the proposed extension. The majority of the land above these areas is undeveloped bushland with smaller areas of semi-cleared or cleared land including in the Mona Creek valley floodplain.

Surface features above the proposed longwall extension areas include:

- A section of the main channel and numerous tributaries of Mona Creek.
- Four small farm dams and access tracks.
- Powerline and Telstra cable.
- Access road on UCMPL land which is used by private land holders.
- Aboriginal heritage sites with one rock shelter site, one grinding grooves site, seven isolated find sites including six new sites and 11 artefact scatter sites including 10 new sites.

Impacts to all these features are expected to be consistent with or less than the predictions for the original UCCO Project EA and subsequent modifications, subsidence performance measures in PA08_0184, and the monitoring experience since PA08_0184 was granted.

Expected impacts to Mona Creek are assessed in Section 5.1.3 which are consistent with the predictions prepared for the original UCCO Project EA and subsequent modifications. Expected impacts to dams are assessed in Section 5.1.3 which indicates impacts are likely to be minor and easily repairable.

Expected impacts to groundwater are discussed in Section 5.1.4.

Expected impacts to the Powerline and Telstra cable are assessed in Section 5.1.6 which indicates impacts are likely to be minor with mitigation and remediation measures and any consequences of impacts in the current circumstances are expected to be insignificant.

Expected impacts to access roads or four-wheel drive tracks are assessed in Section 5.1.9 which indicates impacts are likely to be generally minor and repairable.

Expected impacts to Aboriginal heritage sites are assessed in Section 5.1.5 which indicates the likely impacts and consequences at rock shelter and grinding grooves sites are effectively the same as those for sandstone formations and cliffs as detailed in Sections 5.1.2 and 5.1.11. Subsidence movements are not expected to have any practical effect to isolated finds and artefact scatters.

5.3.4 UWO - Longwall 9A

The proposed northern extension to Longwall 9A is approximately 120m long and 411m wide. The extension area is within ML1468. The overburden depth ranges from 160-180m. The surface above the extension area is undeveloped bushland on land owned by UCMPL.

Surface features above the proposed longwall extension area include:

- A tributary of Mona Creek.
- An isolated sandstone outcrop forming a short section of a steep slope.
- Two Aboriginal heritage sites; an ochre quarry site and an isolated find site.

Impacts to all these features are expected to be consistent with or less than the predictions for the original UCCO Project EA and subsequent modifications, subsidence performance measures in PA08_0184, and the monitoring experience since PA08_0184 was granted.

Impacts to the general landform areas are expected to be generally repairable as discussed in Section 5.1.1.

Expected impacts to Mona Creek are assessed in Section 5.1.3 which are consistent with the predictions prepared for the original UCCO Project EA and subsequent modifications.

Expected impacts to groundwater and compensatory water supply arrangements as required are discussed in Section 5.1.4.

Expected impacts to sandstone outcrop formations are assessed in Section 5.1.2 which indicates the likely impacts include the potential of rock falls and perceptible cracking. The risk from instability at these features and any consequences for public safety is outlined in Section 5.1.11 which indicates these hazards are expected to be manageable.

Expected impacts to Aboriginal heritage sites are assessed in Section 5.1.5 which indicates that no practical impacts are expected at the ochre quarry and isolated find sites.

5.3.5 UWO - Longwall 10A

The proposed northern extension to Longwall 10A is approximately 1685m long and 411m wide. The large majority of the extension area is within EL7542. The overburden depth ranges from 155-175m. All the surface above the area is undeveloped bushland with a small semi-cleared section. The majority of the land is owned by UCMPL with a smaller portion of Crown Land privately leased.

Surface features above the proposed longwall extension area include:

- A few tributaries of Mona Creek.
- One small farm dam and access tracks on UCMPL land.

- A few isolated sandstone outcrops forming small sections of steep slopes on land owned by UCMPL.
- One new Aboriginal heritage rock shelter site.

Impacts to all these features are expected to be consistent with or less than the predictions for the original UCCO Project EA and subsequent modifications, subsidence performance measures in PA08_0184, and the monitoring experience since PA08_0184 was granted.

Impacts to the general landform areas are expected to be generally repairable as discussed in Section 5.1.1.

Expected impacts to Mona Creek are assessed in Section 5.1.3 which are consistent with the predictions prepared for the original UCCO Project EA and subsequent modifications. Expected impacts to dams are assessed in Section 5.1.3 which indicates impacts are likely to be minor and easily repairable.

Expected impacts to groundwater and compensatory water supply arrangements as required are discussed in Section 5.1.4.

Expected impacts to access roads or four-wheel drive tracks are assessed in Section 5.1.9 which indicates impacts are likely to be generally minor and repairable.

Expected impacts to sandstone outcrop formations are assessed in Section 5.1.2 which indicates the likely impacts include the potential of rock falls and perceptible cracking. The risk from instability at these features and any consequences for public safety is outlined in Section 5.1.11 which indicates these hazards are expected to be manageable.

Expected impacts to Aboriginal heritage sites are assessed in Section 5.1.5 which indicates the likely impacts to rock shelter sites are effectively the same as those for sandstone formations and cliffs.

5.3.6 UWO - Longwall 11A

The proposed northern extension to Longwall 11A is approximately 1790m long and 411m wide. The large majority of the extension area is within EL7542. The overburden depth ranges from 130-180m. The land above the area is either owned by UCMPL, Crown Land, Crown Land privately leased or private property. Almost all the surface is undeveloped bushland with a small northern section on private property (DP750742/1) cleared for grazing purposes.

Surface features above the proposed longwall extension area include:

- A few tributaries of Mona Creek including one located in private property.
- Access tracks on UCMPL land and minor farm infrastructure (fencing) on private property.
- A few isolated sandstone outcrops forming small sections of steep slopes on land owned by UCMPL.
- One new Aboriginal heritage isolated find site.

Impacts to all these features are expected to be consistent with or less than the predictions for the original UCCO Project EA and subsequent modifications, subsidence performance measures in PA08_0184, and the monitoring experience since PA08_0184 was granted.

Impacts to the general landform areas are expected to be generally repairable as discussed in Section 5.1.1.

Expected impacts to Mona Creek are assessed in Section 5.1.3 which are consistent with the predictions prepared for the original UCCO Project EA and subsequent modifications.

Expected impacts to groundwater and compensatory water supply arrangements as required are discussed in Section 5.1.4.

Expected impacts to access roads or four-wheel drive tracks and farm infrastructure are assessed in Section 5.1.9 which indicates impacts are likely to be generally minor and repairable.

Expected impacts to sandstone outcrop formations are assessed in Section 5.1.2 which indicates the likely impacts include the potential of rock falls and perceptible cracking. The risk from instability at these features and any consequences for public safety is outlined in Section 5.1.11 which indicates these hazards are expected to be manageable.

Expected impacts to Aboriginal heritage sites are assessed in Section 5.1.5 which indicates that no practical impacts are expected at isolated find sites.

5.3.7 UWO - Longwall 12A (238m Wide)

The proposed northern extension to Longwall 12A into EL7542 is approximately 1890m long and 238m wide. The overburden depth in this extension ranges from 130-200m. The majority of land above the area is Crown Land with a section of the private property (DP750742/1) in the north. Almost all the surface is undeveloped bushland with a small section of the private property cleared for grazing purposes.

Surface features above the proposed longwall extension area include:

- A few tributaries of Mona Creek.
- Minor farm infrastructure (fencing) on private property.
- A couple of isolated sandstone outcrops on the private property.
- One new Aboriginal heritage rock shelter site located above the chain pillar between Longwalls 11A and 12A.

Impacts to all these features are expected to be consistent with or less than the predictions for the original UCCO Project EA and subsequent modifications, subsidence performance measures in PA08_0184, and the monitoring experience since PA08_0184 was granted.

Impacts to the general landform areas are expected to be generally repairable as discussed in Section 5.1.1.

Expected impacts to Mona Creek are assessed in Section 5.1.3 which are consistent with the predictions prepared for the original UCCO Project EA and subsequent modifications.

Expected impacts to groundwater and compensatory water supply arrangements as required are discussed in Section 5.1.4.

Expected impacts to farm infrastructure are assessed in Section 5.1.9 which indicates impacts are likely to be generally minor and repairable.

Expected impacts to sandstone outcrop formations are assessed in Section 5.1.2 which indicates the likely impacts include the potential of rock falls and perceptible cracking. The risk from instability at these features and the consequence for public safety is outlined in Section 5.1.11 which indicates these hazards are expected to be manageable.

Expected impacts to Aboriginal heritage sites are assessed in Section 5.1.5 which indicates the likely impacts to rock shelter sites are effectively the same as those for sandstone formations and cliffs.

6. REFERENCES

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