RESPONSE TO SUBMISSIONS

RESPONSE TO SUBMISSIONS (RTS)

This RTS will only address issues that are still relevant to the Preferred Project. As such there will be no response to issues surrounding the originally proposed longwalls in the Wonga West area, the Wonga Mains, or the Bulli and Balgownie West 1st workings. Those particular issues will be reviewed and addressed as part of a future development application to the DPI.

The RTS is separated into three sections

1. General

1.1 Community Consultation

1.1.1 Misleading Communication

Honesty

Submission

IRRM believes that NRE is unable to communicate truthfully with its neighbours. For example, based on prior promises, NRE failed to deliver:

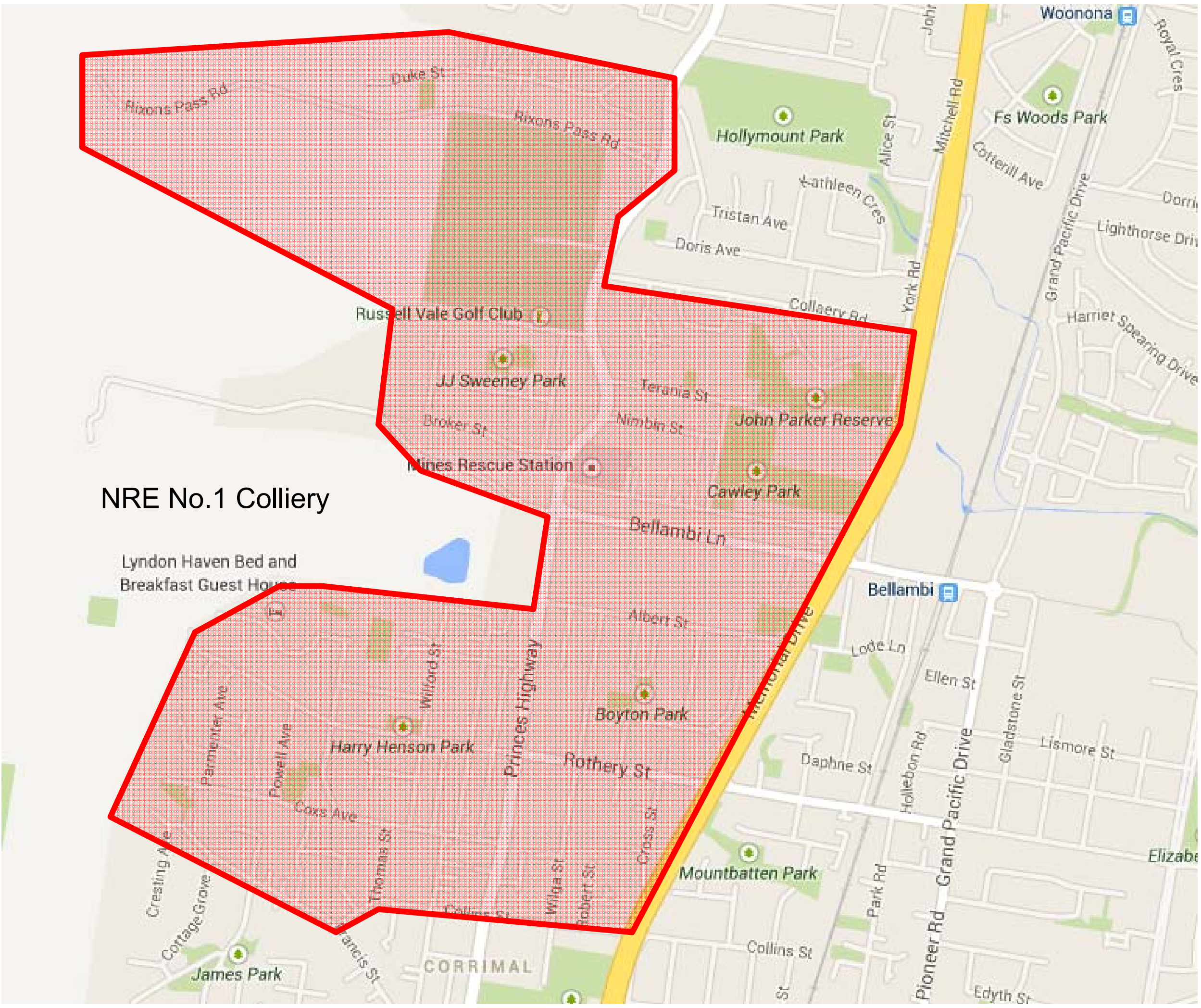
a. a community information day prior to the public exhibition of the EA;
b. a display of the EA at the Russel Vale Golf Club; and
c. a community newsletter advising of the public exhibition of the EA including information on the 'stealthy' modification of certain items in the Preliminary Works Pt3A;

Response

NRE attempts at all times to communicate truthfully with the community. At times changing circumstances, sometimes beyond NRE's control, can affect undertakings previously made by NRE employees in good faith. While NRE has had both actual and perceived failures in dealing with the community in the past, it has significantly improved its consultation in the last 6-9 months, although not necessarily to the satisfaction of IRRM. Undertakings are based on the best available information at that time. Sometimes errors are also made in relaying information or due to other factors. IRRM does not accept these issues as acceptable explanation for failure to deliver an undertaking. However, these types of issues are unavoidable and affect all organisations despite their best intentions. NRE can't control IRRM's perception of what is acceptable consultation or what constitutes truth.

a. IRRM has previously been advised that the reason that NRE was unable to undertake the community information session prior to the public exhibition of the EA as promised, was due to the unexpectedly rapid time between submission to display. Normally there is a one to two week period between the submission of the EA to DPI and the public exhibition. However, in this case the public exhibition period began only a day (not including weekend) after submission of the final EA for exhibition. NRE had planned on the usual one to two week delay to allow for the pre-exhibition information session.
b. Given the rapidity of the time between EA submission and the public exhibition period (18 Feb - 5 April 2013) a permanent display was only established at the Russell Vale Golf Club for around 4 weeks of the 6 week public exhibition period. However, with the agreement of the Golf Club, NRE will maintain information at the Club site into the future.
c. A newsletter outlining the information requested by IRRM in the CCC was delivered on the 8th and 9th of March 2013 to a large number of surrounding residents as can be seen in **Figure 65**, pg 207. Although notification was not given to the community, the modification process was not undertaken in stealth. The matter was discussed with DPI and was subject to PAC determination.

Figure 65 - Delivery Area for Community Newsletter Advising of the Public Exhibition of the EA



Source: Google Maps

Community Engagement

Submission

The community engagement claimed to have been undertaken for the project is not correct.

Response

Due to the changes to the project over time, community engagement was undertaken during the process in a somewhat disjointed manner with the original project being broken into two separate applications, the Preliminary Works and Underground Expansion Project. The general scope of the overall expansion has been made available from the beginning of consultation in 2009. The Twyfords engagement was not focused on the Underground Expansion Project and should not be considered as part of the community consultation for this project

Detail Errors

Submission

There have been conflicting stockpile volumes given to the community (100,000 tonnes), CCC (200,000 tonnes) and options of between 315,000 and 840,000 tonnes in the EA.

Response

The CCC was advised of an incorrect volume by the Group Environment & Approvals Manager who had only recently taken over the management of the EA. That error was later realised and rectified. In the EA, NRE presented alternatives considered for the stockpile as required by *Clause 7(c) of Schedule 2 of the Environmental Planning and Assessment Regulation 2000*. The preferred option has not changed from the addition of 2 x 140,000 tonne stockpiles to the existing 80,000 tonne stockpile.

1.1.2 Inadequate Communication

Complaints Number

Submission

NRE has not provided the community with a complaints number and the 1800 number that was to have been established for the Project does not appear to have ever existed and no longer appears in any communications.

Response

There is a complaints number on the NRE website and on the sign at teh front gate near the main access road to the mine site. The 1800 number was managed by ERM, the lead consultant preparing the EA for NRE. The number was introduced to the community in the October 2008 newsletter and was on all following newsletters from 2009 until July 2011. Due to a change of staff at both NRE and ERM it would appear that the 1800 number fell out of use after July 2011.

Interested Persons List

Submission

Newsletters were only sent to registered interested persons during the Preliminary Works Pt3A. Due to changes in staff the interested persons list was no longer used. The LW 4 & 5; MG 6, 7 & 8 information session did not address this project.

Response

The registered interested persons email distribution list was reinstituted during the LW4 & 5; MG 6, 7 & 8 Pt3A modification application and continues to be used by NRE to advise of the progress of the Project as required. The August 2012 Community Information Day listing in *Table 6.2* in *Section 6.3.1, pg 126 of the EA,* does not state that information was distributed specifically on the overall expansion project but that discussions with community members inevitably crossed into explanations of the broader expansion project due to intrinsic links between the two projects. The August and December listings in *Table 6.2, 21 August to 9 October 2012 listings, pg 126, of the EA*, don't state that this is the only method used to disseminate information

CCC

Submission

While information was provided to the CCC in August and December 2012 *(Table 6.2, 21 August to 9 October 2012 listings, pg 126, of EA)*, the CCC should not be required to have to spread the information on this Project in place of NRE.

Response

In accordance with the DPI *Guidelines for Establishing and Operating Community Consultative Committees for Mining Projects, June 2007*, on which basis the No.1 Colliery CCC was established, NRE provides information to CCC members so that they can fulfil their key role identified in the Committee Member selection criteria This states that members should be selected based on experience and ability to provide feedback to the community and stakeholder groups. The Guidelines also encourage CCC members to discuss issues and disseminate information about the mine with the wider community, including to special interest groups

1.1.3 Community Consultative Committee

Community Engagement

Submission

The Twyfords Community Consultation Strategy referred to in the EA was not an effort to engage the community with regard to this EA but was aimed at creating an alternative to the currently accepted CCC model for community consultation by mines. The CCC cannot be expected to publicise major developments at NRE.

Response

The intent of the Twyfords Community Consultation Strategy was to create an alternate community consultation strategy to the current accepted DPI CCC model as part of the Preliminary Works Pt3A approval. The community was not happy with the alternate strategy proposed by NRE and it was not accepted by DPI, therefore as required by the conditions of the Preliminary Works Pt3A approval, a CCC was established. The CCC members are not expected to publicise major development information for NRE. However, one of the key criteria for membership of the committee is an undertaking to communicate with, and represent the views of, the local community with regard to the mine and its activities

1.2 Economic

1.2.1 Commercial Self Interest

Company Greed

Submission

NRE's is a greedy company only concerned with maximising its profits and uses jobs as leverage to pressure government into granting approvals.

Response

With respect to company profit motives, state and global context is needed.

NSW Context

The current NSW mineral resource development framework was established and is managed by the NSW Government through the Mining Act 1992 and its Regulations. The purpose of the Act is to:

"encourage and facilitate the discovery and development of mineral resources in New South Wales, having regard to the need to encourage ecologically sustainable development, and in particular:
(a) to recognise and foster the significant social and economic benefits to New South Wales that result from the efficient development of mineral resources, and
(b) to provide an integrated framework for the effective regulation of authorisations for prospecting and mining operations, and
(c) to provide a framework for compensation to landholders for loss or damage resulting from such operations, and
(d) to ensure an appropriate return to the State from mineral resources, and
(e) to require the payment of security to provide for the rehabilitation of mine sites, and
(f) to ensure effective rehabilitation of disturbed land and water, and
(g) to ensure mineral resources are identified and developed in ways that minimise impacts on the environment."

The DRE, a section of the NSW Department of Trade and Investment, is responsible for implementing the Act by facilitating profitable and sustainable mineral resources development, effective environmental management and safe and responsible mining and petroleum production in NSW. The division ensures that industry satisfies community and government expectations for safety, health, mine subsidence and resource extraction by close stakeholder consultation and enforcing and promoting world-leading practices. Under this framework, the NSW Government relies heavily on private companies to identify and develop the mineral resources in NSW in order to achieve the purposes of the *Mining Act* 1992. NRE, along with every other resource development company in NSW, operates within this highly regulated and regularly updated framework.

In addition to this the DPI must grant development approval to all companies wishing to develop the state's mineral resources. This adds an additional layer of detailed assessment and regulation to the process. Following major project approval there are a number of subordinate approvals required to implement any major project including SMP, DSC, NOW, OEH (Heritage), NPWS, DPI (Fisheries) and SCA approvals. At the Federal level a parallel approval process under the *Environment Protection and*

Biodiversity Conservation Act 1999 is also required for issues considered to be of national significance.

Australian Context

For the sake of further context, a report by URS for the Mineral Council of Australia, released on 31 May 2013 assessed the current Australian regulatory environment against the 2006 regulatory environment. The key findings were:

1. Mining, through all phases, from exploration to closure, is subject to more regulatory requirements than most, if not all, other economic activities;
2. Since January 2006 there has been a large amount of regulatory change affecting the mineral extraction industry across Australia, including:
    a. the enactment of 6 new pieces of legislation;
    b. the enactment of 6 replacement Acts;
    c. the enactment (in addition to new and replacement legislation) of more than 60 major sets of amendments, spread across all jurisdictions, to the major primary legislation and many more minor amendments; and
    d. there are numerous bills for additional changes in the pipeline.
3. There is significant duplication of assessment processes both within and between State and Federal approval systems; and
4. Regulation of the industry has increased since 2006 despite various government undertakings and reviews aimed at reducing red/green tape in approvals processes.

As a result of the significant number of approval processes that any mining company must pass through, the use of jobs as a pure leverage to get approval to extract coal, at the expense of environmental consideration, is simply not possible.

Global Context

Global steel production is dependent on coking coal. Approximately 70% of the steel produced today uses coking coal as a vital ingredient (Freight Investor Services 2013). Primary steelmaking involves the creation of steel from iron and all forms of primary steelmaking including Basic Oxygen Steelmaking and the newer HIsarna steelmaking process rely on coking coal to remove oxygen from the iron. Global or basic steel production was an estimated 1.55 billion tonnes in 2012 to meet global steel demand (International Steel Statistics Bureau 2013). **To produce one tonne of steel, a mill needs 1.6 tonnes of iron ore and 0.6 tonnes of coking coal**. So a world crude steel production or around 1.5 billion tonnes in 2012 would require around 900 million tonnes of coking coal. The vast majority of steel production occurs outside Australia and many products containing steel that are purchased and used in Australia are not made in Australia nor do they contain Australian made steel. However, Australian coking coal is highly valued in the steel industry and utilised in large amounts of overseas steel production that end up in the hands of Australian consumers. NRE does not create the global demand for steel, that demand is driven by residential and commercial consumers; it simply helps provide the coking coal that is critical for steel production.

The combined value of NSW mineral production in 2010-11 was approximately $19.5 billion. Coal production, at over $15 billion, accounted for around 80 per cent of the total, reflecting the continued significance of the coal industry to the State. The value of metallic and industrial mineral production was approximately $4.1 billion. Investment in petroleum exploration increased to a projected $160 million. NSW mining royalty figures for 2010-11 increased by $255 million from the previous year as a result of stronger commodity prices. The net royalty collected was $1.24 billion, with $1.152 billion from coal and $88 million from minerals (NSW Trade & Investment Annual Report 2010-11). It is obvious that that are significant additional benefits to both the general NSW community and local employees and service providers, not just shareholders of NRE.

Inflated Job Numbers

Submission

These job numbers are always inflated in the EA and are not reflective of current employment levels at the Colliery. As it is an overseas owned corporation all profits leave Australia. The job multiplier used in the NRE report is in conflict with that used in the Bulli Seam Project and appears to be inflated. There is no evidence that NRE workers live and work in the Illawarra SD, Wollongong LGA or local community. Neither is there transparency regarding how many fly-in/fly-out employees are present in the NRE workforce.

Response

Employment numbers in applications are always estimates. The original estimates of employees and their residential locations were located in *Table 28.2, pg 499, of the EA*. Employment numbers at all mines fluctuate dependant on site activities, stage in mine life and economic conditions. Employment is a fact of commercial operations and needs to be considered in the assessment process. There is a range of opinions regarding the flow on economic impact of mining with proponents and opponents substantially disagreeing. The fact that there is a job multiplier, irrespective of its value is not in dispute. There is a variety of industry, special interest group and independent studies that attempt to calculate the multiplier all of which come to different conclusions. The multipliers quoted appear to sit somewhere between 3 and 6 times for mining. The NSW Government will need to assess the EA based on consideration of the information available to them, irrespective of disagreements between the opponents and proponents of any particular project. There were 287 employees of NRE No.1 Colliery on 4 April 2013. Original employee numbers were shown in *Table 28.2, pg 499, of the EA*. The current numbers of NRE No.1 Colliery employees residing in select geographical areas and their relative percentage of the NRE No.1 Colliery workforce are represented in **Table 57**, pg 213195**.** As of 4 April 2013 there were 5 employees on 457 visas. The closure of the mine may not devastate the local economy but it will have an impact, particularly on the individuals and families dependent on the income from NRE.

Table 57 - Employee Residence Locations

Location	NRE Employees Residing *(287 total NRE No.1 Colliery employees as of 4 April 2013)*	
	No.	***% of workforce***
Local Region *(Shellharbour, Wingecarribee, Wollondilly, Sutherland & Wollongong LGA's)*	265	92%
Illawarra Statistical District *(Wollongong, Shellharbour, Kiama, Shoalhaven & Wingecarribee LGA's)*	259	90%
Wollongong LGA	182	63%
Local Area *(Suburbs bounded by Mt Ousley Rd, Bulli Pass, the escarpment and coast)*	97	34%
Adjacent Suburbs *(Russell Vale, Corrimal, Bellambi, Woonona)*	36	13%

Regional Economy

Submission

Mines provide a very small percentage of the Illawarra's workforce and mines can close without devastating the regional economy.

Response

As shown in **Figure 66**, pg 215, an article in the Financial Review dated 21 June 2013 quoting Australian Bureau of Statistics data has indicated that in May 2013 the Illawarra Region has the nation's highest unemployment rate of 15.3% (excluding Wollongong). Even when Wollongong is added into the Illawarra Region unemployment rate is 10.2%, still the highest in Australia. Wollongong LGA on its own is in the top 10 regions of highest unemployment in Australia. This is compared to a national unemployment rate that is currently 5.5% and predicted to climb to 6% by the end of 2013. It could be argued that the Wollongong and the Illawarra can't afford to lose any employment opportunities.

Figure 66 - Current Unemployment Rates in the Illawarra SD

Unemployment Region's rate soars to 15.3pc

Illawarra hit by job losses

Geoff Winestock and Jacob Greber

The possible loss of 600 ANZ call centre jobs in Victoria will be painful, but the epicentre of Australia's unemployment problem is the rust belt of the Illawarra south of Sydney.

New regional unemployment data for May shows that the unemployment rate in south-east Melbourne, where ANZ plans to cut jobs, is 6.6 per cent, slightly higher than the state as a whole.

But the jobless rate has soared to a critical 15.3 per cent in the Illawarra region – excluding the city of Wollongong – that includes Port Kembla, where major steel mills have been shuttered, costing almost 1000 jobs. That is higher than any region in Australia experienced during the height of the global financial crisis. The Illawarra, including Wollongong, has a jobless rate of 10.2 per cent, which would still be the highest rate in Australia.

Industry minister Greg Combet recently said that only 200 people had been hired under a government program to help 800 workers sacked when Bluescope Steel closed its Port Kembla works.

Economists warn the jobless rate will rise from 5.5 per cent now towards 6 per cent by year's end as the mining boom fades and other sectors take time responding to lower rates and a weaker dollar. Other areas of high unemployment are outer southern Brisbane and the west and north-west suburbs of Melbourne where Ford and other manufacturers have been shedding staff.

The figures coincide with renewed concern that the resources investment boom may have peaked.

Australian Bureau of Statistics data released Thursday showed mining employment has posted the first annual drop – excluding the period immediately after the global financial crisis – since 2001, before the boom started. Some 15,900 jobs were lost in the 12 months through May, the most in absolute terms in records going back to 1984. In annual terms, jobs have fallen 5.8 per cent, the first decline in more than three years.

The figures support the view that the employment-intensive phase of the resources boom may have passed, even though companies expanding their operations are expected to keep investment spending at a high level over the coming year.

One explanation for the disconnect between spending and jobs is that more workers are needed on the initial stages of new projects compared to the more technical work that follows. The

Economists warn the jobless rate will rise from 5.5 per cent now towards 6 per cent by year's end.

Reserve Bank of Australia this week cast renewed doubts about the strength of the resources boom, warning that a surge in global supplies of energy threatens the viability of future gas projects.

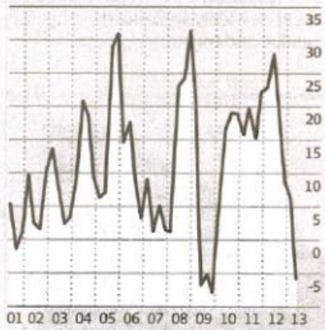
Mining investment faced "considerable uncertainty" in as little as 12 months, the central bank said on Tuesday.

In contrast to mining, healthcare added 43,000 jobs over the past year, followed by government administration (up 31,000) and education (19,000).

Other sectors losing jobs are manufacturing (down 16,000) and finance (down 11,000). Real estate and rental hiring employment fell 21,000.

Struggle streets

Mining jobs
(% change YoY)



Statistical areas with the highest unemployment rate

Region	Rate (%)
Illawarra excluding Wollongong	15.3
South and East Outer Brisbane	8.0
Wide Bay-Burnett	8.0
Newcastle	7.8
Fairfield-Liverpool	7.6
Outer Western Melbourne	7.5
Gosford-Wyong	7.5
North Western Melbourne	7.5
Wollongong	7.4
Central Western Sydney	7.2

SOURCE: ???

Source: Financial Review 21/6/13

1.2.2 Community Benefit

Impacts

Submission

The environmental, amenity and health impacts of mining outweigh the benefits to society and the assessment of financial benefits from the project has not been independently verified. The money raised by the Government as part of this project does not flow to the local community.

Response

The financial benefits of the project were assessed based on the best information NRE had at the time. DPI can request independent verification should they require it. NRE has no influence over how resource royalties are distributed by the NSW State Government. In recognition of community concerns focused around returning some of the royalty payments to the communities affected by mining projects, the NSW Government recently developed a program called Resources for Regions. The money for this program is sourced from Restart NSW, the NSW Government's fund for infrastructure to support economic growth and productivity. The Resources for Regions program is managed by Infrastructure NSW and the objective of the program is to relieve infrastructure constraints and support communities in regional areas affected by mining. In accordance with the most recent Economic Assessment of Mining Affected Communities, a number of LGAs were included in the Resources for Regions Program in 2013/14 including Wollongong City Council (WCC) LGA. As such, WCC and community groups, local businesses and non-government organisations in the Wollongong LGA have nominated programs for funding. Proposals had to demonstrate that they:

- fulfilled the NSW Government's objectives for the Resources for Regions program, the strategic infrastructure objectives in NSW 2021, and align with other regional strategies and policies; and
- have a positive net economic impact.

The shortlisted projects were assessed by the Independent Assessment Panel comprising Infrastructure NSW, NSW Farmers and Local Government NSW and details of the successfully shortlisted projects was released by Infrastructure NSW on 14 August 2013. The project shortlisted for the Illawarra Region was the Cordeaux Road and bridge upgrade valued at $4.5M. The shortlisted projects will undergo further assessment with final projects announced in November 2013, after the Federal election.

Community Contributions

Response

NRE’s community contribution commitments stop in 2010. Why are there no further commitments forthcoming?

Response

NRE will be in a position to consider community funding beyond current contractual agreements once ongoing operations have been guaranteed with an approval.

House Prices

Submission

The approval of this expansion will cause house prices to fall in the local area.

Response

NRE has no information to suggest that the expansion will or will not cause local house prices to decrease.

1.2.3 Financial Viability

Financial Viability

Submission

Doubts are expressed over NRE's financial viability and its capacity to modernise its Pit Top infrastructure. What guarantees are there that NRE will not go into receivership if there is a significant economic or environmental disaster given it was a major shareholder in the Pike River mine and that mine went into receivership after the explosion.

Response

The critical key for the financial viability of any company, once a business plan has been developed, is approval to operate according to that plan. The approval for NRE to operate in accordance with its business plan is the purpose of this project application. Should approval be given, NRE will be able to operate in accordance with its business plan and thus remain financially viable. While NRE was a major shareholder, it did not own or operate the Pike River mine.

1.2.4 Impact of the Carbon Pricing Mechanism

Carbon Credits

Submission

OEH calculates that under the Federal Government's "Core Policy" scenario for the future carbon price that NRE will need to purchase $1.86 billion dollars ($769 million NPV) of carbon credits over the life of the project and that this point has not been considered in the Economic Analysis presented in *Section 28, pg 496, of the EA* or the Greenhouse Gas Assessment in *Section 11, pg 184, of the EA*.

Response

There is currently significant uncertainty as to what the dominant carbon reduction mechanism in Australia will be after the federal outcome. This issue has been addressed in some detail in the Greenhouse Gas Management section in **Section 2.1.1**, pg 23, and **Section 2.4**, pg 238.

A recalculation of Greenhouse Gas emissions resulting from the proposed new longwall layout is located in the same Section. This includes a recalculation of NRE's estimated liability under the existing regime for the life of the Preferred Project.

1.3 *Information Adequacy*

1.3.1 Information Preparation

Contradictory Information

Submission

The EA reflects its extended preparation time from 2009 to 2013 with much of the information internally conflicting, out of date, not updated or inadequate to the current proposal. For example, the JBK drawings and photomontages have not been updated since 2010, omit various changes that have occurred on site since and do not have sufficient detail or legend data such as scale. The diagram JBK Dwg. 282800 also reinstates noise barriers that were removed from the Preliminary works Pt3A by a recent modification.

Response

NRE accepts that due to the various iterations of the proposal over the 5 year history of the project errors have crept into the EA. The errors do not in themselves constitute a significant impediment to the assessment of the EA. NRE will address all issues such as those raised by either the DPI or the PAC during the assessment process. With regard to the reappearance of the sound barriers in the EA they do not form part of this proposal. The JBK diagram presented as *Figure 1 in Annex D of the EA* was not amended after the modification of the Preliminary Works Pt3A thus the barriers inadvertently remained. The drawings and photomontages are representative of the proposal which has not varied substantially since 2010.

1.4 *Statutory/Regulatory Issues*

1.4.1 Application Process

Confusing Process

Submission

A Part 3A application titled ''NRE No. 1 Mine Project' (MP09_0013) was submitted in early 2009 "for the consolidation of its existing operations, continuation of operations and upgrade of associated surface facilities at NRE No. 1 Colliery". Director-General's EA requirements were issued in March 2009. At some unknown point this project application was withdrawn. An "Underground Expansion Project" application was submitted by Gujarat in August 2009, apparently again under MP 09_0013 for the same project as before. The application included a preliminary EA (EA) and this document is available from the DPI Web site. Director General Requirements were issued in the same month. The DPI received a draft EA for the expansion project in February 2011.

Response

In 2009, due to imminent changes to mining legislation which required all mining operations to hold a modern approval, NRE received advice from DPI that if the initial application was broken into two smaller applications it would allow for approval of the continuing operations of the No.1 Colliery while work continued on the proposed future expansion. As such the original application was withdrawn and split into two separate applications: the Preliminary Works and Underground Expansion Project Pt3A's.

1.4.2 Misuse of Legislative Process

Abuse of Process

Submission

LW4 was only approved as an SMP due to abuse of legislative processes, in particular Clause 8K of the EP&A Act transitional provisions. It should have been subject to full assessment by DPI.

Response

LW4 was applied for under the *Mining Act* 1992 on the basis of legal advice received by NRE and accepted by DPI and DRE.

1.4.3 Non-compliances

Approval Compliance

Submission

NRE has committed numerous non-compliances in the last year. For example, NRE was 9 months late submitting its Noise and Air Quality Management Plans and hasn't installed real time air and noise monitors as required in its Preliminary Works approval. The LW4 End of Panel report has not been completed.

Response

NRE's compliance issues in 2012 are not a recent issue. NRE has accepted responsibility for its past and current non-compliance issues and is working with regulators to improve compliance and avoid future issues. For example, as part of a recent undertaking to the DPI, the real time noise and air quality monitors will be installed by 30 September 2013. The LW4 End of Panel report has not yet been fully completed due to the unavailability of key consultants to complete assessments of data related to the extraction. NRE has reached an agreement with DRE that allows it to complete the report and submit it with an undertaking to submit a copy that has been reviewed, and if required, updated by key consultants. The incomplete report was submitted to DRE on 16 June 2013.

1.4.4 Public Involvement

Information Availability

Submission

The public must be allowed full scrutiny of all management plans associated with these projects including SMPs. All data collected by mining companies must be made available to public as it is collected in the public interest. All consultants' reports obtained by the company must be made available to the public and electronic versions of all mine plans must be made available to the public.

Response

NRE is not required to release raw data to the public until it has undergone an internal data quality control procedure and if necessary, has been reviewed and assessed by technical experts. This is very important as it reduces the likelihood of error, misinterpretation and false assumptions causing confusion or unnecessary concern in the general public.

There has also been occasions when efforts to increase transparency by mining companies, including by NRE, have been intentionally or unintentionally misrepresented by special interest groups in the media and the media itself. There is a significant danger of this occurring with the release of raw data that has not been appropriately quality checked and assessed by agency and consultant technical experts nor communicated contextually. This is of no benefit to NRE, the NSW Government agencies or the community as a whole. Other data or information that is considered Commercial in Confidence will not be released to the public without extremely good reason or if it is a legal or statutory requirement.

2 Pit Top Issues

2.1 Air Quality

2.1.1 Air Quality Modelling

Assessment Deficient

Submission

The air quality assessment is deficient and must be revised as it doesn't include all significant emission sources and particularly, doesn't include coal haulage impacts.

Response

Trucks were removed from the assessment based on discussions and advice from the EPA during the initial stages of the modelling. This was based on existing controls rendering significant dust generation as a possibility but not a probability (*see Section 5.2.4, pg 19, of Annex I of the EA*). As part of its monitoring program and annual review of its AQGGMP, NRE will liaise with the EPA to continually improve dust management practices where possible

Background Data

Submission

Background air quality data was sourced from Newcastle when *Figure 6.1 in Annex I of the EA* indicates there are particle monitors on site.

Response

Background PM_{10} levels were sourced from the OEH Wollongong monitors, not Newcastle (*see Section 4.4.1, pg 17, of Annex I of the EA*). With regard to *Figure 6.1 in Annex I of the EA*, the indication of two HVOL and Teom monitors is incorrect. They do not exist at this time. NRE only has depositional dust gauges installed. However, there will be real time air and noise monitors installed at those locations by the end of September 2013. These monitors will be able to provide both PM_{10} and $PM_{2.5}$ data to inform future reviews of the AQGGMP.

Meteorological Data

Submission

The assessment doesn't demonstrate that the meteorological data used in modelling is representative of long term site conditions and should be revised.

Response

The meteorological data was sourced from the Wollongong Automated Weather Station *(see Section 4.2, pg 14 of Annex I of the EA)*. This station is considered to be in the vicinity of the site and therefore to have provided adequate data to inform the model.

Air Quality Criteria

Submission

NEPM guidelines don't set NSW air quality criteria and as such there are no allowable exceedances of NSW PM_{10}, 24hr criteria. References to this must be removed from the EA.

Response

The references to allowable exceedances were based on the NEPM Guidelines. It is true that the NSW impact assessment criteria as stated in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* do not allow for any exceedances. The Approved Methods do however provide guidance to applicants to both refine their modelling to determine if the exceedance is incorrect and review the control mechanisms for dust generation on site. The model predicted one potential exceedance of the PM_{10}, 24hr limit. That modelling used all available background data at the time. At 5 years, the period of the Preferred Project is significantly lower than the predicted 18 years in the EA and NRE has no objection to being held to similar air quality criteria as those applied in Condition 19, Table 7, 8 & 9 of the Preliminary Works Pt3A approval MP10_0046.

Emission Estimates

Submission

Explanation of assumptions and inputs to the model must be justified as the data in Table B1 of Annex I of the EA appear not to be consistent with the *User's Guide for the AMS/EPA Regulatory Model –AERMOD*. Table C1 which lists source emission estimates for the dispersion model doesn't reference the estimation methodologies used. Neither are the emission control efficiencies quantified or justified. There are also emission estimation calculation errors identified by the EPA.

Response

Section 6 in Annex I of the EA contains a full justification of the sigma values used in the dispersion modelling assessment that underlies the construction of Table B1 in the same Annex. The assessment is designed to be consistent with the *User's Guide for the AMS/EPA Regulatory Model –AERMOD*.

Emission estimates were based on *Section 3 of the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* and utilised the same model that informed the Preliminary Works Pt3A application which was approved. The emissions inventory was addressed in detail in *Sections 5 & 6 of Annex I of the EA*. Due to the removal of heavy equipment from stockpile management as compared to the Preliminary Works Pt3A the emissions from the project are likely to decrease.

Currently coal dust makes up between 5 and 25% of depositional dust from gauges located down Bellambi Lane. Recent available dust monitoring results from close proximity to, or within, the site boundary has returned a maximum level of $2.6g/m^3$/month. Given that NRE has a $4g/m^3$/month depositional dust criteria and conservatively assuming that 25% of the dust in each gauge is coal it still represents only $0.65g/m^3$/month from colliery operations. Since October 2012, NRE has commenced the visual assessment of the contents of all 9 of its current depositional dust gauges to determine the coal dust contribution to overall dust deposited. An average coal dust content of 14.3% has been observed in the 4 month period between October 2012 and January 2013 for which records are available at the time of writing. The remainder of the fallout consists of a mixture of dirt, insect residue, vegetation and other particulate matter. The installation of the real time air quality monitors will provide NRE with excellent data on PM_{10} and $PM_{2.5}$ levels and sources. This data will inform future modelling to a much greater level of accuracy than is possible now. As such NRE will not remodel the air quality assessment until improved data is available.

NRE has checked the calculation and it agrees with the EPA result of 0.121g/s rather than the 0.005g/s in the EA. This will create an order of magnitude difference in total tonnes of PM_{10} in uncontrolled conditions on the large stockpile. The assumption is made in the EA that water sprays as a control will reduce uncontrolled emissions by 50% thus reducing the emission rate to 0.061g/s. Total emissions on previous calculation were 5.21 tonnes PM_{10}/year and fixing the identified error increases the calculation to 7.05 tonnes PM_{10}/year.

Comparing this prediction to National Pollution Inventory (NPI) data on PM_{10} emissions for 2011/12 for the Wollongong LGA and the 2517 & 2518 Postcodes shows the following in **Table 58**, pg 223.

Table 58 - Comparison of PM_{10} Contribution Volumes

Source	Tonnes PM_{10}/pa	% NRE Contribution (with calculation error)	% NRE Contribution (no error)
Wollongong LGA	2,160	0.24%	0.33%
2517/2518 Postcodes	100.8	5.17%	6.99%
NRE Preferred Project	(5.21)[1] / 7.05		

1. Original annual emissions based on error in original calculation was 5.21 tonnes PM_{10}/pa. When the error is corrected the value rises to 7.05 tonnes PM_{10}/pa

The error will have a negligible impact on the total PM_{10} emissions in either the local or LGA airsheds when compared to the originally calculated volume of emissions.

<u>PM_{10} Emissions Comparisons</u>

Given that there is a possibility of a single exceedance of the $PM_{10\ -\ 24\ hour}$ OEH criteria, there is value in identifying local PM_{10} emission sources and levels for the purpose of providing context to the application.

Sources of PM_{10} emissions for the Wollongong LGA in 2011/12 as recorded by the NPI are shown in **Table 59**, pg 224. As can be seen in **Figure 67**, pg 224, coal mining represents only 4% of emissions by source.

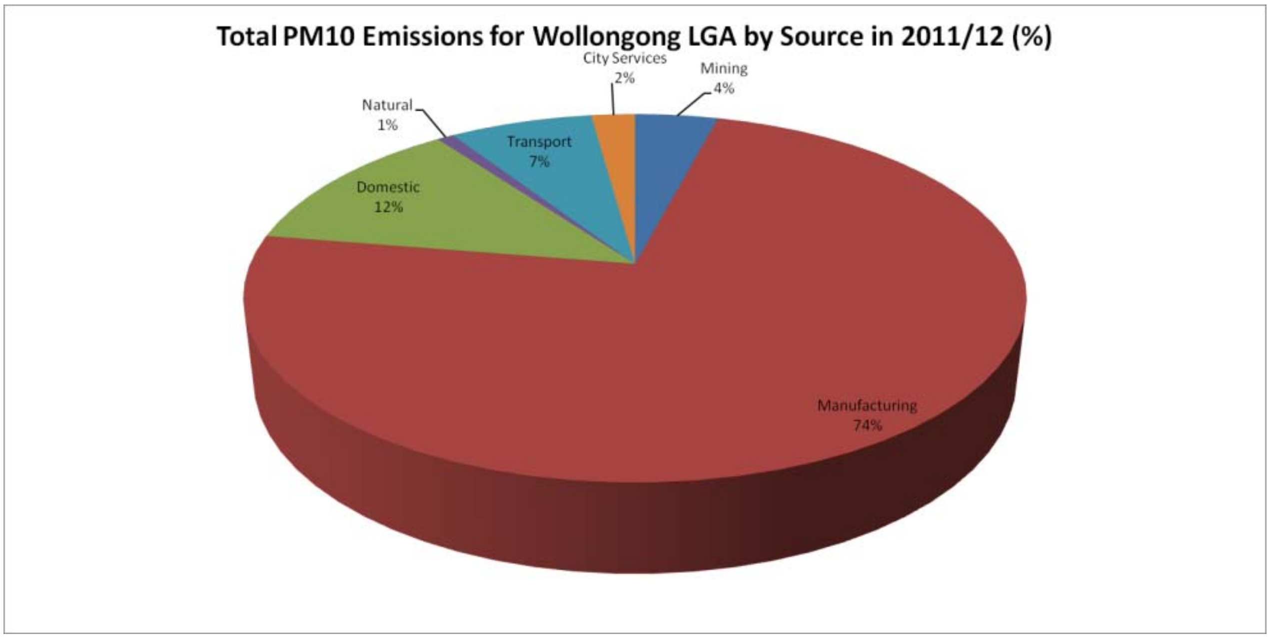
Table 59 - Total Estimated Emissions for the Wollongong LGA by Source in 2011/12

Source	Tonnes/annum	% of Total
Manufacturing[1]	1,602	73.5%
Domestic[2]	270	12.4%
Transport[3]	154	7.0%
Coal Mining	89	4.1%
City Services[4]	47	2.2%
Natural[5]	18	0.8%
Total	**2,180**	**100%**

1. Includes emissions from ceramic product, basic chemical, petroleum & coal product, basic ferrous metal, and other manufacturing as well as fuel combustion in non-reporting industrial premises
2. Includes emissions from liquid, gas & solid fuel burning, BBQ's, recreational boating and lawn mowing
3. Includes emissions from aeroplanes, railway, motor vehicles and commercial shipping/boating
4. Includes emissions from water supply, sewerage, drainage & water transport support services, electricity generation and lawn mowing of public open spaces
5. Includes emissions from windblown dust and fires

Source: NPI Database

Figure 67 - Annual Wollongong LGA PM_{10} Emissions by Source (%)



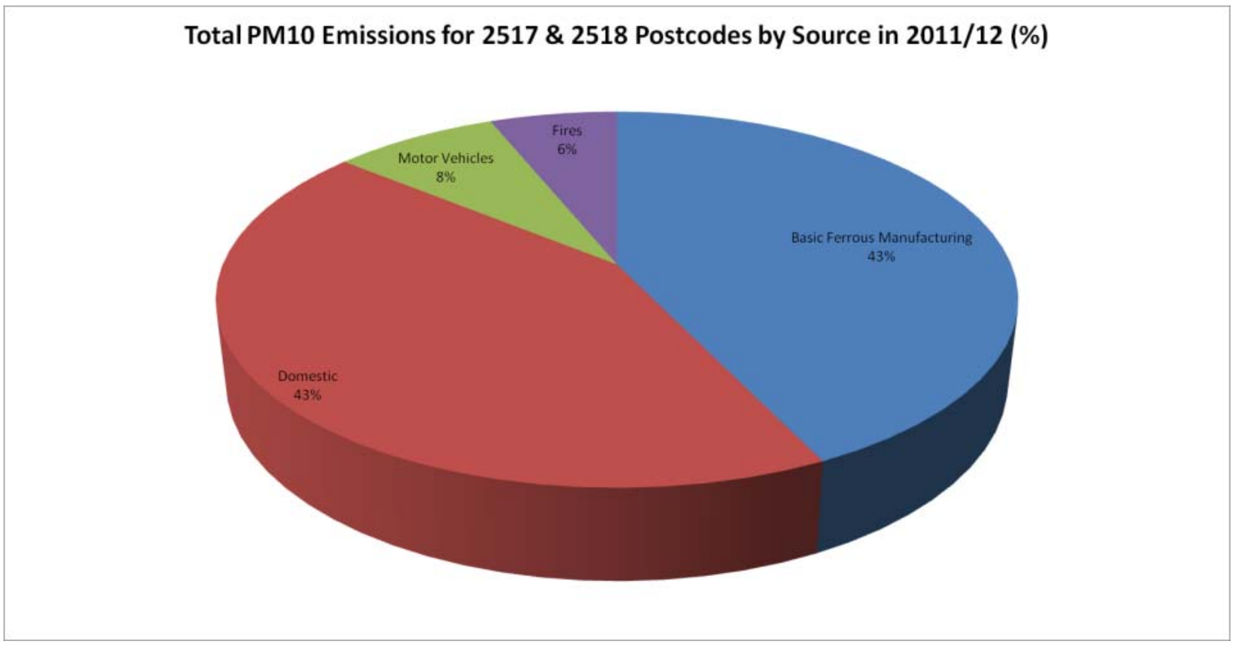
The NRE No.1 Colliery is surrounded by the suburbs of Woonona, Russell Vale, Corrimal, East Corrimal and Bellambi (postcodes 2517 & 2518). As reproduced in **Table 60**, pg 225, the NPI estimates that the total PM_{10} emissions for the 2517 and 2518 postcodes were approximately 101 tonnes for 2011/12. This represents 4.6% of the LGA's total emissions by weight for that year.

In **Figure 68**, pg 225, approximately 43% of the local area's emissions come from manufacturing, an additional 43% comes from domestic sources such as solid fuel burning and lawn mowing (domestic & public), 8% from motor vehicles and the remaining 6% from fires.

Table 60 - Annual Emissions by Source in the 2517 & 2518 Postcodes

Emissions Source	Tonnes/annum	% of Total
Basic Ferrous Manufacturing	43.2	42.9%
Solid Fuel Burning (residential)	41.1	40.8%
Motor Vehicles	8	7.9%
Lawn Mowing (residential)	1.7	1.7%
Lawn Mowing (public open space)	0.6	0.6%
Fires	6.2	6.1%
Total	**100.8**	**100%**
Source: NPI Database		

Figure 68 - Annual 2517 & 2518 Postcodes PM10 Emissions by Source (%)



The Preferred Project is only predicted to add an annual average of 2.16μg/m^3 to the background PM_{10} levels in the direct vicinity of the Colliery. Predicted maximum concentrations of PM_{10} are reproduced from *Figure 10.3, pg 177, of the EA*

Figure 10.4, pg 178, of the EA shows the predicted concentrations of the PM_{10} emissions from the project indicating that the spread of the higher levels of PM_{10} are extremely limited and become undetectable at 1km distance from the Colliery.

For the sake of comparison, the project's estimated PM_{10} emissions in grams/second, post-mitigation are outlined in *Table C1, pg C4, of Annex I of the EA*. Converting the grams/second to tonnes/annum and correcting for the calculation error identified by the EPA, gives a maximum total estimated 7.05 tonnes of PM_{10} emitted by the project per annum.

This represents an additional 7% to local area emissions by weight and it only increases the LGA's total emissions by 0.3%. A current plan to extend the coverage of existing Depositional Dust gauges to 3 local schools in the area has commenced with gauges installed in 2 of the 3 locations. With the installation of real time air quality monitors on the NRE Pit Top in September 2013 the additional locations will provide NRE with excellent local data set available in the area to inform a remodelling of air quality impacts either as part of the 2013/14 review of the AQGGMP or prior to the development of a CEMP for the project if this is considered necessary. There will be some PM_{10} and $PM_{2.5}$ data at this time but it will be able to provide a good basis for establishing PM_{10} and $PM_{2.5}$ sources in the vicinity of the mine.

2.1.2 Air Quality Monitoring

Monitoring Equipment

Submission

NRE's air quality monitoring equipment has not been installed as required by the Preliminary Works Pt3A. Monitoring is unable to measure 2.5μm particles which is concerning given their proven health impacts.

Response

As part of the Preliminary Works Pt3A approval NRE is purchasing and installing real time air quality monitors to monitor TSP, PM_{10} & $PM_{2.5}$ emissions. While there are no requirements for NRE to model or monitor particles of 2.5μm diameter, the new air quality monitoring system will measure 2.5μm particles. As part of a recent undertaking to the DPI, these monitors will be installed by 30 September 2013 and will complement already installed and depositional dust monitors on site and in the community. This will provide invaluable data to NRE, regulators and the public and will inform both real time responses to air quality issues and ongoing annual reviews of the AQGGMP

NRE is also extending its Depositional Dust network to three local schools in the area to provide better background data on local dust levels and particularly coal particle distribution from the Colliery. The gauges have already been installed in 2 of the 3 schools (Corrimal Public School gauge still to be installed) as is shown on **Figure 69**, pg 227 which also shows the locations of all other existing depositional dust gauges around the Colliery.

Figure 69 - Locations of Depositional Dust Gauges

2.1.3 Air Quality Management

Dust Suppression Measures

Submission

Dust suppression measures must include:

- the completion of all Stage 1 coal handling facility upgrades including removing the Balgownie belt and bins, decommissioning the Bulli decline belt, construction of stackout conveyer and tripper and construction of new screen and sizer;
- covering coal conveyors to the stockpile area;
- full enclosure of the screen and sizer plant;
- automatically controlled stockpile spray system;
- mobile water trucks;
- truck washing facilities used by all trucks prior to departure from site;
- covered loads prior to leaving site;
- sealed pit top truck haulage roads and parking areas;
- bobcat mounted road sweeper to be used on all sealed areas; and
- fixed water sprays on surface and underground coal conveyors.

Response

- The Balgownie conveyor has been decommissioned and the vast majority of the conveyor has been removed. The Bulli decline belt has also been removed. A new Wongawilli conveyor, stackout conveyor and tripper have been installed. The new screen and sizing unit hasn't been constructed at this point;
- The stockpile conveyors are covered where practicable;
- The screen and sizer will be fully enclosed when constructed;
- The current stockpile spray system is automated and linked to an anemometer located on the thickener tank near the stockpile area;
- Water trucks are already used to suppress dust on both sealed and unsealed areas of the site and this management practice is contained in Appendix C of the AQGGMP.
- Water trucks are proposed and used rather than a reticulated road side spray system;
- A truck washing system is already in use and is proposed as a continuing control in *Table 10.7, pg 182, of the EA*. A full report on the truck washing facilities is contained in Appendix C of the AQGGMP*;*
- The covering of loads prior to leaving site is both a regulatory requirement and included in the *Drivers Code of Conduct* (*DCC)* which is Appendix B of the NRE No.1 Colliery Traffic Management Plan;
- NRE has committed to seal all haul roads and truck parking areas in *Section 7.1.1, pgs 131-133, of the EA;*
- The area around the Pit Top workshop and portals areas is swept by a road sweeper regularly to keep dust levels down. NRE is also committed to sweep Bellambi Lane weekly;
- There are already water sprays on the underground conveyor system to keep underground dust levels at an acceptable level.

The currently approved NRE No.1 Colliery AQGGMP also contains the following undertakings with regard to air quality management.

- Internal roads will be sealed where practicable. Any unsealed haul routes on the site will be watered at a rate of 2 L/m^2/minute as required;
- Coal will be transported on site using a network of covered conveyors where practicable,
- Coal haulage trucks will be covered before leaving the site in order to minimize the potential for dust;
- Drivers are required to abide by the Driver's Code of Conduct. This includes mitigation measures such as mandatory covering of trucks. NRE has committed to reinforce the Driver's Code of Conduct, through continuing regular driver education (tool box talks);
- To ensure dust emissions along coal haul routes are effectively managed, alternate truck washing arrangements are under consideration. These arrangements will ensure trucks are clean and dry prior to leaving the site, thereby reducing drip waste and dust impacts along Bellambi Lane, which is expected to reduce emissions to negligible levels;
- In the event that coal loading directly from the stockpile is taking place and the truck wash is not operational for a period of time, loading directly from the stockpile would cease until such time as the truck wash is once again operating. This commitment would ensure that coal particulates are removed from trucks prior to leaving the site, minimising the generation of dust emissions from trucks on public roads; and
- Exposed areas will consist of one main stockpile area containing Stockpiles 2 and 3 (~ 2 hectares) and the smaller existing approved stockpile area known as Stockpile 1 (~0.7 hectares). Water sprays will continue to be used on these areas to minimise air borne dust on an as needs basis.

Section 10.6, pgs 181-182, and the *Statement of Commitments, pg 512, of the EA* provide more detailed lists of current and future approaches to minimising air quality impacts. Those not covered in the current approved AQGGMP are replicated below.

- Nature of the Material – The inherent high moisture content (estimated at 7%) of the coal being extracted reduces potential for dust emissions to atmosphere compared to other extracted materials *(Section 10.6, pg 181, of the EA)* ; and
- Equipment will be maintained on a regular basis *(Table 10.7, pg 182, of the EA).*

Diesel Exhaust Emissions

Submission

NRE must undertake a Best Practice Management assessment of diesel exhaust emissions reduction for road haulage as well as off road and underground mobile vehicles and equipment.

Response

The EPA has recently commenced a program titled "*Best Practice Measures for Diesel Exhaust Emissions at Coal Mines*". This program, enforced through the EPL is focused on a review of diesel powered mobile equipment at all EPA licenced coal mines in NSW. As part of that review, a Notice to Provide Information and/or Records has been given to NRE No.1 Colliery. The Notice requires the download and completion of a survey of the emissions from all non-road registered surface and underground diesel powered mobile equipment. Point G of the Background section of the Notice states that one of the outcomes of the survey will be that:

"The EPA will use the survey results to complete the review by conducting a detailed site-specific evaluation of either retrofitting, repowering, replacing, and/or procuring EU/US compliant off-road diesel equipment at EPA-licensed coal mines, including:

- *establish existing practices for reducing diesel exhaust emissions, and benchmark those against international best practice; and*
- *estimate the likely reduction in diesel exhaust emissions, equipment costs and health benefits associated with adopting those international best practice measures which are technically and economically feasible."*

NRE completed and submitted the EPA survey on 7 June 2013. As this diesel powered mobile equipment review process is already underway via the site's EPL it doesn't appear to be necessary to incorporate the requirements to undertake a similar process via the Pt3A application.

Coal Stockpiles

Submission

The coal stockpiles of between 315,000 and 840,000 tonnes will create too much dust. How will this be managed? Trucks must not be loaded from the stockpile. The modelling in the EA did not consider the additional stockpiles as they do not appear on the modelling diagrams in the Air Quality section. The EA claims that there will be less dust generated by this proposal than current operations but this is not supported by contour diagrams. Stockpile 2 will be managed by bulldozer creating more dust.

Response

NRE has only requested approval to construct Stockpile Area 2 consisting of 2 x 140,000 tonne stockpiles (Stockpiles 2 & 3) in addition the already approved and operating 80,000 tonne stockpile (Stockpile 1) in Stockpile Area 1. That makes a total of 360,000 tonnes of stockpile volume on site. The reference to the range in this submission is based on alternative options that were explored and not pursued. They were included in the EA, as required by Schedule 2 of the *Environmental Planning and Assessment Regulation* 2000, to show the considerations that had been undertaken prior to the current preferred option. Dust modelling was undertaken based on the total 360,000 tonne final stockpile area. Details of the proposed stockpile management were outlined in *Table 10.7, pg 182, of the EA*. Trucks will be loaded from truck loading bins when the bins are completed. There may be periods where loading from the stockpile is unavoidable such as mechanical failure affecting the truck loading bins, but this is not a preferred situation as the double or triple handling of coal required as part of stockpile loading is not cost efficient when compared to conveyor fed truck loading bins discharging directly into the truck. The air quality model in the original EA included the additional stockpiling area in its calculations. The statement regarding the reduction of emissions after the completion of the new project compared to current operations is made on the basis of reduced stockpile heavy vehicle movements due to underground reclaim system and direct loading of trucks from new truck loading bins. The two stockpiles in Stockpile Area 2 are emplaced over a gravity fed reclaim conveyor similar to the existing approved Stockpile Area 1.

Depositional Dust

Submission

NRE claim that air quality exceedances around the mine are a result of windblown materials but up to 20% of total dust content has been measured in gauges down Bellambi Lane. Dust down Bellambi Lane wasn't modelled in the EA.

Response

Current analysis of the last 5 months of data for the three existing depositional dust monitors situated along Bellambi Lane indicates that coal dust fallout ranges between 5% and 25% of dust collected and averages only 14% of the total dust fallout along Bellambi Lane. Due to its colouring, coal dust is more visible than other forms of fallout and contributes to perceptions that the problem is significantly worse than it currently is. The depositional dust was not modelled along Bellambi Lane in the EA based on discussions with OEH at the time in which it was felt that the operational controls that already existing were appropriate to manage dust emissions from haulage (*Section 5.2.4, pg 19, of Annex I of the EA*). NRE No.1 Colliery Particulate Matter Control Best Practice Pollution Reduction Program (PRP) undertaken by PAEHolmes in October 2012 as part of an EPL requirement identified many of the Pit Top improvements proposed as part of this application as Best Practice. The outcomes of the PRP will be incorporated into the AQGGMP which is subject to monitoring and review by both the EPA and DPI on an annual basis.

Trucks

Submission

Diesel exhaust emits toxic particles and this will cause serious health effects for locals along Bellambi Lane and truck brakes and other 'frictionable surfaces' will create dangerous dust particles. NRE hasn't improved its truck dust control systems for 8 years and must be shut down until that is brought up to standard.

Response

NRE trucks would only contribute a tiny volume of dust from "frictionable materials' when compared to the large numbers of vehicles using Bellambi Lane, Memorial Drive and Princes Hwy. NRE haulage trucks are not the only, nor the predominant diesel vehicle emissions in the area as there are other industries using diesel vehicles and machinery, and the Princes Hwy and Memorial Dr are used by large numbers of diesel vehicles not associated with NRE's operations.

Ventilation Air

Submission

There are currently two ventilation fans at the surface with plans for up to five. These fans blow unfiltered air across local suburbs. The company must also implement detailed best practice dust control measures including dust prevention and dust suppression techniques in an Air Quality Management Plan.

Response

There are currently two ventilation fans at the Pit Top ventilating the mine workings and no current plans for any further fans. Ventilation air as a contributor to mine emissions was not addressed in the NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining. Current emissions of particulates, gases and other elements from operating ventilation shafts in the Southern Coalfields are historically well below the relevant limits set by regulation as evidenced by the historical emissions data provided in the PAEHolmes report "*Air Quality Impact Assessment – BHP Billiton Illawarra Coal – Ventilation Shaft No.6 Project*."

2.1.4 Air Quality Impacts

Proximity

Submission

The Colliery is too close to residences, schools and pre-schools which are being affected by unsightly dust and air pollution from coal stockpiles and unfiltered ventilation air.

Response

There has been no approach to NRE from local schools or pre-schools with regard to concerns around impacts from its activities. In response to the concerns raised in the submissions, NRE has approached 5 local schools and child care facilities to determine if they would be willing to host depositional dust monitors. Of the 5 local schools, 3 have indicated that they would be happy to have depositional dust monitoring at their sites and gauges have been installed at 2 of the 3 sites. These sites vary in distances of 0m to 480m from the Colliery boundary. Gauges will be established at those sites in liaison with the principals/managers and the AQGGMP will be updated during the annual review process.

2.5µm Particles

Submission

Coal mine dust has been proved to produce 2.5µm particles which cause aggravated asthma, acute respiratory symptoms, lung disease, and chronic bronchitis.

Response

There is no evidence that 2.5µm particles are a significant issue from the operations of underground coal mines in the Southern Coalfield (*Air Quality Impact Assessment – BHP Billiton Illawarra Coal – Ventilation Shaft No.6 Project)*.

Coal Dust Exposure

Submission

Coal dust also causes gastric cancer as reported in a study titled Gastric Cancer and Coal Mine Dust Exposure.

Response

The elevated gastric cancer risk for coal mine dust exposure reported in the study Gastric Cancer and Coal Mine Dust Exposure is limited to coal miners who smoke cigarettes. The paper states "*In conclusion, this study demonstrates that among US white male coal miners, an occupational gastric cancer risk posed by exposure to coal mine dust exists, but only when a life-style feature, cigarette smoking, is also present. When prolonged coal mine dust exposure is conjunctive with prolonged cigarette smoking, a statistically significant gastric cancer risk occurs*."

2.2 Biodiversity

2.2.1 Green and Golden Bell Frog

Habitat Disturbance

Submission

WCC notes that the upgrading works proposed by NRE include disturbance of Green and Golden Bell Frog (GGBF) habitat as a result of stream realignment, pond removal, increase of the coal stockpile area and upgrade of coal handling facilities. There must be a full targeted survey and impact assessment for the GGBF to determine if the GGBF is present on the site. A detailed Assessment of Significance for the GGBF is also required prior to approval.

Response

There is only one known marginal habitat for the GGBF on the NRE No.1 Colliery Pit Top. This is Dam 6 which is proposed to be removed as part of the realignment of the Bellambi Gully Creek in the MP10_0046 Preliminary Works Pt3A application. This application was approved on 13 October 2011 and *Condition 29, Schedule 6 of MP10_0046* required NRE to develop a BMP that incorporated management measures, monitoring procedures, performance indicators and reporting frameworks for the GGBF. This plan was developed and has been approved by DPI.

NRE also received approval EPBC 2011/5891 under the EPBC Act for the proposed works to Dam 6 and Bellambi Gully. This approval also required monitoring and a management plan to be developed for the GGBF in Dam 6. The BMP addresses this conditional requirement of the EPBC Act approval. NRE has been monitoring Dam 6 for 4 years and no GGBF's have been detected during this period of time.

All construction activities proposed in *Section 7, pg 131,* and *Annexes C and D of the EA* remain the same for the Preferred Project. The works will be undertaken in previously disturbed areas that consist of cleared areas, hardstand, regrowth acacia, weed species and/or grass. The areas to be affected by construction works as part of the Preferred Project are shown in **Figure 70**, pg 235, in which the already disturbed nature of the site is evident.

As part of construction associated with the surface facilities upgrade, a CEMP will be prepared. This plan will incorporate an assessment of the construction footprint and, if necessary, will include biodiversity protection measures.

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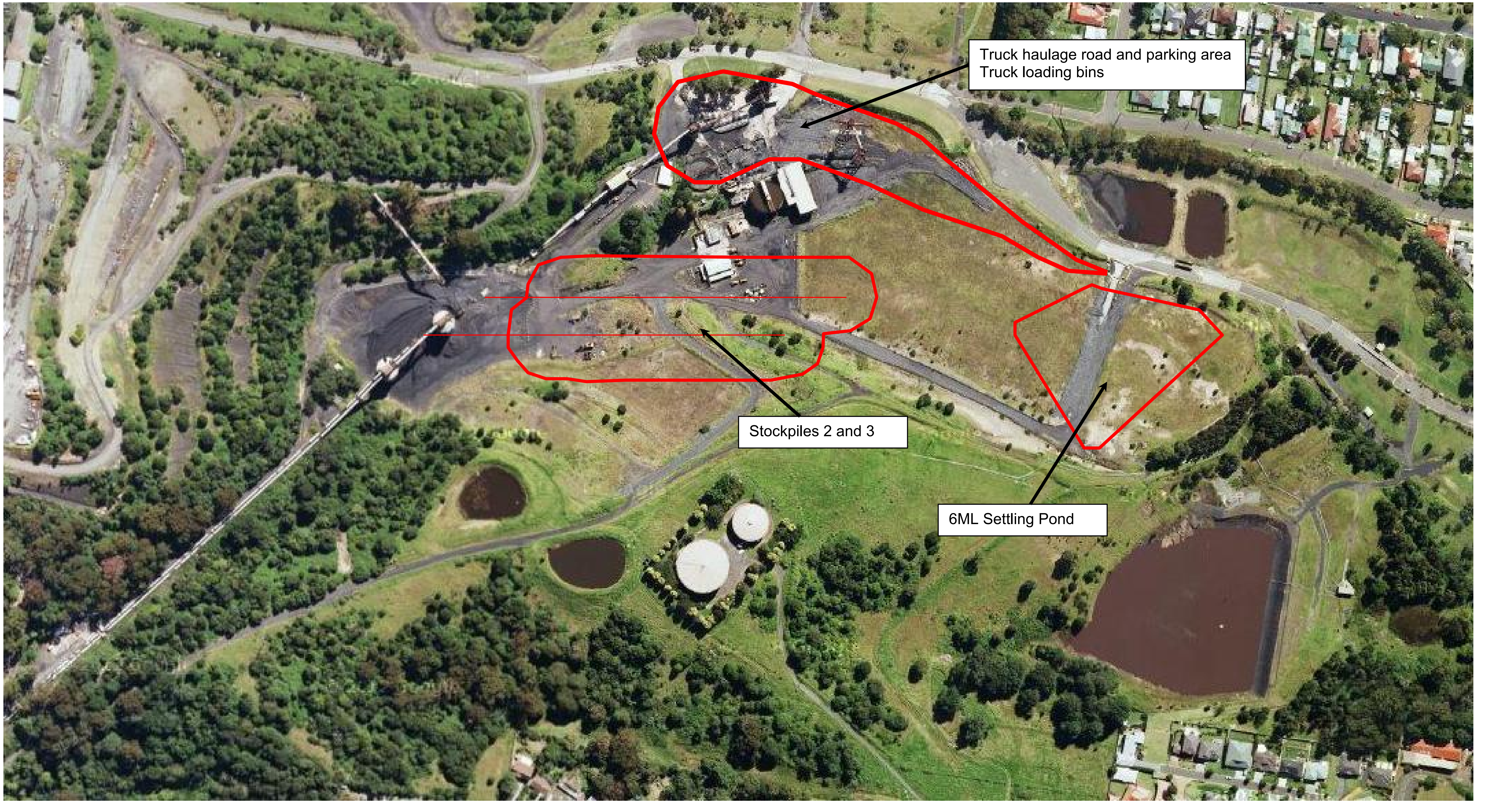
Figure 70 - Approximate Areas to be Impacted by Proposed Surface Facilities Upgrade



2.3 *Cultural Heritage*

2.3.1 Cultural Heritage Management

Adequate Management

Submission

As long as NRE adheres to the Statement of Commitments, the historic heritage at this site (which relates to the former South Bulli Colliery) will be adequately managed during the lifetime of this project.

Response

The cultural heritage assessment for the Pit Top in *Section 14, pg 214, of the EA* did not anticipate any impacts to historic or cultural heritage as a result of the project. There has been no change to the surface facility upgrade and therefore no need to revisit an assessment.

Table 14.4, pgs 223-224, of the EA lists all the items of historic heritage at the site and identifies that there were no predicted impacts to any of them. All upgrade works at the Pit Top will be taking place in historically disturbed areas as shown in **Figure 70**, pg 235, and as such there are no Aboriginal cultural heritage sites that will be affected by the upgrade. There is always the possibility of chance finds occurring during excavation and NRE has an existing approved Heritage Management Plan (HMP) that outlines procedures to cover any chance finds of artefacts.

Section 14.4, pg 224, and the *Statement of Commitments, pg 518, of the EA* outlined a number of undertakings with regard to mitigation of impacts to any items of cultural heritage. These undertakings have been somewhat eclipsed by activities undertaken for the previous Preliminary Works Pt3A approval (MP10_0046). **Table 61**, pg 236, shows the management method and its current status.

Table 61 - Pit Top Cultural Heritage Management Methods and Status

Management Method	Status
No items identified as having heritage value or contributing to the heritage value of the site, will be demolished as part of this Project	Ongoing
A Conservation Management Plan (i.e. HMP) will be prepared to reflect the future need of the site as a continuing mine and include procedures to follow for the discovery of unanticipated 'Relics'	Complete
A photographic recording of the 1887 portal should be undertaken to Heritage Archival Recording standards. Copies of the recording should be lodged with the appropriate Local and State repositories	Complete
A photographic recording of the site should be undertaken, to Heritage Archival Recording standards, prior to commencement of construction for the Project, to provide a lasting record of the site prior to the new development. Copies of the recording should be lodged with the appropriate Local and State repositories;	Complete
Items of moveable heritage will be retained at their current location onsite and documented including historical photos, plans, maps and records to Heritage Archival Recording standards. A conservator will provide advice regarding the long term storage of the items to maximise their survival. When the item has been appropriately catalogued its will be donated to a suitable repository. Appropriate repositories will be identified prior to Project works commencing	Complete

As part of construction associated with the surface facilities upgrade, a CEMP will be prepared. This plan will incorporate an assessment of the construction footprint and, if necessary, will include heritage protection measures.

The current HMP already contains provisions to ensure that contractors are inducted with regard to heritage including methods for dealing with chance finds of Aboriginal or historic heritage items and human remains. It is anticipated that if approval is given for the Preferred Project the DPI will still require an updated HMP to include issues associated with this project.

2.4 Greenhouse Gas Emissions

2.4.1 Coal Yield Ratio

Thermal Coal

Submission

35% of NRE's coal is sold for use in coal fired power generation and the remaining 65% for coking coal use.

Response

NRE operates the No.1 Colliery with the primary aim of developing the significant coking coal resources still located within the lease to supply high quality coking coal for the purposes of steelmaking. Currently the average Wongawilli seam ROM coal yields about 52% coking coal, 28% thermal coal and 20% ash (non-combustible material). While this yield ratio is not to NRE's preference it is a commercial reality of extracting coal from the Wongawilli seam in this area. With regard to the global need for coking coal see **Section 1.2**, pg 211 .

2.4.2 Greenhouse Gas Calculations

Fugitive Emissions

Submission

The Bellambi expansion is likely to release about 95,000 tonnes pa of methane - far more than a usual mine, and about 2% of the methane produced by the entire Queensland coal seam gas industry. That's adding about 0.43 per cent to Australia's total greenhouse emissions! In addition, there is likely to be an increase of the nation's fugitive (leaked gas) emissions by six per cent - from a mine producing about one per cent of Australia's coal.

Response

NRE recognises the need to reduce its fugitive emissions. Recent actions, outlined in **Section 2.1.1**, pg 23, have reduced emissions from No.5 Shaft by an estimated 77%. These works included:

- reducing the ventilation fan speed at the No.5 Shaft; and
- installing structures in underground areas to stop air from currently unused areas of the mine entering the ventilation system and reducing air flow from other areas.

In practice this has resulted in 90,212t CO_2-e/annum reduction in fugitive emissions. These and other similar actions will be captured as part of AQGGMP.

Seam Thickness

Submission

The greenhouse calculations in the proposal have been based on only 2.5m of an 8.5m seam which will release its greenhouse gases well after mining.

Response

The proposed extraction height for the longwall varies from 2.5 up to 3 metres. This fits within the lower section of the Wongawilli Seam which varies in total thickness of 8 to 10 metres. The upper portion of the seam is largely made up of stone or dirt bands and as such contains little to no coal and certainly no coal that is considered to be of any economic value. The greenhouse gas emission calculations for the NGERS are derived from the total gas (both methane and carbon dioxide) emissions for the entire mine not just from the coal that is extracted. Any gas which might be released from the overlying strata will be captured by the mines ventilation system and as such be reported as part of the total emissions for the mine.

Unsupported Claims

Submission

There is no support for:

a. NRE's claims that 95% of diesel emissions are underground and therefore captured in ventilation air measurements; and
b. The consultant's claim that greenhouse gas intensity of NSW grid electricity will reduce to 0.82 t CO_2-e/MWh by 2015 as the information source is unreferenced.

These claims reduce the estimated greenhouse emissions by up to 7.9% for Scope 2 emissions for the project. NRE must provide additional information on the calculation of the proportion of diesel consumed underground, a new estimate of Scope 2 emissions using methods consistent with the 2012 National Greenhouse Accounts Factors.

Response

Of the diesel fuel directly purchased by NRE approximately 95% is used for vehicles which operate within the mine. This does not include any vehicle used by contactors providing stockpile management and coal haulage services. The emissions for contractor's equipment is largely included in Scope 3 emissions as reported in the EA. The design of the coal stockpile area is such that there will be little to no need for additional equipment for coal loading and dispatch once construction is complete. The bulk of the NRE diesel equipment is utilised to transport men and material from the surface to the underground production areas. Due to the closed nature of the mines ventilation system, gases released from these vehicles must report to the mines ventilation system and as such will be recorded as part of the total emissions for the mine. Separately reporting this would represent double accounting of these emissions. However, in order to reflect a maximum emission, NRE has included these in the latest emissions calculations in **Section 2.1.1.6**, pg 32.

The submission from OEH concerning greenhouse gas intensity for electricity consumed from the NSW grid is not correct in its calculation that a change in the emissions factor will cause a significant increase in greenhouse emissions. The Scope 2 emission, which includes those emissions deemed to be associated with power usage, represents at best 4.4% of the total emissions for both Scope 1 and Scope 2. A change in the emissions factor from 0.82 to 0.92 represents an increase of 15,444 tons of CO_2-e which represent 0.6% of the total Scope 1 & 2 emissions for the original project. In this regard, a variation of the emissions factor is considered to be of minimal consequence to the overall greenhouse gas emission footprint for the project. Table 5 in Section 2.3 of the *National Greenhouse Accounts Factors – July 2012* uses 0.88 rather than 0.92 as the emission factor for NSW grid energy. The 0.88 value has been used in calculating the revised greenhouse emissions in **Table 10**, pg 26.

Greenhouse Impacts

Submission

The EA contains qualitative predictions of greenhouse emissions but doesn't contain any discussion of greenhouse impact of those emissions.

Response

Determining the actual impact of the greenhouse emissions of the project on the environment is difficult. The standard approach in EA's is to compare the emissions to local, state and national emission predictions. However, this doesn't measure impact of the emissions.

As the earth's atmosphere circulates globally the potential impacts of the project will have to be determined from a global perspective.

The following has been calculated based on data from the Carbon Dioxide Information Analysis Centre of the US Department of Energy. During the period of 1950 to 2006 for which data was available the annual total global CO_2 emissions (tCO_2) can be divided by the annual global change in CO_2 concentration (ppm) and correct for three years of significant volcanic activity (1964, 1982, and 1992). This gives an emission mass of 14,138MtCO_2 for every 1ppm global increase in the concentration of CO_2 in the atmosphere.

There has been an approximate 120ppm increase in CO_2 concentrations in the atmosphere in the last 150 years, from 280ppm to 400ppm. According to the IPCC, in the same period global average temperatures have risen around 0.8^{o}C. For impact calculation purposes, this gives approximate values of:

- 14,138MtCO_2 per 1pmm global increase on CO_2 concentration;; and
- 150ppm per 1^{o}C global temperature rise.

The current estimated mass of CO_2 in the global atmosphere is around 3.1×10^{12} tonnes. The EA reported an estimated 165,971,970 tC0_2-e for the entire 18 years project life for Scope 1, 2 & 3 emissions compared to 8,109,009t CO_2-e for the Preferred Project. If the above assumptions regarding increases in CO_2 are accepted and that for the case of this calculation, CO_2-e can be used in the place of CO_2 concentrations, the project would contribute the following to global climate change:

- a 1.18% contribution to a 1ppm rise in CO_2 (or equivalent) for the EA compared to a 0.06% contribution from the Preferred Project; and

- a 0.008% contribution toward a 1°C global temperature rise over the 18 year life for the EA or a 0.0004% contribution from the 5 year Preferred Project.

NOTE: This is a conservative calculation as it doesn't take into account that methane only has a 12 year average residence time in the atmosphere, compared to 100 years for CO_2. To try to determine the specific impact on the local or global environment as a result of this scale of emission is beyond the scope of most models.

A full recalculation of the Preferred Project greenhouse gas emissions is contained in **Section 2.1.1.3**, pg 25.

2.4.3 Greenhouse Gas Management

Fugitive Emissions

Submission

There is no commitment in the application to ensure fugitive emissions are monitored or harnessed.

Response

NRE is in the process of obtaining and installing sensors in all exhaust fans and air intakes to monitor the precise volumes of greenhouse gases emitted. For each fan/duct NRE will continuously measure flow, pressure, temperature and moisture. In addition to these parameters the system will also sample gas from each fan/duct, measuring Methane (CH_4) and CO_2 percentages. The gas sampling is done in a cycle, i.e. one fan/duct sampled at a time. These measurements will be input into the CO_2-e calculation (as defined by NGER) which will provide a CO_2-e tonnes/sec output for each fan, as well as a total for each extraction site. This CO_2-e tonnes/sec rate will be used to calculate hourly, daily, monthly and yearly emissions totals in tonnes CO_2-e. The system will also keep record of the corresponding previous hour, day, month and year totals. Similarly, the system will also calculate the volume of CH_4 m^3 and CO_2 m^3 for each fan extraction site. This will allow NRE to rely on actual data to determine the most effective emissions reductions actions it can pursue to reduce greenhouse gas emissions and NRE's Carbon Tax liability.

Management Measures

Submission

The EA also lacks detailed descriptions of the measures that would be implemented to ensure the project is energy efficient. Energy audits should be undertaken and additional information is required including the incorporation of energy efficiency into the procurement process for fuel and electrical powered equipment and estimated energy savings from maintenance regimes, haulage route changes or productivity improvements. NRE should also include measures that would be required as part of the Commonwealth's Energy Efficiency Opportunities program. NRE must demonstrate why pre and post drainage and VAM technologies are not proposed to be used in the proposal considering the volumes of methane likely to be generated by the proposal?

Response

It was a conditional requirement of the Preliminary Works Pt3A approval which NRE anticipates will be subsumed into the current proposal should approval be given. The AQGGMP is a much more adaptable and effective method for managing greenhouse emissions than making up front commitments in a general application. NRE is still in the process of more accurately quantifying emissions levels to enable it move away from reliance on estimations to provide guidance on what reduction techniques should be applied. Once the data is being regularly captured and assessed, detailed proposals will be developed and incorporated into the AQGGMP in liaison with DPI, EPA and OEH.

An example of the effectiveness of the AQGGMP is the recent implementation of two of the actions from the plan outlined below. This relates to undertaking actions to reduce fugitive emissions from old mining areas.

- The fan speed at NRE No1 Colliery's No.5 shaft was slowed down during end of October 2012 bringing down the GHG emission from No.5 shaft by approximately 35%. The total air flow was 182m^3/s (5,724,996,076m^3 / annum) but is now around 118m^3/s (3,721,248,000m^3/annum).
- In April and May 2013, NRE then installed 6 stoppings and adjusted airflow regulators in underground roadways to prevent greenhouse gas emissions from old workings entering the ventilation stream.

The two actions above resulted in a reduction of greenhouse gases in the No.5 Shaft ventilation exhaust as follows:

- CH_4 emissions were reduced from around 116,272 t CO_2-e/annum (~0.26m^3/s) to 16,417 t CO_2-e/annum (~0.037m^3/s);
- CO_2 increased from around 892 t CO_2-e/annum (~0.012m^3/s) to 10,535 t CO_2-e/annum (~0.18m^3/s)

Total changes in CO_2-e emission from No.5 Shaft ventilation as a result of the alterations to the ventilation fan speed and installation of stoppings have reduced the total CO_2-e emissions from the No.5 Shaft ventilation shaft from 117,164 t CO2-e/annum to 26,952 t CO_2-e/annum. This represents a 90,212 t CO_2-e/annum (77%) reduction in fugitive emissions from the No.5 Shaft.

Carbon Price Mechanism/Carbon Tax

Submission

It is uncertain how long the Labour Government's Emissions Trading Scheme (ETS) will remain in place, however, NRE will continue to pay the rate required under the current system until it is revoked by the new government. Under the Labour system, the ETS price was intended to revert from its current level (2013/14) of A$24.15/tonne to match the European market value in 2014/15, one year earlier than originally planned. The current approximate spot price for carbon in that market is around A$7/European Union Allowance (EUA) and contrary to the Garnaut Report, Treasury has previously forecast that the price will likely be around A$12 in 2015 at the original time of transition. This estimate is currently not supported by the European Energy Exchange Future's 2015 price for EUA which is currently priced at A$6.92. It is now likely that the ETS will be replaced with the Coalition's Direct Action policy but there may be a transition period of unknown duration between the ETS and the Direct Action framework being established. The Direct Action policy aspects relevant to this proposal include the creation of an Emissions Reduction Fund to support:

- CO_2 emissions reduction activity by business and industry. The fund will support 140 million tonnes of abatement per annum by 2020 to meet the Coalition's 5 per cent reduction target;
- provide incentives for the oldest and most inefficient power stations to reduce their emissions in an orderly manner which protects jobs, electricity prices and energy security; and
- provide incentives to support further direct action that may be required to meet the Coalition's emissions reductions targets. This may include direct action on forestry, energy efficiency, recycling and other measures as required.

As the requirement to maintain an AQGGMP will remain irrespective of the removal of an ETS and implementation of a Direct Action system, NRE will apply for grants that can be utilised to further reduce the greenhouse emissions of its activities in line with its AQGGMP processes.

Response

The Carbon Tax will end after the next election meaning that NRE won't have to do anything to manage greenhouse emissions. This is why NRE has made no significant commitment to reduce greenhouse emissions. What consideration has the company made for steep rises in the carbon price predicted in the Garnaut Report within the proposed life of this project as the result of present procrastination?

2.5 *Infrastructure*

2.5.1 Public Roads

Impact Assessment

Submission

The RMS requires additional assessment to be carried out to determine the impact of the increased heavy vehicle traffic on the useful life of the road surfaces on the haulage route. It should include vehicle details such as truck configurations, axle loadings and additional equivalent axle loadings along the haulage route. The RMS requires a copy of the SIDRA analysis used for the assessment.

Response

NRE us currently in the process of having the impact assessment revised by Cardno to take into account the 5 year life of the project and maximum anticipated road haulage rates. This information will be forwarded to RMS when it is available. However, as discussed below, NRE believes that the costs of impacts to local roads by the Preferred Project are already captured in Council rates and registration costs.

Community Costs

Submission

There will be community costs (i.e. WCC and RMS) related to damage to roads along the haulage route as a result of increased truck movements. NRE must pay additional amounts to compensate for these increased impacts.

Response

This is a NSW government policy issue as NRE's Haulage Contractor and any independent trucking sub-contractors used are required to pay registration costs for the trucks and trailers they use. Registration fees and charges are a combination of an administration fee and a tax. As stated by the RMS, "*In 2010, new vehicle classification codes were introduced which means that some vehicles are now classified under a different category. The changes establish new classifications for some larger prime-movers and all heavy trailers, with the aim to reflect the greater impact and cost that heavier freight vehicles have on the road network. Heavy vehicle charges are set nationally and are based on the principle – widely supported by industry – that heavy vehicles pay their fair share of road spending. The NSW Government is spending record amounts to build, upgrade and maintain the state's road network. The freight industry is a major beneficiary of these improvements and has acknowledged that it is reasonable to pay a fairer share of the costs*." As all trucks used by NRE to haul ROM coal are NSW registered, the money directly supports the affected RMS road infrastructure. These costs are passed on to NRE by the Haulage Contractor.

NRE also pays rates for its privately owned land which is situated entirely within the Wollongong LGA. As stated on the WCC website, "About Your Rates"

> *Council's rates and charges and why you pay rates - Rates and Charges. Our main source of income comes from rates and charges. Other funding comes through sources like government grants and revenue from investments. Your rates and*

charges help to pay for a whole range of facilities and services in the Wollongong area like:

1) *looking after our beaches, parks and sportsgrounds*
2) *collecting waste*
3) ***maintaining our roads***
4) *managing our development assessment system*
5) *running our libraries, community centres and many other programs.*

Your rates also include a Stormwater Charge to manage water quality and quantity issues, introduced in accordance with the Local Government Amendment (Stormwater) Act 2005. This applies only to residential and business rate categories, and does not apply to vacant land.

As can be seen above, NRE already contributes to the maintenance of local roads, in this case, specifically, Bellambi Lane.

The potential effect on road infrastructure of the significantly reduced project life and total transport volumes are being recalculated by Cardno and the results will be forwarded to the RMS when available.

2.5.2 Pit Top Infrastructure

Insufficient Detail

Submission Issues

There are no design specifications for the truck loading facility or a specific detailed construction schedule for the Pit Top construction works.

Response

The detailed design specifications for all items of infrastructure approved to be constructed will meet operational requirements and ensure that the noise and dust limits imposed in any approval are met. It is much cheaper for NRE to ensure infrastructure is designed to minimise impact than to have to retrofit existing equipment due to noise or dust issues. There is an indicative construction schedule in the EA for the Pit Top works in *Table 3.4, pg 52, of the EA*, however that construction schedule was prepared at a different time, under different global economic conditions and for a different proposed project.

From a practical perspective, this surface facility upgrade process will be undertaken as dictated by production requirements, global economic conditions, financial viability assessments and any other relevant issues. A CEMP will be developed in liaison with the EPA focusing on ensuring compliance with the relevant site noise and air quality criteria. The CEMP will be submitted to the DPI for approval prior to the construction of all or any part of the proposed facilities upgrade. See **Table 6**, pg 21, for more information on the Preferred Project construction times.

2.6 Noise

2.6.1 Noise Levels

Noise Levels

Submission Issues

Noise levels from the operation in the evening, particularly from the exhaust fans are unacceptable as many of the major noise sources are at a high elevation but AHD data was removed from JBK Dwg 282800. The operation of the coal stockpiles of between 315,000 and 840,000 tonnes will create too much noise.

Response

A Noise Audit was completed in December 2012 at the No.1 Colliery by PEL Pty Ltd. The results showed that NRE No.1 Colliery was in compliance with its noise limits in the Preliminary Works Pt3A with the exception of one minor unauthorised evening truck movement. Works undertaken on the mine exhaust fan have resulted in significant improvements to noise emissions and consequent complaints. NRE has not received a complaint specifically about the fan for around 8 months and neither has there been issues raised by the EPA during the same period. The AHD data was not removed from the JBK Dwg 282800 it was inadvertently left off the diagram by JBK. The data is available on other diagrams. NRE is applying to construct an additional 280,000 tonne Stockpile Area 2 (Stockpiles 2 & 3), in addition to the existing 80,000 tonne (Stockpile 1) in the already approved Stockpile Area 1. This is a total of 360,000 tonnes. The reference to the range of 315,000 to 840,000 tonnes is based on alternative options that were explored and not pursued but were included in the EA to show the considerations that had been undertaken in arriving at the current preferred option as required by *Clause 7(c) of Schedule 2 of the Environment Planning and Assessment Regulation 2000*. Noise modelling was undertaken based on the operation of the total 360,000 tonne final stockpile area.

A number of complaints were received from a Midgley St resident in night time periods during the winter of 2013. The location of the complaint corresponds roughly with the sensitive receiver location C3 in **Figure 72**, pg 258. NRE immediately activated the incident response procedures in its Noise Management Plan (NMP) following the process outlined in red on **Figure 71**, pg 250, and determined that the issue was caused by hard igneous dyke material impacting on metal parts of the conveyor system and hitting stockpile material when falling from the conveyor gantry. When these events occurred they caused temporary exceedances of the Colliery's noise limits. Prevailing calm and cold weather conditions with the likely presence of either a temperature inversion or katabatic flow from the escarpment exacerbated the transmission of noise. At the time, a newsletter was also provided to surrounding residents to advise them of the noise issues with the igneous material.

NRE is undertaking noise mitigation on the conveyor and has engaged an industrial acoustic engineer to provide advice on other options to reduce noise emissions from existing infrastructure. The attended noise monitoring is continuing in liaison with DPI to determine the baseline operating noise levels at night during the winter/autumn period to provide data for further assessment of the noise levels and potential actions that may need to be undertaken by NRE and DPI.

Current activities are quieter than any historical operation of the Colliery, as NRE are using almost entirely new surface infrastructure when compared to previous owners and no longer operates a washery on the site. Washeries in particular are known for producing low frequency vibration. Given the older design of historical operations and the presence of a washery it is conceivable that noise from the site could have been RBL + 10 and higher than present. Given the infrequent but observed katabatic drainage flows of 2m/s from the escarpment and possible but unconfirmed potential for inversions there are likely to be occasions in which noise levels are transmitted more clearly from site although this is unlikely to be a regular occurrence.

Rather than specify a PSNL for the project NRE believes that reasonable and achievable noise criteria should be set in liaison with the DPI and EPA. Further, through its NMP and EPL, NRE can continue to work with DPI and EPA to implement best practice noise management measures to continue to reduce noise emissions with an aspirational goal of reaching the agreed appropriate LA_{eq} as set out in *Table 2.1 of the INP*.

2.6.2 Noise & Vibration Modelling

Adequacy Issues

Submission

Matters raised in the EPA submission on the Draft EA dated 28 March 2011 must be confirmed as having been addressed.

Response

NRE is unable to locate the EPA submission referred to either in its files or on the DPI website. As such NRE cannot determine if the EA has or has not addressed the issues raised in the submission.

Background Noise Monitoring

Submission

The noise assessment methodology for determining the background noise levels for the project was limited to 28 days in December 2009. There should have been a reassessment of background noise levels in 2012 to ensure background noise levels were up to date.

Response

The Rating Background Level of the proposal was undertaken in accordance with Section 3 of the EPA's INP and is outlined in *Section 4, pgs 16-20, of Annex H of the EA*. This section only requires 1 week's representative background data. The EA provided 1 month of background data. This background level was taken prior to the approval of the Preliminary Works Pt3A and the operations it allowed which are now part of the background noise. The background level now would be significantly higher if the baseline noise assessment was reassessed in 2012 and there is a case for this to be considered by DPI in assessment of the Preferred Project.

Project Specific Noise Level (PSNL)

Submission

The EA indicates that the PSNL will be exceeded by 2 dB(A) at sensitive receivers in the evening but that the level can be met by further possible noise reductions. The modelling of road traffic noise for peak transport activities will increase the average and peak road traffic noise levels at a number of receivers and will therefore exacerbate existing exceedance of ECRTN criteria. There are no proposals in the EA to mitigate the impact of the exceedances and these must be provided. The EA must address what feasible and reasonable methods will be used to achieve the PSNL noise level during both construction and operation of the project. The proponent must submit a noise model with the modelling result and the duration of both the construction and operation stages of the project. The construction modelling relies on the Interim Construction Noise Guideline (ICNG) which is not appropriate to mining.

Response

1. – *Section 8.1.1, pgs 30-31, of Annex H of the EA* predicts that there will likely be ≤ 2 dB(A) exceedance of the PSNL at three residential premises due to operational noise, exceedance of between 2.5 to 3 dB(A) at two residential premises due to peak truck movements and exceedances of up to 5 dB(A) at numerous receivers during construction. In this case NRE will follow the process as shown in *Figure 1.2 of the INP*. given that

   a. NRE No.1 Colliery is an existing site undergoing upgrade;
   b. the modeling of traffic noise is based on maximum possible truck movements; and
   c. where the PSNL is exceeded but the exceedances are ≤ 5 dB(A);

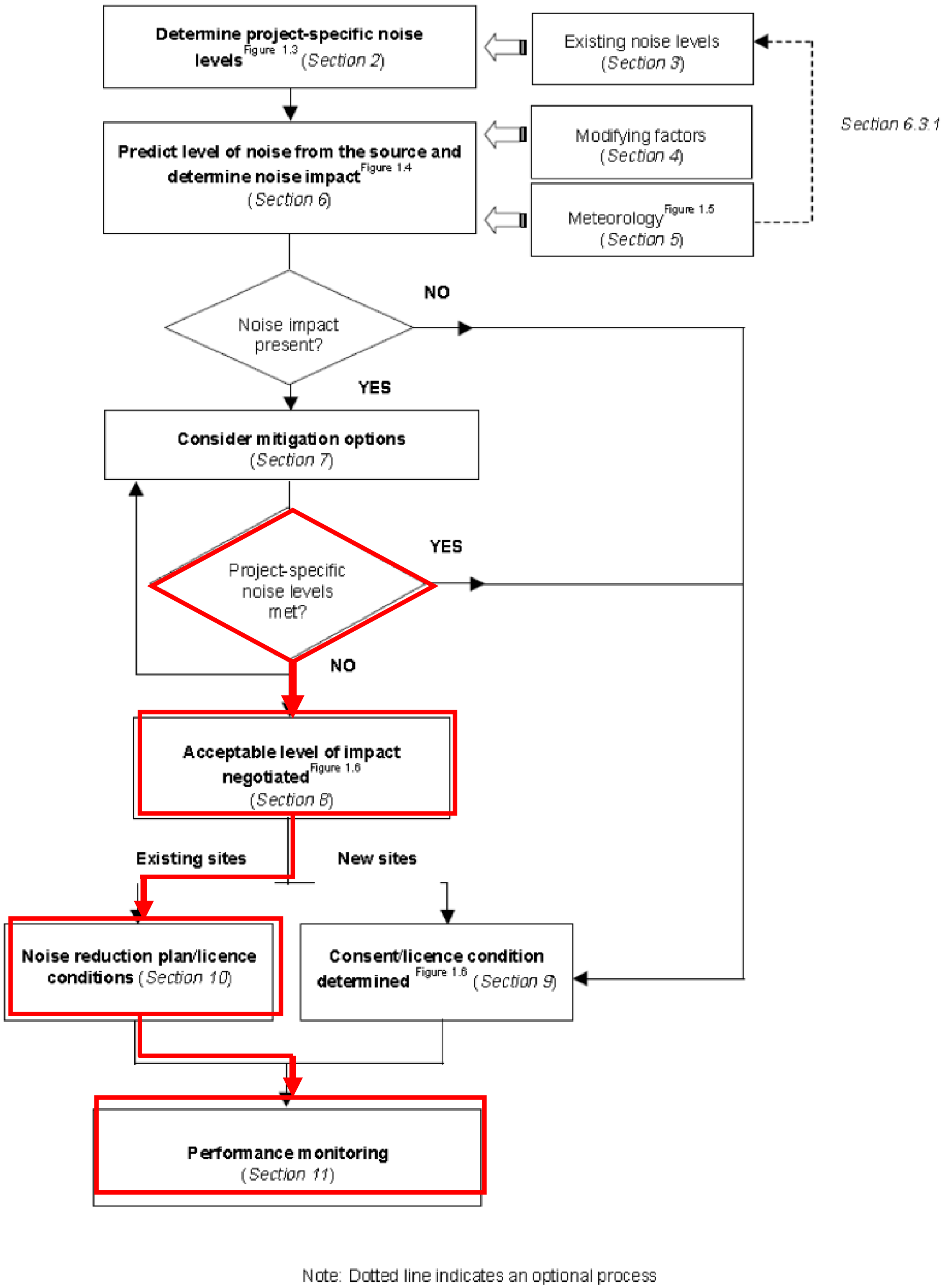
   A copy of *Figure 1.2 of the INP* is reproduced in **Figure 71**, pg 258, showing the pathway (outlined in red) that NRE will follow to manage any exceedances of the PSNL. This will include the use of a NMP that incorporates any conditional requirements from both the sites EPL and any DPI conditions of approval. This approach is entirely consistent with the INP and doesn't require any additional remodeling.

   Sections 9.7.1, pgs166-167, and *9.7.2, pg 167, of the EA* advise that NRE has an existing NMP for the No.1 Colliery and this will be amended to incorporate further noise mitigation options aimed to reduce the likelihood of any exceedance of the PSNL to acceptable levels. The NMP is a live document with undertakings to respond to immediate noise issues as soon as is practical as well as containing programs for longer term noise management. The NMP will be updated in liaison with the EPA and DPI during the Annual Review process which forms part of all modern Major Project approvals. This review process will be informed by any conditions of approval, data from the real time noise monitoring system that will be established by the end of September 2013, feedback from agencies and community complaints.

   The EA discussed the justification for choosing the ICNG instead of the INP as the basis for setting compliance criteria for construction in *Section 5.4, pgs 23-24, of Annex H of the EA*. NRE still accepts the justification for the use of these criteria. The noise assessment doesn't predict any exceedances at sensitive receivers as a result of construction activities on the site. Irrespective of this *Section 9.7.3, pg 167,* *of the EA* also states that a CEMP, containing noise management methods and procedures will be developed specifically to manage the noise impacts of the construction of the project. As with all other management plans, this plan will be developed in liaison with the appropriate regulatory authorities, in this case the EPA and DPI.

Figure 71 - Process Followed by NRE in Addressing PSNL Exceedances

Figure 1.2. The overall process of assessing and managing noise impacts



Sleep Disturbance

Submission

The impact assessment doesn't appear to assess sleep disturbance in accordance with the Industrial Noise Policy (INP) as L_{Amax} values weren't shown. NRE must demonstrate that it has considered sleep disturbance appropriately.

Response

The assessment of sleep disturbance was undertaken in accordance with the INP and its accompanying Application Notes. All sensitive receivers were assessed against the $L_{A1, 1min\ dB(A)}$ criteria that is accepted, along with $L_{Amax,}$ as an appropriate measure of sleep disturbance potential. The outcomes of the assessment are located in *Section 5.2, pg 22,* and *Section 8.1.2, pg 31, of Annex H of the EA,* replicated in *Section 9.3.2, pg 157,* and summarised in *Section 9.5.2, pg 161, of the EA*. Below is an excerpt of the section of the EPA's online INP Application Notes related to sleep disturbance with the section regarding acceptability of the use of the $L_{A1, 1min\ dB(A)}$ criteria outlined in bold.

> *"Research on sleep disturbance is reviewed in the NSW Road Noise Policy. This review concluded that the range of results is sufficiently diverse that it was not reasonable to issue new noise criteria for sleep disturbance.*
>
> *From the research, the EPA recognised that the current sleep disturbance criterion of an LA1, (1 minute) not exceeding the LA90, (15 minute) by more than 15 dB(A) is not ideal. Nevertheless, as there is insufficient evidence to determine what should replace it, the EPA will continue to use it as a guide to identify the likelihood of sleep disturbance. This means that where the criterion is met, sleep disturbance is not likely, but where it is not met, a more detailed analysis is required.*
>
> *The detailed analysis should cover the maximum noise level or LA1, (1 minute), that is, the extent to which the maximum noise level exceeds the background level and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the NSW Road Noise Policy. Other factors that may be important in assessing the extent of impacts on sleep include:*
>
> - *how often high noise events will occur*
> - *time of day (normally between 10pm and 7am)*
> - *whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods).*

The LA1, (1 minute) descriptor is meant to represent a maximum noise level measured under 'fast' time response. ***The EPA will accept analysis based on either LA1, (1 minute) or LA, (Max)****."*

Cumulative Impact

Submission

The impact assessment doesn't take into account the cumulative noise impact of existing industry in the area as the impact of the existing industry is not quantified.

Response

The cumulative impact of existing industrial noise sources was addressed in accordance with the existing INP requirements. There is discussion of the assessment of cumulative noise impact in *Section 10, pg 43, of Annex H of the EA* and in *Annex B to Annex H of the EA*. The INP allows assessment of potential noise impacts associated with existing and future developments by defining appropriate noise emission criteria with regard to preserving residential noise amenity. These amenity criteria are set out in *Table 2.1 of the INP*. The cumulative impact of this project was assessed in relation to preserving the residential noise amenity. *Table 2.2 of the INP* sets modifications to the acceptable noise level to account for existing level of industrial noise if those noise limits are close to the amenity criteria before taking into account the projects contribution. As shown in *Table 9.4, pg 156, of the EA* the predicted intrusive noise levels for this project are below 50 dB(A) $L_{Aeq,\ 15min}$ during daytime periods, 45dB(A) $L_{Aeq,\ 15min}$ during evening periods and 40 dB(A) $L_{Aeq,\ 15min}$ during night periods. As such the cumulative $L_{Aeq,\ Period}$ noise emission would not add to the existing noise levels and would comply with all relevant INP amenity criteria.

Meteorological Data

Submission

Using data from the Bellambi Automatic Weather Station which is located on a coastal headland is not appropriate for an escarpment site as the Bellambi AWS will be subject to different conditions such as sea breezes that will not affect the site. Wind speed data from this Station doesn't meet the Australian Standard 3580.14 for sample frequency or duration. The construction and operational noise impact assessment must be remodelled under adverse weather conditions and incorporate 3m/s katabatic wind flows.

Response

The Bellambi AWS is located approximately 3.5km ESE of the Colliery and provides a very close source of long term local weather data and therefore is suitable to inform the modelling of prevailing weather conditions on the site. The INP Application Notes state that "*The EPA has previously accepted (and will accept) noise predictions based on modelling noise emissions using long term weather data, as it can present a higher level of analysis than that required under the INP.*" NRE can't control the frequency or length of time that the wind is measured at the Bellambi AWS. If the EPA has concerns about this it would benefit all parties if they were to raise this with the Department that operates the AWS to ensure sampling meets Australian Standards. Irrespective of the EPA's concern regarding the AWS and its sampling regime, there is no mention of Australian Standard 3580.14 in the INP or its Application Notes. Based on the above, NRE believes that the Bellambi AWS data is suitable for use in the assessment based on both its proximity to the site and its long term data set.

Section 5.3.2 of the INP contains guidance as to how to model wind affects in noise assessments and states that "*Where there is 30 per cent or more occurrence of wind speeds below 3 m/s (source-to-receiver component), then use the highest wind speed (below 3 m/s) instead of the default.* ***Where there is less than a 30 per cent occurrence of wind of up to 3 m/s (source-to-receiver component), wind is not included in the noise-prediction calculation***." The data from the Bellambi AWS indicates that in the general area there are no prevailing winds that meet the INP criteria for inclusion in noise modelling.

Section 5.2 of the INP under the heading *Applicability of drainage-flow wind* gives guidance on the need to include katabatic flows to the modelling of noise from a site. It states, "*The drainage-flow wind default value should generally be applied where a development is at a higher altitude than a residential receiver, with no intervening higher ground (for example, hills). In these cases, both the specified wind and temperature inversion default values should be used in the noise assessment for receivers at the lower altitude*."

In *Section 4.3, pg 18, of Annex H of the EA*, meteorological data was used to undertake an Inversion Analysis Summary based on the occurrence Pasquill-Gifford Stability Class for the winter evening and night periods. The analysis followed the process contained in *Section 5.2 of INP* and, as shown in *Table 4.5, pg 20, of Annex H of the EA*, determined that the frequency of occurrence of F and G atmospheric stability categories is less that 30% of winter evening and night time periods. Therefore, the effects of temperature inversions were not considered in the noise modelling for the EA. As part of its continuous noise and air monitoring system, NRE will be installing a weather station capable of detecting inversions.

In *Section 4.3, pg 18, of Annex H of the EA*, ERM assessed the location of the primary noise sources in the project proposal and determined that the majority of the noise impacts were located at low elevations and the intervening topography between the noise sources and the southern residents were not conducive to drainage flows. As such it wasn't considered necessary to include katabatic drainage flows in noise modelling. Recent evidence from winter monitoring by DPI and NRE may indicate that the impact of katabatic flows, and possibly also temperature inversions, should have been modelled.

<u>Modelling Omissions</u>

Submission

The noise modelling undertaken didn't include exhaust fans, the Wongawilli conveyor, the Bulli Balgownie conveyor, the conveyor diversion, or the trucks (either on site or Bellambi Lane) yet it includes the effects of the noise barriers that are now not intended to be erected. The noise modelling should be redone with the barriers removed. Justification is required as to what additional noise mitigation will be installed in their place It appears that dozers will be working on top of 31m stockpiles. If this is the case then noise impacts will be significant.

Response

The ventilation fan and outlet was considered in the assessment of noise from the operation. Since the assessment in the EA the original 40 m^3 twin axial mine exhaust fan at the Pit Top has been replaced by two 90m^3 ventilation fans. On 3 September 2012 a noise assessment of the new $90m^3$ ventilation fans was undertaken by BGMA Pty Ltd which compared the findings against the original sound pressure level from the $40m^3$ fan. The noise report is located in **Attachment E**, pg 618. In summary the outcomes of the assessment were:

> *"Based on frequency dependent air absorption, distance the "neutral" atmospheric profile, the predicted sound pressure to the nearest residences in Russell Vale is 30 dB(A). This is a drop of 2.5 dB(A) at the community receivers.*
>
> *The eastern edge of the workshop platform forms a barrier contributing a further reduction of about 10 dB. Adverse atmospheric conditions could accentuate the noise levels up by 1.5 to 5 dB(A).*
>
> *Under "neutral" conditions the predicted level is 20 dB(A) but under "adverse conditions", the predicted level is 25 dB(A).*
>
> *Based on frequency dependent air absorption, distance the "neutral" atmospheric profile, the predicted sound pressure to the nearest residences in Corrimal is 36 dB(A). This also is a drop of 2.5 dB(A) at the community receivers.*
>
> *The topography form forms a barrier contributing a further reduction of about 10 dB. Adverse atmospheric conditions could accentuate the noise levels by 1.5 to 4 dB(A).*
>
> *Under "neutral" conditions the predicted level is 26 dB(A) but under "adverse conditions", the predicted level is 30 dB(A).*
>
> *Measurement and calculations indicate that the two (2) 90 m^3 mine exhaust fan are operating within required noise constraints, and that they will not adversely impact on the acoustic amenity of the local community."*

Section 6.1, pg 26, of Annex H of the EA gives acoustic design parameters for ventilation fans, dozers, new conveyors, existing conveyors and associated equipment. *Section 7.3, pg28, in Annex H* of the EA clearly states that these values were used to inform the model. The sound walls were included in the modelling but a proposed noise bund to the south of the site was not included to ensure that the modelling was conservative. Since the preparation of the EA, NRE has been advised by both independent consultants and DPI noise professionals that the sound walls would have very little impact on noise attenuation in the proposed locations. This is why NRE requested the modification of the Preliminary Works Pt3A to remove the walls and undertook to implement the findings and recommendations of an independent noise audit. The removal of the walls from the modelling in this EA would not make a significant difference to the outcome given its already conservative modelling and the negligible contribution the walls make to noise management.

Dozers will not be working on the top of a 31m high coal stockpile. The system is designed with a subsurface reclaim tunnel that is gravity fed. The only time that dozers will be required is when the central section of the coal stockpile has been reclaimed and sections around the edges need to be pushed into the reclaim tunnel. This will require dozers benching the coal to less than 15m high and pushing coal into the reclaim tunnel.

Vibration

Submission

The assessment of vibration is inadequate, not based on any data and doesn't comply with NSW Guidelines.

Response

Section 5.5, pg 25, of Annex H of the EA sets out the intermittent vibration criteria from *Table 2.4 of the Environmental Noise Management – Assessing vibration – a technical guideline (DECCW 2006)*, that are applicable to the effects on residences from the passage of heavy vehicles. There is no Australian Standard for perceptions of vibration but **Table 62**, pg 255, below shows vibration levels and general human perceptions as per the *German Standard DIN 4150-1975, Part 2 – Vibrations in Buildings – Influence on Persons in Buildings*.

Table 62 - Vibration and Human Perceptions of Motion

Approximate Vibration Levels (mm/s)	Degree of Perception
0.1	Not felt
0.15	Threshold of perception
0.35	Barely noticeable
1.0	Noticeable
2.2	Easily noticeable
6.0	Strongly noticeable

The Australian Standard (AS) 2670.2–1990, Evaluation of human exposure to whole body vibration, Part 2: Continuous and shock induced vibration in buildings outlines levels of vibration that may cause adverse comment. These levels are shown in **Table 63**, pg 255, below.

Table 63 - Human Exposure Vibration Criteria – Peak Particle Velocity (PPV) Building Vibration Levels in Combined Direction

Type of Building Occupancy	Continuous/Intermittent Vibration (mm/s)	Transient Vibration Excitation with Several Occurrences per Day (mm/s)
Residential - Night	0.2	0.2-2.8
Residential - Day	0.3-0.6	4.2-12.7
Office	0.6	8.5-18.1
Workshop	1.0	12.7-18.1

There is no current Australian Standard for structural damage safe limits for short term vibrations, however the *German Standard DIN 4150-1999, Part 3 – Structural Vibration in Buildings – Effects on Structures (DIN 4150)* addresses impacts from construction vibration. The limits are presented in **Table 64**, pg 256.

Table 64 - Structural Damage Safe Limits for Building Vibration

Group	Type of Structure	Vibration Velocity (PPV) in Any Direction (mm/s) At foundation at a frequency of		
		<10Hz	10-50Hz	50-100Hz
1	Commercial, industrial or similar buildings	20	20-40	40-50
2	Dwellings and buildings of similar design and/or use	5	5-15	15-20
3	Structures that, because of their particular sensitivity to vibration, do not correspond to 1 or 2 and have intrinsic value (e.g. buildings under a preservation order)	3	3-8	8-10

As stated by ERM in *Section 9.6.3, pg 166, of the EA*, historical assessments for similar vehicle movements and receiver offset distances of around 10m, the vibrations experienced at this distance are expected to be less than 0.2mm/m. It is therefore likely that any vibrations experienced at residences along Bellambi Lane will only be at the threshold of perception and unlikely to cause adverse comment.

2.6.3 Noise Mitigation

Pit Top Noise Mitigation

Submission

NRE should be required to erect the three noise barriers and other noise mitigation actions as undertaken in the EA. This is despite the removal of these barriers from the Preliminary Works Pt3A.

_*Response*

Based on advice from both DPI noise professionals and respected noise consultants, NRE does not believe that erecting the noise barriers as proposed is the most effective method of reducing noise. NRE will utilise the existing NMP process to ensure that appropriate actions are implemented to meet specific noise criteria that are determined as appropriate for the operation. For more detail on NRE's position on the noise walls see the response to Modelling Omissions in **Section 2.6.2** of this RTS document.

Pit Top Noise Mitigation

Submission

Due to the proposed increase in trucking to a peak rate of up to 682 movements per day there will be an impact on residential receivers especially along Bellambi Lane. As such DPI must put in place a condition limiting truck compression braking in residential areas.

Response

NRE already has a policy to limit compression braking along its haulage route in *Section 12.4, pgs 204-205, of the EA* and *Section 9.7.2, pg 167, of the EA* recommends the use of a NMP to continue to manage impacts from road traffic noise, including compression braking. This has been included in Section 6.1.4 of the NMP. It is addressed in more detail in the Sections 6.2 and 6.7 of the current NRE No.1 Colliery Traffic Management Plan which also includes a copy of the current Drivers Code of Conduct (DCC). Compression braking is addressed in *Sections 6, 7, 8, 10 and 12 of the DCC*. NRE believes that the management plans are the appropriate place to deal with these issues.

The voluntary 50km/hr speed limit for coal haulage trucks will continue to apply. Condition 11 of the approval of theLW4 & 5; MG6, 7 & 8 Pt3A modification to the existing Preliminary Works Pt3A application required the addition of a Condition 28A in the Preliminary Works Pt3A approval requiring that approach WCC to have the statutory speed limit along Bellambi Lane to 50kmhr reduced. Wollongong City Council was approached and is not in favour of a speed reduction for the following reasons.

- Council has no authority to alter any speed limit on public roads;
- Bellambi Lane connects directly with Pioneer Road and the Princes Highway, both of which are 60 kph roads;
- Bellambi Lane is a 4 lane road where drivers expect a 60 kph limit, and most would find it difficult to keep to a lower speed limit with the existing road geometry;
- Bellambi Lane provides direct access to Memorial Drive, a limited access road with an 80 kph speed limit; and
- Bellambi Lane has no properties with access on the east bound carriageway

As a result of the WCC position, the matter has been forwarded to Roads & Maritime Services for their consideration.

Figure 72 - Sensitive Receiver Locations

2.7 Rehabilitation

2.7.1 Rehabilitation Detail

Insufficient Detail

Submission

There was no detailed conceptual post rehabilitation landform plan, detailed description of conceptual final land use, project specific rehabilitation objectives, or strategic completion criteria such as Decommissioning; Landform Establishment; Growth Media Development; Ecosystem Establishment; and Ecosystem Development. There is no commitment to rehabilitate any area that is impacted by this mine proposal.

Response

See **Section 2.1.2**, pg 35, for full details on the conceptual rehabilitation plans for NRE No.1 Colliery.

2.8 Surface Water

2.8.1 Flooding

1998 Flood Event

Submission

The new stockpiles will be washed away in a similar manner to the 1998 Flood event if Bellambi Gully is not realigned.

Response

NRE has undertaken a full investigation of the 1998 Flood event. This is contained in **Attachment G**, pg 626 . As seen on **Figure 76**, pg 263, Bellambi Gully Creek runs to the south of Stockpile Area 1 and then passes beneath Stockpile 1 via an 1800mm diameter concrete pipe culvert and then reorients toward the east. Recently the two (2) operational conveyors (Bulli and Balgownie conveyors) from the original mine operations were removed however the concrete apron on which these conveyors operated remains in place. **Figure 73**, pg 260 shows the removed conveyor alignment and the junction of the culvert (M3 culvert) with this alignment as it currently exists.

Figure 73 - Concrete Apron and Location of the M3 Culvert

A deep drain on the western side of the road transfers surface stormwater down this alignment towards the stockpile. In most rainfall events the drain contains the stormwater and directs water to a clean water collection point which in turn is directed via a 600mm diameter pipe to Bellambi Gully Creek.

The Bellambi Gully Creek upstream of the 1800mm diameter pipe culvert has been divided into three areas as follows:

- **Upper Bellambi Gully Creek** occurring uphill of the pit top area;

- **Middle Bellambi Gully Creek** from the pit top area and the culvert beneath the concrete apron (M3 culvert); and
- **Lower Bellambi Gully Creek** from the concrete apron and the existing headwall for the 1800mm pipe that currently drains flows from the Bellambi Gully Creek under the Stockpile Area 1 to the culvert beneath the Princes Highway.

Bellambi Creek flows from the end of 1800mm pipe, under the Princes highway, past several industrial premises, under the northern distributer, through residential streets, under the railway line, through the Holy Spirit High School's grounds, and then flows out into the ocean. The creek is comprised of culverts under main transport structures and roads, or disturbed creek beds through urban areas. According to the WBM Oceanics Australia report completed for Wollongong City Council in June 2005, the Bellambi Creek catchment area is approximately 427ha and the total creek length is 4.3km (Beca, 2011).

The Bellambi Gully Creek upstream of the 1800mm diameter pipe culvert is a steep sided vegetated gully with trees and large submerged boulders being evident. There is evidence of accumulation of rubble and debris in the invert of the gully.

During August 1998, the Illawarra region experienced a major storm event, which records for the Colliery indicate was in the vicinity of a 100 year average recurrence interval (ARI) event. Although, the existing site had diversion drains and a piped system, the storm water system failed and resulted in diversion of clean water through the coal stockpile causing considerable environmental damage downstream (Beca, 2010).

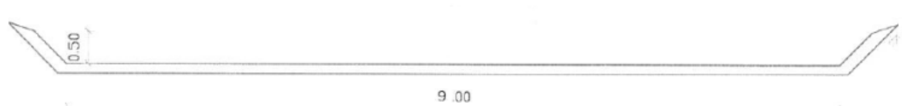
The extreme rainfall events of August 1998 resulted in major erosion and landslips along the Illawarra Escarpment upslope of our operations. The effect of this was that the headwaters of Bellambi Gully Creek carried the stormwater and associated debris for a period of time until it silted up and overflowed the bank at the M3 culvert. The stormwater and associated debris then travelled down to existing ROM stockpile at that time which became unstable and fluidised to the extent of being washed down Bellambi Lane and contaminated Bellambi Creek (Allied Bellambi Collieries Pty. Ltd, 1998 and communication with Don Jephcott).

NRE is proposing following actions to prevent a re-occurrence of this event:

- Improvement works to the M3 Culvert. The design options under consideration for these improvement works are either:

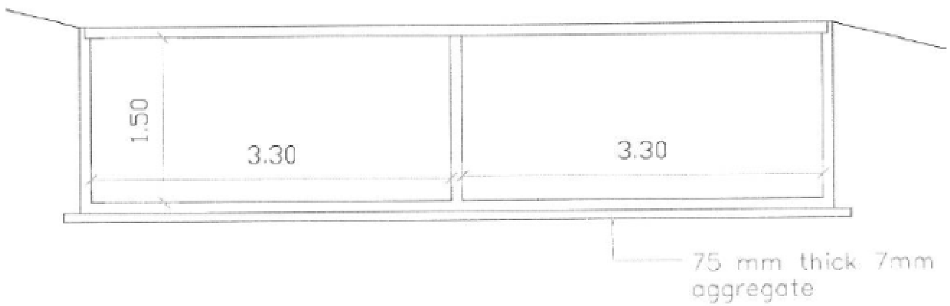
a. Increase the diameter of pipe culvert and install an overflow path during in the event of pipe blockage with capacity of a 1 in 100 year rain event. The overflow path will also allow vehicles to pass. Additional work would be required to transition flows from this overflow path into the steep section of the lower Bellambi Gully Creek. A typical cross section of the overflow path is shown in **Figure 74**, pg 261.

Figure 74 - Cross Section of the Overflow Path



b. An open culvert with sufficient cross section to allow large debris to pass through the culvert i.e. not become fully blocked and has a freeboard of 500mm above the 1 in 100 flow conditions. The culvert will provide for vehicle access and have open sections on either side of the vehicle path for clearing the culvert with excavation machinery. A typical cross section of an open culvert is shown in **Figure 75**, pg 262.

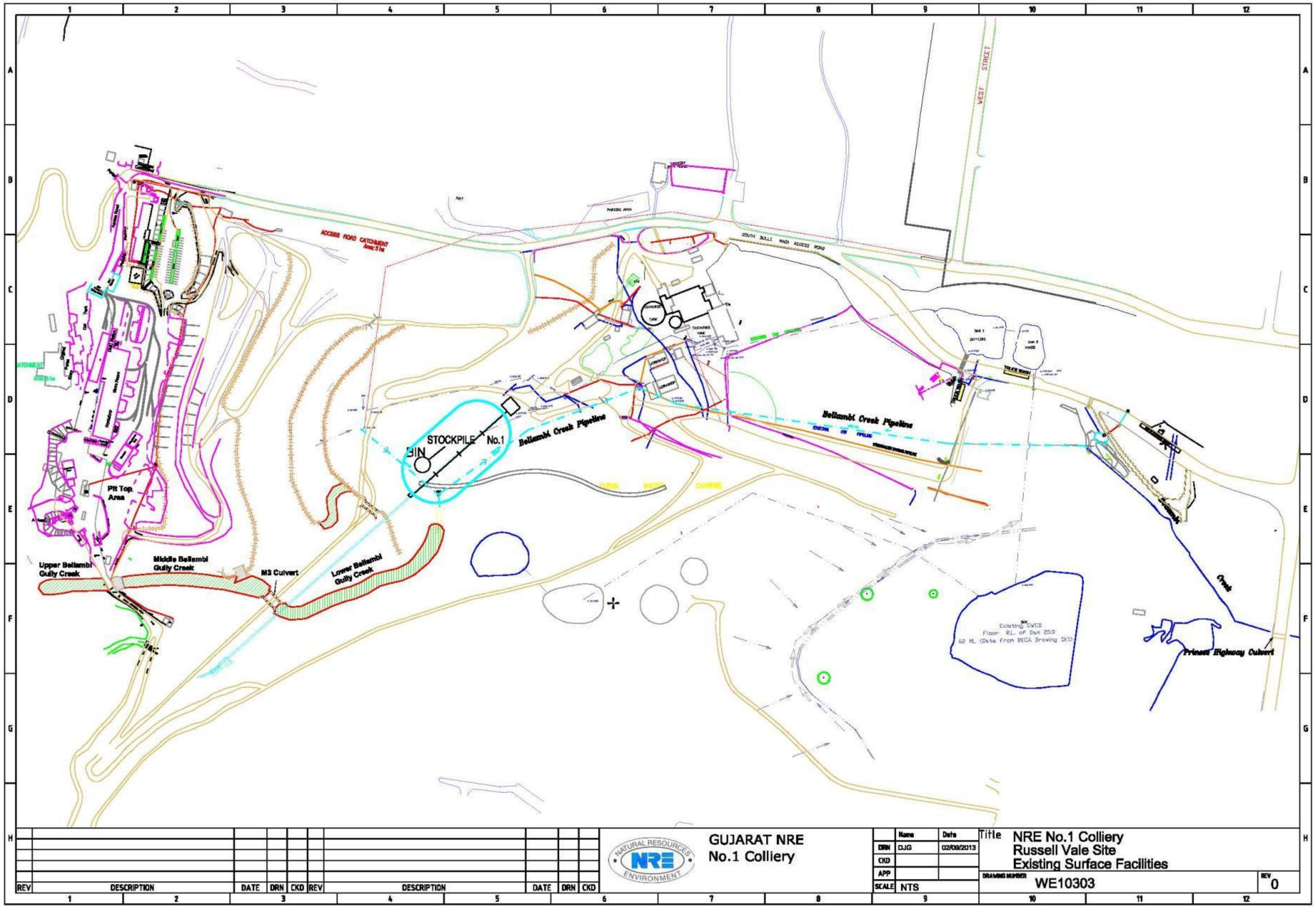
Figure 75 - Cross Section of an Open Culvert



- NRE will review and revise the current Surface Facility Water Management Plan to identify and implement further mitigation measures to Bellambi Gully Creek if required.

The piped section of Bellambi Gully beneath the coal stockpile did not block or overflow during the 1998 Flood. NRE is currently designing an improvement to the culvert to prevent any recurrence of the 1998 incident. All evidence available to NRE suggests that there is no need to realign Bellambi Gully to reduce the risk of a repeat of the 1998 event. As such NRE will not be realigning Bellambi Gully Creek and would request the DPI remove this condition from any approval given for the Preferred Project. Irrespective of cause, NRE will be liable for cleanup of any coal or other operational material from site and as directed by any authorised NSW Government agency.

Figure 76 - Current Coal Surface Facilities and Bellambi Gully Creek



Downstream Flooding

Submission

The EA contends that the culvert under the Princes Highway only has the capacity for a 1 in 10 year ARI storm event but this has not been confirmed in the EA nor has any effort been made to calculate the contributory downstream flood potential from the non-clean areas of the Pit Top overflowing the Dirty Water management system.

Response

The assessment of the inadequacy of the Princes Highway culvert is based on site inspections by BECA that confirmed the dimensions of the culvert to be only 2.4m wide x 1.5m high. The detail of this observation was included in *Section 5.3, pg 37, of Annex B of the EA*. The concern was reiterated in greater detail on *pgs 18-19, of Appendix A of Annex B of the EA.*

2.8.2 Water Audit

Water Audit

Submission

NRE must have a full water audit to determine volumes of potable and non-potable water used and the sufficiency of the water management infrastructure to manage flood events. Of particular concern is the design of the water management system for only a 1 in 10 year event.

Response

A full review of the site's current and predicted future water balance was undertaken as part of the EA. This review is provided in detail in *Annex B of the EA*. An updated water audit will be undertaken if required, as part of the review of the site's SFWMP in liaison with DPI, OEH, NOW, DRE and WCC.

2.8.3 Water Quality

Characterisation of Water Quality

Submission

The water discharges from the project must be fully characterised and assessed given the 18 year life of the proposal and the anticipated daily discharge of 3.1ML by the end of the project. There must be more monitoring of heavy metals due to the limited sampling done for the EA. There must be:

- more baseline data;
- further characterisation of the discharge waters (both flow and volume) including both stormwater runoff and mine water;
- assessment and consideration of the likely impacts of pollutants in the discharge water on receiving waters;
- The relevant environmental values of Bellambi Gully Creek in particular relevant NSW Water Quality and River Flow Objectives for the Illawarra; and
- identification of any proposed mitigation options in order to achieve these values, if required.

Response

Further characterisation of the background water quality is being undertaken and will be factored into future reviews of the SFWMP at the site in liaison with the EPA. The initial sampling will be undertaken at 5 locations and sampling will be undertaken for a large number of parameters including metals. The frequency will initially be fortnightly until NRE is satisfied it has captured significant data across a variety of weather conditions to allow the monitoring frequencies to be dropped back.

Pollution Potential

Submission

There is a need for more information on the Pit Top water management system as proposed in the EA, including:

- justification as to why the Pit Top and mine portal areas are considered as only having a moderate potential for the generation of polluted water;
- a need to justify the first flush volume (expressed in mm of runoff), that would be captured by the first flush system before the remainder is directed to the clean water system;
- a requirement to demonstrate that the proposed first flush system will in fact operate in that capacity;
- justification of the labelling of laydown areas as clean and what sediment control measures will be implemented in these areas to manage the large areas of bare ground;
- modelling the Dirty Water Dam using a daily water balance model to estimate runoff from the catchment areas of the dam and test the required drawdown to achieve the required overflow frequency; and
- investigate the feasibility of sealing the main Stormwater Control Dam to reduce the level of turbidity in the water leaking through the dam wall and discharging through LDP3.

Response

The reasons for the moderate pollution potential rating of the M1 subcatchment is that it is a primarily vegetated, sealed or semi-sealed area that is not used for coal processing. The likely potential for polluted runoff relates only to the unsealed areas to the south of the Administration Building around the mine entry, workshop, storage areas and ventilation fan. There have been no changes to the disturbed areas or activity levels in subcatchment M1 since the Preliminary Works Pt3A was approved and no changes are proposed as part of this application.

The overall design presented in the original EA was conceptual and more detailed work is required prior to finalising any design work on the site water management. NRE has no concern with re-characterising the M1 area as dirty water if that is required. However, if this entails changes to the site water flow regime, particularly with regard to the first flush system then this will need to be modelled and considered on the basis of the total site water management regime. At the time of the resubmission of the PPR, NRE is still remodelling groundwater and surface water flows and potential impacts in the catchment from mine subsidence. The critical element of this remodelling is the potential changes in mine groundwater inflow when compared to the original EA model.

NRE's preference is to incorporate a more detailed design of proposed changes to the sites stormwater system into an update of its existing SFWMP as part of any approval that is given for the following reasons:

- the surface facilities upgrade will not occur immediately and as such the stormwater system does not need to redesigned and reconstructed across the whole site at once;
- there is no proposal to change to the activity levels and use of the M1 area or increase its disturbance footprint from the Preliminary Works Pt3A approval;
- NRE currently complies with its EPL limits;
- any changes to the flow paths from the M1 area may have potentially large capacity implications on the downstream dirty water management system;
- water modelling data will be available for predicted mine groundwater make;
- detailed design can be undertaken to ensure the entire system can manage the predicted flow levels in either the dirty or clean water systems; and
- the system can be designed in liaison with the EPA.

The following issues raised by DPI's independent surface water report, can easily be addressed as part of the site's SFWMP including:

- reassessment of the Pit Top and mine portal area's potential for the generation of polluted water;
- reassessment of the first flush system and exploration of potential alternatives to the existing system at the Pit Top and mine portal areas;
- if the first flush system is considered reasonable, then undertake a reassessment of the existing first flush volume (expressed in mm of runoff), that would be captured by the existing first flush system at the Pit Top and mine portal areas before the remainder is directed to the clean water system;
- demonstrate that any proposed first flush system (existing or redesigned) will in fact operate in that capacity and that the existing dirty water treatment system can handle the large additional flows that may result;
- reassessment of laydown areas to determine what sediment control measures should be implemented in these areas to manage any sediment runoff; and
- model the Stormwater Control Dam using a daily water balance approach to estimate runoff from the catchment areas of the dam and test the required drawdown to achieve the required overflow frequency.

NRE is currently in discussion with the EPA to determine the best way to manage turbid water from the Stormwater Control Dam discharge point. The discharge passes through an extensive wetland prior to joining the LDP2 discharge flow at the Princes Highway culvert. A Pit Top water monitoring regime has been implemented and initial testing of the water flowing through LDP3 shows the turbidity from the Stormwater Control Dam being at around 4.4 Nephelometric Turbidity Units (NTU) rising to 7 NTU on exit of the wetland. While there is no limit on the discharge from LDP3, the LDP2 limit is 50 NTU. It should be noted that this is in initial result after an extended period of dry weather and further monitoring under a variety of conditions will be undertaken. The sealing of the dam, which was designed to allow water to pass through it, is problematic and costly and would be final option to reduce turbidity issues from the dam. Based on the fact that although the EPA's preferred option is sealing of the dam, they will also consider other options that will demonstrate reduced environmental impact on Bellambi Gully Creek. As such NRE will:

- undertake water quality monitoring at the following locations:
  - in Bellambi Gully Creek upstream of the mine site;
  - at LDP2;
  - at LDP3;
  - at the V –notch weir below the wet land;
  - in Bellambi Creek just upstream of the Princess Highway culvert; and
  - in Bellambi Gully Creek at Gladstone street.
- Once sufficient data has been obtained over a variety of weather conditions, NRE will submit a report to the EPA; and
- NRE will engage a suitable consultant to review the feasibility of sealing the dam and provide alternative options that could manage the EPA's concern about turbidity in Bellambi Gully Creek.

The locations of all of the sampling points associated with the Bellambi Creek monitoring are shown in **Figure 77**, pg 268 and **Figure 78**, pg 269. NRE believes the existing SFWMP is most flexible and adaptable vehicle through which to manage the sites stormwater system.

Figure 77 - Pit Top Water Quality Monitoring Locations

Figure 78 - Offsite Bellambi Creek Water Quality Monitoring Location

Water Balance

Submission

The water balance for the Pit Top appears to have some significant shortfalls including:

- the groundwater modelling for the pumpout from the underground workings at the Pit Top appear to be based on pumping records from only one section of the mine. More pumping data is required as an input into the model to establish volumes of groundwater inflow;
- Further justification of the non-relationship between rainfall and groundwater make. It would be clearer if rainfall and inflow graphs were plotted as cumulative values against each other; and
- *Figure 10 in Annex B to the EA* appears to show that there is more than enough water for the mine's use without accessing Cataract Dam supplies but this is not reflected in the water balance.

Response

The project is now only estimated to extend for 5 years and doesn't include extraction in Wonga West, as such the potential for higher volume discharges are significantly reduced. NRE is currently remodelling the potential surface water and groundwater effects from the amended longwall layout in the Preferred Project in accordance with advice from the DPI's independent surface water and groundwater review findings. The new models will benefit from significantly improved understanding of subsidence behaviour and better baseline stream, swamp and groundwater monitoring data and will effectively characterise the mine groundwater inflow that may result from the Preferred Project. This modelling process is anticipated to take up to 3 months. Groundwater inflows as a result of the total extraction of the original proposed longwalls in Wonga East indicated a total predicted inflow of 1.4ML/day. This information was contained in *Table 21.1, pg 342, of the EA* is reproduced in **Table 65**, pg 271.

Table 65 - Predicted Mine Inflows at the End of Mining Area 4

Stage	Current Inflow (ML/day)	Predicted Wongawilli Workings Inflow (ML/day)	Predicted Wongawilli Workings Inflow ML/year
Wonga East	0.2	1.4	511
Wonga West	0.9	1.7	621
TOTAL	1.1	3.1	1131

On the assumption that the original groundwater modelling for the EA provides a generally acceptable groundwater inflow estimate and in order to provide a broad indication of the potential changes to pumpout rates at the surface as a result of the Preferred Project, the above figures in **Table 65**, pg 270, can be amended to remove post mining affects of extraction in Areas 3 and 4 in **Table 66**, pg 271.

Table 66 - Modified Predicted Mine Inflows at End of Mining Area 2

Stage	Current Inflow (ML/day)	Original Predicted Wongawilli Workings Inflow (ML/day) (1)	Modified Preferred Project Wongawilli Workings Inflow (ML/day)(2)	Modified Preferred Project Wongawilli Workings Inflow (ML/year)
Wonga East	0.2	1.4	1.4	511
Wonga West	0.9	1.7	0.9(3)	329
TOTAL	1.1	3.1	2	840

(1) Based on original Wonga East longwalls and dimensions for LW 1-11 as per the original EA
(2) Based on the Preferred Project layout but including contributions from LW 4 & 5
(3) Assumes inflows from the existing Wonga West area remain constant

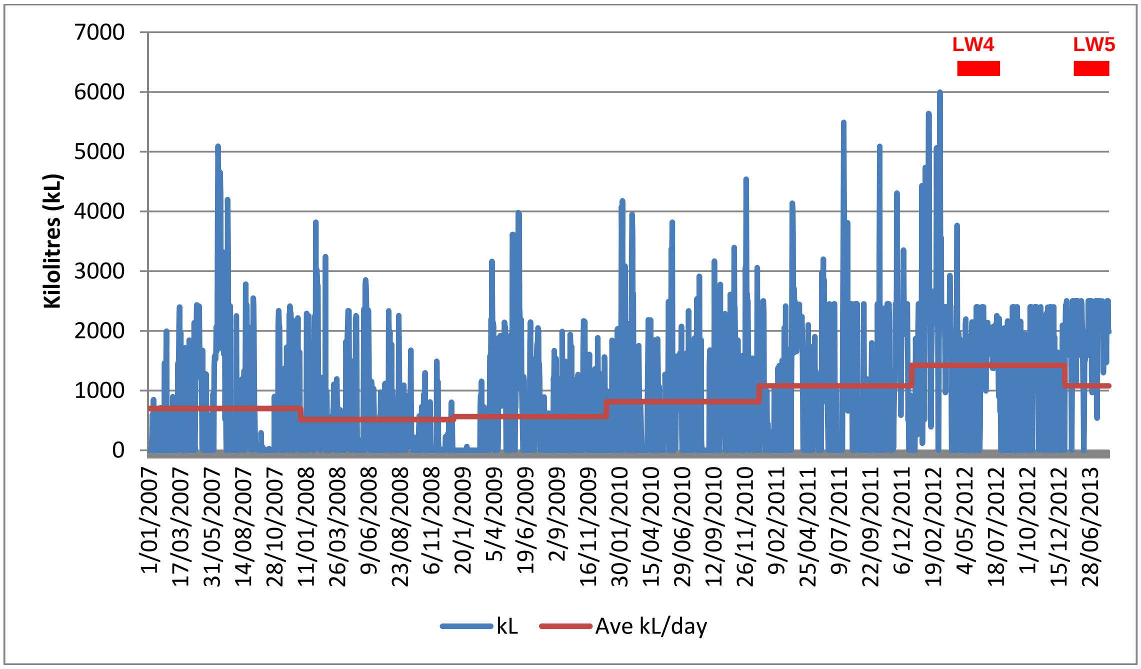
As shown in **Table 67**, pg 271, the average flow through LDP2, which captures underground pumpout water has averaged approximately 880 kL/day since 2007 and around 1,192 kL/day for the last two years.

Table 67 - Daily Average Flow Rates at LDP2

Period	Average Annual LDP2 Flow Volume (kL/day)
2007	700
2008	514
2009	563
2010	813
2011	1,078
2012	1,423
2013	1,077

Longwall extraction in Wonga East commenced in April 2012 with the extraction of LW4 which continued until August 2012. LW5 extraction commenced in January 2013 and is ongoing. In **Figure 79**, pg 272, the daily discharge volumes are shown from 1 January 2007 to 14 August 2013 and compared to extraction dates for LW4 and LW5. The annualised average daily pumpout rates show a gradual increase from around 700 kL/day in 2007 to around 1,100kL/day by August 2013. There is a noticeable flattening out of the previously large fluctuations in the actual daily pumpout volumes from around the time LW4 commenced indicating somewhat of a stabilisation of water make/use underground.

Figure 79 - LDP2 Daily Discharge Volumes from Jan 2007 to Aug 2013



NRE has developed a SFWMP in liaison with the EPA, DRE, WCC and NOW, with final approval by DPI. The SFWMP is the appropriate tool through which to undertake a detailed review assessment on a regular basis, similar to the one required in the submissions, as part of the Annual Review process. As part of this process NRE can liaise with the above regulatory authorities and make adjustments to monitoring, management and performance criteria as required. If approval is granted for the proposal NRE will be required to amend its EPL to meet conditional requirements in the Major Project approval. Going forward, at a minimum, NRE will manage its water treatment system to achieve the discharge quality and quantity required by the EPA in the current No.1 Colliery EPL 12040 and the conditions of any other relevant regulatory approval or the current approved SFWMP.

2.8.4 Effluent Irrigation

Irrigation Area

Submission

The effluent irrigation is quoted in the *Water Management Report* as having an area of 0.25 ha (2,500 m^2). However the effluent balance analysis in Appendix D appears to be based on an area of 4,500 m^2.

Response

The facilities at No.4 Shaft are designed for over 1000 people. The *Section 3.6.2, pg 19, of Annex B to the EA* states that there is 0.25ha of effluent irrigation actually in use to service the needs of the 225 people at the No.4 Shaft at the time the report was produced in February 2011. Currently NRE has 13 people located at the site.

Section 3.6.2, pg 19, of Annex B also identifies additional irrigation area adjacent to the existing irrigation area to the north and the south west that can be used if needed. This area corresponds to approximately 0.2ha. This area is referred to as the “available irrigation area” (i.e. actual area currently in use of 0.25ha plus additional areas of 0.2ha) in the Notes to the Table in *Appendix D of Annex B to the EA*.

Effluent Volumes

Submission

The analysis is based on an effluent flow of 7.4 kL/day. The basis of this assumed flow is not stated either in terms of the number of employees or the volume allowance per employee (which requires justification).

Response

The 7.4kL value for effluent flow is based on the maximum storage required for 30 days retention in the Maturation Ponds 1 & 2 calculated at 222kL. As shown on *Figure 7 in Annex B of the EA*, the total available storage in the Maturation Ponds 1 & 2 is 470kL, or the equivalent of around 5 months under normal conditions, with an additional 950kL available in Maturation Dam 3 if required. The 222kL is based on the water balance in the ponds shown in *Appendix D of Annex B to the EA*. Dividing the 222kL storage requirement by 30 days gives the 7.4kL value for effluent flow.

The 222kL storage volume is conservative as it is higher than the average 7.1kL per day of effluent needing to be irrigated (calculated by evaporation + percolation – rainfall).

Water Balance

Submission

The monthly water balance is appropriate for a single household but is an over simplification for a facility catering for a large number of people. A daily water balance should be used with an extended period (minimum 20 years) of local rainfall and evaporation data.

Response

NRE believes the water balance is appropriate and that the site is more than capable of managing the waste generated by 13 people currently at the site and any increase up to the size the system was originally designed for. NRE is unlikely to ever have 1000 persons located at the No.4 Shaft.

Rainfall Data

Submission

The analysis in Appendix D uses monthly average rainfall for Picton. In view of the local rainfall variation and as rainfall is a key factor in determining how much effluent can be irrigated, the use of Picton data requires justification.

Response

Although NRE has rainfall data from its No.1 Shaft from 2010, the Picton data is the best regional data from a single location in the area in that it incorporates a variety of climatic data for a reasonable period for one location close to the site. It is close enough to be generally comparable to the site's climate.

The only other way to address the issue would be to amalgamate data from other weather sites but the data gaps, local variations in microclimate and incompatible data ranges would make the outcome questionable at the least.

2.9 Traffic and Transport

2.9.1 Haulage Options

Bellambi Lane Conveyor

Submission

The company must be forced to consider the construction of a conveyor from the South Bulli Colliery to rail loading facilities near Bellambi Station (as agreed to by the previous owners of the mine c1980);

Response

The concept of a conveyor along Bellambi Lane with a rail loading facility has been around for several years and was recently considered by NRE.

In the 1980's, Shell, the then owners of the mine, did put this option forward as a longer term solution to transporting the coal to Port Kembla by truck and an Environmental Impact Statement was in fact prepared and approval was requested. The proposal involved an underground conveyor on the northern side of Bellambi Lane feeding coal into bins located adjacent to the railway line, to the north of the Bellambi railway station.

However the project at that time was rejected due to extremely strong objections from the local community, with signs stating "Ban the Bins" and "No Bins for Bellambi" being displayed around the Russell Vale and Corrimal areas. The primary objections related to the size and height of the bins, the noise of the trains and the coal loading operations and problems of dust from the conveyor and the train loading.

Initial approval conditions were considered and these did prohibit train loading to during night times and thereby limiting the value of investing in such a proposal. Due primarily to local objections, the proposal was not considered further and the problems of the day with truck movements were overcome by building the Northern Distributer to Bellambi and upgrading Bellambi Lane to a 4 lane road, as part of the Princes Highway. Prior to this, all traffic (including coal trucks from all the mines north of Russell Vale) travelled along the Princes Highway, through Corrimal and Fairy Meadow. The extension of Bellambi Lane and the Northern Distributor was seen at the time, as a means of overcoming the adverse impacts of coal trucks.

Since the 1980's various aspects of the proposal have been revisited and at this stage it is not considered feasible for a range of reasons including:

- noise impacts on the local community with the movement of trains and the loading of coal. While steps can be taken to minimise this, a large number of houses have been built in close proximity to the railway and the number of residences potentially affected is now far greater than it was in the 1980's;
- The length of the trains used (this is largely dictated by the rail providers) would lead to the possible closure of the Bellambi Lane level crossing creating concern and generating objections from another sector of the community;
- the cost of the proposal is estimated to be over $100 million making it a very costly project; and
- there still exists the very strong potential that operations would be limited to daylight hours only, adding a major constraint on the hours of operations and

the amount of coal which could be transported by the conveyor and the trains.

This option was reviewed by NRE as a result of numerous requests by local community members to consider it as an alternative to trucking. The consideration even extended to the current purchase of land on NRE's surface lease near the rail line in Russell Vale to ensure that should the option prove viable NRE would have the option to proceed with an application as the landowner. This sale is still in progress but has been delayed while NRE restructures its corporate debt. However, as demonstrated in **Figure 80**, pg 276, local special interest group, IRRM has already commenced lobbying WCC against the concept, foreshadowing future community opposition to any proposal of this nature.

Figure 80 - Opposition to Rail Loading Option

Land sale stalls as Gujarat deals to debt

KATE McILWAIN

GUJARAT NRE Coking Coal has failed to close a $5.2 million deal with Wollongong City Council after agreeing to buy a large piece of industrial land in Bellambi nearly three years ago.

The council decided to sell the corner block, located between Memorial Drive and Bellambi railway station, to the Illawarra coalminer in December 2010.

Gujarat NRE was the only company to put in a tender to buy the land and entered into a contract of sale with the council, paying a non-refundable $400,000 deposit.

It was due to pay the remaining $4.8 million by June 30 this year.

However, it did not meet the deadline and asked the council for an extension of the contract, which is now under negotiation.

Title deeds have not changed hands.

Wollongong City Council property and recreation manager Peter Coyte said the council had decided to grant an extension to Gujarat because there was currently no other buyer for the land.

He said the council was earning income by leasing part of the land to a swim centre and was not paying any other costs.

> *We have protected council and the community*
> Peter Coyte

The situation comes as the council faces major concerns over its financial sustainability.

Last week, it announced it would soon begin a wide-ranging financial review, asking residents to assess what services they could do without and whether they would be happy to pay extra rates to help the council meet a massive infrastructure backlog.

Mr Coyte said the delayed sale of land to Gujarat would not disadvantage the council or ratepayers in any way.

"We have protected council and the community to make sure, when it does settle, that the council and the community aren't at a disadvantage," he said.

He said the outstanding $4.8 million was not needed to fund any particular project, and Gujarat NRE would have to pay extra interest after it failed to meet the original settlement date.

Yesterday, Gujarat community relations manager Mat Campbell would not answer questions about why the company had not paid the outstanding $4.8 million, but said the company still intended to go ahead with the purchase.

In June, the miner requested that its stocks be suspended from trading while it worked to refinance its debt.

In early August, the company told the stock exchange that Indian steel giant Jindal had stepped in to buy $66 million of new shares, increasing its share of the Illawarra company to 44 per cent.

This arrangement made up for Gujarat's failed efforts to raise the money needed to fund coal production at its Russell Vale and Wongawilli mines through an issue of new shares to stakeholders.

Gujarat stocks remain suspended, but the company has flagged plans to resume trading at the end of this month.

The delayed land sale has raised concerns among members of the Illawarra Residents for Responsible Mining.

They have written to Lord Mayor Gordon Bradbery asking the council to reconsider the sale.

Group spokesman Gavin Workman said a Gujarat representative had told residents that the land was going to be used as a coal stockpile and rail siding facility.

"You only have to travel past any colliery stockpile to see the black patina of coal dust that cakes the ground, the buildings and even the trees," he said.

He noted that the site was close to houses in Bellambi, Woonona and East Corrimal.

And he said a stockpile could harm residents' health.

Mr Campbell would not say what Gujarat NRE intended to use the land for if the purchase went ahead.

But he noted that the land had historically been part of the northern suburbs mine.

Mr Coyte said the council was happy for the land to be used according to its light-industrial zoning rules once the sale was completed.

ILLAWARRA MERCURY, Wednesday August 14, 2013 5

CA

The proposal for the mine as it stands involves increasing production levels to a rate of up to 3Mtpa but using modern trucks and modern road infrastructure to move the coal and limit the adverse traffic impacts. The Colliery has existed for more than 125 years and for much of that time it has relied on truck transport to the port. Because of the very short haulage distance (about 16 km) alternate transport methods are not currently viable and it would appear that a conveyor/train loader option would create objections from a new and different section of the community.

Maldon Dombarton Rail Link

Submission

Opening of a new mine outlet and connection to the long proposed Maldon Dombarton rail link would remove trucks from the road and must be considered.

Response

There is no guarantee that the Maldon Dombarton rail link will be constructed despite renewed feasibility studies being undertaken by the NSW Government. NRE would not even consider this option until the rail link was constructed.

Different Road Routes

Submission

Examination of other road routes to avoid Bellambi Lane and residential areas must be undertaken.

Response

There is no current alternative road route that would avoid residential areas.

2.9.2 Haulage Volumes

Truck Movements

Submission Issues

The claimed historical haulage volumes of up to 3Mtpa in the 80's and early 90's are not supported by data from the PKCT EIS that state in 1991-92 the haulage volume was only 1.7Mt. NRE should be limited to 1Mtpa. The EA doesn't describe the types of trucks to be used to haul the increased volumes of coal and indicates changed hours of operation but doesn't specify the proposed changes. This volume of movements must affect intersection performances. Peak time trucking is the real cause of concern for the community because at these times all regulations are ignored in order to move more coal.

Response

In order to maintain a viable operation into the future NRE requires a 3Mtpa extraction rate. This does not mean that NRE will develop or haul 3Mtpa every year but there will be occasions in any given year where the production rate, and therefore the haulage rate, will reach 3Mtpa during the Preferred Project. This is a commercially sustainable level for a modern Southern Coalfields operation. When global economic conditions improve, NRE will increase coal development (1st workings) rates. This will increase total production when added to longwall coal volumes to peak at around 3Mtpa. Additionally with proposed future mining in the western areas of the lease, NRE needs appropriate infrastructure in place to manage 3Mtpa that will be produced from that extraction.

The trucks to be used in the future are all B-Double trucks. NRE's haulage contactor currently runs approximately 12 trucks from site. These consist of around 6 B-Doubles, 3 Semi-Doubles and 3 Semitrailers. NRE intends to transition to using only B-Doubles by the end of the Preferred Project period and has no current plans to introduce B-Triple haulage of coal. The hours approved for coal loading and haulage are not changing from the currently approved hours which are 7am-10pm Monday to

Friday; 8am-6pm Saturdays, Sundays and public holidays. The mine site itself is currently approved to operate 24/7 within the noise and dust limits imposed in the Preliminary Works Pt3A. It is not proposed to change this. The two key intersections affected by truck movements are at Bellambi Lane/Princes Hwy and Bellambi Lane/Memorial Drive. Both these intersections are controlled by traffic lights and the timing of these traffic lights can be adjusted by RMS as required if there is deemed to be an issue. The NRE Code of Conduct for its haulage contractor applies at all times.

2.9.3 Public Safety Risk

Road Safety

Submission

Increased truck movements and 70m plus stopping distances for B-Double trucks pose a safety risk to road users and pedestrians, particularly, the local pre-school and public school children. During peak haulage times NRE also uses many subcontractors that have inferior vehicles and don't comply with the NRE Code of Conduct. All NRE trucks must be fitted with tachographs.

Response

Trucks will not operate in close proximity to any schools or pre-schools. On Bellambi Lane, NRE's trucking contractor has accepted a 50km/hr voluntary speed restriction to minimise the likelihood of road traffic/pedestrian incidents. The only legal pedestrian crossing points on or near Bellambi Lane are at traffic lights at either end of the road. NRE's haulage contractor has installed dashboard cameras to much of the fleet and can track truck speeds via GPS. Given the existing tracking technology used, NRE has no current plans to require the installation of tachographs. All drivers working for NRE are subject to the Drivers Code of Conduct and will be held accountable to their responsibilities by the Haulage Contractor and NRE. The goal of NRE is to move to a fleet consisting entirely of B-Doubles in the haulage fleet within 5 years. The National Truck Accident Research Centre Report 2011 also states that B-Doubles are involved in half the number of accidents of semi-trailers and 7 out of 10 all truck accidents involve no other vehicles. Where the accidents include other vehicles truck drivers are only at fault 44% of the time and in fatal truck accidents involving another vehicle truck drivers were at fault only 18% of the time.

2.9.4 Public Health and Amenity

Health Impacts

Submission

Increased truck movements will cause public health and amenity issues along the haulage route including:

- increased dust;
- increased noise;
- increased diesel exhaust;
- traffic congestion;
- vehicle damage due to coal debris on roads; and
- property damage from vibration

The National Truck Accident Research Centre Report 2011 states that truck accident rates are rising and that this is due to increased haulage for the mining industry. IRRM was advised by NRE at a Community Information Session that it has no control over its haulage contractors.

Response

The levels of road haulage transport presented in the EA are based on absolute worst case predictions for haulage at a peak production rate of 3 million tonnes of coal per annum.

All haulage contractors are required by *Clause 61 of the Road Transport (Mass, Loading and Access) Regulation* 2005 and by NRE to ensure that their loads are covered and secured prior to entering the public road system in order to prevent coal from falling onto the road.

IRRM were clearly advised in the Information Session that because NRE is dealing with individual human beings driving the trucks it is impossible for NRE to ensure their performance is perfect at all times. To try to control the actions of every driver would require an NRE representative in the cabin of each truck at all times and even then perfection could not be guaranteed. This is neither practical nor affordable. As such other controls are used.

2.9.5 Monitoring

Health Impacts

Submission

There is no monitoring of affected premises or residences to measure health and amenity impacts.

Response

NRE has established depositional dust monitors in the local community including at residences bordering Bellambi Lane and has commenced extending the coverage into 3 local schools with 2 installations currently complete. NRE will also establish a real time air and noise monitoring network around site by the end of September 2013

2.9.6 External Cost Impacts

Externalities

Submission

External costs do not appear to be a Director - Generals requirement for this application. They are however, a required part of the AusLink project assessment in the National Guidelines for Transport System Management In Australia released in 2004 (and updated in 2006) by the Australian Transport Council.

Response

The National Guidelines for Transport System Management in Australia are directed toward the management of multi-modal land based transport. That is not applicable to this project which uses a single land based transport mode (i.e. truck haulage) and for which there are adequate state guidelines already in place. The following is an excerpt from the Guidelines"

"*Role of the Guidelines. Traditional transport system management is concentrated on individual transport modes and physical infrastructure. Most* *jurisdictions have detailed guidelines to appraise proposals for individual modes, mainly involving road projects. There are few comparable guidelines for multi-modal transport planning or for appraisal of non-road and non-infrastructure initiatives. The Guidelines go some way to towards providing a more comprehensive approach. They provide a Transport System Management Framework (the Framework) incorporating a multi-modal approach to land transport*."

3 Mining Issues

3.1 Biodiversity

3.1.1 Swamp Mapping

Mapping Disparities

Submission

There are major differences between the 2003 NPWS Vegetation Mapping and the 2012 Biosis mapping of swamps. This may represent climate effects or different mapping techniques or is quite possibly due to subsidence impacts changing the character and spatial coverage of swamps.

Response

Vegetation mapping prepared by NPWS (2003) "has a number of potential sources of error" (pg 62) and NPWS recommends that detailed site inspection is undertaken. Upland swamp mapping prepared by Biosis (2012b) uses a combination of LiDAR data and on-ground assessment to map the vegetation of upland swamps. Differences between mapping by Biosis and NPWS is likely a result of the fine-scaled mapping completed by Biosis when compared to the large scale, regional mapping prepared by NPWS.

3.1.2 Swamp Monitoring

Improved Monitoring

Submission

Monitoring of swamps must be improved to meet BACI standards and capture data on surface retention of water and flow from the swamps. It needs to allow the impacts of mining to be separated from other influences such as variable rainfall.

Response

The current ecological monitoring program undertaken for NRE for Longwalls 4 and 5, as well as the Wongawilli Colliery, uses a BACI approach. NRE are currently re-designing the monitoring plan to integrate surface water, groundwater and ecological monitoring programs to ensure a comprehensive assessment of the ecosystem function of upland swamps within the study area.

3.1.3 Swamp Risk Assessment

Subsidence Predictions

Submission

Biosis acknowledges that the subsidence predictions are imprecise and only provide a guide to potential impacts yet bases its impact assessments on these same predictions.

Response

Subsidence predictions have been remodelled following revision of the mine plan. See **Section 2.2.7,** pg 144 for information on the remodelling of the mine subsidence for the Preferred Project. More detailed subsidence information is available in

Attachment B, pg 426. Biosis has revised its impact assessment based on the revised subsidence modelling.

Flow Accumulation Modelling

Submission

OEH believes that Biosis' assessment of risk to swamps contains numerous inconsistencies which leads to incorrect outcomes. The system by which they arrive at their conclusions is puzzling and is probably due to overreliance on flow accumulation changes. The low impact potentials assigned to swamps due to minimal impact on flow accumulation don't' take into account bedrock cracking and perched aquifer drainage. This leads to inconsistent outcomes for similar swamps.

Response

As outlined in **Attachment A, Section 3.3.1**, pg 350, the criteria outlined in DoP (2010) are thresholds for further investigation, not a conclusion that a swamp will be impacted. The use of flow accumulation modeling provides an additional tool to assess potential changes in surface and groundwater flow through an upland swamp in relation to changes in ground level (tilt). A change in water flow is recognised as one potential impact to upland swamps (DoP 2009, DoP 2010). The flow accumulation modeling has been used to predict changes to surface and groundwater flow through an upland swamp in relation to changes in ground level (tilt). A change in water flow is recognised as one potential impact to upland swamps. Flow accumulation is modeled using vertical subsidence data (S_{max}) to model changes in flow pathways through an upland swamp. It is unrelated to tensile stress and strains.

Impact Causes

Submission

OEH believes that Biosis shows a bias toward mining evidenced by its selective literature citation, claim that mine subsidence is only a contributory factor in swamp damage rather than the cause and that loss of perched aquifers may not result in changes to swamp ecology. There is plenty of evidence from Metropolitan and Dendrobium Collieries End of Panel and Annual Environmental Management Reviews to prove this is not the case.

Response

To date, a large number of upland swamps on the Woronora Plateau have been undermined. Mining has included a combination of bord and pillar and longwall mining. Changes in groundwater availability have been observed at a number of upland swamps (e.g. Swamp 1 in Dendrobium Area 2 and Swamp 15b in Dendrobium Area 3A), and gully erosion and scouring have been observed at a number of additional upland swamps (e.g. Swamp 37, Swamp 18A and Flatrock Swamp). Biosis recognises that subsidence associated with longwall mining can result in the fracturing of bedrock below upland swamps and changes in groundwater availability. However, the persistence of upland swamps in previously mined areas, as illustrated in **Attachment A, Section 3.3.3** indicates that fracturing of bedrock and changes in groundwater availability do not always result in secondary impacts to vegetation or increased erosion, or the catastrophic loss of upland swamps. DoP (2008) recognises that certain swamp characteristics mean some upland swamps are more susceptible to impacts from subsidence than others. For example, given their location in the landscape, valley infill swamps are more likely to be in direct contact with surrounding groundwater, and much more susceptible to fracturing due to valley closure and upsidence. Biosis does not assert that subsidence associated with longwall mining does not result in impacts to upland swamps, or that changes in groundwater availability are not an impact to upland swamps. Rather, that the maintenance and persistence of upland swamps is much more complex than has been recognised, and that further research and assessment is required to understand the complex processes that maintain upland swamps, particularly in relation to changes brought about by longwall mining.

Special Significance

Submission

Biosis have only identified 15 of 72 swamps as of ‘special significance’. All swamps are significant with regard to providing baseflow to downstream drainage lines and as such hydrological significance needs to considered in swamp significance assessments. Biosis make no reference to the BSO account of swamp impact mechanisms.

Response

The upland swamp impact assessment (Biosis 2012b) uses the methodology for identifying swamps of special significance outlined in OEH (2012). In their submission OEH recognises that 'Biosis has applied the OEH draft guidelines appropriately in identifying swamps of potential special significance'.

Community Value

Submission

According the valuation accorded to swamps in the BSO EA of $2million/ha, OEH has calculated that the 72 swamps affected by this proposal have a total community value of $121 million. This has not been accounted for in the cost benefit analysis of the current proposal.

Response

See **Section 2.3.1,** pg 199, for a discussion of the community value of Upland Swamps.

3.1.4 Swamp Impacts

Impacts

Submission

The SCA is very concerned about impacts to the swamps affecting their ecological function such as stormwater buffering, providing baseflow to streams, and maintaining water quality. Any dewatering of these swamps also increases the likelihood of erosion. Impacts and consequences to swamps will be greater than accepted by NRE and will take a long time to become evident.

Response

The new Wonga East layout will significantly reduce the likelihood of impact to swamps of special significance. See **Figure 2**, pg 11, and **Section 2.2.1**, pg 57. The upland swamp impact assessment has been revised based on a revised mine plan and associated subsidence predictions. The preferred project will result in reduced risk of impact for upland swamps CCUS1, CCUS5, CCUS10, CRUS2 and CRUS3. BCUS4 and CCUS4 are considered to have a moderate likelihood of impacts, of which only CCUS4 is considered to be of 'special significance'. NRE has previously accepted that TARP's are not an effective method of managing swamp impacts and doesn't intend to use them as a management tool for this purpose.

Management

Submission

Swamps can't be remediated once the base of the swamp is cracked. Adaptive management and TARP's are not effective due to the time lag in impacts being observed. The only way to manage swamp impacts is to not mine beneath them or within a 35 or 40 degree angle of draw. It is obvious that NRE has not modified its longwall layout to attempt to avoid specially significant swamps. NRE has not proposed offsetting or remediation for any of the Upland Swamps predicted to be impacted such as CCUS1, CCUS4, CCUS5, CCUS10, and CRUS1. WCC would like to see NRE modify longwall panel A1 LW3 to ensure it doesn't pass beneath CCUS1; shorten A2 LW6 to protect CCUS4 and CRUS1; and either modify or delete longwall panels A2 LW7 and A2 LW8 to protect CCUS5.

Response

NRE has modified the Wonga East longwall layout to minimise impacts to special significance swamps as identified by Biosis. Full avoidance of all swamps is not possible while maintaining a commercially viable operation as evidenced in **Figure 2**, pg 11. The current ecological monitoring program undertaken for NRE for Longwalls 4 and 5, as well as the Wongawilli Colliery, uses a BACI approach. NRE are currently re-designing the monitoring plan to integrate surface water, groundwater and ecological monitoring programs to ensure a comprehensive assessment of the ecosystem function of upland swamps within the study area. *Section 22.9, pgs 385-386, of the EA* outlines the proposed remediation techniques that NRE could consider depending on the type of impact to a swamp. Offsets are already required by *Condition 3, Schedule 3 of the Preliminary Works Pt3A* and NRE see no reason why this condition would not carry through to the current proposal should it be approved. A commitment to offsets is also contained in the current LW5 SMP BMP and this will be continued as part of future SMP plans. Attempts have been made to remediate upland swamps following impacts such as erosion using techniques such as coir logs, wooden structures etc. (Save Our Swamps 2010). However, these remediation techniques have been undertaken in relation to erosion. Biosis is not aware of the successful remediation of upland swamps impacted by the fracturing of bedrock. It is not feasible to remediate bedrock fractures and changes in groundwater availability, as the degree of impact from the remediation works would likely be far greater than the degree of benefit. NRE proposes to outline an offset strategy once a Project Approval is received. This offset strategy will be developed in conjunction with relevant stakeholders, including OEH

3.1.5 Fish Habitat

Undermining of Cataract Creek

Submission

There is significant concern that the undermining of Cataract Creek cannot be adaptively managed to prevent more that 250mm of subsidence or pillar run due to multi-seam mining issues. Remediation of damaged waterways is not considered an effective option to repair any impacts to the creek in order to restore habitat and it is noted that NRE has not committed to undertake remediation should impacts occur. As a result, NRE must not undermine Cataract Creek.

Response

NRE has modified its Wonga East longwall layout to avoid mining beneath Cataract Creek. See **Figure 2**, pg 11. In *Section 20.6.7, pgs 325-326, of the EA*, NRE does commit to rehabilitation measures should unacceptable impacts occur to Cataract Creek. Offsets are already required by *Condition 3, Schedule 3 of the Preliminary Works Pt3A* and NRE see no reason why this condition would not carry through to the current proposal should it be approved. A commitment to rehabilitation is also contained in the current LW5 SMP WMP and this will be continued as part of future SMP plans and, if required, clarified to specifically identify offsets. It should be noted that due to past mining of the Bulli and Balgownie seams significant iron flocculent is already present in Cataract Creek, smothering some sections of the creek. Additional fish surveys have been undertaken by Biosis, and the results of these surveys are outlined in **Section 2.2.1, pg 57**, and **Attachment A, Section 3.2, pg 350**. The revision of the mine plan now avoids mining below Cataract Creek

<u>Fish Passage</u>

Submission

There is insufficient evidence to suggest that Macquarie Perch cannot utilise flood conditions to access above the rock bar located over LW7/8 that is considered to block further passage. Further information is required on fish passage and habitat above this rock bar prior to any mining beneath the creek.

Response

Additional survey indicates that it is unlikely that locations upstream of the rock bar would support populations of adult fish. For further details on endangered fish habitat see **Section 2.2.1**, pg 57

<u>Fish Monitoring</u>

Submission

OEH believes that monitoring program for baseline data has inadequately sampled all major streams in the area and should have used electrofishing, rather than just relying on dipnets. The data collected is insufficient to allow assessment of impacts on fish communities by the project. A monitoring and management program must be developed in liaison with Fisheries NSW for Macquarie Perch, Trout Cod, and Murray Cod in Cataract Creek. In particular, monitoring of Cataract Creek should be carried out weekly to determine the amount of iron floc that is developing and measures implemented to ensure that during the potential spawning period for Macquarie Perch (late spring at water temperatures of 15-16^{o}C), the iron floc doesn't smother gravel riffle zones.

Response

Additional sampling of aquatic habitat has been undertaken by Biosis (In Prep.), including sampling of fish using a backpack electrofisher in upstream reaches of Cataract Creek. No threatened species were recorded in this area.

3.1.6 Ecology Assessment

Giant Dragonfly

Submission

There was no survey for the Giant Dragonfly undertaken as part of the assessment. The dragonfly has recently been observed in the Dendrobium area in swamps. A more robust survey for the species is required.

Response

Table 5.6 in Annex E of Annex S to the EA indicates that the Giant Dragonfly was assessed as being highly likely to occur in the area in larger Upland Swamps that support Tea Tree Thicket, particularly CRUS1 *(Section 4.5.2 and Section E1.6 in Annex E of Annex S to the EA).* The dragonfly was identified as vulnerable to subsidence. The alteration of layout in Wonga East has removed the risk to this species. See **Figure 1**, pg 10, **Figure 2**, pg 11, and **Section 2.2.1,** pg 57, of the PPR.

Threatened Frogs

Submission

There is potential for impacts to threatened frogs.

Response

As outlined in **Section 2.2.1,** pg 57, and **Section 1.1.1 of Attachment A,** pg 350, the Giant Burrowing Frog, Littlejohn's Tree Frog and Stuttering Frog have not been recorded within the subsidence impact zone and no impacts to identified breeding habitat for the Giant Burrowing Frog (below CRUS2) are predicted to occur. Although the Red-crowned Toadlet has been recorded above Longwall 4 and 5, habitat for this species is widespread and unlikely to be significantly impacted by subsidence. The Green and Golden Bell Frog has not been recorded within the study area. Suitable habitat is not present.

3.2 Cultural Heritage

3.2.1 Heritage Assessment

New Assessment

Submission

– WCC requires a complete reassessment of the potential heritage impacts of the proposal in accordance with the current guidelines. It believes that the assessment in the EA did not adequately address the DPI EA guidelines, existing DEC Aboriginal Cultural Heritage Impact Assessment and Community Consultation guideline requirements, or the PAC decisions for similar projects such as the BSO.

Response

A subsidence impact assessment has been undertaken based on new subsidence predictions, mine plan changes and newly identified or relocated sites. This information is presented in **Section 2.2.3**, pg 93.

Relocation of Known Sites

Submission

A number of known Aboriginal sites were not relocated as part of the assessment. OEH believes that these sites should be relocated to allow subsidence impact predictions to be undertaken. Additional effort is also required to attempt to locate predicted sites within the mining area.

Response

Biosis has now undertaken comprehensive survey for Aboriginal heritage sites in Wonga East. Survey efforts were targeted to cliffs providing potential shelter sites using LiDAR mapping of cliffs. This resulted in the relocation of all shelter sites previously recorded, as well as the recording of two new shelter sites. Due to dense vegetation in comparison to when initial surveys were undertaken, only one axe grinding groove (52-3-0322) has been relocated. Extensive survey was undertaken for all sites; however the remaining sites could not be relocated. Given additional surveys undertaken by Biosis have relocated all shelter sites and recorded five new sites we consider the current survey effort to be comprehensive. See **Section 2.2.3**, pg 93, for more detail.

3.2.2 Heritage Monitoring

Monitoring Program

Submission Issues

A monitoring program must be established that covers all known Aboriginal sites in the mining area, including baseline recording prior to mining, and regularly during extraction and for up to 6 months after mining.

Response

This will be developed in detail as part of the EP and SMP process.

3.2.3 Heritage Impacts

General Concerns

Submission

There were general community concerns raised about the potential for destruction of Aboriginal cultural heritage as a result of subsidence impacts. In particular, OEH requires that subsidence impact assessment be undertaken if new subsidence predictions are produced.

Response

A subsidence impact assessment has been undertaken based on new subsidence predictions, mine plan changes and newly identified or relocated sites. This information is presented in **Section 2.2.3**, pg 93.

3.2.3 Heritage Management

Mine Plan

Submission

WCC requires the reduction in length of A2 LW9 and A2 LW10 as the impacts caused by subsidence to 4 moderately significant rock shelters are unacceptable.

Response

LW9 and LW10 have been reoriented and shortened. See **Section 2.2.3**, pg 93, for more detail on potential impacts to Aboriginal archaeology as a result of the layout changes.

3.2.4 Aboriginal Consultation

Consultation

Submission

Consultation with the Aboriginal community must be undertaken properly and continue throughout the life of the mine and particularly with regard to management of Aboriginal sites or if a site is impacted by subsidence.

Response

A Commitment to ongoing consultation was included in *Section 25.8.2, pg 463-465, of the EA* as part of the management of subsidence impacts. NRE has undertaken additional consultation with the Aboriginal community following relocation of a number of additional sites by Biosis, including a visit to all relocated sites not previously visited and allowing for comments from the Aboriginal community on the significance of relocated sites.

NRE has undertaken additional consultation with the Aboriginal community throughout the project. This consultation with registered Aboriginal parties has been undertaken following relocation of a number of additional sites by Biosis, allowing for comments from the Aboriginal community on the significance of relocated sites. NRE will continue its consultation with the Aboriginal community throughout the life of the mine. This will include discussion with the Aboriginal community on the management of Aboriginal sites, and a commitment to involve the Aboriginal community in proposed mitigation should sites be impacted as a result of mining activities.

Consultation is also carried out with the Aboriginal community in the development and implementation of a HMP for Aboriginal sites at the Pit Top and in the catchment area is required by *Condition 38, Schedule 3 of the Preliminary Works Pt3A* approval and NRE sees no reason why that condition or similar would be placed in any approval for this proposal. Consultation is required by *Section 6 of the Guideline for Applications for Subsidence Management Approvals* and as such was a key part of developing the LW5 SMP HMP. The LW5 SMP HMP will be modified for future longwalls and consultation will again be undertaken. NRE has recently engaged Biosis to undertake further consultation with the Aboriginal community particularly with regard to the additional sites that have been either located or relocated as a result of additional surveys in the Wonga East area. See **Section 2.2.3**, pg 93, for further detail.

3.3 Drinking Water Supplies

3.3.1 Metropolitan Special Area

Water Supply Security

Submission

The Special Areas provide water to Greater Sydney and the Illawarra - more than 4.7 million people and water quality and quantity should not be allowed to be affected by mining in any way, especially by allowing mining beneath the Cataract Reservoir.

Response

NRE has removed the proposed Wonga West longwalls from this proposal and amended its Wonga East longwall layout such that there will be no longwall extraction within the 35 degree angle of draw from the full supply level of Cataract Reservoir.

3.3.2 Reservoir Leakage

Reservoir Exclusion Zone

Submission

There is a concern that there may be a loss of stored waters from Cataract Reservoir to the mine workings at the upper arm of Cataract Reservoir as a result of mine induced leakage. The SCA requires that the Cataract Reservoir Notification Area be adopted as a no mining area. If mining is approved via the Pt3A process in this zone no mining can commence until a DSC approval has been received.

Response

The adoption of the Cataract Reservoir Notification Area as a no mining zone will render Wonga East non-viable. The revised layout for Wonga East is partially within the Notification Area but outside the 35 degree angle of draw from the stored waters. NRE believes that this provides an adequate buffer from the Reservoir and that any remaining issues of a technical nature can easily be resolved as part of an application for DSC approval.

3.3.3 Catchment Yield

Catchment Yield Modelling

Submission

The catchment yield modelling was based on the Loddon River and Bellambi Creek catchments which won't be undermined and the model does not have sufficient low flow data to allow for accurate water loss predictions.

Response

Catchment surface water and groundwater are being remodelled in accordance with DPI directions. This information will be available within 3 months. See **Section 2.2.5**, pg 128 and **Section 2.2.9**, pg 197, for more detail.

Baseflow

Submission

The SCA believe that the reduced baseflow to streams and the Cataract Reservoir as a result of subsidence cracking, leakage and groundwater depressurisation is a source of concern as baseflow contributes 35% of average annual inflow during drought periods when surface runoff is considerably reduced. This may lead to reduced catchment yield which is potentially very important during periods of low flows. Therefore:

- there must be no change in the extent or duration of stream connectivity in low flow conditions;
- the average annual baseflow from Cataract catchment must no be reduced by more than 10% or 100ML/yr, whichever is the lesser;
- additional down gradient boreholes be installed in Wonga East; and
- the groundwater model must be updated and improved as more data becomes available.

Response

Catchment surface water and groundwater are being remodelled in accordance with DPI directions. This information will be available within 3 months. See **Section 2.2.5**, pg 128 and **Section 2.2.9**, pg 197, for more detail.

Stream Yield

Submission

The EA predicts the potential for cracking of the bed of Cataract Creek. The SCA disagrees that any water lost subsurface will re-emerge further downstream as this has not been proved to its satisfaction. The experience in Waratah Rivulet seems to indicate that the fracture network below creeks is deeper than predicted leading to at least partial water loss.

Response

Catchment surface water and groundwater are being remodelled in accordance with DPI directions. This information will be available within 3 months. See **Section 2.2.5**, pg 128, and **Section 2.2.9**, pg 197, for more detail.

3.4 Geology

3.4.1 Lack of Geological Investigations

Geology Report

Submission

Comprehensive geological investigations have still not been undertaken for the proposed mining areas and the potential impacts of geological structures in Wonga East have not been addressed such as:

(a) structures have interrupted the Bulli and Balgownie workings but no comment has been made on the impact of these structures on the surface or the potential for loss of storage via connection of this structure to the floor of the mine;
(b) a large number of the Wonga East longwalls extend within the Notification Area close to or beneath the Full Supply Level (FSL).
(c) the fact that there are a large number of dykes and faults that appear to have surface expressions aligned with streams;
(d) there are fault swarms that align with the Rixons Pass Fault and Cataract Creek also lines up with this fault plane. There is also a possibility that two faults which extend from the mine to surface intersect at the confluence of Cataract River and Cataract Creek leading to a potential for seepage from the Reservoir to the mine workings;
(e) the Bald Hill Claystone (BHCS) regional aquitard is absent over much of the area leaving the more permeable Bulgo Sandstone (BSS) exposed and connected to the fracture zone above the Wongawilli goaf. The rate of water loss through this unit has not been calculated but there is a potential for significant capacity of the Reservoir to be at risk. Further assuming the Corrimal Fault outcrops in the base of the Reservoir what is the potential for mining to cause the faults permeability to rise?;
(f) There is no reference to the regional unconfined aquifer contained in the Quaternary sandy and gravelly alluvial deposits that overlie the Hawkesbury Sandstone or the impacts of subsidence on this aquifer;
(g) there is no contingency mine closure plan for a Reservoir/mine connection event;
(h) the impacts of extending the Wonga Mains under the Reservoir and through an area known to be impacted by igneous intrusion from the Bulli seam to the surface; and
(i) there is no information on the maximum working height of the longwall and the intended extraction height for each longwall.

Response

With respect to the DSC concerns regarding the lack of a geological report for the EA, Hebblewhite 2013 states, "*The concern regarding lack of a geological report – at least with respect to detailed structural geology – appears to be a valid concern. The inclusion of such a report would assist greatly in understanding the presence of major geological structures. However, a caution should be raised on at least two counts. Firstly, it is not always possible to locate all significant geological structures in advance of mining – even with the highest level exploration technologies. Secondly, it must be understood that the presence of a geological structure does not, in itself, represent a potential flow path connecting to the surface. It is a more complex situation related to other geological units, stresses, mining geometries and hydrogeological factors which lie outside the scope of this report. As mentioned in the detailed comments by DSC, a detailed* *geological risk assessment – once major structures are identified – would be a very useful management tool to address many of the concerns raised*."

See **Section 2.2.4**, pg 111, for a full geological assessment of the Wonga East area. This geological assessment has been considered in the subsidence calculations for the new Preferred Project layout in Wonga East.

3.5 Groundwater

3.5.1 Groundwater Model

Model Type and Method

Submission

The groundwater assessment model is FEFLOW which is not appropriate for the severe impacts likely to occur to the water systems as a result of mine subsidence and can't be used to model hydraulic conductivity changes at the base of individual swamps. Conductivity values selected for the goaf zone in the model are very low and the model has been calibrated in steady state mode using only hydraulic head targets and no correlation between observed and calibrated hydraulic heads is given (*see Figures 19 & 20 of Appendix D in Annex P of the EA*). Transient calibration has not been undertaken using multiple parameters and this is a significant deficiency. As such the model can't be used to model impacts. In particular the potential leakage from Cataract Reservoir will require probabilistic assessment using a transiently calibrated model.

The SCA has assessed the model as treating creeks as always flowing and it is not clear if intermittent or ephemeral tributaries were included.

Response

In **Attachment F**, pg 621, Golders Associates (Golders) have responded in detail to the key technical issues raised regarding the groundwater model, in particular by the Coffee report for the DPI. The following information is a summary of the Golders response.

FEFLOW can accommodate both saturated and unsaturated flow, though modelling unsaturated flow requires additional (and uncertain) parameters (up to 8 parameters) to represent the relative conductivity and capillary pressure relationships to be defined for each soil type in the model. Severe impacts such as the voids of extracted workings can be applied in FEFLOW as hydraulic head, pressure, seepage, saturation or moisture content boundary conditions.

The model doesn't attempt to model the hydraulic impacts to the base of individual swamps. The hydraulic conductivity changes were applied from values supplied by Geoterra.

The conductivity values in the zones immediately above the goaf are two to three orders of magnitude higher than the surrounding material. Any higher values caused instability in the model. All the model elements representing the goaf had boundary conditions applied that allowed water to be removed instantaneously from the model domain.

Figure 19 in Appendix D to Annex P of the EA shows the calibrated water level and *Figure 20* of the same *Appendix* has a correlation of 95%. Calibration of the model was conducted in steady-state mode to the hydraulic head. Predictive simulations were conducted in transient mode. This was due to the fact that groundwater level data records were only available at one point of time in 2010 when the model was created. Data records of transient baseflow and void discharge were not available at the time and thus not included in the steady-state calibration. Following the steady-state calibration, modelled mine inflow/outflow volumes were close to actual flows and baseflow values appeared reasonable. The model would have benefited from transient calibration if the data had been available at the time.

Determining the potential leakage from Cataract Reservoir via a probabilistic assessment of a transiently calibrated model is a new approach in groundwater models. Monte-Carlo simulations can be achieved using software such as PEST but this approach is very numerically intensive. Simulation runs are in the order of weeks for each stage resulting in months for multi-stage assessments.

Golders have stated that the questioning of the steady-state mode appears to arise from the application of very recent (2012) changes in the regulatory sphere to groundwater models constructed before they came into effect. In the recent two years, the regulatory situation has undergone significant changes with respect to the use of modelling results in the approvals process, namely:

- the 2012 Aquifer Interference Policy, issued by NOW; and
- the 2012 Australian Groundwater Modelling Guidelines, issued by the National Water Commission.

The 2012 Australian Groundwater Modelling Guidelines has classified groundwater models into three categories, defined by model confidence level. Applying these guidelines, Coffey appears to suggest that Gujarat requires a Class 3 (highest confidence level) groundwater model. Class 3 models are required to satisfy the following criteria, and must be able to:

- predict groundwater responses to arbitrary changes in applied stress of hydrological conditions anywhere within the model domain;
- evaluate and manage potentially high-risk impacts;
- be used to design complex mine-dewatering schemes; and
- simulate the interaction between groundwater and surface water bodies to a level of reliability required for dynamic linkage to surface water models.

This places an increased emphasis on the quantity, quality and diversity of the dataset required for model development, requiring that:

- spatial and temporal distribution of groundwater head observations adequately define groundwater behaviour, especially in areas of greatest interest and where outcomes are to be reported;
- spatial distribution of bore logs and associated stratigraphic interpretations clearly define aquifer geometry;
- reliable metered groundwater extraction and injection data is available;
- rainfall and evaporation data is available;
- there is aquifer-testing data define key parameters;
- streamflow and stage measurements are available with reliable baseflow estimates at a number of points;
- reliable land-use and soil-mapping data is available;
- reliable irrigation application data (where relevant) is available; and
- there is good quality and adequate spatial coverage of a digital elevation model to define ground surfaces elevation.

It also places an increased emphasis on the quantity, quality and diversity of the dataset required for model calibration, requiring that:

- long-term trends are adequately replicated where these are important;
- seasonal fluctuations are adequately replicated where these are important;
- transient calibration is current, i.e. uses recent data;
- the model is calibrated to heads and fluxes;
- observations of the key modelling outcomes dataset is used in calibration;

- the model's predictive time frame is less than 3 times the duration of transient calibration;
- stresses are not more than 2 times greater than those included in calibration;
- temporal discretisation in the predictive model is the same as that used in calibration; and
- the mass balance closure error is less than 0.5% of total.

Current practice now (as opposed to the situation in 2010) requires a more thorough level of study. The 2012 Australian Groundwater Modelling Guidelines recommend that the quantities for which the model is being developed to predict (for example groundwater inflows to mine workings) be included in the calibration process.

Unlike the situation in 2010, more data has become available so it may be possible to now conduct a transient calibration, though this would be almost totally dependent on the quantity and diversity of available data, especially with respect to water volumes extracted from the mine workings at NRE No.1, and monitored streamflow records. For more information see **Section 2.2.5,** , pg 128.

Depressurized Zones

Submission

The groundwater model does not accurately reflect the true scope of the free draining depressurised zone as it doesn't take into account longwall width but assumes the zone stops at the same strata in all cases. This doesn't reflect the accepted Southern Coalfields Inquiry finding that this free draining zone extends to 1.7 times the panel width. Given the sensitivity of the Special Areas, single seam longwall and pillar widths should be within the limits of the Reynolds recommendations. Multi-seam layouts should be more conservative.

Response

See **Section 2.2.5**, pg 128.

Geological Data

Submission

The model must:

- include improved geological structure data to account for potential linkage between the mine and Reservoir as a result of these structures;
- define the boundary conditions along the Illawarra Escarpment. This is necessary as there is potential for pressure differentials between the Reservoir and the Illawarra Escarpment drives water through the Bulgo Sandstone (BSS) and out the Escarpment face;
- utilise known horizontal packer test data for the area and address the potential changes to the vertical permeability values as a result of past mining;
- describe all strata, including hydrogeological data, and all know geological features that cut across the strata including the degree of confidence that the element exists;
- describe all hydrogeological elements not covered in the dot point above;
- describe all man-made hydrogeological elements such as old workings, drill holes etc;
- identify drainage points outside the Cataract catchment;

- include a hydrogeological model of pre-mining conditions;
- comment on unknowns and their implications;
- comment of further work required to refine the model;
- show evidence that comprehensive identification of the impacts of mining has been undertaken;
- have an assessment of the impacts of mining;
- contain an evaluation of the risk of loss of storage from the Reservoir by comparison to the DSC risk acceptance criterion;
- undertake an assessment of the effectiveness of controls required to manage risks;
- include a report on a risk assessment undertaken to AS/NZ4360:2004 standards; and
- be peer reviewed.

Response

See **Section 2.2.4**, pg 111.

Modelling Data

Submission

As there is no attempt to compare the modelling results to results from other areas in the Southern Coalfields, OEH believes that the groundwater drawdowns have been significantly underestimated when compared to actual results from other Collieries. There is only 10 years worth of meteorological data and a limited and inadequate period of groundwater data used in the model. The model doesn't take into account any cumulative impact from previous mining and treats all existing workings as flooded and therefore already in equilibrium.

Response

See **Section 2.2.5**, pg 128.

3.5.2 Groundwater Monitoring

Water Fingerprinting

Submission

Any approval for this project should include conditions requiring at a minimum frequency of monthly, the collection, analysis and reporting on the water chemistry of the overlying strata, the water entering the mine and the Reservoir waters. Specifically the analysis should include algae trace element and Tritium isotope assessment.

Response

This issue is most appropriately dealt with through the DSC approval process. However it should be noted that using algae, trace element and isotope sampling as a guide to potential connection to the dam / creeks requires a sampling location in the mine that is:

- accessible (now and into the future);
- that is below the dam or Cataract Creek,
- has sufficient air; and
- has stable roof / floor walls to be safe (now and into the future).

These conditions don't exist at No.1 Colliery as a result of the multi-seam mining that has already occurred. In particular, tritium has about a 3 month turnaround time from sampling to results as there are only 2 labs that do it (ANSTO and one in New Zealand). Tritium is therefore a very poor method to use if rapid response is required to an issue.

Location of Monitoring Points

Submission

There are no groundwater monitoring bores down-gradient in Wonga East.

Response

There are no current or proposed groundwater monitoring bores down-gradient in Wonga East.

3.5.3 Groundwater Impacts

Water Loss

Submission

Mining that causes the loss of 3ML per day will seriously disturb and possibly pollute the groundwater which will have impacts near the surface. The reduced overburden strength in already mined areas means water will be lost down subsidence cracks from the base of a creek or swamp and can travel through delaminated and cracked strata to depths below the base of the nearby streams and thus fail to report downstream. Geoterra's comments to the contrary are incorrect. The reported changes from previous mining show that even low subsidence levels and strains can cause significant groundwater changes, and that there is every reason to believe that there is enhanced hydraulic connectivity throughout the rock column above the goaf. NRE has not demonstrated that it has a contingency plan for a worst case situation in which previous plugs placed in the Bulli Seam roadways were designed to prevent any significant water flow from connection to the Reservoir from being able to exit from the Pit Top.

Response

An updated assessment of potential structural / hydrogeological changes to the overburden and the effect on inflow of water into the mine and / or transferred from stream flow will be addressed in the proposed subsidence, groundwater and surface water models. NRE has commissioned a consultant to prepare a Closure Plan for the DSC to address the agency's concerns regarding potential consequences of connection to the Reservoir allowing large volumes of water to exit from the NRE No.1 Colliery Pit top portals. More detailed information with regard to these issues is contained in **Section 2.2.5**, pg 128, and **Section 2.2.9**, pg 197,.

Quaternary Aquifer

Submission

There is a sequence of 5 to 6m thick Quaternary sandy and gravelly alluvial deposits above the Hawkesbury Sandstone that act as a regional unconfined aquifer supplying baseflow to local creeks and Upland Swamps. The EA states that the Bald Hill Claystone will maintain hydraulic separation between the Quaternary aquifer and the underlying Hawkesbury regional aquifer and lower stratigraphic units. WCC doesn't believe that the Bald Hill Claystone will fulfil this role when affected by mine subsidence. The subsidence will increase soluble iron and manganese concentrations in the aquifer which will eventually result in iron hydroxide precipitation in the affected creeks.

Response

The limited extent of the 5 - 6m thick Quaternary sandy and gravelly alluvial deposits in some locations within the stream does not supply a significant baseflow to Cataract Creek and is independent of the Upland Swamps. The majority of baseflow would arise from delayed yield from the thin colluvial soil over the catchment as well as the up to 1.5m thick soil developed in the upland swamps and delayed yield from ephemeral perched and the regional phreatic surface within the overburden.

Subsidence is anticipated to potentially enhance soluble iron and manganese concentrations in surface seeps from the overburden, however current monitoring over a range of rainfall / recharge / runoff situations has already observed very distinctive iron flocculation in the tributary creeks and main channel of Cataract Creek which existed prior to the extraction of LW4 and LW5.

Baseflow Loss

Submission

There has been no attempt to address or quantify the baseflow losses to streams reliant on the Hawkesbury and Bulgo Sandstone aquifers as a result of groundwater depressurisation.

Response

The proposed groundwater model and revised surface water model will address the potential baseflow losses to streams as a result of groundwater depressurisation and surface fracturing. Further detail of the remodelling is available in **Section 2.2.5**, pg 128, and **Section 2.2.9**, pg 197.

3.5.4 Bald Hill Claystone

Aquiclude Properties

Submission

The Bald Hill Claystone does not effectively separate aquifers in the Hawkesbury Sandstone from aquifers below it.

Response

It is interpreted that the Bald Hill Claystone acts as an aquitard (not an aquiclude) where it is present and that mine subsidence may potentially enhance the vertical conductivity of the claystone, thereby reducing its aquitard properties after mine subsidence. See **Section 2.2.7**, pg 144, for more detail.

3.6 *Infrastructure*

3.6.1 Road Works

Approval for Road Works

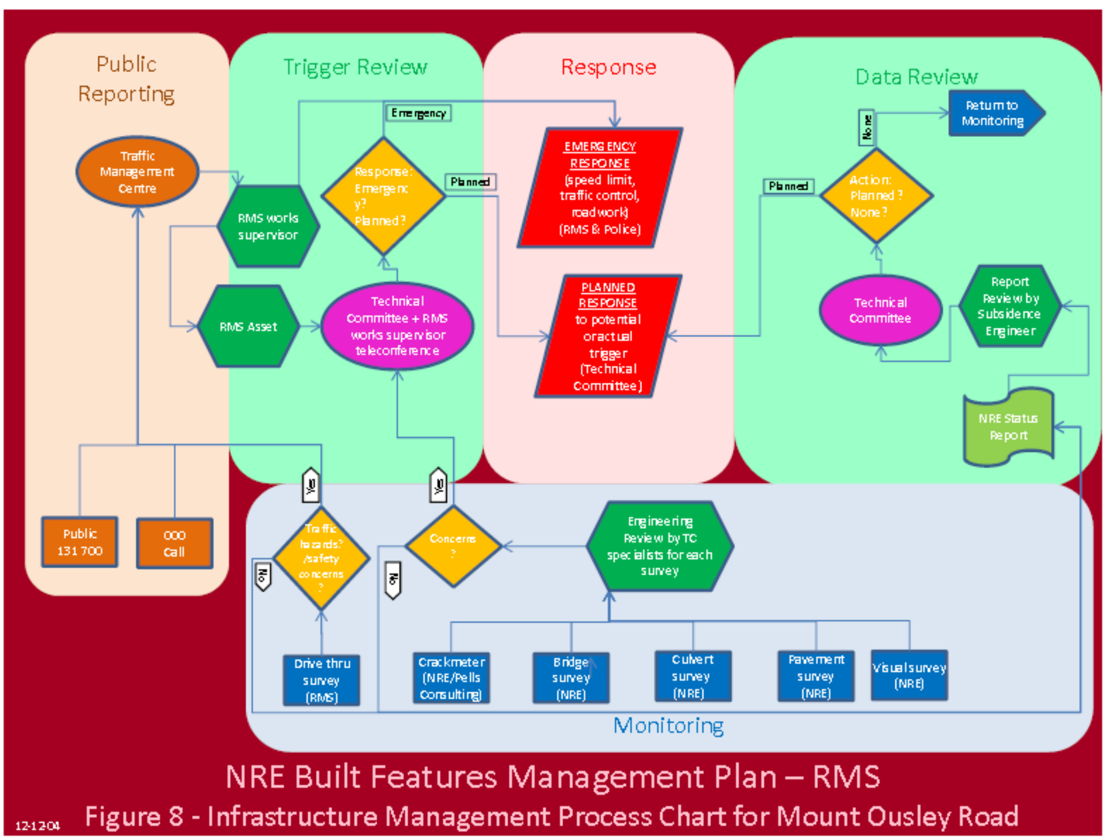
Submission

Consent under *Section 13 of the Roads Act*, 1993 is required for any proposed longwall adjacent to or under Mt Ousley Rd, or any RMS network, as well as any works within the classified road reserve. It should be noted that the proponent would need to enter into a Deed of Agreement to manage the mining impacts and relationships.

Responses

NRE is already working very closely with RMS through the RMS Technical Committee that was established to oversee the management of potential impacts on Mt Ousley Rd, Picton Rd Bridge and other RMS infrastructure from extraction of LW4 and 5. NRE is aware of its responsibilities with regard to works and activities on the road reserve and only operates within agreed process as outlined below in **Figure 81**, pg 300. The management process is outlined in full in the current LW5 SMP Built Features Management Plan - RMS which was developed in consultation with the RMS Technical Committee.

Figure 81 - Agreed Subsidence Management Process for Mt Ousley Rd



3.7 Mine Subsidence

3.7.1 Subsidence Predictions

Accuracy of Predictions

Submission

Subsidence predictions in multi-seam environments are much more complex and have lower confidence levels in the magnitude of subsidence than single seam mining. As such all design parameters and approaches must adopt extremely conservative values to account for the reduced level of confidence. Seedsman acknowledges this and adopts a sound engineering approach using worst case or upper bound values. However, this is still difficult to do without any calibration data or back-analysis based on actual mining results. (*Hebblewhite 2013*).

The use of the Seedsman 'visualisation' method is largely untested and is yet to be validated in multi-seam mining applications. Despite peer reviews finding significant shortfalls in the Seedsman approach, these inadequacies were not addressed in the final EA. The lack of empirical multi-seam subsidence data, particularly 3D survey data, means that subsidence predictions are largely based on expert opinion and personal judgement. Therefore accurate subsidence prediction in multi-seam environments is not possible with impacts likely to occur well outside the prediction area. OEH believe that it isn't acceptable to utilise adaptive management by mining first and then adjusting predictions to fit observed subsidence as this represents a 'trial and error' approach to mining. The subsidence in the opinion of OEH will represent the total of the subsidence of each individual seam. In general, the predictions are considered to have:

i. underestimated subsidence;
ii. not considered the reduced bridging capacity of the overburden;
iii. are not representative of observed subsidence behaviour; and
iv. have not addressed the issue of the continued subsidence of the 500 panels which were completed in 2000.

Therefore the 20mm subsidence zone must be assumed to be no less than the 35 degree angle of draw from the seam being mined.

Response

The reduced level of accuracy of the prediction methodology in multi-seam environments was raised in a number of submissions. While this concern is valid, the recent subsidence monitoring above LW4 and LW5 and a review of previous subsidence monitoring above the Balgownie Seam longwall panels provides a strong basis of local site based experience to allow more accurate predictions to be made.

The use of actual data from the extraction of LW4 to fine tune subsidence predictions in line with adaptive management philosophies is strongly supported by Hebblewhite 2013 while acknowledging that it is a slow response mechanism. "*OEH rejects what they refer to as a "trial and error" mining approach. In my earlier comments, I mentioned that the complexity of the subsidence modelling task in this case makes it difficult to make dramatic improvements in quality and accuracy of predictions. Some initial mining under the old workings, with comprehensive and time-dependant surface monitoring (in areas that do not impact significant features) would be a prudent approach to gain further understanding and validation of the modelling predictions. I would not classify this approach as "trial and error" mining. Such language is rather emotive and misleading*."

OEH spend considerable effort on "*discussion regarding the means of producing subsidence predictions from multiple seam workings. A number of these points may be valid, but some points made are challenged, such as a statement that the total subsidence will be the sum of subsidence from each individual seam. The complexity of seam interactions; old workings and the timing of the different extractions makes the situation far more complex than this statement suggests"* (Hebblewhite 2013).

The subsidence prediction technique used has been updated to reflect the available data. The revised approach is based on using the available data to provide insight in the subsidence mechanics and continuing to develop this understanding recognising the various subsidence processes involved. The results of this previous monitoring indicate that, although the magnitude of subsidence is greater in a multi-seam environment where there has been previous subsidence of the overburden strata because of the lower shear stiffness of previously disturbed strata, the subsidence behaviour in a multi-seam environment is essentially to single seam subsidence in its general characteristics. There are some subtle differences but these are second order effects and do not change the general characteristics. Another difference is that there is potential for pillar instability in areas of standing pillars in overlying seams in some areas and this potential needs to be recognised.

For the most part though, subsidence movements are essentially similar in multi-seam environment to single seam environments. Subsidence occurs primarily over the panel being mined with only low levels of ground movement outside. Vertical subsidence occur as low level movements at the goaf edge and become less than 20mm at about 0.7 times depth from the goaf edge. There is softer behaviour evident over previously mined goaf compared to over solid, but the differences are relatively small and tend to soften the movements at the goaf edge. Sag subsidence can be controlled by limiting the width of the panel but the panel widths required to keep subsidence to any given level are much less than in a single seam mining environment because of the reduced bridging capacity of previously disturbed overburden strata.

The issue of pillar instability and recovery of latent subsidence associated with bridging strata at the goaf edge is recognised as having potential to cause additional subsidence. This potential needs to be considered on a site by site basis, but experience of mining the Balgownie Seam longwalls and Longwalls 4 and 5 in the Wongawilli Seam suggest that the potential is less than was initially envisaged and the impacts less significant. Nevertheless, an area of standing pillars near the finish of Longwall 1 is recognised as having potential to become destabilised with potential for additional subsidence. Additional monitoring is recommended in this area, but it is noted that any additional subsidence is not expected to have an impact on any surface features of significance.

Although there is somewhat greater uncertainty for subsidence predictions in a multi-seam environment, the available data and further monitoring data is expected to continue to provide a strong base for further understanding. At this stage, the behaviour observed is repeatable and consistent with the mechanics of the process involved.

See **Section 2.2.7**, pg 144, and **Attachment B**, pg 426, for more detail on subsidence remodelling.

Geological Interactions

Submission

Seedsman states that due to the effects of prior mining in the Bulli seam on the overlying Bulgo Sandstone, the subsidence due to the underlying Balgownie seam can vary significantly. This then appears to be contradicted later in Seedsman's report when it is claimed that the Bulgo Sandstone can span Bulli seam void widths of up to 250m. This assertion needs verification from actual Balgownie seam subsidence (Hebblewhite 2013).

The SCA and OEH consider that multi-seam mining in Wonga East, coupled with the network of faults and dyke features is likely to give rise to variable and complex interactions across the area. Historically, OEH believes that that geological structures interacting with subsidence have led to damage to surface features, such as swamps. This complexity will cause a serious impediment to subsidence calculations irrespective of the method employed. This has been demonstrated by the much greater subsidence over LW4 than was predicted.

Response

There are a number of geological structures located in the general area of the proposed mining, but only two are considered to be significant in the context of the proposed mining. The others are located away from the areas of mining and are not considered to have any significant potential to be affected by mining.

A significant benefit of the previous mining activity is that the dykes and faults through the area are very well defined by previous mining activity. It is not credible that there could be other major structures in the proposed longwall area because any such geological structures would be evident in the overlying seams. This certainty of location of geological features gives this site a significant advantage in terms of potential geological issues.

A dyke referred to as D8 crosses several of the longwall panels and passes close to several others. The dyke is continuous through to the surface and essentially vertical. There is no experience of it being hydraulically conductive or in any way affecting the subsidence behaviour except in so far as the dyke has modified the mine layout which has itself altered the surface subsidence.

The Corrimal Fault is located to the south and east of the proposed longwall area and dips to the north. This structure tapers to the west and is not evident in the mine workings in the Bulli Seam from about Longwall 6. This type of tapering behaviour is typical of geological faults in the Southern Coalfield. The Corrimal Fault is not expected to have any significant influence on either subsidence behaviour or the hydraulic conductivity of the overburden strata.

Other faults such as the Rixons Pass Fault and Woonona Fault are remote from the area of mining and are not expected to be affected by mining.

See **Section 2.2.4**, pg 111, **Section 2.2.7**, pg 144, and **Attachment B**, pg 426 for a more detailed response to the issues raised.

<u>Bulli Seam Workings</u>

Submission

There is a risk of irregular subsidence of the old Bulli seam pillar workings. NRE must prove that the currently assumed Bulli seam pillar workings mine layout is correct as there is evidence that some of the pillars shown on plans don't exist. It must also demonstrate the existence, nature, geometry, distribution and stability of any significant voids and/or standing pillars/remnants within the Bulli Pillar workings.

This is of particular importance in the LW1-3 area as the DRE believes the area may be subject to higher risk of Pillar Run.

Response

The potential for pillar instability in the Bulli Seam has been discussed above. There is certainly some potential in the vicinity of Longwall 1 and the particular area where this potential exists has been identified as needing special consideration. Other areas where there may be a similar potential are more difficult to identify because the mine records for the period of mining are incomplete and may be inaccurate.

Nevertheless, a large part of the Bulli Seam mine workings have been mined under by the Balgownie Seam longwall panels (1970-1982) and more recently by the Wongawilli Seam longwalls (2012-2013). The subsidence monitoring from both periods of mining indicate that there has been no evidence of a significant subsidence event associated with pillar instability although there are several areas where a low level of additional subsidence has been observed and this is additional subsidence is attributed to possible pillar instability.

Even if such instability were to occur, the irregular nature of the panels that have been developed and their limited width mean that the surface subsidence that results is likely to be less than a few hundred millimetres and limited in size to within the area of the panel affected. Such a low level of additional subsidence is within the tolerance of the subsidence predictions that have been made and the impacts associated with any such subsidence would be within the range of predicted impacts.

Mount Ousley Road is protected by a barrier of about 170m and the area adjacent to the Mount Ousley Road has already been mined under by the Balgownie Seam longwall panels so it is not credible that there could be marginally stable pillars in the Bulli Seam still standing in this area.

Some of the tower on the power transmission lines are planned to be subsided up to several metres and the additional subsidence that may result from pillar instability in the Bulli Seam is not considered to have potential to cause any significant additional impacts compared to those that are already planned for.

Although the potential for pillar instability in the Bulli Seam is credible, the significance of any surface subsidence that may result is considered to be low, especially as this subsidence affects the items of major surface infrastructure.

See **Section 2.2.7**, pg 144, and **Attachment B**, pg 426.

<u>Valley Closure, Upsidence and Far Field Movements</u>

Submission

Seedsman states that valley closure is only due to down-hill movement and bedding plan shear. While this is part of valley closure, the predictions ignore stress as part of valley closure and the related valley floor buckling related to upsidence. The Seedsman model cannot allow for the problem of assuming continuum behaviour in a jointed rock mass. As such, valley closure, upsidence and far-field horizontal movements are not likely to be predictable by the model and it doesn't take into account surface topographical changes and their impact on the stress field. The lack of valley closure, upsidence predictions and far field movements is a deficiency of the model given the widespread acceptance of the phenomenon (*Hebblewhite 2013*).

Response

The prediction of valley closure, upsidence, and far-field movements is recognised as not being an exact science even for single seam mining. Nevertheless some characteristics are recognised. The influence of horizontal stresses as a source of energy to displace rock strata is dependent on their magnitude. Near to the Illawarra Escarpment and adjacent to previous mining activity as this site is, the in situ horizontal stresses are likely to be significantly diminished as both a result of the free surface of the escarpment and as a result of previous mining activity.

Nevertheless, a far-field subsidence monitoring survey network has been installed and is planned to be further upgraded to allow measurement of any such movements. These movements are unlikely to be significant in the context of any of the infrastructure located in the vicinity of the proposed mining area.

The predictions of valley closure and upsidence are recognised as being upper bound predictions because they are based on experience in deep gorges where the in situ stresses are much higher than they are at this site. A program of predicting, monitoring and response (limiting the length of longwall panels) is considered to be an effective method of managing this uncertainty. The monitoring available from the Balgownie Seam longwall panels and from Longwall 5 indicates that this method is likely to be effective in terms of managing impact on Cataract Creek.

The offsets that have been designed into the revised mine layout and the avoidance of mining directly under the main channel of Cataract Creek provide a buffer against closure related impacts. The commitment by NRE to stop the longwalls short if closure movements become excessive provides an additional level of management control.

See **Section 2.2.7**, pg 144 and **Attachment B**, pg 426.

3.7.2 Impact Predictions

Accuracy of Predictions

Submission

Given the actual subsidence observed for LW4 it would appear that the Seedsman subsidence predictions are too optimistic. The reliability of subsidence prediction is critical for calculation potential subsidence impacts. As a result the impact predictions can't be used as a base for a reliable impact assessment. OEH believe that it is likely that the impacts from the proposal are likely to be at least equal and potentially worse than previous mining impacts identified.

Response

In response to a review of the DRE submission on subsidence Hebblewhite 2013 notes, "*DRE expresses concerns over the accuracy of impact assessments, based on uncertainty over accuracy of subsidence modelling. They note "there is a need to further validate subsidence modelling to improve certainty around the accompanying impact assessments". This concern over accuracy and uncertainty in the subsidence modelling has been raised in my earlier report reviewing the subsidence prediction contained in the EA. It is a valid concern. However, as noted previously, the presence of the old workings together with multi-seam interactions makes this an extremely complex subsidence modelling task. It is unlikely that any further improvements in modelling predictions can be made, prior to mining commencing and calibration/validation being collected progressively. The DRE request for further validation is therefore considered reasonable, only in the context of validation data being gathered once mining commences and proceeds in initial areas. Further* *validation prior to any approval is not considered to be a viable option based on the complexity of the problem*."

NRE agrees with this assessment and has been using the extraction of LW4 and LW5 as an opportunity to gather critical data to further revise its approach to predictions of subsidence behaviour.

With regard to the OEH assertion that impacts from this project are likely to be equal or greater than prior mining NRE will refer again to Hebblewhite 2013 in which the following statement is made, "*In the supporting detail the OEH makes a statement that because multiple seams have been mined, the impact on surface features "are likely to be at least equal to (and potentially worse than) previous mining impacts identified...".* ***This is a very broad statement which does not take any account of detailed mine dimensions, geology and depth****. Whilst such a statement represents one possibility, it is certainly not valid to claim that this is a logical conclusion – without taking account of other factors which may well mitigate against worse or even equal impacts*.

OEH makes further comments about previous subsidence impacts of longwall mining as being worse than predicted – again, this is a very broad and unsubstantiated statement. ***Caution should be exercised in accepting this opinion without supporting evidence from all other sources of previous mining.***

See **Section 2.2.7**, pg 144 and **Attachment B**, pg 426, for more detail on subsidence.

Specific Predictions

Submission

Stating no mining beneath or near an item will cause no impact on the item is not correct. The design strategy of longwall panel layout must be aimed at no impact irrespective of distance from the item (*Hepplewhite 2013*).

There are some surface features that have not been assessed as significant due to prior mining impacts and other which may not be manageable if affected by mine subsidence and require a full risk assessment of subsidence or pillar run, particularly in the LW1-3 area. These include:

- angled electricity transmission towers for which there is no current established mitigation measures;
- the Illawarra Escarpment slope and cliff stability as a result of subsidence or pillar run. This must include a full assessment of current slope stability and existing landslides and other risk factors; and
- Mt Ousley Rd if there is potential for pillar run of subsidence to impact adversely on the road causing public access disruption.

Response

There is considered to be no potential for the proposed mining to impact on the Illawarra Escarpment and in particular the section of Hawkesbury Sandstone outcrop at Brokers Nose. It should be recognised that there is always potential for natural cliff falls to occur. Two such natural events have occurred in the last six years, one on Mount Keira in 2007 and a second at Clifton in 2013.

The only recognised mechanism for the cliff formations on the Illawarra Escarpment at Brokers Nose to be impacted by mining would be for horizontal stress concentrations to occur along the line of the escarpment. However, the cliffs associated with Brokers Nose are 900-1000m from Longwall 1 and are therefore two far away from the proposed longwall panels for there to be any potential for significant horizontal stress concentrations between the longwall panels and the escarpment.

See **Section 2.2.7**, pg 144 and **Attachment B**, pg 426 for more detail.

3.7.3 Management Methods

Subsidence Surveying

Submission

NRE only use 2D subsidence surveying and must be required to use 3D surveying. The subsidence surveying must be maintained for the longer term to ensure that residual subsidence is captured (*Hebblewhite 2013*)

Response

The subsidence monitoring systems being used at NRE are undergoing continued upgrading from two dimensional surveying techniques used during the initial stages of mining LW4 through to full three dimensional subsidence monitoring with a far-field GPS survey control network. The 3D monitoring network used for LW5 is considered to be an intermediate step. Additional closure marks and further upgrading of the monitoring is proposed in this report.

Adaptive Management

Submission

> NRE must utilise adaptive management including mine layout adjustment to address subsidence impacts and must provide the details of the adaptive management approach and TARP's. According to Hebblewhite 2013, NRE needs to "*provide a more definitive explanation of exactly how their adaptive management approach would work – what data will be monitored; what mining decisions will be made with regard to any changes to the mine plan; when will such decision be made; who will make such decisions; and when will they be implemented relative to the progress of mining; and what will be the overall decision-making process*."

Response

> The first stage of adaptive management is evidenced by the changes made as part of the Preferred Project. Closure monitoring across Cataract Creek is being used to control the length of LW5 and is planned to be used for LW6 and LW7 as well. Other opportunities exist as part of the Pt3A process such as the PAC assessment, via Extraction Plan preparation, via Subsidence Management Plan (SMP) preparation, via SMP reviews at the end of the extraction of each longwall block and via directions from government agencies at any time during the approved extraction.

Stopping longwalls

Submission

> NRE have advised that it is a difficult and dangerous operation to stop a longwall at a point that has not be prepared beforehand. It is therefore likely that NRE will simply continue to mine despite surface impacts.

Response

> The current LW5 SMP contains a TARP that undertakes to stop mining once accepted trigger levels reach a specific value for valley closure. This type of adaptive management measure can be used and is designed to allow the longwall managers to plan for a longwall cessation so that it can be undertaken safely. This type of approach will continue to be used by NRE in its remaining longwalls where applicable, should they be approved.

Exclusion Zones

Submission

> An exclusion zone of 100m either side of the Mt Ousley Rd has been recommend wherever Bulli Seam extraction has occurred. While this may be appropriate and adequate it is not backed up by any calculation. Monitoring data must be used to back up the validity of this exclusion zone (*Hebblewhite 2013*).

Response

> NRE will not be adopting exclusion zones as part of the Preferred Project. All mining will be undertaken on a risk management basis in liaison with key stakeholders.

3.7.4 Pillar Run

Pillar Run

Submission

1. - DRE has advised that pillar run is a significant concern that must be addressed, particularly with regard to LW1-3 in Wonga East. It must also be recognised that any failure or simple settlement of these pillar workings may involve some time-dependent longer term behaviour (*Hebblewhite 2013*).

Response

1. **Pillar Run** - Hebblewhite 2013 agrees with the peer review's in the EA that, "*the risk of large scale regional pillar run is low, albeit not impossible. Similarly, a slower speed pillar creep event may occur (such as has been seen in the Bulli Seam before (Coal Cliff Colliery), but not due to an underlying goaf. The most likely consequence of an underlying goaf causing vertical subsidence beneath pillar regions is a settlement of the overall pillar region rather than any form of catastrophic, wide-scale failure*."

   See **Section 2.2.7**, pg 144, for more detail on this issue, particularly with regard to LW1.

3.8 Rehabilitation

3.8.1 Rehabilitation Management

<u>Rehabilitation of Impacts</u>

Submission

There is no commitment by the Proponent to rehabilitate any area that is impacted by mine subsidence as a result of this proposal.

Response

See **Section 2.1.2,** pg 35, and **Section 2.2.8**, pg 195.

3.9 *Surface Water*

3.9.1 Stream Assessment and Modelling

Insufficient Data

Submission

The WRM stream modelling was undertaken with insufficient flow, rainfall, runoff and evaporation data for Cataract Creek catchment.

Response

NRE is remodelling catchment Surface Water. See **Section 2.2.9**, pg 197.

Model Validation

Submission

The validity of the calibrated model parameters to characterize the daily flow regime is expressed in terms of daily and monthly statistics for the Nash Sutcliff coefficient. In both cases, the coefficient indicates reasonable agreement between observed and modeled data for daily and monthly runoff. However, it appears that the statistic has been calculated by comparing the model output against that data actually used to derive the parameters. It is hardly surprising, therefore, that the Nash Sutcliff coefficient indicates reasonable agreement between the runoff data and modeled values. This does not constitute an independent validation of the models. More appropriate methods to validate the AWBM model would be to either separate the available data into two and use one as the calibration period and one as the validation period or to separate the data into separate years and use the 'leave-one-out cross validation' procedure.

Response

NRE is remodelling catchment Surface Water. See **Section 2.2.9**, pg 197.

Flow Modeling

Submission

As shown in *Figure 6.8, pg 46, and Figure 6.10, pg 48, of Appendix A in Annex O of the EA* the model parameters derived for Bellambi Creek tend to over-estimate the low flows (<1 ML/day) and the model parameters derived for Loddon River tend to under-estimate the lower flow range (<10 ML/day). The discrepancy between the observed and modelled flows in the low flow range indicate that the current AWBM model does not provide a reliable basis for assessing the potential impacts of subsidence on the lower flow range that is relevant for stream health.

Response

NRE is remodelling catchment Surface Water. See **Section 2.2.9**, pg 197.

Reservoir Modelling

Submission

Based on the available data and results, the AWBM model is a reasonable model for the assessment of reservoir yield. However, when discussing potential consequences of subsidence, *Section 7.2.1, pgs 59-60, of Appendix A in Annex O of the EA* report notes that *"During higher flow events, where there was a large discrepancy between the modelled and observed inflow, the modelled inflow was modified to achieve an improved fit to observed volumes.* This statement calls into question what other 'modification' to the modelled flows was necessary during the validation modelling reported in *Section 6.5, pgs 49-53*, *of Appendix A in Annex O of the EA.* Statistics and flow duration graphs are required for Cataract Creek and Cataract River for the period 1976 to 2010 to inform the Cataract Reservoir water balance model.

Response

NRE is remodelling catchment Surface Water. See **Section 2.2.9**, pg 197.

Baseflow Modeling

Submission

Baseflow has two potential sources which are subject to separate impacts from mine subsidence, they are:

- seepage from swamps that could be subject to shallow sub-surface cracking leading to flow diversion; and
- release of groundwater from sandstone aquifers that could be affected by drawdown.

It would be useful to quantify the relative contributions in a way that is consistent between the surface and groundwater assessment.

There is also no detail or diagram of which sections of Cataract Creek are groundwater gaining and which parts of Cataract Creek are groundwater losing. A groundwater baseflow estimate for Cataract River is required similar to the one for Cataract Creek in *Table 10, pg 89, in Annex P of the EA*.

Response

NRE is remodelling catchment Surface Water. See **Section 2.2.9**, pg 197.

Data Presentation

Submission

The visual presentation could be improved as follows:

- Catchment boundaries need to be shown on plans to assist assessment of potential impacts on hydrology; and
- Update *Figure 11, pg 47, in Annex O of the EA* to cover all of Wonga East and add the colour coded swamps from *Figures 4 and 5 in Annex Q of the EA* to assist in gaining an understanding of the relationship between the drainage network and the swamps.

Response

Visual presentation will be improved as follows:

- Catchment boundaries will be shown on plans to assist assessment of potential impacts on hydrology (WRM as well);

WRM will update *Figure 11 in Annex O of the EA* to cover all of Wonga East and add the colour coded swamps from *Figures 4 and 5 in Annex Q of the EA* to assist in gaining an understanding of the relationship between the drainage network and the swamps.

3.9.2 Stream Monitoring

Lower Order Streams

Submission

Geoterra refers to 1st and 2nd order streams as ephemeral and of little consequence if impacted without any measurement of flow. This ignores the fact that many Upland Swamps provide continuous flow via 1st and 2nd order streams between the catchment headwaters and larger streams.

Response

The contribution of 1st and 2nd order streams and upland swamps will be addressed in the revised modelling that is being undertaken. See **Section 2.2.9**, pg 197.

Creek Cross Sections

Submission

The Evans and Peck Review of Surface Water Assessments recommends that the orientation (facing up or downstream) of the cross sections for Cataract Creek and Cataract River, shown in *Figures 3.7 and 3.10 of Appendix A to Annex O of the EA* be indicated via text. Also the surface water assessment and surface water modelling use different conventions for measuring along the stream. A common convention must be used for all references to features along the creeks such as rock bars, pools and riffle zones.

Response

Common conventions will be used for measurements along the streams in the revised surface water assessment. See **Section 2.2.9**, pg 197.

Flow Monitoring

Submission

There is no current volumetric monitoring undertaken in Cataract River or Cataract Creek. As such there is no quantifiable evidence that surface water that flows into subsidence cracks re-emerges downstream. Monitoring must be established along the entire stretch of the Cataract Creek system from 1st order streams to the Reservoir to determine if water that passes down subsidence cracks does indeed report downstream or is lost and what the impacts of any emergent flows are on the water quality.

Additional information would assist as follows:

- There was no flow monitoring data available to inform any hydrological analysis of the creeks in the Wonga East area for the EA so alternative data from Bellambi Creek and Loddon Creek catchments were used. The EA states that both systems show similar responses to rainfall with baseflow being a notable feature and runoff constituting a small percentage of total runoff. The runoff from Loddon Catchment is 90% greater than Bellambi Catchment. A comparison runoff as a percentage of rainfall in each catchment area would assist in justifying the EA's assertion that this greater runoff is due to differences in rainfall and a dam in Bellambi Creek;

The flow duration curve in *Figure 5.3 of Appendix A in Annex O of the EA* would benefit from being expressed in mm/day to help distinguish differences in runoff characteristics. Another option to account for runoff differences may be a comparison of swamp areas between the catchments.

Response

Volumetric monitoring commenced in December 2012 at CC2 & CC3 and in January 2013 at sites CC6, CC7 & CC8 in Cataract Creek. The SCA has monitoring data for the Cataract River. Back calculation based on stream heights will be undertaken by WRM as part of the remodelling of the surface water impacts from the Preferred Project in order to assess the degree of flow loss / gains in the streams.

Additional information will be amalgamated as follows to assist in the remodelling of the surface water impacts from the Preferred Project:

- flow monitoring data from Cataract Creek (Gujarat), Cataract River (SCA) as well as Bellambi Creek and Loddon Creek (SCA); and

the expression of data in the flow duration curve will be in mm/day to help distinguish the differences in runoff characteristics. Consideration will be given to making a comparison of swamp areas between the catchments to account for runoff differences.

Pool Monitoring

Submission

There was insufficient pool depth monitoring to inform a hydrological analysis of Cataract Creek and Cataract River catchments. *Figure 11, pg 47, in Annex O of the EA* would be more informative if it provided greater detail such as:

- the extent of the pools;
- which pools have been instrumented for water level monitoring since November 2010 (CC3, CC4 and CC9);
- which pools are proposed to be instrumented in the future (CC6, CC7 and CC8);
- why no monitoring is proposed for pools constrained by ccRB13 and 14 which appear to be susceptible to rockbar cracking from LW8 in Wonga East; and
- giving the level of the logger in each pool so that the pool level records quoted as "*Pool Water Level (mm Above Logger)*" takes on some meaning.

Response

Pool depth monitoring has been expanded in Cataract Creek (CC1 to CC9 and CT1 with possible additional sites in CT2 and CT3 currently being investigated) as well as in Cataract River (CR1-3) to enable an informed hydrological analysis of Cataract Creek and Cataract River catchments to be conducted. Additional details and figures showing the extent of pools and rockbars as well as instrumentation of pools will be provided when the remodelling is complete. See **Section 2.2.9**, pg 197.

Water Quality Monitoring

Submission

It appears that water quality monitoring for the project was only undertaken 2 monthly rather than the usual practice of monthly with no explanation in the EA. A full list of all the analytes monitored and tables showing the key statistics must be produced to assist assessment of the project. Further analysis of water quality statistics must be undertaken along with justification of why proposed water triggers have been selected that are different to the ANZECC Guidelines.

Response

The spatial and temporal distribution of water quality monitoring of streams within the project area will be detailed, including the analytes monitored and tables showing key statistics and justification of proposed triggers when the remodelling is complete. See **Section 2.2.9**, pg 197.

3.9.3 Subsidence Impacts

Remediation

Submission

Watercourses cannot be repaired once cracked. Peabody has tried and failed at Waratah Rivulet.

Response

See **Section 2.2.8**, pg 195.

Negligible Impact Criteria

Submission

All streams are significant in water catchment areas and should therefore be subject to no more than negligible impacts. NRE have not addressed the PAC expectations that for any third order or larger stream of special significance status, or otherwise qualifying for special protection, an assessment is undertaken of all of its tributaries to determine whether subsidence induced impacts could compromise the protection status of the stream itself. Cataract Creek itself must be subjected to no more than negligible damage and therefore not undermined nor should mining be undertaken within the 35 degree angle of draw.

Response

NRE will address the PAC expectations that for any third order or larger stream of special significance status, or otherwise qualifying for special protection, an assessment will be undertaken of all of its tributaries to determine whether subsidence induced impacts could compromise the protection status of the stream itself. Cataract Creek will be subjected to no more than negligible damage.

Adaptive Management

Submission

Adaptive management cannot guarantee that no more than 250mm of subsidence will be experienced by the creek or that impacts will be non-negligible. Vertical subsidence is an inappropriate measure for stream impacts. More appropriate measures should be valley closure, and systematic tensile and compressive strains.

Response

Adaptive management measures for streams will be proposed which will be based on measurement of, and triggers based on, monitoring of tensile and compressive strains, vertical subsidence, and valley closure.

Ferruginous Seeps

Submission

Geoterra is incorrect in stating that ferruginous seeps are natural occurrences. According to the BSO PAC, seeps on the Woronora Plateau are due to far field impacts from mining and cause significant ecological and physical impacts. The proposed mining will create new seeps and make existing seeps worse.

Response

Although natural, non-mining related ferruginous seeps have been observed in both the Southern Coalfields, and within the NRE No.1 lease area, it is recognised that either existing seeps can be enhanced or new seepage points may develop. The location, likelihood and ecological / physical impacts of ferruginous seeps will be addressed in a revised surface water assessment.

3.9.4 Subsidence Management

Rehabilitation

Submission

There is no undertaking by NRE to remediate or rehabilitate any stream impacted by this proposal.

Response

Section 20.6.7, pgs 325-326, of the EA undertakes to rehabilitate impacts to streams if required as part of a Contingency Plan.

Mine Layout

Submission

WCC would like to see A2 LW9 shortened and LW 8 deleted to protect Cataract Creek from undermining and cracking.

Response

This has been addressed. See **Figure 2**, pg 11.

3.9.5 Subsidence Management

RMS Risk Assessment

Submission Issues

Any longwall within a distance of 5 times the seam depth to an RMS asset needs to be submitted to RMS for a risk assessment of subsidence impacts and far-field effects. Consideration of subsidence impacts on RMS infrastructure would need to include consequential impacts on infrastructure, functionality and user safety, and far-field effects.

Response

NRE has had continued involvement in subsidence management activities with RMS via the RMS Technical Committee for LW4 and LW5. The 5 times depth of cover from the edge of Mt Ousley road is around 1.3km, in order to be conservative NRE will use the 1.5km far field criteria to determine which longwalls will required RMS input. On this basis NRE will continue its liaison with the RMS Technical Committee for longwalls 1, 2, 3, 6, 7 & 9 at a minimum or until advised by RMS that liaison is no longer necessary.

4 Statement of Commitments

This section outlines the proposed changes from the Draft Statement of Commitments contained in *Table 29.1, pg 506 of the EA*.

4.1 Proposed Changes to the Statement of Commitments

4.1.1 Removal of the Statement of Commitments from the PPR

It is proposed to remove the Statement of Commitments from the Preferred Project for the following broad reasons:

- The Commitments were unnecessary restatements of existing and unavoidable responsibilities such as compliance with legislation
- The Commitments are broad, unmeasurable, and inflexible
- Some commitments refer to elements of the original EA that is no longer part of the PPR.
- It is assumed that the Preliminary Works Pt3A will be integrated into any approval issued for this application thus capturing existing approval conditions such as management plans etc; and
- It is NRE's experience that a Statement of Commitments results in unnecessary time delays and costs on NRE and unnecessary processing of application by DPI considering that a modification of the Pt3A would be required every time economic or operational changes made the Commitments redundant or if timing needed to change. These commitments are better suited as part of a defined, conditionally required, regularly reviewed and approved management plan that exists as part of a site environmental management system.

4.2.2 Recommendations for Replacing Commitments in PPR

Based on recent experience, NRE believes that the Statement of Commitments creates significant difficulties for companies attempting to address dynamic economic, commercial and legislative issues in their operations. The need to submit a modification application to DPI to change issues with incorrect or unclear wording, modify deliverable dates for elements of an approval or make changes to improve the effectiveness of environmental management is an unnecessarily slow, inefficient and wasteful process with regard to both cost and time.

An excellent framework for effective environmental management, that can be both flexible and easily regulated by DPI, is already in existence as part of the Environmental Management, Reporting and Auditing section of modern Major Project approvals and can provide good environmental outcomes when coupled with specific management plans developed to achieve detailed and measurable performance criteria. Therefore, in place of the existing Statement of Commitments, NRE would like to recommend that the DPI consider the following conditioning, if considered necessary, to ensure that specific environmental outcomes are met.

1. Include a general condition in any approval requiring:
    - NRE to comply with all relevant legislation related to its operational environmental impacts (*this would automatically include the MOP, AEMR & SMP process and capture the majority of the Commitments made in the original EA*)

2. Include specific conditions for the Pit Top areas requiring the preparation of a
    - Stakeholder Engagement Plan (*developed in liaison with appropriate agencies/community/CCC and submitted to DPI for approval*);

- Bushfire Management Plan (*developed in liaison with appropriate agencies and submitted to DPI for approval*);
- Public Safety Management Plan (*developed in liaison with appropriate agencies and submitted to DPI for approval*);
- Visual Amenity Management Plan (*developed in liaison with appropriate agencies and submitted to DPI for approval*);
- Waste Management Plan (*developed in liaison with appropriate agencies and submitted to DPI for approval*)
- Construction Management Plan/s (*developed in liaison with appropriate agencies and submitted to DPI for approval prior to commencement of construction*);
- Noise Management Plan (*developed in liaison with appropriate agencies and submitted to DPI for approval*);
- Air Quality and Greenhouse Gas Management Plan (*developed in liaison with appropriate agencies and submitted to DPI for approval*);
- Traffic Management Plan (*developed in liaison with appropriate agencies and submitted to DPI for approval*)
- Biodiversity Management Plan (*developed in liaison with appropriate agencies and submitted to DPI for approval*);
- Surface Facilities Water Management Plan (*developed in liaison with appropriate agencies and submitted to DPI for approval*);
- Heritage Management Plan (*developed in liaison with appropriate agencies and submitted to DPI for approval*); and
- Rehabilitation Management Plan (*developed in liaison with appropriate agencies and submitted to DPI for approval*).

3. Include specific conditions for Mine Subsidence areas requiring the preparation of an:
    - Extraction Plan.

4. Add to the standard condition for Management Plan Requirements the inclusion of detailed QA/QC processes for data capture, storage and processing.

4.2 Reasons for Removal of Individual Statement of Commitments from the EA to PPR

Table 68 - Reasons for Removal of Individual Commitments

ISSUE	EA OUTCOME	EA COMMITMENT	EA TIMING	REASON FOR REMOVAL FROM PPR
Statutory Requirements	Compliance with all conditional requirements in all approvals, licences and leases	The development will be carried out a s outlined in : • this EA Report (EA); • Project Approvals; • Environment Protection Licence; • Subsidence Management Plans; • Mining Lease(s); • Controlled Activity Approvals; and • any other required approvals, licences or leases.	Continuous and as required	This is an unnecessary commitment. Under NSW and Australian law NRE is already required to comply with all relevant legislation, approvals, conditions and legal undertakings.
	All operations conducted in accordance with all relevant documentation	Undertake all activities in accordance with the accepted Mining Operations Plan, environmental procedures, safety management plan and/or site-specific documentation in force at that time	Continuous and as required	This is an unnecessary commitment. This is a conditional requirement under modern planning approvals (e.g. Schedule 2, Conditions 2, 3 & 4 of MP10_0046)
Stakeholder Consultation	Effective communication / consultation is undertaken throughout construction and operation of the Project.	Conduct regular community liaison meetings and provide regular updates to the community both during construction and operation of the project	Prior to the construction and at regular intervals of not less than twice a year during operation of the Project.	Placing broad and unmeasurable commitments in a development approval Statement of Commitments is an inappropriate and inflexible method for ensuring good community consultation is undertaken. A more appropriate method is for DPI to conditionally require a Stakeholder Engagement Plan as part of any approval and outline required content as was required for various management plans under MP10_0046.
Risk	Bush fire risk will be managed by existing response procedures and on-site fire fighting water and equipment	Bush fire management measures will continue throughout the Project and include: • slashing/landscaping/vegetation management to minimise fuel build-up; • maintenance of fire breaks; • ongoing communication with the NSW Rural Fire Service; and • site fire fighting equipment and emergency response procedures		Placing broad and unmeasurable commitments in a development approval Statement of Commitments is an inappropriate and inflexible method for ensuring adequate bushfire management. A more appropriate method is for DPI to conditionally require a Bushfire Management Plan as part of any approval and outline required content as was required for various management plans under MP10_0046.

	Public Safety is a matter of regular consideration given the close proximity of the Russell Vale site to local residential areas.	Steps taken to ensure Public Safety will include: • signage around the site to inform the public of the dangers of entering the site Signs are to be replaced if removed or damaged; • Maintenance of boundary fences particularly adjacent to residential areas; • random mobile patrols of the site and some adjacent streets, covering after hours, weekend and public holiday periods by a private security company ; • locked access gates after hours; • installation of camera surveillance facilities as both the Russell Vale and No.4 Shaft sites; • sealing of locking off entrances to portals where possible; • ensuring all truck drivers obey the road rules through implementation of a driver code of conduct; and • limiting the speed of trucks entering and leaving the site.		This is a reiteration of existing public safety activities that are required as part of safety functions overseen by WorkCover, DRE or required as part of insurance policies and generally to minimise NRE's exposure to litigation due to trespassers becoming injured
Subsidence	Potential adverse impacts from subsidence are managed, monitored and remediated where necessary	Implement a subsidence monitoring program and management plan that includes , but may not be limited to: • appropriate triggers and monitoring systems to demonstrate how management strategies have been • achieved and where improvements can be made before, during and after mining; • a set of pre-determined triggers; • responses and actions that flow from each trigger. • adaptive management processes for continually detecting impacts and, validating predictions; • contingency planning for any unpredicted impacts; and • remediation of unpredicted impacts	Prior to mining and ongoing	NRE has an existing approved monitoring plan for Wonga East LW5 that meets the requirements of the Preliminary Works Pt3A and the SMP process. This plan is updated at the end of each approved longwall and resubmitted for approval for the following longwall. Any future longwall mining undertaken as part of this proposal will require a new Extraction Plan and SMP to be submitted that meets these criteria.
		Ground movements will be monitored as mining occurs, to measure the extent to which the actual movements may differ from those predicted. Any predicted impacts will be periodically reviewed in the light of additional data	Prior to mining and ongoing	
		An ongoing surface water monitoring and remediation program will be developed in consultation with the SCA, DRE and OEH.	Prior to mining and ongoing	

		A Built Features Management Plan (BFMP) will be developed, in consultation with infrastructure owners such as RTA to manage impacts due to mining, if any, to the RTA infrastructure identified through a risk management assessment.	Prior to mining and ongoing	
		For areas where the standing pillars in the Bulli seam are present under and within 100 m of Mount Ousley Road, subsidence will be monitored to assist in locating the finish line of the longwall panels.	Prior to mining and ongoing	
		The specific longwall layout along with the start and end lines of applicable longwalls will be altered in the event that minimal subsidence impact cannot be demonstrated prior to secondary extraction under Cataract Creek	Prior to mining and ongoing	No extraction is proposed under Cataract Creek.
Soil &Water	Construction and operations are managed such that adverse impacts to water quality and flows in Bellambi Gully Creek and the impact to surrounding residents is prevented or minimised	Dirty stormwater and mine water (up to the design standard) will be treated on site prior to discharge.	Continuous and as required	This is a matter that is already regulated by DPI under the Surface Facilities Water Management Plan as part of the Preliminary Works Pt3A, by the DRE as part of NRE's mining lease and by the EPA under the Colliery's EPL. Any changes resulting from the approval are most appropriately dealt with as part of an update of the approved Surface Facilities Management Plan and EPL (if required).
		Dirty stormwater from hard surfaces will be diverted into the SWCD. Water will be held in the SWCD to reduce solids prior to treatment and then discharging via LDP2.	Continuous and as required	
		The stormwater control dam (SWCD) will be kept at a level that allows 30 ML of stormwater to be captured on site, reducing the flow and flood potential downstream.	Continuous and as required	
		Chemicals will be properly stored and bunded. Dosing of flocculent will be metered and monitored on site.	Continuous and as required	
		Monitoring and dosing of flocculent will be audited.	Continuous and as required	

		Preparation of a Construction Management Plan that includes the following: • a dry and wet basin arrangement to minimise sediment transportation to the stormwater dam; • works likely to contribute to erosion will not take place during heavy rainfall; • stripping of topsoil, where available, immediately before starting bulk earthworks to be used for rehabilitation or revegetation works on site; • suitable areas for any temporary stockpiling of excavated soil (on flat ground) will be clearly identified and delineated before the commencement of works; • ensure stockpiles are: o constructed on the contour at least 2 (preferably 5) metres from hazard areas, particularly areas of concentrated water flows or slopes steeper than 10 percent; o stabilised if they are to be in place for more than 10 days. The stockpile of VENM excavated from the construction of the bypass channel will be grassed; o protected from run-on water by installing water diversions upslope; and o installed with sediment filters immediately downslope to protect other lands and waterways from pollution.	Prior to construction	It is recommended that, if considered necessary, the DPI add the requirement for a Construction Management Plan to any approval conditions. This will provide most flexibility to the document to allow changes as required while still maintaining oversight of the process by both EPA and DPI.
		Erosion, sediment control and runoff diversion measures will be established before any excavation begins. These will be left in place throughout works execution and beyond works completion until all surfaces have been fully restored and stabilised	Prior to construction and for the duration of construction	Most appropriate as part of a Construction Management Plan approved by DPI and EPA prior to construction commencing.
		At Russell Vale site, solids will be mechanically dewatered and returned to the ROM coal product as appropriate or removed from site.	Continuous and as required	This is what already occurs at site. Most appropriate as part of both the Surface Facilities Water Management Plan and Construction Management Plan
		A new 6 ML storage dam will be constructed at Russell Vale to collect run off from stockpile area.	Within 12 months of approval	This is part of the EA and PPR proposal and only needs to be constructed as part of the construction of the new stockpile areas. This will be constructed when required and will be integrated into the Surface Water Management Plan on completion. It will also be integrated into the Construction Management Plan

		A water efficiency audit will be undertaken to identify ways to reduce water usage at the colliery.	Within 12 months of completion of surface works	This is already a condition of the Preliminary Works Pt3A’s requirements for ,and is already included in, the Surface Facilities Water Management Plan

Surface Water	Operations are managed such that adverse impacts to catchment surface water are prevented or minimised.	Development and implementation of a monitoring program in liaison with SCA, OEH and NoW and to the approval of DPI including: • daily automated monitoring of selected pool water depths upstream, within and downstream of the 20mm subsidence zone. Monitoring will assess the inputs from catchment runoff and any flow variations within the Project Area before, during and after extraction; • water quality monitoring in the Cataract River upstream of Cataract Reservoir, and Wallandoola, Lizard and Cataract Creeks upstream, within and downstream of the mining area, before, during and after mining; • water quality field studies including regular visits to main channel sites to monitor for all key water quality parameter variations for the duration of mining and for an appropriate period following mining; • visual monitoring of creek banks, stream gradients and vegetation in the stream and banks before and after any stream is undermined, particularly after significant stream flow events. If adverse impacts due to mining, such as subsidence/uplift, are identified a specific management and rehabilitation plan will be developed for the affected areas; • monitoring of the integrity and overland flow of the waterfalls and rockbars will be undertaken, along with specific subsidence measurements to indicate any adverse effects to waterfalls and rockbars. Should monitoring identify any significant adverse impacts, appropriate adaptive management measures will be developed and implemented; • monitoring of mine inflows through measurement of all water pumped, where practicable, into and out of the mine workings; • rainfall monitored daily at the mine's weather station; and • the quantity and variability of stream flow measured in Wallandoola, Lizard and Cataract Creeks by data loggers to assess the rainfall / runoff relationship, with photography used to monitor flow conditions in both the creeks and their unnamed tributaries.	Prior to, during and after mining	NRE has an existing approved Water Management Plan for Wonga East LW5 that meets the requirements of the Preliminary Works Pt3A and the SMP process. This plan is updated at the end of each approved longwall and resubmitted for approval for the following longwall. Any future longwall mining undertaken as part of this proposal will require a new Extraction Plan and SMP to be submitted that meets these criteria.

		An end of panel report, will be prepared for each mined panel, to summarise all monitoring over the period and outline any changes in the surface water or groundwater system.	Post mining of each panel	Unnecessary commitment. The requirement for an End of Panel report is a standard condition in all SMP approvals.
		All monitoring and management will be reported in the Annual Environmental Management Report (AEMR), or its equivalent, in subsequent years.		Unnecessary commitment. This information is already required as part of the AEMR and the Annual Review that is part of any Major Project approval
		All results will be reviewed one year after each panel has been completed and an updated ongoing monitoring and remediation program will be developed in consultation with the SCA, DRE, and NoW.		Unnecessary commitment. This process is an integral part of the preparation of End of Panel reports and is already required as part of the AEMR and the Annual Review that is part of any Major Project approval
		Precautionary and adaptive management procedures will be implemented to provide a systematic process for continually detecting impacts, validating predictions and improving mining operations to prevent adverse impacts on the streams systems overlying the proposed mining domains.	Prior to and during mining	Unnecessary commitment. This is already a requirement of both the Extraction Plan and SMP processes.
		A Stream Management Contingency Plan will be prepared to: • formulate intervention trigger levels for a range of physical and chemical parameters; • provide further details on the adaptive management process; • provide a range of applicable management measures; • provide a range of applicable rehabilitation measures; • clarify any further approvals that might be required for such management or rehabilitation; and • set out the consultation, reporting and approval process.	Prior to mining	Unnecessary commitment. NRE has an existing approved Water Management Plan for Wonga East LW5 that meets the requirements of the Preliminary Works Pt3A and the SMP process. This plan is updated at the end of each approved longwall and resubmitted for approval for the following longwall. Any future longwall mining undertaken as part of this proposal will require a new Extraction Plan and SMP to be submitted that meets these criteria.

		Contingency measures will be developed in consideration of the specific circumstances of the exceedance and the assessment of environmental consequence. Potential contingency measures for an exceedance of the water resource or watercourse performance measures could include, if appropriate; • additional monitoring that increases the monitoring frequency or additional sampling to inform the proposed contingency measures; • implementation of stream remediation measures to reduce the extent of fracturing; • implementation of revegetation measures to remediate impacts of gas releases on riparian vegetation; • provision of a suitable offset(s) to compensate for the reduction in the quantity of water resources reaching Cataract Reservoir or Cataract River; or • implementation of adaptive management measures, such as reducing the thickness of the coal seam extracted, narrowing of the longwall panels and/or increasing the setback of the longwalls from the affected area.	If required	Unnecessary commitment. NRE has an existing approved Water Management Plan for Wonga East LW5 that meets the requirements of the Preliminary Works Pt3A and the SMP process. This plan is updated at the end of each approved longwall and resubmitted for approval for the following longwall. Any future longwall mining undertaken as part of this proposal will require a new Extraction Plan and SMP to be submitted that meets these criteria.
Groundwater	Operations are managed such that adverse impacts to local and regional groundwater resources are prevented or minimised.	Prepare and implement a monitoring program including: • installation of a suite of shallow piezometers within upland swamps; • automatic measurement of standing water levels, twice daily by pressure transducers and at least bi-monthly by manual dip meter; • collection of at least one sample from each piezometer pre and post undermining to enable ongoing assessment of any subsidence related changes in groundwater quality; and • daily monitoring of mine inflows through measurement of all water pumped into and out of the NRE No. 1 workings to enable the differential groundwater seepage into the workings to be assessed.	Ongoing during mining and for 12 months after mining has ceased	Unnecessary commitment. NRE has an existing approved Water Management Plan for Wonga East LW5 that meets the requirements of the Preliminary Works Pt3A and the SMP process. This plan is updated at the end of each approved longwall and resubmitted for approval for the following longwall. Any future longwall mining undertaken as part of this proposal will require a new Extraction Plan and SMP to be submitted that meets these criteria.
		Groundwater samples to be collected at the start and finish of each panel from piezometers either adjacent to an active panel, or within an active mining area, and analysed at a NATA registered laboratory for major ions and selected metals. Piezometers not within an active mining area will be sampled and analysed once per year.		

		Results of the monitoring programs will be reviewed after each panel and one year after longwall extraction has been completed and an updated ongoing monitoring and remediation program will be developed in association with DRE, NOW and the SCA. This will also be reported in the AEMR.		
		Contingency procedures will be developed as required, with the measures to be developed being dependent on the issue to be addressed.		Unnecessary commitment. NRE has an existing approved Water Management Plan for Wonga East LW5 that meets the requirements of the Preliminary Works Pt3A and the SMP process. This plan is updated at the end of each approved longwall and resubmitted for approval for the following longwall. Any future longwall mining undertaken as part of this proposal will require a new Extraction Plan and SMP to be submitted that meets these criteria.
		The procedures will be used to manage any impacts identified by monitoring that demonstrate the groundwater management strategies may not have adequately predicted or managed the groundwater system's anticipated response to mining.	As required and for 12 months after completion of mining	
		Performance indicators will be identified prior to extraction of the proposed underground workings and a statistical assessment would be undertaken to detect when, or if, a significant change has occurred in the groundwater system which would benchmark the natural variation in groundwater quality and standing water levels		
		A monitoring and management strategy along with an outline of a Trigger Action Response Plan (TARP) will be prepared to provide guidance on the procedures and actions required in regard to the surface water and groundwater systems in the proposed mining area.		
		An adaptive management plan will be developed to use the monitoring program to detect the need for adjustment to the mining operation so that the subsidence predictions are not exceeded and subsidence impacts creating a risk of negative environmental consequences do not occur.		
		The potential for surface water and groundwater system hydraulic connectivity will be assessed through monitoring of stream flows in and near actively mined areas as well as through monitoring and interpretation of the basement groundwater open standpipe and vibrating wire piezometers water levels / pressures and mine inflow changes.	As required and for 12 months after completion of mining	
		The ground surface over the proposed underground workings will be surveyed in accordance with DRE subsidence monitoring requirements	As required	

		An end of panel extraction report will be prepared, which summarises all monitoring over the period. The report will outline any changes in the groundwater and include the following: • a statistical analysis (mean, range, variable, standard deviation) of the results for the parameters measured; • an interpretation of water quality and standing water level changes supported with graphs or contour plots; and • an interpretation and review of the results in relation to the impact assessment criteria.	At the end of each panel extraction	Unnecessary commitment. The requirement for an End of Panel report is a standard condition in all SMP approvals
		Daily rainfall data would be obtained from a local weather station for the duration of mining in the NRE No.1 catchment area.	For the duration of mining	Unnecessary commitment. NRE has an existing approved Water Management Plan for Wonga East LW5 that meets the requirements of the Preliminary Works Pt3A and the SMP process. This plan is updated at the end of each approved longwall and resubmitted for approval for the following longwall. Any future longwall mining undertaken as part of this proposal will require a new Extraction Plan and SMP to be submitted that meets these criteria
		QA/QC would be attained by calibrating all measuring equipment, ensuring that sampling equipment is suitable for the intended purpose, using NATA registered laboratories for chemical analyses and ensuring that site inspections and reporting follow procedures outlined in the ANZECC 2000 Guidelines for Water Quality Monitoring and Reporting.	As required	
Air Quality	Operations are managed to minimise potential adverse impacts to the environment, residences and the community	The decline conveyor and all new conveyors will be fully enclosed. Consideration will be given to the covering of the other conveyors where practical.	Continuous and as required	Unnecessary commitment. NRE has an existing approved AQGGMP that meets the requirements of the Preliminary Works Pt3A and contains these commitments or improvements on them. This plan is updated annually, or as required, in liaison with the EPA, WCC and OEH and resubmitted to DPI for approval.
		Water sprays will continue to be used to minimise dust on an as needs basis.	Continuous and as required	
		Trucks will be washed, as required.	Continuous and as required	
		Trucks will be covered before leaving the site.	Continuous and as required	
		Equipment will be maintained on a regular basis.	Continuous and as required	
		Opportunities to control dust and dust related issues, regarding truck movements will be investigated	Continuous and as required	
		Alternate truck washing arrangements will be investigated to ensure trucks are clean and dry prior to leaving the site.	Continuous and as required	
		NRE will continue to enforce the Driver's Code of Conduct, through continuing driver education (tool box talks) and regular audits.	Continuous and as required	

Greenhouse Gas	Manage operations such that greenhouse gas emissions on the environment are minimised	Energy audits will be held to ensure that the mine is using current practice techniques to minimise energy use and is operating at optimum energy levels.	Continuous	
		Upgrades to internal surface haulage routes will be undertaken to improve efficiency of on-site operations.	As required	
		The efficiency of all upgraded mobile and fixed equipment will be considered during procurement for fuel powered equipment	Prior to procurement of mobile and fixed equipment	Unnecessary commitment. NRE has an existing approved AQGGMP that meets the requirements of the Preliminary Works Pt3A and contains these commitments or improvements on them. This plan is updated annually, or as required, in liaison with the EPA, WCC and OEH and resubmitted to DPI for approval.
		Site management will ensure that equipment is maintained to retain energy efficiency.	Continuous.	
		The inventory of emissions developed for this assessment will be updated and maintained.	Continuous and as required	
		Emissions and abatement strategies will be reported annually as part of internal environmental reporting and National Greenhouse and Energy Reporting System obligations.	Annually	
		NRE will investigate opportunities to capture and/or use methane.	2015 onwards	
Acoustics	Operations are managed to minimise potential adverse impacts on the environment, residences and the community	The existing Bulli decline conveyor will be decommissioned and demolished by 31 December 2016 (under Stage 1 Preliminary Works Project).	On completion of the new driveage.	This matter was addressed during the recent modification application to the Preliminary Works Pt3A
		Attended noise monitoring will be undertaken upon the commencement of operations to confirm predictions	Within 12 months of approval	Unnecessary commitment. NRE has an existing approved Noise Management Plan (NMP) that meets the requirements of the Preliminary Works Pt3A and contains these commitments or improvements on them. This plan is updated annually, or as required, in liaison with the EPA and WCC and resubmitted to DPI for approval.
		Site equipment to be selected to meet appropriate INP noise goals in accordance with the acoustic design parameters for acoustically significant plant and equipment presented in NRE No. 1 Colliery Preliminary Works Acoustic Assessment.	Prior to operation	

		An operational Noise Management Plan (NMP) will be developed to specifically address potential noise impacts associated with the proposed operations at the nearest receivers, including road traffic noise. The NMP will outline methods and procedures to manage the following: • results of the regular noise monitoring program on-site and within the surrounding area; • response to any complaints or issues raised by the owner of the affected residence; • noise mitigation measures and operating procedures to ensure compliance with noise goals; and • noise monitoring data from the early stages of Project operations will be utilised to calibrate an operational • specific noise model, to refine the potential predicted noise impacts.	Within 12 months of approval.	This already exists as a result of the Preliminary Works Pt3A approval
		An operational noise monitoring program will be developed to monitor noise emissions from the proposed operations, including road traffic noise to determine ongoing compliance with PSNLs and to identify any further feasible noise mitigation measures that can be implemented. The monitoring program will be implemented during periods of maximum production to confirm the acoustic performance of the proposed operations.	Following construction, during operational periods of maximum production.	Unnecessary commitment. NRE has an existing approved Noise Management Plan (NMP) that meets the requirements of the Preliminary Works Pt3A and contains these commitments or improvements on them. This plan is updated annually, or as required, in liaison with the EPA and WCC and resubmitted to DPI for approval.
		The results of the noise monitoring program will be reviewed to assess compliance with the PSNLs and reported in accordance with any requirements of the approval or EPL.	Following each noise monitoring event.	
		Liaising directly with the affected community in respect of the timing and frequency of Peak periods of coal haulage.	Prior to peak coal haulage	
	Construction activities are managed to minimise potential adverse impacts on the environment, residences and the community.	A construction NMP will be developed to specifically address potential noise impacts associated with the proposed construction activities. The NMP will outline methods and procedures to manage the following: • response to any complaints or issues raised by the owner of the affected residence; and • noise mitigation measures and operating procedures to ensure compliance with noise goals.	Prior to commencement of construction	It is recommended that, if considered necessary, the DPI add the requirement for a Construction Management Plan to any approval conditions. This will provide most flexibility to the document to allow changes as required while still maintaining oversight of the process by both EPA and DPI.
		The results of the NMP will be reviewed by the operations manager to assess compliance with the goals and reported in accordance with any requirements of the approval or Environment Protection Licence required for the Project under the POEO Act.	Ongoing	

		Construction will be limited to Monday to Friday 7:00am to 6:00pm and 8:00am to 1:00pm Saturday unless monitoring shows works to be inaudible at nearby residences.	During construction	
		All works will be undertaken in accordance with the OEH's Interim Construction Noise Guideline (2009).	Prior to construction	
		Where feasible, silenced site equipment will be used to minimise environmental noise emissions.	During construction	
		All residents adjacent to the site will be notified of the start of works.	Prior to construction	
		Any complaints regarding environmental noise emissions will be logged, investigated and responded to in an appropriate manner.	During construction	
Upland Swamps	Operations are managed such that adverse impacts to upland swamps are prevented or minimised. Provide best practice environmental monitoring of upland swamps and allow analysis of the nature and extent of mine subsidence impacts, if any.	The swamp monitoring plan developed for the extraction of A2 LW4 and 5 in Wonga East as part of the Biodiversity Management Plan (Biosis 2012b) and the Subsidence Management Plan Monitoring Program for A2 LW4 and A2 LW5 (Gujarat NRE 2012) will be revised and updated in liaison with SCA, OEH and to the approval of DPI.	Prior to commencement of operations	Unnecessary commitment. NRE has an existing approved Biodiversity Management Plan for Wonga East LW5 that meets the requirements of the Preliminary Works Pt3A and the SMP process. This plan is updated at the end of each approved longwall and resubmitted for approval for the following longwall. Any future longwall mining undertaken as part of this proposal will require a new Extraction Plan and SMP to be submitted that meets these criteria
		A risk assessment will be incorporated into the Biodiversity Management Plan to demonstrate predicted subsidence to ensure the size and functioning of the swamp, including potential changes in species composition or distribution within the swamp will not be adversely affected and to ensure that water drainage from the swamps will not be adversely affected due to subsidence or be re-distributed to an extent where such potential adverse changes could occur.		Unnecessary commitment. NRE has an existing approved Biodiversity Management Plan for Wonga East LW5 that incorporates these measures and meets the requirements of the Preliminary Works Pt3A and the SMP process. This plan is updated at the end of each approved longwall and resubmitted for approval for the following longwall. Any future longwall mining undertaken as part of this proposal will require a new Extraction Plan and SMP to be submitted that meets these criteria
		A monitoring program will be designed and implemented to: • assess the swamp hydrology; • provide advance warning of potential breaches of subsidence predictions; • detection of adverse impacts on a swamp and underlying strata hydrology; and • characterise the relationship between swamp/s and their role in recharging the regional groundwater systems.		

		Water levels will be measured automatically, twice daily by pressure transducers and regularly by manual dip meter from a network of shallow piezometers in potentially impacted swamps and reference sites, before and after mining.	Prior to, during and for 12 months after mining has ceased.	
		Should the standing water level or groundwater quality be unacceptably affected due to subsidence, methods to ameliorate the situation until the water level or water quality recovers will be investigated.		
		Evaporation and rainfall data will be collected daily.		
		At least one appropriately purged and collected, stored and transported groundwater sample will be collected from each swamp piezometer pre and post undermining to enable ongoing assessment of any subsidence related changes in groundwater quality.	Pre and post undermining	
		Regular ground monitoring of the surface around swamps, and in swamps where visibility permits, will be undertaken at regular intervals and at least 18 months following mining. Inspection transects will be randomly selected varying at each survey to maximise detection. Inspections will record cracking in rock outcrops, slumping or erosion of soil, changes in flow patterns within the swamps evident as channelization or development of knick points.	Ongoing during mining and for 12 months after mining has ceased.	Unnecessary commitment. NRE has an existing approved Biodiversity Management Plan for Wonga East LW5 that incorporates these measures and meets the requirements of the Preliminary Works Pt3A and the SMP process. This plan is updated at the end of each approved longwall and resubmitted for approval for the following longwall. Any future longwall mining undertaken as part of this proposal will require a new Extraction Plan and SMP to be submitted that meets these criteria
		An end of panel (EoP) report, or its equivalent, will be prepared upon completion of each mined panel, to summarise all monitoring over the period. The report will outline any changes in the surface water or groundwater system over the mined out areas.	At the end of each panel extraction.	Unnecessary commitment. The requirement for an End of Panel report is a standard condition in all SMP approvals
		All monitoring and management activities will be reported in the AEMR, or its equivalent, in subsequent years.		Unnecessary commitment. This information is already required as part of the AEMR and the Annual Review that is part of any Major Project approval
		All results will be reviewed one year after each panel has been completed and an updated ongoing monitoring and remediation program will be developed in consultation with the SCA, DRE and NoW.		Unnecessary commitment. This process is an integral part of the preparation of End of Panel reports and is already required as part of the AEMR and the Annual Review that is part of any Major Project approval

		An adaptive management plan will be developed to use the monitoring program to detect the need for adjustment to the mining operations so that the subsidence predictions are not exceeded and subsidence impacts creating a risk of negative environmental consequences do not occur in upland swamps.	As required and for 12 months after completion of mining.	Unnecessary commitment. NRE has an existing approved Biodiversity Management Plan for Wonga East LW5 that incorporates these measures and meets the requirements of the Preliminary Works Pt3A and the SMP process. This plan is updated at the end of each approved longwall and resubmitted for approval for the following longwall. Any future longwall mining undertaken as part of this proposal will require a new Extraction Plan and SMP to be submitted that meets these criteria
Aquatic Ecology	Operations are managed such that adverse impacts to native aquatic habitats are prevented or minimised. Provide best practice environmental monitoring of aquatic ecology and allow analysis of the nature and extent of mine subsidence impacts, if any.	Observations of aquatic habitats and surveys of aquatic macro invertebrates will be undertaken at impact and control locations in the headwater swamp regions during and after mining.	In accordance with a monitoring plan developed in liaison with relevant authorities.	Unnecessary commitment. NRE has an existing approved Biodiversity Management Plan for Wonga East LW5 that incorporates these measures and meets the requirements of the Preliminary Works Pt3A and the SMP process. This plan is updated at the end of each approved longwall and resubmitted for approval for the following longwall. Any future longwall mining undertaken as part of this proposal will require a new Extraction Plan and SMP to be submitted that meets these criteria
		A survey of aquatic macro invertebrates (at impact and control locations) will be undertaken if the regular water quality monitoring program detects changes in the depth and quality of the water within Wallandoola Creek and Lizard Creek that are greater than anticipated on the basis of the subsidence predictions	In accordance with a monitoring plan developed in liaison with relevant authorities.	Wonga West is no longer part of this PPR
		Ongoing monitoring of water quality, aquatic habitat, macro invertebrates and fish during the same seasons as used for the baseline study.		Unnecessary commitment. NRE has an existing approved Biodiversity Management Plan for Wonga East LW5

	To validate the predictions about the consequences of subsidence on aquatic habitats and biota and assess any unexpected impacts on these that may occur	Additional surveys of aquatic habitats and biota will be undertaken as soon as possible if fractures of the stream bed and associated loss of water from pools or significant changes in pH, dissolved oxygen, turbidity or metal concentrations are detected during routine surface monitoring of the potential impact creeks. If fish or yabby kills are noted during routine surface monitoring, further studies will be undertaken to determine the extent of impact on aquatic ecology and whether there is a need for management/mitigation measures.	As required	that incorporates these measures and meets the requirements of the Preliminary Works Pt3A and the SMP process. This plan is updated at the end of each approved longwall and resubmitted for approval for the following longwall. Any future longwall mining undertaken as part of this proposal will require a new Extraction Plan and SMP to be submitted that meets these criteria
Terrestrial Ecology	Monitoring to identify subsidence impacts as early as possible and identify any alterations required to the extraction plan.	Ongoing monitoring of significant sensitive areas will be undertaken in accordance with an EMP.	During and after mining	
		Additional monitoring for threatened species identified as having a moderate to high likelihood of occurring in the Study Area, and as vulnerable to the impacts of subsidence, will be undertaken annually in seasons appropriate for the detection of each individual species. In particular, potential habitat in areas in which subsidence risk is greatest will be targeted, for example, Heath Frog habitat in WCVFS2, Giant Burrowing Frog in Wallandoola Creek, Large-eared Pied Bat, Eastern Bentwing-bat and Large-footed Myotis surveys in Lizard Creek gorge and associated tributaries. The design of ongoing ecological monitoring will be detailed in the EMP and will be flexible to account for seasonal and inter-annual variation in ecological conditions.		
	Appropriate remediation measures are identified if required	All remediation works will be controlled and implemented in accordance with an Environmental Management Plan (EMP).	As required	
		If significant cracking occurs in vegetated areas, then measures such as temporary fencing would be implemented to ensure that fauna are not injured or trapped; and		
		prior to any remediation works, advice would be sought from an ecologist regarding the potential impacts of such remediation works to plant and animal populations.		

Aboriginal Cultural Heritage	To provide sites officers with a teaching and learning experience regarding cultural heritage sites	Additional monitoring and risk assessment will be undertaken in accordance with the Bulli PAC, for sites particularly within the predicted subsidence footprint prior to longwall mining relevant longwalls	As required	Unnecessary commitment. NRE has an existing approved Heritage Management Plan for both the Pit Top and Wonga East LW5 that incorporates these measures and meets the requirements of the Preliminary Works Pt3A and, for LW5, the SMP process. This plan is updated at the end of each approved longwall and resubmitted for approval for the following longwall. Any future longwall mining undertaken as part of this proposal will require a new Extraction Plan and SMP to be submitted that meets these criteria
		All monitoring and management to be undertaken in accordance with Table 21.10 of the EAR and the monitoring programme will include any Aboriginal objects that may be impacted by mining activities and that the mining footprint for these purposes includes the maximum extent of predicted subsidence.		Unnecessary commitment. NRE has an existing approved Heritage Management Plan for both the Pit Top and Wonga East LW5 that incorporates these measures and meets the requirements of the Preliminary Works Pt3A and, for LW5, the SMP process. This plan is updated at the end of each approved longwall and resubmitted for approval for the following longwall. Any future longwall mining undertaken as part of this proposal will require a new Extraction Plan and SMP to be submitted that meets these criteria
		Open Sites will be relocated where possible. Monitoring will involve visual inspection and update to the AHIMS sites. The women's site will be included in a monitoring program developed in consultation with female elders.		The relocation of sites has been undertaken as part of this PPR. The women's site is in Wonga West and is no longer impacted by this PPR.
		The following shelter sites will be monitored, 52-2-1183, 52-2-1187, 52-2-1198 and 52-2-1225 in the Wonga West Study Area; and 52-3-0311 Wonga East 1 and Wonga East 2 in the Wonga East Study Area. The monitoring program will include archival photographic recording of the three Wonga West sites with high significance (52-2- 1183, 52-2-1187 and 52-2-1198) in conjunction with the initial pre-mining monitoring including archival recording including sketch plans of the art and shelter;	Pre mining; three and six months after mining beneath the shelter and post mining.	The sites in Wonga West are no longer impacted by this PPR. The references to Wonga East are an unnecessary commitment. NRE has an existing approved Heritage Management Plan for both the Pit Top and Wonga East LW5 that incorporates these measures and meets the requirements of the Preliminary Works Pt3A and, for LW5, the SMP process. This plan is updated at the end of each approved longwall
		A report will be prepared, and a copy given to OEH. The AHIMS site cards will be updated with the information;		

		If any of the sites show changes during the course of monitoring, additional management and mitigation measures will be determined on a case by case basis by a qualified archaeologist in consultation with an Aboriginal representative;		and resubmitted for approval for the following LW. Any future LW mining undertaken as part of this proposal will require a new Extraction Plan and SMP to be submitted that meets these criteria
		The balance of the shelters will be relocated if possible and monitored pre and post mining. The AHIMS site cards will be updated as the sites are located;		
		All monitoring will be undertaken by a qualified archaeologist with the involvement of the Aboriginal community.		
		A chance finds protocol will be developed and will outline the need for : • contacting the registered stakeholder groups who participated in fieldwork (Illawarra Local Aboriginal Land Council and D'harawal Knowledge Holders) and have a representative identify the object; • the identification is positive, contacting a qualified archaeologist to record and provide management measures.; • if human skeletal remains are suspected; o surface works would stop in the immediate area of the remains; o the local police and a physical anthropologist or archaeologist would be contacted; o if the remains are determined to be of antiquity and of Indigenous origin; and management and mitigation measures would be drawn up in consultation with the registered stakeholder groups and the archaeologist.	Pre and post mining	The sites in Wonga West are no longer impacted by this PPR. The references to Wonga East are an unnecessary commitment. NRE has an existing approved Heritage Management Plan for both the Pit Top and Wonga East LW5 that incorporates these measures and meets the requirements of the Preliminary Works Pt3A and, for LW5, the SMP process. This plan is updated at the end of each approved longwall and resubmitted for approval for the following longwall. Any future longwall mining undertaken as part of this proposal will require a new Extraction Plan and SMP to be submitted that meets these criteria

Cliffs and Steep Slopes	Monitoring to identify subsidence impacts as early as possible and identify any alterations required to the extraction plan.	Monitoring and adaptive management strategies will be implemented to limit mining impacts on features of special significance; and	During and after mining	Unnecessary commitment. NRE addresses cliffs and steep slopes in its existing approved Subsidence Monitoring, Biodiversity and Public Safety Management Plans for Wonga East LW5 that incorporates these measures and meets the requirements of the Preliminary Works Pt3A and, for LW5, the SMP process. This plan is updated at the end of each approved longwall and resubmitted for approval for the following longwall. Any future longwall mining undertaken as part of this proposal will require a new Extraction Plan and SMP to be submitted that meets these criteria
		To avoid additional impacts to Lizard Creek waterfall and the Wallandoola Creek waterfall a trigger, action, and response plan will developed which limits horizontal movements to low levels in these areas.		Wonga West is no longer relevant to this PPR.
Non-Aboriginal Heritage	Surface works at the Russell Vale site are managed such that adverse impacts to archaeology are minimised	A Conservation Management Plan will be prepared for the Project. The plan will reflect the future need of the site as a continuing mine and include procedures to follow for the discovery of unanticipated 'Relics'.	Prior to commencement of construction	Unnecessary commitment. NRE has an existing approved Heritage Management Plan for the Pit Top that incorporates these measures and meets the requirements of the Preliminary Works Pt3A. This plan is updated at the end of each approved longwall and resubmitted for approval for the following longwall.
		No items identified as having heritage value or contributing to the heritage value of the site, will be demolished as part of this Project	Prior to commencement of construction	Unnecessary commitment. NRE has an existing approved Heritage Management Plan for the Pit Top that incorporates these measures and meets the requirements of the Preliminary Works Pt3A. This plan is updated at the end of each approved longwall and resubmitted for approval for the following longwall.
	To provide a lasting record of the site	A photographic recording of the 1887 portal and the site will be undertaken and copies will be lodged with the appropriate Local and State repositories.	Prior to construction	
		A photographic recording of the site should be undertaken, to Heritage Archival Recording standards, prior to commencement of construction for the Project, to provide a lasting record of the site prior to the new development. Copies of the recording should be lodged with the appropriate Local and State repositories	Prior to construction	

		Items of moveable heritage, including historical photos, plans, maps, records and the like will be documented, collated and catalogued. Items of moveable heritage will be retained at their current location onsite and documented including historical photos, plans, maps and records to Heritage Archival Recording standards. A conservator will provide advice regarding the long term storage of the items to maximise their survival. When the item has been appropriately catalogued its will be donated to a suitable repository. Appropriate repositories will be identified prior to Project works commencing.	Prior to construction	
		No secondary extraction will occur beneath or within a 1km of the Cataract Dam wall.	Ongoing	
Traffic and Transport	Operations are managed to ensure minimal impacts on the local road network	NRE will implement a traffic/driver code of conduct which includes: • trucking during PCKT approved hours; • obeying legal speed limits including self-imposed 50km/hr speed limit along Bellambi Lane; • ensuring drivers are vigilant regarding separation distances; • avoiding compression braking. Compression brakes must not be used on the approach to Port Kembla • Road/Springhill Road lights when entering or exiting PKCT; • covering all loads; • washing all trucks prior to leaving the site; • reporting all vehicle faults to the owner; and • reporting all traffic incidents	Ongoing	Unnecessary commitment. NRE has an existing approved Traffic Management Plan for the Pit Top that incorporates these measures and meets the requirements of the Preliminary Works Pt3A. This plan is updated at the end of each approved longwall and resubmitted for approval for the following longwall.
		Engage the transport company through regular toolbox talks.	Ongoing	
		Design of truck bodies will be progressively upgraded to reduce noise and related impacts and increase operational efficiency.	Ongoing	
Visual Amenity	Construction and design is managed to ensure minimal visual impacts on local residents	Colour treatments for surface facility components will be selected to match the surrounding environment	Prior to construction	It is recommended that, if considered necessary, the DPI add the requirement for a Construction Management Plan to any approval conditions. This will provide most flexibility to the document to allow changes as required while still maintaining oversight of the process by both EPA and DPI.
		Ensuring lighting is directed away from residences through the use of directional lighting and shielding in accordance with safety regulations, and which complies with Australian Standard AS4282 (INT) 1995 – Control of Obtrusive Effects of Outdoor Lighting.	During design and construction	
	Operations are managed to ensure	Routine use of low beam on vehicle headlights by all operation and maintenance personnel.	Continuous	It is recommended that, if considered necessary, the DPI add the requirement

	minimal visual impacts on local residents	Appropriate use of lighting to limit impacts on sensitive locations. This will be managed through inductions of all construction and operations employees	Continuous	for a Visual Amenity Management Plan to any approval conditions. This will provide most flexibility to the document to allow changes as required while still maintaining oversight of the process by both EPA and DPI
Waste	Avoidance of unnecessary resource consumption; reuse, reprocessing, recycling and energy recovery wherever possible and, where this is not possible, disposal of wastes in an environmentally responsible manner.	On site storage and disposal of different categories of waste will be defined prior to construction. A sufficient number of covered storage bins will be provided for waste disposal on site, with separate bins for recyclable and non-recyclable waste.	Ongoing	It is recommended that, if considered necessary, the DPI add the requirement for a Construction Management Plan to any approval conditions. This will provide most flexibility to the document to allow changes as required while still maintaining oversight of the process by both EPA and DPI.
		Construction materials will be purchased with the aim of reducing waste products.		
		All waste material will be disposed of in accordance with the provisions of the Protection of the *Environment Operations Act 1997 and the Waste Classification Guidelines* (DECC, 2008).		It is recommended that, if considered necessary, the DPI add the requirement for a Waste Management Plan to any approval conditions. This will provide most flexibility to the document to allow changes as required while still maintaining oversight of the process by both EPA and DPI.
		Waste will be recycled where possible or disposed of at an appropriately licensed waste disposal facility.		
		All records will be retained as proof of correct disposal for environmental audit purposes.		
Rehabilitation		Progressive short term rehabilitation of the site will be undertaken, particularly in respect to removal of surplus mining equipment, sealing of redundant mine entries and shafts and stabilisation of slopes and embankments. This will be carried out in accordance with the schedule in *Section 16.4.2* of the EA.	In accordance with the approved MOP and operational requirements in liaison with the Department of Resources and Energy.	Unnecessary commitment. NRE has an existing approved Rehabilitation Management Plan for the Pit Top that incorporates these measures, meets the requirements of the Preliminary Works Pt3A and is updated annually. This plan is based on the MOP that is a conditional requirement of NRE Mining Leases and assessed by DRE. A new MOP is due to be submitted to DRE by 31 December 2013 and will contain all information contained in the PPR.
		Progressive medium term rehabilitation will include: • decommissioning and removal of the steel core belt and transfer house; • decommissioning and removal of the existing Bulli and Balgownie decline belts; • decommissioning and rehabilitation of No.1 and no.2 shafts; and • decommissioning and rehabilitation of the current Balgownie seam entries.	In accordance with the approved MOP and operational requirements in liaison with the Department of Resources and Energy	

		Rehabilitation and mine closure will be developed with consideration for previous land uses, existing zoning and the potential to reuse existing structures and materials in the future. A final mine closure plan will be developed having regards to 'Rehabilitation and Mine Closure' guidelines and 'ANZMEC Strategic Framework for Mine Closure' objectives and principles to ensure that all relevant aspects of closure have been addressed	Prior to mining ceasing.	Unnecessary commitment. NRE has an existing approved Rehabilitation Management Plan for the Pit Top that incorporates these measures, meets the requirements of the Preliminary Works Pt3A and is updated annually. This plan is based on the MOP that is a conditional requirement of NRE Mining Leases and assessed by DRE. A new MOP is due to be submitted to DRE by 31 December 2013 and will contain all information contained in the PPR.
		Areas no longer required for operation will be rehabilitated progressively.	Ongoing	

Abbreviations

Abbreviation	Definition
° C	Degree Celsius
A1	Area 1
AEMR	Annual Environmental Management Report
AERMOD	AMS/EPA Regulatory Model
AHD	Australian Height Datum
AHIMS	Aboriginal Heritage Information Management System
ANZECC	Australian and New Zealand Environment Conservation Council
ARI	Annual Recurrence Interval
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
AWS	Automatic Weather Station
BACI	Before/After, Control/Impact
BCUS	Bellambi Creek Upland Swamp
BFMC	Bush Fire Management Committee
BHPB	BHPBilliton
BOD	Biochemical Oxygen Demand
BoM	Bureau of Meteorology
BSO	Bulli Seam Operations Project (Illawarra Coal Holdings Pty Ltd)
CC	Cataract Creek
CCC	Community Consultative Committee
CCD	Census Collection Districts
CCUS	Cataract Creek Upland Swamp
CCL	Consolidated Coal Lease
CEMP	Construction Environment Management Plan
CMP	Conservation Management Plan
CO_2	Carbon Dioxide
CO_2-e	Carbon Dioxide Equivalent
COD	Chemical Oxygen Demand
CPRS	Carbon Pollution Reduction Scheme
CRUS	Cataract River Upland Swamp
CSG	Coal Seam Gas
dB	Decibels
DCC	Department of Climate Change
DECCW	Department of Environment , Climate Change and Water
DEWHA	Department of Environment, Water, Heritage and the Arts
DGRs	Director-General's Requirements
DKH	D'harawal Knowledge Holders
DLEP 2009	Draft Wollondilly Local Environmental Plan 2009
DO	Dissolved Oxygen
DoP	Department of Planning
DP	Deposited Plan
DPI	Department of Planning & Infrastructure
DRE	NSW Department of Trade and Investment, Division of Resources and Energy
DSC	Dam Safety Committee
DSEWPC	Department of Sustainability, Environment, Water, Population & Communities
DWCREP	Drinking Water Catchments Regional Environmental Plan No. 1
EA	Environmental Assessment
EAR	Environmental Assessment Report
EC	Electrical Conductivity
ECRTN	Environmental Criteria for Road Traffic Noise
EEC	Endangered Ecological Communities
EMP	Environmental Management Plan
ENCM	Environmental Noise Control Manual
EPA	Environmental Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPIs	Environmental Planning Instruments
EPL	Environmental Protection Licence
EWG	Executive Working Group
FMEA	Failure Mode and Risk and Effect Analysis
FSL	Full Supply Level

GDE	Groundwater dependent ecosystem
GFS	Groundwater flow system
GHG	Greenhouse Gas
GIS	Global information system
GJ	Gigajoules
Golders	
GPS	Global positioning system
ha	hectare
ICNC	Interim Construction Noise Guidelines
ILALC	Illawarra Local Aboriginal Land Council
INP	NSW Industrial Noise Policy 2000
IPCC	Intergovernmental Panel on Climate Change
IREP	Illawarra Regional Environmental Plan No.1
KL	kilolitres
km	kilometre
KSC	Kullila Site Consultants
kV	kilovolt
kW	kilowatt
LC	Lizard Creek
LCUS	Lizard Creek Upland Swamp
LCT1	Lizard Creek Tributary 1
LDP	Licence Discharge Point
LEP	Local Environmental Plan
LEP 1991	Wollondilly Local Environmental Plan 1991
LGA	Local Government Area
m	metre
mm	millimetre
MD	Major Development
ML	Mining lease
MOP	Mining Operation Plan
MP	Major Project
MPL	Mining Purposes Lease
MSEC	Mine Subsidence Engineering Consultuants Pty Ltd
Mtpa	Million tonnes per annum
MWh	Megawatt hours
NES	National environmental significance
NEPM	National Environment Protection Measures
NGA	National Greenhouse Accounts
NGER Act	*National Greenhouse and Energy Reporting Act 2007*
NGERS	National Greenhouse and Energy Reporting Scheme established under the NGER Act
NIAC e	Northern Illawarra Aboriginal Collective
NMP	Noise Management Plan
NOW	NSW Office of Water
NPI	National Pollutant Inventory
NPWS	National Parks and Wildlife Service
NRE	Gujarat NRE Coking Coal Limited
NTU	Nephelometric Turbidity Units
OEH	Office of Environment and Heritage
OCG	Olsen Consulting Group
PAA	Project Application Area
PAC	Planning Assessment Commission
PEA	Preliminary Environmental Assessment
PFC	Peter Falk Consultancy
PKCT	Port Kembla Coal Terminal
PM	Particulate matter
PM10	Particulate matter less than 10 microns in size
POEO Act	*Protection of the Environment and Operations Act 1997*
ppm	Parts per million (1mg/L or 1mg/kg)
PRP	Pollution Reduction Programs
PSNL	Project Specific Noise Levels
PWP	Preliminary Works Project
RBL	Rating Background Noise Level
REMP	Rehabilitation and Environmental Management Plan
REPs	Regional Environmental Plans

RL	Reduced level
RMS	Roads and Maritime Services
RMZ	Risk Management Zone
RNE	Register of the National Estate
ROM	Run of Mine
RoTAP	Rare or Threatened Australian Plants
RTA	Roads and Traffic Authority (now Roads and Maritime Services)
RVEA	Russell Vale emplacement area
SASPoM	Sydney Catchment Authority Special Areas Strategic Plan of Management 2007
SCA	Sydney Catchment Authority
SCI	Southern Coalfield Inquiry
SD	Statistical Division
SDPS	Subsidence Deformation Prediction System
SEPP	State Environmental Planning Policy
SEPP MD	State Environmental Planning Policy (Major Development) 2005
SFWMP	NRE Surface Facilities Water Management Plan
SMP	Subsidence Management Plan
SP	Stockpile
SSD	State Significant Development
SWCD	Stormwater control dam
SWL	Sound Power Levels
tCO_2	Tonnes of carbon dioxide
tCO_2-e	Tonnes of carbon dioxide equivalent
TSC Act	*Threatened Species Conservation Act 1995*
TSP	Total suspended particulates
UNFCCC	United Nations Framework Convention on Climate Change
VENM	Virgin excavated natural material
WCC	Wollongong City Council
WC	Wallandoola Creek
WCUS	Wallandoola Creek Upland Swamp
WLEP	Wollongong Local Environmental Plan 2009
WM Act	*Water Management Act 2000*% percent
WWEC	Wodi Wodi Elders Corporation

Definitions

Term	Definition
309 Panel	The last panel in the Bulli seam at the eastern end of T and W Mains.
angle of draw	The angle between the vertical and the line joining the edge of the mining void with the limit of vertical subsidence, usually taken as 20 millimetres.
aquifer	A permeable body of rock or regolith that both stores and transmits groundwater.
base flow	The flow of water entering stream channels not attributable to direct runoff from rainfall and usually from groundwater or related sources.
Bellambi Gully Creek	Watercourse that flows through the Russell Vale site.
Bellambi Gully Creek bypass channel	New open channel to be constructed to conduct water flowing through Bellambi Gully Creek around the stockpile area.
Bulli West	Area of first workings west of existing workings.
cliff	A continuous rockface having a minimum height of 10 m and a minimum slope of 2to 1.
coal clearance system	A system used to transfer coal from the working faces to the surface.
coking coal	Coking coal is coal that can be used in the production of coke which in turn is used in the blast furnace in the production of pig iron. Ash content of less than 10% and volatile matter of 21-23%.
continuous miner	A remote-controlled, tracked, electrically powered coal cutting and loading machine used to form mine roadways and extract coal pillars.
conveyor	Fixed mechanical apparatus consisting of a continuous moving belt used to transport coal from one place to another.
day	The period from 7am to 6pm Monday to Saturday, and 8am to 6pm on Sundays and Public Holidays.
depth of cover	The depth of the roof of the coal seam from the ground measured in metres.
Director-General	Director-General of Department of Planning and Infrastructure, or delegate.
driveage	A horizontal or inclined heading or roadway in the process of construction. The road way will be used to access a new mining area within the lease.
dyke	A sheet like vertical intrusion of igneous rock cutting across the strata of older rocks.
ecological community	An assemblage of native species that inhabits a particular area.
ephemeral stream	Stream that may or may not have a well-defined channel, generally with unpredictable flow, only during and immediately after rain.
endangered	A species, population or ecological community that is likely to become extinct or is in immediate danger of extinction.
endangered ecological community	Ecological community specified as endangered under Part 3 of Schedule 1 of the Threatened Species Conservation Act 1995 or under the Environment Protection and Biodiversity Conservation Act 1999
endangered population	Population identified as endangered under Part 2 of Schedule 1 of the Threatened Species Conservation Act 1995.
endangered species	Species identified in Part 1 of Schedule 1 of the Threatened Species Conservation Act 1995 or under the Environment Protection and Biodiversity Conservation Act 1999.
evening	The period from 6pm to 10pm.
faulting (normal)	Major fracture of the earth's crust caused by the relative movement of the rock masses on either side.
first workings	Involves the development headings or roadways which will provide access to the coal resource. They are developed using continuous miners with integrated roof and rib bolting rigs. First workings leave the coal pillars intact and the overlying strata fully supported resulting in 'zero' subsidence.
gate roads (maingates and tailgates)	Underground access roadways that provides access to a

	working longwall face for continuous mining or connects the longwall working face with the main roadway.
goaf (or goafing)	The space left following extraction of the coal seam where the roof material is allowed to collapse.
Greenhouse gases	Gases with potential to cause climate change (e.g. methane, carbon dioxide and non-methane volatile organic compounds). Usually expressed in terms of carbon dioxide equivalent.
groundwater	Water that occurs beneath the surface of the ground in the saturated zone.
groundwater dependent ecosystem	Ecosystems which have their species composition and their natural ecological processes determined by groundwater.
headwater swamp	Headwater swamps are freshwater wetlands situated in areas high in the catchment near catchment divides, located in areas of shallow, impervious substrate formed by either sandstone or clay horizons. Headwater swamps are likely to have perched watertables within the sediments that are independent of the water table in the Hawkesbury sandstone, dependent upon rainfall and surface runoff.
intermittent stream	Stream with a well-defined channel that carries water for at least part of the year, but ceases to flow occasionally or seasonally because bed seepage and evapotranspiration exceed the available water supply.
iron oxidizing bacteria	Bacteria that derive energy by converting iron in the ferrous form to the ferric form, which then combines with oxygen to produce iron oxide, often appearing as a rusty red or orange 'fluffy' clumps or stains in the stream. Reaction is dependent on oxygen presence and is more likely to be found where oxygen-poor groundwater is reaching the surface of the stream.
key threatening process	Threatening process identified as such in Schedule 3 of the *Threatened Species Conservation Act 1995* or under the *Environment Protection and Biodiversity Conservation Act 1999*.
Longwall mining	A high capacity underground mining method which utilises a mechanical shearer to cut the coal. The loosened coal falls onto a conveyor for removal from the mine to the surface. As the coal is cut away (a 'shear') both the longwall machine (known as the 'shearer') and the hydraulic roof supports advance forward along the panel, ready for the next shear.
longwall panel	A large contiguous block of coal, typically suitable for longwall extraction.
main roadways	Roadways that are used as the means of primary access/egress, to supply materials, provide ventilation and enable coal to be conveyed to the surface.
Metropolitan Special Area	An area categorised as Restricted Access under Schedule 1 of the Sydney Water Catchment Management Act 1998. It is managed by the Sydney Catchment Authority.
Mining Lease	Title granted under the Mining Act 1992 that provides rights to mine a coal resource.
mitigation	Activities associated with reducing the impacts of the project prior to or during those impacts occurring.
negligible	Small and unimportant, such as to be not worth considering.
night	The period from 10pm to 7am Monday to Saturday, 10pm to 8am on Sundays and Public Holidays.
No.4 Shaft	Main downcast shaft for men and materials.
offset (biodiversity)	One or more appropriate actions put in place in an appropriate location to counterbalance or offset an impact on biodiversity values.
perennial stream	Stream with a well-defined channel that flows continuously all year during a year of average rainfall with the aquatic bed located below the water table for most of the year.
pillar extraction panel	A continuous miner system of mining whereby coal pillars are systematically extracted.
pillar run	A large scale progressive collapse of coal pillars in a short period of time.
portal	Entry point on the Escarpment into the coal seam.
Preliminary Works Project	Stage 1 works to allow for continuation of mining and ancillary operations at NRE No 1 Colliery as approved by DP&I (MP

	10_0046).
Project Application Area	Area to which this Project applies.
relic	Any deposit, artifact, object or material evidence that: (a) relates to the settlement of the area that comprises New South Wales, not being Aboriginal settlement, and (b) is of State or local heritage significance.
riffle	A section of a stream with shallow, fast-flowing water with a distinctly disturbed surface and usually with a gravel or pebble base.
risk management zone	An identified area containing significant natural features as defined by DoP (2008), delineated from the outside extremity of the surface feature, either by a 40° angle from the vertical down to the coal seam which is proposed to be extracted, or by a surface lateral distance of 400 m, whichever is the greater.
run-of-mine	Raw coal as mined that has not undergone any screening, crushing or washing.
Russell Vale site	Location of main surface infrastructure, including stock pile area, offices etc.
second workings	Extraction of coal by pillar extraction methods.
shaft	A vertical or inclined excavation used for the purpose of opening or servicing a mine.
sill	A flat sheet of igneous rock that has forced between older layers of sedimentary rock. Sills are fed by dikes, except in unusual locations where they form in nearly vertical beds attached directly to a magma source
South Bulli Colliery	Previous name for the NRE No.1 Colliery.
special areas	Areas surrounding SCA's dams which are subject to additional management measures to protect the quality of drinking water. These areas are declared under the *Sydney Water Catchment Management Act 1998* for their value in protecting the quality of the raw water used to provide drinking water to greater Sydney and for their ecological integrity
special significance status	Special significance status is based on an assessment of a natural feature that determines the feature to be so special that it warrants a level of consideration (and possibly protection) well beyond that accorded to others of its kind. It may be based on a rigorous assessment of scientific importance, archaeological and cultural importance, uniqueness, meeting a statutory threshold or some other identifiable value or combination of values (PAC 2009).
strain	The change in the horizontal distance between two points divided by the original horizontal distance between the points.
Stage 1 Preliminary Works Project	Production continuing at current rates of 1Mtpa.
Stage 2 Underground Expansion Project	Production rate increasing to 3Mtpa.
steep slope	An area of land having a gradient between 1 in 3 and 2 in 1.
subsidence	The totality of subsidence effects and impacts and their associated environmental consequences.
subsidence effects	The deformation of the ground mass due to the mining activity, including both vertical and horizontal displacement, tilt, strain and curvature.
subsidence impacts	The physical changes to the ground and its surface caused by subsidence effects. These impacts are principally tensile and shear cracking of the rock mass and localised buckling of strata caused by valley closure and upsidence but also include subsidence depressions or troughs.
surface facilities sites	The Russell Vale site; all ventilation shaft sites; sites used for gas drainage or for other mining purposes infrastructure; and any other site subject to existing or proposed surface disturbance associated with the project.
T and W Mains	Current extraction action area west of the 309 Panel.
The Project	The consolidation of its existing operations and an expansion of operations and upgrade of associated surface facilities at NRE No. 1 Colliery in the Southern Coalfield.
threatened species	A plant or animal identified in the *Threatened Species Conservation Act 1995* or *Environment Protection and*

	Biodiversity Conservation Act 1999 as extinct, critically endangered, endangered, or vulnerable. This term may be extended to encompass threatened species, populations or ecological communities.
threatening process	A process that threatens, or may threaten the survival, abundance or evolutionary development of species, populations or ecological communities.
tilt	The difference in subsidence between two points divided by the horizontal distance between the points.
upland swamp	Upland swamps are vegetated freshwater wetlands occurring in shallow basins located in low hills, plateaus of mountains.
upsidence	Relative upward movement, or uplift, created by the horizontal compression and buckling behaviour of the rock strata in the vicinity of a valley floor.
valley	closure A phenomenon whereby one or both sides of a valley move horizontally towards the valley centreline, due to changed stress conditions beneath the valley and its confining land masses.
valley infill swamp	Valley infill swamps form on the floor of incised second or third order stream valleys on sediment deposited possibly as a result of channel blockage such as a log jam (DoP 2008). Valley infill swamps are likely to have direct connection to regional water table and may receive water from multiple sources including rainfall, streamflow and groundwater seepage (PAC 2010).
vertical subsidence	Vertical downward movements of the ground surface caused by underground coal mining.
V-Mains	A current extraction area in Bulli seam between earlier longwalls to the south of Wonga West.
vulnerable	A species, population or ecological community that is likely to become extinct or is in immediate danger of extinction.
Wonga East	The eastern area of proposed Stage 2 workings.
Wonga Mains	Main driveage through the Wongawilli seam.
Wonga West	The western area of proposed Stage 2 workings.
zero subsidence	Defined by DRE as vertical downward movement of the ground surface that is less than or equal to 20 mm.

ATTACHMENTS

ATTACHMENT A –Underground Expansion Project: Preferred Project Report – Biodiversity

NRE No. 1 Colliery – Underground Expansion Project:

Preferred Project Report – Biodiversity

DRAFT REPORT

Prepared for Gujarat NRE Coking Coal Ltd

20 September 2013

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- Ashleigh Pritchard for mapping
- Robert Speirs for review and quality assurance

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Summary

NRE previously submitted an Environmental Assessment (EA) for the Underground Expansion Part 3A project to the NSW Department of Planning and Infrastructure (DP&I) in February 2013. As a result of the submissions received, NRE has made the decision to substantially modify the project application, including:

- Removal of Wonga West from the project application;
- Shortening of the Wonga Main drivage to not extend under the south arm of Cataract Reservoir through the known geological feature (in the Bulli Seam); and,
- Modification of the longwall layout in Wonga East.

Due to the substantive changes made DP&I have requested NRE prepare a Preferred Project Report (PPR).

This report provides revised impact assessments for significant natural features previously recorded within the study area, based on the revised mine plan and associated revised subsidence predictions, as well as additional surveys and information that have been undertaken or has become available since the EA was submitted. This report also includes an assessment of likely historic impacts to these natural features based on past mining of the Bulli and Balgownie Seams.

The revised impact assessment concluded that there was a reduced risk of impact for many species due to the removal of Wonga West from the project application, the removal of longwalls from beneath Cataract Creek and a reduction in the number and extent of upland swamps being undermined.

1. Introduction

1.1 Project background

NRE No. 1 Colliery is located at Russell Vale, to the west of Bellambi, in the Illawarra region of New South Wales (NSW). NRE purchased the Colliery in December 2004, but extensive underground mining has been undertaken within the Colliery holdings dating from the late nineteenth century. However, a substantial volume of high quality coking coal resources remain along with some potential thermal coal resources.

The Colliery holding includes a number of sub leases between NRE and surrounding mine operators, including Consolidated Coal Lease (CCL) 745, Mining Purposes Lease (MPL) 271 and Mining Lease (ML) 1575, and covers a total area of approximately 6,973 hectares (ha).

Originally, NRE intended to expand its operations in two stages. Stage 1 plans were included in the Preliminary Works Part 3A project application that was approved on 13 October 2011, allowing some first workings coal extraction and surface facility upgrades. On 24 December 2012, the Preliminary Works Part 3A project was modified to allow the extraction of Longwalls 4 and 5 and the establishment of Maingate 6.

The original Stage 2 application, known as the Underground Expansion Project Part 3A, was lodged with the NSW Department of Planning and Infrastructure (DP&I) on 12 August 2009 and contained an application to extract 11 longwalls in the Wonga East area and 7 longwalls in the Wonga West area along with surface facilities upgrades to allow production up to 3 million tonnes per annum (Mtpa) for up to 20 years. Since that time it has been progressing through the Major Project approvals process and was placed on Public Exhibition on 18 February 2013. As a result of the submissions received on the application, NRE has made the decision to substantially revise the application to facilitate the approval process and allow continuity in operations. Due to the scope of the changes, the DP&I request NRE prepare a Preferred Project Report (PPR) for the revised Underground Expansion Project Part 3A.

The Preferred Project Report (NRE 2013) outlines the revised Underground Expansion Project which has been reduced to a five year interim stage project, with extraction of eight longwalls in the Wonga East area and upgrading of surface facilities to manage an extraction rate of up to 3 Mtpa run of mine (ROM) coal per annum. The original Wonga West longwall extraction will be resubmitted to DP&I as a separate application.

This report provides revised impact assessments for terrestrial ecology, aquatic ecology and upland swamps (Section 3). A response to submissions received is provided in Section 4.

1.2 Scope of assessment

The objectives of this report are to:

- Provide details of changes to the original project relevant to terrestrial ecology, aquatic ecology and upland swamps;
- Prepare revised impact assessments based on these changes, including revised subsidence predictions; and,
- Provide a response to submissions received on the original Ecological Assessment (EA) (ERM 2013a) based on the changes outlined above.

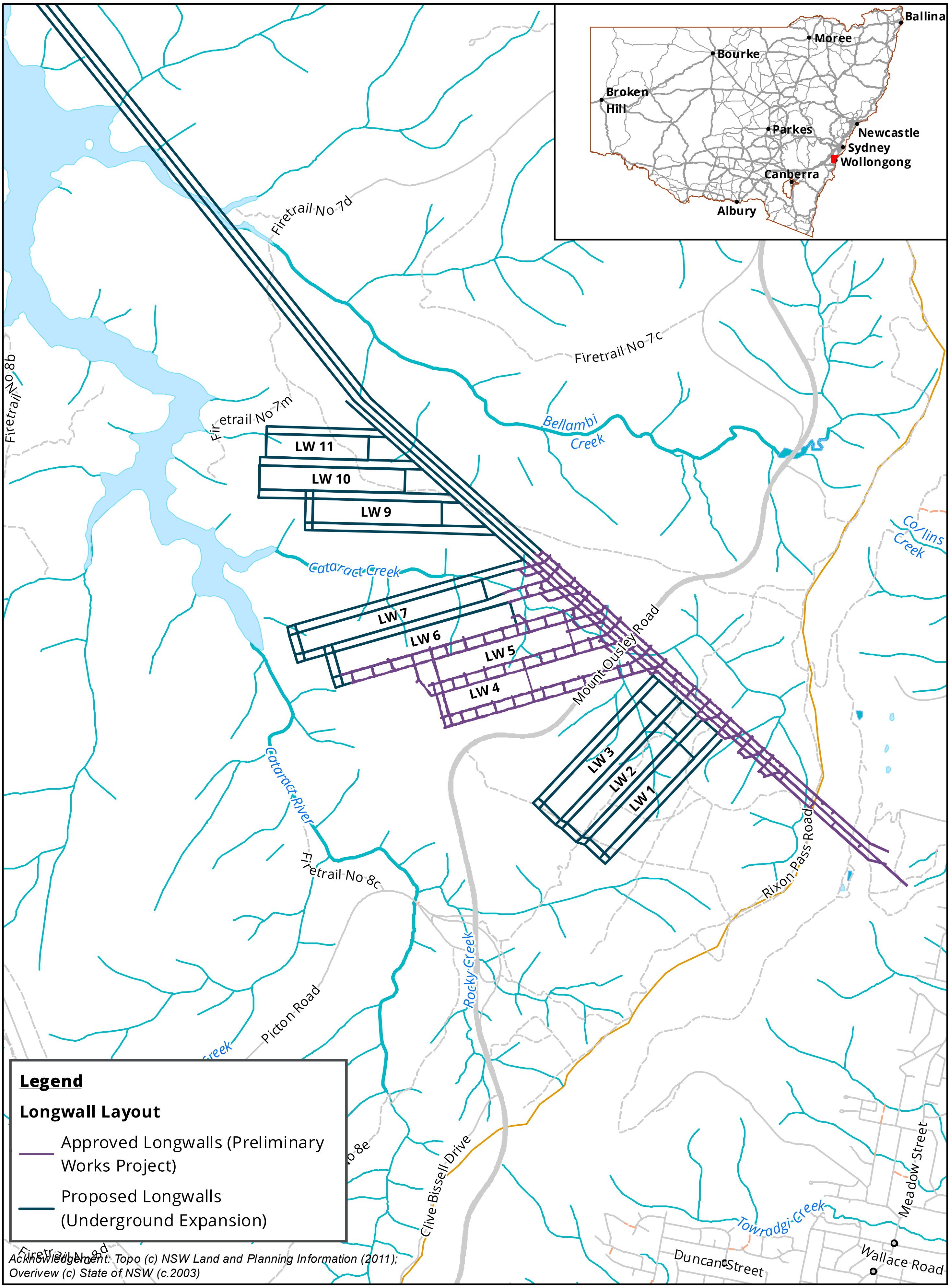

Figure 1: Location of the Study Area, New South Wales

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Date: 09 September 2013,
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Location:P:\16600s\16646\Mapping\Report Figures\Ecology\

0 300 600 900 1,200
Metres
Scale 1:30,000 @ A4, GDA 1994 MGA Zone 55

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2. Preferred Project Changes

After serious consideration of the community and agency submissions, NRE has decided to modify its Underground Expansion Project Part 3A application in the following manner:

1. The Wonga East longwall layout will be modified to minimise impacts to identified significant features while recovering the maximum volume of coal reserves possible.
2. The Wonga Mains driveage will not be extended northwards under the south arm of Cataract Reservoir through the known geological feature (in the Bulli Seam).
3. The Wonga West longwalls will be removed from this application and resubmitted as a separate application.
4. No change to the Pit Top from the original proposal.

A more detailed summary comparing the original proposal presented in the Environmental Assessment with the current Preferred Project is presented in Table 1 and Figure 2.

Table 1: Detailed Summary of Project Changes

Project Area	Original Project	PPR
Project Application Area	• As per Figure 1.2 of Underground Expansion Project Environmental Assessment	• No changes proposed
Production Limit	• 3 Mtpa	• No changes proposed
Pit Top	• Two new stockpiles of 140,000 tonnes capacity each (SP2 & SP3) with associated reclaim facilities • New truck loading facilities • Designated coal dispatch road • Progressive upgrading of trucking fleet • Continued road haulage of ROM coal to the Port Kembla Coal Terminal. • 6ML Settling Pond • Continuing use of No.4 Shaft for mine access, bathhouse, parking and offices • Ongoing maintenance and refurbishment of ventilation shafts, water and electrical facilities. • Ongoing geological and geotechnical investigations to determine coal	• No changes proposed

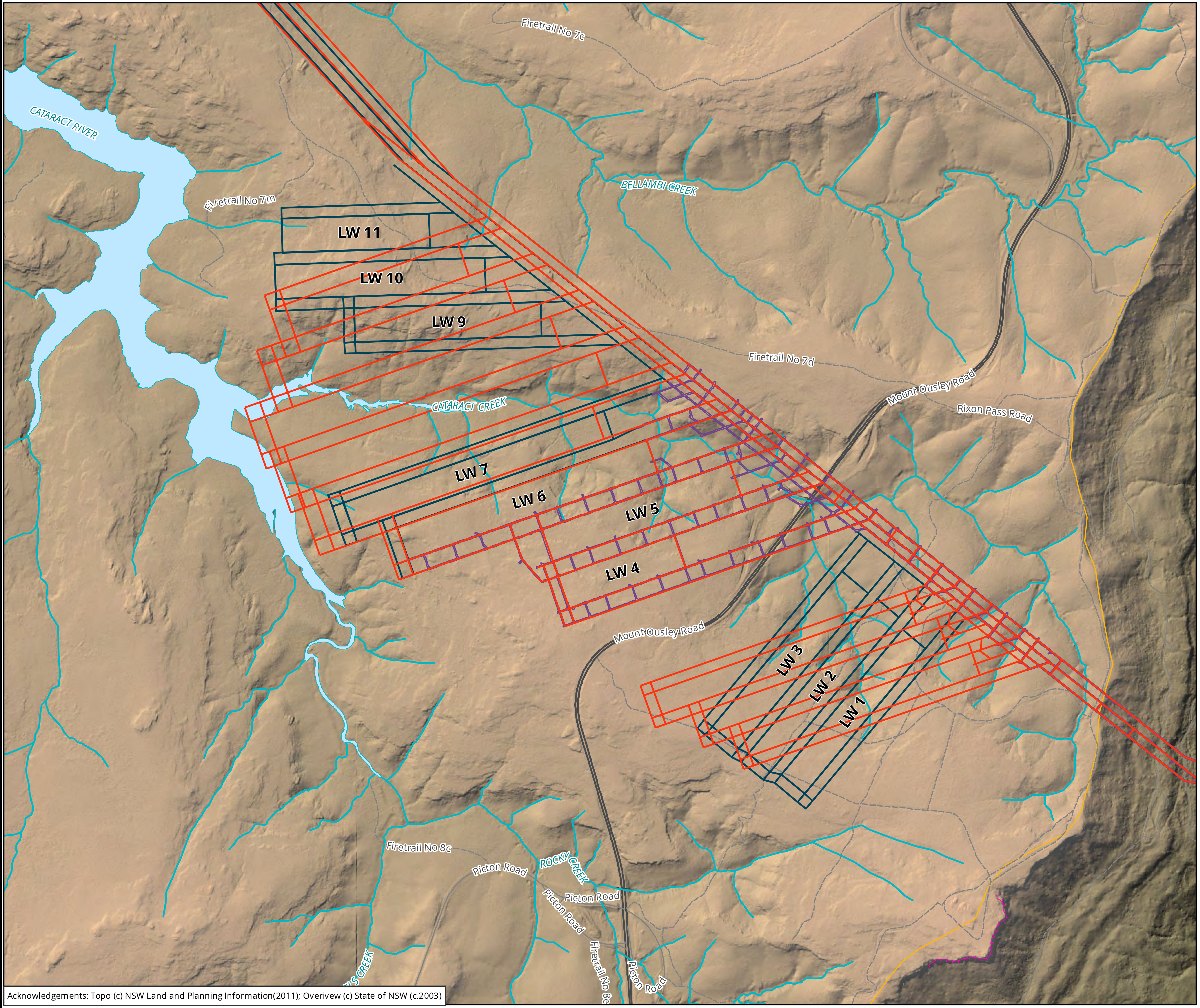
Project Area	Original Project	PPR
	quality and geotechnical conditions using drilling and related techniques.	
Wonga East Longwalls	• 9 longwalls (LW) in two Areas – Area 1 – LW's 1-3 – Area 2 – LW's 6-11	• 8 longwalls in two Areas (see Figure 2). – Area 1 – LW's 1-3 shortened and reoriented to the southwest – Area 2 – LW 6 shortened – Area 2 – LW7 shortened and moved slightly south east – Area 2 – LW 8 removed – Area 2 – LW9-11 shortened and reoriented to the northwest
Wonga Mains	• Mains drivage from the end of the Preliminary Works approved drivage heading north west, beneath Cataract Reservoir to bisect the proposed Wonga West Areas 3 and 4.	• Mains drivage from the end of the Preliminary Works approved drivage heading west-northwest to what was the southern end of Wonga West Area 3.
Wonga West Longwalls	• 7 longwalls in two Areas – Area 3 – LW's 1-5 – Area 4 – LW's 6-7	• Removed from this application. To be resubmitted as a separate application to Department of Planning and Infrastructure.
Bulli West - Bulli Seam 1st Workings	• 1st workings to the Bulli Seam to access the Bulli Seam in the western area of the Project Application Area.	• No changes proposed
Balgownie Seam 1st Workings	• 1st workings in the Balgownie Seam to access the Balgownie Seam in the western area of the Project Application Area.	• No changes proposed

For further detail see Section 1 of the PPR (NRE 2013).

These changes have resulted in the following changes to significant natural features in the Wonga East area:

- Cataract Creek will no longer be undermined;
- A reduction in undermining of cliffs associated with Cataract Creek;
- Upland swamp CCUS1 will no longer be undermined;
- Minimisation of the extent of upland swamps CCUS5 and CCUS10 that will be undermined; and,
- Changes in impacts to significant natural features based on revised subsidence predictions.

These changes and their impacts are discussed further below.



Acknowledgements: Topo (c) NSW Land and Planning Information(2011); Overivew (c) State of NSW (c.2003)

Legend

Previous Wonga East Longwalls

Longwall Layout

Approved Longwalls (Preliminary Works Project)

Proposed Longwalls (Underground Expansion)

Figure 2: Proposed PPR mine plan

0 150 300 450 600 750

Metres

Scale: 1:15,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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16646 PPR F2 Mine Plan

3. Revised Impact Assessments

This section provides a revised impact assessment for ecological features within the Wonga East study area. The study area is defined as the area located within 600m of proposed secondary extraction for the revised longwall layout (Figure 3).

The Wonga East study area supports a wide range of ecological features, including the following significant natural features:

- Thirty-two upland swamps (an endangered ecological community (EEC));
- Third and fourth order streams, including Cataract Creek and Cataract River;
- Rocky habitats, including rocky outcrops and cliffs; and,
- Threatened species and their habitats.

Significant natural features are shown in Figure 4. For a comprehensive discussion of these features see Section 2.4 of ERM (2013b).

This revised impact assessment focuses on those species, populations and communities listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and/or the NSW *Threatened Species Conservation Act 1995* (TSC Act) and deemed at risk of impact due to subsidence associated with longwall mining. This includes species that are reliant on natural features at risk of impact; particularly aquatic ecosystems (streams and creeks), upland swamps and rocky environments (including caves and overhangs) (DECC 2007a, DoP 2008). Past experience with longwall mining in the Southern Coalfield indicates that impacts to terrestrial ecosystems are generally less significant than those experienced by aquatic ecosystems, upland swamps and rocky environments. Terrestrial ecosystems are considered to be at negligible risk of impact from subsidence associated with longwall mining (DECC 2007a) and are not considered further.

3.1 Terrestrial ecology

A number of ecological assessments of the Wonga East area have been undertaken by ERM (summarised in ERM 2013b) and Biosis (2012a, 2012b, 2013). Together, these assessments provide a comprehensive inventory of the terrestrial biodiversity values present within the Wonga East area. A summary of these assessments can be found in ERM (2013a, 2013b).

Species, populations and communities either recorded during previous assessment, or deemed likely to occur within the study area, and considered vulnerable to impacts due to subsidence (DECC 2007a, ERM 2013b) are listed in Table 2.

Table 2: Threatened species, populations and communities likely to occur in the study area and vulnerable to impacts due to subsidence (DECC 2007a, ERM 2013b)

E – Endangered, V - Vulnerable

Scientific name	Common name	EPBC Act status	TSC Act status
Flora			
Acacia baueri* ssp. *aspera	-	-	V

Scientific name	Common name	EPBC Act status	TSC Act status
Epacris purpurascens* var. *purpurascens	-	-	V
Grevillea parviflora* ssp. *parviflora	Small-flowered Grevillea		
Leucopogon exolasius	Woronora Beard-heath	V	V
Melaleuca deanei	Deane's Melaleuca	V	V
Persoonia bargoensis	Bargo Geebung	V	E
Pultenaea aristata	Prickly Bush-pea	V	V
Threatened ecological communities			
-	*Coastal Upland swamp in the Sydney Basin Bioregion*	-	E
Birds			
Pezoporus wallicus wallicus	Eastern Ground Parrot	-	V
Mammals (excl. bats)			
Cercartetus nanus	Eastern Pygmy Possum	-	V
Dasyurus maculatus maculatus	Spotted-tailed Quoll	E	V
Mammals - Bats			
Chalinolobus dwyeri	Large-eared Pied Bat	V	V
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	-	V
Myotis macropus	Large-footed Myotis	-	V
Reptiles			
Hoplocephalus bungaroides	Broad-headed Snake	V	E
Varanus rosenbergi	Rosenberg's Goanna	-	V
Frogs			
Heleioporus australiacus	Giant Burrowing Frog	V	V
Litoria littlejohni	Littlejohn's Tree frog	V	V
Pseudophryne australis	Red-crowned Toadlet	-	V
Mixophyes balbus	Stuttering Frog	V	E
Invertebrates			
Petalura gigantea	Giant Dragonfly	-	E

These species are discussed further below in Sections 3.1.1 (flora) and Section 1.1.1 (fauna). A revised impact assessment is provided in Section 3.1.4.

Upland swamps are discussed further in Section 3.3.

3.1.1 Flora

ERM (2013b) identified seven flora species at risk of impact due to subsidence associated with extraction of coal from the Wonga East and Wonga West areas. Given the changes to the project, including the removal of the Wonga West area from the application, a reassessment of the potential for species to occur within the study area is required.

Table 3 provides a reassessment of habitat for these species, the potential for this habitat to occur within the study area, and a determination of the reliance of these species on microhabitats that are at risk of impacts from subsidence associated with the Preferred Project.

Species that are considered likely to occur within the study area and are considered to be at risk of impact from subsidence associated with the Preferred Project are considered further in Section 3.1.4.

Table 3: Terrestrial flora species vulnerable to impacts from subsidence (DECC 2007a), and an assessment of microhabitats within the study area

Species	Description	Does the species occur in, and is it reliant on, susceptible microhabitats within the study area?
Acacia baueri* ssp. *aspera	*Acacia baueri* ssp. *baueri* occurs in damp heaths associated with sandstone woodland (ERM 2013b) and often occurs in small depressions on rocky outcrops. Further, targeted and opportunistic surveys in the study area have not recorded this species. The Wonga East area does not contain many rocky outcrops, and suitable habitat for this species within the study area is limited.	Yes Rocky outcrops
Epacris purpurascens* var. *purpurascens	*Epacris purpurascens* var. *purpurascens* is found within a wide range of habitat, usually associated with moisture, most of which have a strong shale influence (ERM 2013b, BHPBIC 2009). It is not considered to be a swamp specialist. This habitat is considered to be at negligible risk of impact. Further, targeted and opportunistic surveys in the study area have not recorded this species.	No
Small-flowered Grevillea	Small-flower Grevillea grows in sandy or light clay soils, usually over thin shales, and occurs in a wide range of vegetation types (ERM 2013b). Habitat for this species is considered to be at negligible risk of impact. Further, targeted and opportunistic surveys in the study area have not recorded this species.	No
Woronora Beard-heath	Woronora Beard-heath occurs in a wide range of habitat types, including woodland, rocky hillsides and creeks (ERM 2013b). The wide range of habitats this species occurs in are considered to be at negligible risk of impact. Further, targeted and opportunistic surveys in the study area have not recorded this species.	No
Deane's Melaleuca	Deane's Paperbark grows in heath communities on sand, and has been recorded from ridgetops, dry ridges and slopes. It is often associated with sandy loam soils (ERM 2013b). This species is not considered to be reliant on microhabitats that are at risk of impact due to subsidence. Further, targeted and opportunistic surveys in the study area have not recorded this species.	No

Species	Description	Does the species occur in, and is it reliant on, susceptible microhabitats within the study area?
Bargo Geebung	Bargo Geebung grows in woodland and dry Sclerophyll forest on a wide variety of soils types. This species is not reliant on microhabitats at risk of impact from subsidence. Further, targeted and opportunistic surveys in the study area have not recorded this species.	No
Prickly Bush-pea	Prickly Bush-pea has been recorded within the study area from open habitats, including upland swamps and adjacent woodland. The species occurs where drainage is impeded (NPWS 2003), usually in areas where low degree slopes result in slowing of surface and groundwater flows (Biosis pers. obs.). Since the original EA (ERM 2013a) was submitted this species has been recorded at a number of additional locations and the species is known to be common and widely distributed in the study area.	Yes Upland swamps

3.1.2 Fauna

ERM (2013b) identified thirteen fauna species at risk of impact due to subsidence associated with the original project. This assessment considered available habitat in the Wonga East and Wonga West area. Given changes to the project, including the removal of the Wonga West area from the application, a reassessment of the potential for species to occur within the study area is required. Table 4 provides a reassessment of habitat for these species, the potential for this habitat to occur within the study area, and a determination of the reliance of these species on microhabitats that are at risk of impacts from subsidence.

Species that are considered likely to occur within the study area and at risk of impact from subsidence associated with the Preferred Project are considered further in Section 3.1.4.

Table 4: Terrestrial fauna species vulnerable to impacts from subsidence (DECC 2007a), and an assessment of microhabitats within the study area

Species	Description	Does the species occur in, and is it reliant on, susceptible microhabitats within the study area?
Eastern Ground Parrot	The Eastern Ground Parrot was previously thought to be extinct within the local area (DECC 2007b) prior to several observations of this species during surveys for the Metropolitan Coal Project and the Bulli Seam Operations Project. The Eastern Ground Parrot occurs in low heathlands and sedgelands, generally below one metre in height and very dense (OEH 2013b). Habitat within the study area is largely limited to MU 44 Upland swamp: Sedgeland-Heath Complex. This vegetation community is severely restricted and highly fragmented within the study area. The previous assessment (ERM 2013b) assessed that this species could potentially occur in the Wonga West area, but was unlikely to occur within the Wonga East area. This species is considered unlikely to occur within the study area.	No
Eastern Pygmy Possum	The Eastern Pygmy Possum occurs in a wide variety of habitat types, including rainforest, sclerophyll forest and heaths (DECC 2007b) and upland swamps (Biosis pers. obs., DECC 2007a). Given the wide range of habitat types that this species inhabits it is not considered to be at significant risk of impact from subsidence.	No
Spotted-tailed Quoll	The Spotted-tailed Quoll utilises a wide range of habitat types, with cliffs, rock benches or overhangs listed as habitat with potential to be impacted (DECC 2007a). Given the widespread nature of this species' habitat the risk of impact is considered to be negligible.	No
Large-eared Pied Bat	The Large-eared Pied Bat is considered rare within the local area and has narrow habitat requirements, including productive land close to suitable roosting habitats (DECC 2007b). The species roosts in caves and overhangs, and it is this habitat which is of high conservation significance (DECC 2007b). Cliffs that may provide suitable roosting sites within the study area are limited in extent, and restricted to an area over LW9.	Yes Cliffs over LW9
Eastern Bentwing-bat	The Eastern Bentwing-bat is common in the local area, being one of the most commonly recorded bats	Yes

Species	Description	Does the species occur in, and is it reliant on, susceptible microhabitats within the study area?
	during surveys (Biosis pers. obs.). This species has been recorded within the study area. The species forages within a wide range of habitat types and across a large area. The species roosts in caves and overhangs, and it is this habitat which is of high conservation significance (DECC 2007b). Cliffs that may provide suitable roosting sites within the study area are limited in extent, and restricted to an area over LW9.	Cliffs over LW9
Large-footed Myotis	The Large-footed Mytois is considered to be rare in the local area (DECC 2007b). The species forages along waterways, including disturbed waterways in urban environments, and is more common in more highly productive environments, although the species has been recorded on the Woronora plateau. The species roosts in caves and overhangs, and it is this habitat, which is of high conservation significance (DECC 2007b). Cliffs that may provide suitable roosting sites within the study area are limited in extent, and restricted to an area over LW9. Cataract Creek provides potential foraging habitat for this species. The species may be susceptible to changes in water quality or natural flow regimes (DECC 2007b).	Yes Cliffs over LW9 and Cataract Creek
Broad-headed Snake	The Broad-headed Snake occurs on exposed rocky outcrops with bedrock providing suitable winter sheltering habitat. This species is extremely rare in the local area (DECC 2007b). Due to the presence of this species on rocky outcrops that are susceptible to fracturing due to subsidence, the species is listed by DECC (2007a) as being at risk of impact from longwall mining. Biosis has previously undertaken monitoring of rocky outcrops for the Dendrobium, Wongawilli and Nebo mines. While subsidence effects, including fracturing of rocky outcrops, have been observed, no impacts to sheltering habitat for reptiles was observed in these areas. The Wonga East area does not contain many rocky outcrops, and suitable habitat for this species within the study area is limited. The risk of impact to this species is considered minimal. However, if specific locations for this species were identified these would be considered of high conservation value given the species' rarity. For this reason, the species is considered further below.	Yes Rocky outcrops

Species	Description	Does the species occur in, and is it reliant on, susceptible microhabitats within the study area?
Rosenberg's Goanna	Rosenberg's Goanna inhabits ridgetops with higher levels of rocks and shrubs that provide habitat for prey species (DECC 2007b). Although this species is located on rocky outcrops which are at risk of impacts from subsidence (DECC 2007a) the species or its prey do not rely on specific habitat features at risk of impact. Thus the species is considered at negligible risk of impact from the preferred project.	No
Giant Burrowing Frog	The Giant Burrowing Frog occurs in sandstone environments and is generally associated with first and second order intermittent creeks that provide suitable breeding pools (Biosis pers. obs.). Although often associated with upland swamps, DECC (2007b) assert that this association is not direct, rather that upland swamps are associated with minor drainage lines that provide suitable breeding pools and burrowing habitat for this species. Detailed habitat mapping was undertaken by Biosis (2012b, 2013a) with suitable breeding habitat for this species mapped at four locations in the study area (Figure 5). Targeted surveys undertaken by Biosis as a part of the ecological monitoring program for Longwalls 4 and 5 in August and December 2012 and February, April and May 2013 have detected tadpoles for the Giant Burrowing Frog in a tributary of CRUS2. A total of 17 tadpoles were observed in three breeding pools located along the 245 metre transect (Figure 5). This tributary of CRUS2 is located approximately 700 m from the nearest longwall (LW4) and is outside the active subsidence zone. The species has not been recorded elsewhere within the study area.	Yes Creeks shown in Figure 5
Littlejohn's Tree frog	Littlejohn's Tree Frog occurs in sandstone environments and is generally associated with first and second order intermittent creeks that provide suitable breeding pools (Biosis pers. obs.). The species has been recorded within a wide variety of vegetation types, all associated with more open habitat and intermittent creeks. This includes, but is not restricted to, upland swamps (Biosis pers. obs.). Detailed habitat mapping was undertaken by Biosis (2012b, 2013a) with suitable breeding habitat for this species mapped at four locations in the study area (Figure 5). Targeted surveys undertaken by Biosis as a part of the ecological monitoring program for Longwalls 4 and 5 in August and December 2012 and February, April and May 2013 have not recorded this species.	Yes Creeks shown in Figure 5

Species	Description	Does the species occur in, and is it reliant on, susceptible microhabitats within the study area?
Red-crowned Toadlet	The Red-crowned Toadlet is fairly common in preferred ridgetop habitat and first order ephemeral creeks below ridges (DECC 2007b) and has been recorded, using drainage lines, sheltering under bushrock on ridgetops and in depressions along fire trails (Biosis pers. obs.). Habitat for this species within the study area has not been mapped, as it is widely distributed and common. Targeted surveys for the Red-crowned Toadlet have been undertaken by Biosis as a part of the ecological monitoring program for Longwalls 4 and 5 (Biosis 2013a). Surveys were conducted using auditory recording devices located in suitable breeding habitat along two ephemeral creeks below ridgelines above Longwall 4 and Longwall 5 (Figure 4). The Red-crowned Toadlet was recorded calling at both sites (Biosis 2013a). However, preferred habitat for this species is considered to be at limited risk of impact.	No
Stuttering Frog	The Stuttering Frog is generally considered rare within the Sydney Basin bioregion and is now close to extinction in the local area (DECC 2007b). Detailed habitat mapping was undertaken by Biosis (2012b, 2013a) with suitable breeding habitat for this species mapped along Cataract Creek in the study area (Figure 5). Cataract Creek has been impacted by past mining of the Bulli and Balgownie coal seams, with an iron seep located along a tributary of Cataract Creek resulting in moderate to high levels of iron flocculent in the creek. This past impact is likely to reduce the suitability of the habitat for this species (ERM 2013b). Targeted surveys undertaken by Biosis as a part of the ecological monitoring program for Longwalls 4 and 5 in October, November and December 2012 and February 2013 have not recorded the Stuttering Frog along Cataract Creek.	Yes Cataract Creek (Figure 5)
Giant Dragonfly	The Giant Dragonfly is found in upland swamps with open vegetation and free water (OEH 2013d). Suitable habitat for this species within the study area is limited to lower sections of upland swamp CCUS4. Given the limited extent of suitable habitat within the study area this species is considered unlikely to occur within the study area.	No

3.1.3 Assessment of historic impacts to terrestrial biodiversity from extraction of the Bulli and Balgownie seams

Sections 3.1.1 and 1.1.1 identify the following significant natural features at risk of impact due to subsidence:

- Rocky outcrops;
- Upland swamps;
- Cliffs over Longwall 9;
- Cataract Creek; and
- Threatened frog habitat as identified in Figure 5.

ERM (2013a) and ERM (2013b) provide a summary of potential impact mechanisms. This section assesses the potential impacts of past mining of the Bulli and Balgownie seams, before assessing the impacts of the original project versus the preferred project on these significant natural features

Extraction of the Bulli and Balgownie seams has occurred within the Wonga East area. Within the study area, the Bulli seam was extracted via hand workings and pillar extraction between 1890 and 1960. The Balgownie seam was extracted using continuous miner pillar extraction in 1969 and the retreat longwall mining method from 1970 to 1982. Assessment of subsidence data from the extraction of the Bulli and Balgownie coal seams has been undertaken by SCT Operations (2013).

Table 5 provides subsidence predictions for identified significant natural features from the extraction of the Bulli and Balgownie Seams in the Wonga East area.

Table 5: Balgownie seam subsidence predictions for selected significant features in the study area

	Bulli seam and Balgownie seam Subsidence (m)	Balgownie seam Tilt (mm/m)	Balgownie seam Max Tensile Strain (mm/m) and Typical (in brackets)	Balgownie seam Max Compressive Strain (mm/m) and Typical (in brackets)	Balgownie seam Closure (mm)
Selected natural features					
Threatened frog habitat CRUS2 Trib	0.5	5	3	4	-
Threatened frog habitat CRUS1 Trib1	0.5	5	3	4	-
Threatened frog habitat CRUS1 Trib2	0.9	11	3	4	-
Threatened frog habitat CCUS4 Trib	1.2	18	7.5 (3)	14 (4)	-
Cliffs over LW9	0.5	N/A	N/A	N/A	-
Cataract Creek	1.4	15	N/A	N/A	310

Available data indicates that past mining of the Bulli and Balgownie Seams is likely to have resulted in fracturing of bedrock beneath identified threatened frog habitat, and that closure in Cataract Creek is likely to have been sufficient to have resulted in diversion of surface flows using criteria identified by MSEC (DoP 2010).

Based on this data, it is likely that there are pre-existing impacts to identified natural features, as outlined above. There is evidence to support this conclusion, with iron seeping from a tributary of Cataract Creek resulting in a significant amount of iron flocculent in Cataract Creek. Cliffs in the study area show signs of previous collapse, including some where likely mining-induced collapse has occurred (K. Mills pers. comm.).

This assessment of past mining in the Wonga East area indicates that natural features in the study area have been subject to subsidence resulting from extraction of the Bulli and Balgownie Seams. This data provides a baseline against which assessments of potential impacts resulting from extraction of the Wongawilli Seam, as part of the preferred project, must be assessed.

3.1.4 Revised impacts assessment for terrestrial biodiversity

A summary of subsidence predictions for extraction of the Wongawilli Seam in the Wonga East area is provided in Table 6. This table provides predicted subsidence parameters for each longwall, as well as predicted subsidence for significant natural features outlined above.

The extraction of the Wongawilli Seam in the Wonga East area will result in a maximum of 2.1 m of subsidence, with tilts between 24 and 51 mm / m, tensile strain of between 7 and 15 mm / m and compressive strains between 14 and 31 mm / m. Closure within Cataract Creek will be managed to be less than 200 mm.

As can be seen from Table 6, the majority of significant natural features within the study area are at minimal risk of impact, with subsidence predictions indicating subsidence effects are likely to be minimal. The exception to this is threatened frog habitat in CRUS4 Trib and cliffs over Longwall 9.

Table 7 provides impact assessments, including an assessment of impacts from the original project compared to the preferred project, for natural features identified in Sections 3.1.1 and 1.1.1.

Tilts, tensile strains and compressive strains in CRUS4 Trib are sufficient to result in fracturing of the bedrock beneath this tributary. However, no threatened frogs have been recorded at this location to date. Known habitat in CRUS2 Trib will not be impacted.

Subsidence predictions for cliffs over Longwall 9 are of sufficient magnitude to result in impacts to these cliffs. Impacts, including tensile cracking of the rock strata and collapse, are likely to occur, particularly where horizontal compression exceeds 50 – 100 mm per 20 m length of cliff formation. However, It is difficult to predict the location/s at which where impacts may occur. Given the limited extent of suitable roosting sites for microchiropteran bats the risk of impact is considered low, particularly when compared with the availability of suitable habitat in the local area. Risk of collapse is considered minimal.

Subsidence predictions for Cataract Creek indicate that this waterway is unlikely to be subject to negative environmental consequences. Closure will be managed to ensure it does not exceed 200 mm / m, and tilts, compressive and tensile strains are unlikely to be of sufficient magnitude to result in fracturing of the bedrock of Cataract Creek. However, fracturing of tributaries of Cataract Creek may result in decreased inflow into Cataract Creek, and an increase in iron seepage at the base of these tributaries and resultant potential for increased iron flocculent in Cataract Creek (A. Dawkins pers. comm.). It is difficult to determine whether these impacts will result in observable impacts to Cataract Creek above and beyond those present.

Further assessment and discussion of potential impacts is provided below.

Table 6: Wongawilli seam subsidence predictions for longwalls and selected significant features in the study area

	Overburden depth to Wongawilli Seam (m)	Subsidence predicted (m) and measured (in brackets)	Tilt predicted (mm/m) and measured (in brackets)	Tensile strain predicted (mm/m) and measured (in brackets)	Compressive strain predicted (mm/m) and measured (in brackets)	Closure on Cataract Creek (mm)
Longwall 1	260	2.1	40	12	24	-
Longwall 2	260	2.1	40	12	24	-
Longwall 3	255	2.6	51	15	31	-
Longwall 4	300	2.1 (1.6)	35 (30)	10.5 (7.5)	21 (14)	< 5
Longwall 5 (mining still in progress)	265	1.9 (1.5)	36 (16*)	10.8 (4.5*)	22 (14*)	130 (20*)
Longwall 6	280	2.1	38	11	23	130
Longwall 7	270	1.5	28	8	17	200
Longwall 9	330	2.1	32	10	19	120
Longwall 10	340	1.6	24	7	14	20
Longwall 11	350	2.1	30	9	18	0
Selected natural features						
Threatened frog habitat CRUS2 Trib	300	0	0	0	0	-
Threatened frog habitat CRUS1 Trib1	320	0	0	0	0	-
Threatened frog habitat CRUS1 Trib2	320	0.02	0	0	0	-
Threatened frog habitat CCUS4 Trib	270	1.5	28	8	17	-
Cliffs over LW9	330	2.1	32	10	19	-

	Overburden depth to Wongawilli Seam (m)	Subsidence predicted (m) and measured (in brackets)	Tilt predicted (mm/m) and measured (in brackets)	Tensile strain predicted (mm/m) and measured (in brackets)	Compressive strain predicted (mm/m) and measured (in brackets)	Closure on Cataract Creek (mm)
Cataract Creek	260	0.1	1	0	N/A	200

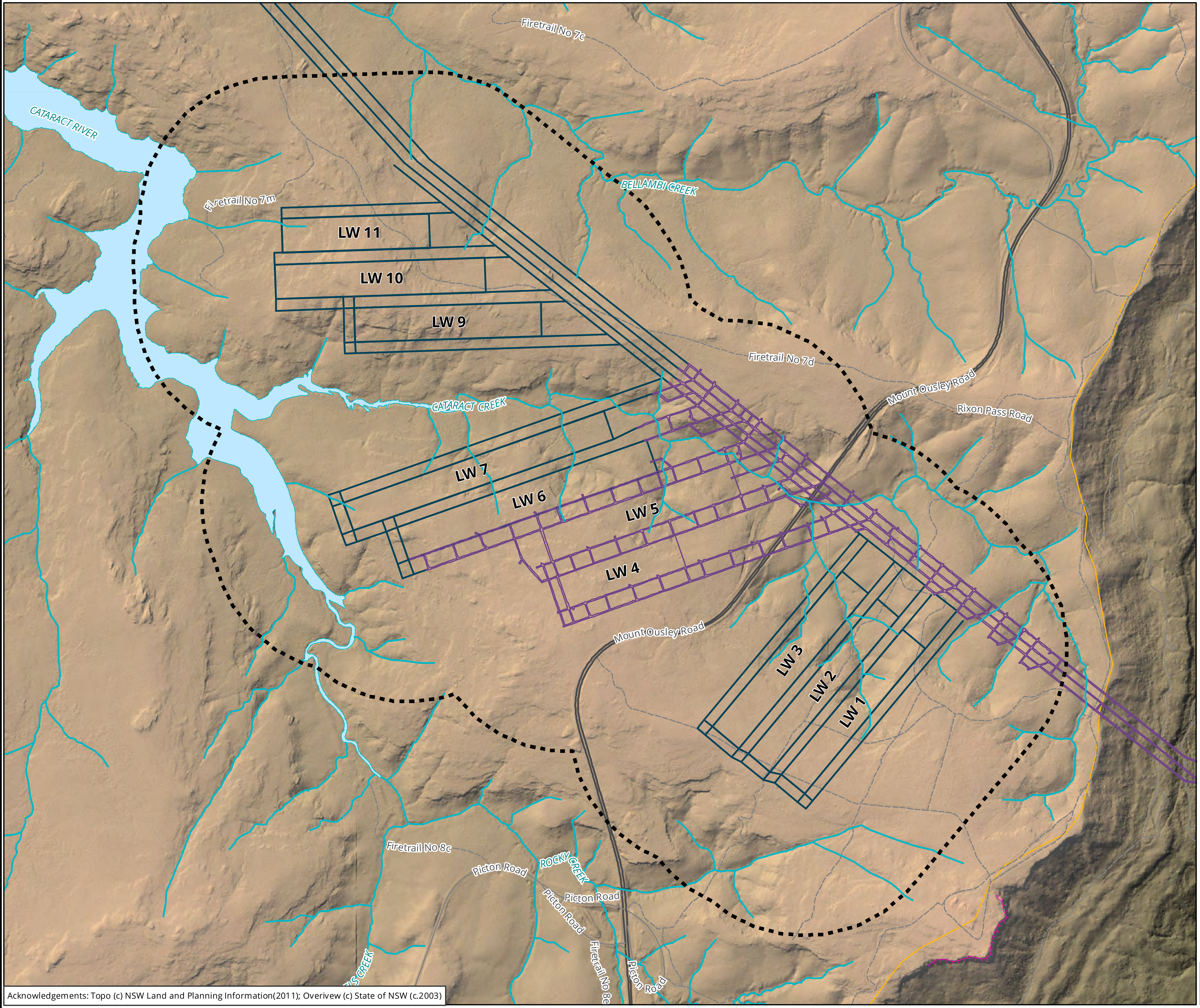
Table 7: Impact assessment for species at risk of subsidence, including comparison of risks from the original project and preferred project

Species	Microhabitats at significant risk of impact from subsidence	Potential impacts to critical microhabitat	Notes	Risk of impact from original project (based on ERM 2013a and ERM 2013b)	Risk of impact from preferred project
Acacia baueri* ssp. *aspera	Rocky outcrops	Fracturing of the base of minor depressions in rocky outcrops, leading to reduced moisture in these areas and potential loss of individual plants.	The general risk of fracturing of rocky outcrops within the study area is considered moderately high; however suitable habitat (i.e. rocky outcrops with minor depressions) is limited within the study area	Low	Low
Prickly Bush-pea	Upland swamps	Fracturing of bedrock resulting in changes in water availability or changes in vegetation composition resulting in increased competition. Changes in slope gradient resulting in decreased water availability.	The species is widespread and common within the study area, having been recorded at a greater number of locations since the submission of the EA (ERM 2013b). Although there is potential for fracturing of bedrock beneath suitable upland swamp habitat, and changes in hydrology, impacts to wider habitat are predicted to be minimal.	Low	Low

Species	Microhabitats at significant risk of impact from subsidence	Potential impacts to critical microhabitat	Notes	Risk of impact from original project (based on ERM 2013a and ERM 2013b)	Risk of impact from preferred project
Large-eared Pied Bat **Eastern Bentwing-bat** **Large-footed Myotis**	Cliffs	Overhang collapse resulting in destruction of roosting habitat	Potential roosting habitat within the study area is limited in extent, and restricted to an area above LW9. Further, the risk of collapse of these cliffs is considered to be low (~5%; K. Mills pers. comm.). The removal of Wonga West from the project, where suitable habitat was much more prevalent along Lizard and Wallandoola Creeks, has resulted in a reduction in risk.	Moderate (Wonga West)	Low
	Cataract Creek (Large-footed Mytois only)	Fracturing of stream bed resulting in diversion of flows along sections of creeks. Increased iron entering the waterway, resulting in changes in water quality and choking of vegetation by iron flocculent.	The revision of the mine plan now avoids mining below Cataract Creek. No impacts to the bed of Cataract Creek are predicted to occur and diversion of flows is unlikely (A. Dawkins pers. comm.). There is potential for fracturing of the base of tributaries of Cataract Creek, resulting in diversion of flows, decreased inflow into Cataract Creek and iron seepage (A. Dawkins pers. comm.). The extent and magnitude of impact will be dependent on past impacts from extraction of the Bulli and Balgownie seams.	Low	Low
Broad-headed Snake	Rocky outcrops	Fracturing of rocky outcrops leading to a loss or change in shelter sites for this species or its prey.	The general risk of fracturing of rocky outcrops within the study area is considered moderately high with perceptible cracking in up to 30% of bare rock areas located directly above longwalls (k. Mills pers. comm.). However suitable habitat	Moderate (Wonga West)	Low

Species	Microhabitats at significant risk of impact from subsidence	Potential impacts to critical microhabitat	Notes	Risk of impact from original project (based on ERM 2013a and ERM 2013b)	Risk of impact from preferred project
			(i.e. rocky outcrops with suitable shelter) is limited within the study area. Suitable habitat for the species, identified within the EA (ERM 2013b) was largely limited to Wonga West.		
Giant Burrowing Frog **Littlejohn's Tree frog**	Creeks shown in Figure 5	Fracturing of stream bed resulting in diversion of flows along sections of creeks providing breeding habitat, resulting in loss of breeding pools. Fracturing of the base and draining of breeding pools. Increased iron entering the waterway, resulting in changes in water quality and choking of vegetation by iron flocculent. Release of methane gas into the water column, resulting in vegetation dieback in riparian environments and impacts to water quality.	Suitable habitat for these species has been identified in three tributaries of Cataract River and one tributary of Cataract Creek (Figure 5; Biosis 2012a, Biosis 2013a). Surveys undertaken as a part of the ecological monitoring program for Longwalls 4 and 5 have identified Giant Burrowing Frog tadpoles at one of these locations, in a tributary of Cataract River below CRUS2. This site is located outside of the predicted subsidence impact zone. These species have not been recorded at any other sites. Additional targeted surveys and the removal of Wonga West from the project application have resulted in a significant reduction in risk of impact to this species.	High	Low
Stuttering Frog	Yes Cataract Creek (Figure 5)	Fracturing of stream bed resulting in diversion of flows along sections of creeks	Suitable habitat for this species has been identified in Cataract Creek (Figure 5; Biosis 2012a, Biosis 2013a). Surveys undertaken as a	Moderate	Low

Species	Microhabitats at significant risk of impact from subsidence	Potential impacts to critical microhabitat	Notes	Risk of impact from original project (based on ERM 2013a and ERM 2013b)	Risk of impact from preferred project
		providing breeding habitat, resulting in impacts to suitable breeding habitat. Fracturing of the base and draining of breeding pools. Increased iron entering the waterway, resulting in changes in water quality and choking of vegetation by iron flocculent. Release of methane gas into the water column, resulting in vegetation dieback in riparian environments and impacts to water quality.	part of the ecological monitoring program for Longwalls 4 and 5 have not recorded this species in the study area. Additional targeted surveys have resulted in a reduction in risk of impact to this species.		



Acknowledgements: Topo (c) NSW Land and Planning Information(2011); Overivew (c) State of NSW (c.2003)

Legend

Longwall Layout

Approved Longwalls (Preliminary Works Project)

Proposed Longwalls (Underground Expansion)

600m Study Area

Figure 3: Wonga East study area

0 150 300 450 600 750

Metres

Scale: 1:15,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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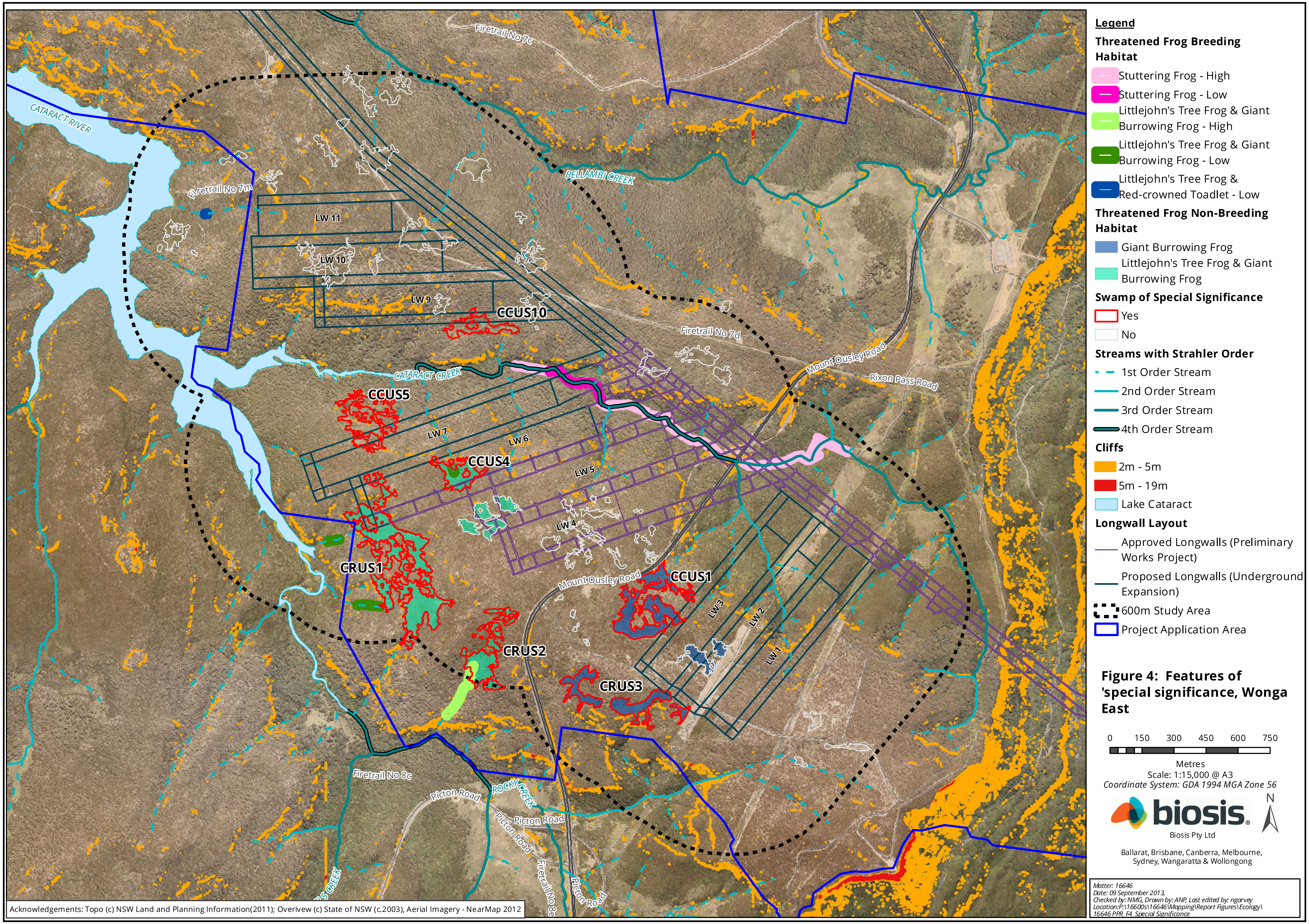

Figure 4: Features of 'special significance, Wonga East

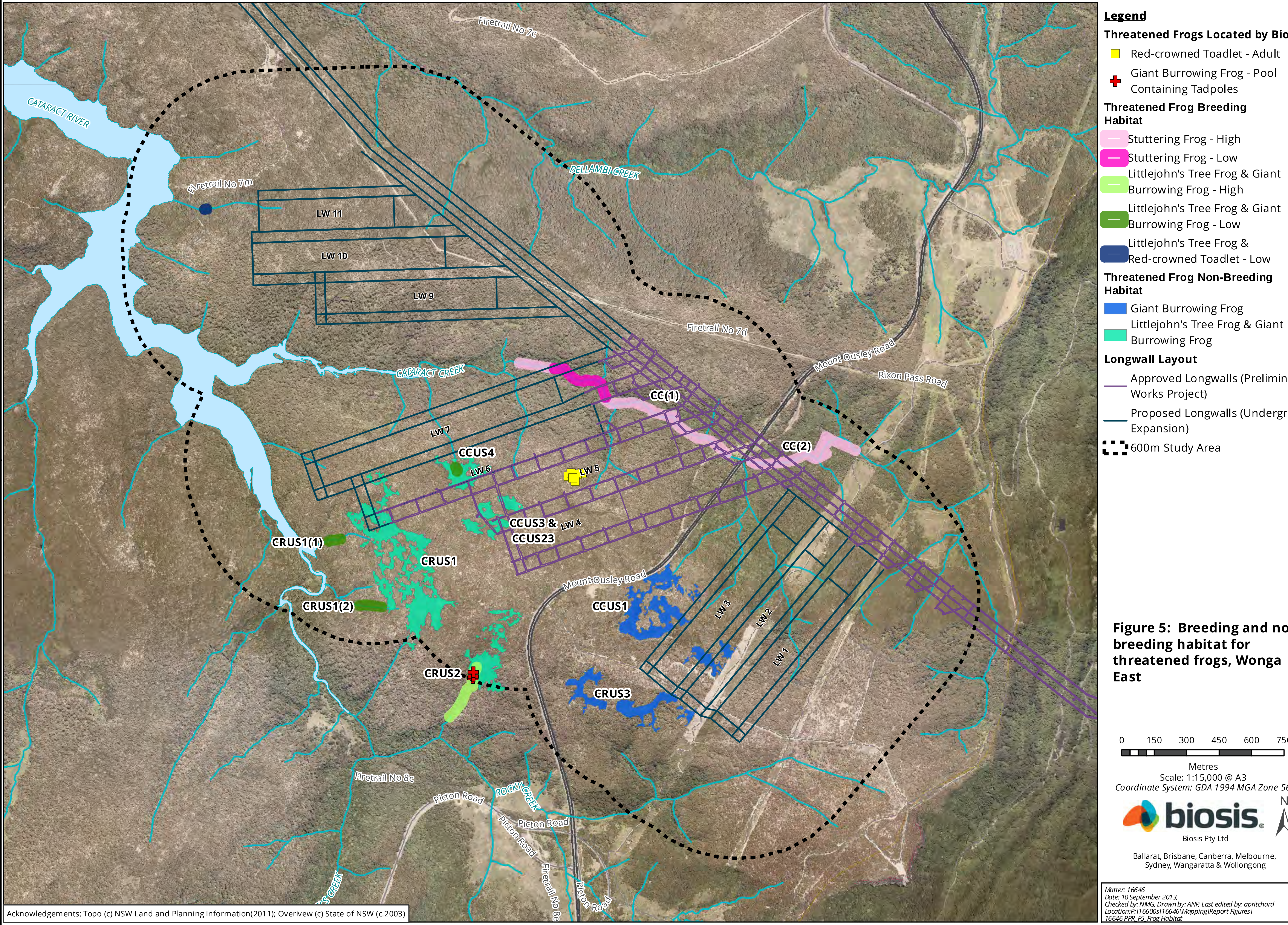

Figure 5: Breeding and non-breeding habitat for threatened frogs, Wonga East

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16646 PPR_F5_Frog Habitat

3.2 Aquatic ecology

Cardno Ecology Lab (2009; 2011a, b; 2012a, b) and Biosis (In Prep.) have undertaken seasonal assessments of aquatic habitat condition and macroinvertebrate assemblages at impact and control monitoring reaches in spring and autumn each year since 2008. Table 8 and Table 9 provide a summary of work undertaken to date. These assessments provide a comprehensive inventory and understanding of the aquatic biodiversity values present in the Wonga East area.

Table 8: Aquatic ecology monitoring approach

Aquatic Ecological Value	Monitoring	Frequency
Aquatic Habitat	Habitat assessment (including photopoint monitoring).	Baseline monitoring has been conducted twice per year specifically during spring and autumn each year.
Aquatic Macroinvertebrates	Macroinvertebrates (AUSRIVAS) including threatened species.	Baseline monitoring has been conducted twice per year specifically during spring and autumn each year.
Fish	Targeted threatened fish surveys.	Surveys have been undertaken according to the 'Survey guidelines for Australia's threatened fish' (DSEWPaC 2011).
Water Quality	In-situ water quality provides a snapshot of each monitoring reach.	During each monitoring event.

Table 9: Overview of previous aquatic surveys in Cataract Creek (*n* = 2), Cataract River (*n* = 2) and Allen Creek (*n* = 2)

✓ = sampled, N/A = not sampled

	Spring 2008	Autumn 2009	Spring 2009	Autumn 2010	Spring 2010	Autumn 2011	Spring 2011	Autumn 2012	Spring 2012	Autumn 2013
Water Quality (*in situ*)	✓	✓	✓	✓	N/A	✓	✓	✓	N/A	✓
Aquatic Habitat Assessments (HABSCORE)	✓	✓	✓	✓	N/A	✓	✓	✓	N/A	✓
Aquatic Macronvertebrate Sampling (AUSRIVAS)	✓	✓	✓	✓	N/A	✓	✓	✓	N/A	✓
Threatened Fish Surveys	N/A	✓	N/A	Summer 2010	N/A	Summer 2011	N/A	Summer 2012	N/A	✓
Reference	Cardno Ecology Lab (2010)	Cardno Ecology Lab (2010)	Cardno Ecology Lab (2012a)	Cardno Ecology Lab (2012a)		Cardno Ecology Lab (2012a) Cardno Ecology Lab (2012b)	Cardno Ecology Lab (2012a) Cardno Ecology Lab (2012b)	Cardno Ecology Lab (2012a) Cardno Ecology Lab (2012c)	N/A	Biosis (In Prep)

3.2.1 Threatened aquatic species

Due to the potential presence of threatened aquatic species and the potential of suitable habitat for these species, targeted threatened species surveys were undertaken to confirm their presence/absence. An overview of the threatened species relevant to the Wonga East Domain is provided in Table 10 . An overview of the survey locations is presented in Figure 6.

Table 10: Aquatic species likely to occur in the study area and vulnerable to impacts due to subsidence

E = endangered, V = vulnerable

Scientific name	Common name	EPBC Act status	FM Act status
Fish			
Macquaria australasica	Macquarie Perch	E	E
Maccullochella macquariensis	Trout Cod	E	E
Maccullochella peelii	Murray Cod	V	-
Bidyanus bidyanus	Silver Perch	-	V
Macroinvertebrates			
Archaeophya adamsi	Adam's Emerald Dragonfly	-	E
Austrocordulia leonardi	Sydney Hawk Dragonfly	-	E

Silver Perch have previously been captured from Lake Cataract (Cardno Ecology Lab 2012; Horrobin 1996) and these individuals would have resulted from a translocation of these species into this catchment. Targeted threatened fish surveys undertaken in the Wonga East area between Spring 2008 and Spring 2011 have confirmed the presence of Macquarie Perch and Silver Perch, and an unidentified freshwater cod, which was assumed to be either Murray Cod or Trout Cod, within the lower reaches of Cataract Creek (Cardno Ecology Lab 2010; 2011).

Biosis (In Prep.) has undertaken surveys of additional sections of Cataract Creek upstream of the sites surveyed by Cardno Ecology Lab (see Fish Reach 19US in Figure 6 and Additional Fish Reach in Figure 7). These additional surveys did not record any threatened fish species.

Numbers of Macquarie Perch, Murray Cod, Silver Perch and Trout Cod recorded between 2009 and 2013 are presented in Table 11. The locations of Macquarie Perch and Murray Cod captured during the most recent survey undertaken in Cataract Creek (Biosis In Prep.) are presented in Figure 7.

Table 11: Numbers of threatened fish captured in Cataract Creek

	2009/2010	2010/2011	20011/2012	2012/2013
Macquarie Perch	30	90	18	14
Murray Cod	0	0	0	16
Silver Perch	9	9	0	0
Trout Cod	0	0	0	0

In order to ascertain the presence/absence of two species of threatened dragonfly listed under the NSW *Fisheries Management Act 1994* (FM Act), Adam's Emerald Dragonfly and Sydney Hawk Dragonfly, surveys undertaken in autumn 2013 included an assessment of habitat suitability for these two species, based on the habitat requirements outlined in DPI (2007) and DPI (2012), as well as targeted searches for exuviae. Furthermore, the presence of individuals of the appropriate dragonfly family was assessed during live-picking of macorinvertabrates undertaken in the field. Neither of the two threatened dragonfly species have been recorded during aquatic surveys in the Wonga East area since 2008.

3.2.2 Aquatic macroinvertebrates (AUSRIVAS)

A summary of aquatic macroinvertabrate data is provided in Table 12.

Table 12: AUSRIVAS, OE50 Taxa and SIGNAL2 scores for Wonga East (including control sites)

a) AUSRIVAS data, 2008 – 2012

X = Invertebrate assemblage is richer than reference condition; A = equivalent to reference condition; B = below reference condition (i.e. significantly impaired); C= well below reference condition (i.e. severely impaired).

	Site	2008a	2008b	2009a		2009b	2010		2011		2012	
		Spring	Spring	Spring	Autumn	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn
Cataract Creek	WGE-AQ5	B	A	B	B	B	A	C	B	B	C	B
	WGE-AQ6	B	B	B	A	A	A	C	C	B	B	A
Cataract River	WGE-AQ9	A	B	A	A	B	B	B	C	B	A	B
	WGE-AQ10	A	A	B	A	A	X	C	B	A	B	B
Allen's Creek	WGE-AQ13	-	-	B	A	A	A	B	B	A	A	A
	WGE-AQ14	-	-	A	A	A	A	B	B	A	B	A

b) OE50 Taxa scores, 2008 – 2012

A score of 1 indicates that the observed water bug community is similar to the expected one and therefore equivalent to that of a reference or undisturbed stream. A score lower than 1 means that less water bugs were observed than expected and that the community is impoverished when compared to a reference site.

	Site	2008a	2008b	2009a		2009b	2010		2011		2012	
		Spring	Spring	Spring	Autumn	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn
Cataract Creek	WGE-AQ5	0.6	0.85	0.6	0.7	0.7	0.85	0.3	0.7	0.65	0.5	0.625
	WGE-AQ6	0.7	0.7	0.6	1.05	0.825	0.875	0.3	0.35	0.75	0.6	0.925
Cataract	WGE-AQ9	0.925	0.8	1.1	1.125	0.725	0.8	0.5	0.375	0.575	0.85	0.7

	Site	2008a	2008b	2009a		2009b	2010		2011		2012	
		Spring	Spring	Spring	Autumn	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn
River	WGE-AQ10	0.925	0.925	0.575	1.1	1	1.2	0.35	0.6	0.8	0.575	0.5
Allen's Creek	WGE-AQ13	-	-	0.8	1.1	0.95	1.175	0.5	0.525	1	0.875	0.9
	WGE-AQ14	-	-	0.9	1.1	0.025	0.925	0.625	0.675	1.025	0.7	0.85

c) SIGNAL2 scores, 2008 – 2012

Score < 4 = severely polluted; 4-5 moderately polluted, 5-6 mildly polluted

	Site	2008a	2008b	2009a		2009b	2010		2011		2012	
		Spring	Spring	Spring	Autumn	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn
Cataract Creek	WGE-AQ5	4.9	4.6	4.9	6	5.8	4.9	4.5	4.6	5	5.2	5.8
	WGE-AQ6	4.9	4.8	4.5	5.2	5.1	4.9	4.8	3.6	4.9	5.1	5.1
Cataract River	WGE-AQ9	4.9	4.8	4.9	4.8	5.2	5.2	4.5	2.8	5.5	5.1	5.5
	WGE-AQ10	5	4.5	5.7	5.3	4.6	4.6	4.5	4	4.9	5.5	6
Allen's Creek	WGE-AQ13	-	-	5	5	5	4.7	4.9	4	5.2	4.8	5.5
	WGE-AQ14	-	-	5.2	5.4	4.8	4.9	5.2	2.9	5	5.2	5.5

The number of taxa collected at each monitoring reach varied at a temporal and spatial scale (Cardno Ecology Lab 2009; 2011a, b; 2012a, b; Biosis In Prep.). Samples collected from Cataract Creek were generally less diverse than those collected from Cataract River and Allen's Creek. However, AUSRIVAS and OE50 Taxa scores indicate that there is little difference in the macroinvertebrate assemblage present in Cataract Creek when compared to control sites. SIGNAL2 scores indicate that, while Cataract Creek is moderately polluted, there is little difference in the presence or absence of pollution sensitive aquatic macroinvertebrate species when compared to control sites.

More detail on each of these surveys can be found in Cardno Ecology Lab (2009; 2011a, b; 2012a, b) and Biosis (2013a).

3.2.3 Impact Assessment

The main aquatic habitat present in the Wonga East area is along Cataract Creek, which provides habitat for several threatened fish species. Macroinvertebrate monitoring of Cataract Creek indicates that there is a lower diversity of macroinvertebrate taxa, but AUSRIVAS, OE50 Taxa and SIGNAL2 scores indicate that there is little difference between Cataract Creek and control sites in Cataract River and Allen's Creek. Lower diversity of macoinvertebrate taxa in Cataract Creek may be indicative of historic impacts to this waterway from extraction of the Bulli and Balgownie seams.

Extraction of the Bulli seam has resulted in up to 0.2 m of subsidence, whilst extraction of the Balgownie seams has resulted in subsidence of 1.1 m beneath Cataract Creek. Based on compressive tilts and strains, fracturing of the base of Cataract Creek and its tributaries is likely to have occurred. This has resulted in observable impacts to Cataract Creek, particularly iron flocculent within the creek, as discussed previously in Section 3.1.3.

As outlined in Section 3.1.4, there are unlikely to be any direct impacts to Cataract Creek; however additional fracturing of tributaries of Cataract Creek may result in decreased inflow into Cataract Creek and an increase in iron seepage at the base of these tributaries (A. Dawkins pers. comm.). Increases in iron flocculent has potential to smother eggs of Macquarie Perch and result in changes in water quality, whilst reduced flows into Cataract Creek have the potential to reduce the quality of habitat for Macquarie Perch and result in changes to community composition of macroinvertebrate communities. However, given past mining, it is considered unlikely that these impacts will result in observable changes to Cataract Creek above and beyond those present.

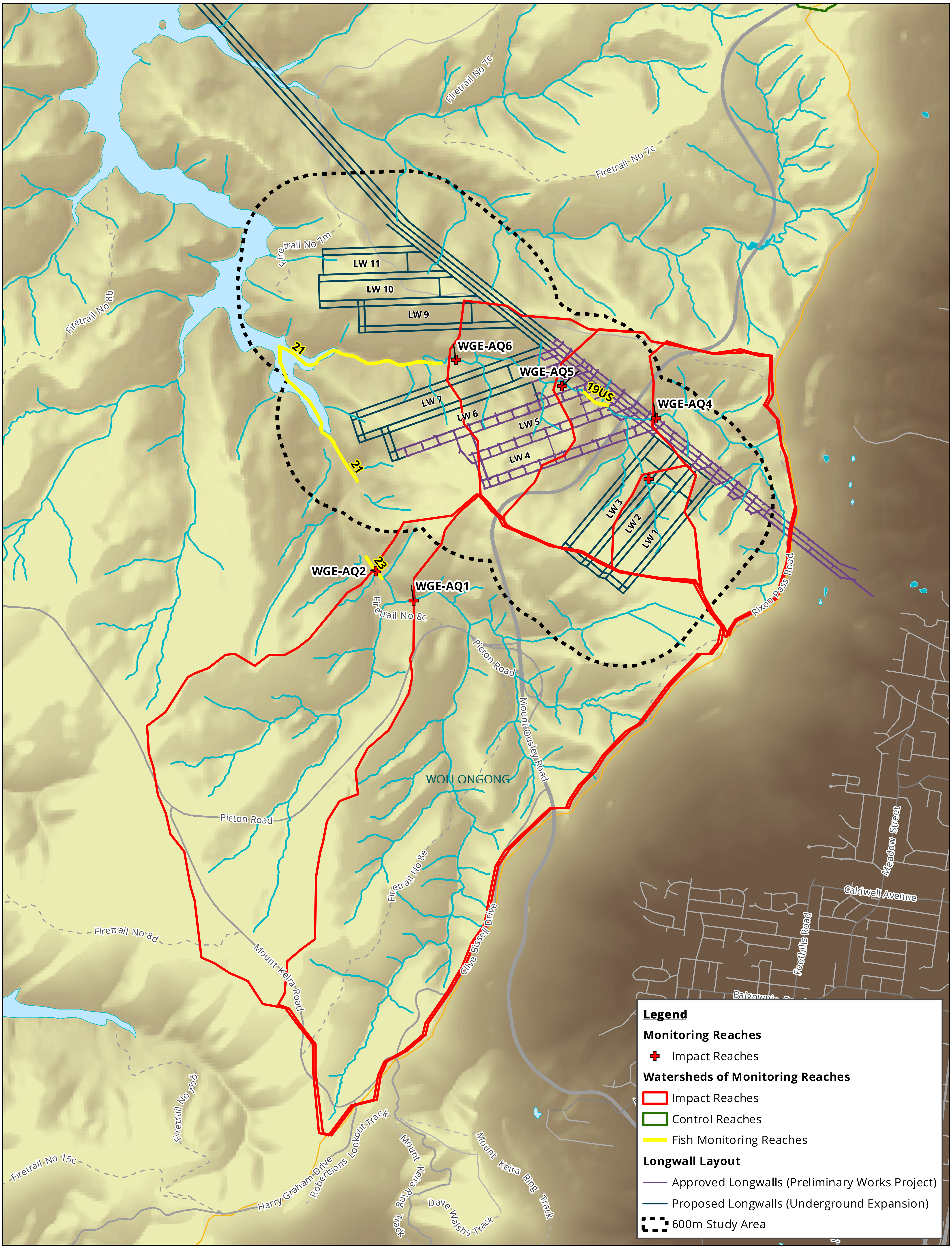

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Figure 6: Study Area and Catchment of Monitoring Reaches

Acknowledgements: Topo (c) NSW Land and Planning Information (2012)

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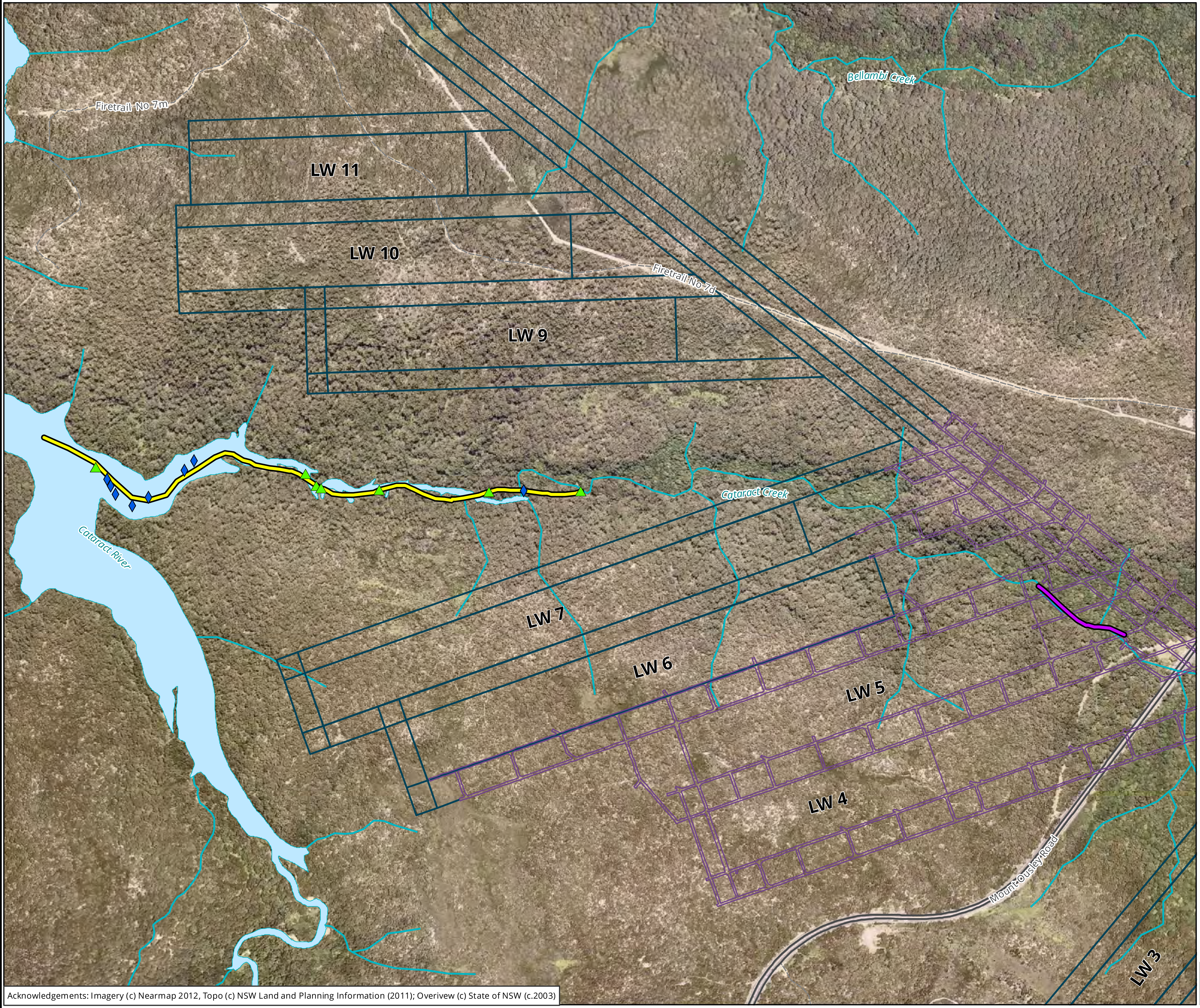

Legend

- Fish Monitoring Reaches
- Additional Fish Monitoring Reach (Biosis in Prep.)

Recorded fish locations

- Macquarie Perch
- Murray Cod

Longwall Layout

- Approved Longwalls (Preliminary Works Project)
- Proposed Longwalls (Underground Expansion)

Figure 7: Threatened fish species locations in Cataract Creek

0 80 160 240 320 400
Metres
Scale: 1:8,000 @ A3
Coordinate System: GDA 1994 MGA Zone 56

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3.3 Upland swamps

Mapping and characterisation of upland swamps in the Wonga East and Wonga West area was undertaken by Biosis (2012b). This previous assessment included assessment of the 'special significance' of upland swamps in the project area using criteria outlined in OEH (2012). This assessment of upland swamps for the preferred project should be read in conjunction with Biosis (2012b).

Biosis (2012b) included an assessment of impacts to upland swamps, based on the previous mine plan. This impact assessment included several steps:

- An initial risk assessment using criteria outlined in DoP (2010) and OEH (2012);
- A comparative analysis of impacts to upland swamps that have resulted from previous mining, as required by OEH (2012);
- A summary of available data on groundwater in upland swamps within the project area;
- An analysis of flow accumulation based on changes in water flow due to subsidence levels; and,
- Use of tensile and compressive strains to assess where fracturing of bedrock may occur, and potential resultant impacts to upland swamp vegetation communities.

This impact assessment identified a number of upland swamps considered to be at risk of negative environmental impacts. Based on this impact assessment, Biosis recommended a number of changes to the original mine plan with the objective of avoiding and mitigating impacts to upland swamps.

A number of submissions were received critiquing the methodology used in the upland swamp impact assessment process. Section 3.3.1 provides further information on how the methodology used addresses issues and recommendations raised in DoP (2008), DoP (2009), DoP (2010) and OEH (2012), while Section 3.3.2 provides a rationale for the upland swamps impact assessment and discusses how criticisms have been addressed in the updated assessment.

An assessment of potential impacts arising from historic mining of the Bulli and Balgownie Seams in the Wonga East area is provided in Section 3.3.3.

Section 3.3.4 provides an updated upland swamp impact assessment based on the revised mine plan and revised subsidence calculations.

3.3.1 Criticisms of the upland swamp impact assessment

The upland swamp impact assessment (Biosis 2012b) was the first upland swamp impact assessment to utilise the methodology outlined in OEH (2012). Although the impact assessment was commended by OEH for the mapping and characterisation of swamps as well as how upland swamps of 'special significance' were determined, a number of concerns and criticisms were raised. These criticisms, and our response to these criticisms, are provided below.

The previous assessment did not consider impacts to all swamps, only swamps of special significance

OEH (2012, p.3) sets out several steps that are required to undertake an environmental assessment of the level of significance and risks to upland swamps. Step 4 requires that, following the initial risk assessment and comparative analysis, the mine plan should be adjusted if damage to swamps of 'special significance' is predicted to occur. This is further detailed in Section 3 (p.12) of the guidelines, which states proponents must assess the following:

- *'If negative outcomes are predicted for a special significance swamp, the mining plan should be adjusted in advance so that no negative environmental outcomes are anticipated.*
- *If no negative environmental outcomes are predicted, then proceeding to mining, monitoring and adaptive management.'* (OEH 2012, p.12)

Given the focus of this section on swamps of 'special significance' Biosis understood the intent of the guidelines was to assess potential impacts to these 'special' swamps.

In the current impact assessment (Section 3.3.4) potential impacts to all upland swamps within the study area has been undertaken.

Consideration of measures other than the fracturing of bedrock, and resultant changes in hydrology, in the assessment of impacts to upland swamps

Section 3 of OEH (2012, p.11) defines six criteria used to identify upland swamps at risk of negative environmental outcomes. It is our understanding that these criteria come from values defined by MSEC to determine longwall setback distances from major creeks, and were used by DoP (2010) and OEH (2012) for assessment of upland swamps to be considered at risk of negative environmental impacts. As stated in DoP (2010), these criteria are a '*threshold for investigation – not a conclusion that the swamp will be impacted or suffer consequences*' (p. 120), i.e. these swamps are at risk and further assessment is required.

The use of multiple criteria in Biosis (2012b) is an attempt to address this requirement, by assessing other factors such as groundwater availability (and thus potential for draining), changes in flow accumulation (to assess risk of erosion and scouring and potential changes in water availability), orientation in relation to longwalls (to assess potential for ponding) and vegetation sub-communities (to assess the presence of species reliant on soil moisture and thus with greatest risk of change).

We believe this multi-criteria approach is valid, and have used a similar methodology in the current assessment. See Section 3.3.2 for a rational behind our methodology.

Reliance on flow accumulation modeling and poor definition of 'small' potential for change to flow accumulation

DoP (2009) identifies three potential impact mechanisms to upland swamps:

1. The bedrock below the swamp cracks as a consequence of tensile strains and water drains into the fracture zone. If the fracture zone is large enough or connected to a source of escape (e.g. a deeper aquifer or bedding shear pathway to an open hillside) then it is possible for sufficient water to drain to alter the hydrologic balance of the swamp.
2. Tilting of sufficient magnitude occurs to either re-concentrate runoff leading to scour and erosion, potentially allowing water to escape from the swamp margins (possibly affecting the whole swamp) or to alter water distribution in parts of the swamp, thus favouring some flora species associations over others.
3. Buckling and bedding shear enhances fracture connectivity in the host bedrock which promotes vertical then lateral drainage of the swamp. This mechanism is similar to redirected surface flow observed in subsidence-upsidence affected creek beds.

Flow accumulation modelling pre- and post-mining is undertaken by modelling flow pathways across a catchment using a digital elevation model (DEM) constructed from LiDAR data. Changes in surface topography are modelled by deducting predicted subsidence values (Smax) from the pre-mining DEM. Flow accumulation is then re-modelled. This is used to predict changes to surface and sub-surface flow through an upland swamp in relation to changes in ground level (tilt) and is unrelated to tilts and strains. This method directly addresses swamp impact mechanism 2 outlined above, and in particular addresses dot point 2 on page 116 of DoP (2010), which states that changes in water distribution in parts of the swamp can lead to changes in swamp health or vegetation composition.

In previous upland swamps assessments (BHPBIC 2009) changes in water flow through an upland swamp have been assessed using a single cross-section of an upland swamp. This methodology was criticised in DoP (2010) due to the reliance on a single cross-sectional representation. The use of flow accumulation modelling across an entire swamp addresses this concern.

In line with DoP (2010) Biosis (2012b) has used multiple criteria to determine the potential for impacts to upland swamps. These criteria have been developed with reference to the three potential upland swamp impact mechanisms outlined in DoP (2009) and outlined above. In this case we believe that the use of flow accumulation modelling in the assessment of impacts to upland swamps is valid.

Use of inexact subsidence predictions to determine potential zones of fracturing

Upland swamps form across a range of soil moisture gradients supporting different flora species and vegetation communities (Keith et al 2006, NSW Scientific Committee 2012). The model of upland swamp response to climatic change outlined in Keith et al (2006) describes a transition between MU43 Tea-tree Thicket to MU44c Cyperoid Heath and MU44a Sedgeland / MU44b Restioid heath / MU42 Banksia Thicket in response to changes on soil moisture. MU43 Tea-tree Thicket is likely to be reliant on semi-permanent to permanent waterlogging and MU44C Cyperoid heath on intermittent waterlogging, whilst the water table is likely to reach the root zone in other vegetation communities only following heavy rains. Similar changes in vegetation community composition within an upland swamp would be expected to occur due to changes in soil moisture resulting from fracturing of bedrock beneath an upland swamp.

Changes in soil moisture can occur in two ways; either through loss of water through fracturing of the bedrock and / or through changes in water flow through an upland swamp resulting. Whilst we use the flow accumulation model to assess the second potential mechanism of change, we must use predictions for tensile and compressive strain to assess the potential for fracturing of the base of upland swamps and potential for loss of groundwater availability.

In light of this, we believe it is reasonable to use such parameters to assess potential for impacts to particular vegetation communities within an upland swamp, despite their inexact nature.

3.3.2 Rationale behind Biosis' approach to upland swamp impact assessment

DoP (2008) recognises that certain swamp characteristics mean some upland swamps are more susceptible to impacts from subsidence than others. For example, given their location in the landscape, valley infill swamps are more likely to be in direct contact with surrounding groundwater, and much more susceptible to fracturing due to valley closure and upsidence (swamp impact mechanism 3 above). DoP (2009) states that, other than one headwater swamp (Swamp 1) in Dendrobium Area 2, the panel was not aware of any other headwater swamps that have been negatively impacted. However, in DoP (2010) evidence of impacts to several other upland swamps were bought to the attention of the panel, and available data now indicates that changes in groundwater availability have occurred at Swamp 12 (also a headwater swamp) and Swamp 15B (a valley infill swamp).

Changes in groundwater availability through fracturing of bedrock beneath an upland swamp is one type of impact. Fracturing of the bedrock beneath upland swamps, and/or changes in groundwater availability have been observed at a number of upland swamps on the Woronora plateau. To date, secondary impacts, including erosion, gullying, changes in size of an upland swamp or changes in vegetation within an upland swamps have been observed at a limited number of undermined upland swamps. This may be due to a lack of suitable quantitative monitoring (DoP 2010). Given the long history of mining on the Woronora plateau, and evidence of significant, observable impacts to only a limited number of previously undermined upland swamps, we do not believe that the available scientific evidence supports a conclusion that this primary impact (our term) will lead to secondary impacts (our term) in all cases, or will result in the catastrophic loss of upland swamps.

In their submission OEH raise statistical analysis of Swamp 1 in Symbolix (2011), as discussed in Krogh (2012), and a lack of the use of this data by Biosis (2012b) in our comparative analysis. The Krogh (2012) paper is not currently available for Biosis to comment on, but further analysis of data available from Swamp 1 indicates a gradual change in species diversity and richness indices at two out of three monitoring sites between 2006 and 2012. However, this change has also been observed at a number of control sites over the same period, albeit not at the same rate. Further to this, the rate of decline at Swamp 1 appears to be slowing, with an increase in both indices in recent years. To date, the data does not clearly indicate whether changes in groundwater in Swamp 1 have resulted in secondary impacts to vegetation or vegetation communities above and beyond what has been observed at control swamps, using a Before After Control Impact (BACI) design.

Biosis does not assert that subsidence associated with longwall mining does not result in impacts to upland swamps, or that a change in groundwater availability is not an impact to upland swamps. Rather, that the maintenance and persistence of upland swamps is much more complex than has been recognised, and that further research and assessment is required to understand the complex processes that maintain upland swamps, particularly in relation to changes brought about by longwall mining.

The swamp impact assessment methodology employed by Biosis (2012b) assesses multiple upland swamp characteristics to determine the potential for impact, in line with the recommendation of DoP (2010) that upland swamps that exceed these thresholds indicating they are risk of negative environmental consequences require further investigation.

3.3.3 Assessment of the historic impacts to upland swamps in Wonga East

Extraction of the Bulli and Balgownie seams has occurred within the Wonga East area. Within the study area, the Bulli Seam was extracted via hand workings and pillar extraction between 1890 and 1960. The Balgownie Seam was extracted using continuous miner pillar extraction in 1969 and the retreat longwall mining method from 1970 to 1982. Table 13 and Table 14 provide modelled subsidence data for upland swamps within the study area.

Table 13: Subsidence data from extraction of the Bulli seams for upland swamps within the study area (values in bold exceed subsidence criteria in OEH 2012)

Swamp	Subsidence (m)	Overburden Depth (m)	Longwall Panel Width	Ratio of Overburden to Panel Width	Max Tensile Strain (mm/m)	Max Compressive Strain (mm/m)	Max Tilt (mm/m)
CCUS1	0.7	285	945	**0.3**	**3.7**	**7.4**	**12**
CCUS2	0.1	285	-	-	0.5	1.1	2
CCUS3	1	300	55	5.45	**5**	**10**	**17**
CCUS4	0.1	290	50	5.8	0.5	1	2
CCUS5	0.5	272	230	**1.18**	**2.8**	**5.5**	**9**
CCUS6	1	285	605	**0.47**	**5.3**	**10.5**	**18**
CCUS7	1	270	276	**0.98**	**5.6**	**11.1**	**19**

Swamp	Subsidence (m)	Overburden Depth (m)	Longwall Panel Width	Ratio of Overburden to Panel Width	Max Tensile Strain (mm/m)	Max Compressive Strain (mm/m)	Max Tilt (mm/m)
CCUS8	0.1	270	20	13.5	**0.6**	1.1	2
CCUS9	0.1	293	25	11.72	0.5	1	2
CCUS10	0.5	280	185	1.51	**2.7**	**5.4**	**9**
CCUS12	0.5	355	185	1.92	**2.1**	**4.2**	**7**
CCUS13	0.1	335	195	1.72	0.4	0.9	1
CCUS14	1	275	-	-	**5.5**	**10.9**	**18**
CCUS15	0.1	325	40	8.13	0.5	0.9	2
CCUS16	0.5	300	-	-	**2.5**	**5**	**8**
CCUS17	0.1	325	45	7.22	0.5	0.9	2
CCUS18	0.1	325	30	10.83	0.5	0.9	2
CCUS19	0.1	325	10	32.5	0.5	0.9	2
CCUS20	1	290	570	**0.51**	**5.2**	**10.3**	**17**
CCUS21	1	280	490	**0.57**	**5.4**	**10.7**	**18**
CCUS22	0.5	317	150	2.11	**2.4**	**4.7**	**8**
CCUS23	0.1	310	45	6.89	0.5	1	2
CRUS1	0.5	300	310	**0.97**	**2.5**	**5**	**8**
CRUS2	0.5	210	280	**0.75**	**3.6**	**7.1**	**12**
CRUS3	0.4	295	45	6.56	**2**	**4.1**	**7**
BCUS1	1	270	270	**1**	**5.6**	**11.1**	**19**
BCUS2	0.5	285	40	7.13	**2.6**	**5.3**	**9**
BCUS3	0.5	265	80	3.31	**2.8**	**5.7**	**9**
BCUS4	0.5	295	230	**1.28**	**2.5**	**5.1**	**8**
BCUS5	0.5	273	105	2.6	**2.7**	**5.5**	**9**
BCUS6	0.1	308	15	20.53	0.5	1	2
BCUS11	0.5	335	225	1.49	2.2	4.5	7

Table 14: Subsidence data from extraction of the Balgownie seams for upland swamps within the study area (values in bold exceed subsidence criteria in OEH 2012)

Swamp	Subsidence Used (m)	Overburden Depth (m)	Longwall Panel Width	Ratio of Overburden to Panel Width	Max Tensile Strain (mm/m)	Max Comp Strain (mm/m)	Max Tilt (mm/m)
CCUS1	0.8	295	130	2.27	**4.1**	**8.1**	**14**
CCUS2	1	295	130	2.27	**5.1**	**10.2**	**17**
CCUS3	1	310	170	1.82	**4.8**	**9.7**	**16**
CCUS4	0.8	300	170	1.76	**4**	**8**	**13**
CCUS5	0.1	282	-	-	0.5	1.1	2
CCUS6	1	295	170	1.74	**5.1**	**10.2**	**17**
CCUS7	0.1	280	-	-	0.5	1.1	2
CCUS8	0.1	280	-	-	0.5	1.1	2
CCUS9	0.1	303	-	-	0.5	1	2
CCUS10	0.1	290	-	-	0.5	1	2
CCUS12	0.1	365	-	-	0.4	0.8	1
CCUS13	0.1	345	-	-	0.4	0.9	1
CCUS14	0.1	285	130	2.19	0.5	1.1	2
CCUS15	0.5	335	-	-	**2.2**	**4.5**	**7**
CCUS16	0.1	310	-	-	0.5	1	2
CCUS17	0.3	335	-	-	**1.3**	**2.7**	4
CCUS18	0.1	335	-	-	0.4	0.9	1
CCUS19	0.1	335	-	-	0.4	0.9	1
CCUS20	1	300	170	1.76	**5**	**10**	**17**
CCUS21	1	290	170	1.71	**5.2**	**10.3**	**17**
CCUS22	0.1	327	-	-	0.5	0.9	2
CCUS23	1	320	170	1.88	**4.7**	**9.4**	**16**
CRUS1	0.1	310	-	-	0.5	1	2
CRUS2	0.1	220	-	-	**0.7**	1.4	2
CRUS3	0.1	305	-	-	0.5	1	2
BCUS1	0.1	280	-	-	0.5	1.1	2

Swamp	Subsidence Used (m)	Overburden Depth (m)	Longwall Panel Width	Ratio of Overburden to Panel Width	Max Tensile Strain (mm/m)	Max Comp Strain (mm/m)	Max Tilt (mm/m)
BCUS2	0.1	295	-	-	0.5	1	2
BCUS3	0.1	275	-	-	0.5	1.1	2
BCUS4	0.1	305	-	-	0.5	1	2
BCUS5	0.1	283	-	-	0.5	1.1	2
BCUS6	0.1	318	-	-	0.5	0.9	2
BCUS11	0.1	345	-	-	0.4	0.9	1

Subsidence data for upland swamps in the study area from extraction of the Bulli and Balgownie seams indicates that all upland swamps in the study area, except CCUS13, CCUS18, CCUS19 and BCUS6, have been subject to subsidence criteria sufficient to have placed these upland swamps at risk of negative environmental consequences, according to criteria outlined in DoP (2010) and OEH (2012).

This assessment of past mining in the Wonga East area indicates that natural features in the study area have been subject to subsidence resulting from extraction of the Bulli and Balgownie Seams sufficient to have placed the majority of upland swamps in the study area at risk of negative environmental consequences. This data provides a baseline against which assessments of potential impacts resulting from extraction of the Wongawilli Seam, as part of the preferred project, must be assessed.

Two pertinent examples are provided in CCUS4 and CCUS1. Through the extraction of the Bulli and Balgownie seams, upland swamp CCUS4, which is recognised as a 'wet swamp' containing MU44c Cyperoid Heath and MU43 Tea-tree Thicket, has previously been subject to:

- 900 mm of subsidence
- 4.7 mm / m of tensile strain
- 9.3 mm / m of compressive strain
- 16 mm / m of tilt

Upland swamp CCUS1, which contains a mix of all upland swamp vegetation communities, has previously been subject to:

- 2000 mm of subsidence
- 10.5 mm / m of tensile strain
- 21.1 mm / m of compressive strain
- 35 mm / m of tilt

Due to a lack of quantitative monitoring of these upland swamps during extraction of the Bulli and Balgownie seams we cannot determine with any degree of certainty what primary or secondary impacts, if any, did or did not result from this historic mining. However, these two swamps continue to support a wide range of vegetation communities, and provide an illustration of how subsidence criteria from DoP (2010) and OEH (2012) cannot be used alone to determine the impacts to upland swamps.

3.3.4 Revised upland swamp impact assessment

Following on from the swamp impact assessment undertaken by Biosis (2012b), a recommendation was made suggesting a number of changes to the original mine plan with the objective of avoiding and mitigating impacts to upland swamps. NRE have now redesigned the mine plan for Wonga East and have removed Wonga West from the project application. This revised impact assessment follows the methodology outlined in Biosis (2012b), and is based on the revised mine plan and revised subsidence predictions.

In summary, 39 upland swamps have been mapped as occurring within the study area (Figure 8). Section 3.1 and Appendix 1 of Biosis (2012b) provide a summary of upland swamps within the study area, while Table 6 in Biosis (2012b) provides an assessment of 'special significance' against criteria outlined in OEH (2012). This assessment identified that seven upland swamps in the Wonga East area meet the criteria of 'special significance', including CCUS1, CCUS4, CCUS5, CCUS10, CRUS1, CRUS2 and CRUS3. Swamps of 'special significance' are shown in Figure 9.

Initial risk assessment

Following step 1 of OEH (2012), a risk assessment has been undertaken to determine upland swamps at risk of negative environmental consequences. To address concerns raised by OEH (2012), the risk assessment has been undertaken for all upland swamps within the study area.

Table 15: Initial Risk Assessment for Wonga East (Swamp names in italics indicate 'special significance'

Figures in bold are greater than criteria outlined in OEH (2012).

Swamp	Maximum subsidence within swamp boundary (m)	Adjacent subsidence used to calculate strains and tilts (m)	Overburden Depth (m)	Longwall panel width (m)	Ratio of Overburden to Panel Width	Max Tensile Strain (mm/m)	Max Comp Strain (mm/m)	Max Tilt (mm/m)
BCUS1	< 0.1	1	270	-	-	0.5	1	2
BCUS2	< 0.1	0.5	285	-	-	0.5	0.9	2
BCUS3	< 0.1	0.5	265	-	-	0.5	1	2
BCUS4	1	0.5	295	150	1.97	**6.8**	**13.6**	**23**
BCUS5	< 0.1	0.5	273	-	-	0.5	1	2
BCUS6	< 0.1	< 0.1	308	-	-	0.4	0.9	1
BCUS11		0.5	335	150	2.23	**6.1**	**12.2**	**20**
CCUS1	0.6	0.7	285	-	-	**7**	**14.1**	**23**
CCUS2	2	< 0.1	285	150	1.90	**9.4**	**18.8**	**31**
CCUS3	1	1	300	125	2.40	**6.7**	**13.4**	**22**
CCUS4	1.4	< 0.1	290	150	1.93	**9.2**	**18.5**	**31**
CCUS5	1.2	0.5	272	131	2.08	**7.3**	**14.7**	**24**
CCUS6	2	1	285	125	2.28	**9.4**	**18.8**	**31**
CCUS7	< 0.1	1	270	-	-	0.5	1	2
CCUS8	< 0.1	< 0.1	270	-	-	0.5	1	2

Swamp	Maximum subsidence within swamp boundary (m)	Adjacent subsidence used to calculate strains and tilts (m)	Overburden Depth (m)	Longwall panel width (m)	Ratio of Overburden to Panel Width	Max Tensile Strain (mm/m)	Max Comp Strain (mm/m)	Max Tilt (mm/m)
CCUS9	< 0.1	< 0.1	293	-	-	0.5	0.9	2
CCUS10	0.8	0.5	280	150	1.87	**3.8**	**7.6**	**13**
CCUS11	1.8	1	340	150	2.27	**8.8**	**18**	**29**
CCUS12	1	0.5	355	150	2.37	**5.8**	**11.5**	**19**
CCUS13	< 0.1	< 0.1	335	-	-	0.4	0.8	1
CCUS14	< 0.1	1	275	-	-	0.5	1	2
CCUS15	< 0.1	< 0.1	325	-	-	0.4	0.8	1
CCUS16	< 0.1	0.5	300	-	-	0.4	0.9	1
CCUS17	< 0.1	< 0.1	325	-	-	0.4	0.8	1
CCUS18	< 0.1	< 0.1	325	-	-	0.4	0.8	1
CCUS19	< 0.1	< 0.1	325	-	-	0.4	0.8	1
CCUS20	< 0.1	1	290	-	-	0.5	0.9	2
CCUS21	< 0.1	1	280	-	-	**9.5**	**19**	**32**
CCUS22	< 0.1	0.5	317	-	-	0.4	0.9	1
CCUS23	0.2	< 0.1	310	125	2.48	**6.5**	**13**	**22**
CRUS1	1.4	0.5	300	150	2.00	**6.7**	**13.4**	**22**
CRUS2	< 0.1	0.5	210	-	-	0.6	1.2	2

Swamp	Maximum subsidence within swamp boundary (m)	Adjacent subsidence used to calculate strains and tilts (m)	Overburden Depth (m)	Longwall panel width (m)	Ratio of Overburden to Panel Width	Max Tensile Strain (mm/m)	Max Comp Strain (mm/m)	Max Tilt (mm/m)
CRUS3	< 0.1	0.4	295	-	-	0.5	0.9	2

Reassessment of subsidence predictions following monitoring of Longwalls 4 and 5 indicates that past mining has resulted in the softening of the underlying rock strata, and that subsidence is occurring over a much shorter distance than has previously occurred in un-mined areas, with subsidence largely restricted to immediately above the goaf. Whilst this means that subsidence movements occur over a smaller area, it also means that tilts and strains are greater than previously predicted (SCT Operations 2013). Subsidence predictions for all upland swamps within the predicted impact subsidence zone, except upland swamp CCUS10, are greater than previously predicted.

Upland swamps outside of the predicted subsidence impact zone are not discussed further. To address criticisms received on the previous upland swamps impact assessment (Biosis 2012b), all upland swamps within the predicted subsidence impact zone are considered further.

Comparative analysis

A comparative analysis was undertaken in Biosis (2012b). Additional data has become available following the completion of mining in the Wongawilli domain at NRE Wongawilli Colliery. Table 16 provides a summary of subsidence predictions for four upland swamps located above the Wongawilli longwalls. Observed data is not available for Swamp 20; however observed values along subsidence monitoring lines located to the east and west of Swamp 20 were greater than predicted (MSEC 2012), so it is reasonable to assume that predictions listed below are conservative.

Table 16: Predicted and observed subsidence for four upland swamps located above the Wongawilli domain

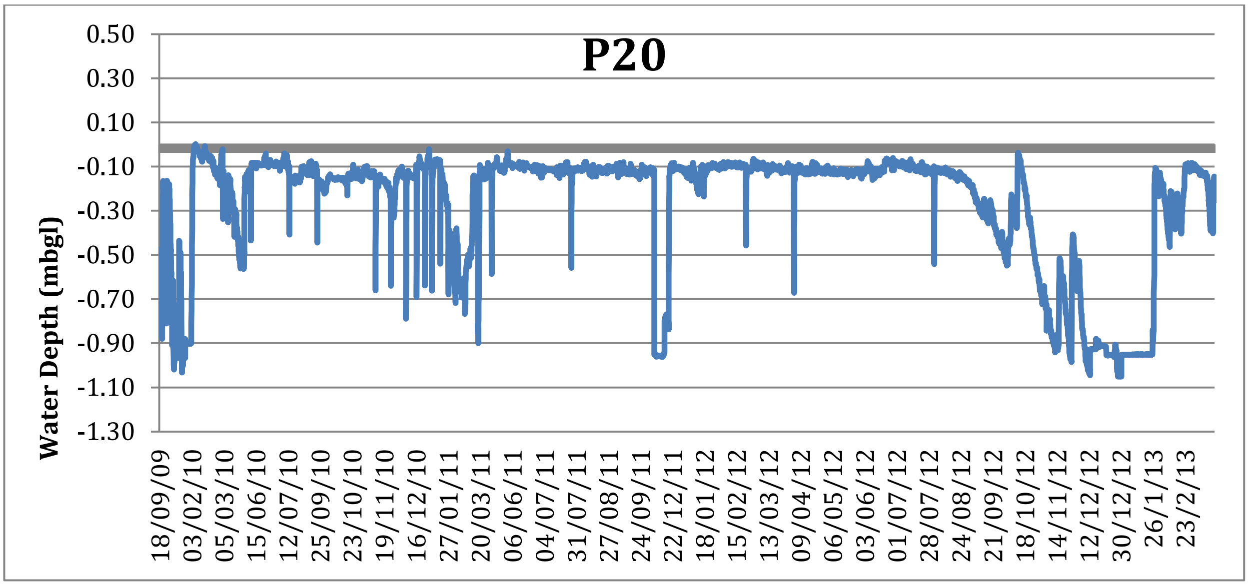
Figures in bold are greater than criteria outlined in OEH (2012)

Swamp	Subsidence (mm)	Tensile strain (mm / m)	Compressive strain (mm / m)	Tilt (mm / m)
20	895	**1.3**	**2.0**	**6.8**
21a	170	0.2	0.5	1.1
24	270	0.3	0.3	2.2
46	285	0.3	0.8	2.0

Subsidence predictions outlined above indicate that predictions for Swamp 20 exceeded criteria in OEH (2012), and thus upland swamps would be considered at risk of negative environmental consequences from extraction of Longwalls 11 and 20. One swamp piezometer is located approximately 100m east of Longwall 20 and overlies the eastern end of Longwall 11. Data from this piezometer is presented in Graph 1. This data indicates that "*no sustained change in groundwater levels in Swamp 20 due to subsidence induced impacts from extraction of Longwalls 11, 12, 19 and 20 has been observed*" (Geoterra 2012, p.8). Further, no impacts to vegetation within Swamp 20 have been observed (Biosis 2013b). Although Swamp 20 has been undermined previously by the Elouera Colliery, mining under the swamp used a bord and pillar mining method, resulting in negligible subsidence. Extraction of Longwalls 11 and 20 was undertaken using longwall mining techniques.

This data indicates that, despite subsidence predictions exceeding criteria in DoP (2010) and OEH (2012) for determining risk of negative environmental consequences, no impacts to groundwater or vegetation have been observed.

Graph 1: Swamp piezometer, P20, groundwater levels



Groundwater analysis

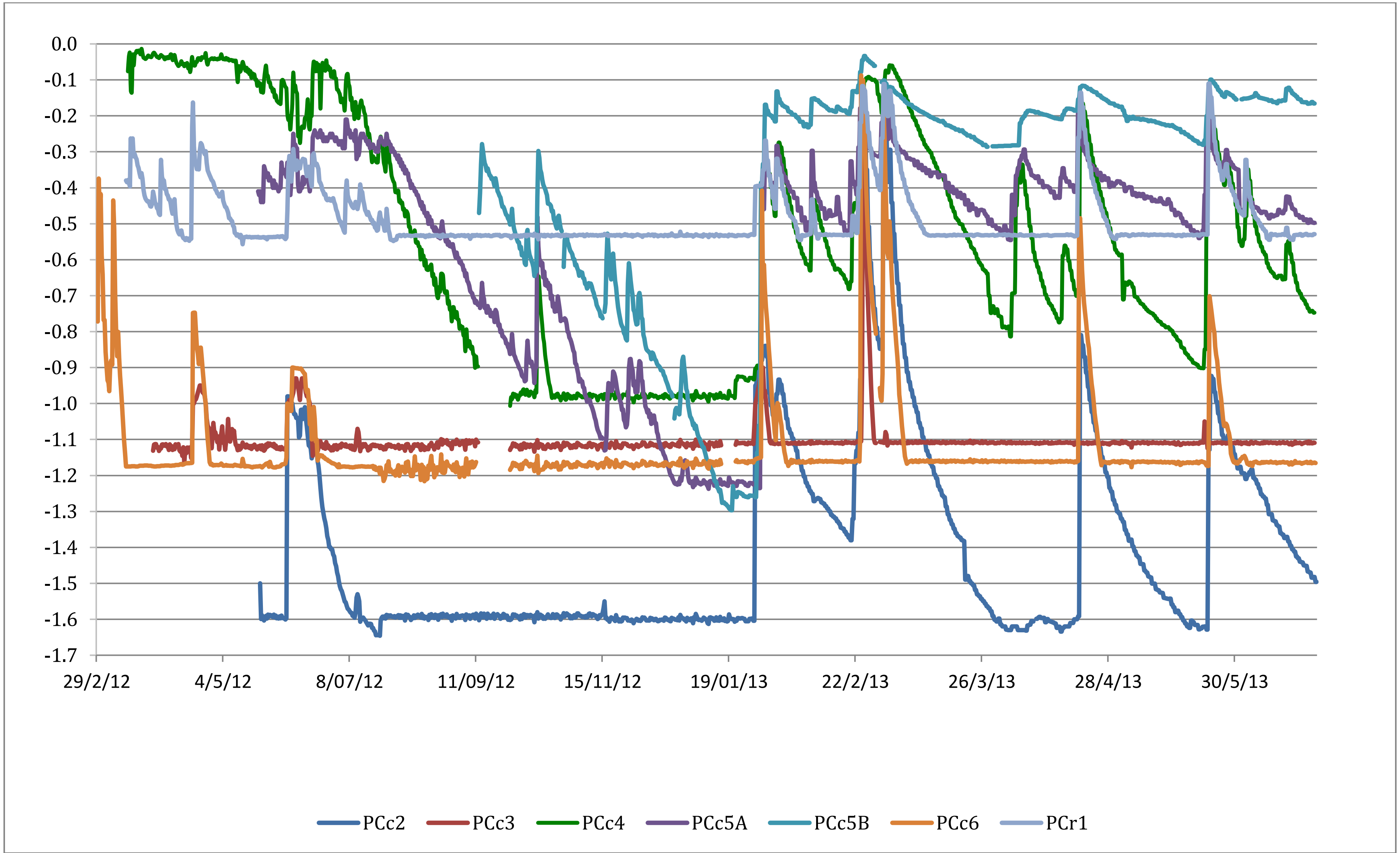
Groundwater monitoring piezometers have been installed in upland swamps CCUS2 (PCc2), CCUS3 (PCc3), CCUS4 (PCc4), CCUS5 (PcC5a and PCC5b), CCUS6 (PCc6) and CRUS1 (PCr1). Data from these piezometers indicates:

- CCUS2 fills to near surface level following significant rainfall, but recedes to basement level within one month;
- CCUS3 shows very little response to rainfall and remains dry the majority of the time;
- CCUS4 shows significant recharge to near surface levels after rainfall, and recedes gradually over approximately three months;
- CCUS5 shows significant recharge to near surface levels following rain. Groundwater recession is gradual, occurring over a five month period;
- CCUS6 shows a muted response to rainfall, with spikes in groundwater to near surface levels following significant rainfall, and receding rapidly to basement levels within one week; and,
- CRUS1 shows a brief response to rainfall with recharge to near surface levels following rainfall and recession to basement levels within a few weeks. CRUS1 is situated in shallow (0.5 m) soils.

Groundwater data from piezometers located in upland swamps within the study area indicates that there are varying degrees of contact with groundwater resources in these upland swamps. CCUS4 and CCUS5 show significant groundwater contact for prolonged periods, CCUS2 shows some contact but recedes rapidly, while CCUS3 and CCUS6 show little groundwater recharge following rainfall. This corresponds with the vegetation communities within these upland swamps, with CCUS4 and CCUS5 supporting areas of MU43 Tea-tree Thicket (both upland swamps) and MU44c Cyperoid Heath (CCUS4 only), which both rely on permanent to intermittent waterlogging. In contrast, CCUS2, CCUS3 and CCUS6 support MU42 Banksia Thicket (CCUS3 and CCUS6) or MU44a Sedgeland and MU44b Restioid Heath (CCUS2) which are less reliant on waterlogging. CRUS1, which supports a mix of MU42 and MU43, is an anomaly. This upland swamp has shallow soils and areas of MU43 are likely to be located in areas of terracing, resulting in water accumulation in depressions in bedrock.

It is worth noting that all of the upland swamps listed above have been subject to significant tilts and strains from past mining (see Table 13 and Table 14), substantially above what has been predicted by MSEC to result in fracturing of bedrock in waterways (DoP 2010) and the criteria listed in OEH (2012) for assessing the risk of negative environmental consequences to upland swamps. These levels of tilts and strains are likely to have resulted in fracturing of the bedrock beneath these upland swamps from past mining. However, monitoring data is not available to confirm whether this has occurred.

Graph 2: Swamp piezometer data from upland swamps in the Wonga East area



Flow accumulation

Flow accumulation modelling was undertaken based on the revised longwall layout and revised subsidence predictions (SCT Consultants 2013). The methodology for undertaking flow accumulation modelling is presented in Biosis (2012b). To address criticism regarding quantification of impacts from flow accumulation modelling, the percentage change in flow accumulation following mining is presented in Table 17, in addition to a discussion on flow accumulation.

Table 17: Discussion of changes in flow accumulation pre- versus post-mining for upland swamps in Wonga East (swamps of 'special significance' are shown in italics)

Swamp	Percentage change in flow accumulation following mining	Discussion of changes in flow accumulation
BCUS4	114.64	Flow accumulation modeling for BCUS4 pre-mining indicates that there is a dispersed flow through this upland swamp, with four exit points from the base of the upland swamp. Modeling of post-mining flow indicates an increase in catchment yield of 14.64%. There are minimal changes to the exit points within this upland swamp; however a redistribution of water within the swamp may result in decreased water flow through a small patch of MU43 Tea-tree Thicket. This may result in changes to vegetation composition in this area.
BCUS11	108.29	Flow accumulation modeling for BCUS11 pre-mining indicates that this small upland swamp has three flow pathways through the swamp. Following mining, changes in tilt are likely to result in a very minor increase in summed flow within this upland swamp of 8.29%. There is unlikely to be any change to flow pathways through the upland swamp. Changes are predicted to be negligible.
CCUS1	98.32	Flow accumulation modeling pre-mining indicates the presence of two main flow pathways through this upland swamp – one exiting the swamp in the northeast section of the swamp and one in the southeast section of the swamp. These exit points coincide with area of MU42 Tea-tree Thicket and MU44c Cyperoid Heath. Flow accumulation modeling post-mining indicates that tilts associated with Longwall 3 will result in a minor change to the flow pathway through the southeast section of the upland swamp with a minor (8.32%) increase in catchment area. This is likely to result in an increase in water availability for a small section of MU44a Sedgeland in this southeastern section. Any changes are likely to be minor.
CCUS2	99.62	Pre-mining flow accumulation modeling for CCUS2 indicates a dispersed flow of water through this upland swamp. Tilts associated with Longwalls 2 and 3 will result in only a negligible (0.38%) change to water availability across the swamp. Flow pathways through the swamp are likely to change following mining; however there are no significant concentrations of water, and given the dispersed nature of flow prior to mining

Swamp	Percentage change in flow accumulation following mining	Discussion of changes in flow accumulation
		this is predicted to result in minor changes.
CCUS3	99.18	Modeling of pre-mining flow accumulation through CCUS3 indicates the presence of two main flow pathways through this upland swamp, largely through areas of MU42 Banksia Thicket. Tilts associated with extraction of Longwall 5 are likely to result in only negligible (0.72%) changes in overall catchment yield for this upland swamp, and a minor re-direction of flow from the western edge of CCUS3 to the centre. This change in unlikely to result in any significant impacts to this upland swamp.
CCUS4	95.23	Flow accumulation modeling pre-mining indicates the presence of two main flow pathways through this upland swamp. One minor flow path passes through the eastern section of the swamp, while the main flow pathway passes through the western section of the swamp. The western flow pathway corresponds with areas of MU43 Tea-tree Thicket and MU44c Cyperoid Heath. Post-mining, tilts will result in a minor (4.77%) decline in overall catchment yield. Only negligible changes in the western flow accumulation pathway are predicted to occur, with minor changes in flows through the patches of MU43 and MU44c. Tilts will result in result in a new flow pathway through the centre of this upland swamp, with resultant increases in water availability to patches of MU42 Banksia Thicket. A shift in the flow pathway through the eastern section of the swamp will result in a minor redistribution of water in this eastern section.
CCUS5	73.49	Pre-mining flow accumulation modeling indicates that this upland swamp has a dispersed flow accumulation, with numerous flow pathways through the swamp. There is a significant flow pathway through the eastern section of the swamp, corresponding with an area of MU43 Tea-Tree Thicket. Substantial benching within this swamp appears to be correlated with vegetation sub-communities; with areas of Tea-Tree Thicket (MU43) corresponding with the location of rockbars within the swamp, and it is likely that community composition in this swamp relates to a combination of flow and these rockbars allowing pooling of water at these locations. Tilts associated with Longwall 7 are likely to result in a significant (26.51%) decline in overall water availability within this swamp. This decline is likely to impact most on the eastern section of this upland swamp, diverting flow away from the major flow pathway mentioned above, resulting in a decrease in water availability for a patch of MU43. This may result in changes to vegetation composition within this swamp; however it is predicted to impact on a small section of the swamp only.
CCUS6	97.69	Flow pathways through CCUS6 prior to mining are dispersed, with multiple entry and exit points reflecting the disconnected nature of this upland swamp. Tilt associated with extraction of Longwall 4 and 5 may result in a minor (2.31%)

Swamp	Percentage change in flow accumulation following mining	Discussion of changes in flow accumulation
		decrease in flow accumulation, but is unlikely to result in any significant changes in these pathways. Minor changes are predicted to occur.
CCUS10	106.91	Flow accumulation modeling pre-mining indicates a dispersed flow accumulation across this upland swamp. This swamp has a small catchment area that commences just above Longwall 9. Vegetation sub-communities appear to correspond with area of benching down the slope, with these rockbars resulting in accumulation of water in these areas. Post-mining flow accumulation modeling indicates a small (6.91%) increase in catchment yield, and only minor changes in flow pathways through this swamp.
CCUS11	50.35	Flow accumulation modeling indicates that this upland swamp has a small catchment, with the upland swamp likely to be reliant on terracing and accumulation of water. Post-mining modeling indicates a significant (49.65%) decline in this catchment yield. Tilts associated with extraction of Longwall 8 are likely to result in a diversion of this flow pathway around this upland swamp, reducing water availability. There is potential that this decline in water availability may result in impacts to this upland swamp.
CCUS12	103.58	CCUS12is located at the boundary between the catchments of Cataract Creek and Bellambi Creek, and as a result, has a very small catchment area. Pre- versus post-mining flow accumulation modeling indicates that only minor (3.58%) increases in catchment yield and no change in flow pathways. Negligible changes are predicted to occur.
CCUS23	97.06	Given the orientation of the flow pathway perpendicular to the longwall, flow accumulation modeling pre- versus post-mining indicates only a minor (2.94%) increase in catchment yield for this upland swamp. There is unlikely to be any change in flow pathways through this swamp. Negligible changes in water availability due to flow are predicted.
CRUS1	100.21	Only the upper northern section of CRUS1 is located above Longwall 6. An assessment of pre- versus post-mining flow accumulation through the upland swamp indicates a negligible (0.21%) increase in catchment yield and negligible changes in flow pathways through this upland swamps. No changes in water availability are predicted to occur.

Flow accumulation modelling for upland swamps within the study area indicates that, for the majority of upland swamps, only negligible or minor changes in both cumulative flow and flow pathways are likely to occur following mining. No significant reconcentration of flows, that may result in increased erosion risk, are likely to occur. For the majority of upland swamps mining is likely to result in only minor changes in water availability.

Flow accumulation modelling indicates that BCUS4, CCUS5 and CCUS11 are at risk of impact due to changes in water availability, particularly to vegetation communities sensitive to decreases in water availability. Of these, only CCUS5 is considered to be of 'special significance'.

Compressive and tensile strain

Reassessment of subsidence predictions following monitoring of Longwalls 4 and 5 indicates that past mining has resulted in the softening of the underlying rock strata, and that subsidence is occurring over a much shorter distance than has previously occurred in un-mined areas, with subsidence largely restricted to immediately above the goaf. Whilst this means that subsidence movements occur over a smaller area, it also means that tilts and strains are greater than previously predicted (SCT Operations 2013).

Subsidence predictions are presented in Table 15. This data indicates that tensile and compressive strains and tilts are of sufficient magnitude to result in fracturing of bedrock beneath upland swamps within the Wonga East area. Table 18 assesses the risk of a significant impact to these upland swamps based on vegetation communities present, and recorded response to groundwater (for upland swamps with groundwater data available).

Table 18: Discussion of tensile and compressive and strains for upland swamps within the study area (swamps of 'special significance' are shown in italics)

Swamp	Discussion of tilts and strains
BCUS4	BCUS4 is located over the edge of Longwall 9. Tilts and strains affect a small section of MU43 Tea-tree Thicket. Lower sections of the upland swamp are unlikely to be subject to strains of sufficient magnitude to fracture bedrock. No groundwater data is available. Risk is assessed as low due to impacts to a small section of this swamp.
BCUS11	BCUS11 does not support vegetation communities reliant on waterlogging. No groundwater data is available. Risk is assessed as low.
CCUS1	Given changes to the longwall layout, impacts are likely to be restricted to a very small section of this upland swamp at the eastern end. Any changes here are likely to be limited in extent, and are unlikely to result in a significant impact to this upland swamp. No groundwater data is available. Risk is assessed as low.
CCUS2	CCUS2 does not support vegetation communities reliant on waterlogging. In addition, groundwater levels in CCUS2 recede rapidly following rainfall. Risk of impact is considered low.
CCUS3	CCUS3 supports MU42 Banksia Thicket and MU44a Sedgeland, which are not reliant on waterlogging and are thus deemed less susceptible to decreased groundwater availability. Groundwater data indicates rapid recession to basement levels following rainfall. Risk is assessed as low.
CCUS4	CCUS4 supports MU43 Tea-tree Thicket and MU44c Cyperoid heath, which are reliant on permanent to semi-permanent water availability, as well as MU42 Banksia Thicket. Strains and tilts have increased significantly following the revision of subsidence data by SCT Operations (2013). The location of water MU42 Banksia Thicket and MU43 Tea-tree Thicket at the base of the longwall, in areas of lowest strain and tilt, are likely to mitigate impacts to

Swamp	Discussion of tilts and strains
	some degree. Groundwater data indicates a strong retention of groundwater following rainfall. Risk is assessed as moderate.
CCUS5	CCUS5 supports a mix of MU43 Tea-tree Thicket, which depends on permanent water availability, and MU42 Banksia Thicket and MU44a Sedgeland. Following revision of the longwall layout only a small section of this swamp will be subject to subsidence, and areas of MU43 Tea-tree Thicket are located in areas of lower strain. Groundwater monitoring in CCUS5 indicates a strong response to rainwater recharge, with groundwater recharge to near surface and a very gradual decline over months. Risk is assessed as low.
CCUS6	CCUS6 supports MU42 Banksia Thicket, which is not reliant on waterlogging and is thus deemed less susceptible to decreased groundwater availability. Groundwater data indicates rapid recession to basement levels rapidly following rainfall. Risk is assessed as low.
CCUS10	CCUS10 supports a mix of MU43 Tea-tree Thicket and MU44c Cyperoid Heath, which depends on permanent water availability, and MU42 Banksia Thicket. Following revision of the longwall layout only a small section of this swamp will be subject to subsidence, and areas of MU43 Tea-tree Thicket and MU44c Cyperoid Heath are located in areas of lower strain. No groundwater data is available. Risk is assessed as low.
CCUS11	CCUS11 supports MU42 Banksia Thicket, which is not reliant on waterlogging and is thus deemed less susceptible to decreased groundwater availability. No groundwater data is available. Risk is assessed as low.
CCUS12	CCUS12 supports MU42 Banksia Thicket, which is not reliant on waterlogging and is thus deemed less susceptible to decreased groundwater availability. No groundwater data is available. Risk is assessed as low.
CCUS23	CCUS23 supports MU42 Banksia Thicket and MU44a Sedgeland. No groundwater data is available. Risk is assessed as low.
CRUS1	CRUS1 supports a mix of MU43 Tea-tree Thicket and MU42 Banksia Thicket. Based on shallow soil profile, MU43 Tea-tree Thicket is likely to persist in areas of water accumulation resulting from rock terracing, as evident from analysis of slope. Only the upper section of this upland swamp is located within the predicted subsidence zone. Groundwater data indicates rapid recession following rainfall. Risk is assessed as low.

Final risk assessment

Following assessment of a variety of risk factors, Table 19 provides an overall assessment of the potential for a significant impact to occur. This final risk assessment assesses the overall risk of a primary impact (based on the initial risk assessment) and the consequent risk of a secondary impact (based on factors such as groundwater data, reliance of vegetation communities on water availability, changes in flow accumulation and the position of water dependent communities within the upland swamp compared to areas of greatest tilt and strain).

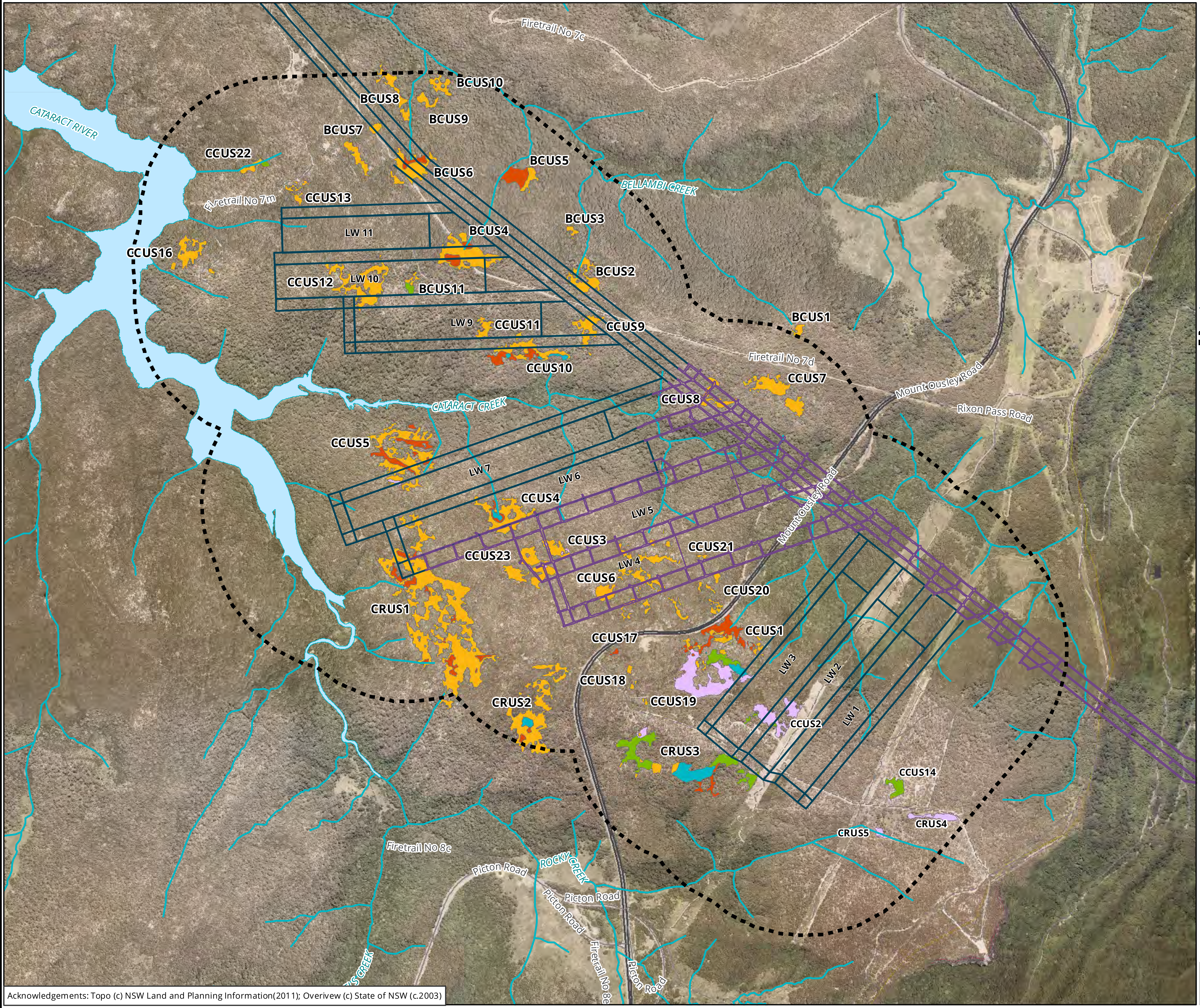
This final risk assessment indicates that there is a risk of a significant secondary impact to upland swamps BCUS4 and CCUS4 from the proposed extraction of coal in Wonga East. Only CCUS4 is considered to be of special significance.

The revision of the mine plan for Wonga East has resulted in a reduction in risk to upland swamps of 'special significance' CRUS2 and CRUS3 due to these upland swamps now being situated outside of the predicted subsidence impact zone. Revision of the longwall layout has also resulted in a reduction in risk for CCUS5, as only the upper reaches of this upland swamp are now within the predicted subsidence impact zone.

The changes in subsidence predictions and higher tilts and strains have resulted in an increase in risk level for CCUS4.

Table 19: Final risk assessment for upland swamp sin the Wonga East area (swamps of 'special significance' are shown in italics)

Swamp	Initial risk assessment (risk of negative environmental consequences?)	Groundwater	Flow accumulation	Compressive tilts and strains	Final risk assessment
BCUS4	No	N/A	Moderate	Low	Moderate
BCUS11	Yes	N/A	Negligible	Low	Low
CCUS1	Yes	N/A	Low	Low	Low
CCUS2	Yes	Low	Low	Low	Low
CCUS3	Yes	Low	Low	Moderate	Low
CCUS4	Yes	Moderate	Moderate	Low	Moderate
CCUS5	Yes	High	Moderate	Low	Low
CCUS6	Yes	Low	Low	Low	Low
CCUS10	Yes	N/A	Low	Low	Low
CCUS11	Yes	N/A	Moderate	Low	Low
CCUS12	Yes	N/A	Negligible	Low	Low
CCUS23	Yes	N/A	Negligible	Low	Low
CRUS1	Yes	Low	Low	Low	Low



Legend

Vegetation Sub-Communities

- MU42, Upland Swamps: Banksia Thicket
- MU43, Upland Swamps: Tea-Tree Thicket
- MU44a, Upland Swamps: Sedgeland-Heath Complex (Sedgeland)
- MU44b, Upland Swamps: Sedgeland-Heath Complex (Restioid Heath)
- MU44c, Upland Swamps: Sedgeland-Heath Complex (Cyperoid Heath)

Longwall Layout

- Approved Longwalls (Preliminary works project)
- Proposed Longwalls (Underground Expansion)
- 600m Study Area

Figure 8: Upland swamps in the study area

0 150 300 450 600 750

Metres

Scale: 1:15,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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Matter: 16646
Date: 09 September 2013,
Checked by: NMG, Drawn by: ANP, Last edited by: apritchard
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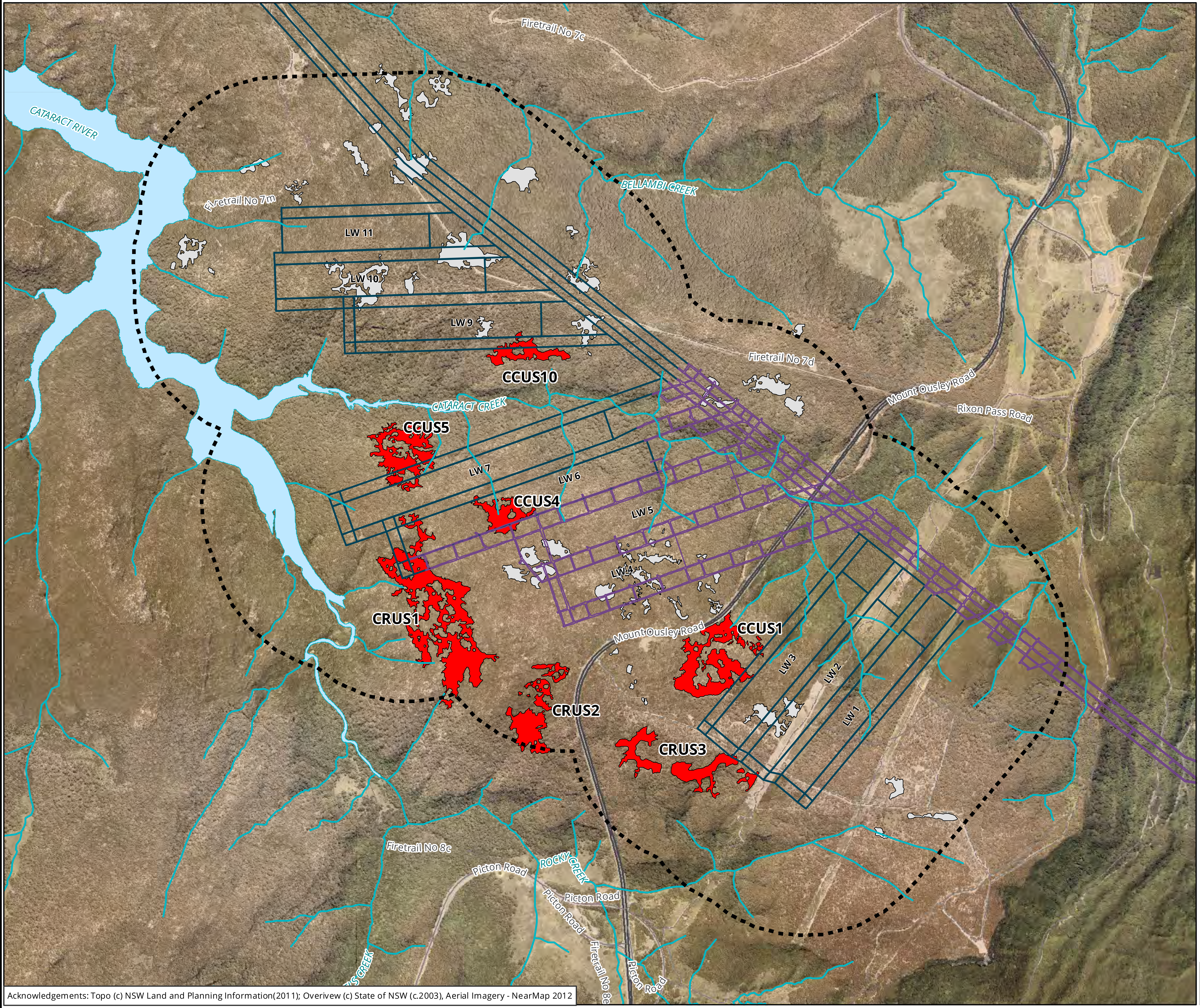

Legend

Swamp of Special Significance

- Yes
- No

Longwall Layout

- Approved Longwalls (Preliminary Works Project)
- Proposed Longwalls (Underground Expansion)
- 600m Study Area

Figure 9: Upland swamps of 'special significance' in the study area

0 150 300 450 600 750

Metres

Scale: 1:15,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Date: 09 September 2013,
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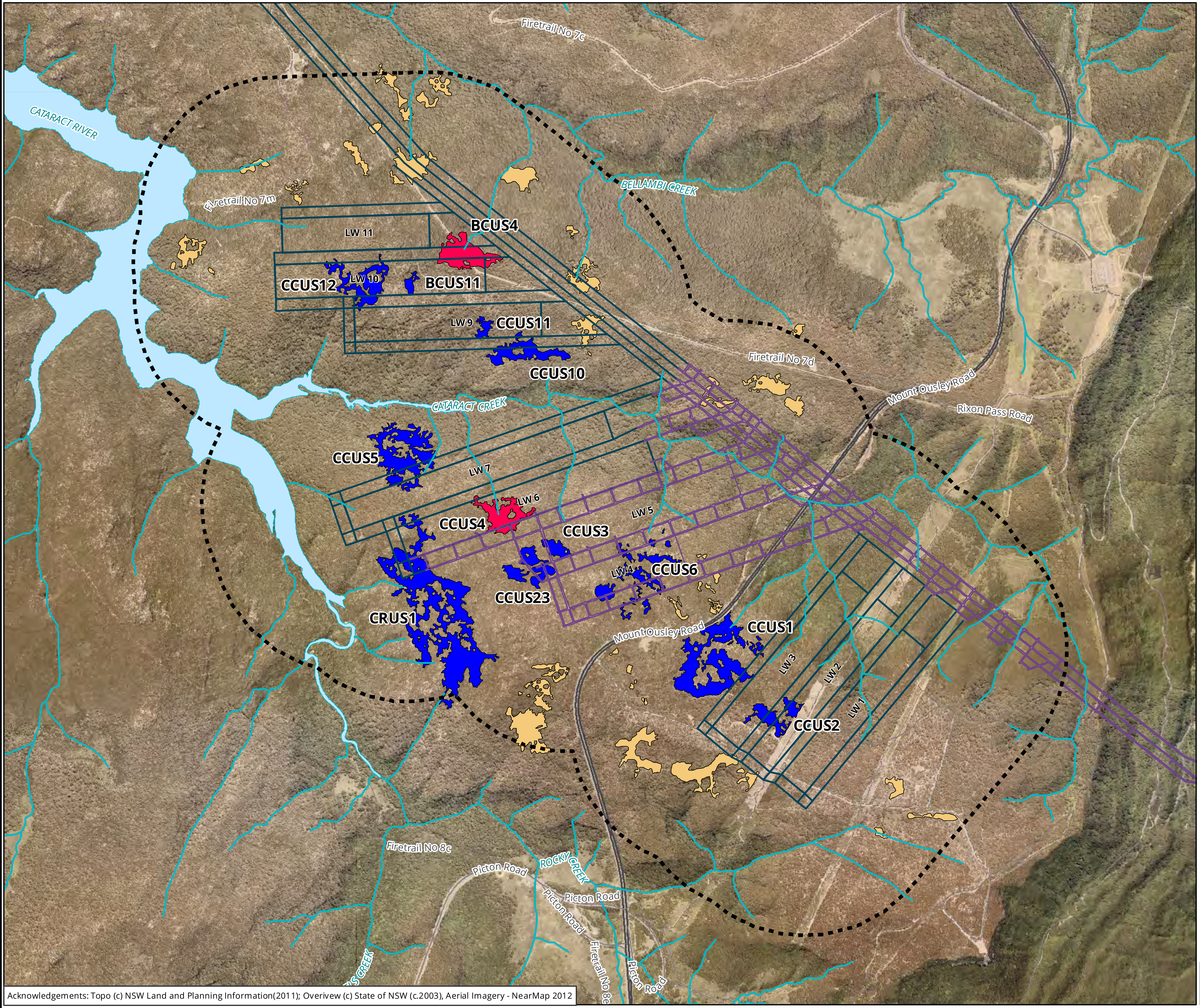
16646 PPR_F9_Swamps of Special Significance



Acknowledgements: Topo (c) NSW Land and Planning Information(2011); Overivew (c) State of NSW (c.2003), Aerial Imagery - NearMap 2012

Legend

Risk Assessment

- Moderate
- Low
- Negligible

Longwall Layout

- Approved Longwalls (Preliminary Works Project)
- Proposed Longwalls (Underground Expansion)
- 600m Study Area

Figure 10: Final risk assessment for upland swamps in Wonga East

0 150 300 450 600 750

Metres

Scale: 1:15,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Date: 09 September 2013,
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16646 PPR_F10_Swamps Final Risk

4. Response to Submissions

This section provides a response to submissions received on the Underground Expansion Project (UEP) EA based on changes outlined in Section 2 and revised impact assessments present in Sections 3.1.4, 3.2.3 and 3.3.4.

Responses are provided to submissions received from the general public (Section 4.1) and from government agencies (Section 4.2).

4.1 Public submissions

A total of 804 public submissions were received for the UEP. Public submissions received, relevant to biodiversity, largely related to upland swamps, including the use of the OEH (2012) *Upland swamp environmental assessment guidelines*, the use of flow accumulation modelling and the conclusion of the Biosis (2012b) upland swamp impact assessment.

Table 20 provides a summary of public submissions and outlines responses to these submissions.

Table 20: Summary of public submissions, including responses

Submission	Response
Impacts and consequences to swamps will be greater than accepted by NRE. Swamps are critical to maintain baseflow water for the streams and rivers. Adaptive management and TARP's are not effective. The only way to manage swamp impacts is to not mine beneath them or within a 35 degree angle of draw	The upland swamp impact assessment has been revised based on a revised mine plan and associated subsidence predictions. The preferred project will result in reduced risk of impact for upland swamps CCUS1, CCUS5, CCUS10, CRUS2 and CRUS3. BCUS4 and CCUS4 are considered to have a moderate likelihood of impacts, of which only CCUS4 is considered to be of 'special significance'.
Monitoring of swamps must be improved to meet BACI standards and capture data on surface retention of water and flow from the swamps. It needs to allow the impacts of mining to be separated from other influences such as variable rainfall	The current ecological monitoring program undertaken for NRE for Longwalls 4 and 5, as well as the Wongawilli Colliery, uses a BACI approach. NRE are currently re-designing the monitoring plan to integrate surface water, groundwater and ecological monitoring programs to ensure a comprehensive assessment of the ecosystem function of upland swamps within the study area.
There are major differences between the 2003 NPWS Vegetation Mapping and the 2012 Biosis mapping of swamps. This may represent climate effects or different mapping techniques or is quite possibly due to subsidence impacts changing the character and spatial coverage of swamps	Vegetation mapping prepared by NPWS (2003) "*has a number of potential sources of error*" (p. 62) and NPWS recommends that detailed site inspection is undertaken. Upland swamp mapping prepared by Biosis (2012b) uses a combination of LiDAR data and on-ground assessment to map the vegetation of upland swamps. Differences between mapping by Biosis and NPWS is likely a result of the fine-scaled mapping completed

Submission	Response
	by Biosis when compared to the large scale, regional mapping prepared by NPWS.
Biosis assessment of risk to swamps is incorrect and the system by which they arrive at their conclusions is puzzling and is probably due to overreliance on flow accumulation changes. Biosis make no reference to the BSO account of swamp impact mechanisms	As outlined in Section 3.3.1, the criteria outlined in DoP (2010) are thresholds for further investigation, not a conclusion that a swamp will be impacted. The use of flow accumulation modeling provides an additional tool to assess potential changes in surface and groundwater flow through an upland swamp in relation to changes in ground level (tilt). A change in water flow is recognised as one potential impact to upland swamps (DoP 2009, DoP 2010).
Biosis' bias toward mining as evidenced by claims that mine subsidence is only a contributory factor in swamp damage rather than the cause. There is plenty of evidence from Metropolitan and Dendrobium Collieries End of Panel and Annual Environmental Management Reviews to prove this is the case.	To date, a large number of upland swamps on the Woronora Plateau have been undermined. Mining has included a combination of bord and pillar and longwall mining. Changes in groundwater availability have been observed at a number of upland swamps (e.g. Swamp 1 in Dendrobium Area 2 and Swamp 15b in Dendrobium Area 3A), and gully erosion and scouring have been observed at a number of additional upland swamps (e.g. Swamp 37, Swamp 18A and Flatrock Swamp). Biosis recognises that subsidence associated with longwall mining can result in the fracturing of bedrock below upland swamps and changes in groundwater availability. However, the persistence of upland swamps in previously mined areas, as illustrated in Section 3.3.3 of this report, indicates that fracturing of bedrock and changes in groundwater availability do not result in secondary impacts to vegetation or increased erosion, or the catastrophic loss of upland swamps. DoP (2008) recognises that certain swamp characteristics mean some upland swamps are more susceptible to impacts from subsidence than others. For example, given their location in the landscape, valley infill swamps are more likely to be in direct contact with surrounding groundwater, and much more susceptible to fracturing due to valley closure and upsidence. Biosis does not assert that subsidence associated with longwall mining does not result in impacts to upland swamps, or that changes in groundwater availability are not an impact to upland swamps. Rather, that the maintenance and persistence of upland swamps is much more complex than has

Submission	Response
	been recognised, and that further research and assessment is required to understand the complex processes that maintain upland swamps, particularly in relation to changes brought about by longwall mining.
Biosis have only identified 15 of 72 swamps as of 'special significance'. All 74 swamps are significant. Biosis make no reference to the BSO account of swamp impact mechanisms	The upland swamp impact assessment (Biosis 2012b) uses the methodology for identifying swamps of special significance outlined in OEH (2012). In their submission OEH recognises that *'Biosis has applied the OEH draft guidelines appropriately in identifying swamps of potential special significance'*.
Swamps can't be remediated once the base of the swamp is cracked	Attempts have been made to remediate upland swamps following impacts such as erosion using techniques such as coir logs, wooden structures etc. (Save Our Swamps 2010). However, these remediation techniques have been undertaken in relation to erosion. Biosis is not aware of the successful remediation of upland swamps impacted by the fracturing of bedrock. It is not feasible to remediate bedrock fractures and changes in groundwater availability, as the degree of impact from the remediation works would likely be far greater than the degree of benefit.

4.2 Agency submissions

Submissions relevant to biodiversity were received from the following agencies:

- Department of Resources and Energy (DRE)
- Department of Fisheries
- Office of Environment and Heritage (OEH)
- NSW Office of Water (NOW)
- Sydney Catchment Authority (SCA)
- Wollongong City Council (WCC)

Submissions related to several key issues, including subsidence predictions, the use of flow accumulation modelling and the conclusion of the Biosis (2012b) upland swamp impact assessment.

Table 21 provides a summary of agency submissions and outlines responses to these submissions.

Table 21: Summary of agency submissions, including responses

Submission	Response
Subsidence predictions	
Subsidence impacts are likely to have been underestimated with consequences for the adequacy of the environmental and Aboriginal heritage impact assessments	Subsidence predictions have been updated following revision of the mine plan (see SCT Operations 2013).
Creeks	
Location of Longwalls in relation to third order and fourth order streams, including cataract Creek, Lizard Creek and Wallandoola Creek	The revision of the mine plan now avoids mining below Cataract Creek. Mining in the Wonga West area, and thus beneath Lizard Creek and Wallandoola Creek, has now been removed from the preferred project.
Threatened species	
Potential impacts to threatened frogs	As outlined in Section 1.1.1, the Giant Burrowing Frog, Littlejohn's Tree Frog and Stuttering Frog have not been recorded within the subsidence impact zone and no impacts to identified breeding habitat for the Giant Burrowing Frog (below CRUS2) are predicted to occur. Although the Red-crowned Toadlet has been recorded above Longwall 4 and 5, habitat for this species is widespread and unlikely to be significantly impacted by subsidence. The Green and Golden Bell Frog has not been recorded within the study area. Suitable habitat is not present.
The sampling methods used to assess impacts on aquatic ecology are not scientifically robust	Additional sampling of aquatic habitat has been undertaken by Biosis (In Prep.), including sampling of fish using a backpack electrofisher in upstream reaches of Cataract Creek. No threatened species were recorded in this area.
Impacts to Macquarie Perch and Trout Cod, particularly spawning habitat and refugia for juveniles	It should be noted that due to past mining of the Bulli and Balgownie seams significant iron flocculent is already present in Cataract Creek, smothering some sections of the creek. Additional fish surveys have been undertaken by Biosis, and the results of these surveys are outlined in Section 3.2. The revision of the mine plan now avoids mining below Cataract Creek.
Potential presence of Adam's Emerald Dragonfly in Lizard Creek and Wallandoola Creek	Mining in the Wonga West area has now been removed from the preferred project.

Submission	Response
Upland swamps	
Mining under upland swamps due to the potential for fracturing of bedrock below upland swamps and resultant loss of groundwater, base flow and increased erosion potential	A revised upland swamp impact assessment has been undertaken using the revised mine plan and subsidence predictions. The revised mine plan has resulted in a reduction in the number of upland swamps at risk of negative environmental impacts, as well as a reduction in the number of upland swamps at risk of secondary impacts.
Mining under swamps of special significance	Revision of the mine plan has reduced the number of upland swamps of 'special significance' that will be undermined. Upland swamps CRUS3 and CCUS1 are no longer within the predicted subsidence impact zone, while CCUS1, CCUS5, CCUS 10 and CRUS1 are now largely located over pillars. CCUS4 is the only upland swamp of 'special significance' that will now be wholly undermined.
Objection to the use of flow accumulation modeling and definition of 'small' potential for change without defining small	The flow accumulation modeling has been used to predict changes to surface and groundwater flow through an upland swamp in relation to changes in ground level (tilt). A change in water flow is recognised as one potential impact to upland swamps (DoP 2009). Flow accumulation is modeled using vertical subsidence data (Smax) to model changes in flow pathways through an upland swamp. It is unrelated to tensile stress and strains.
Despite the impacts to upland swamps, no offsetting or remediation of groundwater or biodiversity impacts are proposed. This is not consistent with current government principles of avoid, mitigate or offset environmental impacts.	NRE proposes to outline an offset strategy once a Project Approval is received. This offset strategy will be developed in conjunction with relevant stakeholders, including OEH.

5. Conclusions

Changes to the project, as outlined in Section 2 have resulted in a significant reduction in predicted impacts to terrestrial and aquatic biodiversity and upland swamps. A summary of the reduced impact predictions is provided below:

- Removal of Wonga West from the program has resulted in reduced impacts to cliffs, providing habitat for threatened bats, rocky outcrops, providing habitat for threatened flora species and the Broad-headed Snake, and habitat for threatened frogs. The risk assessment for each of these groups of species now indicates a low risk of potential impact.
- The revision of the mine plan to avoid undermining of Cataract Creek has resulted in a reduced risk of impact to Macquarie Perch, Murray Cod and Silver Perch, as well as habitat for the threatened Adam's Emerald Dragonfly.
- The revision of the mine plan has resulted in a reduction in risk for several upland swamps, including CRUS2, CRUS3 and CCUS5, and will result in low risk of impact for all upland swamps except BCUS4 and CCUS4.
- The revised mine plan and revised subsidence predictions have resulted in an increase in risk to one upland swamp, CCUS4.

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ATTACHMENT B – Subsidence Assessment for Gujarat NRE Preferred Project

REPORT TO:

GUJARAT NRE COKING COAL LIMITED

Subsidence Assessment for Gujarat NRE Preferred Project Russell Vale No 1 Colliery

NRE14123

Strata Control Technology

REPORT TO

David Clarkson
Group Environment & Approvals Manager
Gujarat NRE Coking Coal Limited
PO Box 281
FAIRY MEADOW NSW 2519

SUBJECT

Subsidence Assessment for Gujarat NRE Preferred Project Russell Vale No 1 Colliery

REPORT NO

NRE14123

PREPARED BY

Ken Mills

DATE

24 September 2013

Ken Mills
Principal Geotechnical Engineer

SUMMARY

Gujarat NRE Coking Coal Limited (NRE) is proposing to mine eight additional longwall panels in an area referred to as the Wonga East mining area approximately 9km north-north-west of Wollongong in New South Wales. After consideration of submissions from the community and government agencies to its earlier Underground Expansion Project Part 3A (Pt3A) application, NRE has significantly modified the application in a proposal referred to as the Preferred Project Report (PPR). NRE commissioned SCT Operations Pty Ltd (SCT) to estimate the subsidence likely to be associated with mining the proposed longwall panels and to assess the subsidence impacts for the PPR recognising the influence of previous mining in the area. This report presents the results of our assessment.

Our assessment indicates that the subsidence impacts associated with the proposed PPR mining layout can be managed to a level consistent with impacts from previous mining in the area. Continued monitoring and adaptive management strategies are considered appropriate to manage these impacts. Mitigation measures will be required to manage the impacts on high voltage power transmission lines.

Site Description

The PPR Assessment Area is located entirely within the headwaters of Cataract River in the catchment of the Cataract Metropolitan Water Supply Reservoir and predominantly within the catchment of Cataract Creek. The surface is mainly undeveloped bushland. Surface features include sections of rain forest in the valleys, a variety of upland swamps located mainly on the valley sides and numerous sandstone rock formations on the upper slopes associated with Hawkesbury Sandstone. Some archaeological heritage sites are located within this outcrop. The surface is traversed by the Mount Ousley Road and four high voltage power transmission lines. A telecommunications installation and the Illawarra Escarpment are located approximately 1km to the east of the proposed longwall mining area.

Coal has previously been mined in three seams at this site, the Bulli Seam, the Balgownie Seam 10m below, and the Wongawilli Seam a further 20m below that. The Bulli Seam was mined from the late nineteenth century through to the 1950's using a variety of mining systems including in the later stages mechanised pillar extraction. The Balgownie Seam was mined as one of the first longwall mining operations in Australia from 1970 through to 1982. The Wongawilli Seam has been mined by NRE with the first of two longwall panels commencing in April 2012. Within the PPR Assessment Area the overburden depth to the coal seams ranges 220-390m mainly as a result of variation in surface topography but also as a result of the strata dipping at between 1 in 25 and 1 in 30 to the west-north-west away from its outcrop on the Illawarra Escarpment.

The presence of this previous mining presents some challenges for future mining but also brings some advantages in terms of providing high confidence definition of the nature, location, and characteristics of geological structures, actual measurements of the subsidence behaviour of the overburden strata at the site during previous mining, and an extended baseline of some 60-100 years to study the recovery of natural features from previous surface impacts.

Prediction Methodology

The subsidence prediction methodology used in this assessment is based on previous subsidence monitoring experience at this site available from mining in the Bulli Seam (over longwall panels 6-8km to the west) and the Balgownie and Wongawilli Seams in the PPR Assessment Area. This data is considered to provide a strong basis for predicting subsidence above the proposed longwall panels, particularly when consideration is given to the mechanics of the subsidence processes involved, specifically the differences between sag subsidence over individual panels and elastic compression subsidence associated with elastic compression of the strata between panels. Tilts and strains are predicted using incremental subsidence and the approach forwarded by Holla and Barclay (2000). Maximum closure is predicted using the ACARP Method developed by Waddington and Kay (2003).

The approach to predicting subsidence movements is considered to be appropriate in the relatively complex mining environment that exists within the PPR Assessment Area especially now that there is actual subsidence data available from Longwalls 4 and 5 in the Wongawilli Seam to provide confirmation of behaviour when a third seam is mined.

The experience available from mining Longwalls 4 and 5 indicates that the subsidence behaviour is essentially predictable albeit with somewhat different characteristics to subsidence over single seam mining operations. The subsidence behaviour in a multi-seam environment is different in respect of the overburden stiffness characteristics and therefore the bridging capacity across individual panels, but is otherwise essentially similar to the subsidence behaviour above single seam operations.

Predicted Subsidence

Maximum subsidence over individual longwall panels in the Wongawilli Seam is predicted to range from 1.5m over the slightly narrower Longwall 7 through to 2.6m over Longwall 3 where the overburden depth is shallowest and there is overlying goaf in both seams. Previous mining in the Bulli and Balgownie Seams is estimated to have caused up to 1.9m of subsidence.

There is considered to be some potential for pillar instability in the Bulli Seam to cause additional surface subsidence when the proposed longwall panels are mined in the Wongawilli Seam, but the area likely to be affected at the northern end of Longwall 1 is not expected to cause significant surface subsidence or significantly greater surface impacts.

Maximum tilts over individual longwall panels in the Wongawilli Seam are expected to range from peaks of 24mm/m over Longwall 10 through to peaks of 51mm/m above Longwall 3. The peak values predicted are expected to be the maximum anywhere in the panel, most likely at goaf edges in overlying seams and in areas of topographic change in gradient. More generally across the panel, systematic tilts are likely to be in the range 50-90% of the peak values.

Maximum strains over individual longwall panels in the Wongawilli Seam are expected to range from peaks of 14mm/m over Longwall 10 to peaks of 31mm/m over Longwall 3. The peak values predicted may occur anywhere within the panel but tensile peaks are most likely to occur at topographic high points and compression peaks are most likely to occur at topographic low points. More generally across the panel, systematic strains are likely to be 20-30% of the peak values.

The predicted closure across Cataract Creek ranges up to 400mm adjacent to the ends of Longwalls 6 and 7 and up to 210mm at the end of Longwall 5. These closure estimates are recognised as being upper limit values because they are based on experience in deep gorges at high stress levels. Monitoring so far indicates closure movements that are much less than the predicted maxima consistent with the local site conditions.

The following table summarises the subsidence that has occurred in the area of each longwall panel during mining in the Bulli Seam (estimated) and the Balgownie Seam (measured) as well as the subsidence that is predicted above each longwall panel from proposed mining in the Wongawilli Seam.

General Observations Above Individual Panels	Previous Bulli and Balgownie Seam Subsidence (m)	Predicted Subsidence for PPR Wongawilli Seam (m) and Measured (in bold)	Predicted Tilt for PPR Wongawilli Seam (mm/m) and Measured (in bold)	Predicted Tensile Strain for PPR Wongawilli Seam (mm/m) and Measured (in bold)	Compressive Strain for PPR Wongawilli Seam (mm/m) and	Maximum Closure on Cataract Creek (mm) (Southern Tributary in
Longwall 1	1.3	2.1	40	12	24	N/A (650)
Longwall 2	1.1	2.1	40	12	24	N/A (610)
Longwall 3	1.3	2.6	51	15	31	N/A (350)
Longwall 4	1.9	2.1 (**1.6**)	35 (**30**)	10.5 (**7.5**)	21 (**14**)	N/A
Longwall 5	0.9	1.9 (**1.5***)	36 (**16***)	10.8 (**4.5***)	22 (**14***)	210 (**20***)
Longwall 6	1.5	2.1	38	11	23	400
Longwall 7	1.2	1.5	28	8	17	400
Longwall 9	0.5	2.1	32	10	19	50
Longwall 10	0.6	1.6	24	7	14	30
Longwall 11	0.6	2.1	30	9	18	10

(*mining still in progress)

Movement outside the goaf edge are expected to be essentially similar to the movements observed so far during mining of Longwalls 4 and 5. Vertical movements of greater than 20mm are expected to be limited to within a distance of 0.7 time overburden depth from the nearest goaf edge equivalent to an angle of draw of 35°. In areas where there has been previous mining in both the overlying seams, vertical subsidence at the goaf edge is expected to be up to 300-500mm and the goaf edge subsidence profile is expected to be general softer than elsewhere. In areas where there is either solid coal or substantial coal pillars directly above the goaf edge, goaf edge subsidence is expected to be of the order of 100-200mm.

Impact Assessment

The impacts of mining subsidence on surface features are considered in detail within the body of the report. These features include natural features such as Cataract Creek, Cataract River, upland swamps, and sandstone cliffs including the Illawarra Escarpment, archaeological heritage features, and surface infrastructure including Mount Ousley Road, four high power transmission lines, Cataract Water Supply Reservoir, and a telecommunications installation on Brokers Nose.

Cataract Creek flows across the PPR Assessment Area. The PPR mine layout has been designed to avoid mining directly under the main channel of Cataract Creek and particularly the third and fourth order sections. An adaptive management strategy based on closure monitoring and cessation of mining if there is a likelihood of significant perceptible impacts becoming apparent is considered to be an effective method of managing the potential for subsidence impacts on Cataract Creek.

Cataract River is remote from the proposed mining in an area where there are not expected to be any perceptible impacts.

Biosis (2013) has mapped and described 33 separate upland swamps within the PPR Assessment Area. Many of these swamps have been previously mined under in both the Bulli Seam and Balgownie Seam. The proposed mining is not expected to cause significantly different impacts to those already experienced. It is considered that more work is required to determine the relationship between mining subsidence and the long term health of swamps. The extended baseline of subsidence impacts over 60-100 years in the Bulli Seam and 30-40 years in the Balgownie Seam provides a rare opportunity to study these effects. The development of a monitoring and review strategy involving relevant experts is recommended to manage mining impacts on these swamps. This process should include a review of the recovery of these features from previous impacts and the implication of this recovery for future swamp protection strategies.

There are numerous sandstone cliff formations located within the Hawkesbury Sandstone outcrop in the PPR Assessment Area. Most of these are less than 5m high and none are considered to be significant based on the assessment criteria presented in PAC (2010). Some perceptible cracking on hard rock surfaces is expected to be apparent as a result of the proposed mining. Minor rock falls are expected on up to 5% of the length of sandstone cliff formations that are mined directly under. It is noted that there are a number of rock falls present across the site that can be attributed to previous mining impacts and others that have occurred naturally.

Nineteen Aboriginal heritage sites have been identified within the PPR Assessment Area. Some of these sites have potential to be impacted by rock falls caused by mining subsidence. A detailed assessment of these sites is presented in the body of the report and in Biosis (2013).

Mount Ousley Road is protected from direct mine subsidence by a horizontal distance from the nearest goaf edge equal to half overburden depth. Low levels of vertical subsidence of less than about 100mm in total are expected in the vicinity of Mount Ousley Road with up to approximately 30mm of this maximum having already occurred from mining Longwall 4. These low level vertical movements are expected to be imperceptible for all practical purposes although tensile cracking adjacent to the topographic high ground south of Cataract Creek and closure of up to a maximum of 125mm of closure predicted using the ACARP Method is expected at Cataract Creek. There is considered to be no potential for significant horizontal movements to impact the Picton Road Interchange.

There are four power transmission lines located in two corridors between Mount Ousley Road and the Illawarra Escarpment. All four lines were mined under by Longwalls 1 and 3 in the Balgownie Seam and potentially by late stage pillar extraction in the main heading pillars in the Bulli Seam although this latter mining may have preceded their construction. Subsidence movements predicted in the vicinity of four of the towers (two each on the 330kV and 132kV lines) are expected to be sufficient to require construction of cruciform bases to protect them from mining subsidence. T56 on the 330kV line will require a special design to accommodate the slight change in direction that occurs at this tower.

The 33kV single and double pole structures are relatively tolerant of subsidence movements and because these structures are located more than 60m outside of the footprint of the longwall panels no protection measures are considered necessary, although a monitoring regime is nevertheless recommended.

The Cataract Water Storage Reservoir is not expected to be impacted by the proposed mining. The Full Supply Level (FSL) for the reservoir including the section that extends up Cataract Creek is protected from the nearest longwall goafs by a nominal horizontal distance of greater than 203m at 290m overburden depth (equivalent to 0.7 times overburden depth or an angle of draw of 35°). Vertical subsidence at the FSL is expected to be less than about 20mm.

Geological structures within the PPR Assessment Area are well defined because of the previous mining that has occurred in the overlying Bulli Seam over a large area and the overlying Balgownie Seam in a more limited area. The only geological structure that extends through to the proposed longwall panels in the PPR Assessment Area and the reservoir is Dyke D8. The horizontal distance along the dyke from the end of Longwall 10 to the FSL is approximately 560m at an overburden depth of 320m at the FSL. There is considered to be no potential for proposed mining to intersect the stored waters directly. There are also a number of small pre-existing Bulli Seam goaf areas that are located within the 0.7 times depth protection zone around the FSL. It is considered unlikely that the proposed mining will interact with these pre-existing goaf areas and currently there does not appear to be any connection between the reservoir and the mining horizon. Nevertheless, the presence of these goafs reduces the effectiveness of the 0.7 times depth barrier between the FSL and the proposed mining, particularly for mining of Longwalls 7 and 9.

The Illawarra Escarpment at Brokers Nose and the telecommunications infrastructure located on it are protected by a horizontal distance of approximately 1km from the nearest point on Longwall 1. No ground movements or any perceptible impacts are expected in this area as a result of the proposed mining.

Management Strategies

The subsidence management strategies recommended include continuation of the upgrade to subsidence monitoring technique that has been ongoing since the start of Longwall 4.

Ongoing management and review by a technical committee of subsidence impacts to Mount Ousley Road using the same approach as for Longwalls 4 and 5 is considered suitable to manage the potential for any future impacts. The half depth barrier used to substantially protect the road alignment provides a relatively high level of protection. Some consideration to remedial work to prevent water ingress into minor tension cracks that have formed is recommended to protect the road sub-base.

A technical committee comprising representatives from the colliery, the power utility companies, the Mine Subsidence Board, and government regulators is recommended to manage potential impacts on the power transmission towers. This forum provides all interested parties with understanding and control of the management processes. Several of the power transmission towers are likely to require the construction of cruciform bases to allow them to remain structurally stable during mining. There is usually a significant lead time involved in getting cruciforms approved, financed, designed, and constructed.

The Dams Safety Committee (DSC) is a statutory body with legal powers to manage mining to protect the stored waters in Cataract Reservoir. The colliery has been working with the DSC for many years and it is considered that the management process that has been adopted in the past continues to be appropriate. The 0.7 times depth (approximately 200m) stand-off from the FSL is considered to be the primary control for protecting the stored waters of Cataract Reservoir and this stand-off is expected to provide a high level of protection notwithstanding the presence of localised existing extraction in the Bulli Seam.

The detail of monitoring of swamps, heritage sites, and creek biota is beyond the scope of this report and has been addressed in other specialist's reports. However, it is recommended that one or more technical committees are formed to design monitoring programs that not only review the changes that may be associated with proposed mining but also take the opportunity to review the longer term impacts from previous mining in the same area. Ideally these technical committees would include external expertise from the community where appropriate so that monitoring programs are targeted, appropriate, and can be ongoing.

Response to Submissions

A range of submissions were received in response to the Underground Expansion Project Pt3A. These submissions were received prior to the PPR amendments and while the PPR amendments have addressed many of the issues raised, a number of these issues are worth discussing in the context of the PPR design and how they have driven the changes that have been made to the design and the design process.

The subsidence prediction technique used has been updated to reflect the available data. The revised approach is based on using the available data to provide insight into the subsidence mechanics and continuing to develop this understanding recognising the various subsidence processes involved. Although there is somewhat greater uncertainty for subsidence predictions in a multi-seam environment, the available data indicates that the behaviour observed is repeatable and consistent with the mechanics of the processes involved.

There are a number of geological structures located in the general area of the proposed mining, but only two are considered to be significant in the context of the proposed mining. The others are located away from the areas of mining and are not considered to have any significant potential to be affected by mining. A significant benefit of the previous mining activity is that the dykes and faults through the area are very well defined by previous mining activity.

The potential in the Bulli Seam for pillar instability and latent subsidence (where full subsidence has not occurred during previous mining) has been recognised as having some potential to cause additional subsidence at the northern end of Longwall 1 and this area is accepted as needing special consideration. Other areas where there may be a similar potential are more difficult to identify because the mine records for the period of mining are incomplete and may be inaccurate but the significance of any surface subsidence that may result is considered to be low, especially in terms of impacts to major surface infrastructure.

The prediction of valley closure, upsidence, and far-field movements is recognised as being only approximate. Offsets that have been designed into the revised mine layout are aimed to avoid mining directly under the main channel of Cataract Creek to provide a buffer against closure related impacts and this protection is supported by NRE's commitment to stop the longwalls short if closure movements become likely to cause unacceptable impacts..

There is considered to be no potential for the proposed mining to impact on the Illawarra Escarpment and in particular the section of Hawkesbury Sandstone outcrop at Brokers Nose. It should be recognised that there is always potential for cliff falls to occur naturally as part of the natural erosion processes of cliffs. .

The subsidence monitoring systems being used at NRE are undergoing continued upgrading from two dimensional surveying techniques used during the initial stages of mining Longwall 4 through to full three dimensional subsidence monitoring with a far-field GPS survey control network. The monitoring network used for Longwall 5 is considered to be an intermediate step. Additional monitoring and further upgrading of the monitoring is proposed in this report.

Adaptive management strategies are being practiced by NRE. Examples include the significant revision to the mine layout represented by the PPR and the use of closure monitoring across Cataract Creek to control the length of Longwalls 5, 6 and 7. Further monitoring is also expected to provide greater understanding of the processes involved and guide future design.

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1. INTRODUCTION

Gujarat NRE Coking Coal Limited (NRE) is proposing to mine eight additional longwall panels in an area referred to as the Wonga East mining area approximately 9km north-north-west of Wollongong in New South Wales. After consideration of submissions from the community and government agencies to its earlier Underground Expansion Project Part 3A (Pt3A) application, NRE has significantly modified the application in a proposal referred to as the Preferred Project Report (PPR). NRE commissioned SCT Operations Pty Ltd (SCT) to estimate the subsidence likely to be associated with mining the proposed longwall panels and to assess the subsidence impacts for the PPR recognising the influence of previous mining in the area. This report presents the results of our assessment.

The report is structured into three parts:

The first part, Section 2, describes the site, the background to the project and the rationale for the mining layout in the Preferred Project showing changes to the geometry compared to the earlier Pt3A application, the geological setting, and an overview of the surface features.

The second part, Sections 3 to 7, describes the previous mining activity, the past and future subsidence including available monitoring data from mining in one, two, and three overlying seams, a description of the subsidence prediction methodology and a discussion of the accuracy and level of confidence that can be placed in the predictions, estimates of subsidence for the proposed mining based on the data currently available, an assessment of likely subsidence impacts on each of the surface features including a review of past impacts and the threats that previous mining activity still has for unpredictable subsidence behaviour. In the last section, a range of strategies to manage the subsidence impacts expected are presented and discussed.

The third part, Section 8, presents a response to submissions to the earlier Part 3A application where these responses remain relevant to the PPR.

2. SITE DESCRIPTION

This section is structured to provide an overview of the site, background to the PPR and the Assessment Area and changes since the Underground Expansion Project Pt3A application, a review of surface ownership, an overview of the main surface features and the geological setting.

This site description section is presented primarily to provide context for the subsidence assessment. More detail of specific aspects of various features such as the geological setting, the flora and fauna, surface features such as swamps and cliffs, archaeological and other heritage sites, and surface and groundwater interactions is presented in other specialist reports associated with the project.

2.1 Site Overview

Figure 1 shows the location of the PPR Assessment Area superimposed on a 1:25,000 topographic series map. Detail of the surface contour available from LiDAR (Laser Interferometry Detection and Ranging) imagery flown since the production of the 1:25,000 series topographic series map has been used to refine the location of surface watercourses, particularly Cataract Creek. These watercourses have been coloured on the basis of their stream order using the approach described in the Southern Coalfields Inquiry. The longwall panels discussed in this report and shown in Figure 1 include Longwall 4 in the Wongawilli Seam which has already been mined and Longwall 5 which has been substantially mined.

The Assessment Area is located entirely within the headwaters of Cataract River and the Cataract Reservoir and predominantly within the catchment of Cataract Creek. The surface is mainly undeveloped bushland. Surface features include sections of rain forest in the valleys, a variety of upland swamps located mainly on the valley sides and numerous sandstone rock formations on the upper slopes associated with Hawkesbury Sandstone outcrop. The surface is traversed by the Mount Ousley Road and four high voltage power transmission lines.

2.2 Project Background

NRE No. 1 Colliery is located at Russell Vale, to the west of Bellambi, in the Illawarra region of New South Wales (NSW). NRE purchased the Colliery in December 2004, but extensive underground mining has been undertaken within the Colliery holdings dating from the late nineteenth century. However, a substantial volume of high quality coking coal resources remains along with some potential thermal coal resources.

The colliery holding includes a number of sub leases between NRE and surrounding mine operators, including Consolidated Coal Lease (CCL) 745, Mining Purposes Lease (MPL) 271 and Mining Lease (ML) 1575 and covers a total area of approximately 6,973 hectares (ha).

Originally, NRE intended to expand its Wongawilli Seam operations in two stages. Stage 1 plans were included in the Preliminary Works Pt3A that was approved on 13 October 2011 allowing some first workings coal extraction and surface facility upgrades. On 24 December 2012, the Preliminary Works Part 3A was modified to allow the extraction of Longwalls 4 and 5 and the establishment of Maingate 6.

The original Stage 2 application known as the Underground Expansion Project Pt3A was lodged with the DPI on 12 August 2009 and contained an application to extract eleven longwalls in the Wonga East area and seven longwalls in the Wonga West area along with surface facilities upgrades to allow production of up to 3Mtpa for up to 20 years. Since that time the application has been progressing through the Major Project approvals process and was placed on Public Exhibition on 18 February 2013.

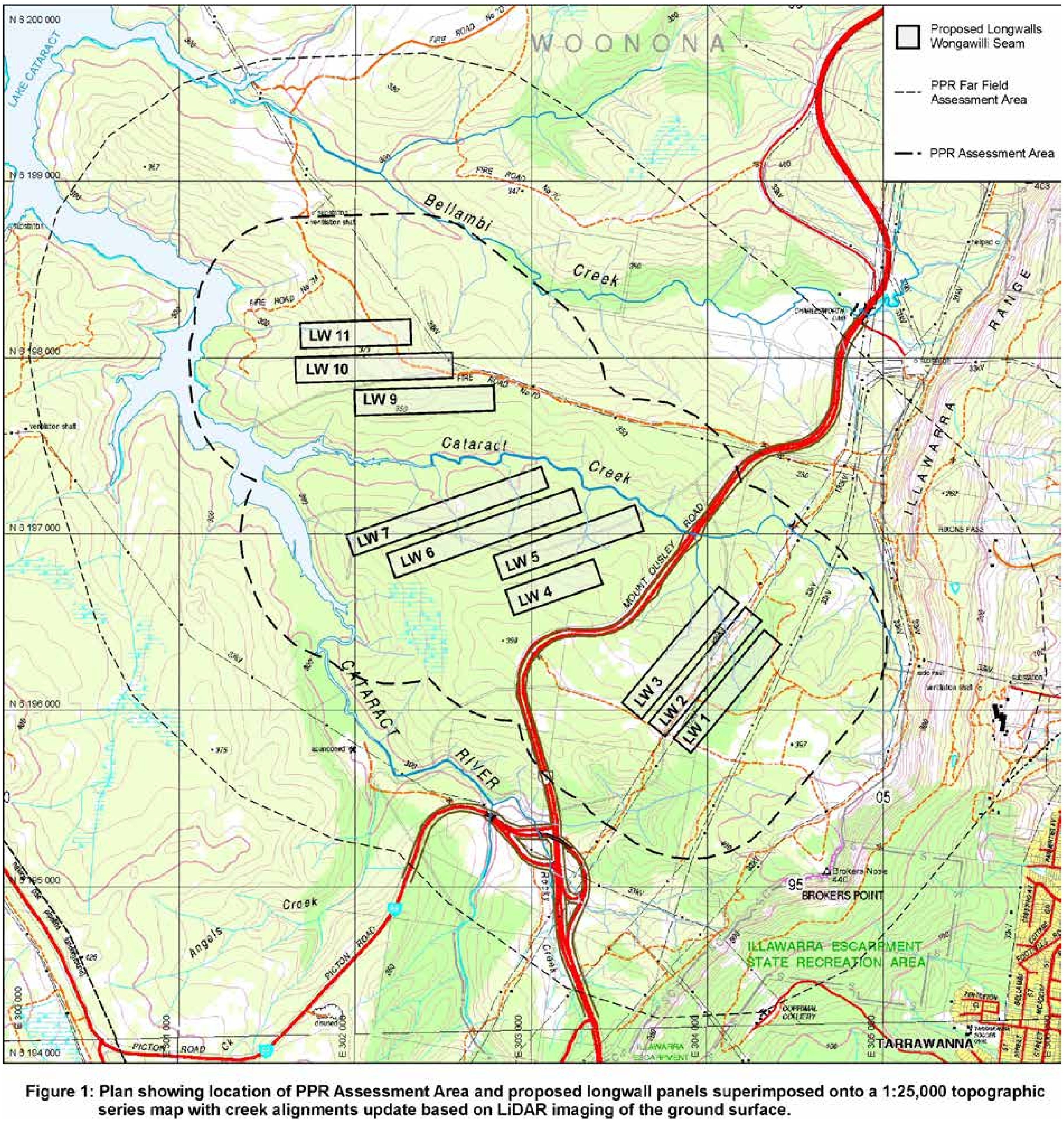


Figure 1: Plan showing location of PPR Assessment Area and proposed longwall panels superimposed onto a 1:25,000 topographic series map with creek alignments update based on LiDAR imaging of the ground surface.

As a result of the submissions received on the application, NRE has made the decision to substantially revise the application to facilitate the approval process and allow continuity in operations. Due to the scope of the changes, the New South Wales Department of Planning and Infrastructure (DPI) requested NRE to prepare a Preferred Project Report for the revised Underground Expansion Project Pt3A.

The Preferred Project report outlines the revised Underground Expansion Project which has been reduced to a 5 year interim stage project, with extraction of eight longwalls in the Wonga East area and upgrading of surface facilities to manage an extraction rate of up to 3Mtpa ROM coal per annum. The original Wonga West longwall extraction is planned to be reviewed and resubmitted to DPI as a separate application at a later time.

2.3 PPR Assessment Area

Taking account of the various submissions received, the longwall panels in the PPR have been designed recognising the following constraints:

- The constraints of the mine lease.
- Geological constraints including the Corrimal Fault in the south, silling (an igneous intrusion within the seam) in the north, and coal quality considerations and its impact on mining height.
- Mining constraints associated with the need for main headings in the north and the legacy of previous mining extent and geometry.
- Surface subsidence constraints including:
    - o Avoiding longwall extraction within 0.7 times depth (equivalent of 35° angle of draw) of the full supply level (FSL) of Cataract Reservoir including the section of the reservoir that extends up Cataract Creek.
    - o Avoiding mining directly under the third and fourth order sections of Cataract Creek.
    - o Minimising impacts on Mount Ousley Road to tolerable levels by remaining beyond approximately half depth (equivalent to 26.5° angle of draw) from the road easement.
    - o Significant upland swamps

These constraints are illustrated in Figure 2 together with the PPR layout and the original layout proposed for the Underground Expansion Project Pt3A application. In the PPR, Longwall 8 has been left out, most of the panels have been shortened, Longwall 7 has been narrowed, and six of the panels (Longwalls 1-3 and 9-11) have been rotated in order to remain within the constraints described above.

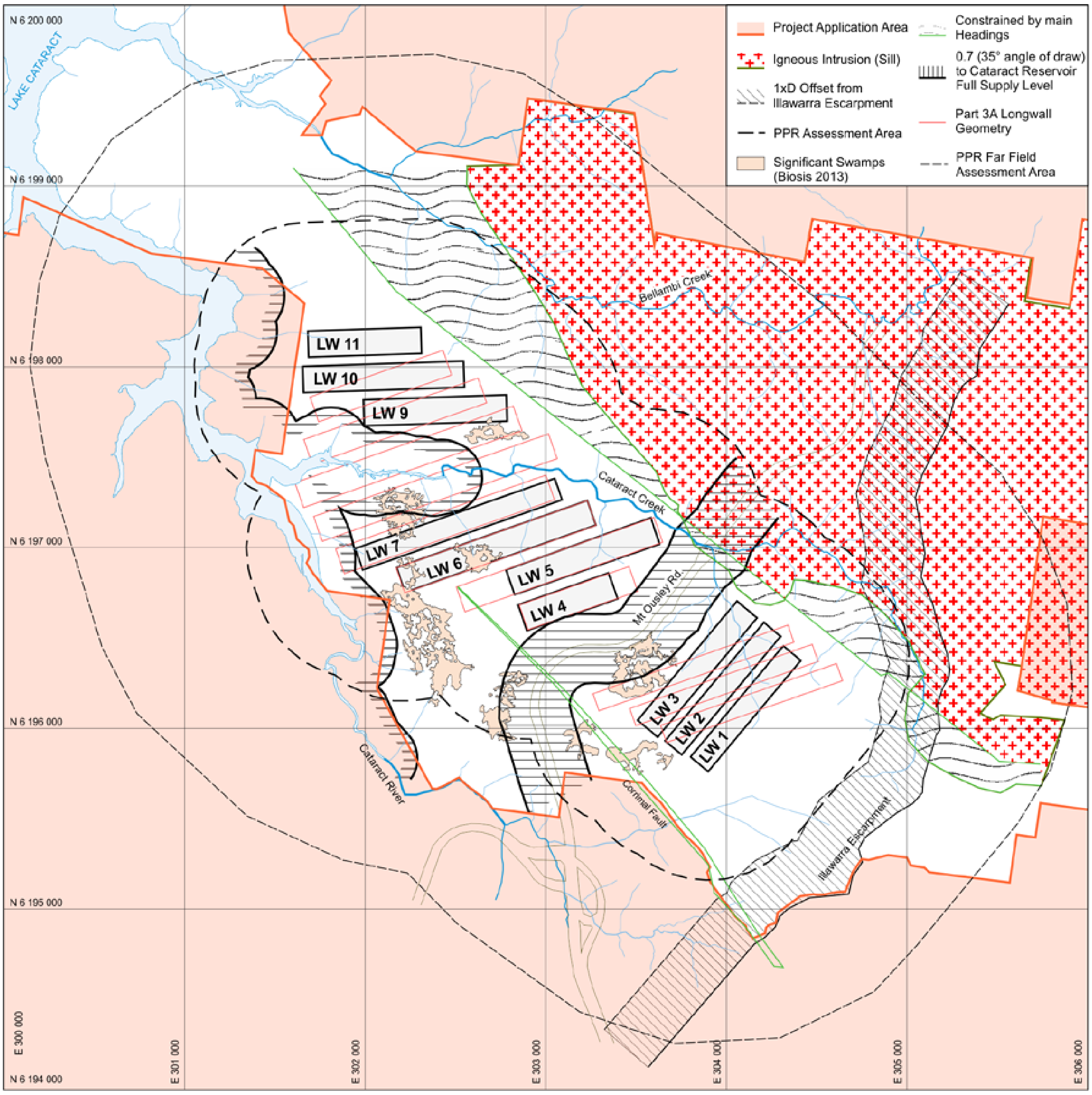


Figure 2: Plan showing the design constraints (lease, geological, mining, and surface protection) as the basis for the PPR mine layout design.

The PPR Assessment Area has been defined as an area that extends to a horizontal distance of 600m from the outside edge of any of the proposed longwall panels including Longwalls 4 and 5 (NSW Department of Planning 2008). A second far field assessment area extending to 1.5km outside the proposed longwall panels has been used to include significant features such as the Illawarra Escarpment and the bridges of the Picton Road Interchange that while remote from mining are within the area where far-field horizontal movements may occur.

Longwall 4 which has already been mined and Longwall 5 which is currently in the process of being mined are included in the assessment area and this subsidence assessment because:

- Although they have been mined under a different regulatory process, they are nevertheless within the purview of the current mining area and it is appropriate to assess their impacts in this context.

- The levels of subsidence measured were significantly higher than predicted using the single seam subsidence prediction methodology used for the original assessments and therefore reassessment is considered appropriate.

- The measured subsidence movements and impacts provide a gauge of the accuracy of the prediction methodology and impact assessments.

2.4 Surface Ownership

Figure 3 shows the surface ownership within the PPR Assessment Area. Most of the area is within the Metropolitan Special Area for Cataract Water Supply Reservoir. The surface area above the catchment is administered by the Sydney Catchment Authority (SCA). The stored waters of Cataract Reservoir are also administered by the Dams Safety Committee (DSC). A large part of the area to the east of Mount Ousley Road and small areas to the west are owned by NRE. The easement for the Mount Ousley Road and an area northeast of the Picton Interchange within the Assessment Area is owned and administered by the Roads and Maritime Services (RMS).

2.5 Surface Infrastructure

Major infrastructure within the Assessment Area includes the Mount Ousley Road and four high voltage power lines to the east that cross the area. The location of this infrastructure is shown on the topographic map in Figure 1.

Mount Ousley Road (recently renamed the M1 Princes Motorway) is a major four lane highway connecting New South Wales largest and third largest cities. This road is administered by Roads and Maritime Services (RMS). The interchange with the Picton Road is located to the south outside the Assessment Area but within the 1.5km far field assessment area. This interchange includes a concrete bridge and several drainage culverts.

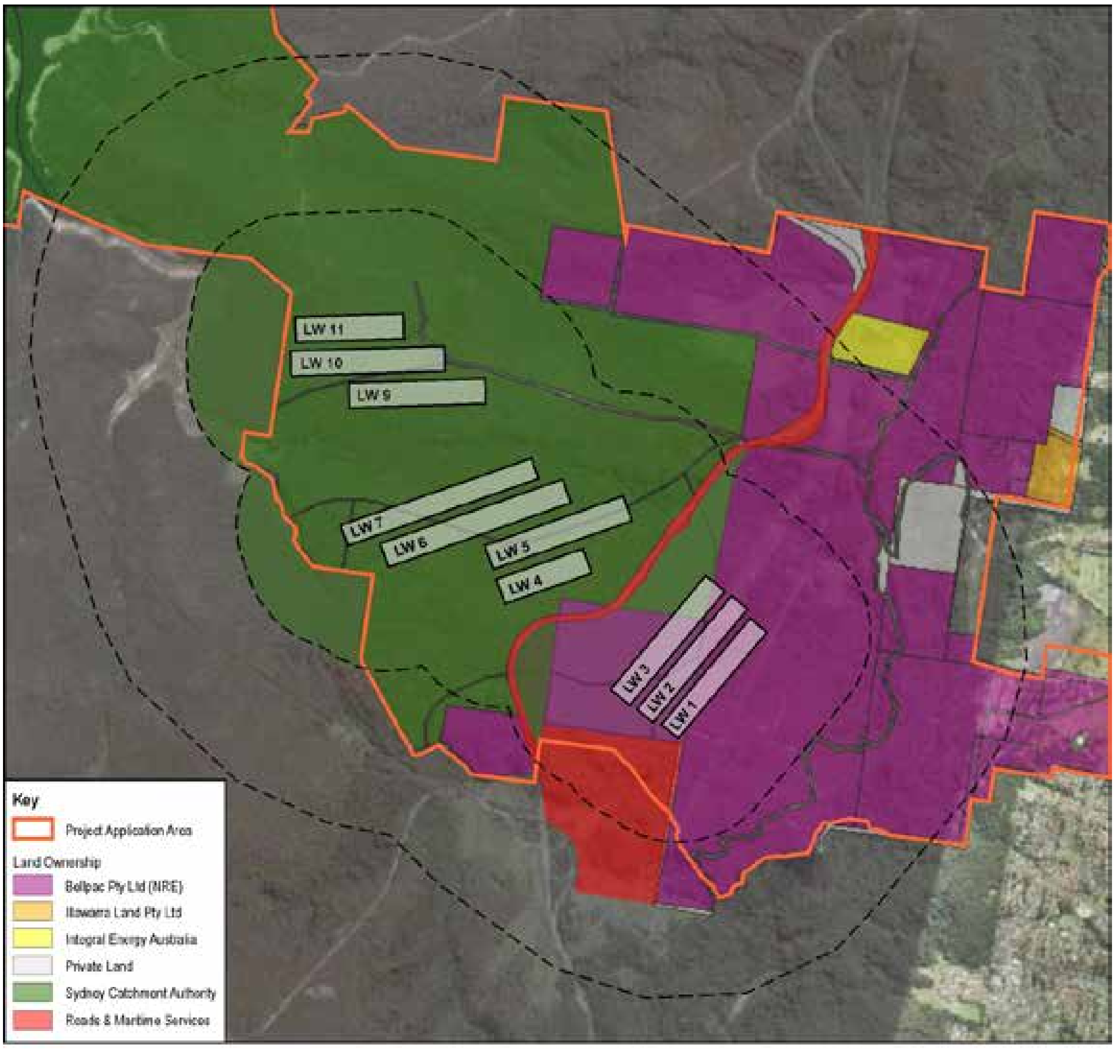


Figure 3: Plan showing land ownership within PPR Application Area. (Diagram modified from Figure 1.5 of EA from Environmental Resources Management Drawing Number 0079383s_EA_GIS013_RO.mxd dated 22/9/10)

Mount Ousley Road was constructed as a defence route during 1942 with duplication of the highway commencing in 1965 reaching Picton Road from the south in 1979 (OzRoads 2012). A major deviation at Cataract Creek was opened in 1980. The northbound carriageway on Mount Ousley Road at Cataract Creek was last resurfaced in 2009 with the surface expected to last 10-12 years (Vecovski 2012). The southbound carriageway was last resurfaced in 2003 and resurfacing of this section is expected within 5-6 years.

There are four power transmission lines located within the Assessment Area, a 330kV transmission line owned and maintained by Transgrid, a 132kV transmission line located alongside that is owned and maintained by Endeavour Energy and two 33kV transmission lines and associated infrastructure owned and maintained by Endeavour Energy. There are also two more 33kV lines and sub-station infrastructure located outside the Assessment Area but within or just outside the 1.5km far field assessment area. One of these line services colliery infrastructure.

There is a telecommunications installation located adjacent to the Illawarra Escarpment at Brokers Nose. This facility is approximately 980m from the goaf edge of Longwall 1. The site is outside the PPR Assessment Area but within the far field assessment area.

2.6 Natural Features

Major natural features and natural resources in the area include the Illawarra Escarpment and the upper parts of Lake Cataract that forms part of the Sydney's water supply catchment. The Illawarra Escarpment is located some 800-900m east of proposed Longwall 1 and outside the PPR Assessment Area but within the far field assessment area. Approximately one third of the Assessment Area and sections of five longwall panels are located within the DSC Notification Area (2013).

There are numerous natural swamps identified within the Assessment Area. The nature and distribution of these swamps are described in detail in associated specialist reports (Biosis 2013).

There are numerous sandstone cliff formations within the Assessment Area but all except for a few isolated sections are less than 5m high and none are considered to be significant using the significance criteria developed by the Planning Assessment Commission (PAC) in 2010 for the Bulli Seam Operations PAC Report (PAC 2010).

2.7 Heritage Features

Several Aboriginal heritage sites have been identified within the Assessment Area. These sites are mainly associated with rock shelters in sandstone cliff formations and grinding groove sites on upland sandstone outcrops. One of the shelter sites appears to have been impacted by instability of the associated sandstone overhang either as a result of previous mining in the Bulli Seam or as a result of tree root invasion and natural erosion processes.

2.8 Geological Setting

In this section, an overview of the geological setting is presented as context for the subsidence assessment. The geological setting is described in more detail in Clark (2013) but several of the key diagrams are reproduced here.

Within the Assessment Area, the strata dips at between 1 in 25 and 1 in 30 to the west-north-west from outcrop on the Illawarra Escarpment.

Figure 4 shows a plan of the geological formations that outcrop at the surface and the geological structure that exists at the Wongawilli Seam

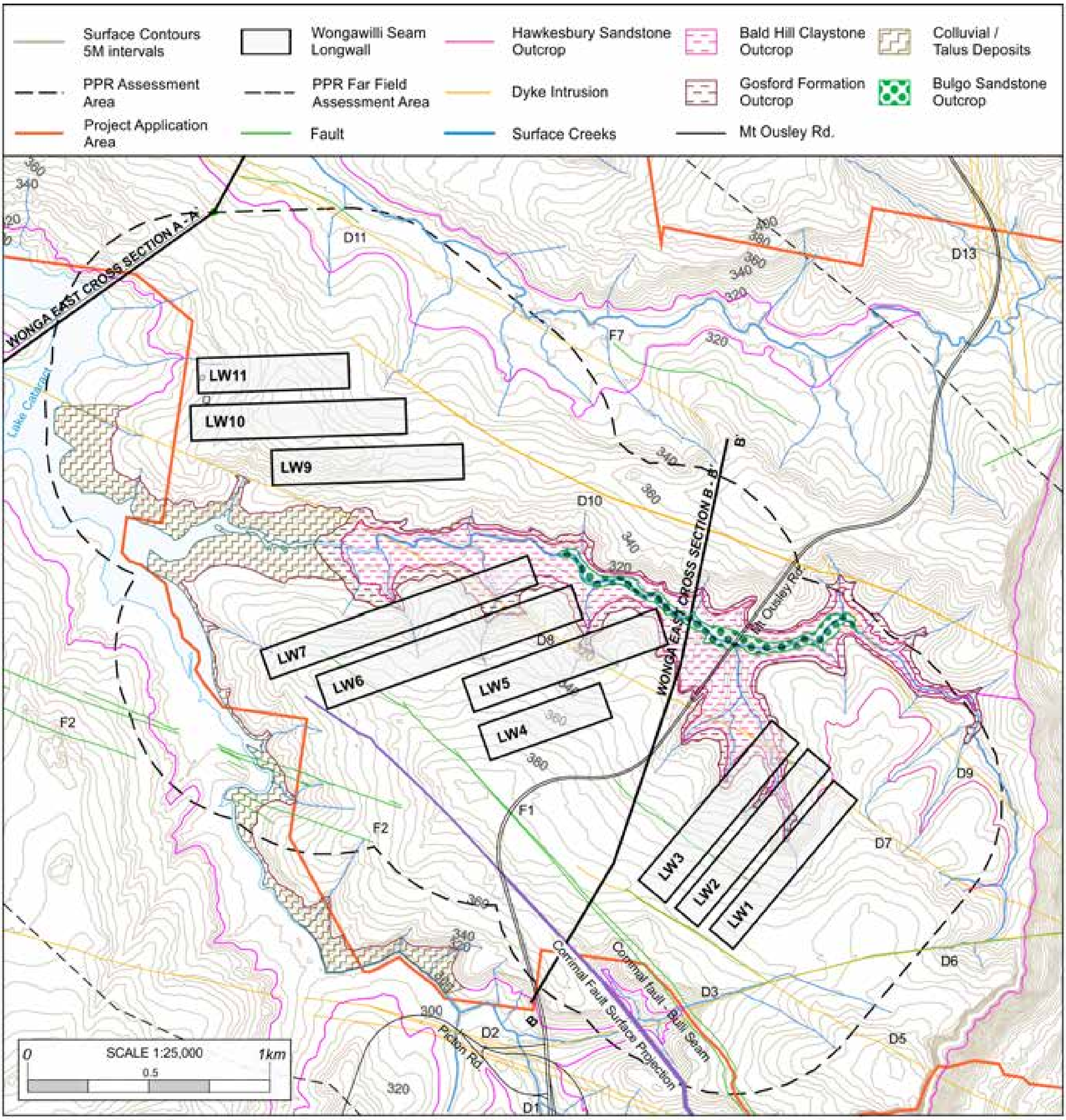


Figure 4: Plan showing geological outcrop at the surface and the location of major geological structures. (reproduced from Figure 11 of Clark 2013)

level and at the surface. Hawkesbury Sandstone is present on the surface over most of the Assessment Area. The Bald Hill Claystone that underlies the Hawkesbury Sandstone outcrops in Cataract Creek and its tributaries. The Bulgo Sandstone that underlies the Bald Hill Claystone outcrops along the main channel of Cataract Creek on both sides of Mount Ousley Road.

Figure 5 shows a cross-section through the Assessment Area extending from south to north in the vicinity of Mount Ousley Road drawn at natural scale. This section shows how Cataract Creek has cut down through the stratigraphy near the top of the anticlinal structure (an upward or arch shaped fold in the geological strata) that exists in this area.

2.8.1 Coal Seams

The three coal seams that have been mined at the colliery are all located within the Illawarra Coal Measures.

The Bulli Seam is the uppermost of the three seams and averages about 2.2m in thickness across the Assessment Area. Figure 6 shows the layout of the Bulli Seam workings and the geological structure in the Bulli Seam (reproduced from Clark 2013).

The Balgownie Seam is located on average about 10m below the floor of the Bulli Seam ranging from 5m to 14m across the Assessment Area. Figure 7 shows the layout of the Balgownie Seam workings and the geological structure in the Balgownie Seam. The Balgownie Seam is approximately 1.2m thick, but anecdotal evidence from miners who worked the seam and subsidence monitoring indicates that the mining height may have been up to 1.5m on the longwall faces to accommodate the mining equipment. It is understood the additional height was gained by mining the immediate roof strata.

The Wongawilli Seam is located approximately 20m below the Balgownie Seam and ranges in thickness from 7.7m to 11.9m, but only the lower 2.6-2.8m is economic to mine and this section is planned to be targeted by proposed mining. Figure 8 shows a plan of the geological structure at the Wongawilli Seam level reproduced from Clark (2013) and modified to include the Wongawilli Seam floor contours.

The floor of the Wongawilli Seam has an elevation of approximately 80mAHD at the north eastern corner of Longwall 1 and an elevation of approximately -25mAHD at the north western corner of Longwall 11. The dip of the seam between these two points is, for practical purposes, constant.

2.8.2 Geological Structures

The geological structure in each seam is shown in Figures 6-8. The major geological structures of interest in the area are igneous sills and dykes and the Corrimal fault. The vertically continuous structures are evident in the Bulli and Balgownie Seam and in the geomorphology on the surface. The position of these features is considered to be well defined as a result of the underground exposures.

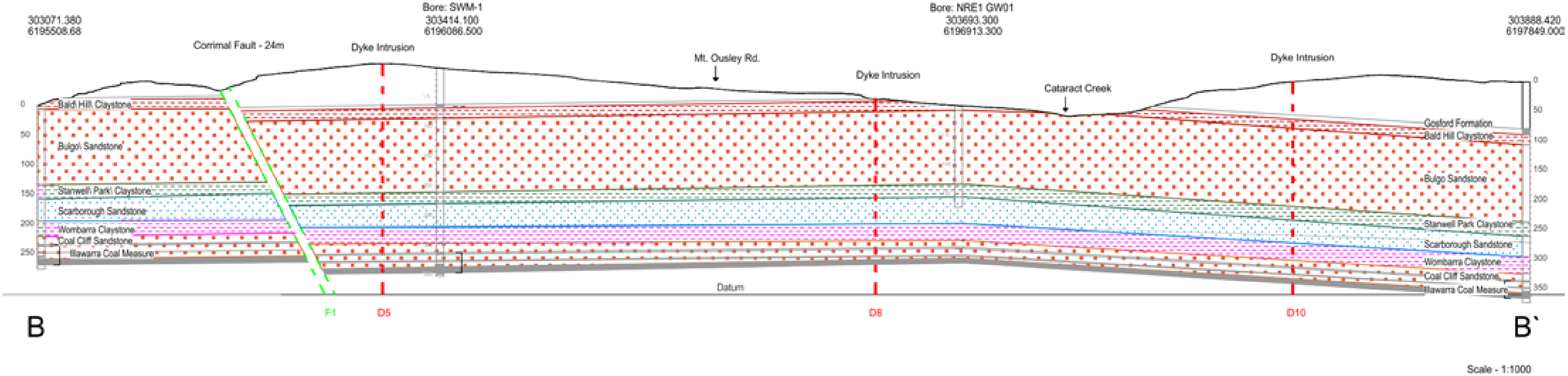


Figure 5: South-North geological section through PPR Application Area in the vicinity of Mount Ousley Road. (reproduced from Figure 12 of Clark 2013) ***Note: vertical scale is the same as the horizontal scale.***

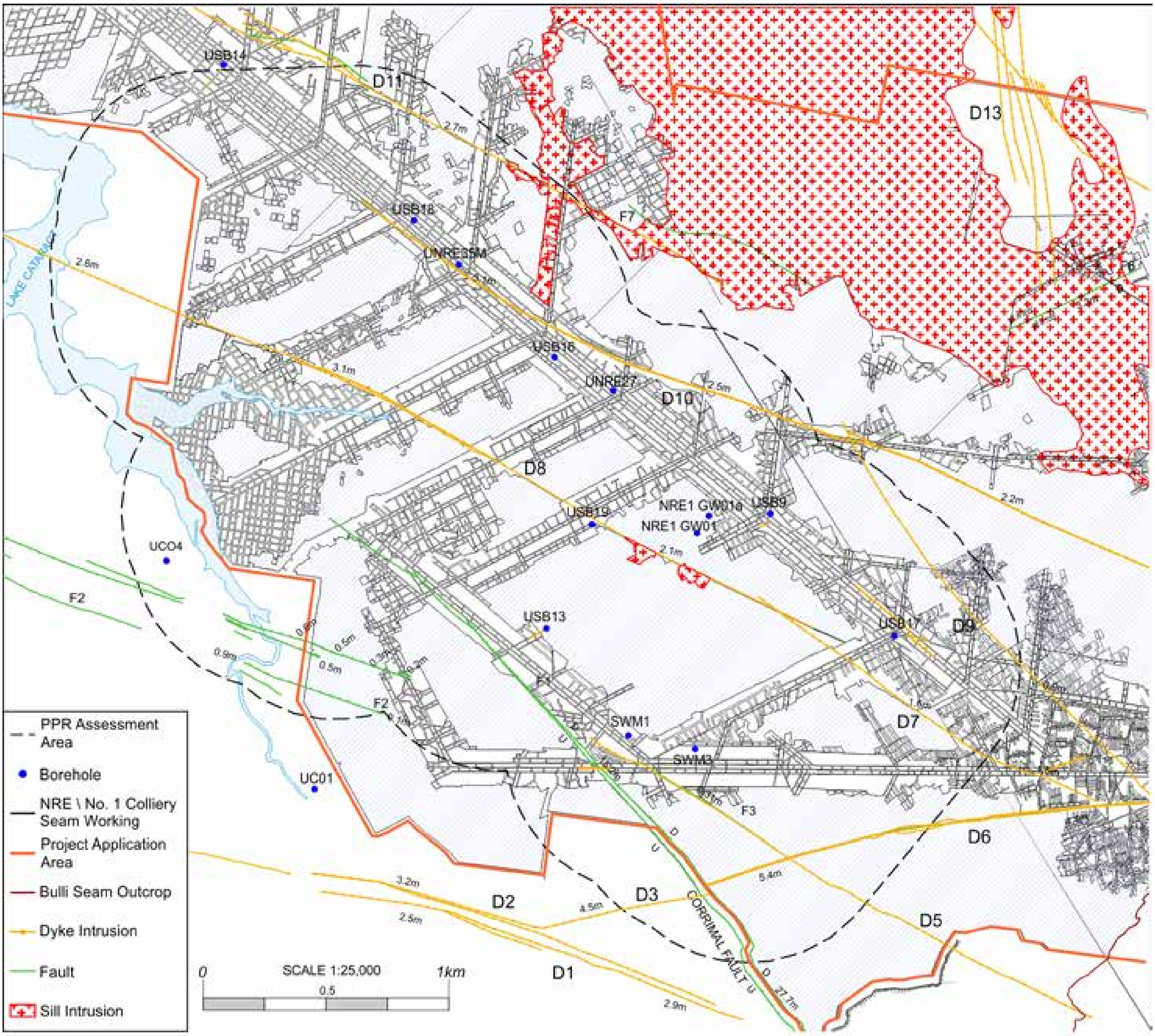


Figure 6: Plan showing geological structures and the extent of mining in the Bulli Seam level. (reproduced from Figure 14 of Clark 2013)

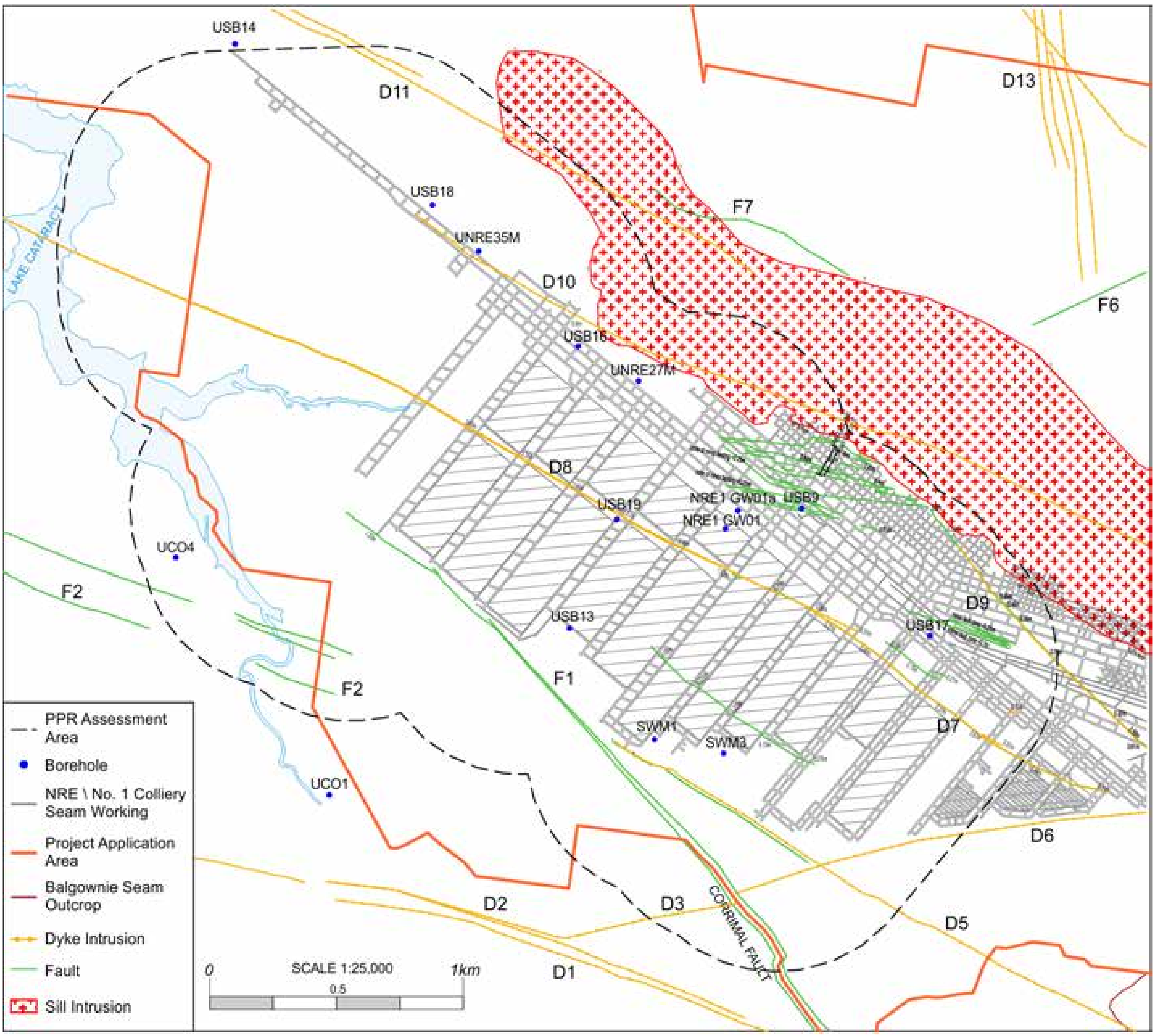


Figure 7: Plan showing geological structures and the extent of mining in the Balgownie Seam level. (reproduced from Figure 15 of Clark 2013)

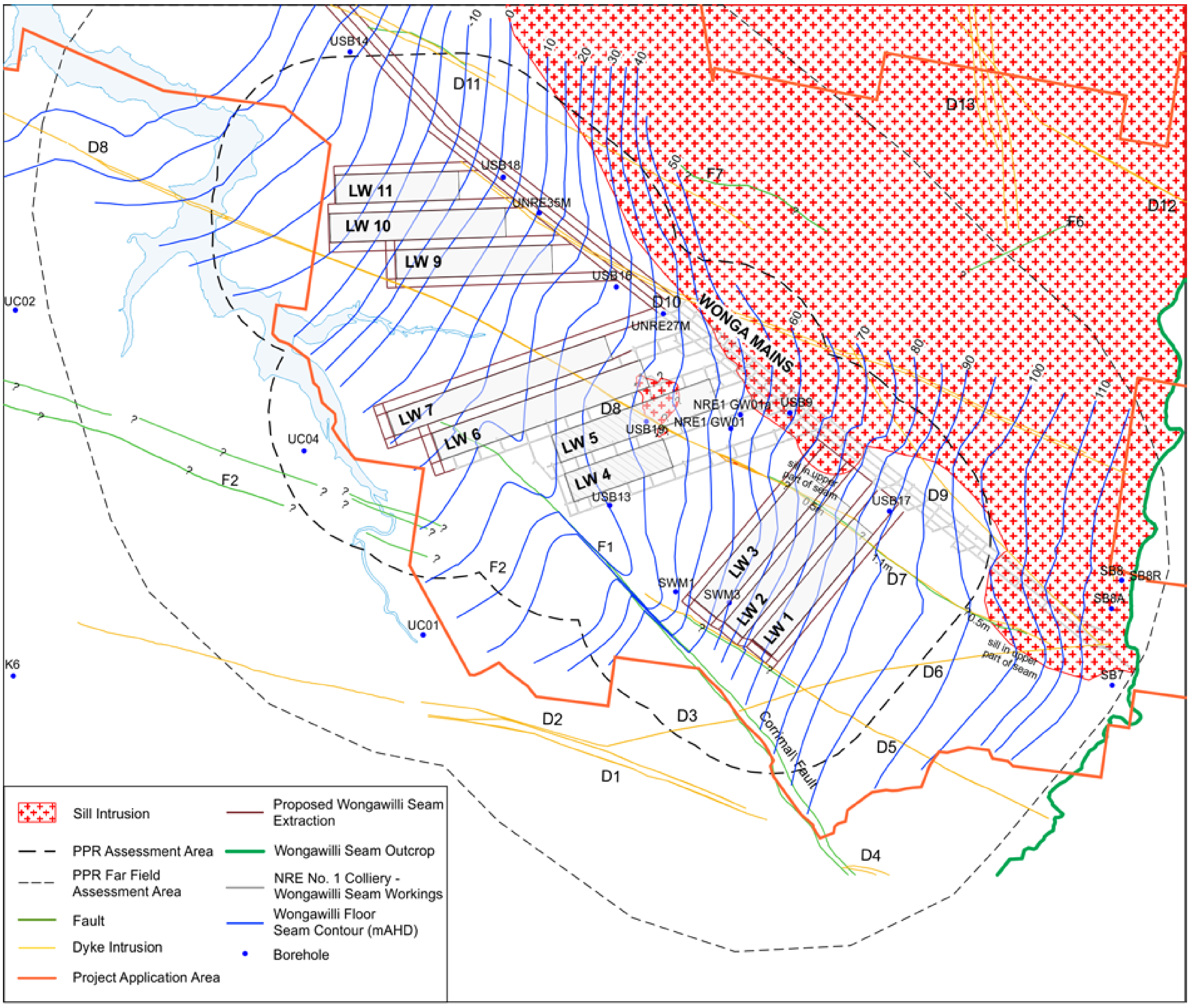


Figure 8: Plan showing geological structures in the Wongawilli Seam (reproduced from Figure 17 of Clark 2013) and floor contours of the Wongawilli Seam based on floor contours in the Bulli Seam.

An igneous sill has intruded into the Wongawilli Seam to the north of the main headings and the coal in this area is cindered and unsuitable to mine. A sill forms when molten igneous rock is injected under pressure into the host strata causing it to fracture hydraulically. When the in situ stresses at the time of injection are such that the lowest stress is vertical, the hydraulic fracture that forms is oriented horizontally. The injected rock then cools to form a horizontal layer of intruded rock within the host rock.

Several dykes exist within the Assessment Area with most having a west-north-west east-south-east orientation. Dykes are the vertical equivalent of sills and form when the lowest in situ stresses at the time of injection is one of the horizontal stresses. The resulting hydraulic fracture opens against this lowest stress cutting across the host strata to form an intrusion that is vertically and laterally continuous often many kilometres in length. The dykes that have formed in the Southern Coalfield are generally less than a few tens of centimetres thick in the general strata but often increase in thickness at coal seam level where the in situ stresses are less. Dykes are usually hard to mine, dilute the coal product, cause damage to the mining equipment, and tend to be avoided where possible.

The site constraints within the Assessment Area mean that several of the proposed longwall panels will need to mine through Dyke D8. This dyke has been previously encountered in the Bulli Seam and Balgownie Seam workings and its trace is apparent in the geomorphology on the surface indicating that it is vertically continuous to the surface.

Figure 9 shows a photograph of Dyke D8 at Wongawilli Seam level where it was intersected on the longwall face at a shallow angle making it appear thicker than it actually is. Dyke D8 is approximately two metres thick in this area and fractured. Although the dyke appeared damp at the time of inspection (21/6/13), the coal seam to either side also appeared similarly damp. This dampness is considered likely to be a result of water sprays on the longwall shearer. There did not appear to be any significant seepage flow emanating from the dyke consistent with experience at almost all other dyke intersections in the Southern Coalfield.

The only major geological fault within the Assessment Area is the Corrimal Fault (F1) which extends in a north-west south-east orientation in the southern part of the Assessment Area. This fault was intersected in the overlying Bulli Seam but the longwall panels in the Balgownie Seam did not extend far enough south, although some of the headings extended to the fault and the associated dyke D5. The fault is also apparent in the surface geomorphology and so its location and characteristics are well defined. The fault diminishes to the northwest and has become insignificant where it is to be intersected by the gateroads for Longwall 6.

Other faults in the general area, the Rixons Pass Fault, the Woonona Fault, and F2 are remote from the proposed mining and are not considered likely to affect mining or to be affected in any significant way by the proposed mining.

Figure 9: Dyke D8 exposed in the face of Longwall 5 on 21 June 2013. (Note this dyke was intersected at a shallow angle so the dyke appears thicker than it is).

2.8.3 Overburden Depth

Figure 10 shows a plan of the overburden depth to the Wongawilli Seam. The overburden depth ranges from 250m above Longwalls 2 and 3 in the northern part below the southern tributary of Cataract Creek through to 390m above the central part of Longwalls 10 and 11.

The overburden depth range for individual longwall panels is shown in Table 1. The ratios of panel width to depth range from 0.37 to 0.60. In previously unmined terrain, low levels of subsidence would be expected above each individual panel with the overall maximum subsidence controlled by elastic compression of the chain pillars between panels. However, subsidence monitoring data from the recently mined Longwalls 4 and 5 and from the Balgownie Seam longwall panels indicates that the presence of overlying mine workings has the effect of softening the overburden strata so that its bridging capacity (shear stiffness) is reduced thereby increasing the maximum subsidence above each individual panel to the higher magnitudes of subsidence that have been observed. This effect is discussed in more detail in the following sections.

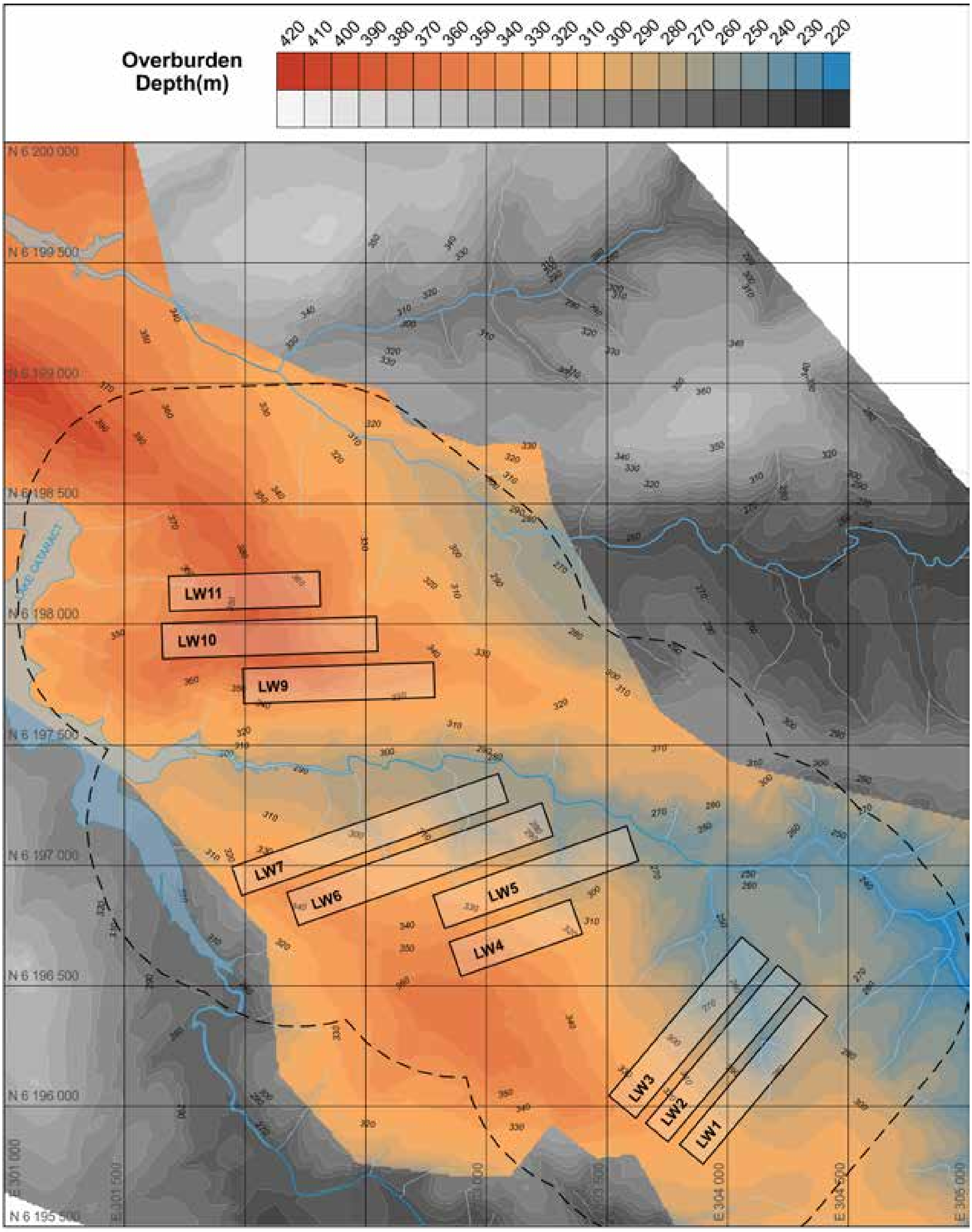


Figure 10: Depth of Overburden to the Wongawilli Seam.

Table 1: Overburden Depth Range

Longwall Panel	Panel Width (m)	Overburden Depth Range (m)	Width on Depth Ratio
1	131	255-320	0.41-0.51
2	125	255-330	0.37-0.49
3	150	250-340	0.44-0.60
4	150	300-360	0.42-0.50
5	150	265-345	0.43-0.57
6	150	270-345	0.43-0.55
7	131	270-340	0.39-0.49
9	150	330-380	0.39-0.45
10	150	335-390	0.38-0.45
11	150	350-385	0.39-0.43

3 PREVIOUS MINING ACTIVITY

A unique characteristic of the PPR Assessment Area is the presence of previous mining activity in two other seams in geometries that are unrelated to mining in the third seam. Figure 11 and Figures 6-8 show the extent of previous mining in the Bulli Seam and Balgownie Seam within the PPR Assessment Area.

This previous mining provides a number of opportunities that are not usually available in single seam mining applications but also brings a number of differences as well. Geological structure and seam contour are much better known as a result of previous mining activity than would normally be possible for single seam mining.

Previous mining activity provides an opportunity to examine the mining impacts over timeframes of 50-100 years for the Bulli Seam and 30-40 year for the Balgownie Seam mining. The subsidence movements associated with the earlier mining have been estimated for the Bulli Seam and measured for the Balgownie Seam providing a baseline of impact experience and recovery that is not typically available.

The ongoing nature of the mining operation at NRE No 1 Colliery provides the opportunity to inspect the mine workings in the Bulli Seam and the Balgownie Seam to better understand the nature of the potential interactions between seams and the potential for pillar instability particularly in the Bulli Seam to cause unexpected additional subsidence. In preparation for this report, a site visit was made on 21 June 2013 to inspect the workings in all three seams.

Subsidence monitoring data available from mining in the Balgownie Seam and more recently from two longwall panels in the Wongawilli Seam is available and this provides a basis for predicting future subsidence behaviour. This data indicates that while there are some significant differences in behaviour compared to single seam mining, the multi-seam behaviour is essentially predictable and occurs predominantly within the bounds of the panel being mined and the chain pillar to the previous panel. This data and observations of previous impacts indicate that the impacts of future mining are likely to be essentially similar in nature to the impacts that have already occurred.

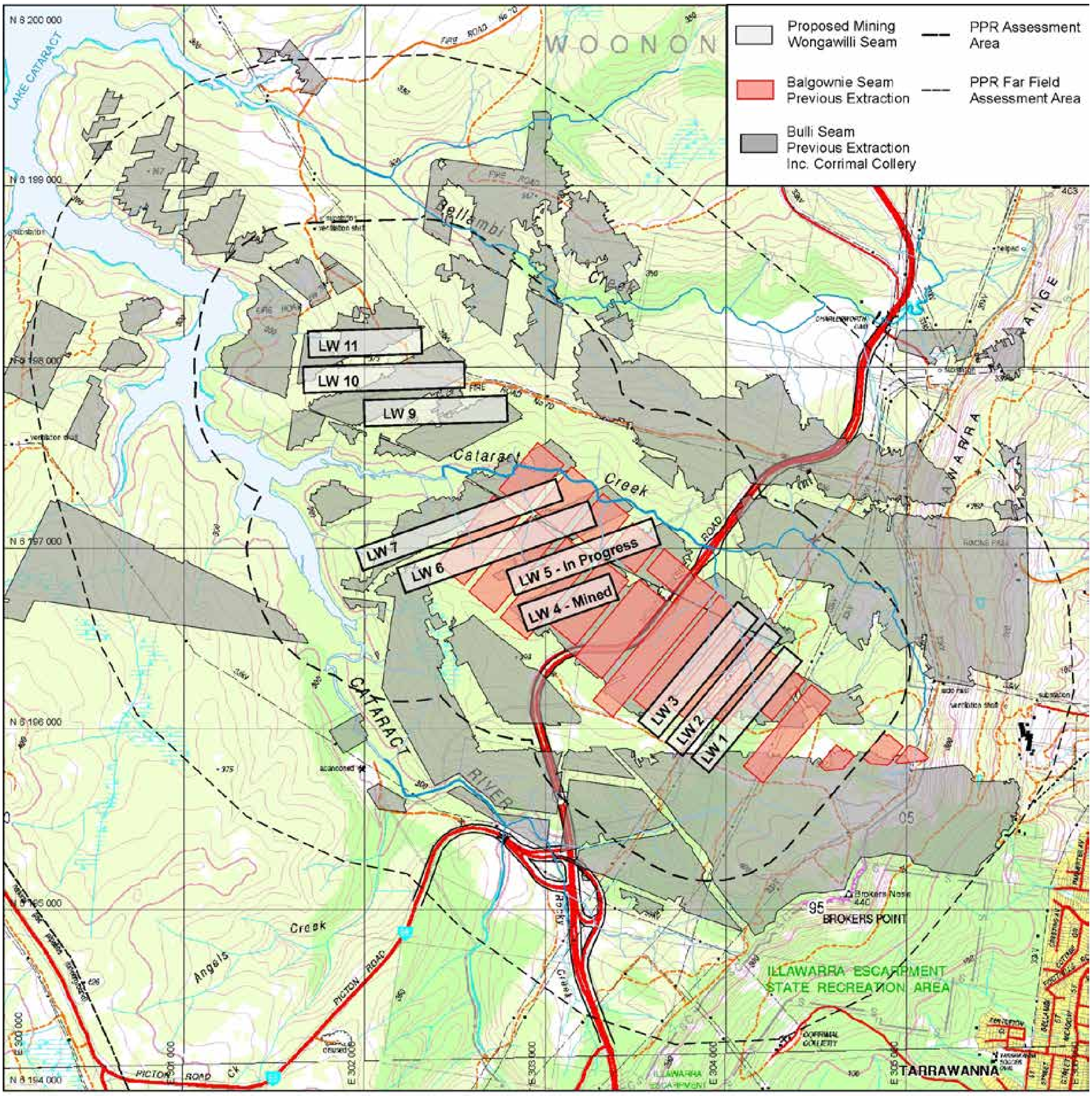


Figure 11: Plan showing extent of previous extraction in Bulli Seam (black) and Balgownie Seam (red) in the PPR Application Area.

The available subsidence monitoring data indicates that there is some softening of the goaf edge subsidence in areas where overlying seams have been mined but the effect is a second order effect and of relatively little significance in terms of subsidence impacts.

3.1 Bulli Seam Workings and Associated Subsidence

The Bulli Seam was mined initially using hand bord and pillar mining techniques from the 1890's through until pillar extraction became possible with improvements in mining technique and the arrival of mechanised mining. Some of the standing pillars associated with the main headings and original mining areas were extracted during the later stages of retreat. Mining in the Bulli Seam within the PPR Assessment Area had effectively finished by the 1950's. Areas of pillar extraction in Corrimal Colliery immediately to the south are also included in the estimation of subsidence from the Bulli Seam because they fall within the Assessment Area.

There are no known detailed subsidence records for the period of mining in the Bulli Seam. However, it is possible to estimate the levels of subsidence that are likely to have occurred given the geometry of the panels mined and estimating the likely extraction ratios.

Figure 12 shows contours of the surface subsidence in the areas where subsidence is likely to have occurred as a result of the pillar extraction operations in the Bulli Seam. This subsidence has been estimated based on subsidence monitoring results and subsidence profiles from mining in the Bulli Seam further to the west above the T and W (200 and 300 series) longwall panels at South Bulli and subsequent pillar extraction operations.

A site inspection conducted on 21 June 2013 showed that there are existing bord and pillar workings alongside the Bulli Seam main headings that are likely to be destabilised if mined directly under in the Wongawilli Seam. Similar workings were directly mined under by the Balgownie Seam longwall panels and it is clear from the underground inspection that these overlying pillars were destabilised in the area directly above the Balgownie Seam longwall goaf as shown in Figure 13. There did not appear to be any evidence that the footprint of instability extended significantly beyond the footprint of the underlying goaf, but it is considered possible that this potential may exist in some places where there are localised areas of standing pillars.

The detail of the Bulli Seam extraction is lost in some places where large areas have simply been shaded (cross-hatched) in to represent the end of mining there. These areas are likely to include different levels of mining ranging from solid coal, large standing pillars, standing pillars associated with Welsh bords, and goaf areas where there has been pillar extraction or the pillars have previously collapsed.

The downward movements that occurred during Balgownie Seam mining and were observed on the surface as subsidence provide a basis to differentiate these shaded areas where they have been directly mined under by the Balgownie Seam longwall panels. Small pillars that have been mined under by

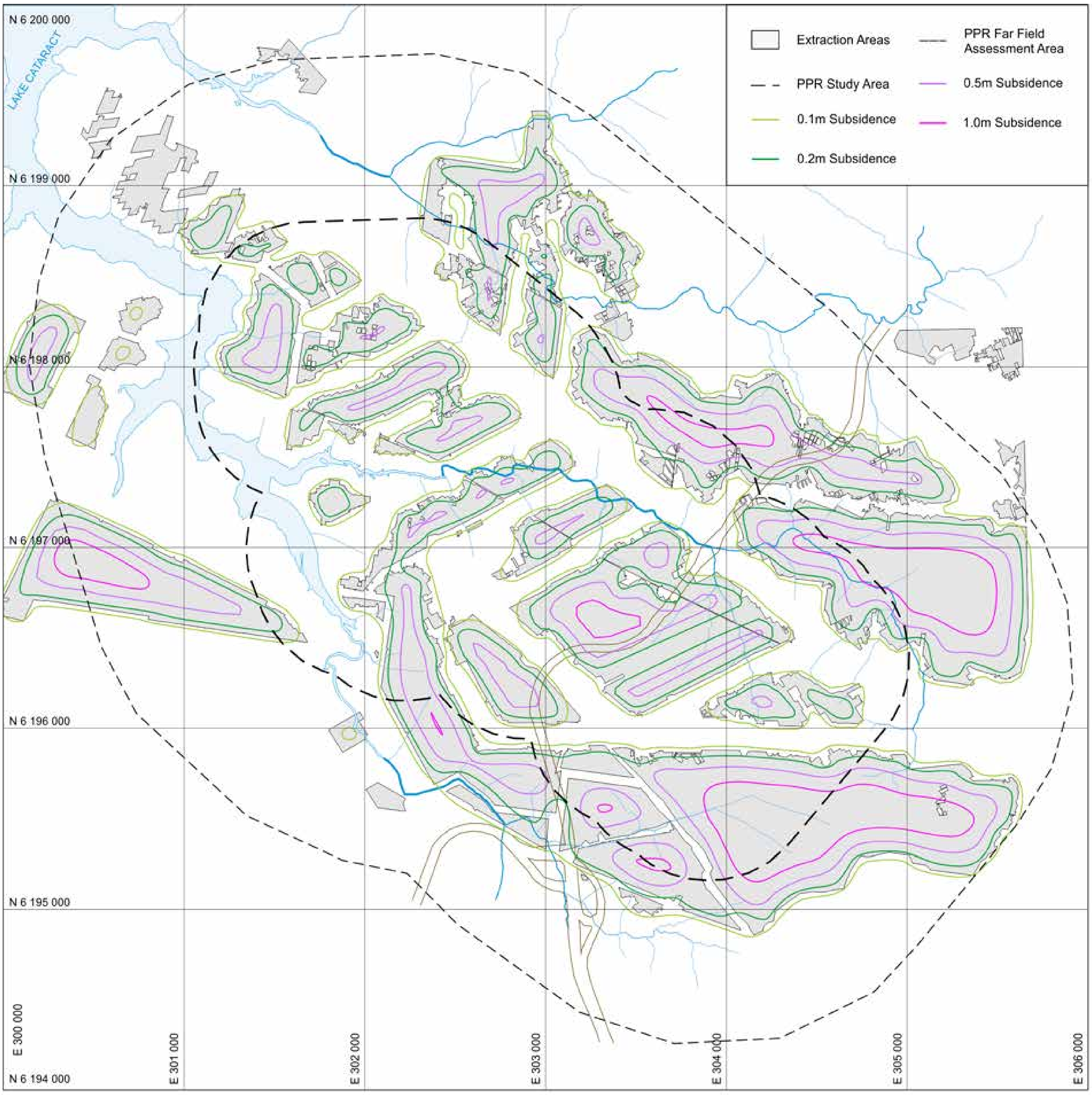


Figure 12: Plan showing estimated subsidence movements likely to have been associated with pillar extraction operations in the Bulli Seam.

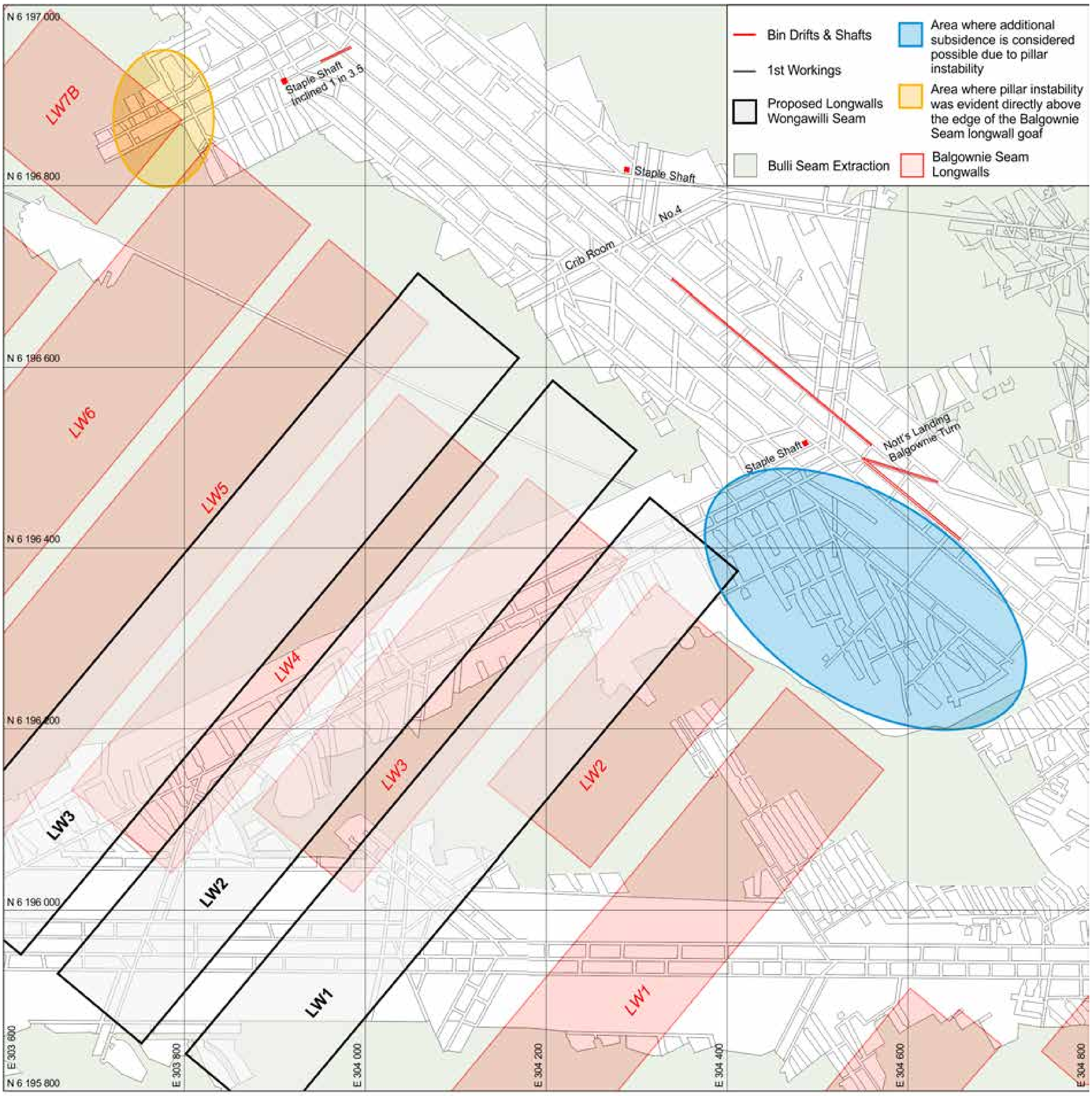


Figure 13: Plan showing areas of pillar instability in overlaying Bulli seam caused or possibly caused by mining in seams below.

the Balgownie Seam longwall panels are considered to have almost certainly been destabilised during the 1-1.5m downward movement that would have occurred as the pillars were mined under. Subsidence monitoring above the Balgownie Seam longwall panels shows areas where there has been some additional subsidence consistent with pillar instability, areas where there has been additional consolidation of an existing Bulli Seam goaf, and areas where there has been either no mining in the Bulli Seam or the Bulli Seam pillars are large enough to behave like solid coal.

The Bulli Seam subsidence estimates shown in Figure 12 include refinements based on the ground behaviour observed during longwall mining in the Balgownie Seam. Although it is not possible to interpret the characteristics of some of the other large Bulli Seam goaf areas that have not been directly mined under in the Balgownie Seam, these other large goaf areas are remote from the areas where the PPR longwall panels are proposed.

The detail of the Bulli Seam pillars is available in some areas close to the main headings as shown in Figure 13. The site visit to this area indicated that additional subsidence due to pillar instability would be possible in the area shown if Longwall 1 was extended to its full length although surface subsidence may be relatively small given the narrowness of the panel at an overburden depth of 270m. Any additional subsidence would have potential to impact on pylons on the two 33kV power transmission lines and this potential is addressed in the impact assessment for these structures.

The issue of a “pillar run” in the Bulli Seam has been raised in the Pt3A submissions. As indicated above, there is considered to be potential for a classical “pillar run” associated with pillar instability, but the geometries in the Bulli Seam and the evidence from previous mining in the Balgownie Seam make it unlikely that such an event would extend more than a few hundred metres from the goaf edge – i.e. the extent of the panel of standing pillars – and would be limited to only those areas where there are small standing pillars that have not previously been mined under in the Balgownie Seam.

However, the term “pillar run” may also be used to describe the phenomenon of elastic stress redistribution and the relatively smaller ground movements that can be associated with this redistribution. As one area is subsided, pillars become more heavily loaded, and compress slightly causing lateral migration of low level subsidence movements well beyond the limits of subsidence normally associated with single seam mining. This phenomenon is particularly common where panels are relatively narrow compared with overburden depth and surface subsidence is controlled mainly by elastic compression of the pillars between panels.

A similar process can also occur for horizontal movements as horizontal stresses are redistributed and dilation of subsiding strata causes horizontal movement in a downslope direction. Again the ground movements tend to be small second order movements that may cause perceptible low level cracking on hard surfaces such as sealed roads especially adjacent to topographic high points, but such movements are not usually significant because they tend to be of small magnitude and occur over large areas.

3.2 Balgownie Seam Workings and Associated Subsidence

Figure 7 shows the extent of the Balgownie Seam workings. There are eleven longwall panels extending to the south of the main headings. Apart from development headings, the remaining coal was recovered from three small areas of pillar extraction in the east and more recently as a panel of pillars formed up as stable first workings against the sill in the north.

Longwall mining in the Balgownie Seam started in September 1970 at Longwall 1 and finished on 27 May 1982 at Longwall 11. The first six panels were located east of Mount Ousley Road and ranged in width from 141m to 145m. The last five panels were located west of Mount Ousley Road and ranged in width from 185m to 189m. These later panels were split into two parts either side of the D8 Dyke.

3.2.1 Vertical Subsidence

Surface subsidence was monitored along the centreline of each of the eleven longwall panels and on three cross-lines. The vertical subsidence was monitored at regular intervals during panel retreat above the initial panels and less frequently during the last few panels. Surface strains were also measured during the last panel.

Figure 14 shows an example of the subsidence measured on the second cross-line that extends from the centre of Longwall 5 to the solid coal west of Longwall 11. The characteristics of the subsidence measured that are of relevance to this assessment are:

- The chain pillars are clearly evident in the subsidence profile with 0.5m to 0.75m of subsidence directly over these pillars.
- Coal left in the Balgownie Seam around the dyke is clearly evident as reduced surface subsidence.
- The maximum sag subsidence in the centre of each panel is reduced (0.2m relative to the chain pillar subsidence) in areas where the panels are narrower compared to (0.5m above the wide panels).
- The sag subsidence is much less in areas where there are Bulli Seam main heading pillars.
- The subsidence is greatest (1.42m) over Longwall 10 in an area on the fringe of Bulli Seam goaf where full subsidence was prevented during mining of the Bulli Seam by the presence of solid abutment coal or marginally stable pillars were destabilised.
- Surface subsidence is occurred essentially within the geometry of the Balgownie Seam longwall panels.
- The goaf edge subsidence is greater and extends further when there is overlying Bulli goaf, but this effect is a second order effect and the subsidence beyond the goaf edge is not significantly different to goaf edge subsidence that would be expected in a single seam operation.

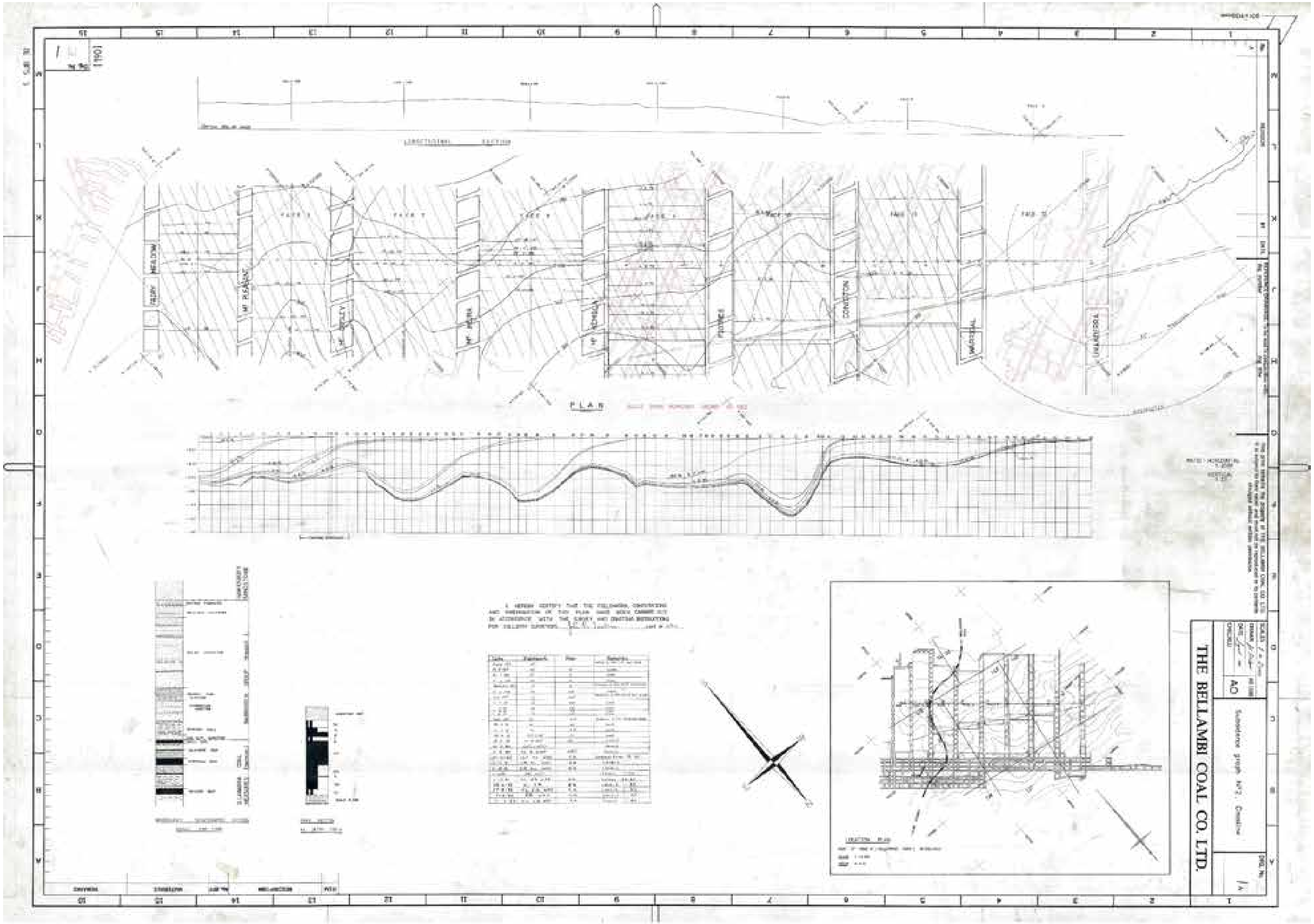


Figure 14: Example of subsidence monitoring of Balgownie Seam longwall panels

These different characteristic behaviours have been considered for each of the subsidence lines and the maximum subsidence observed is able to be used to characterise the condition of the Bulli Seam goaf above.

Figure 15 shows the maximum subsidence observed for each of the longwall panels. The different areas can be differentiated as shown in Table 2 based on where there are pillars and goaf in the two seams.

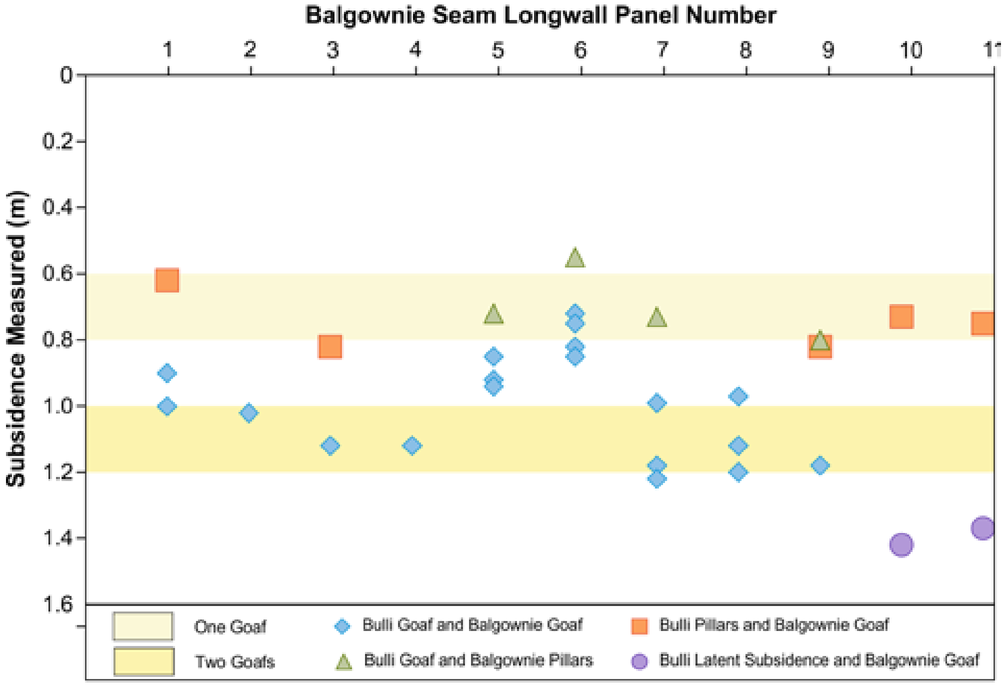


Figure 15: Maximum subsidence observed for each longwall panel in the Balgownie Seam.

Table 2: Subsidence Observed in Different Conditions

	Bulli Seam Pillars	Bulli Seam Goaf	Unstable Bulli Pillars
Balgownie Seam Pillars	Low level subsidence (<0.2m)	0.6-0.8m	Low level (<0.2m)
Balgownie Seam Goaf	0.6-0.8m	1.0-1.2m	1.4m

In areas where there are Balgownie chain pillars and pillars in the Bulli Seam, the subsidence directly over the chain pillars is less than 0.2m. If there are pillars in one seam and extraction in the other seam, there is between 0.6m and 0.8m of subsidence. Where there has been extraction in both seams, the maximum incremental subsidence is in the range 1.0m to 1.2m – i.e. approaching 80% of the nominal mining height of the second seam mind.

In areas where there is clearly potential for either latent subsidence because the Bulli Seam goaf is narrow and bridging (such as in the high subsidence zone over Longwall 11 in the Balgownie Seam) or along a goaf edge where full subsidence has not been able to develop during mining the first seam (such as the high subsidence zone above Longwall 10), the incremental subsidence reaches 1.4m and is of the order of 100% of the mining height of the second seam mined.

It is also possible that the 1.4m of subsidence observed is a result of pillar destabilisation of standing pillars in the Bulli Seam caused by mining in the Balgownie Seam. Up to 0.4m of subsidence would be expected from mining below pillars in the Bulli Seam plus additional subsidence in the Bulli Seam of about 50% of the 2.2m mining height given an extraction ratio of about 50%. The total subsidence would therefore be about 1.5m.

Figure 16 shows the subsidence measured during mining the Balgownie Seam based on interpolation of the subsidence monitoring data. This data represents the incremental subsidence associated with mining the Balgownie Seam given that all the Bulli Seam subsidence had already occurred prior to the subsidence pegs being installed.

Maximum subsidence is 1.42m and 1.33m over Longwalls 10 and 11 respectively but in most of the areas, subsidence over the longwall goafs is in the range 0.6m to 1.2m.

3.2.2 Horizontal Strains and Tilts

Maximum strains measured over Longwall 11 ranged from 3-4mm/m along the panel to peaks of 14mm/m in compression across the topographic low point of Cataract Creek and 9mm/m in tension on the slope beyond. For the maximum subsidence of 1.4m and an overburden depth to the Balgownie Seam at this location of 260m, the strain peaks measured indicate a relationship between maximum strain and maximum subsidence of:

E_{max} = 500 S_{max} / D for systematic strains and
E_{max} = 1500-2500 S_{max} / D for non-systematic strains associated with valley closure and steep topography.

These compare reasonably with the peak strain subsidence relationships presented by Holla and Barclay (2000) for the Southern Coalfield which indicate:

$E_{max\ tensile}$ = 1500 S_{max} / D
$E_{max\ compressive}$ = 3000 S_{max} / D
$Tilt_{max}$ = 5000 S_{max} / D

for peak strains and tilts that include non-systematic strains and tilts associated with valley closure and steep topography. The peak compressive strains tend to be apparent in topographic low points and the peak tensile strains tend to be apparent at the start of panels in ground sloping in the same direction as mining, and along topographic high points such as ridges.

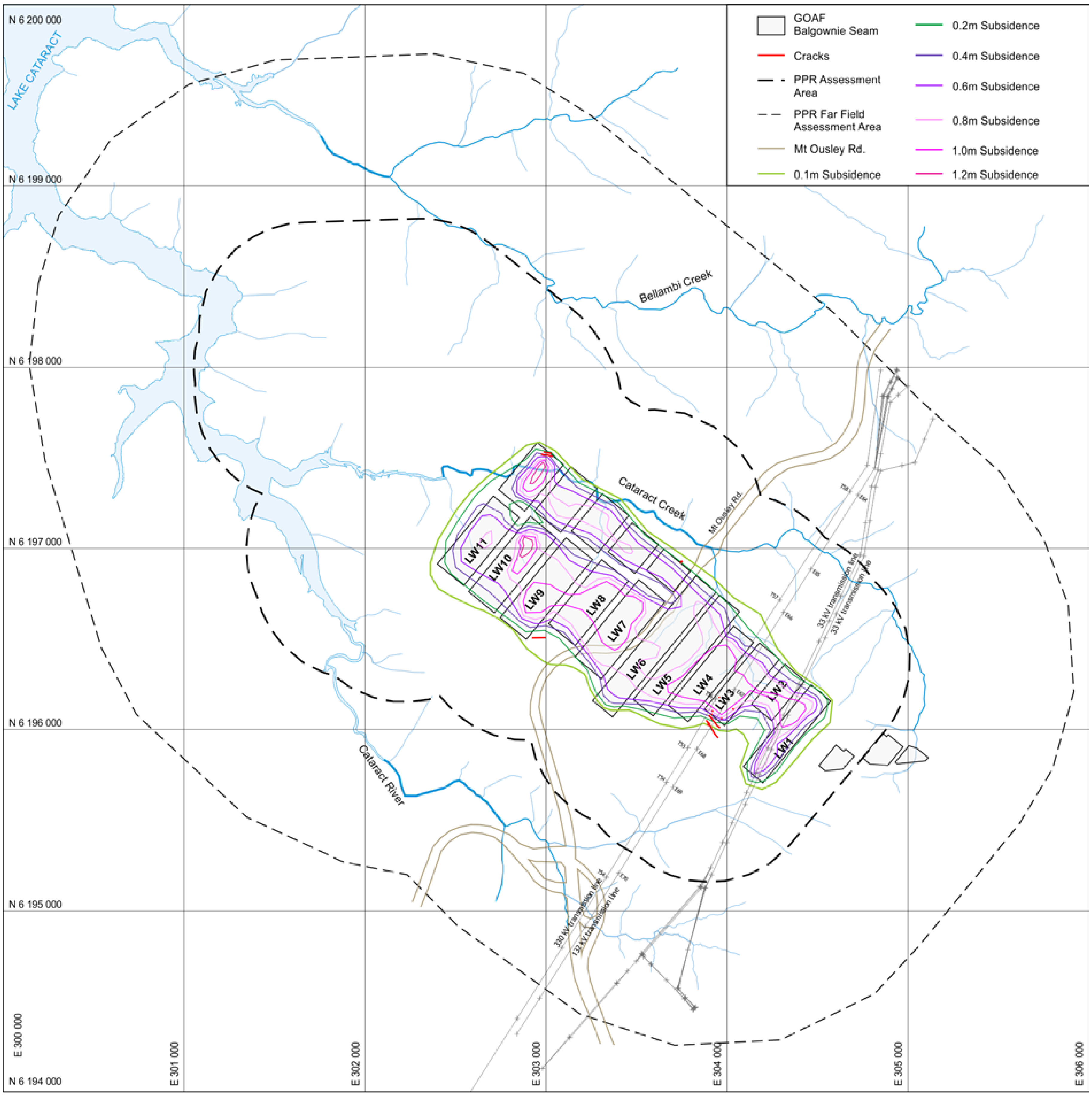


Figure 16: Contours of subsidence measured above the Balgownie Seam longwall panels.

Table 3: Comparison of Measured and Calculated Upsidence

Balgownie Longwall Panel	Distance from End of Panel (m) (negative over goaf)	Upsidence Indicated (mm) (not necessarily peak)	Overburden Depth (m)	Maximum Subsidence (m)	Calculated Upsidence (mm)
3	-170	130	230	1.1	70
4	-30	210	230	1.1	100
5	0	80	230	0.8	100
6	75	30	240	0.8	120
8	106	80	240	0.9	130
9	30	120	250	0.9	110
10	-20	100	260	0.9	100
11	-116	100	260	1.4	90

3.2.3 Valley Closure and Upsidence

The 14mm/m compressive strain peak measured across Cataract Creek on the centreline of Longwall 11 as measured between pegs spaced 18m apart and the 4mm/m strain measured between the next two pegs spaced 15m apart imply a total closure across the creek of about 310mm. The ACARP method for estimating valley closure by Waddington and Kay (2003) indicates valley closure for this geometry and level of subsidence as being of the order of 200-300mm depending on assumptions about the somewhat irregular geometry associated with the short longwall panels.

Valley closure at other locations is also evident as upsidence in the subsidence profiles that extend across Cataract Creek. The upsidence measured is summarised in Table 3.

Upsidence measurements shown in Table 3 are made at the peg locations. The pegs are 15-20m apart while the upsidence tends to peak over a distance of only a few metres. The location of the pegs may not necessarily coincide with the peak upsidence, so the measured upsidence is considered to be a lower bound estimate of the maximum upsidence that occurred. The measurements made during mining of the Balgownie Seam longwall panels indicate that Cataract Creek has already sustained upsidence in the range 100-300mm from this mining with some additional upsidence likely to have occurred during mining in the Bulli Seam.

The ACARP method for estimating upsidence for single seam mining operations indicates that upsidence from the Balgownie Seam longwall panels would have been in the range 70-130mm for each longwall panel. This method appears likely to still be relevant for estimating upper bound upsidence and valley closure for future mining activity in the Wongawilli Seam even in a multi-seam mining environment.

3.2.4 Total Cumulative Subsidence

Figure 17 shows the total cumulative subsidence estimated by adding together the estimated subsidence from the Bulli Seam and the measured subsidence from the Balgownie Seam using Surfer and a 10m by 10m grid spacing. The locations of surface features that have or may have been impacted by subsidence from this previous mining are also shown.

The total cumulative subsidence associated with mining both the Bulli Seam and Balgownie Seam is an estimate because the Bulli Seam subsidence was not measured. The total subsidence is nevertheless useful as an indicator of maximum subsidence when interpreting subsidence impacts from previous mining activity.

Maximum cumulative subsidence is approximately 1.9m in the area above Longwalls 7 and 8 in the Balgownie Seam just to the west of the Mount Ousley alignment on the slope to the south of Cataract Creek.

3.3 Historical Mining Impacts

While it is not possible to completely separate the impacts from previous mining in the Bulli Seam from the impacts associated with previous mining in the Balgownie Seam in areas where both have been mined, it is nevertheless helpful to review the impacts that have occurred previously as a basis for estimating the likely impacts of future mining.

These impacts are most evident as rock falls and surface cracking on hard rock surfaces and changes in the character of stream channels such as upsidence cracking, iron staining, and sediment infilling in areas where the stream bed has been subsided. Other features where evidence of impacts is not so apparent include Mount Ousley Road, the power transmission lines, and natural features such as swamps and other vegetation.

3.3.1 Surface Cracks

Surface cracking is reported on subsidence plans during mining of the Balgownie Seam longwall panels. The cracks reported are mainly located near the start of Longwall 3 in the open terrain of the power transmission line easement.

These cracks are located near the start of the longwall panel on a topographic ridge in an area where the combination of systematic horizontal movements at the start of the panel and horizontal movements in a downslope direction would be expected and are commonly observed. Similar cracks are likely to have occurred at other locations but most of these would be in bushland locations where they would be difficult to detect.

For instance, a linear depression opened up near the southern corner of Longwall 4 in the Wongawilli Seam during mining of Longwall 5. This depression appears to be associated with subsidence cracking. The

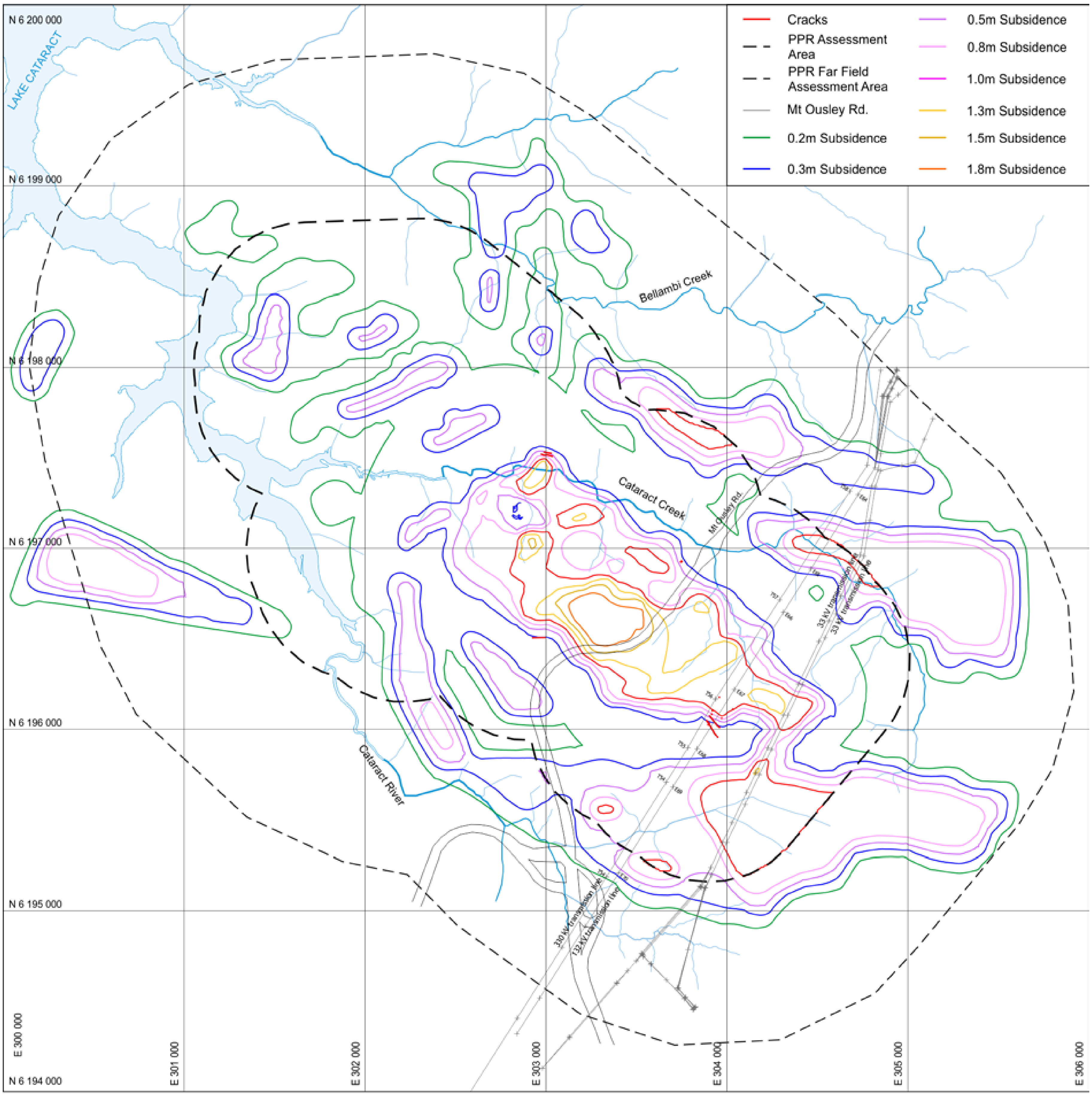


Figure 17: Contours of cumulative subsidence for the Bulli Seam and the Balgownie Seam.

depression and associated crack are located in an area where the goaf edges in all three seams are superimposed. The area is also near the top of the ridge between Cataract Creek and Cataract River where horizontal ground movements are expected to concentrate surface cracks. The ground displacement indicated by this crack is of the order of 700mm but subsidence monitoring indicates that only a small part of this movement occurred during recent mining of Longwalls 4 and 5. The implication of these measurements is that the crack occurred during previous mining but was disguised below the soil and had been substantially infilled by soil material over the period since it formed.

3.3.2 Rock Falls

An inspection of cliff formations across the PPR Assessment Area conducted during the subsidence assessment program indicates that there are several rock falls that are considered to be attributable to mining subsidence from both Bulli Seam and Balgownie Seam mining activity. These rock falls are small in volume and are barely discernable from natural rock falls that have occurred in the general area over the period since mining was completed.

A length of cliff formation located above Longwall 9 that includes archaeological site 52-2-3941 appears to have been subjected to fracturing and resultant rock falls which are likely to have been caused by subsidence associated with mining activity in the Bulli Seam. The nature of the fracturing and the age of the rock weathering appear consistent with the rock fall having occurred many decades ago.

A small rock fall of only a few cubic metres of material was also observed above Longwall 10 in the Balgownie Seam. The rock fall is located at the head of a small gully where the horizontal compression movements have been concentrated as the strata has subsided.

A rock fall located over the proposed Longwall 11 in the Wongawilli Seam was observed during a recent surface inspection. This rock fall involving several tens of cubic metres appears to have occurred from natural causes over the last few years. The site is remote from recent mining activity and there is evidence of tree root invasion at the back of the fall.

There are numerous examples of much older natural rock falls along the slopes below most of the cliff formations. These isolated boulders are consistent with the natural processes of erosion. Similar boulders are observed in areas where there has been no mining.

3.3.3 Cataract Creek

Subsidence monitoring above Longwall 11 in the Balgownie Seam indicates that Cataract Creek was subsided by greater than 0.4m over a 400m length of the creek with maximum subsidence of 1.3m over about 40m. The same length of creek is also estimated to have been subsided 0.2-0.4m during mining in the Bulli Seam.

Inspection of the bed of Cataract Creek indicates that there is almost no physical disturbance to the rock strata in the bed of the creek attributable to mining activity despite the indicated closure of 310mm. This level of closure would typically be apparent as surface cracking in Hawkesbury Sandstone strata.

Geological mapping presented in Figure 4 indicates that this section of the creek is located in outcrop of the Bald Hill Claystone and Newport/Garie Formations immediately below it. The presence of the Bald Hill Claystone is considered likely to have contributed to the lack of physical disturbance evident in the bed of Cataract Creek.

The presence of iron staining in the water of Cataract Creek is consistent with previous mining activity in the area causing disturbance to the overlying Hawkesbury Sandstone. Recent mining of Longwall 4 in the Wongawilli Seam appears to have increased the level of iron rich precipitate in the tributary leading down from the area above Longwall 4.

3.3.4 Power Transmission Towers

The power transmission towers T56 (on the 330kV line) and E57 (on the 132kV line) are located 100m and 200m respectively from the area of cracking at the start of Longwall 3 in the Wongawilli Seam and directly over Longwall 3 in the Balgownie Seam where there has been 1-1.2m of subsidence. The tower locations are noted on subsidence plans as T56 and T52 so it appears that they had been constructed prior to mining Longwall 3 in 1975. These towers do not appear to have been significantly impacted by previous mining.

3.3.5 Mount Ousley Road

The construction of the Mount Ousley Road on its current alignment appears to have taken place after mining directly below the alignment in the Bulli Seam and Balgownie Seams was complete. The Cataract deviation was opened in 1980. Bulli Seam mining was complete in the 1950's and mining in the Balgownie Seam in 1979 had progressed to Longwall 9 well to the west of the alignment.

There does not appear to have been any significant impact of historical mining on the operation of the highway although recent mining in the Wongawilli Seam has caused minor cracking on the hard surface of the Mount Ousley Road that coincides with the goaf edges of previous mining activity in the Bulli Seam suggesting the possibility of remobilising pre-existing subsidence cracks.

4. SUBSIDENCE PREDICTION METHODOLOGY

In this section, the subsidence monitoring from Longwalls 4 and 5 in the Wongawilli Seam is reviewed as a basis for predicting future subsidence behaviour. The subsidence prediction methodology is described and the accuracy and sensitivity of the method are examined.

4.1 Review of Mining in the Wongawilli Seam

Two longwall panels have so far been mined in the Wongawilli Seam. Longwall 4 is a 150m wide panel that was extracted between 21 April and 21 September 2012 and Longwall 5 is a 150m wide panel that commenced on 15 January 2013 and was still continuing at the time of writing this report. The subsidence monitoring associated with the mining of these two panels provides insight into the incremental subsidence behaviour when multiple seams have already been mined, the magnitude of subsidence movements, and the nature of surface impacts. In this section, the results of recent subsidence monitoring in Longwalls 4 and 5 are reviewed.

It is convenient to discuss the surface subsidence as comprising two components. These two components are described in detail in Mills (1998).

The first component, called sag subsidence, is the subsidence that results from the overburden strata draping down into the void created by each longwall panel. Sag subsidence increases with increasing panel width up to a maximum at a distance referred to as critical width. Sag subsidence also increases as the overburden depth reduces, as the thickness of the coal seam mined increases, and with the presence of previous mining activity in the overlying seams. Sag subsidence is essentially a measure of the capacity of the overburden strata to bridge across each longwall panel and in wide panels the vertical support able to be provided by the extracted goaf.

The second component, called elastic strata compression subsidence, is the subsidence that results from elastic compression of the chain pillar between panels and the rock strata above and below the chain pillar. The total elastic strata compression is seen on the surface as subsidence. The compression of coal in the chain pillar contributes a relatively small proportion of the total elastic compression. The rock strata above and below contributes almost all of the elastic compression subsidence. Elastic compression subsidence increases with depth from less than 100mm when the overburden depth is less than 100m to 600-800mm at an overburden depth of 400m. Elastic strata compression subsidence is function of the compression of the strata between panels and is essentially independent of the sag subsidence and the capacity of the strata to bridge across each panel.

4.1.1 Vertical Subsidence

Figure 18 shows a summary of the results of subsidence monitoring over Longwall 4 and 5 on the two centreline subsidence lines and three cross-lines, one short line, M Line, located across the chain pillar to measure elastic chain pillar compression.

At the completion of Longwall 4, the maximum subsidence in the centre of the panel was 1.3m and this represents the sag subsidence for a single panel 150m wide and about 340m deep. When Longwall 5 had mined approximately 525m (on 14 June 2013) centreline subsidence ranged from 1.3-1.5m and the centreline subsidence on Longwall 4 had increased to 1.6m consistent with elastic strata compression at the intermediate chain pillar. Subsidence monitoring on M Line indicated that the total elastic chain pillar compression was approximately 0.6m based on superposition of the subsidence measured on M Line during Longwall 5 and goaf edge monitoring observed during mining of Longwall 4.

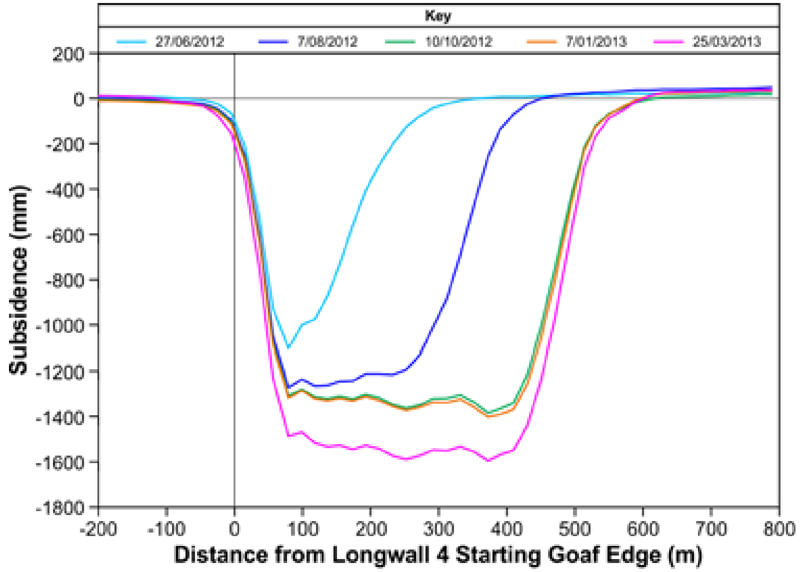
The increase in Longwall 4 centreline subsidence from 1.3m at the completion of Longwall 4 to 1.6m when Longwall 5 had been substantially mined is consistent with elastic pillar compression of 0.6m lowering the surface above one side of the panel causing 0.3m of additional subsidence in the centre of the panel. In other words, there was no increase in sag subsidence over Longwall 4. The additional subsidence is due entirely to 0.6m of elastic strata compression between Longwalls 4 and 5. The sag subsidence above Longwall 5 was 1.0-1.2m (the measured 1.3-1.5 minus half the elastic strata compression above and below the chain pillar between Longwalls 4 and 5.

Figure 19 shows the sag subsidence plotted as a function of the panel width for Longwalls 4 and 5 and the sag subsidence that is commonly observed in undisturbed strata for a broad range of panel width to overburden depth ratios. Longwall 4 is mined in an area where there is both Bulli Seam goaf and Balgownie Seam goaf above most of the panel. Longwall 5 is mined in an area where there are Bulli Seam main heading pillars that have been partly mined and Balgownie Seam longwall goaf that has been completely extracted. The difference in disturbance to the overburden strata is clearly evident in the sag subsidence results plotted in Figure 19.

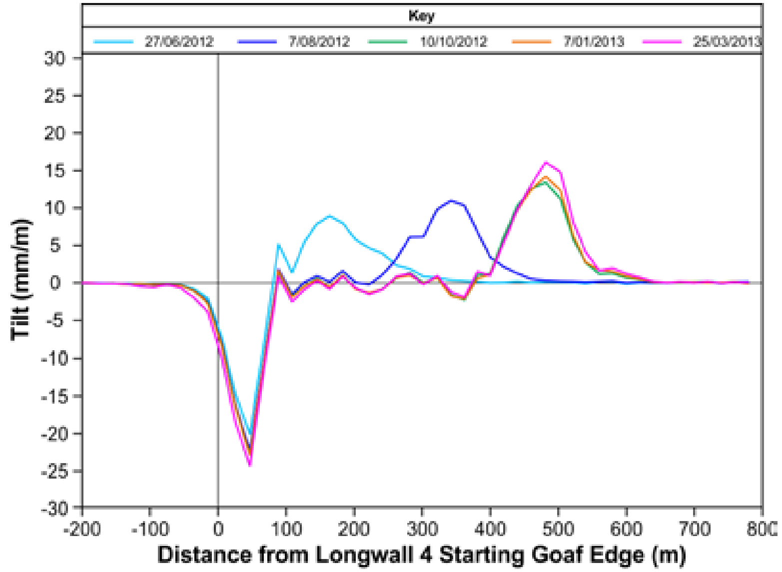
Above Longwall 5 where the Balgownie Seam has been fully extracted, the sag subsidence is significantly more than the sag subsidence that would be expected in previously undisturbed strata. Above Longwall 4, the Bulli Seam has also been mined, the sag subsidence is greater again consistent with the additional mining in the overlying Bulli Seam and the greater disturbance to the overburden strata that mining in both overlying seams has caused.

In narrow panels that depend on the overburden bridging to reduce the magnitude of surface subsidence as was the intention in the original Pt3A application, this reduction in the bridging capacity of the overburden strata has a profound effect on the maximum subsidence observed at the surface.

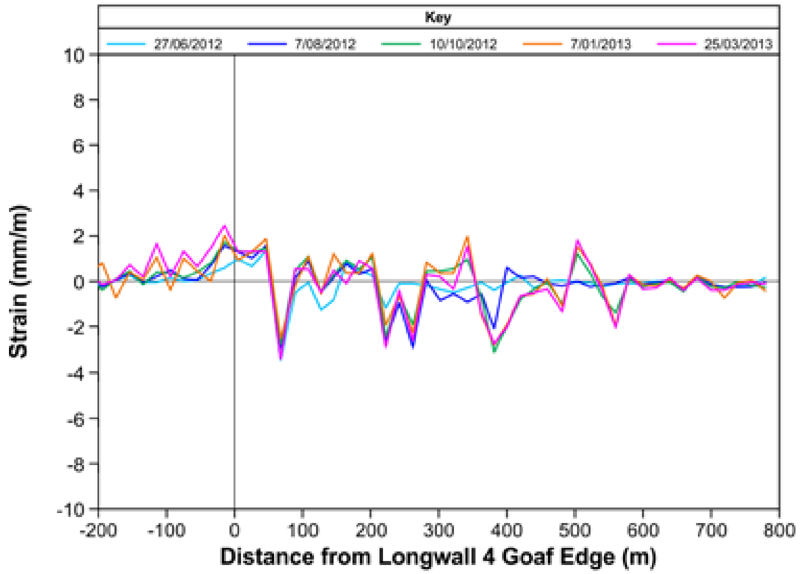
Another way to visualise the reduction in bridging capacity of overburden strata is through the goaf edge subsidence profiles. Figure 20 shows the range of goaf edge subsidence profiles observed in undisturbed strata compared to when one seam and two seams have been mined. These profiles show that as the number of seams mined increases and the disturbance to the overburden strata increases, the shear stiffness and rigidity of the overburden strata decreases. .



a) Subsidence - Longwall 4 Centerline



b) Tilt - Longwall 4 Centreline



c) Strain - Longwall 4 Centreline

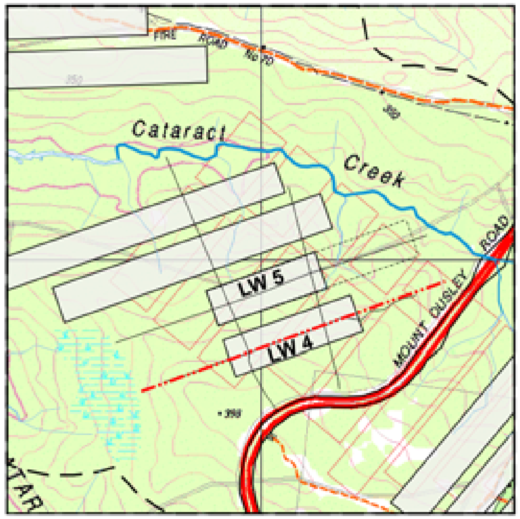
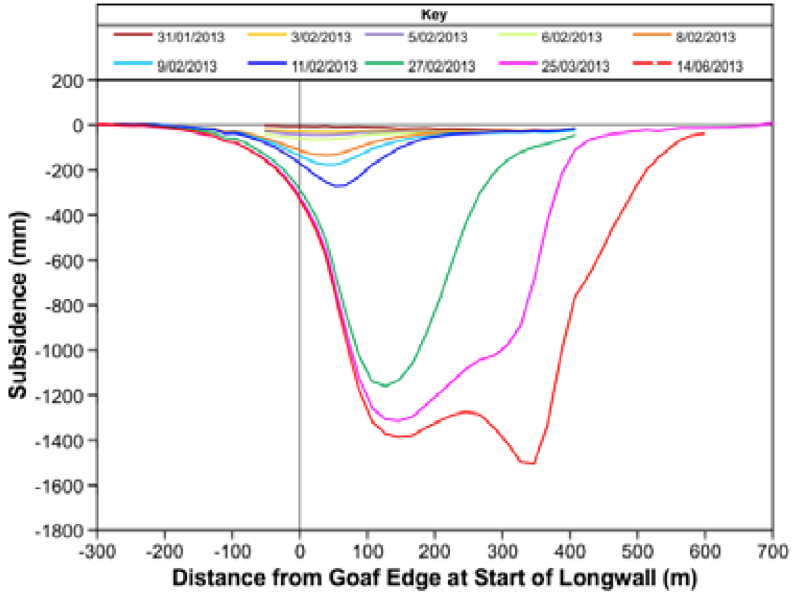
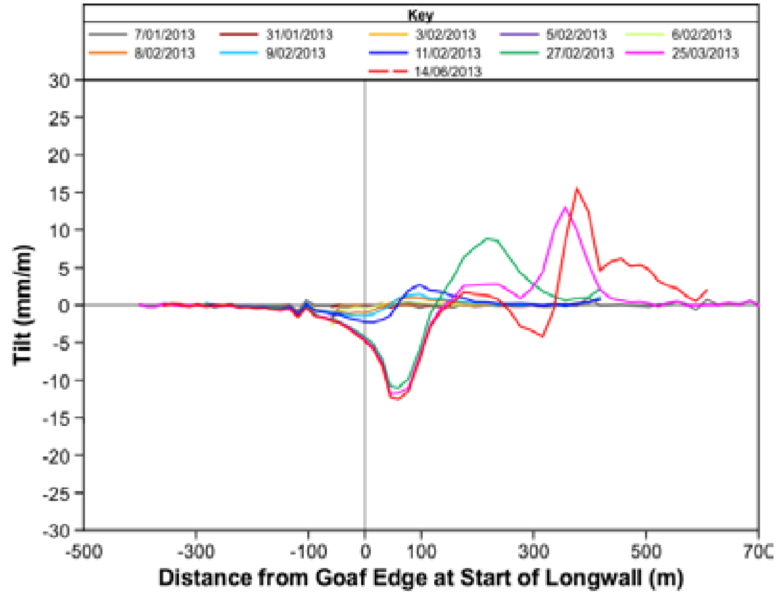


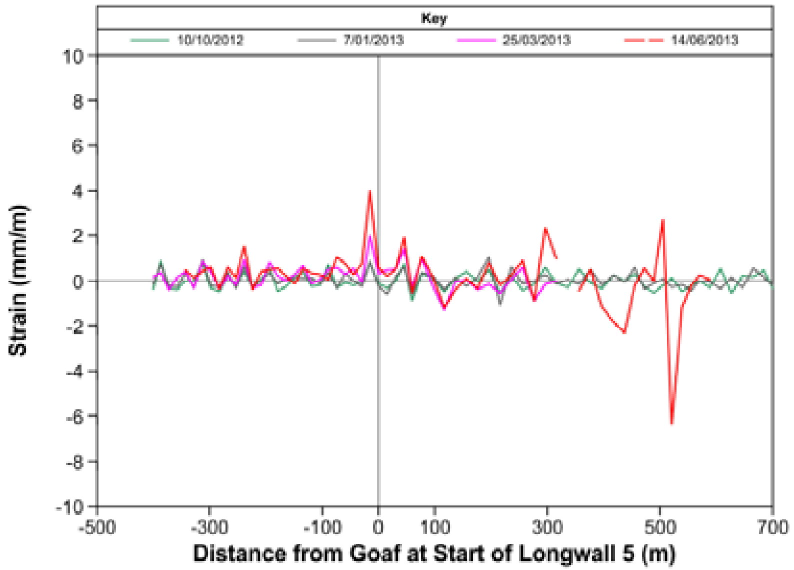
Figure 18a: Summary of Subsidence Monitoring Results from Longwalls 4 in the Wongawilli Seam.



a) Subsidence - Longwall 5 Centerline



b) Tilt - Longwall 5 Centreline



c) Strain - Longwall 5 Centreline

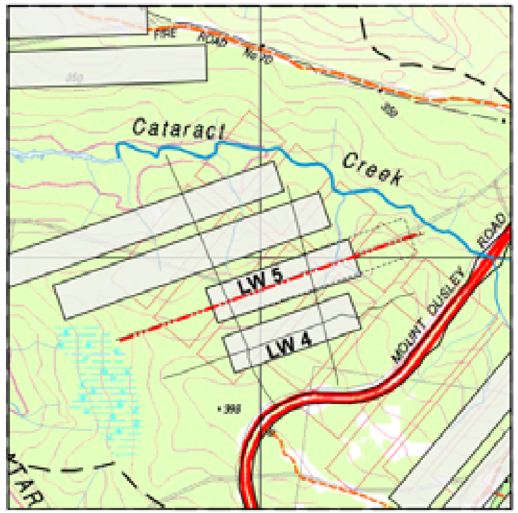
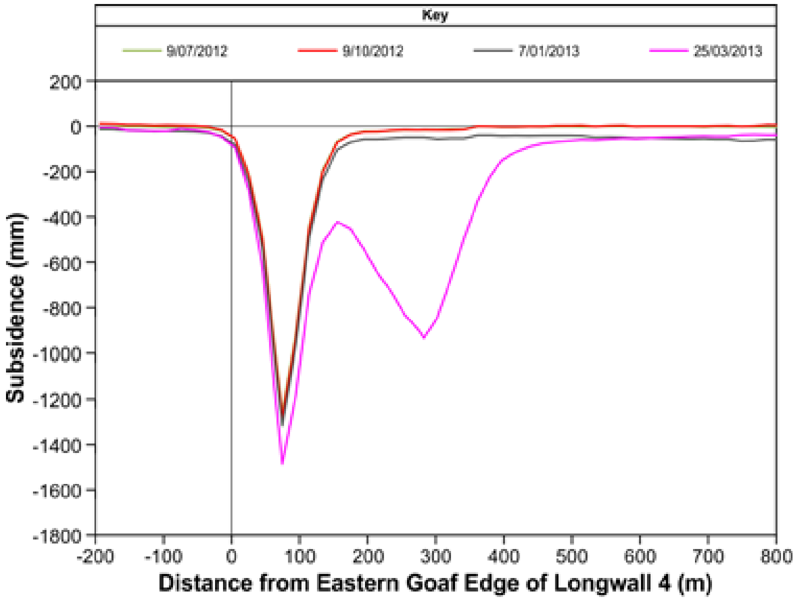
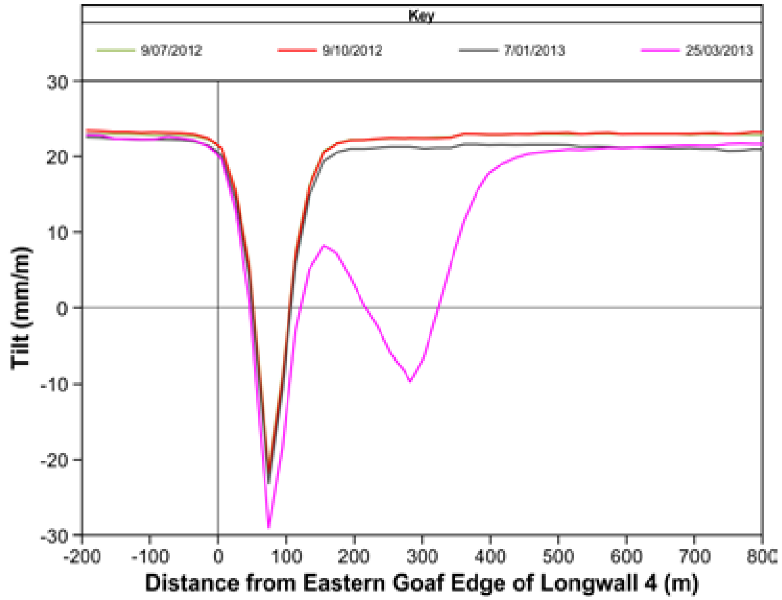


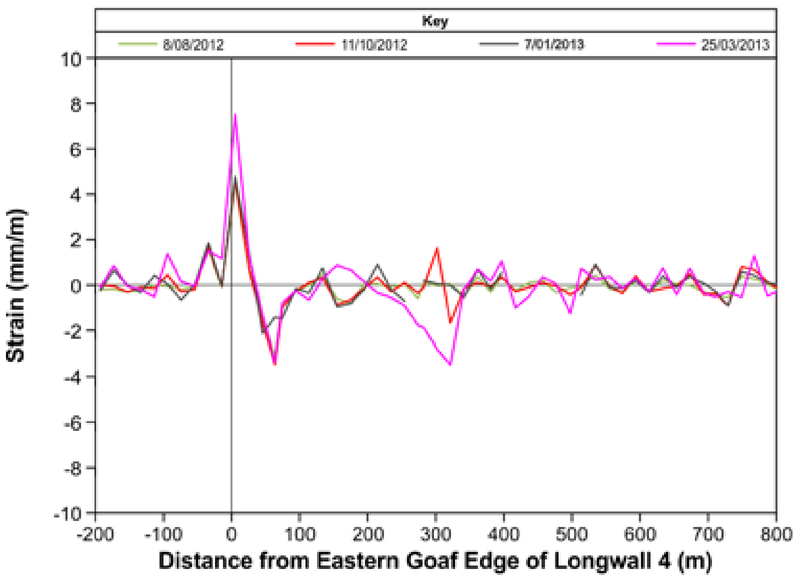
Figure 18b: Summary of Subsidence Monitoring Results from Longwall 5 in the Wongawilli Seam.



a) Subsidence - SX Cross Line



b) Tilt - SX Cross Line



c) Strain - SX Cross Section

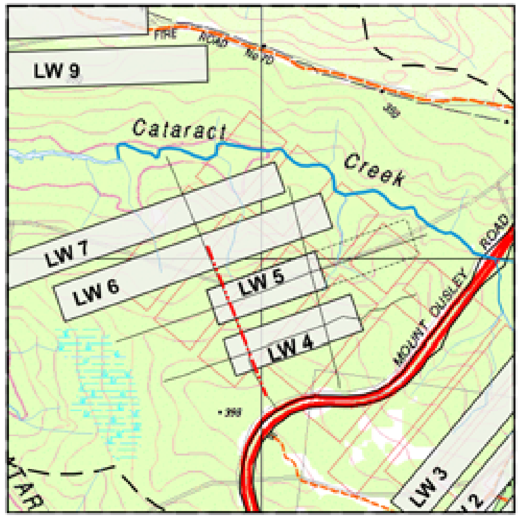


Figure 18c: Summary of Subsidence Monitoring on SX Cross Line – Longwalls 4 and 5 in Wongawilli Seam.

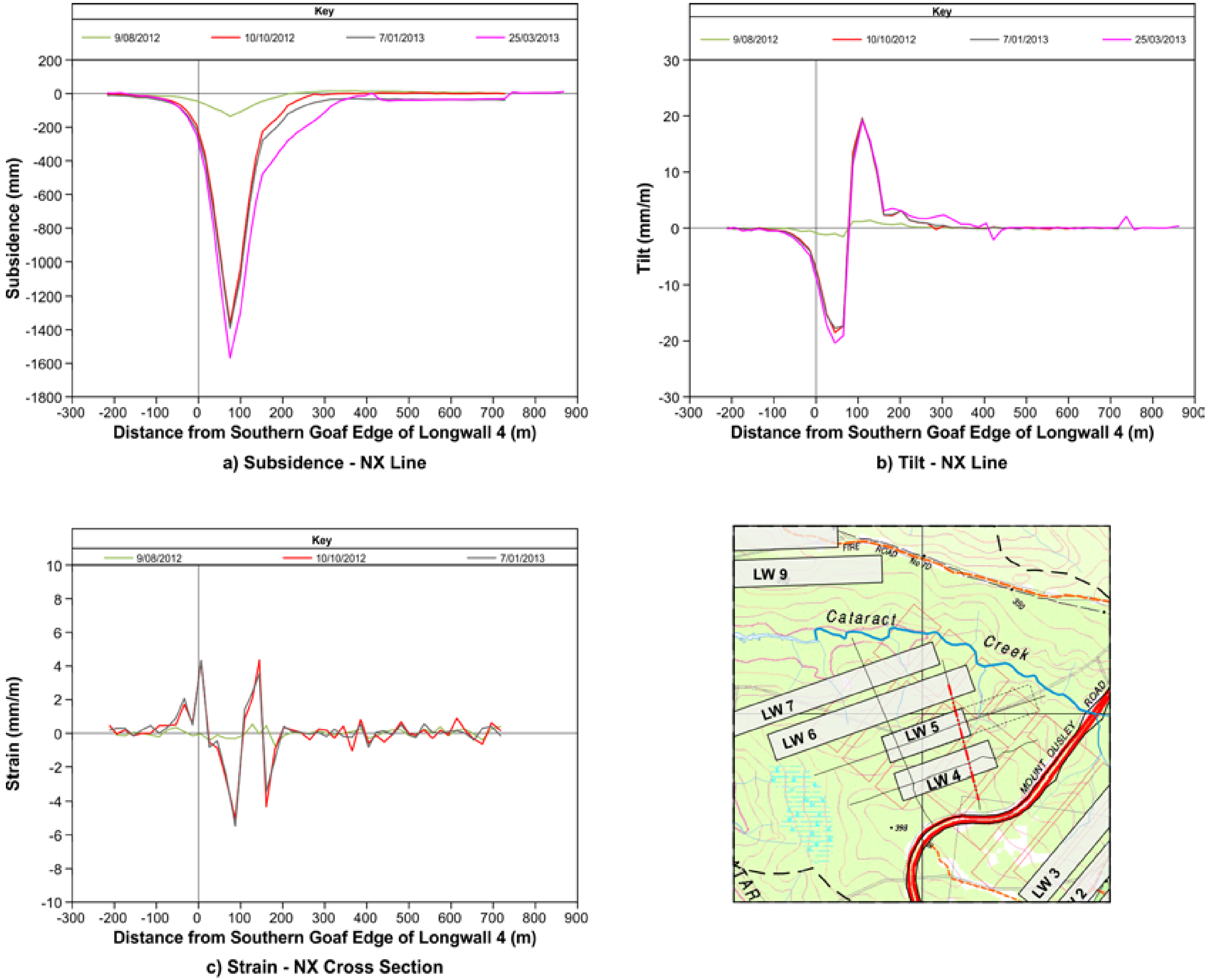
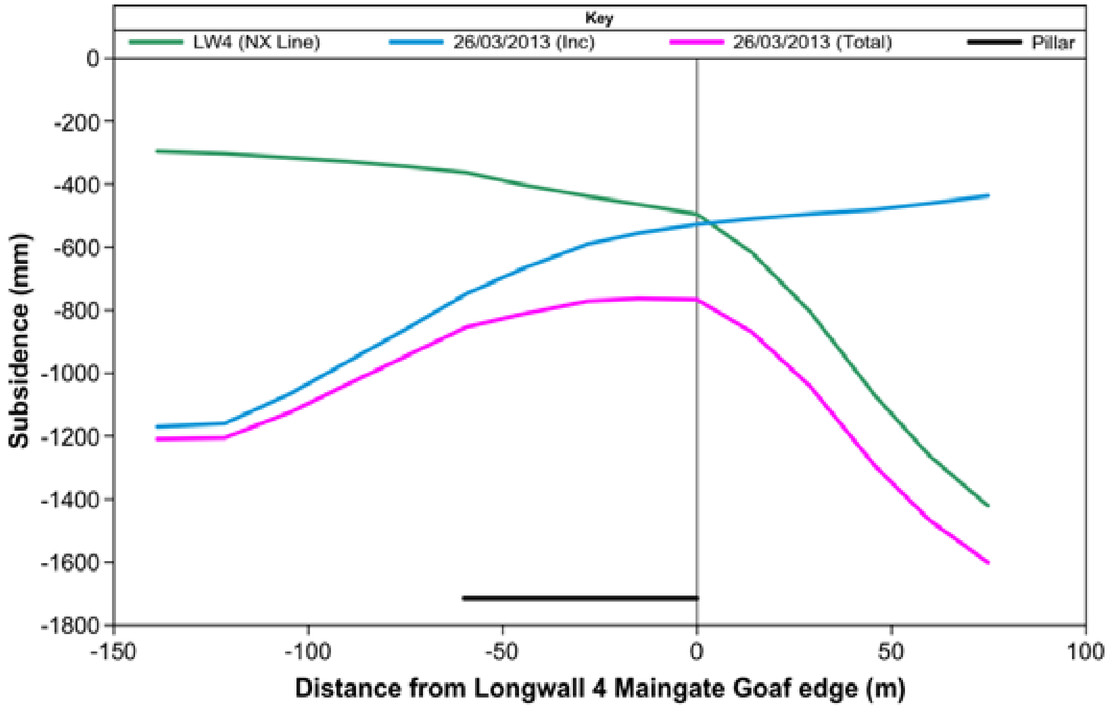


Figure 18d: Summary of Subsidence Monitoring on NX Cross Line – Longwalls 4 and 5 in Wongawilli Seam.



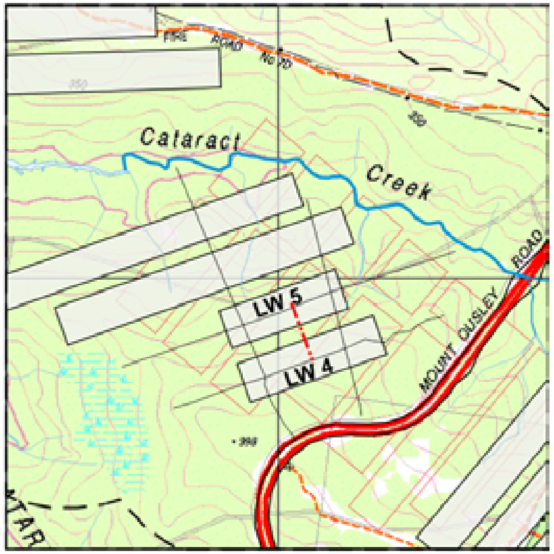


Figure 18e: Summary of Subsidence Monitoring on M Cross Line – Longwalls 4 and 5 in Wongawilli Seam.

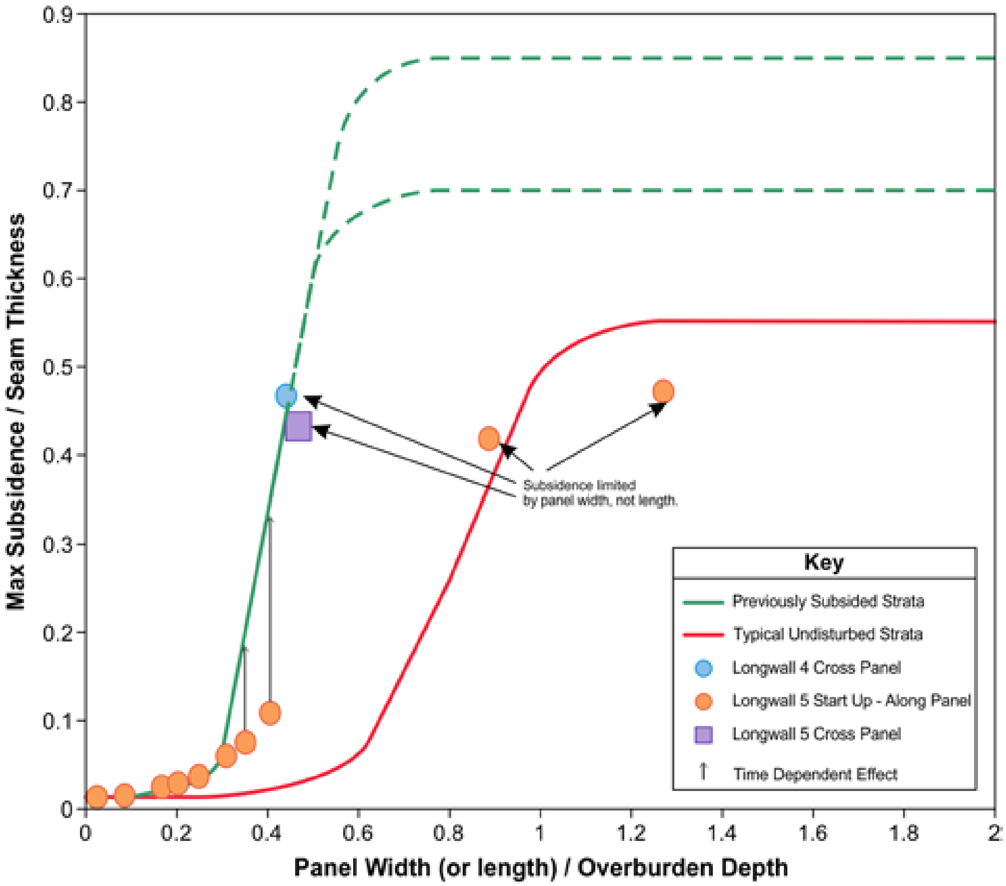


Figure 19: Summary of Sag Subsidence Measured at Start of Longwalls 4 and 5 in the Wongawilli Seam.

The profiles in Figure 20 show that the sag subsidence behaviour above multiple goafs is essentially consistent with subsidence behaviour observed over panels in single seam mining operations except that the shear stiffness or rigidity of the overburden strata is greatly diminished as a result of previous mining activity. The reduced shear stiffness leads to reduced bridging capacity of the overburden strata and significantly increased maximum subsidence for the same overburden depth and longwall panel geometry.

In previously undisturbed overburden strata, the maximum subsidence above a 150m wide longwall panel at 300-360m would be of the order of 0.1-0.3m and barely perceptible for all practical purposes. The measured maximum sag subsidence has been 1.3m because softening of the overburden strata by previous mining has significantly increased the sag subsidence.

This phenomenon was also apparent in the Balgownie Seam longwall panels located below Bulli goaf compared to when the longwall panels were mined below solid pillars as summarised in Table 2 above.

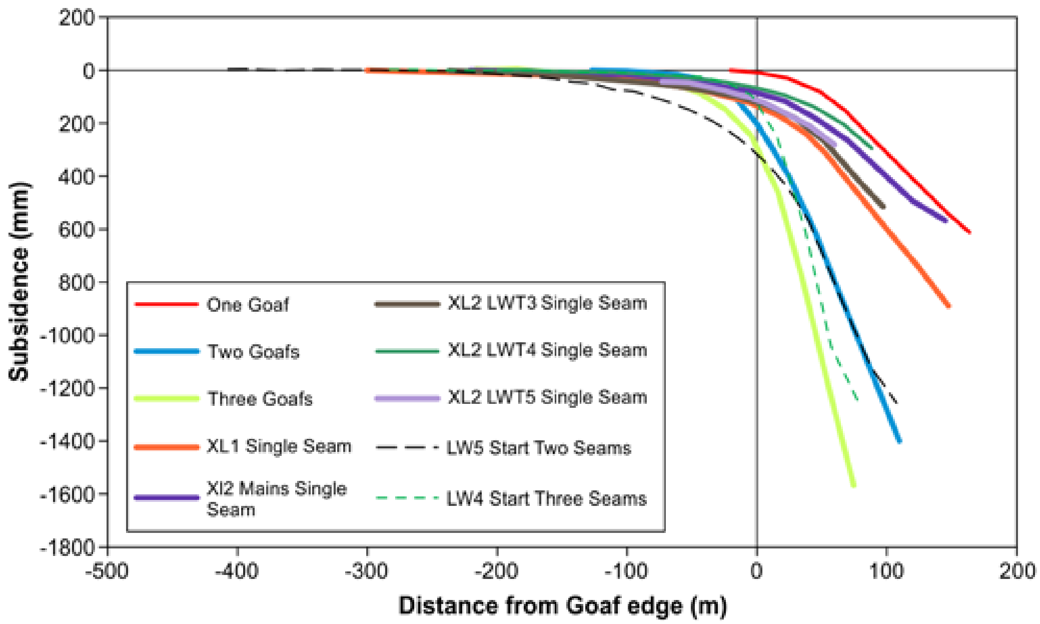


Figure 20: Summary of Goaf Edge Profiles for Mining in One, Two, and Three Seams.

Elastic pillar compression subsidence of 0.6m observed above the 60m wide chain pillar between Longwalls 4 and 5 is consistent with the level of strata compression subsidence that would be expected for the panel geometries at an overburden depth of 340m.

A significant characteristic of the subsidence observed over Longwalls 4 and 5 is that the additional sag subsidence caused by mining panels in the deeper seams is substantially limited to within the footprint of the panel, much the same as for single seam mining operations. This characteristic is clearly apparent despite the presence of somewhat variable overlying goafs. In some areas above Longwalls 4 and 5, there are overlying goafs in both seams, in others just one seam and not the other, and in other areas there are standing pillars. And yet, in all three circumstances, the surface subsidence is substantially limited to within the area that has been mined.

The form of the cross-panel subsidence profiles also indicates that maximum subsidence in the centre of each panel is not being controlled by recompression of the strata directly above the longwall goaf but rather by the disturbance to the overburden strata from previous mining affecting the ability of the overburden strata to bridge.

There are subtle variations outside the goaf edge compared to single seam mining operations. Softer subsidence profiles and greater goaf edge subsidence are evident where there are goaf areas in both the Bulli and Balgownie Seams as can be seen in Figure 21. Where there are goaf areas directly above the goaf edge in only one of the overlying seams, the subsidence profile is sharper and shows less subsidence outside the goaf. When there are no overlying goaf areas, the subsidence profile is sharpest and the subsidence profile beyond the goaf edge is essentially the same as for single seam mining geometries.

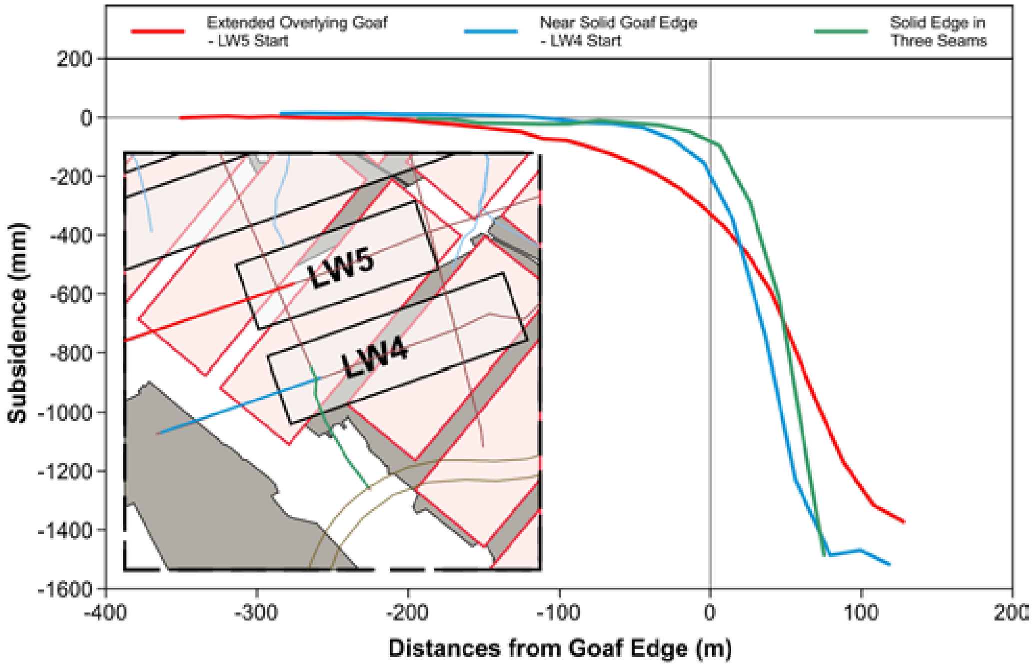


Figure 21: Goaf edge variations above Longwalls 4 and 5.

In areas where there are small standing pillars in the Bulli Seam above the goaf edge, there exists the possibility that mining in the Wongawilli Seam below will cause these pillars to be destabilised. If the pillars were destabilised, the resulting subsidence from the pillar destabilisation could then extend outside the Wongawilli Seam goaf edge to the edge of the overlying pillar panel in the Bulli Seam.

There has been no evidence of this type of behaviour so far from longwall mining in the Wongawilli Seam or in the Balgownie Seam but there is considered to be some opportunity for additional subsidence during mining of Longwall 1. A panel of Welsh bords was visited during the site inspection on 21 June 2012 in an area of the Bulli Seam immediately above and to the northeast of the end of Longwall 1 as shown in Figure 13.

If this area of pillars were to be destabilised, there would be potential for the surface subsidence to extend some 100m to the northeast of the panel and up to 300m east of the eastern corner of Longwall 1, but this subsidence would only occur if Longwall 1 was mined full length and the pillars in the Bulli Seam were destabilised. Special consideration is required in this area to manage this potential.

4.1.2 Extent of Vertical Subsidence Outside the Panel

Survey measurements conducted along the edge of the northbound lane of Mount Ousley Road have measured the influence of multi-seam mining based on the distance from the goaf edge providing evidence that vertical subsidence diminishes to low levels a short distance beyond the goaf edge.

Figure 22 shows a summary of the vertical subsidence measured along Mount Ousley Road during mining of Longwall 4. The projections of adjacent

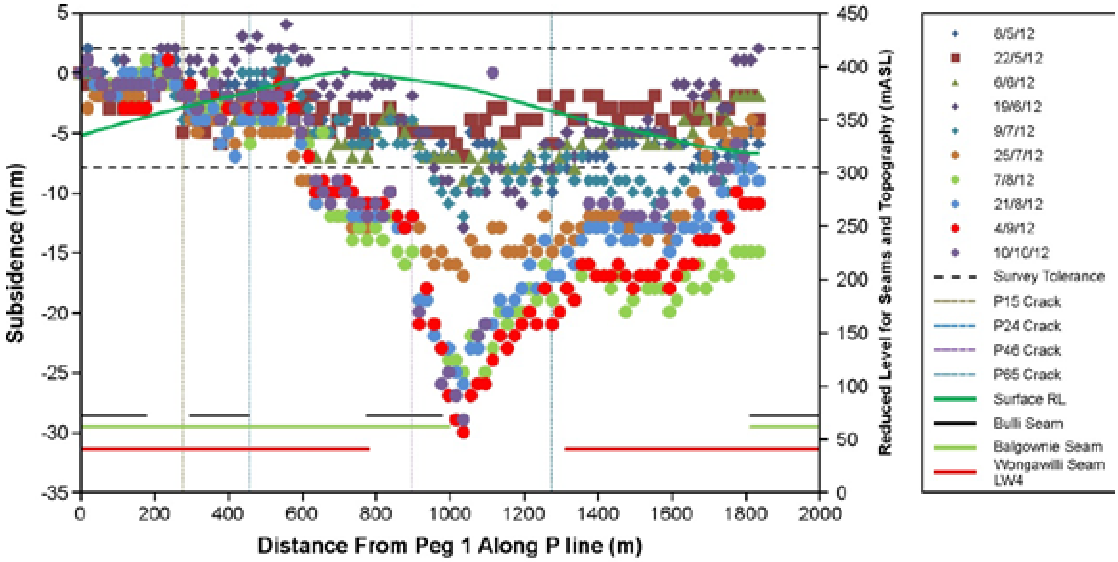


Figure 22: Subsidence measured on P Line along Mount Ousley Road during mining of Longwall 4 in the Wongawilli Seam and Relationship to Mining Geometries in the Bulli Seam, Balgownie Seam, and Wongawilli Seam.

goaf areas in the Bulli, Balgownie, and Wongawilli Seams are also shown. The subsidence observed is of low level reaching a maximum of 31mm at the projected centre of Longwall 4 some 180m from the goaf edge at an overburden depth of 350m.

These measurements indicate the angle of draw to 20mm of subsidence is greater than 26.5° consistent with experience elsewhere in the Southern Coalfield at this overburden depth. At the projection of the north-eastern corner of Longwall 4 where both the Bulli Seam and the Balgownie Seam have been mined, subsidence at 230m from the goaf corner is 20mm at 320m deep indicates the angle of draw to 20mm off the corner of the panel is equal to 35°. At the south-eastern corner of Longwall 4, where the Balgownie Seam has not been mined but there are areas of mining in the Bulli Seam, the 14mm of subsidence at 225m at 360m overburden depth indicates an angle of draw off the corner of the panel of less than 32°.

Other cross line measurements indicate the vertical subsidence is 50mm at between 20m and 100m from the goaf edge.

On the basis of these measurements, the angle of draw to 20mm of subsidence is considered likely to be slightly greater than 35° in areas where both overlying seams have been mined and slightly less than 35° where only one overlying seam has been mined. The angle of draw is therefore not significantly different to the angle of draw that would be expected for mining in a single seam at similar overburden depths. There does not appear to be any evidence of significant vertical subsidence outside the panel being mined associated with any type of pillar run.

4.1.3 Far-Field Horizontal Movements

There are several sources of far-field horizontal subsidence measurements available from mining Longwalls 4 and 5. The Mount Ousley Road P Line and Picton Road Interchange provide measurements of horizontal movements based on three dimensional GPS controlled surveying and the closure measurements across Cataract Creek provide an indication of the horizontal movement in the middle distance. Observations of cracks on Mount Ousley Road provide an indication of the horizontal distance that changes potentially associated with mining have been observed.

The GPS controlled surveying does not show any convincing evidence of far-field horizontal movements. The survey tolerance of the systems being used is ±20mm. The monitoring at Picton Road Interchange is approximately 1300m from the southern end of Longwall 4 and there is no evidence that there has been any differential or even total movement at the interchange associated with mining Longwalls 4 and 5.

Figure 23 shows the closure measurements on Cataract Creek up until the end of August 2013. Closure measurements across Cataract Creek first became evident at three of the four measurement points when Longwall 5 was 450m from the finishing end of the panel (i.e. at longwall chainage CH450m). The longwall face at this position was approximately 320m from CC4, 420m from CC2, 530m from CC1, and 700m from CC3.

At Cataract Creek where the measurement points are located, the overburden depth to the Wongawilli Seam is approximately 280m, so the horizontal closure movements have been observed out to a distance from the goaf edge equal to between 1.1 and 2.9 times depth.

The closure measured on the Cataract closure lines has steadily increased to about 20mm at CH205m (250m from CC1) as Longwall 5 has continued to retreat. These measurements indicate that far-field downslope movements have been evident to a distance of between 530m and 700m from the approaching longwall panel but are of low magnitude (less than 20mm) at a distance beyond 250m (0.9 times overburden depth).

Relatively fresh cracks that have appeared on Mount Ousley Road at P24 and P25 are approximately 500m from the southern end of Longwall 4 at an overburden depth of about 360m, so there is some evidence of small horizontal movements to a distance of about 1.4 times overburden depth.

These various observations indicate that while there are small far-field movements evident from the longwall mining conducted so far in the PPR Assessment Area, these movements are of low magnitude and decrease with distance from mining

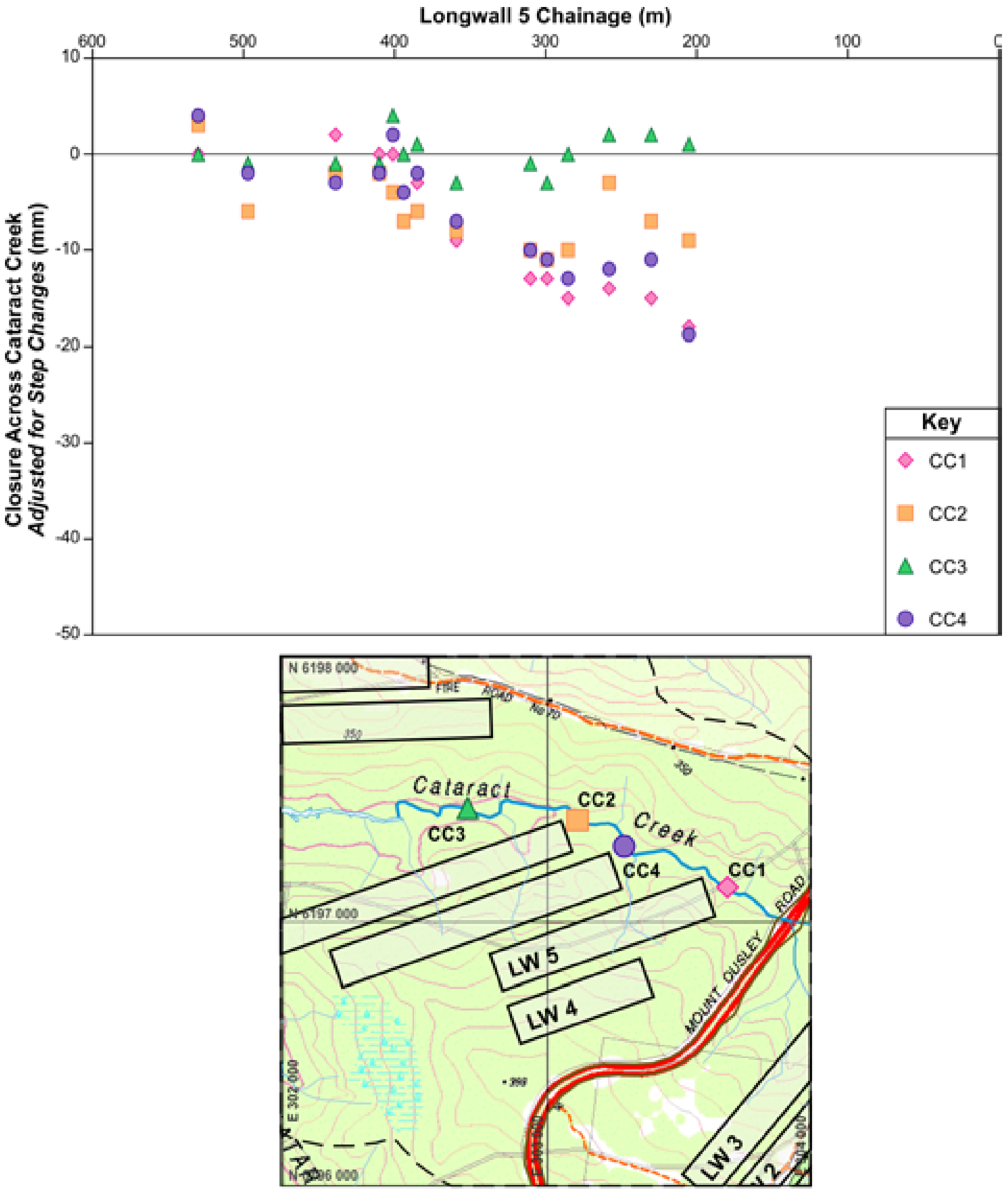


Figure 23: Closures observed across Cataract Creek to 29/8/2013 during mining of Longwall 5.

4.2 Subsidence Prediction Methodology

The subsidence prediction methodology used in this assessment is based on consideration of the mechanics of the subsidence processes involved, particularly the differences between the two components of subsidence, sag subsidence and elastic compression subsidence and using measured subsidence profiles to characterise the subsidence behaviour and provide a basis for prediction of subsidence associated with future mining.

This approach is considered to be appropriate in the relatively complex mining environment that exists within the PPR Assessment Area especially now that there is actual subsidence data available from Longwalls 4 and 5.

The presence of mining in two other overlying seams makes the use of methods such as the Incremental Profile Method which relies on repeatable elastic superposition of goaf edge profiles and the Influence Function Method which assumes essentially elastic strata behaviour somewhat unreliable because of the complex and variable characteristics of the overburden strata when mining has occurred in multiple seams.

The method used to estimate subsidence in all three seams is primarily based on existing monitoring data. Contours of subsidence for the Bulli Seam mining operations have been estimated using subsidence profiles measured in the 1990's over the longwall panels at South Bulli Colliery (now owned by NRE). These profiles have been adjusted for overburden depth and contours of subsidence have been drawn in AutoCAD relative to the edges of goaf areas indicated on mine record tracings.

The subsidence observed on the surface above the Balgownie Seam longwall panels also provides an indication of the status of the Bulli Seam mining. The Bulli Seam subsidence contours have been modified slightly to reflect this indicated status. The subsidence contours thus produced have then been converted into gridded model of subsidence values on a 10m by 10m grid using Golden Software's Surfer program.

Hard copies of measured subsidence from each of the Balgownie Seam longwall panels are available in the mine archives. These drawings have been scanned, scaled, and converted into a format that allows the final subsidence across all the panels to be contoured in AutoCAD. The contours have then been converted to a 10m x 10m grid of subsidence using the same approach described above for the Bulli Seam subsidence.

Subsidence predictions for mining in the Wongawilli Seam are based on measured subsidence profiles from Longwalls 4 and 5. These profiles have been adjusted for panel width and overburden depth and allowances have been made for possible chain pillar interactions with the overlying Balgownie Seam longwall goafs above Longwalls 1-3. The contour plots generated have again been drawn in AutoCAD and then gridded in Surfer onto a 10m by 10m grid.

The combined subsidence from each seam or from combinations of seams has then been determined by adding together the components from each seam.

Contours of the surface topography have been generated from LiDAR data on the same 10m by 10m grid to allow the subsidence to be added and subtracted from the surface topography. Contours of the three coal seams have been developed from survey information of floor seam contours available in the Bulli Seam within the mine lease boundary.

The Balgownie and Wongawilli Seam floor contours have been estimated from the Bulli Seam floor contours assuming a separation of 10m and 30m to the Bulli Seam respectively. Overburden depth to the Wongawilli Seam has been determined as the difference in the Surfer model between the surface topography and the estimated Wongawilli Seam floor contours.

Estimates of strains and tilts presented in this assessment are based on measured values and the experience more broadly of monitoring in the Southern Coalfield reported by Holla and Barclay (2000). This broader experience is considered to provide a strong basis for predicting surface strains and tilts. Based on the subsidence measurements that have been made over Longwalls 4 and 5 and previously above the Balgownie Seam longwall panels the method described by Holla and Barclay (2000) appears to provide a reasonable and conservative basis to predict the incremental maximum strains and tilts even for multi-seam mining environments.

The strains and tilts are highly variable and are generally of a much more modest magnitude than the peak values. For prediction purposes, the peak values have been determined to be conservative and recognise that the exact position of the maximum values is difficult to determine accurately. Although the exact position of peak strains is difficult to determine, it is recognised that peak tensile strains are most likely to occur at topographic high points and the start of panels, particularly in areas where mining is proceeding in a downslope direction. Peak compressive strains are most likely to occur in topographic low points or near the finishing end of the panel particularly when mining in a downslope direction.

The measurements of incremental tilts and strains made so far indicate that the background values of tilts are more generally of the order of 50-80% of the peak values and background values of strains are more generally of the order of 20-30% of the peak values indicated by the approach presented by Holla and Barclay (2000).

Closures across Cataract Creek have been estimated using the ACARP method developed by Waddington, Kay and Associates (2003). This method is recognised to be an upper limit prediction method and an alternative approach has also been used based on the increment from only the nearest panel.

4.3 Accuracy and Sensitivity Assessment

The subsidence monitoring data available from eleven longwall panels in the Balgownie Seam mined 10m below the Bulli Seam and more recent subsidence data from Longwalls 4 mining under two levels of previous mining and from Longwall 5 mining under Balgownie Seam goaf and Bulli Seam main heading pillars is considered to provide a strong basis to predict future subsidence.

The accuracy of the subsidence predictions is limited by the uncertainties that exist in a natural environment combined with additional uncertainties about the detail of mining geometries in the Bulli Seam and some aspects of subsidence behaviour in a multi-seam mining environment.

Available subsidence monitoring data from mining in the PPR Assessment Area indicates that the subsidence associated with multi-seam subsidence in this area is essentially similar to the subsidence behaviour in a single seam mining environment except that the bridging capacity of the overburden strata is significantly reduced.

This reduction in bridging capacity affects the magnitude of the maximum sag subsidence over the centre of each longwall panel. Importantly though, subsidence occurs predominantly within the footprint of the panel being mined – notwithstanding the possibility of pillar instability which is discussed separately below – and the panel width can still be used to control the magnitude of maximum subsidence. Also, elastic strata compression subsidence above the chain pillars between longwall panels appears to be of a similar magnitude to that which occurs in single seam mining operations.

Subsidence at the goaf edge is also somewhat softened by previous mining activity in overlying seams, but the effect is small and of second order significance. The angle of draw to 20mm of subsidence appears to be of the order of 35° and consistent with experience in single seam mining operations.

The uncertainties that remain from predicting subsidence behaviour in a multi-seam environment are offset somewhat by the benefits of having previous subsidence monitoring experience and the opportunity to review the longer term recovery of surface impacts associated with earlier mining activity. The ability to inspect all three levels of underground mining also improves confidence in the understanding of the mechanics involved at this site.

There exists some potential in areas where there are small standing pillars in the Bulli Seam above the goaf edge for these pillars to be destabilised by mining in the Wongawilli Seam below similar to the destabilisation that is evident in the Bulli Seam beyond the end of Longwall 7 in the Balgownie Seam. If the pillars were destabilised, the resulting subsidence from the pillar destabilisation could then extend outside the Wongawilli Seam goaf edge to the edge of the overlying pillar panel in the Bulli Seam. The only place where this type of behaviour appears credible is in an area beyond the northeast corner of Longwall 1 (see Figure 13). Special consideration is required in this area to manage this potential.

The monitoring data indicates that maximum sag subsidence is able to be controlled by the width of individual panels. It is nevertheless helpful to have an indication of the maximum credible subsidence that might result. Li et al (2010) provide a summary of the experience of multi-seam mining subsidence that indicates maximum subsidence of up to 83% of the cumulative mining height for all seams compared to 65% for single seam mining. The maximum subsidence indicated by this approach provides an upper limit to the maximum subsidence.

The combined mining height for all three seams ranges 5.4-6.9m depending on how much the thickness of the Bulli Seam is discounted to allow for the realistic recovery rates of pillar extraction and bord and pillar mining. The maximum subsidence using 85% of this thickness would be 4.6-5.8m.

Maximum subsidence of up to 1.4m has so far been observed above the Balgownie Seam with an additional 0.5m estimated for the Bulli Seam to give a maximum of 1.9m of subsidence from previous mining. Using the Li et al approach would indicate maximum subsidence from mining in the Wongawilli Seam would be likely to be in the range 2.7m (allowing for the 1.9m that may have already occurred) to 5.8m (in areas of small standing pillars in the Bulli Seam that may be destabilised by further mining and are coincident with the goaf edge of Balgownie Seam longwall panels).

Above Longwalls 4 and 5, the maximum subsidence measured in the centre of the longwall panels ranges 1.3-1.6m and is therefore much less than the maximum subsidence that would be expected if these panels were wider. The subsidence observed above Longwalls 4 and 5 is significantly reduced from this maximum by the bridging characteristics of the overburden strata albeit the bridging capacity is reduced compared to undisturbed strata.

Although the bridging capacity of previously mined strata is less than the bridging capacity of previously undisturbed strata, the narrower panel widths of Longwalls 4 and 5 and the remaining longwalls proposed within the PPR are clearly still limiting maximum subsidence to well below the level that would be observed if the panels were wider and full subsidence could develop in the centre of each panel.

Strain and tilt values observed to date are within the range of predicted values using the approach presented by Holla and Barclay (2000). While it is possible that higher values of strain and tilt may be observed in isolated locations, the approach is considered unlikely to significantly underestimate strain and tilt values.

Small errors or tolerances in the data used in the assessment are not considered likely to significantly influence the accuracy of the subsidence predictions. The LiDAR surface data is expected to be accurate to a few tens of centimetres across the entire PPR Assessment Area. The Bulli Seam floor contours have been surveyed and are therefore likely to be accurate to about a metre.

The PPR Assessment Area extends beyond the mine lease boundary so the floor contours beyond the lease boundary have been extrapolated and are therefore of lower confidence, but are nevertheless considered suitable for the purposes of this assessment. There is considered to be potential for a 5-10m difference in seam separation across the PPR Assessment Area that will slightly affect the calculation of overburden depth, but not significantly.

5. PREDICTED SUBSIDENCE

In this section, the predicted subsidence parameters above the proposed Wongawilli Seam longwall panels are presented and discussed.

5.1 Vertical Subsidence

Figures 24a and 24b shows the contours of subsidence predicted above the proposed longwall panels in the PPR Assessment Area at the same scale as other diagrams and at a magnified scale. The area is also shown where special consideration of the potential for pillar instability in the Bulli Seam is recommended. Table 4 presents a summary of the predicted subsidence movements for mining in the Wongawilli Seam, as well as estimated and measured subsidence in the Bulli Seam and Balgownie Seam in the area of each Wongawilli Seam longwall panel. Actual measurements from the Balgownie Seam longwalls and Longwalls 4 and 5 in the Wongawilli Seam are shown in brackets as a basis for comparison with the predictions.

Maximum subsidence over individual longwall panels in the Wongawilli Seam is predicted to range from 1.5m over the slightly narrower Longwall 7 through to 2.6m over Longwall 3 where the overburden depth is shallowest and there is overlying goaf in both seams.

5.2 Tilts and Strains

Maximum tilts over individual longwall panels in the Wongawilli Seam are expected to range from peaks of 24mm/m over Longwall 10 through to peaks of 51mm/m above Longwall 3. The peak values predicted are expected to be the maximum anywhere in the panel, most likely at goaf edges in overlying seams and in areas of topographic change in gradient. More generally across the panel, systematic tilts are likely to be in the range 50-90% of the peak values.

Maximum strains over individual longwall panels in the Wongawilli Seam are expected to range from peaks of 14mm/m over Longwall 10 to peaks of 31mm/m over Longwall 3. The peak values predicted are expected to be the maximum anywhere in the panel. More generally across the panel, systematic strains are likely to be 20-30% of the peak values.

5.3 Valley Closure

The upper limit of valley closure across Cataract Creek downstream of the Mount Ousley Road has been estimated using the ACARP Method. The predicted closure ranges up to 400mm adjacent to the ends of Longwalls 6 and 7 and up to 210mm at the end of Longwall 5. These closure estimates are recognised as being upper limit values because they are based on experience in the 70m deep gorges around Tower Colliery where the in situ stresses are much higher.

The measurements made so far during mining of Longwall 5 indicate measured closure values are much lower those predicted using the ACARP method. The closure monitoring at Cataract Creek off the end of Longwall 5 indicates closures of 20mm compared to 80mm that are predicted using the ACARP Method for the equivalent longwall face position. On this basis, although maximum closures of 400mm are predicted across Cataract Creek from mining Longwalls 6 and 7, the actual closure is expected to be significantly less than predicted by the ACARP Method. Closures of 600mm are predicted using the ACARP Method for the southern tributary of Cataract Creek above Longwalls 1-3. This section of the creek is a second order creek and some impacts are expected. The northern tributary is the main channel of Cataract Creek. This section, some of which is third order stream is remote from the proposed mining and no significant closure is expected.

Cataract River is located to the south of the longwall panels. There is considered to be no potential for significant valley closure movements along the section of Cataract River adjacent to the start of Longwalls 6 and 7. These longwall panels are located substantially on the northern side of the ridge and any downslope horizontal movements are expected to occur mainly on the northern slope toward Cataract Creek.

There is considered to be potential for valley closure across numerous first, and second order creeks where longwall panels are located directly below the slopes that lead down to these creeks and the creeks are within about 300m of the longwall panel goaf edge.

5.4 Subsidence Movements Beyond the Goaf Edge

Movement outside the goaf edge are expected to be essentially similar to the movements observed so far during mining of Longwalls 4 and 5. Vertical movements of greater than 20mm are expected to be limited to within a distance of 0.7 time overburden depth from the nearest goaf edge equivalent to an angle of draw of 35°. In areas where there has been previous mining in both the overlying seams, vertical subsidence at the goaf edge is expected to be up to 300-500mm and the goaf edge subsidence profile is expected to be general softer than elsewhere. In areas where there is either solid coal or substantial coal pillars directly above the goaf edge, goaf edge subsidence is expected to be of the order of 100-200mm.

The area of potential pillar instability adjacent to the end of Longwall 1 may cause additional vertical subsidence of up to about 0.7m over a limited area to a distance of about 300m from the goaf corner in an area where the overburden depth is about 270m.

Horizontal movements are also expected to be of low magnitude but may still be perceptible at up to 1.5-3 times overburden depth from the nearest goaf edge. These movements may be concentrated above previous goaf edges such as has been observed to date along the Mount Ousley Road. Horizontal downslope movements associated with valley closure have been observed at the site to extend ahead of mining in a downslope direction to distances ranging from 1 times overburden depth to 2.9 times overburden depth when mining below the slope.

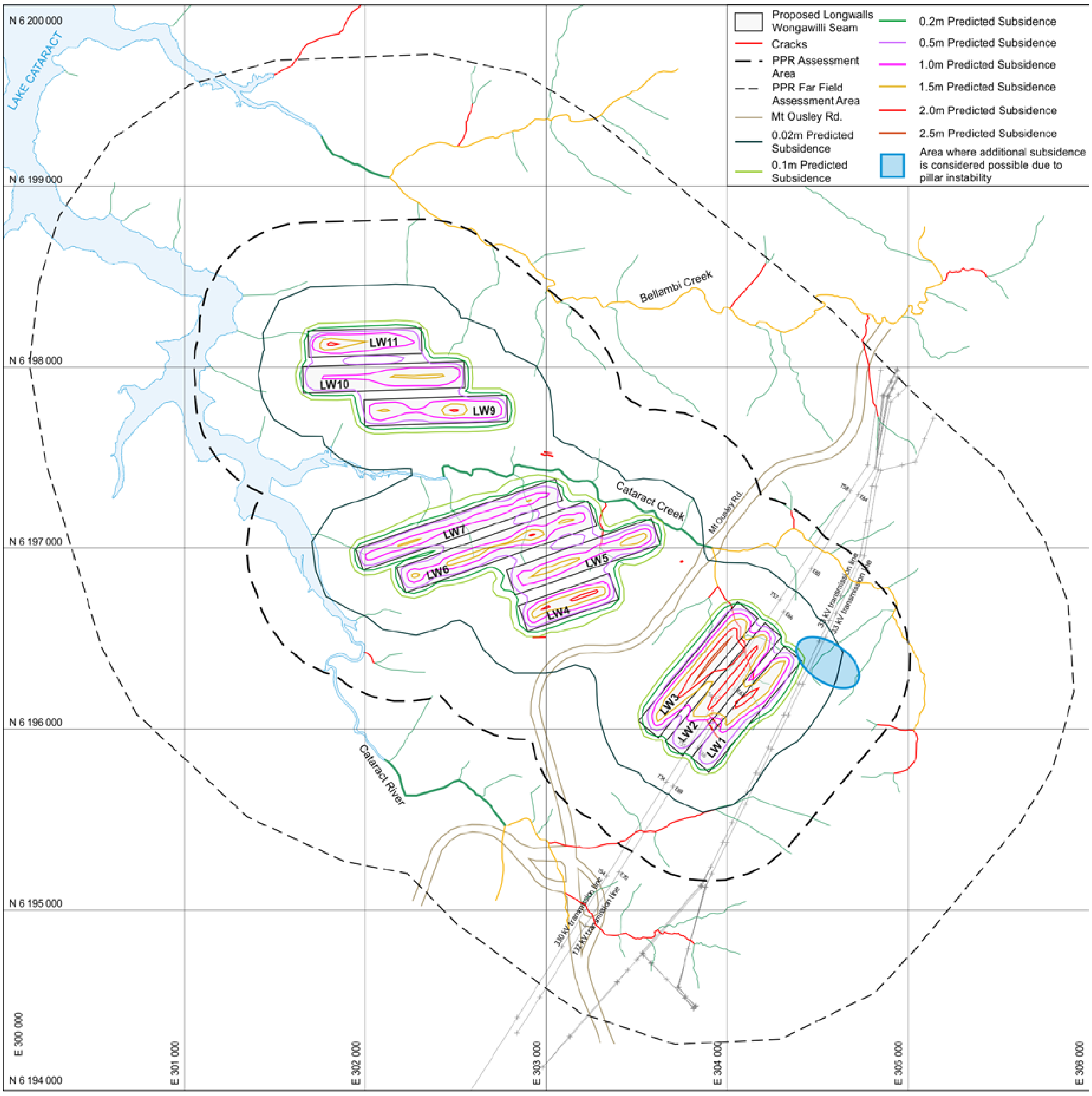


Figure 24a: Contours of predicted subsidence from the Wongawilli Seam (at same scale as previous diagrams).

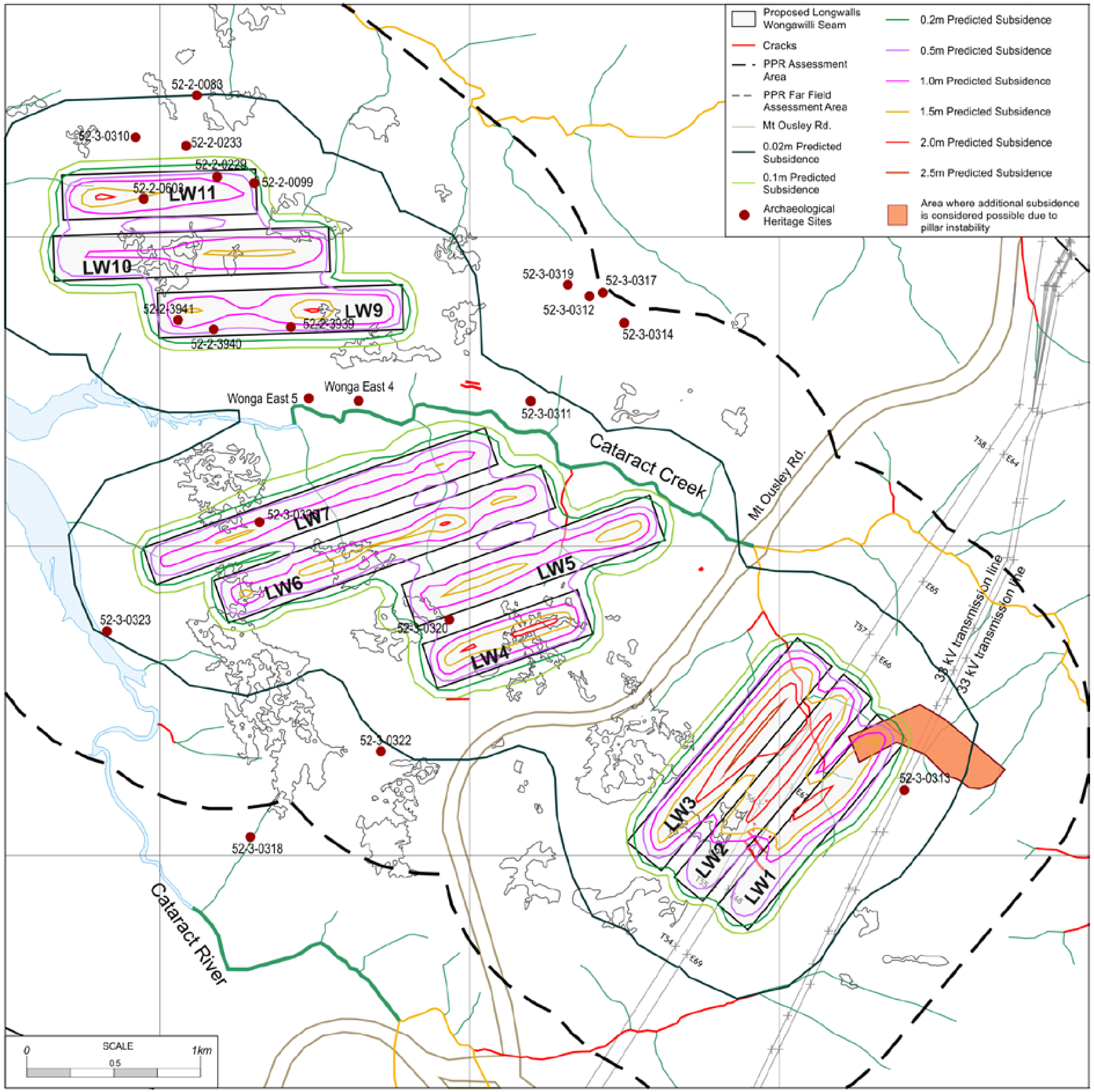


Figure 24b: Enlarged view showing contours of predicted subsidence from the Wongawilli Seam relative to surface features.

Table 4: Subsidence Predictions for PPR Assessment Area

General Observations Above Individual Panels	Overburden Depth to WWSM (m)	BUSM and BASM Subsidence (m)	WWSM Subsidence Predicted (m) and Measured (in bold)	BASM Tilt (mm/m)	Predicted WWSM Tilt (mm/m) and Measured (in bold)	BASM Max Tensile Strain (mm/m) and Typical (in brackets)	Predicted WWSM Tensile Strain (mm/m) and Measured (in bold)	BASM Max Compressive Strain (mm/m) and Typical (in brackets)	Predicted WWSM Compressive Strain (mm/m) and Measured (in bold)	Closure on Cataract Creek Observed Directly and Inferred from Upsidence (mm)	Closure on Cataract Creek (mm) (Southern Tributary in Brackets)
Longwall 1	260	1.3	2.1	19	40	N/A	12	N/A	24	N/A	N/A (650)
Longwall 2	260	1.1	2.1	19	40	N/A	12	N/A	24	N/A	N/A (610)
Longwall 3	255	1.3	2.6	13	51	N/A	15	N/A	31	N/A	N/A (350)
Longwall 4	300	1.9	2.1 (**1.6**)	11	35 (**30**)	N/A	10.5 (**7.5**)	N/A	21 (**14**)	100	N/A
Longwall 5 (*mining still in progress)	265	0.9	1.9 (**1.5***)	11	36 (**16***)	N/A	10.8 (**4.5***)	N/A	22 (**14***)	130	210 (**20***)
Longwall 6	280	1.5	2.1	18	38	7.5 (3)	11	14 (4)	23	310	400
Longwall 7	270	1.2	1.5	18	28	7.5 (3)	8	14 (4)	17	310	400
Longwall 9	330	0.5	2.1	N/A	32	N/A	10	N/A	19	N/A	50
Longwall 10	340	0.6	1.6	N/A	24	N/A	7	N/A	14	N/A	30
Longwall 11	350	0.6	2.1	N/A	30	N/A	9	N/A	18	N/A	10
SELECTED NATURAL FEATURES											
Threatened frog habitat CRUS2 Trib	300		0	5 estd	0	3	0	4	0		
Threatened frog habitat CRUS1 Trib1	320	0.5	0	5 estd	0	3	0	4	0		
Threatened frog habitat CRUS1 Trib2	320	0.5	0.02	11 estd	0	3	0	4	0		
CCUS4 Trib	270	0.9	1.5	18	28	7.5 (3)	8	14 (4)	17		
Cliffs over LW9	330	1.2	2.1	N/A	32	N/A	10	N/A	19		
Cataract Creek	260	0.5	0.1	15 estd	1	N/A	0	N/A	N/A		

6. SUBSIDENCE IMPACTS

In this section, the subsidence impacts on the range of surface features identified within the PPR Assessment Area and the far field assessment area are assessed.

6.1 NATURAL FEATURES

The natural features considered in this section include Cataract Creek and its tributaries, Cataract River and its tributaries, swamps across the area identified and mapped by Biosis (2013), cliff formations associated with the Hawkesbury Sandstone outcrop, and the Illawarra Escarpment.

The stored waters of Cataract Reservoir are discussed in the surface infrastructure section.

6.1.1 Rivers and Creeks

Figure 24 shows the creeks across the PPR Assessment Area coloured to show their stream order (as depicted in NSW Department of Planning 2008).

6.1.1.1 Cataract Creek

Cataract Creek flows west across the PPR Assessment Area and is the major creek system within the assessment area. The creek starts as first order creeks west of the Illawarra Escarpment and becomes a fourth order creek from where it flows under Mount Ousley Road to where it joins Cataract Reservoir. There is no mining proposed directly under the third and fourth order sections of Cataract Creek. Second order sections of the southern branch of Cataract Creek are mined under by Longwalls 2 and 3 and a short section of another branch has been mined under by Longwall 5. First order tributaries are mined under by all but three of the panels.

Almost all the second order and higher sections of Cataract Creek that are either directly mined under or are close to longwall panels are flowing within the outcrop of the Bald Hill Claystone. Previous experience of mining under the Bald Hill Claystone outcrop in Cataract Creek indicates that there have not been any significant long term effects on the bed of the creek or the character of the creek despite Longwall 11 in the Balgownie Seam causing the creek bed to subside1.4m.

A management approach based on monitoring closure and stopping the longwall panels if these reach unacceptably high values is considered an appropriate method of managing the closures across Cataract Creek.

Experience in Hawkesbury Sandstone river channels indicates that there has been not been total loss of surface flow in major river channels such as Cataract Creek where valley closure is less than 200mm. By adopting a

TARP system based on maintaining closure to less than 200mm, it is anticipated that the potential for loss of surface flow can be managed.

Figure 25 shows the profile of the southern branch of Cataract Creek located over Longwalls 1-3 and its continuation downstream to Cataract Reservoir. This profile has been generated from the Surfer model derived from LiDAR imaging of the surface. The subsided profiles at the completion of mining in the Bulli Seam, Balgownie Seam, and Wongawilli Seam are shown. The vertical subsidence predicted mainly influences the creek profile in the second order section above Longwalls 1-3. In this area there is potential for up to 2.6m of subsidence below the creek.

Although there is potential for water to pool in this area, valley closure effects are expected to increase the potential for sub-surface flow so pooling may only be short lived during periods of heavy rain. Valley closures are expected to cause perceptible cracking and surface flow diversion in the upper reaches of the southern branch of Cataract Creek, particularly where it flows across Hawkesbury Sandstone outcrop above Longwall 1. Some loss of surface water and iron staining is expected from this area as a result.

Further downstream above Longwalls 2 and 3 and downstream of the crossing below Mount Ousley Road where the creek will not be directly mined under, the bed of the stream is located mainly in Bald Hill Claystone and only low levels of perceptible impact are expected in this strata based on previous experience. Iron staining and flow diversion into the surface strata are not expected to be so apparent in Bald Hill Claystone because of its finer grained nature and high levels of natural fracturing.

A management strategy based on closure monitoring and cessation of mining if there is a likelihood of significant perceptible impacts becoming apparent is considered to be an effective method of managing the potential for subsidence impacts on Cataract Creek.

6.1.1.2 Cataract River

Cataract River is located on the southern side of the ridge that runs below the start of Longwalls 4-7. Only the southern ends of Longwalls 6 and 7 mine directly below the slopes that lead down to Cataract River and mining is in an upslope direction at the start of these panels. As a result, only very low levels of valley closure are expected across Cataract River from mining these two panels. The maximum valley closure indicated by the ACARP method is approximately 30mm and 40mm from Longwalls 6 and 7 respectively. The nature of the bed of Cataract River in this area is such that these low levels of closure will have no perceptible impact on Cataract River or the surface flows.

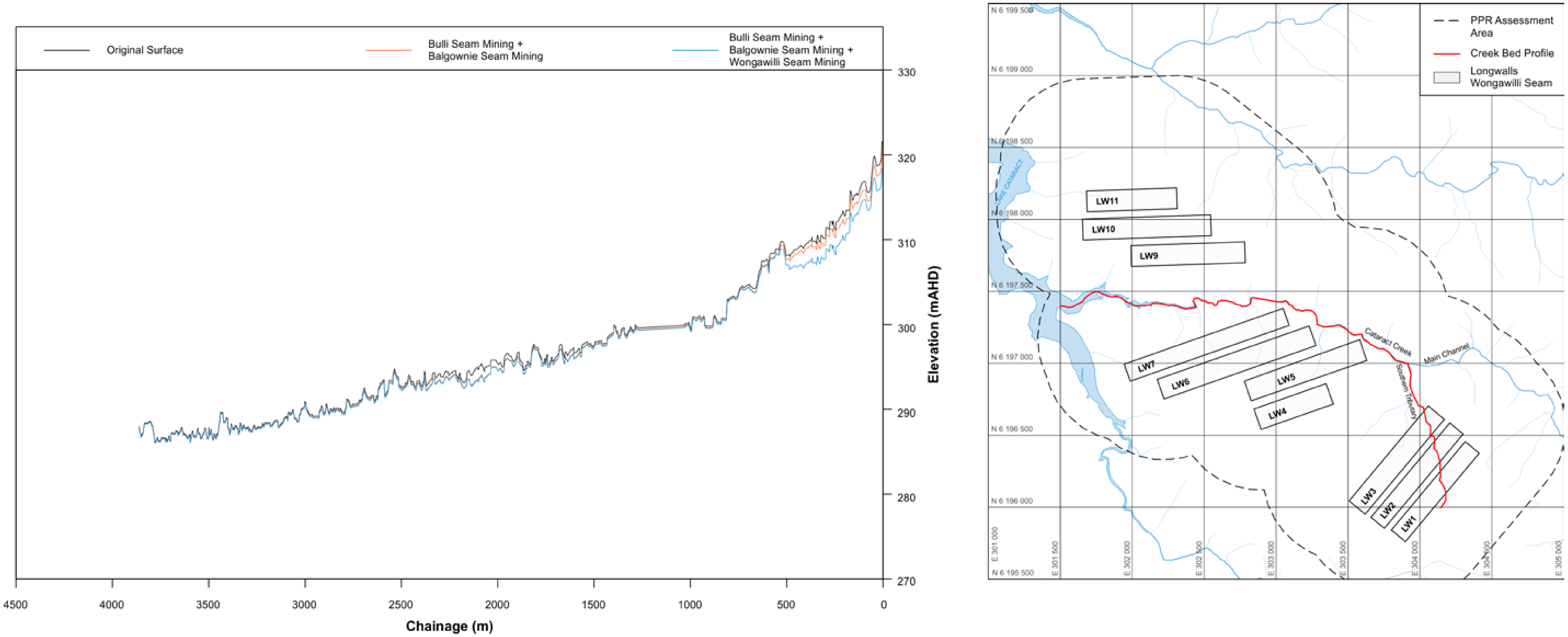


Figure 25: Profile of Bed of Cataract Creek from the Southern Tributary Headwaters to Junction with Cataract Reservoir.

6.1.1.3 Cataract River Tributary

A second order tributary of Cataract River flows west-south-west and joins the river at Picton Road Interchange. This tributary flows off the Hawkesbury Sandstone outcrop at a point that is approximately 260m south of the start of Longwall 1. No significant valley closure or perceptible impacts are expected along this section of creek because Longwalls 1-3 do not mine under any significant part of the slope that leads down to this creek. Instead they start under the ridge and mine to the north so that downslope movements are expected to occur mainly on the northern slopes toward Cataract Creek.

6.1.2 Upland Swamps

Biosis (2013) has mapped and described 33 separate upland swamps within the PPR Assessment Area. Figure 26 shows the location of these swamps. Different swamps are differentiated on the basis of the tributaries into which they flow and the nature of the swamp vegetation.

Many of these swamps have been previously mined under in both the Bulli Seam and Balgownie Seam. The proposed mining is not expected to cause significantly different impacts to those already experienced. The subsidence parameters estimated and measured for previous mining and predicted for proposed mining in the Wongawilli Seam are presented in Appendix 1.

Individual swamps cover large areas and may be somewhat discontinuous in nature. The prediction of relevant subsidence parameters is challenging because of the large area of some swamps and the relatively large change in subsidence parameters such as strain and tilt over short distances.

The approach taken has been to present the maximum subsidence parameters that are considered credible based on the experience presented in Holla and Barclay (2000) and recognise that these may only occur in one isolated area of a swamp if at all. The subsidence parameters more likely to occur are in the order of 50-80% of the peak values for tilt and in the order of 20-30% of the peak values for horizontal strain.

Maximum subsidence within the bounds of the swamp may not necessarily be a good indicator of the maximum subsidence parameters of strain and tilt given that maximum strain and tilt typically occur on the fringes of a subsided area. The maximum strain and tilt values have been estimated based on the level of subsidence within the general proximity of a swamp that would contribute to maximum strains and tilts within the swamp boundary.

When strains are greater than about 1-2mm/m in tension and 2-3mm/m in compression, perceptible fracturing of the sandstone strata below swamps are expected.

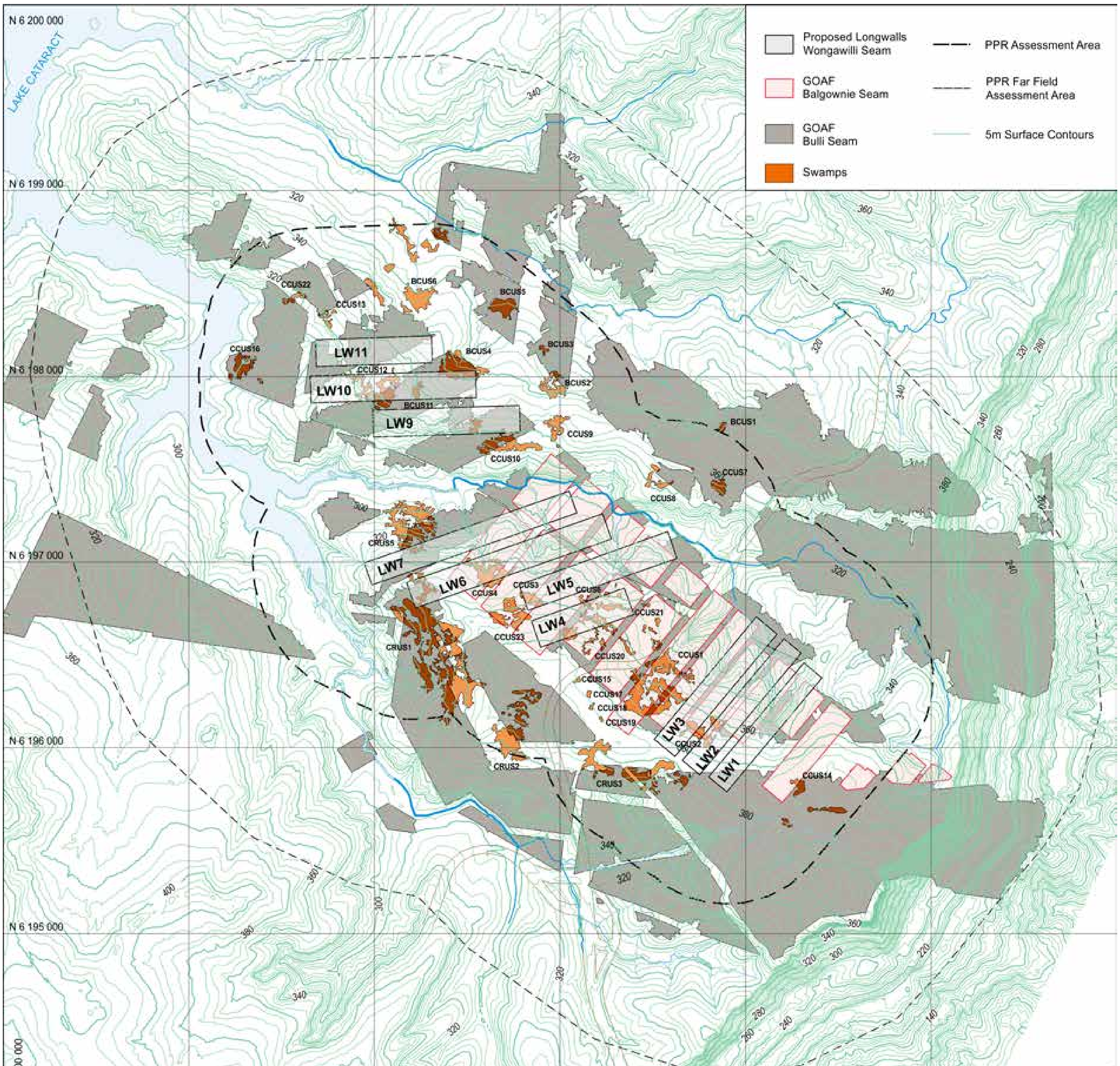


Figure 26: Location of Peat Swamps relative to historic mining and proposed longwall panels.

It is unclear how sensitive swamps are to mining subsidence. There is a clear association between mining and short term loss of piezometric pressure after rain within the surface layers of some swamps. However, the swamps located within the PPR Assessment Area appear to be thriving despite having been previously subsided to levels that are of the same order as the subsidence expected above future longwall panels. This observation suggests that the drop in piezometric pressure observed when some swamps are mined under may not have a significant impact on their long term condition.

It is considered that more work is required to determine the relationship between mining subsidence and the long term health of swamps. The extended baseline of subsidence impacts over 60-100 years in the Bulli Seam and 30-40 years in the Balgownie Seam provides a rare opportunity to study these effects. The changes that are expected from proposed mining are nominally sufficient to cause significant impacts to the rock strata and to surface and near surface water flows in the areas directly mined under, so it would be helpful to study how and if the wide range of swamps present above the site are significantly impacted by further mining.

6.1.3 Sandstone Cliff Formations and Steep Slopes

There are numerous sandstone cliff formations located within the Hawkesbury Sandstone outcrop in the PPR Assessment Area. Figure 27 shows the distribution of these cliff formations relative to the proposed longwall panels based on an interpretation of LiDAR data by Mine Subsidence Engineering Consultants (MSEC).

Many of these features have previously been mined directly beneath. The impacts of previous mining were able to be assessed during site visits to inspect the surface area.

The most significant cliff formations are those associated with Brokers Nose on the Illawarra Escarpment located some 900m east of the southern end of Longwall 1. Within the PPR Assessment Area, there are several short sections of cliffs between 3m and 10m high located on the northern side of Cataract Creek and several short sections of slightly greater than 10m high cliff formations along the southern periphery of the PPR Assessment Area.

Most of the sandstone cliff formations are less than 3m high and occur along the lower edge of the Hawkesbury Sandstone outcrop as a series of typically discontinuous outcrops and detached boulders. Figure 28 shows a variety of photographs of sandstone cliff formations typical of the PPR Assessment Area. Individual sandstone rock formations are typically less than 20m in length with sections of overhang in some of the formations and numerous isolated or toppled boulders scattered on the slopes immediately below.

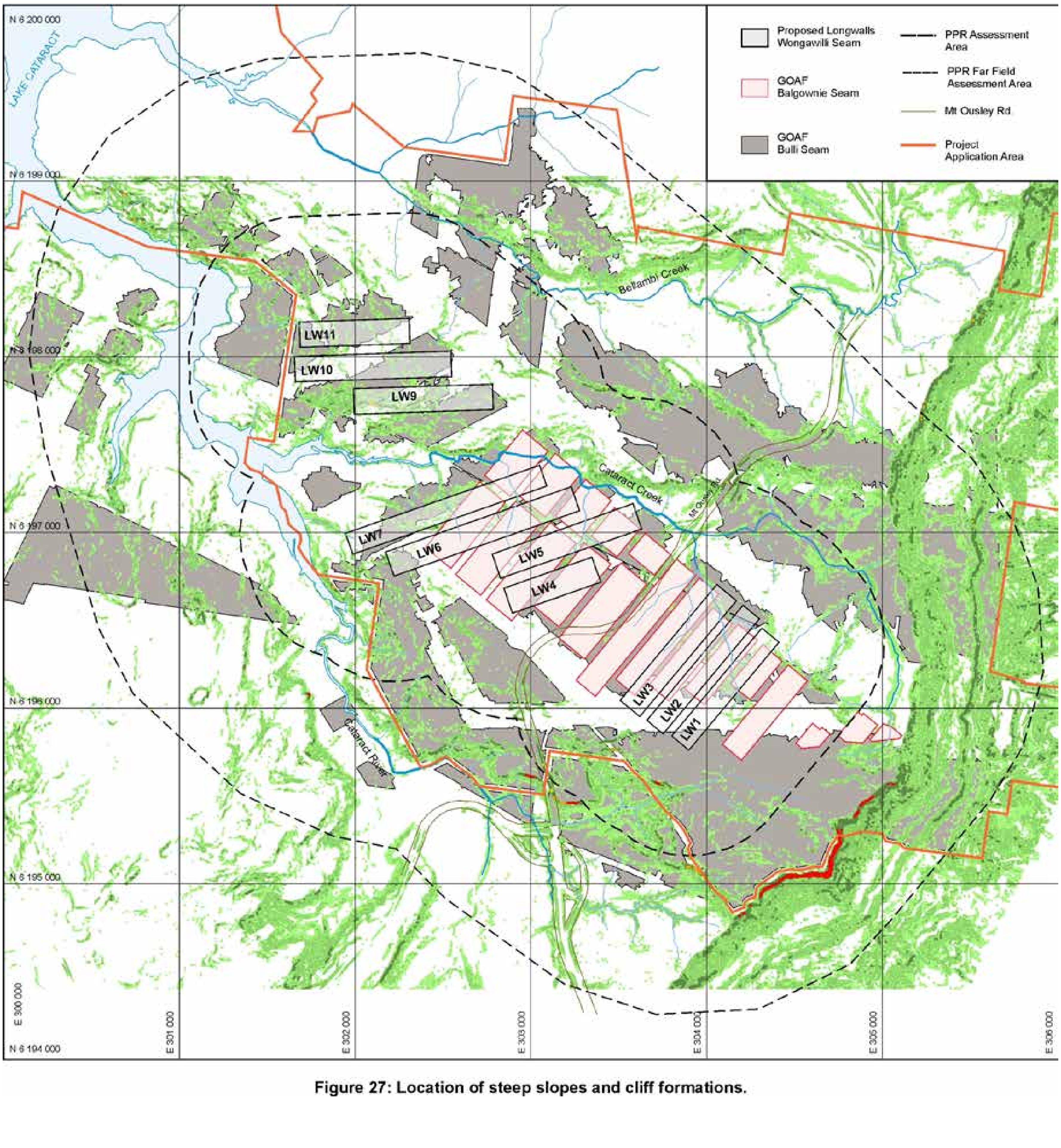


Figure 27: Location of steep slopes and cliff formations.

The approach outlined in the NSW PAC (2010) is used as the basis for assessing significance. The categories of significance adopted are:

- Special significance – cliff formations that are longer than 200m, higher than 40m, and higher than 5m that constitute waterfalls.

- Minor environmental consequences – cliff formations where isolated rock falls of less than $30m^3$ are anticipated but where rock falls do not impact on Aboriginal heritage, endangered ecological communities, public safety and the like and rock falls and occur on less than 5% of the total length of cliff formations.

- Negligible environmental consequences – occasional displacement of boulders, hairline cracks, isolated dislodgement of overhanging rock slabs impacting less than 0.5% of the total length of a cliff formation.

- Nil environmental consequences – no mining impacts, although it is recognised that natural processes that cause ongoing erosion such as diurnal and seasonal thermal variations, high intensity rainfall, and the like continue to operate at a low level irrespective of mining activities.

Only the cliff formations associated with Brokers Nose are significant using the criteria outlined in the PAC (2010) based on their physical characteristics alone. Brokers Nose is remote from proposed mining and there is considered to be no potential for mining subsidence movements to impact the cliff formations along the Illawarra Escarpment.

The critical factor for the stability of sandstone cliff formations is horizontal compression along the line of the cliffs. Once this compression is greater than about 50-100mm per 20m length of cliff formation, rock falls become likely and their frequency increases as the compression increases, as the overhang increases, and as tree root invasion becomes more prevalent.

There is considered to be some potential for rock falls on up to 5% of the length of cliff formations directly mined under with potential for perceptible impacts such as tension cracking on up to 30% of the length of cliff formations directly mined under and extending outside the goaf edge to a distance of 0.4 times overburden depth (typically about 140m). A minor rock fall at approximately MGA 302600E, 6197000N on Hawkesbury Sandstone outcrop is considered likely to have been associated with mining activity in the Balgownie Seam and is typical of the impacts that are expected. This rock fall was difficult to detect, and was relatively minor in the context of ongoing natural erosion at the site.

Figure 28: Sandstone cliff formations typical of the PPR Assessment Area

The environmental consequences of impacts on steep slopes are considered to be generally negligible although some cracks may need to be filled in where they are crossed by vehicle access tracks.

6.2 Heritage Features

Nineteen Aboriginal heritage sites have been identified within the PPR Assessment Area. These are described separately in Biosis (2013). The locations of these sites are shown in Figure 29 relative to proposed mining and summarised in Table 5.

Table 5: Subsidence Parameters Expected at Heritage Sites

Site ID	Subsidence at Site (m)	Adjacent Subsidence Used for Strain and Tilt Calcs (m)	Overburden Depth (m)	Max Tensile Strain (mm/m)	Max Comp Strain (mm/m)	Max Tilt (mm/m)	Compressive Horizontal Movement Along 20m Section of Cliff (mm)
52-2-3939	0.8	2	340	8.8	18	29	350
52-2-3940	0.6	1.5	340	6.6	13	22	250
52-2-3941	1.2	1.5	340	6.6	13	22	250
52-2-0603	1.5	1.5	340	6.6	13	22	250
Wonga East 4	< 0.1	< 0.1	300	< 0.5	< 1	< 2	< 20
Wonga East 5	< 0.1	< 0.1	300	< 0.5	< 1	< 2	< 20
52-3-0320	0.7	2	340	8.8	18	29	350
52-3-0325	1.1	1.5	315	7.1	14	24	250
52-3-0311	< 0.1	< 0.1	285	< 0.5	< 1	< 2	< 20
52-3-0310	< 0.1	< 0.1	385	< 0.5	< 1	< 2	< 20
52-2-0099	0.4	1	355	4.2	8	14	150
52-2-0229	0.7	1	365	4.1	8	14	150

There are two sites on the southern side of Cataract Creek that will be mined under or adjacent to. Three more sites are located over Longwall 9, another above Longwall 11, and the rest are located in areas that are unlikely to be significantly affected by mining subsidence.

Estimates and measurements of subsidence movements associated with past mining activity and predictions of subsidence movements for proposed mining activity are presented in Appendix 1. Table 5 presents a summary of the subsidence parameters expected from mining in the Wongawilli Seam.

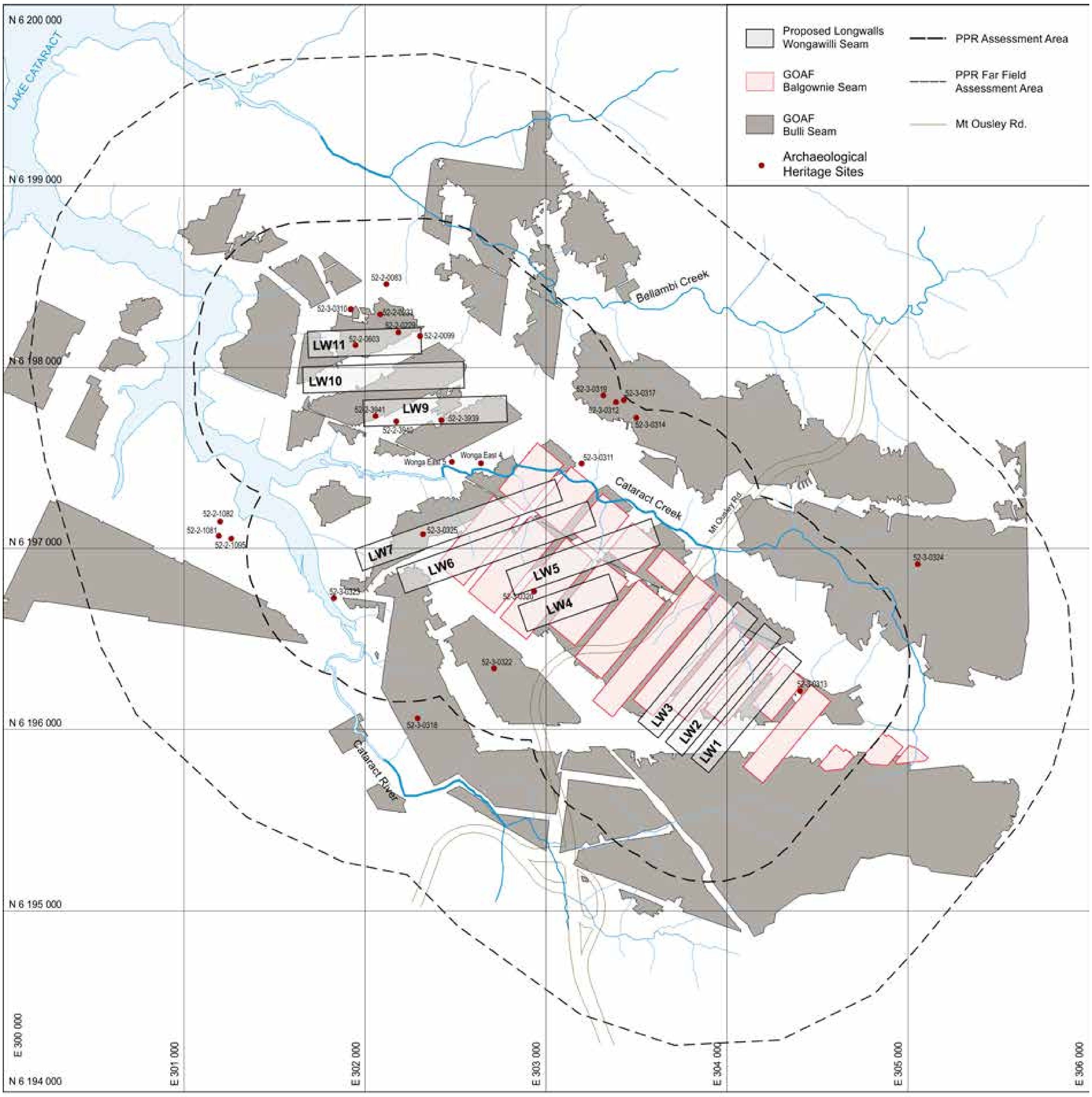


Figure 29: Location of Archaeological Heritage Sites relative to historic mining and proposed longwall panels.

6.2.1 Site 52-2-3939

Site 52-2-3939 site forms part of a 3-5m high sandstone cliff formation that protrudes from the general line of the cliffs with a 6m overhang as shown in Figure 30. The site is protected somewhat by being relatively short in length and protruding out from the general line of the cliffs in the area. The probability of rock falls at the site is assessed as being 2% which means that there is likely to be rock fall within the general area of the site i.e. somewhere along the 100-200m of cliff line that are located within a short distance of the site. Perceptible tensile cracking is assessed as having a 30% probability of being evident on rock surfaces in the general area including possibly through the site.

Figure 30: Photograph of Archaeological Site 52-2-3939.

6.2.2 52-2-3940

Site 52-2-3940 is part of an extended (100m long) line of 4-6m high cliff formations, some of which have already fallen either naturally or as a result of previous mining in the Bulli Seam more than 50 years ago, and has a 5m overhang as shown in Figure 31.

The site is estimated to have previously experienced approximately 0.1m of subsidence with horizontal compression of about 0.1m. Proposed mining of Longwall 9 in the Wongawilli Seam is expected to cause up to 0.6m of

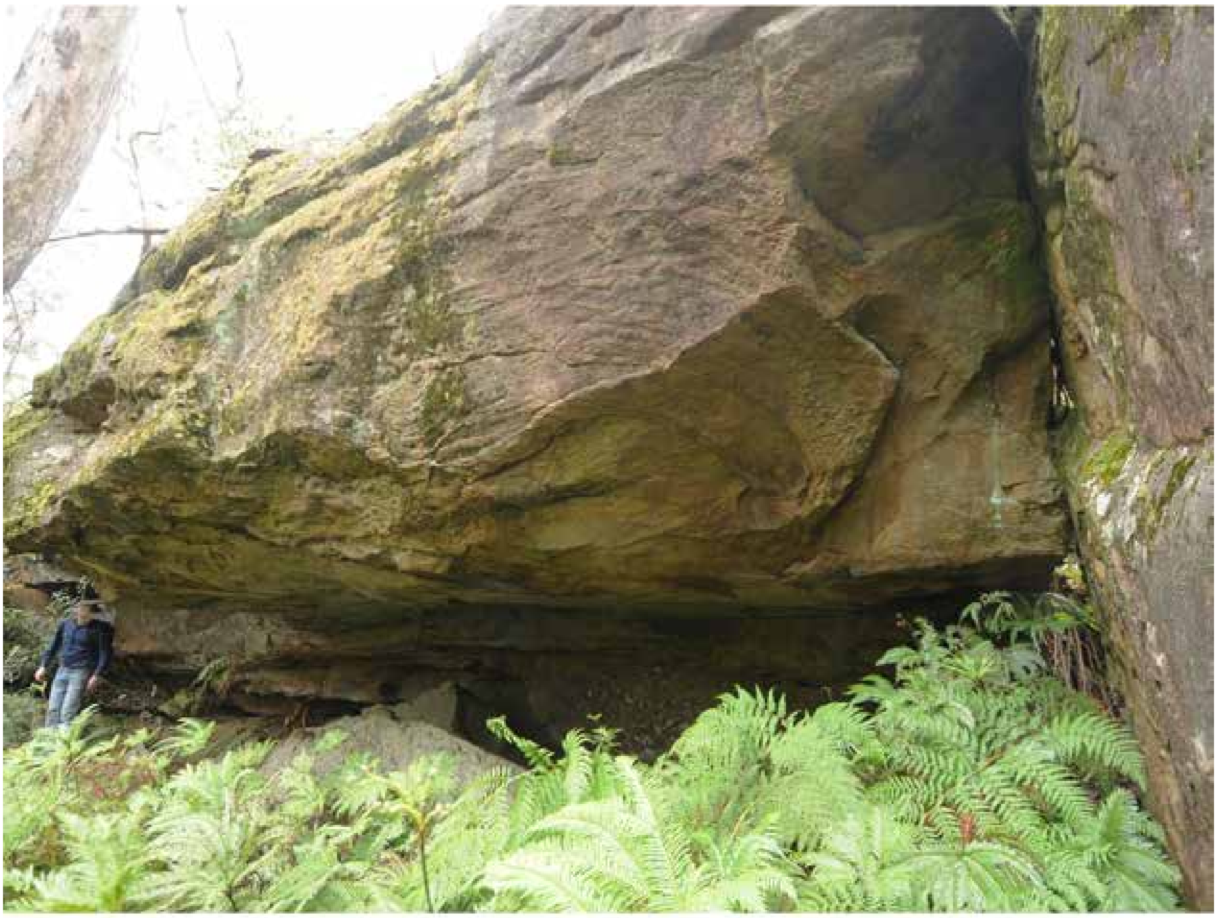


Figure 31: Photograph of Archaeological Site 52-2-3940.

additional subsidence with 1.5m expected nearby, up to 250mm of additional compression at the site, and tensile strains of about 7mm/m.

The site is considered to be vulnerable to further rock falls because it is part of a long line of cliffs, some of which have already collapsed. The probability of rock falls at the site is assessed as being 5% which equates to a 5m rock fall being likely somewhere along the 100m section of cliff line adjacent to the site. Perceptible tensile cracking is assessed as having a 30% probability of being evident on rock surfaces in the general area including possibly through the site.

6.2.3 52-2-3941

Site 52-2-3941 is part of a 3-4m high cliff formation that been previously involved in a rock fall. The overhang that constitutes the site is located below a detached boulder and has an overhang of approximately 4m. Figure 32 shows a photograph of the site including the fractured rock strata where the boulder has detached from the general cliff formation.

Figure 32: Photograph of Archaeological Site 52-2-3941.

There are several characteristics of the rock fall that indicate it is likely to have been associated with mining in the Bulli Seam more than 50 years ago. The site is estimated to have previously experienced approximately 0.2m of subsidence with horizontal compression of about 0.1m. Proposed mining of Longwall 9 in the Wongawilli Seam is expected to cause up to 1.2m of additional subsidence with 1.5m expected nearby, up to 250mm of additional compression at the site, and tensile strains of about 7mm/m.

The site itself is not considered vulnerable to further rock falls because it is detached from the cliff line and is not large enough to experience significant lateral compression so the probability of a rock fall at the site is considered to be low (<1%). However, the probability of further rock falls in the general vicinity of the site along the standing cliff line is assessed as being 5%. This probability equates to a 5m length of the adjacent 100m of cliff formation likely to experience a rock fall. Perceptible tensile cracking is assessed as having a 30% probability of being evident on rock surfaces in the general area although a tension crack directly through the site is considered unlikely.

6.2.4 52-2-0603

Site 52-2-0603 is located high up on the ridge line. The cliff formation is estimated to be 50-70m long and the overhang where the rock art is located is approximately 4m deep and 3m high as shown in Figure 33. The rock in the roof of the overhang is only about 1-2m thick but relatively continuous.

The site is estimated to have experienced up to 0.3m of subsidence as a result of previous Bulli Seam mining activity with horizontal movement of about 0.1m although it is possible that the geometry of the Bulli Seam mining was sufficiently narrow in this area to prevent significant subsidence movements at the site. Proposed mining of Longwall 11 is expected to cause up to 1.5m of additional subsidence and up to 250mm of horizontal compression.

The site's location near the top of the ridge is likely to have reduced some of the horizontal compression because there is currently no evidence of a rock fall within the period of previous mining. There is a rock fall evident on a nearby formation, but this fall appears to be too recent (last few years) for it to have been directly associated with previous mining subsidence.

The level of horizontal compression expected is assessed as being likely to cause perceptible cracking in the vicinity of the site with the probability of rock fall assessed as being 5-10%. The nature of the site is such that a rock fall anywhere along the 30-40m length of the overhang is likely to be considered as having impacted the site.

6.2.5 Grinding Groove Sites

There are several grinding groove sites located on bare rock areas in upland areas away from creeks. Perceptible cracking is expected in up to 30% of bare rock areas when these areas located directly above longwall panels

Outside the goaf edge, the frequency of cracking is expected to decrease in magnitude with distance from the goaf edge and become imperceptible beyond a distance of about 0.4 times the overburden depth or about 120-150m from the goaf edge.

Within any given site where cracking occurs, individual cracks may be perceptible as tension cracks that cause the rock to move apart, usually on natural joints if these exist but also through intact rock, shear cracks that cause opening and lateral displacement of the two sides, and compression cracks that result in the rock surface popping up in slabs. Shear and tension cracks tend to be more prevalent in upland areas.
The probability of one of the tension or shear cracks directly intersecting a grinding groove depends on the site characteristics, but is generally low because such cracks tend to be widely spaced (5-10m). However, the potential for a bare rock sites to be impacted generally is expected to up to about 30%.

Compression fracturing tends to be more prevalent in topographic low points and the fracturing that occurs tends to affect a larger proportion of the site.

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Figure 33: Photograph of Archaeological Site 52-2-0603.

6.2.6 Other Sites

The Wonga East 4, Wonga East 5, 52-3-0310, and 52-3-0311 sites are located beyond the footprint of the longwall panels and are not expected to be perceptibly impacted by mining subsidence because of their location.

Sites 52-2-0099, 52-2-0229, 52-3-0320 and 52-3-0325 are located within the boundaries of the longwall panels and some perceptible impacts are expected in the general area of these sites as a result. Those sites that are associated with detached boulders such as 52-3-0325 are considered unlikely to be significantly impacted.

6.3 Surface Infrastructure

The surface infrastructure located within the PPR Assessment Area includes the Mount Ousley Road, four power transmission lines that run between Mount Ousley and the Illawarra Escarpment with two of these lines having pylons directly over the Longwall 2 and the chain pillar between Longwalls 1 and 2, and the storage of Lake Cataract. Other infrastructure within the extended assessment area includes the Picton Road Interchange and communications tower infrastructure near the top of Brokers Nose.

6.3.1 Mount Ousley Road

Mount Ousley Road is protected from direct mine subsidence by a horizontal distance from the nearest goaf edge of greater than half overburden depth. Low levels of vertical subsidence of less than about 100mm in total are expected in the vicinity of Mount Ousley Road with up to approximately 30mm of this maximum having already occurred from mining Longwall 4. These low level vertical movements are expected to be imperceptible for all practical purposes.
The ACARP method for predicting valley closure indicates horizontal movement in a downslope direction caused by mining below the slope on the southern side of Cataract Creek is likely to generate closure at the creek crossing as summarised in Table 6.

Table 6: Predicted Horizontal Closure Across Cataract Creek at Mount Ousley Road

Longwall	Maximum Incremental Closure Predicted (mm)	Maximum Cumulative Closure Predicted (mm)
4	30	30
5	50	80
2	5	85
3	40	125

The upper limit of 125mm of compression in the bottom of the valley estimated at the completion of proposed mining is expected to be accompanied by a similar level of cumulative tensile cracking toward the top of the slope. Cracking is likely to continue to develop at the same location once a crack has formed. Some of the tensile cracking that began during Longwall 4 appears to be continuing during mining of Longwall 5.

The current program of monitoring and visual inspection is considered appropriate while mining is ongoing in Longwalls 2 to 5. A reduced survey frequency is considered likely to be appropriate during mining of the other longwall panels. Some localised resealing of the cracked sections of Mount Ousley Road is likely to be required at the completion of mining or whenever the tensile cracking becomes too wide to be considered serviceable. The cracking is expected to develop incrementally with mining and so a program of repairs can be scheduled based on forecast longwall retreat.

Tension cracking is likely to be concentrated on the road pavement near the top of the ridge between Cataract Creek and Cataract River. In this area, it is possible that water ingress into the road formation through cracks may cause loss of fines from the sub-base with increased potential for pot holes to develop on the road surface.

The Picton Road Interchange is located on the opposite side of Cataract River and the opposite side of a tributary that joins Cataract River at the interchange. Longwalls 1-5 mine predominantly below the slope that leads down to Cataract Creek rather than the south facing slope that leads to Cataract River and its tributaries. As these longwall panels start below the ridge and mine away to the north, horizontal movements in a downslope direction are considered unlikely to extend across Cataract River to interact with the Picton Road Interchange. The bridge on the Picton Road Interchange is further protected by being on the far side of the west flowing tributary to Cataract River.

On this basis, there is considered to be no potential for significant horizontal movements to impact the Picton Road Interchange. A monitoring strategy is considered appropriate to confirm that subsidence movements are of low level and of no significance for the structures around the interchange. Once this monitoring regime has established there is no significant interaction, a reduction in the frequency of monitoring is considered likely to be appropriate.

The road cutting on the northern side of Cataract Creek has been formed in Hawkesbury Sandstone strata to form high embankments. These embankments are located beyond 500m from the nearest longwall panel on the opposite side of Cataract Creek. There is considered to be no potential for mining induced cliff falls to occur along this section of exposed rock.

6.3.2 Power Transmission Lines

There are four power transmission lines located in two corridors between Mount Ousley Road and the Illawarra Escarpment. Figure 34 shows photographs of the four different types of support structure used on these lines. The 330kV and 132kV lines are supported on trussed steel pylons. One of the 33kV lines is supported on single pole structures and the other

Figure 34: Power transmission lines above Longwalls 1 and 2.

one is supported on double pole structures that appear to have been replaced in the last few years.

All four lines were mined under by Longwalls 1 and 3 in the Balgownie Seam and potentially by late stage pillar extraction in the main heading pillars in the Bulli Seam although this latter mining may have preceded construction of the lines.

The power transmission towers T56 (on the 330kV line) and E57 (on the 132kV line) are suspension towers located in an area where there was 1-1.2m of vertical subsidence measured during mining of the Longwall 3 in the Balgownie Seam. The tower locations are noted on subsidence plans as T56 and T52 so it appears that they had been constructed prior to mining Longwall 3 in 1975.

In general, suspension towers are located on straight sections of line and the conductors are suspended from the tower structure on hanging insulators rather than directly to fixed insulators on the structure. However, it is noted that T56 is located at a slight change of direction in the line. The side load associated with this slight change in direction is managed through rotation from vertical of the suspended insulators as can be seen in Figure 34. In contrast, E57 is located on a straight section of line and the insulators hang vertically.

The towers T56 and E57 are 100m and 200m respectively down slope from the area of cracking at the topographic high point near the start of proposed Wongawilli Seam Longwall 3. The tension cracking observed is consistent with expected ground movements. These towers do not appear to have been significantly impacted by previous mining possibly because they are located on Hawkesbury Sandstone and, fortuitously, the cracks have not passed between the legs of the towers.

The structural integrity of pylons is sensitive to even small levels of differential displacement between the four legs. It would appear that cracking or differential movement did not occur through the sandstone strata between the tower legs so that the tower foundations moved together as one unit allowing any subsidence and tilting of the pylons to occur without compromising the structural integrity of the towers themselves. Small tilting and horizontal movements are normally able to be accommodated by rotation of the suspended insulators that support the

conductors. Realigning the insulators during subsequent maintenance allows any misalignment to be rectified.

The predicted subsidence at the tower locations are detailed in Table 7 and illustrated in Figure 35.

Table 7: Subsidence Expected at Power Pylon Locations

Tower	Subs (m)	Maximum Tensile Strain (mm/m)	Maximum Compressive Strain (mm/m)	Maximum Tilt (mm/m)	Differential movement over 10m (mm)	Horizontal Movement (m)
330kV T54	0.03	< 0.2	0	< 0.5	< 2	< 0.1 NE
330kV T55	0.5	4.6	9	15	50	0.3 NE
330kV T56	2.2	11.2	22	37	120	0.7 NE
330kV T57	0.05	< 0.2	0.0	< 0.5	< 2	<0.1 SW
132kV E66	0.07	< 0.2	0.0	< 0.5	< 2	<0.1 SW
132kV E67	1.8	11.8	0.0	39	120	0.3 NE
132kV E68	0.3	4.8	10	16	50	0.7 NE
132kV E69	0.03	< 0.2	0	< 0.5	< 2	<0.1 NE
33kV Lines	< 0.1	< 0.2	0	< 0.5	N/A	<0.1 W

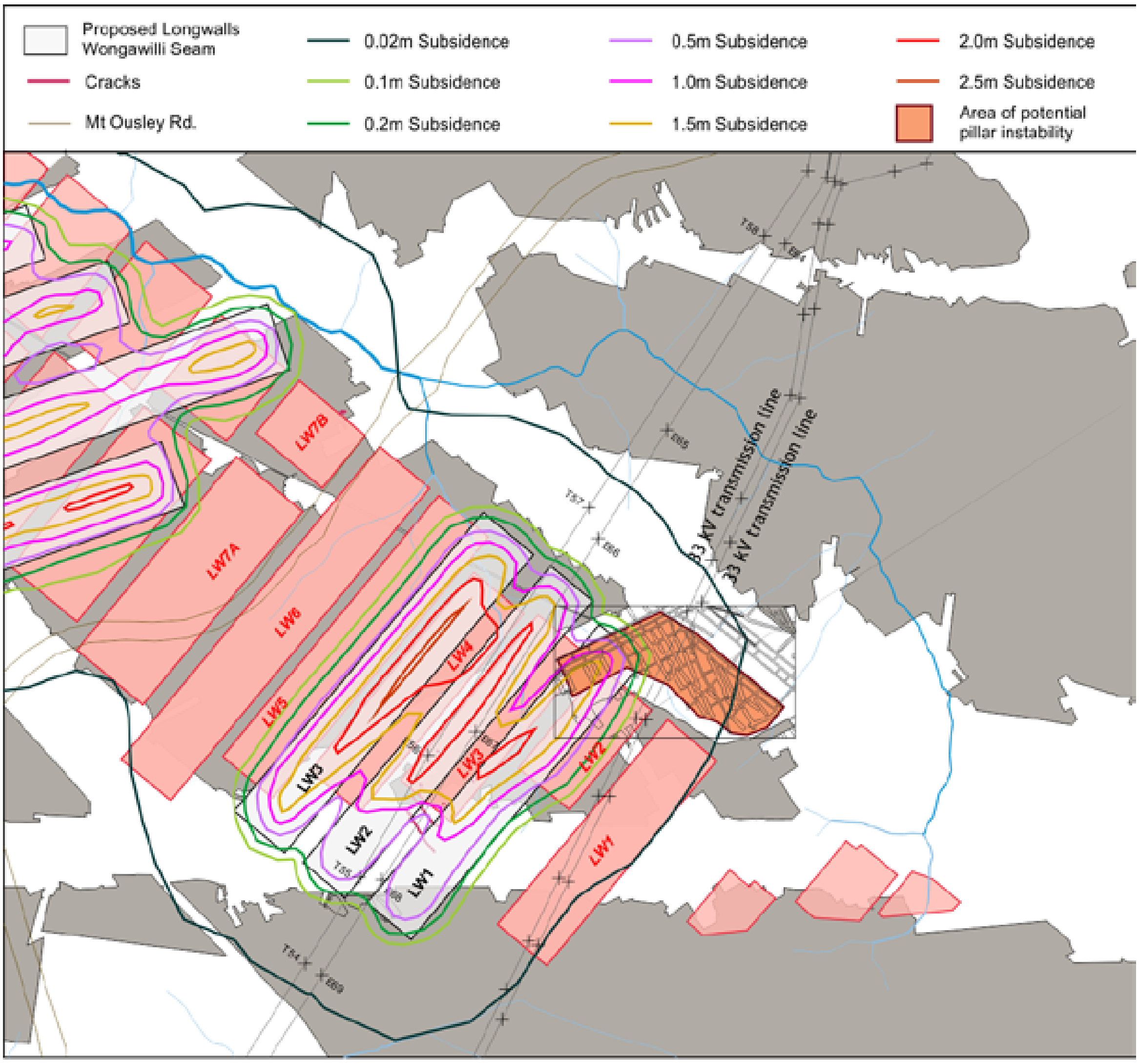

Figure 35: Location of power transmission structures relative to proposed longwalls, Balgownie Seam longwalls, and area of potential pillar instability in the Wongawilli Seam.

There is also an area where there is some potential for pillar collapse in the Bulli Seam. This area is shown in Figure 35. Fortunately, the towers and poles are located outside the area likely to be affected by any pillar instability.

Permanent horizontal movement in the direction of mining is expected to occur at all the four towers located directly over the longwall panels. The horizontal movement is expected to range up to 700mm and is likely to be greatest on the two towers located directly over the goaf, T56 and E67.

The proposed mining is expected to cause ground movements that have potential to compromise the structural integrity of towers T55, T56, E67 and E68 if the movements occur differentially between the tower legs.

Although there has been previous cracking nearby and such cracking is likely to continue to localise further ground movements, the risk of new cracking causing structural damage is considered to be too high without some form of mitigation. It is considered that all four towers require some mitigation works to remain serviceable during the period of mining Longwalls 1, 2 and 3.

The use of a cruciform foundation is considered likely to be effective to protect the structural integrity of the tower foundations. Some active realignment is likely to be required, particularly on Tower E67 where permanent tilts of up to 39mm/m are expected. Tilting of 39mm/m equates to a horizontal movement at 20m above the ground of about 800mm. This movement is likely to be able to be accommodated by rotation of the hanging insulators, but this needs to be checked in consultation with the power utility companies that own the infrastructure. It may be necessary to suspend the conductor in roller sheaves during the active phase of mining below the structures.

A single point tie down may be required on the western leg of the cruciform for T56 to accommodate the lateral loads associated with the slight change in direction at this tower. The loads involved are expected to be able to be accommodated through appropriate design of the cruciform.

The adjacent towers to the south T54 and E69 are considered to be sufficiently remote from mining for there to be no significant potential for ground movements. These towers are protected by an angle of draw of 30°. Both towers are located on ground that is sloping away from the direction of mining in an area where the slope the towers are on is not directly mined under. Some monitoring of these towers is recommended, but there does not appear to be a compelling case to provide additional protection.

The adjacent towers to the north T57 and E66 are protected by an angle of draw of 26° and 23° respectively, and they are therefore remote enough for systematic ground movements to be low. However, both towers are located on top of a ridgeline where tension cracks tend to be concentrated. While the direction of mining toward the ridge tends to lessen the potential for cracking on the ridge line, there is nevertheless considered to be a low level hazard associated with the potential for cracking between the tower legs with potential to compromise the structural integrity of the tower. It may be possible to cut a slot or confirm that the tower will be protected by the local site conditions, but a site specific risk assessment is required to develop a mitigation strategy for this tower.

There is a significant change in direction on both the 330kV and 132kV transmission lines at a point approximately 1km north of the northern ends of Longwalls 1, 2 and 3. Some additional monitoring of these structures may be appropriate to monitor and manage any changes in conductor tension that results from the subsidence movements. Far-field movements are not expected to create any significant hazard in terms of the structural integrity of these towers because of the low levels of movement and even lower levels of differential movement expected at 1km from the goaf edge.

The 33kV lines are supported on single and double pole structures. The double pole structure appears to be relatively new. These structures are tolerant to mine subsidence movements. Mining of Longwall 1 in the Balgownie Seam caused subsidence of 0.8-1.2m below four of these pole locations and 0.4-0.6m on four others. It is considered unlikely that this mining caused any significant impact to these lines although they may have needed to be straightened up at the completion of mining.

The 33kV single and double pole structures are relatively tolerant of subsidence movements and because these structures are located more than 60m outside of the footprint of the longwall panels, only low levels of subsidence and no significant impacts are expected.
No protection measures are considered necessary for the 33kV single and double pole structures, although some before and after mining survey monitoring program is recommended to confirm the low levels of ground movement that are expected.

6.3.3 Cataract Water Supply Reservoir

No impacts are expected on the Cataract Reservoir from the proposed mining. The FSL including the section that extends up Cataract Creek is protected from the nearest longwall goaf by a nominal horizontal distance of greater than 203m at 290m overburden depth (equivalent to 0.7 times overburden depth or an angle of draw of 35°). Vertical subsidence at the FSL is expected to be less than about 20mm.

Geological structures within the PPR Assessment Area are relatively well defined because of the previous mining that has occurred in the overlying Bulli Seam over a large area and the overlying Balgownie Seam in a more limited area. The only geological structure that extends through to the proposed longwall panels in the PPR Assessment Area and the reservoir is Dyke D8. The horizontal distance along the dyke from the end of Longwall 10 to the FSL is approximately 560m at an overburden depth of 320m at the FSL.

The faults labelled F2 are apparent in the workings in Corrimal Colliery but become degraded in the Bulli Seam workings at South Bulli Colliery. These faults are not proposed to be directly intersected in the Wongawilli Seam but there is a flow pathway between the faults and the Wongawilli Seam mining horizon through the Bulli Seam mine workings that intersect both.

There is considered to be no potential for proposed mining to intersect the stored waters directly. There may be potential for flow along the dyke via the Bulli Seam, but experience in the Southern Coalfield indicates that dykes are very rarely hydraulically conductive and there does not appear to have been any significant inflow associated with mining the Bulli Seam on this dyke. Mining in the Wongawilli Seam 560m away from the reservoir is not expected to have any potential to increase hydraulic conductivity between the reservoir and the mine.

There are also a number of small pre-existing Bulli Seam goaf areas that are located within the 0.7 time depth protection zone around the FSL. The largest width of any of these is 200m and it is located within 80m of the FSL at an overburden depth to the Bulli Seam of approximately 260m. It is considered unlikely that the proposed mining will interact with these pre-existing goaf areas and there does not appear to be any connection between the reservoir and the mining horizon. Nevertheless, the presence of these goafs reduces slightly the effectiveness of the 0.7 times depth barrier between the FSL and the proposed mining, particularly during mining of Longwalls 7 and 9.

6.3.4 Telecommunications Infrastructure

There is a telecommunications tower located on Brokers Nose on the Illawarra Escarpment. This telecommunications infrastructure and the cliff formations at Brokers Nose are protected by a horizontal distance of approximately 1km from the nearest point on Longwall 1. No ground movements are expected at this distance from the proposed mining because there is no potential for significant horizontal stress concentration along the escarpment and no potential for change in any of the other stress components.

The only monitoring system that is likely to be effective would be in situ stress change monitoring. This equipment can be deployed in a borehole in the sandstone strata and remotely monitored to confirm that there have been no significant changes. The system is significantly more sensitive than conventional surveying.

7. Management Strategies

The subsidence management strategies have been discussed in the previous section, but are consolidated in this section.

7.1 Survey Monitoring

Survey monitoring is expected to provide the primary basis for informing the processes used to manage subsidence impacts. This monitoring is discussed first because it underpins all the other processes.

Conventional subsidence monitoring using repeat surveys in three dimensions with far-field GPS control is considered to provide the industry best practice subsidence monitoring technique in steep terrain. This type of three dimensional surveying captures the full three dimensional ground movements independent of location to an accuracy that is suitable to characterise the nature of the ground movements. Strains and tilts are not necessarily captured to the same level of accuracy as is possible with levelling and peg to peg chaining but the reduced accuracy is offset by capturing all components of movement rather than just the components in the direction of the subsidence line. It is recommended that the existing survey lines are monitored in three dimensions using this approach.

Two cross lines across each panel and a centreline subsidence line are considered appropriate to monitor subsidence movements in the relatively complex subsidence environment above Longwalls 1-11. The three dimensional movements on the active sections of these lines should be monitored regularly, particularly at the commencement of each longwall panel and during mining below or near significant infrastructure. The broader network should be resurveyed at the midpoint and end of each longwall panel or every 2-3 months whichever occurs first.

It is recommended that a survey monitoring base line is extended to include three dimensional far field GPS control for a distributed array of monitoring points that are located at easily accessible locations across the mining area as well as around the periphery of the mining area out to about 3km. This monitoring network can then be checked at any time and used to confirm the levels of movement that have occurred on all the monitoring lines and infrastructure in the area. This distributed array is intended to provide an overview of any movements that are occurring. The array can also be used to provide confirmation of the accuracy of the survey control grid.

High resolution point to point measurement of valley closure across Cataract Creek is recommended at as many crossing points as can conveniently be established. The four that are currently located across Cataract Creek are considered suitable locations. It would be useful to extend these somewhat to increase the horizontal coverage so as not to miss any closure movements that occur beyond the ends of the convergence line, although the practical difficulties of surveying in a rainforest environment are recognised.

7.2 Infrastructure Management

The mining impacts on infrastructure that need to be managed include the Mount Ousley Road, the power transmission lines, the Cataract Water Supply Storage, and the telecommunications facility at Brokers Nose.

7.2.1 Mount Ousley Road

Management of the Mount Ousley Road and any subsidence impacts using a technical committee such as was used for Longwalls 4 and 5 is considered appropriate for the ongoing management of subsidence impacts to the road.

The half depth stand-off of mining from Mount Ousley Road is considered to significantly reduce the potential for impacts on the highway and this potential will reduce further as active mining moves away from the road.

Some low level ground movements have been observed and surface cracking has also been observed on the road surface particularly around the crest of the ridge between Cataract Creek and Cataract River where stretching movements are expected. It is recommended that the observed surface cracks are filled from time to time to reduce ingress of surface water into the formation because unlike conventional road cracks that are likely to occur mainly in the surface layers, these subsidence cracks are likely to extend through the sub-grade. There is then potential for water ingress to cause damage to the road base and potential for particle migration into the cracks that eventually has potential to cause a pot hole.

Continued survey monitoring of the Mount Ousley Road, perhaps at reduced frequency, and in due course the power transmission towers and poles is recommended as the basis to confirm the actual subsidence movements are consistent with those predicted.

A high level of monitoring of the Mount Ousley Road and Picton Road Interchange have been appropriate during mining of Longwalls 4 and 5 in close proximity to the highway. However, some reduction in the frequency of the survey monitoring is now considered appropriate given the low level and zero change respectively that have so far been observed. A management strategy based on regular visual inspections and mid panel and end of panel surveying unless otherwise triggered would appear to be sufficient to manage the levels of impacts expected once Longwalls 4 and 5 have been completed. The frequency of monitoring, particularly of the Mount Ousley Road may need to increase again during mining of Longwalls 2 and 3.

7.2.2 Power Transmission Towers

A technical committee comprising representatives from the colliery, the power utility companies, the Mine Subsidence Board, and government regulators is recommended to manage potential impacts on the power transmission towers. This forum provides all interested parties with understanding and control of the management processes.

Several of the power transmission towers are likely to require the construction of cruciform bases to allow them to remain structurally stable during mining. There is usually a significant lead time involved in getting cruciforms approved, financed, designed, and constructed.

Monitoring on the power transmission poles and towers needs to be designed in consultation with the power utility companies. It is envisaged that reflectors on the structures to capture tilt and high resolution surveying of the relative position of individual legs relative to each other and in three dimensions for the cruciforms would be appropriate.

Strain gauge monitoring of the steel structures and automatic regular logging of the changes transmitted back to a website portal is a practical solution for towers that are on the periphery of the mining area and do not have cruciforms.

Prior to the approach of Longwall 1, a number of short survey lines should be located in the vicinity of the panel of small pillars at the northern end of the panel to confirm the nature and extent of any subsidence that occurs as a result of pillar destabilisation in this area.

All the monitoring points for the power transmission towers and the telecommunications infrastructure on Brokers Nose should be linked back into the distributed array of monitoring points and the control already established for Mount Ousley Road.

7.2.3 Cataract Reservoir

The Dams Safety Committee (DSC) is a statutory body with legal powers to manage mining to protect the stored waters in Cataract Reservoir. As is appropriate, the DSC takes a conservative view of the potential threats of mining to the stored waters because of the challenges of effectively remediating any leakage of water from the reservoir to the mine. The DSC also recognises that some minor loss is inevitable and is tolerable. The colliery has been working with the DSC for many years and it is considered that the management process that has been adopted in the past continues to be appropriate.

The management of potential impacts revolves around providing a sufficient standoff from the FSL, confirming that there are no geological structures with potential to provide elevated hydraulic conductivity between the reservoir and the mining horizon and that any such structures will not be adversely affected by mining, and monitoring the mine water balance to confirm the magnitude of any flows that occur.

The 0.7 times depth (nominally 203m) stand-off from the FSL is considered to be the primary control for protecting the stored waters of Cataract Reservoir and this barrier is expected to provide a high level of protection to these stored water. The presence of existing pillar extraction areas within the barrier reduces the protection afforded by the barrier to 80m from the FSL in some areas.

Geological structure in the area is well defined by the presence of previous mining. The D8 dyke is considered to be the only geological structure with potential for increased hydraulic conductivity but there is a separation between the reservoir and the mine along the dyke of approximately 500m horizontally and 360m vertically and exposures underground do not indicate a history of increased inflow despite previous mining adjacent to the dyke directly under Cataract Creek.

A review of the integrity of the mine water balance is recommended to confirm that all sources of water are accounted for particularly that there is no unaccounted for loss of water into inaccessible storage deeper in the mine or into adjacent mines.

The piezometer monitoring network currently in place provides an indication of the changes in groundwater characteristics around the site. Further monitoring in areas where there are multiple goafs stacked above each other and in the area between the reservoir and the mine would increase confidence in and understanding of the impacts of mining on the groundwater system. The design of this monitoring would need to be done in consultation with the DSC.

SCT understand that NRE has engaged a consultant to prepare a Mine Closure plan for the DSC to manage any uncontrolled inflow of water and prevent its egress from the mine workings. However, it should be recognised that there are limited options to control any significant inflow through sealing up the longwall panels or the mine portals because the Wongawilli Seam, the Balgownie Seam, and the Bulli Seam are all hydraulically connected in this area through the interconnected goafs. The 0.7 times depth offset between the longwall panels and the FSL has been designed as the primary control and is expected to be effective to control an potential for inflow from Cataract Reservoir into the mine.

7.2.4 Telecommunications Infrastructure

No mining subsidence movements are expected at the site of the telecommunications infrastructure located on Brokers Nose. Nevertheless engagement with the owners of the infrastructure and regular monitoring to confirm that there have been no changes is recommended.

A remotely logged borehole strain cell located in the rock strata between Longwall 1 and the Illawarra Escarpment would provide confirmation of the level of any stress concentrations that may occur. These instruments are more sensitive than conventional survey monitoring in this situation.

7.3 Natural Features

The detail of monitoring of swamps, heritage sites, and creek biota is beyond the scope of this report and has been addressed in other specialist reports.

However, it is recommended that one or more technical committees are formed to design monitoring programs that not only review the changes that may be associated with proposed mining but also take the opportunity to review the longer term impacts from previous mining in the same area. These technical committees should include external expertise from the community where appropriate so that monitoring programs are targeted, appropriate, and can be ongoing.

8. RESPONSE TO SUBMISSIONS

A range of submissions were received in response to the Underground Expansion Project Pt3A. These submissions were received prior to the PPR amendments. The PPR amendments have addressed many of the issues raised. In this section, a number of these issues are discussed in the context of the PPR design and how they have driven the changes that have been made to the design and the design process.

8.1 Accuracy of Prediction

The reduced level of accuracy of the prediction methodology in multi-seam environments was raised in a number of submissions.

While this concern is valid, the recent subsidence monitoring above Longwalls 4 and 5 and a review of previous subsidence monitoring above the Balgownie Seam longwall panels provides a strong basis of local site based experience to allow more accurate predictions to be made.

The subsidence prediction technique used has been updated to reflect the available data. The revised approach is based on using the available data to provide insight in the subsidence mechanics and continuing to develop this understanding recognising the various subsidence processes involved.

The results of this previous monitoring indicate that, although the magnitude of subsidence is greater in a multi-seam environment where there has been previous subsidence of the overburden strata because of the lower shear stiffness of previously disturbed strata, the subsidence behaviour in a multi-seam environment is essentially similar to single seam subsidence in its general characteristics. There are some subtle differences but these are second order effects and do not change the general characteristics. Another difference is that there is potential for pillar instability in areas of standing pillars in overlying seams in some areas and this potential needs to be recognised.

For the most part though, the subsidence mechanics in a multi-seam environment are essentially similar to the mechanics in a single seam environment. Subsidence occurs primarily over the panel being mined with only low levels of ground movement outside. Vertical subsidence occur as low level movements at the goaf edge and become less than 20mm at about 0.7 times depth from the goaf edge. There is softer behaviour evident over previously mined goaf compared to over solid, but the differences are relatively small and tend to soften the movements at the goaf edge. Sag subsidence can be controlled by limiting the width of the panel but the panel widths required to keep subsidence to any given level are much less than in a single seam mining environment because of the reduced bridging capacity of previously disturbed overburden strata.

The issue of pillar instability and recovery of latent subsidence associated with bridging strata at the goaf edge is recognised as having potential to cause additional subsidence. This potential needs to be considered on a site by site basis, but experience of mining the Balgownie Seam longwalls and Longwalls 4 and 5 in the Wongawilli Seam suggest that the potential is less than was initially envisaged and the impacts are of a relatively low level. Nevertheless, an area of standing pillars near the finish of Longwall 1 is recognised as having potential to become destabilised with potential for additional subsidence. Additional monitoring is recommended in this area, but it is noted that any additional subsidence is not expected to have an impact on any surface features of significance.

Although there is somewhat greater uncertainty for subsidence predictions in a multi-seam environment, the available data and further monitoring data is expected to continue to provide a strong base for further understanding. The behaviour observed is repeatable and consistent with the mechanics of the processes involved.

8.2 Geological Structures

There are a number of geological structures located in the general area of the proposed mining, but only two are considered to be significant in the context of the proposed mining. The others are located away from the areas of mining and are not considered to have any significant potential to be affected by mining.

A significant benefit of the previous mining activity is that the dykes and faults through the area are very well defined by previous mining activity. It is not credible that there could be other major structures in the proposed longwall area because any such geological structures would be evident in the overlying seams. This certainty of location of geological features gives this site a significant advantage in terms of potential geological issues.

A dyke referred to as D8 crosses several of the longwall panels and passes close to several others. The dyke is continuous through to the surface and essentially vertical. There is no experience of it being hydraulically conductive or in any way affecting the subsidence behaviour except in so far as the dyke has modified the mine layout which has itself altered the surface subsidence. The Corrimal Fault is located to the south and east of the proposed longwall area and dips to the north. This structure tapers to the west and is not evident in the mine workings in the Bulli Seam from about Longwall 6. This type of tapering behaviour is typical of geological faults in the Southern Coalfield. The Corrimal Fault is not expected to have any significant influence on either subsidence behaviour or the hydraulic conductivity of the overburden strata.

Other faults such as the Rixons Pass Fault and Woonona Fault are remote from the area of mining and are not expected to be affected by mining.

8.3 Pillar Instability in the Bulli Seam

The potential for pillar instability in the Bulli Seam has been discussed above. There is certainly some potential in the vicinity of Longwall 1 and the particular area where this potential exists has been identified as needing special consideration. Other areas where there may be a similar potential are more difficult to identify because the mine records for the period of mining are incomplete and may be inaccurate.

Nevertheless, a large part of the Bulli Seam mine workings have been mined under by the Balgownie Seam longwall panels (1970-1982) and more recently by the Wongawilli Seam longwalls (2012-2013). The subsidence monitoring from both periods of mining indicate that there has been no evidence of a significant subsidence event associated with pillar instability although there are several areas where a low level of additional subsidence has been observed and this is additional subsidence is attributed to recovery of latent subsidence from earlier mining activity.

Even if such instability were to occur, the irregular nature of the panels that have been developed and their limited width mean that the surface subsidence that results is likely to be less than a few hundred millimetres and limited in size to within the area of the panel affected. Such a low level of additional subsidence is within the tolerance of the subsidence predictions that have been made and the impacts associated with any such subsidence would be within the range of predicted impacts.

The Mount Ousley Road is protected by a barrier of approximately 170m and the area adjacent to the Mount Ousley Road has already been mined under by the Balgownie Seam longwall panels so it is not credible that there could be marginally stable pillars in the Bulli Seam still standing in this area.

Some of the tower on the power transmission lines are planned to be subsided up to several metres and the additional subsidence that may result from pillar instability in the Bulli Seam is not considered to have potential to cause any significant additional impacts compared to those that are already planned for.

Although the potential for pillar instability in the Bulli Seam is credible, the significance of any surface subsidence that may result is considered to be low, especially in terms of impacts to major surface infrastructure.

8.4 Valley Closure, Upsidence and Far-Field Movements

The prediction of valley closure, upsidence, and far-field movements is recognised as not being an exact science even for single seam mining. Nevertheless some characteristics are recognised. The influence of horizontal stresses as a source of energy to displace rock strata is dependent on their magnitude. Near to the Illawarra Escarpment and adjacent to previous mining activity as this site is, the in situ horizontal stresses are likely to be significantly diminished both as a result of the free surface of the escarpment and as a result of previous mining activity.

Nevertheless, a far-field subsidence monitoring survey network has been installed and is planned to be further upgraded to allow measurement of any such movements. These movements are unlikely to be significant in the context of any of the infrastructure located in the vicinity of the proposed mining area.

The predictions of valley closure and upsidence are recognised as being upper bound predictions because they are based on experience in deep gorges where the in situ stresses are much higher than they are at this site. A program of predicting, monitoring and response (limiting the length of longwall panels) is considered to be an effective method of managing this uncertainty. The monitoring available from the Balgownie Seam longwall panels and from Longwall 5 indicates that this method is likely to be effective in terms of managing impact on Cataract Creek.

The offsets that have been designed into the revised mine layout and the avoidance of mining directly under the main channel of Cataract Creek provide a buffer against closure related impacts. The commitment by NRE to stop the longwalls short if closure movements become excessive provides an additional level of management control.

8.5 Illawarra Escarpment

There is considered to be no potential for the proposed mining to impact on the Illawarra Escarpment and in particular the section of Hawkesbury Sandstone outcrop at Brokers Nose. It should be recognised that there is always potential for cliff falls to occur naturally as part of the natural erosion processes of cliffs. Two such natural events have occurred in the last six years, one on Mount Keira in 2007 and a second at Clifton in 2013.

The only recognised mechanism for the cliff formations on the Illawarra Escarpment at Brokers Nose to be impacted by mining would be for horizontal stress concentrations to occur along the line of the escarpment. However, the cliffs associated with Brokers Nose are 900-1000m from Longwall 1 and are therefore two far away from the proposed longwall panels for there to be any potential for significant horizontal stress concentrations between the longwall panels and the escarpment.

8.6 Subsidence Management Methods

In the submissions there has been some discussion over the accuracy of the surveying and the adaptive management approach proposed by NRE.

The subsidence monitoring systems being used at NRE are undergoing continued upgrading from two dimensional surveying techniques used during the initial stages of mining Longwall 4 through to full three dimensional subsidence monitoring with a far-field GPS survey control network. The monitoring network used for Longwall 5 is considered to be an intermediate step. Additional monitoring and further upgrading of the monitoring is proposed in this report.

Adaptive management strategies are being practiced by NRE including the significant revision to the mine layout represented by the PPR. Closure monitoring across Cataract Creek is being used to control the length of Longwall 5 and is planned to be used for Longwalls 6 and 7 as well.

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APPENDIX 1 - SUBSIDENCE MOVEMENTS PREDICTED FOR SWAMPS AND ARCHAEOLOGICAL SITES

Seam Depths

Swamp	RL of Bulli Seam Floor (mAHD)	Surface RL (m AHD)	Overburden Depth to Bulli Seam (m)	Overburden Depth to Balgownie Seam (m)	Overburden Depth to Wongawilli Seam (m)
CCUS1	75	360	285	295	320
CCUS2	85	370	285	295	320
CCUS3	55	355	300	310	335
CCUS4	50	340	290	300	325
CCUS5	38	310	272	282	307
CCUS6	65	350	285	295	320
CCUS7	85	355	270	280	305
CCUS8	75	345	270	280	305
CCUS9	52	345	293	303	328
CCUS10	50	330	280	290	315
CCUS11	5	345	310	320	340
CCUS12	15	370	355	365	390
CCUS13	5	340	335	345	370
CCUS14	115	390	275	285	310
CCUS15	60	385	325	335	360
CCUS16	0	300	300	310	335
CCUS17	60	385	325	335	360
CCUS18	60	385	325	335	360
CCUS19	60	385	325	335	360
CCUS20	70	360	290	300	325
CCUS21	70	350	280	290	315
CCUS22	-2	315	317	327	352
CCUS23	55	365	310	320	345
CRUS1	50	350	300	310	335
CRUS2	65	275	210	220	245
CRUS3	80	375	295	305	330
BCUS1	90	360	270	280	305
BCUS2	50	335	285	295	320
BCUS3	50	315	265	275	300
BCUS4	35	330	295	305	330
BCUS5	37	310	273	283	308
BCUS6	17	325	308	318	343
BCUS11	25	360	335	345	370
52-2-3939					340
52-2-3940					340
52-2-3941					355
52-2-0603					380
Wonga East 4					300
Wonga East 5					300
52-3-0320					340
52-3-0325					315
52-3-0311					285
52-3-0310					385
52-2-0099					355
52-2-0229					365

Subsidence Movements after Bulli Seam was Mined

Swamp	Subsidence Used (m)	Overburden Depth (m)	Max Tensile Strain (mm/m)	Max Comp Strain (mm/m)	Max Tilt (mm/m)
CCUS1	0.7	285	3.7	7.4	12
CCUS2	0.1	285	0.5	1.1	2
CCUS3	1	300	5.0	10.0	17
CCUS4	0.1	290	0.5	1.0	2
CCUS5	0.5	272	2.8	5.5	9
CCUS6	1	285	5.3	10.5	18
CCUS7	1	270	5.6	11.1	19
CCUS8	0.1	270	0.6	1.1	2
CCUS9	0.1	293	0.5	1.0	2
CCUS10	0.5	280	2.7	5.4	9
CCUS11	1	340	4.4	8.8	15
CCUS12	0.5	355	2.1	4.2	7
CCUS13	0.1	335	0.4	0.9	1
CCUS14	1	275	5.5	10.9	18
CCUS15	0.1	325	0.5	0.9	2
CCUS16	0.5	300	2.5	5.0	8
CCUS17	0.1	325	0.5	0.9	2
CCUS18	0.1	325	0.5	0.9	2
CCUS19	0.1	325	0.5	0.9	2
CCUS20	1	290	5.2	10.3	17
CCUS21	1	280	5.4	10.7	18
CCUS22	0.5	317	2.4	4.7	8
CCUS23	0.1	310	0.5	1.0	2
CRUS1	0.5	300	2.5	5.0	8
CRUS2	0.5	210	3.6	7.1	12
CRUS3	0.4	295	2.0	4.1	7
BCUS1	1	270	5.6	11.1	19
BCUS2	0.5	285	2.6	5.3	9
BCUS3	0.5	265	2.8	5.7	9
BCUS4	0.5	295	2.5	5.1	8
BCUS5	0.5	273	2.7	5.5	9
BCUS6	0.1	308	0.5	1.0	2
BCUS11	0.5	335	2.2	4.5	7

Site ID	Subs at Site (m)	Adjacent Subsidence Used for Strain and Tilt Calcs (m)	Overburden Depth (m)	Max Tensile Strain (mm/m)	Max Comp Strain (mm/m)	Max Tilt (mm/m)	Compressive Horizontal Movement Along 20m Section of Cliff (mm)
52-2-3939	0.2	0.2	340	0.9	1.8	3	40
52-2-3940	0.1	0.1	340	0.4	0.9	1	20
52-2-3941	0.2	0.2	355	0.8	1.7	3	40
52-2-0603	0.3	0.3	380	1.2	2.4	3.9	50
Wonga East 4	< 0.1	< 0.1	300	< 0.5	< 1	< 2	< 20
Wonga East 5	< 0.1	< 0.1	300	< 0.5	< 1	< 2	< 20
52-3-0320	0.1	0.1	310	0.5	1	2	20
52-3-0325	0.3	0.3	285	1.6	3	5	60
52-3-0311	< 0.1	< 0.1	255	< 0.5	< 1	< 2	< 20
52-3-0310	0.1	0.1	355	0.4	1	1	20
52-2-0099	0.1	0.1	325	0.5	1	2	20
52-2-0229	0.2	0.2	335	0.9	2	3	40

Incremental Subsidence Measured During Balgownie Seam Mining

Swamp	Subsidence Used (m)	Overburden Depth (m)	Max Tensile Strain (mm/m)	Max Comp Strain (mm/m)	Max Tilt (mm/m)
CCUS1	0.8	295	4.1	8.1	14
CCUS2	1	295	5.1	10.2	17
CCUS3	1	310	4.8	9.7	16
CCUS4	0.8	300	4.0	8.0	13
CCUS5	0.1	282	0.5	1.1	2
CCUS6	1	295	5.1	10.2	17
CCUS7	0.1	280	0.5	1.1	2
CCUS8	0.1	280	0.5	1.1	2
CCUS9	0.1	303	0.5	1.0	2
CCUS10	0.1	290	0.5	1.0	2
CCUS11	0.1	340	0.4	0.9	1
CCUS12	0.1	365	0.4	0.8	1
CCUS13	0.1	345	0.4	0.9	1
CCUS14	0.1	285	0.5	1.1	2
CCUS15	0.5	335	2.2	4.5	7
CCUS16	0.1	310	0.5	1.0	2
CCUS17	0.3	335	1.3	2.7	4
CCUS18	0.1	335	0.4	0.9	1
CCUS19	0.1	335	0.4	0.9	1
CCUS20	1	300	5.0	10.0	17
CCUS21	1	290	5.2	10.3	17
CCUS22	0.1	327	0.5	0.9	2
CCUS23	1	320	4.7	9.4	16
CRUS1	0.1	310	0.5	1.0	2
CRUS2	0.1	220	0.7	1.4	2
CRUS3	0.1	305	0.5	1.0	2
BCUS1	0.1	280	0.5	1.1	2
BCUS2	0.1	295	0.5	1.0	2
BCUS3	0.1	275	0.5	1.1	2
BCUS4	0.1	305	0.5	1.0	2
BCUS5	0.1	283	0.5	1.1	2
BCUS6	0.1	318	0.5	0.9	2
BCUS11	0.1	345	0.4	0.9	1

Site ID	Subsidence at Site (m)	Adjacent Subsidence Used for Strain and Tilt Calcs (m)	Overburden Depth (m)	Max Tensile Strain (mm/m)	Max Comp Strain (mm/m)	Max Tilt (mm/m)	Compressive Horizontal Movement Along 20m Section of Cliff (m)
52-2-3939	< 0.1	< 0.1	340	< 0.5	< 1	< 2	< 20
52-2-3940	< 0.1	< 0.1	340	< 0.5	< 1	< 2	< 20
52-2-3941	< 0.1	< 0.1	355	< 0.5	< 1	< 2	< 20
52-2-0603	< 0.1	< 0.1	380	< 0.5	< 1	< 2	< 20
Wonga East 4	< 0.1	< 0.1	300	< 0.5	< 1	< 2	< 20
Wonga East 5	< 0.1	< 0.1	300	< 0.5	< 1	< 2	< 20
52-3-0320	1.1	1.2	320	5.6	11	19	200
52-3-0325	N/A	N/A	295	N/A	N/A	N/A	N/A
52-3-0311	< 0.1	< 0.1	265	< 0.5	< 1	< 2	< 20
52-3-0310	N/A	0.1	365	N/A	N/A	N/A	N/A
52-2-0099	N/A	0.1	335	N/A	N/A	N/A	N/A
52-2-0229	N/A	0.2	345	N/A	N/A	N/A	N/A

Incremental Subsidence for Proposed Mining of Wongawilli Seam

Swamp	Subsidence Used (m)	Overburden Depth (m)	Max Tensile Strain (mm/m)	Max Comp Strain (mm/m)	Max Tilt (mm/m)
CCUS1	1.5	320	7.0	14.1	23
CCUS2	2	320	9.4	18.8	31
CCUS3	1.5	335	6.7	13.4	22
CCUS4	2	325	9.2	18.5	31
CCUS5	1.5	307	7.3	14.7	24
CCUS6	2	320	9.4	18.8	31
CCUS7	0.1	305	0.5	1.0	2
CCUS8	0.1	305	0.5	1.0	2
CCUS9	0.1	328	0.5	0.9	2
CCUS10	0.8	315	3.8	7.6	13
CCUS11	2	340	8.8	17.6	29
CCUS12	1.5	390	5.8	11.5	19
CCUS13	0.1	370	0.4	0.8	1
CCUS14	0.1	310	0.5	1.0	2
CCUS15	0.1	360	0.4	0.8	1
CCUS16	0.1	335	0.4	0.9	1
CCUS17	0.1	360	0.4	0.8	1
CCUS18	0.1	360	0.4	0.8	1
CCUS19	0.1	360	0.4	0.8	1
CCUS20	0.1	325	0.5	0.9	2
CCUS21	2	315	9.5	19.0	32
CCUS22	0.1	352	0.4	0.9	1
CCUS23	1.5	345	6.5	13.0	22
CRUS1	1.5	335	6.7	13.4	22
CRUS2	0.1	245	0.6	1.2	2
CRUS3	0.1	330	0.5	0.9	2
BCUS1	0.1	305	0.5	1.0	2
BCUS2	0.1	320	0.5	0.9	2
BCUS3	0.1	300	0.5	1.0	2
BCUS4	1.5	330	6.8	13.6	23
BCUS5	0.1	308	0.5	1.0	2
BCUS6	0.1	343	0.4	0.9	1
BCUS11	1.5	370	6.1	12.2	20

Site ID	Subsidence at Site (m)	Adjacent Subsidence Used for Strain and Tilt Calcs (m)	Overburden Depth (m)	Max Tensile Strain (mm/m)	Max Comp Strain (mm/m)	Max Tilt (mm/m)	Compressive Horizontal Movement Along 20m Section of Cliff (m)
52-2-3939	0.8	2	340	8.8	18	29	350
52-2-3940	0.6	1.5	340	6.6	13	22	250
52-2-3941	1.2	1.5	340	6.6	13	22	250
52-2-0603	1.5	1.5	340	6.6	13	22	250
Wonga East 4	< 0.1	< 0.1	300	< 0.5	< 1	< 2	< 20
Wonga East 5	< 0.1	< 0.1	300	< 0.5	< 1	< 2	< 20
52-3-0320	0.7	2	340	8.8	18	29	350
52-3-0325	1.1	1.5	315	7.1	14	24	250
52-3-0311	< 0.1	< 0.1	285	< 0.5	< 1	< 2	< 20
52-3-0310	< 0.1	< 0.1	385	< 0.5	< 1	< 2	< 20
52-2-0099	0.4	1	355	4.2	8	14	150
52-2-0229	0.7	1	365	4.1	8	14	150

Cumulative Subsidence at the Completion of Bulli and Balgownie Seam Mining

Swamp	Subsidence Used (m)	Overburden Depth (m)	Max Tensile Strain (mm/m)	Max Comp Strain (mm/m)	Max Tilt (mm/m)
CCUS1	2	285	10.5	21.1	35
CCUS2	1.1	285	5.8	11.6	19
CCUS3	1.1	300	5.5	11.0	18
CCUS4	0.9	290	4.7	9.3	16
CCUS5	0.6	272	3.3	6.6	11
CCUS6	2	285	10.5	21.1	35
CCUS7	1	270	5.6	11.1	19
CCUS8	0.1	270	0.6	1.1	2
CCUS9	0.1	293	0.5	1.0	2
CCUS10	0.6	280	3.2	6.4	11
CCUS11	1	340	4.4	8.8	15
CCUS12	0.5	355	2.1	4.2	7
CCUS13	0.1	335	0.4	0.9	1
CCUS14	1.2	275	6.5	13.1	22
CCUS15	0.2	325	0.9	1.8	3
CCUS16	0.5	300	2.5	5.0	8
CCUS17	0.1	325	0.5	0.9	2
CCUS18	0.1	325	0.5	0.9	2
CCUS19	0.1	325	0.5	0.9	2
CCUS20	2	290	10.3	20.7	34
CCUS21	2	280	10.7	21.4	36
CCUS22	0.5	317	2.4	4.7	8
CCUS23	0.9	310	4.4	8.7	15
CRUS1	0.5	300	2.5	5.0	8
CRUS2	0.6	210	4.3	8.6	14
CRUS3	0.6	295	3.1	6.1	10
BCUS1	1	270	5.6	11.1	19
BCUS2	0.5	285	2.6	5.3	9
BCUS3	0.5	265	2.8	5.7	9
BCUS4	0.6	295	3.1	6.1	10
BCUS5	0.5	273	2.7	5.5	9
BCUS6	0.1	308	0.5	1.0	2
BCUS11	0.5	335	2.2	4.5	7

Site ID	Subsidence at Site (m)	Adjacent Subsidence Used for Strain and Tilt Calcs (m)	Overburden Depth (m)	Max Tensile Strain (mm/m)	Max Comp Strain (mm/m)	Max Tilt (mm/m)	Compressive Horizontal Movement Along 20m Cliff (m)
52-2-3939	0.2	0.7	340	3.1	6.2	10	120
52-2-3940	0.1	0.7	340	3.1	6.2	10	120
52-2-3941	0.2	0.7	355	3.0	5.9	10	120
52-2-0603	0.3	0.6	380	2.4	4.7	7.9	120
Wonga East 4	< 0.1	< 0.1	300	< 0.5	< 1	< 2	< 20
Wonga East 5	< 0.1	< 0.1	300	< 0.5	< 1	< 2	< 20
52-3-0320	1.1	1.2	320	5.6	11	19	200
52-3-0325	0.3	0.3	315	1.4	3	5	60
52-3-0311	< 0.1	< 0.1	285	< 0.5	< 1	< 2	< 20
52-3-0310	0.1	0.1	385	0.4	1	1	20
52-2-0099	0.1	0.1	355	0.4	1	1	20
52-2-0229	0.2	0.2	365	0.8	2	3	40

Total Cumulative Subsidence at Completion of Bulli, Balgownie and Wongawilli Seam Mining

Swamp	Subsidence Used (m)	Overburden Depth (m)	Max Tensile Strain (mm/m)	Max Comp Strain (mm/m)	Max Tilt (mm/m)
CCUS1	2	285	10.5	21.1	35
CCUS2	3	285	15.8	31.6	53
CCUS3	2.5	300	12.5	25.0	42
CCUS4	2.4	290	12.4	24.8	41
CCUS5	1.8	272	9.9	19.9	33
CCUS6	3.8	285	20.0	40.0	67
CCUS7	1	270	5.6	11.1	19
CCUS8	0.1	270	0.6	1.1	2
CCUS9	0.1	293	0.5	1.0	2
CCUS10	1.5	280	8.0	16.1	27
CCUS11	3	340	13.2	26.5	44
CCUS12	1.5	355	6.3	12.7	21
CCUS13	0.1	335	0.4	0.9	1
CCUS14	1.3	275	7.1	14.2	24
CCUS15	0.2	325	0.9	1.8	3
CCUS16	0.5	300	2.5	5.0	8
CCUS17	0.1	325	0.5	0.9	2
CCUS18	0.1	325	0.5	0.9	2
CCUS19	0.1	325	0.5	0.9	2
CCUS20	2	290	10.3	20.7	34
CCUS21	3.8	280	20.4	40.7	68
CCUS22	0.5	317	2.4	4.7	8
CCUS23	2.1	310	10.2	20.3	34
CRUS1	0.8	300	4.0	8.0	13
CRUS2	0.6	210	4.3	8.6	14
CRUS3	0.6	295	3.1	6.1	10
BCUS1	1	270	5.6	11.1	19
BCUS2	0.5	285	2.6	5.3	9
BCUS3	0.5	265	2.8	5.7	9
BCUS4	2	295	10.2	20.3	34
BCUS5	0.5	273	2.7	5.5	9
BCUS6	0.1	308	0.5	1.0	2
BCUS11	2	335	9.0	17.9	30

SiteID	Subs at Site (m)	Adjacent Subsidence Used for Strain and Tilt Calcs (m)	Overburden Depth (m)	Max Tensile Strain (mm/m)	Max Comp Strain (mm/m)	Max Tilt (mm/m)	Compressive Horizontal Movement Along 20m Section of Cliff (m)
52-2-3939	1	2.4	340	10.6	21.2	35	450
52-2-3940	0.7	1.6	340	7.1	14.1	24	300
52-2-3941	1.4	1.6	355	6.8	13.5	23	250
52-2-0603	1.8	1.8	380	7.1	14.2	23.7	300
Wonga East 4	< 0.1	< 0.1	300	< 0.5	< 1	< 2	< 20
Wonga East 5	< 0.1	< 0.1	300	< 0.5	< 1	< 2	< 20
52-3-0320	1.8	3.2	340	14.1	28	47	450
52-3-0325	1.4	1.8	315	8.6	17	29	250
52-3-0311	< 0.1	< 0.1	285	< 0.5	< 1	< 2	< 20
52-3-0310	< 0.1	< 0.1	385	< 0.5	< 1	< 2	< 20
52-2-0099	0.5	1	355	4.2	8	14	150
52-2-0229	0.9	1	365	4.1	8	14	150

ATTACHMENT C – Underground Expansion Project: Preferred Project Report – Heritage

NRE No. 1 Colliery – Underground Expansion Project:

Preferred Project Report – Heritage

FINAL REPORT

Prepared for Gujarat NRE Coking Coal Ltd

24 September 2013

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SCT Consultants: Ken Mills

The following Biosis staff were involved in this project:

Ashleigh Pritchard for mapping

Nathan Garvey and Asher Ford for review and quality assurance

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1. Introduction

1.1 Project background

NRE No. 1 Colliery is located at Russell Vale, to the west of Bellambi, in the Illawarra region of New South Wales (NSW) (see Figure 1). NRE purchased the Colliery in December 2004, but extensive underground mining has been undertaken within the Colliery holdings dating from the late nineteenth century. However, a substantial volume of high quality coking coal resources remains along with some potential thermal coal resources.

The Colliery holding includes a number of sub leases between NRE and surrounding mine operators, including Consolidated Coal Lease (CCL) 745, Mining Purposes Lease (MPL) 271 and Mining Lease (ML) 1575, and covers a total area of approximately 6,973 hectares (ha).

Originally, NRE intended to expand its operations in two stages. Stage 1 plans were included in the Preliminary Works Part 3A project application that was approved on 13 October 2011, allowing some first workings coal extraction and surface facility upgrades. On 24 December 2012, the Preliminary Works Part 3A project was modified to allow the extraction of Longwalls 4 and 5 and the establishment of Maingate 6.

The original Stage 2 application, known as the Underground Expansion Project Part 3A, was lodged with the NSW Department of Planning and Infrastructure (DP&I) on 12 August 2009 and contained an application to extract 11 longwalls in the Wonga East area and 7 longwalls in the Wonga West area along with surface facilities upgrades to allow production up to 3 million tonnes per annum (Mtpa) for up to 20 years. Since that time it has been progressing through the Major Project approvals process and was placed on Public Exhibition on 18 February 2013. As a result of the submissions received on the application, NRE has made the decision to substantially revise the application to facilitate the approval process and allow continuity in operations. Due to the scope of the changes, the DP&I request NRE prepare a Preferred Project Report (PPR) for the revised Underground Expansion Project Part 3A.

The Preferred Project report (NRE 2013) outlines the revised Underground Expansion Project which has been reduced to a five year interim stage project, with extraction of eight longwalls in the Wonga East area and upgrading of surface facilities to manage an extraction rate of up to 3 Mtpa run of mine (ROM) coal per annum. The original Wonga West longwall extraction will be resubmitted to DP&I as a separate application.

This report provides revised impact assessments for Aboriginal cultural heritage sites (Section 3). A response to submissions received is provided in Section 4.

1.2 Scope of assessment

The objectives of this report are to:

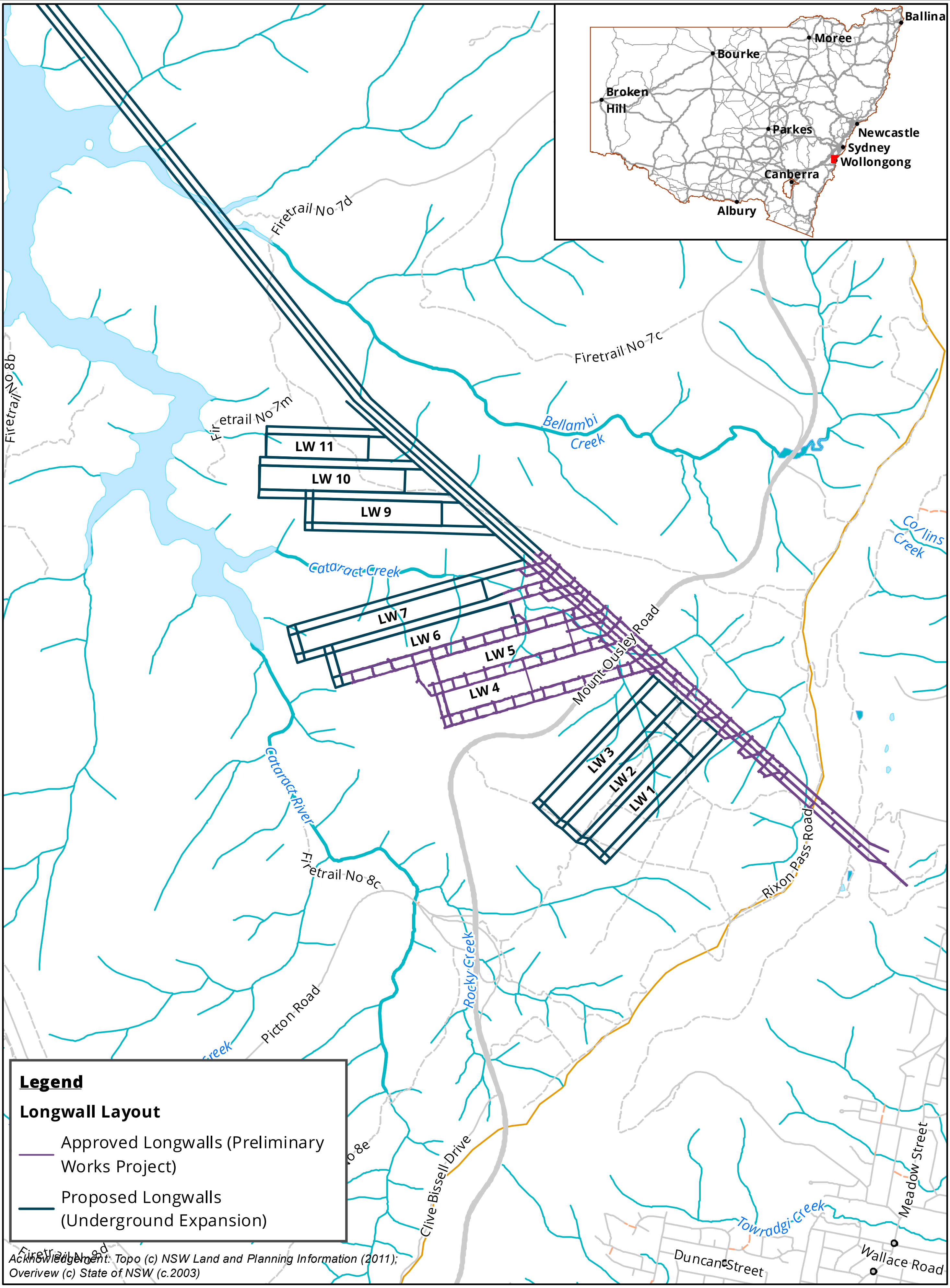
- Provide details of changes to the original project relevant to cultural heritage;
- Prepare revised impact assessments based on these changes, including revised subsidence predictions; and
- Provide a response to submission received on the original EA (ERM 2013) based on the changes outlined above.

1.3 Aboriginal Stakeholder Consultation

ERM (2012) undertook Aboriginal stakeholder consultation in accordance with the OEH 2005 *Interim Community Consultation Requirements Guideline*. Consultation for the project commenced in October 2008 with five Aboriginal groups registered for the project. Section 2 and Annex U of the ERM (2012) details the Aboriginal Community Consultation undertaken.

As part of this PPR report, and to address comments received from the NSW Office of Environment and Heritage (OEH) in their submission, Biosis has continued consultation with the groups registered for the project. To facilitate an assessment of the cultural values associated with re-located and newly identified sites, Aboriginal stakeholders participated in a series of site visits conducted between 4 and 6 September 2013. These site visits were attended by representatives of the Northern Illawarra Aboriginal Collective (NIAC), Kullila Site Consultants (KSC), Peter Falk Consultancy (PFC), Illawarra Local Aboriginal Land Council (ILALC) and Wodi Wodi Elders Corporation (WWEC).

Copies of the draft this PPR report will be sent to all registered Aboriginal groups for feedback on the content, assessment and recommendations. All comments received from these groups will be appended to this report, when received.



Acknowledgement: Topo (c) NSW Land and Planning Information (2011); Overivew (c) State of NSW (c.2003)

Figure 1: Location of the Study Area, New South Wales

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2. Preferred Project Changes

After serious consideration of the community and agency submissions, NRE has decided to modify its Underground Expansion Project Part 3A application in the following manner:

1. The Wonga East longwall layout will be modified to minimise impacts to identified significant features while recovering the maximum volume of coal reserves possible.
2. The Wonga Mains driveage will not be extended northwards under the south arm of Cataract Reservoir through the known geological feature (in the Bulli Seam).
3. The Wonga West longwalls will be removed from this application and resubmitted as a separate application.
4. No change to the Pit Top from the original proposal.

A more detailed summary comparing the original proposal presented in the Environmental Assessment with the current Preferred Project is presented in Table 1 and Figure 2.

Table 1: Detailed Summary of Project Changes

Project Area	Original Project	PPR
Project Application Area	• As per Figure 1.2 of Underground Expansion Project Environmental Assessment	• No changes proposed
Production Limit	• 3 Mtpa	• No changes proposed
Pit Top	• Two new stockpiles of 140,000 tonnes capacity each (SP2 & SP3) with associated reclaim facilities • New truck loading facilities • Designated coal dispatch road • Progressive upgrading of trucking fleet • Continued road haulage of ROM coal to the Port Kembla Coal Terminal. • 6ML Settling Pond • Continuing use of No.4 Shaft for mine access, bathhouse, parking and offices • Ongoing maintenance and refurbishment of ventilation shafts, water and electrical facilities.	• No changes proposed

Project Area	Original Project	PPR
	• Ongoing geological and geotechnical investigations to determine coal quality and geotechnical conditions using drilling and related techniques.	
Wonga East Longwalls	• 9 longwalls (LW) in two Areas – Area 1 – LW's 1-3 – Area 2 – LW's 6-11	• 8 longwalls in two Areas (see Figure 2). – Area 1 – LW's 1-3 shortened and reoriented to the southwest – Area 2 – LW 6 shortened – Area 2 – LW7 shortened and moved slightly south east – Area 2 – LW 8 removed – Area 2 – LW9-11 shortened and reoriented to the northwest
Wonga Mains	• Mains drivage from the end of the Preliminary Works approved drivage heading north west, beneath Cataract Reservoir to bisect the proposed Wonga West Areas 3 and 4.	• Mains drivage from the end of the Preliminary Works approved drivage heading west-northwest to what was the southern end of Wonga West Area 3.
Wonga West Longwalls	• 7 longwalls in two Areas – Area 3 – LW's 1-5 – Area 4 – LW's 6-7	• Removed from this application. To be resubmitted as a separate application to Department of Planning and Infrastructure.
Bulli West - Bulli Seam 1st Workings	• 1st workings to the Bulli Seam to access the Bulli Seam in the western area of the Project Application Area.	• No changes proposed
Balgownie Seam 1st Workings	• 1st workings in the Balgownie Seam to access the Balgownie Seam in the western area of the Project Application Area.	• No changes proposed

For further detail see Section 1 of the PPR report (NRE 2013).

These changes and subsequent investigations have resulted in the following changes to predicted impacts to Aboriginal cultural heritage sites in the Wonga East area:

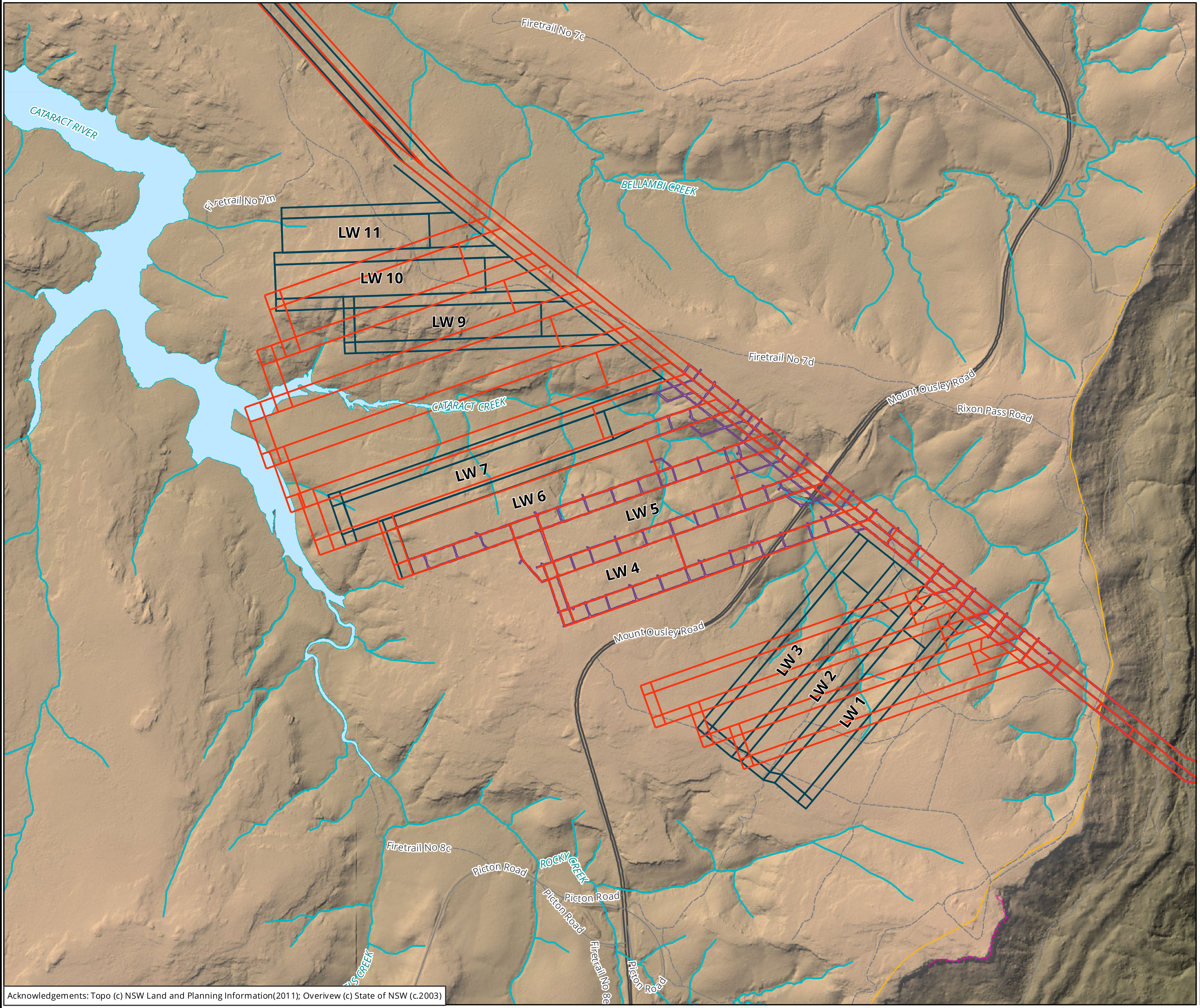
- Re-location of Aboriginal cultural heritage sites within Wonga East study area and revised locations in relation to impact footprint;
- Newly identified Aboriginal cultural heritage sites within the Wonga East study area not considered in ERM (2012) or ERM (2013);
- Changes in the location, orientation, length and width of long wall panels and reduction to the number of Aboriginal cultural heritage sites that will be undermined; and
- Changes in impacts to Aboriginal cultural heritage sites based on revised subsidence predictions.

A summary of changes relating to Aboriginal cultural heritage sites is detailed in Table 2 and Figure 3. A revised summary of Aboriginal cultural heritage sites, their significance and predicted impacts is presented in Section 3.

Table 2: Aboriginal sites in Wonga East, showing their status (relocated or not) and previous and current location with regards to long wall layout

Site	Status	Previous location in relation to Longwalls	Current location in relation to Longwalls
All Aboriginal sites in Wonga West	-	Located within Wonga West area	No longer part of the project
52-2-0083	Relocated (current surveys)	Located above chain pillar of LW10	Located outside of longwalls, but within 600m study area
52-2-0099	Cannot be relocated	Located outside of longwalls, but within 600m study area	Located above LW10
52-2-0229	Cannot be relocated	Located outside of longwalls, but within 600m study area	Located above LW10
52-2-0233	Cannot be relocated	Located outside of longwalls, but within 600m study area	Located outside of longwalls, but within 600m study area
52-2-0603	Relocated (ERM 2012)	Located outside of longwalls, but within 600m study area	Located outside of longwalls, but within 600m study area
52-2-1081	Relocated (current surveys)	Located outside of longwalls, but within 600m study area	No longer located within 600m study area
52-2-1082	Relocated (current surveys)	Located outside of longwalls, but within 600m study area	No longer located within 600m study area
52-2-1095	Relocated (current surveys)	Located outside of longwalls, but within 600m study area	No longer located within 600m study area
52-2-3939	New site (Biosis 2012)	Located above LW10	Located above LW8
52-2-3940	New site (Biosis 2012)	Located above LW10	Located above LW8

Site	Status	Previous location in relation to Longwalls	Current location in relation to Longwalls
52-2-3941	New site (Biosis 2012)	Located above LW10	Located above LW8
52-3-0310	Relocated (ERM 2012)	Located outside of longwalls, but within 600m study area	Located outside of longwalls, but within 600m study area
52-3-0311	Relocated (current surveys)	Located above LW9	Located outside of longwalls, but within 600m study area
52-3-0312	Relocated (ERM 2012)	Located outside of longwalls, but within 600m study area	Located outside of longwalls, but within 600m study area
52-3-0313	Relocated (ERM 2012)	Located above LW1	Located outside of longwalls, but within 600m study area
52-3-0314	Relocated (ERM 2012)	Located outside of longwalls, but within 600m study area	Located outside of longwalls, but within 600m study area
52-3-0317	Relocated (Biosis 2012)	Located outside of longwalls, but within 600m study area	Located outside of longwalls, but within 600m study area
52-3-0318	Relocated (Biosis 2012)	Located outside of longwalls	No longer located within 600m study area
52-3-0319	Relocated (ERM 2012)	Located outside of longwalls, but within 600m study area	Located outside of longwalls, but within 600m study area
52-3-0320	Cannot be relocated	Located above chain pillar between LW4 and LW5	No change
52-3-0322	Relocated (Biosis 2012)	Located outside of longwalls, but within 600m study area	No change
52-3-0323	Relocated (current surveys)	Located above chain pillar between LW 7 and LW 8	Located outside of longwalls, but within 600m study area
52-3-0325	Relocated (current surveys)	Located above chain pillar between LW 6 and LW 7	Located above LW7
Wonga 4	New site (current surveys)	-	Located outside of longwalls, but within 600m study area
Wonga 5	New site (current surveys)		Located outside of longwalls, but within 600m study area



Legend

Previous Wonga East Longwalls

Longwall Layout

Approved Longwalls (Preliminary Works Project)

Proposed Longwalls (Underground Expansion)

Figure 2: Proposed PPR mine plan

0 150 300 450 600 750

Metres

Scale: 1:15,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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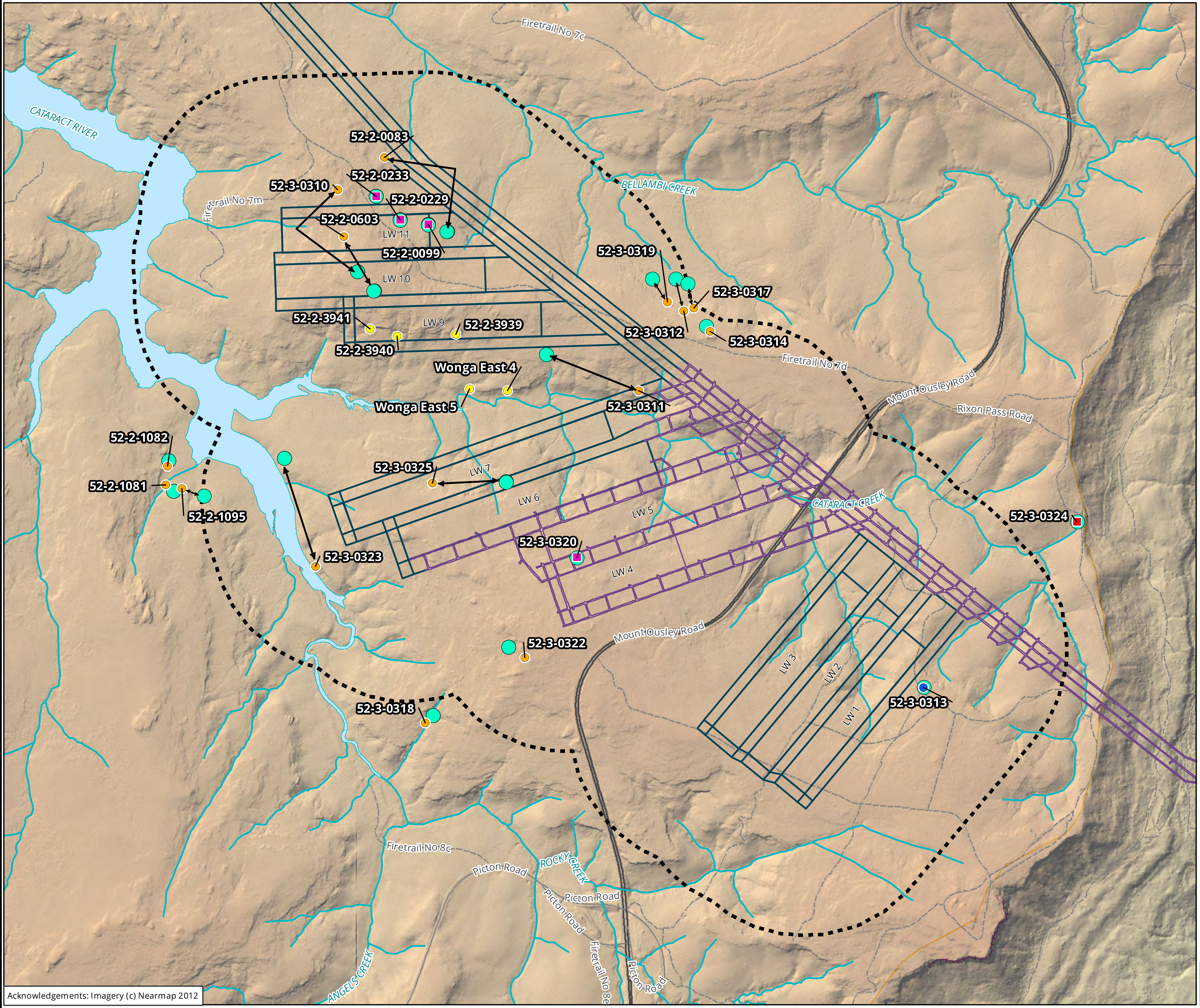

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Sites Located by Biosis

- Relocated
- In Recorded Location
- New Site
- Not Relocated
- Not Surveyed

Site Locations (ERM 2012)

- GA Site Locations

Longwall Layout

- Approved Longwalls (Preliminary Works Project)
- Proposed Longwalls (Underground Expansion)
- 600m Study Area

Figure 3: Aboriginal cultural heritage sites in Wonga East, documenting their status, previous and current location in comparison to the current impact footprint

0 150 300 450 600 750

Metres

Scale: 1:15,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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3. Revised Impact Assessments

Changes to the project from that proposed in the original Aboriginal heritage assessment (ERM 2012), project application and EA (ERM 2013) necessitate a revision of the impact and significance assessments for the project. The heritage features of the study area are described below and mapped in Figure 4.

3.1 Cultural Heritage Sites

The EA and Aboriginal heritage assessment (ERM 2013; ERM 2012) state that a total of twenty-three sites are located in the Wonga East study area, seventeen of which would not be impacted by mine subsidence. ERM (2012) were able to relocate a total of nine sites within Wonga East. Since this time Biosis has undertaken an extensive relocation program and relocated an additional ten sites and identified five new sites; however four sites (all grinding grooves) remain unaccounted for (Biosis 2012, Biosis *in prep*). Four sites assessed by ERM (2012) are no longer located within the study area. A summary of the twenty-one Aboriginal sites located within Wonga East study area is contained within Table 3, site locations are displayed in Figure 4.

Table 3: Aboriginal sites within Wonga East

Sites in bold are located within the 200 mm subsidence impact footprint; all other sites are located within the 600m study area buffer.

Site	Name	Context	Site Type
52-2-0083	Bulli Mine Shaft Site 7	Enclosed Shelter	Shelter with Deposit
52-2-0099	**Bulli Mine Shaft Site 8**	**Open Site**	**Axe grinding grooves**
52-2-0229	**Bulli Mine Shaft Site 12**	**Open Site**	**Axe grinding grooves**
52-2-0233	Bulli Mine Shaft Site 13	Open Site	Axe grinding grooves
52-2-0603	**Bulli Mine Shaft Site 19**	**Enclosed Shelter**	**Shelter with Art and Artefact**
52-2-3939	**Wonga East 1**	**Enclosed Shelter**	**Shelter with Deposit**
52-2-3940	**Wonga East 2**	**Enclosed Shelter**	**Shelter with Deposit**
52-2-3941	**Wonga East 3**	**Enclosed Shelter**	**Shelter with Deposit**
52-3-0310	Bulli Mine Shaft Site 18	Enclosed Shelter	Shelter with Art, Deposit and axe grinding grooves
52-3-0311	Bulli Mine Shaft Site 20	Enclosed Shelter	Shelter with Deposit
52-3-0312	Bulli Mine Shaft Site 23	Enclosed Shelter	Shelter with Deposit
52-3-0313	Bulli Mine Shaft Site 29	Open Site	Open Camp Site
52-3-0314	Bulli Mine Shaft Site 21	Enclosed Shelter	Shelter with Art
52-3-0317	Bulli Mine Shaft Site 22	Enclosed Shelter	Shelter with Deposit
52-3-0319	Bulli Mine Shaft Site 24	Enclosed Shelter	Shelter with Deposit
52-3-0320	**Bulli Mine Shaft Site 25**	**Open Site**	**Axe grinding grooves**
52-3-0322	Bulli Mine Shaft Site 31	Open Site	Axe grinding grooves
52-3-0323	Bulli Mine Shaft Site 26	Enclosed Shelter	Shelter with Deposit
52-3-0325	**Bulli Mine Shaft Site 27**	**Enclosed Shelter**	**Shelter with Art and Deposit**
n/a	Wonga East 4	Enclosed Shelter	Shelter with Deposit

Site	Name	Context	Site Type
n/a	Wonga East 5	Enclosed Shelter	Shelter with Stone Arrangement

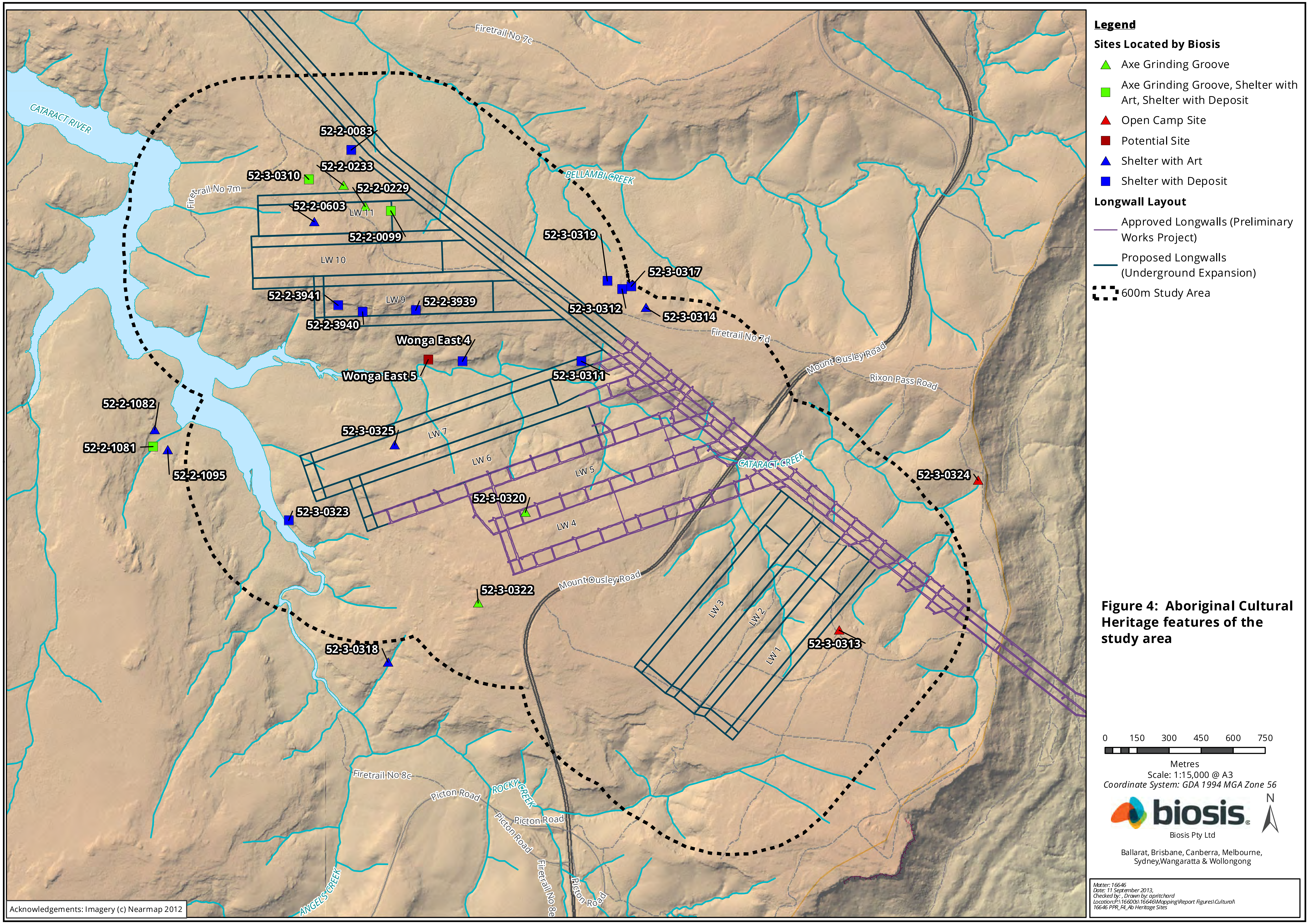

Figure 4: Aboriginal Cultural Heritage features of the study area

3.2 Significance Assessment

In order to inform the revised impact assessment it is necessary to consider the significance of Aboriginal Cultural heritage sites within Wonga East. The high volume of re-identified and new sites has necessitated the re-assessment of scientific significance. The assessment of scientific significance for Aboriginal sites in the Study Area has used a different methodology from the ERM Aboriginal Heritage Assessment (2012) and, as a result, the scientific significance for all sites has been reassessed.

The two main values addressed when assessing the significance of Aboriginal sites are cultural values to the Aboriginal community and archaeological (scientific) values. This report will assess scientific values while the Aboriginal Cultural Heritage Assessment Report will detail the cultural values of Aboriginal sites in the Project Area.

3.3 Introduction to the Assessment Process

Heritage assessment criteria in NSW fall broadly within the significance values outlined in the Australia International Council on Monuments and Sites (ICOMOS) Burra Charter (Australia ICOMOS 1999). This approach to heritage has been adopted by cultural heritage managers and government agencies as the set of guidelines for best practice heritage management in Australia. These values are provided as background and include:

Historical significance (evolution and association) refers to historic values and encompasses the history of aesthetics, science and society, and therefore to a large extent underlies all of the terms set out in this section. A place may have historic value because it has influenced, or has been influenced by, an historic figure, event, phase or activity. It may also have historic value as the site of an important event. For any given place the significance will be greater where evidence of the association or event survives in situ, or where the settings are substantially intact, than where it has been changed or evidence does not survive. However, some events or associations may be so important that the place retains significance regardless of subsequent treatment.

Aesthetic significance (Scenic/architectural qualities, creative accomplishment) refers to the sensory, scenic, architectural and creative aspects of the place. It is often closely linked with social values and may include consideration of form, scale, colour, texture, and material of the fabric or landscape, and the smell and sounds associated with the place and its use.

Social significance (contemporary community esteem) refers to the spiritual, traditional, historical or contemporary associations and attachment that the place or area has for the present-day community. Places of social significance have associations with contemporary community identity. These places can have associations with tragic or warmly remembered experiences, periods or events. Communities can experience a sense of loss should a place of social significance be damaged or destroyed. These aspects of heritage significance can only be determined through consultative processes with local communities.

Scientific significance (Archaeological, industrial, educational, research potential and scientific significance values) refers to the importance of a landscape, area, place or object because of its archaeological and/or other technical aspects. Assessment of scientific value is often based on the likely research potential of the area, place or object and will consider the importance of the data involved, its rarity, quality or representativeness, and the degree to which it may contribute further substantial information.

The cultural and archaeological significance of Aboriginal and historic sites and places is assessed on the basis of the significance values outlined above. As well as the ICOMOS Burra Charter significance values guidelines, various government agencies have developed formal criteria and guidelines that have application when assessing the significance of heritage places within NSW. Of primary interest are guidelines prepared by the

Commonwealth Department of the Environment, Water, Heritage and the Arts (DEWHA), the OEH and the Heritage Branch, NSW Department of Planning. The relevant sections of these guidelines are presented below.

These guidelines state that an area may contain evidence and associations which demonstrate one or any combination of the ICOMOS Burra Charter significance values outlined above in reference to Aboriginal heritage. Reference to each of the values should be made when evaluating archaeological and cultural significance for Aboriginal sites and places.

In addition to the previously outlined heritage values, the OEH Guidelines (DECC 2006) also specify the importance of considering cultural landscapes when determining and assessing Aboriginal heritage values. The principle behind a cultural landscape is that 'the significance of individual features is derived from their inter-relatedness within the cultural landscape'. This means that sites or places cannot be 'assessed in isolation' but must be considered as parts of the wider cultural landscape. Hence the site or place will possibly have values derived from its association with other sites and places. By investigating the associations between sites, places, and (for example) natural resources in the cultural landscape the stories behind the features can be told. The context of the cultural landscape can unlock 'better understanding of the cultural meaning and importance' of sites and places.

Although other values may be considered – such as educational or tourism values – the two principal values that are likely to be addressed in a consideration of Aboriginal sites and places are the cultural/social significance to Aboriginal people and their archaeological or scientific significance to archaeologists. The determinations of archaeological and cultural significance for sites and places should then be expressed as statements of significance that preface a concise discussion of the contributing factors to Aboriginal cultural heritage significance.

3.4 Archaeological (Scientific Significance) Values

Archaeological significance (also called scientific significance, as per the ICOMOS Burra Charter) refers to the value of archaeological objects or sites as they relate to research questions that are of importance to the archaeological community, including indigenous communities, heritage managers and academic archaeologists. Generally the value of this type of significance is determined on the basis of the potential for sites and objects to provide information regarding the past life-ways of people (Burke and Smith 2004: 249, NPWS 1998). For this reason, the NPWS (part of DECC) summarises the situation as 'while various criteria for archaeological significance assessment have been advanced over the years, most of them fall under the heading of archaeological research potential' (NPWS 1998: 26). The NPWS criteria for archaeological significance assessment are based largely on the ICOMOS Burra Charter.

3.4.1 Research Potential

Research potential is assessed by examining site content and site condition. Site content refers to all cultural materials and organic remains associated with human activity at a site. Site content also refers to the site structure – the size of the site, the patterning of cultural materials within the site, the presence of any stratified deposits and the rarity of particular artefact types. As the site contents criterion is not applicable to scarred trees, the assessment of scarred trees is outlined separately below. Site condition refers to the degree of disturbance to the contents of a site at the time it was recorded.

The site contents ratings used for archaeological sites are:

0 No cultural material remaining.

1 Site contains a small number (e.g. 0–10 artefacts) or limited range of cultural materials with no evident stratification. Art is in poor condition and a small number of motifs are present.

2 Site contains a larger number, but limited range of cultural materials and/or motifs; and/or some intact stratified deposit remains; and/or are or unusual example(s) of a particular artefact, material, art technique or motif type.

3 Site contains a large number and diverse range of cultural materials and/or art techniques and motifs; and/or largely intact stratified deposit; and/or surface spatial patterning of cultural materials that still reflect the way in which the cultural materials were deposited.

The site condition ratings used for archaeological sites are:

0 Site destroyed.

1 Site in a deteriorated condition with a high degree of disturbance; lack of stratified deposits; some cultural materials remaining.

2 Site in a fair to good condition, but with some disturbance.

3 Site in an excellent condition with little or no disturbance. For surface artefact scatters this may mean that the spatial patterning of cultural materials still reflects the way in which the cultural materials were laid down.

Pearson and Sullivan note that Aboriginal archaeological sites are generally of high research potential because 'they are the major source of information about Aboriginal prehistory' (1995: 149). Indeed, the often great time depth of Aboriginal archaeological sites gives them research value from a global perspective, as they are an important record of humanity's history. Research potential can also refer to specific local circumstances in space and time – a site may have particular characteristics (well preserved samples for absolute dating, or a series of refitting artefacts, for example) that mean it can provide information about certain aspects of Aboriginal life in the past that other less or alternatively valuable sites may not (Burke and Smith 2004: 247-8). When determining research potential value particular emphasis has been placed on the potential for absolute dating of sites.

The following sections provide statements of significance for the Aboriginal archaeological sites recorded during the assessment. The significance of each site follows the assessment process outlined above. This includes a statement of significance based on the categories defined in the Burra Charter. These categories include social, historic, scientific, aesthetic and cultural (in this case archaeological) landscape values. Nomination of the level of value—high, moderate, low or not applicable—for each relevant category is also proposed. Where suitable the determination of cultural (archaeological) landscape value is applied to both individual sites and places (to explore their associations) and also, to the Study Area as a whole. The nomination levels for the archaeological significance of each site are summarised below.

3.4.2 Representativeness

Representativeness refers to the regional distribution of a particular site type. Representativeness is assessed by whether the site is common, occasional, or rare in a given region. Assessments of representativeness are subjectively biased by current knowledge of the distribution and number of archaeological sites in a region. This varies from place to place depending on the extent of archaeological research. Consequently, a site that is assigned low significance values for contents and condition, but a high significance value for representativeness, can only be regarded as significant in terms of knowledge of the regional archaeology. Any such site should be subject to re-assessment as more archaeological research is undertaken.

Assessment of representativeness also takes into account the contents and condition of a site. For example, in any region there may only be a limited number of sites of any type that have suffered minimal disturbance.

Such sites would therefore be given a high significance rating for representativeness, although they may occur commonly within the region.

The representativeness ratings used for considers the site type and its contents in regards to other archaeological sites in the region and is considered as follows:

1 common occurrence

2 occasional occurrence

3 rare occurrence

Overall scientific significance ratings for sites, based on a cumulative score for site contents, site integrity and representativeness are:

1-3 low scientific significance

4-6 moderate scientific significance

7-9 high scientific significance

Each site is given a score on the basis of these criteria – the overall scientific significance is determined by the cumulative score. This scoring procedure has been applied to the Aboriginal archaeological sites identified during the sub-surface testing. The results are presented in Table 4.

3.5 Statements of Scientific Significance

The following scientific (archaeological) significance assessment is based on Requirement 11 of the *Code of practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (DECCW 2010). Using the assessment criteria detailed in Section 3.4, an assessment of significance was determined and a rating for each site was determined. The results of the archaeological significance assessment are given in Table 4 below.

Table 4: Scientific significance assessment of archaeological sites recorded within the Study Area.

Site	Site Type	Site Content	Site Condition	Representativeness	Scientific Significance	Statement of Significance
52-2-0083	Shelter with Deposit	2	2	1	5 - Moderate	52-2-0083 is a shelter with deposit site. Five artefacts were identified including chert, silcrete and quartz flakes. A yellowish sandy deposit with a depth of 30cm has accumulated in a 1 x 2m area of the shelter. The site is a typical example of a common site type in the region and is of moderate scientific significance due to its preservation and lack of disturbance.
52-2-0099	Axe grinding grooves	1	1	1	3 - Low	52-2-0099 is a grinding groove site. Three grinding grooves were located on a sandstone outcrop measuring 8m x 4m. The site is an example of a common site type in the region with poorly preserved features and is of low scientific significance.
52-2-0229	Axe grinding grooves	1	1	1	3 - Low	52-3-0229 is a grinding groove site. The site was recorded as a single grinding groove located within a sandstone outcrop measuring 18 x 2m. The site is recorded as being in reasonable condition. The site is an example of a common site type in the region with poorly preserved features and is of low scientific significance.
52-2-0233	Axe grinding grooves	1	1	1	3 - Low	52-3-0233 is a grinding groove site. The site was recorded as two grinding grooves located within a sandstone outcrop measuring approximately 18 x 4m. The site is recorded as being in reasonable condition. The site is an example of a common site type in the region with poorly preserved features and is of low scientific significance.
52-2-0603	Shelter with Art and Artefact	1	1	1	3 - Low	52-2-0603 is a shelter with art, no identified deposit and a single artefact. The art is located on two panels on the rear wall and consists of a single red ochre hand stencil and a separate indeterminate charcoal motif. A single silcrete core has previously been identified within the shelter. The art is faded and in a poor condition. The site is an example of a common site type in the region with poorly preserved features and is of low scientific significance.

Site	Site Type	Site Content	Site Condition	Representativeness	Scientific Significance	Statement of Significance
52-2-3939	Shelter with Deposit	2	2	1	5 - Moderate	52-2-3939 is a shelter with deposit. Five surface artefacts consisting of quartz, chert and silcrete flakes have been recorded in the drip line at this site. A deposit of yellowish grey sand is present and is an intact and fair condition. The site is a typical example of a common site type in the region, and is of moderate scientific significance due to its preservation and lack of disturbance.
52-2-3940	Shelter with Deposit	2	2	1	5 - Moderate	52-2-3940 is a shelter with deposit. Six surface artefacts consisting of silcrete flakes and quartz angular fragments have been recorded in the drip line at this site. A deposit of yellowish grey sand is present and is an intact and fair condition. The site is a typical example of a common site type in the region, and is of moderate scientific significance due to its preservation and lack of disturbance.
52-2-3941	Shelter with Deposit	2	2	1	5 - Moderate	52-2-3941 is a shelter with deposit. Four surface artefacts consisting of quartz and silcrete flakes have been recorded in the drip line at this site. A deposit of yellowish grey sand is present and is an intact and fair condition. The site is a typical example of a common site type in the region, and is of moderate scientific significance due to its preservation and lack of disturbance.
52-3-0310	Shelter with Art, Deposit and axe grinding grooves	4	2	2	8 - High	52-2-0310 is a shelter site that has art, grinding grooves and an archaeological deposit. The deposit consists of over 100 stone artefacts on the shelter floor, suggesting a high potential for further material in the grey-brown sandy loam deposit, which has been partially disturbed through animal burrowing. The art assemblage contains 12 recognisable motifs including charcoal outline and infill anthropomorphic figures, macropods, fish and geometric lines and dots. The art is in good condition and is still easily recognisable. Three grinding grooves are located in the southern end of the shelter. The relatively large assemblage of big motifs, with multiple techniques affords rarity value, and the site is generally representative of charcoal and ochre motif art for the study area and region. This site is

Site	Site Type	Site Content	Site Condition	Representativeness	Scientific Significance	Statement of Significance
						of high scientific significance.
52-3-0311	Shelter with Deposit	2	1	1	4 - Moderate	52-3-0311 is a shelter site with deposit. The deposit consists of yellowish-brown sand with quartz, silcrete and chert flakes. The deposit has been disturbed to some extent through wombat burrowing. The site is a typical example of a common site type in the region and is of moderate scientific significance due to its preservation and lack of disturbance.
52-3-0312	Shelter with Deposit	2	2	1	5 - Moderate	52-3-0312 is a shelter site with deposit. The deposit consists of a yellowish-brown sand with high densities of artefacts located at two points in the drip line. The deposit is relatively undisturbed. The site is a typical example of a common site type in the region and is of moderate scientific significance due to its preservation and lack of disturbance.
52-3-0313	Open Camp Site	1	1	1	3 - Low	52-3-0313 is an open camp site. The site was recorded as containing nine stone artefacts with a range of raw material types including silcrete, chert and fossilized wood. The site has a shallow white sand overlaying a yellow clay, this has been extensively disturbed by erosion of the topsoil through flooding and fire train upgrades. The site is an example of a common site type in the region with poorly preserved features and is of low scientific significance.
52-3-0314	Shelter with Art	4	2	1	7 - High	52-3-0314 is a shelter with art and deposit. The shelter contains two art panels. The first panel contains 2 charcoal outline motifs of a lizard and indeterminate drawing. Nearby the second art panel contains a series of charcoal lines. The art is in good condition and is still easily recognisable. The small but unique motifs affords rarity value, and the site is generally representative of charcoal and ochre motif art for the study area and region. This site is of high scientific significance.

Site	Site Type	Site Content	Site Condition	Representativeness	Scientific Significance	Statement of Significance
52-3-0317	Shelter with Deposit	2	1	1	4 - Moderate	52-3-0317 is a shelter site with deposit. The deposit consists of a yellowish-brown sand with a singe artefact identified. The deposit has been disturbed to some extent. The site is a typical example of a common site type in the region and is of moderate scientific significance due to its preservation and lack of disturbance.
52-3-0319	Shelter with Deposit	2	1	1	4 - Moderate	52-3-0319 is a shelter site with deposit. The deposit consists of a yellowish-clay loam with two artefacts consisting of a fossilized wood flake and a quartz flake identified. The deposit is in reasonable condition. The site is a typical example of a common site type in the region and is of moderate scientific significance due to its preservation and lack of disturbance.
52-3-0320	Axe grinding grooves	1	1	1	3 - Low	52-3-0320 is a grinding groove site. The site was recorded as a single grinding groove located within a sandstone outcrop measuring 22 x 2.5m. The site is recorded as being in reasonable condition. The site is an example of a common site type in the region with poorly preserved features and is of low scientific significance.
52-3-0322	Axe grinding grooves	1	1	1	3 - Low	52-3-0322 is a grinding groove site. The site was recorded as two grinding grooves located within a sandstone outcrop measuring approximately 11 x 20m. The site is recorded as being in reasonable condition. The site is an example of a common site type in the region with poorly preserved features and is of low scientific significance.
52-3-0323	Shelter with Deposit	2	2	1	5 - Moderate	52-3-0323 is a shelter with deposit. Three surface artefacts consisting of silcrete, chert and quartz flakes have been recorded in the drip line at this site. A deposit of yellowish grey sand is present with a depth of 20 cm and is an intact and fair condition. The site is a typical example of a common site type in the region, and is of moderate scientific significance due to its preservation and lack of disturbance.

Site	Site Type	Site Content	Site Condition	Representativeness	Scientific Significance	Statement of Significance
52-3-0325	Shelter with Art and Deposit	2	1	1	4 - Moderate	52-3-0325 is a shelter with Art and deposit. Five surface artefacts consisting of silcrete, fossilized wood and quartz flakes and a quartz core have been recorded. A deposit of yellowish clayey sand is present but has been subject to wombat burrowing. A single art panel consisting of sprayed red ochre is present on the rear wall. The art is in poor condition and indiscernible. The site is a typical example of a common site type in the region, and is of moderate scientific significance due to the range of features present.
Wonga East 4	Shelter with Deposit	2	2	1	5 - Moderate	Wonga East 4 is a shelter with deposit. Four surface artefacts consisting of quartz and silcrete flakes have been recorded in the drip line at this site. A deposit of yellowish grey sand is present and is an intact and fair condition. The site is a typical example of a common site type in the region, and is of moderate scientific significance due to its preservation and lack of disturbance.
Wonga East 5	Shelter with Stone Arrangement	1	1	1	3 - Low	Wonga East 5 is a shelter with stone arrangement. The shelter is low with two piles of stones in the entrance. The lichen growing on the stones indicates that they were placed some time ago. The shelter does not contain a deposit, art or artefacts. Although this may have been a historical feature, consultation with Aboriginal stakeholders indicates that the site may have cultural significance. Given the condition of the site, limited range of site features the site is of low scientific significance.

3.6 Potential Impacts to Aboriginal Heritage

During and following the extraction of coal via longwall mining methods, overlying rock strata are subject to varying degrees of subsidence, tilt and strain (SCT 2013). At the surface, the ground subsides vertically and also moves horizontally towards the centre of the mined ground. These movements can cause slumping of soils on poorly consolidated landform elements such as talus slopes and cracking of rigid areas such as sandstone platforms, ledges and cliffs. These ground surface changes can potentially impact on cultural heritage sites.

It is difficult to make precise statements of impact due to subsidence effects to Aboriginal shelter sites, and subsidence impact prediction modeling for Aboriginal shelter sites is still developing. Following on from Sefton's (2000) review of subsidence impacts in the Southern Coalfield, the majority of subsequent subsidence impact prediction modeling has been based on the identification of characteristics associated with the potential for subsidence effects to occur. To date, no single characteristic has been identified as the sole contributor to subsidence effects and risk assessments consider a combination of shelter, longwall and subsidence characteristics and parameters. In order to determine the level of risk of impacts to Aboriginal shelter sites from subsidence impacts in the Project Area, ratings and criteria have been developed considering the following, which are discussed in greater detail below:

- Potential of subsidence effects to impact on Aboriginal shelter sites;
- A review of the results of Aboriginal shelter subsidence monitoring in the wider Southern Coalfield; and,
- A review of the results of Aboriginal shelter subsidence monitoring in the Dendrobium and Delta (Elouera) Collieries which share similar geological characteristics with the Study Area.

3.6.1 Subsidence Impacts

The 2008 *Impacts of Underground Coal Mining on Natural Features in the Southern Coalfield Strategic Review* defines subsidence effects as "the deformation of the ground mass surrounding a mine due to mining activity" (DoP 2008: vii). Subsidence impacts are the changes to the ground that subsequently occur as a result of subsidence effects. Subsidence impacts are not always recognisable within Aboriginal shelters or are difficult to separate from normal background effects. Any change of Aboriginal shelter site condition observed during subsidence is managed under the assumption that it could be the result of a subsidence impact.

Changes to Aboriginal shelter site conditions resulting from subsidence impacts associated with longwall mining were first recorded by Lambert and Rosenfield in the mid to late 1980's (Sefton 2000: 23-24). To date, changes in shelter conditions have been recorded at 14 shelter sites in the Southern Coalfield. Of these changes, nine are directly attributed to subsidence impacts and two are possibly related to subsidence impacts. In the case of changes in conditions at two sites, 52-2-1619 Browns Road 4 and PAD 3, Sefton (2000) noted that block fall in these shelters occurred along pre-existing cracks and there were no clear indicators if it was a result of subsidence impacts or a natural block fall event.

Changes to shelter conditions attributed to subsidence impacts include small movements along joints, tension cracking of strata, cliff collapse or block fall and increased water seepage of shelter sandstone surfaces. While subsidence impacts do not always have direct heritage values impacts, i.e. impacts to art panels, they can cause a change in shelter conditions that can then lead to a heritage values impact, such as altering water seepage patterns that subsequently adversely affects art panels. Thus the heritage values at a given Aboriginal shelter site, such as the presence or absence of art panels, will influence the occurrence risk of a heritage values impact due to subsidence impacts.

Changes to site conditions of axe grinding grooves and engraving sites due to subsidence effects could include cracking of sandstone platforms, tree fall and change in drainage patterns. It is possible that these changes in site conditions could result in impacts to axe grinding grooves and engravings if cracks directly impact grooves or engravings, tree fall obscures grooves or engravings and/or changes in drainage patterns alters the natural setting context of axe grinding grooves.

To date, 14 axe grinding grooves and engravings on sandstone rock platforms/outcrops have been monitored for changes in site conditions as a result of mine related subsidence effects. Changes in site conditions have been recorded at one site, 52-2-0258 Flat Rock Creek 57, an axe grinding groove and engraving site at the Metropolitan Colliery (Sefton 2003). A 25 m crack running east to west was observed on the northwest section of the rock outcrop on which the site was located, however no impacts were observed to either the axe grinding grooves or the engraving (ibid: 12-13). For a site to incur a total loss of cultural heritage value; the complete destruction of axe grinding grooves or engravings in their entirety would have to occur. Subsidence monitoring to date indicates that this is highly unlikely to occur and changes in site conditions from subsidence effects are at most only likely to result in partial loss of cultural heritage values.

To date, no impacts to other Aboriginal sites, including open camp sites and artefact scatters have been recorded.

3.6.2 Review of Aboriginal Site Monitoring Results in the Southern Coalfield

Subsidence monitoring data has been collected for 104 shelter sites in the Southern Coal Fields by Sefton, Biosis and Niche Environment and Heritage. Eleven of these sites have had a change in condition due to subsidence impacts, or 10.6% of all sites monitored. A combination of large overhang size and presence of bedding planes with water seepage remains the most common shared characteristics in shelters to have a change in shelter conditions. Of the 11 sites where change has been recorded, eight have water seepage and only one site has a shelter volume of less than 50 cubic metres. All shelters which showed impacts as a result of subsidence had a maximum predicted subsidence movement of greater than 300 mm; however predicted tilt, tensile and compressive strains varied greatly across sites. Other contributing characteristics distinguishable in the data as possibly contributing to the risk of impact resulting from subsidence impacts included maximum predicted subsidence movement and landform.

There are 22 sites in the dataset (21%) that were recorded during baseline recording as having a combination of water seepage and a shelter volume of more than 50 cubic metres. Of these large wet sites, eight (36%) have had changes in shelter conditions. In comparison, of the 31 large dry shelters only two (6.5%) have been subject to subsidence impacts. These trends are relatively consistent with Sefton's (2000) review in which four of the nine large shelter sites with water seepage suffered subsidence impacts (44%), in comparison to only one of the 14 large dry shelter sites (7.14%).

Landform also seems to play a role with lower valley slopes (14.3%), ridge/plateau tops (25%) and valley bottoms (15.4%) having a higher rate of impacts than the main landform in which shelters are located, which is upper ridge/valley slopes (6.1% of sites impacted). However, rates of subsidence impact associated with landforms may also be coincidental with other factors such as water seepage, which have higher chances of occurring in some landforms. For example the vast majority of sites with water seepage are located in lower valley slopes (39.3% of all sites have water seepage) and valley bases (30.7% of all sites have water seepage).

Of the shelter sites impacted by subsidence, there is only one shelter site with a volume of less than 50 cubic metres, 52-2-0277 Sandy Creek Road 25. This site is unusual in that it is a relatively small shelter created by cavernous weathering and is part of a larger rock platform. Subsidence impacts at the site included minor cracking and the separation of a vertical joint on the rear wall of the shelter. It is possible that these impacts are related to a combination of the presence of joints and the size of the larger rock platform in which it is located.

A preliminary Discriminant Analysis (DA) of Southern Coalfield Aboriginal site subsidence monitoring data has been undertaken by Symbolix on behalf of Biosis. The DA aimed to discriminate between sites that experienced subsidence effects and those that did not. While the results are only preliminary at this stage, preliminary trends indicate that larger wet sites on ridge tops or valley bottoms are the features that best group into those that experience changes versus those that do not (Symbolix 2012). These findings are consistent with Sefton's 2000 findings and the simple analysis provided above.

3.6.3 Aboriginal Site Monitoring in the Dendrobium and Delta (Elouera) Collieries

Subsidence monitoring data has been collected for 17 shelter sites within the Dendrobium and Delta (Elouera) Colliery areas. These colliery areas share similar geological characteristics to the current Study Area, such as depth of coal seams being mined, and are of direct relevance in assessing the risk of impact from subsidence impacts. Of these sites, two sites have had impacts due to subsidence effects, 52-2-2252 and 52-5-0277, accounting for 17.5% of sites monitored. Site 52-2-2252 is a large dry shelter and 52-5-0277 is a small wet shelter.

Subsidence predictions for 52-2-2252 and 52-5-0277 had maximum predicted vertical movements of between 900mm to 1540mm and maximum predicted tensile strains of between 2.5mm/m and 7.4mm/m. Only one other site had similar subsidence predictions, 52-5-0278, but was not subject to subsidence impacts.

The frequency of subsidence impacts observed at Aboriginal shelter sites in the Dendrobium and Delta Collieries is higher than observed across the Southern Coalfield in general. However the dataset is still small and the difference in trends between the Southern Coalfield and Dendrobium/Delta datasets should be treated with caution.

3.6.4 Risk of Impact Ratings and Criteria

The development of an impact prediction methodology has attempted to provide reasonably accurate subsidence impact predictions to shelter sites, which, in combination with a cultural heritage significance assessment, is then used to provide appropriate avoidance and mitigation recommendations (generally subsidence monitoring). The risk of impact criteria adopted for the purposes of this assessment are shelter size (volume), the presence of water seepage, maximum predicted subsidence movement and the presence/absence of art. Risk categories are from moderate to negligible and reflect subsidence effect occurrence and actual impacts to heritage values from subsidence effects monitored to date.

A description of risk categories and criteria is provided in Table 5.

Table 5: Subsidence Effect Risk Categories and Criteria

Category	Description	Criteria
Moderate	There is a moderate chance of subsidence effects occurring which may result in impacts to heritage values.	The shelter has an art panel present; and The shelter has a volume larger than 50 cubic metres; The shelter has joints or bedding plans subject to water seepage; and Maximum predicted subsidence is greater than 300mm.
Low	There is a low chance of subsidence effects occurring which may result in impacts to heritage values.	The shelter has a volume larger than 50 cubic metres; and Maximum predicted subsidence is greater than

Category	Description	Criteria
		300mm
Very Low	There is a very low chance of subsidence effects occurring which may result in impacts to heritage values.	The shelter has a volume less than 50 cubic metres and maximum predicted subsidence is greater than 300mm; or The shelter has a volume more than 50 cubic metres and maximum predicted subsidence is less than 300mm.
Negligible	Impacts to heritage values are unlikely and if they did occur would normally be indistinguishable from natural environmental effects; or The site is located outside of the predicted subsidence impact zone	The shelter has a volume less than 50 cubic metres; Maximum predicted subsidence is less than 300mm, tensile strain predictions are <0.5mm/m and compressive strain estimates are <0.01mm/m.

3.6.5 Subsidence Impact Predictions

The subsidence impact assessment for Aboriginal sites in the Study Area is presented below in Table 6. This assessment was made using the parameters in Sefton's PCA and in conjunction with the subsidence predictions provided by SCT (SCT 2013), detailed in Table 7. The assessment of risk was made using the criteria outlined in Section 3.6.4

Table 6: Summary of the predicted risk of impact to Aboriginal Sites in Study Area

Sites in bold are located within the 200 mm subsidence impact footprint; all other sites are located within the 600m study area buffer.

Site Number	Site Name	Site Type	Scientific Significance	Cultural Significance	Risk of Impact
52-2-0083	Bulli Mine Shaft Site 7	Shelter with Deposit	Moderate	High	Negligible
52-2-0099	**Bulli Mine Shaft Site 8**	**Axe grinding grooves**	**Low**	**High**	**Very Low**
52-2-0229	**Bulli Mine Shaft Site 12**	**Axe grinding grooves**	**Low**	**High**	**Very Low**
52-2-0233	Bulli Mine Shaft Site 13	Axe grinding grooves	Low	High	Negligible
52-2-0603	**Bulli Mine Shaft Site 19**	**Shelter with Art and Artefact**	**Low**	**High**	**Moderate**
52-2-3939	**Wonga East 1**	**Shelter with Deposit**	**Moderate**	**High**	**Low**
52-2-3940	**Wonga East 2**	**Shelter with Deposit**	**Moderate**	**High**	**Low**
52-2-3941	**Wonga East 3**	**Shelter with Deposit**	**Moderate**	**High**	**Very Low**
52-3-0310	Bulli Mine Shaft Site 18	Shelter with Art, Deposit and axe grinding grooves	High	High	Negligible
52-3-0311	Bulli Mine Shaft Site 20	Shelter with Deposit	Moderate	High	Negligible
52-3-0312	Bulli Mine Shaft Site	Shelter with Deposit	Moderate	High	Negligible

Site Number	Site Name	Site Type	Scientific Significance	Cultural Significance	Risk of Impact
	23				
52-3-0313	Bulli Mine Shaft Site 29	Open Camp Site	Low	High	Negligible
52-3-0314	Bulli Mine Shaft Site 21	Shelter with Art	High	High	Negligible
52-3-0317	Bulli Mine Shaft Site 22	Shelter with Deposit	Moderate	High	Negligible
52-3-0319	Bulli Mine Shaft Site 24	Shelter with Deposit	Moderate	High	Negligible
52-3-0320	**Bulli Mine Shaft Site 25**	**Axe grinding grooves**	**Low**	**High**	**Very Low**
52-3-0322	Bulli Mine Shaft Site 31	Axe grinding grooves	Low	High	Negligible
52-3-0323	Bulli Mine Shaft Site 26	Shelter with Deposit	Moderate	High	Negligible
52-3-0325	**Bulli Mine Shaft Site 27**	**Shelter with Art and Deposit**	**Moderate**	**High**	**Negligible**
n/a	Wonga East 4	Shelter with Deposit	Moderate	High	Negligible
n/a	Wonga East 5	Shelter with Stone Arrangement	Low	High	Negligible

Table 7: Subsidence Effect Risk Assessment

Site Number	L (m)	W (m)	H (m)	Volm³	Aspect	Faces aspect	Art	Location	Wet / Dry	Location End LW	Location in LW	DIR	SUBS	Tensile Strain	Comp Strain	Tilt	Previously Undermined	Previously Subsided
52-2-0083	2.5	1.5	1.5	5.625	NE	CW	N	LVS	D	N	O	E-W	<0.1	<0.5	<1.0	<2.0	Yes	No
52-2-0099	8	4	N/A	N/A	N	SP	N	UVS	W	Y	O	E-W	0.5	4.2	8	14	Yes	No
52-2-0229	18	2	N/A	N/A	N	SP	N	RT	W	Y	O	E-W	0.9	4.1	8	14	Yes	Yes
52-2-0233	18	4	N/A	N/A	N	SP	N	RT	W	N	O	E-W	<0.1	<0.5	<1.0	<2.0	Yes	Yes
52-2-0603	7	3	3	63.00	W	CW	Y	RT	W	Y	E	E-W	0.3	0.6	2.4	4.7	Yes	Yes
52-2-3939	8	8	1.5	96.00	W	BF	N	UVS	D	Y	E	E-W	0.2	6.2	6.2	10	Yes	Yes
52-2-3940	25	4	4	400.00	S	BF	N	UVS	D	Y	E	E-W	0.1	3.1	6.2	10	Yes	No
52-2-3941	8	2	1	16.00	S	BF	N	UVS	D	Y	M	E-W	0.2	3.0	5.9	10	Yes	Yes
52-3-0310	9.6	8.5	1.6	130.56	W	CW	Y	RT	D	N	O	E-W	<0.1	<0.5	<1.0	<2.0	Yes	No
52-3-0311	7.5	6.9	1.2	62.10	SW	CW	N	UVS	W	N	O	SE-NW	<0.1	<0.5	<1.0	<2.0	Yes	Yes
52-3-0312	20	4.5	3.3	297.00	N	CW	N	UVS	W	N	O	SE-NW	<0.1	<0.5	<1.0	<2.0	Yes	Yes
52-3-0313	5	25	N/A	N/A	N/A	SP	N	UVS	W	N	O	SE-NW	<0.1	<0.5	<1.0	<2.0	Yes	Yes
52-3-0314	6.3	3.4	2.5	53.55	NE	CW	Y	RT	W	N	O	SE-NW	<0.1	<0.5	<1.0	<2.0	Yes	Yes
52-3-0317	20	4	4	320.00	NW	BF	N	UVS	W	N	O	SE-NW	<0.1	<0.5	<1.0	<2.0	Yes	Yes
52-3-0319	67	4.5	3	904.50	NE	CW	N	UVS	W	N	O	SE-NW	<0.1	<0.5	<1.0	<2.0	Yes	Yes
52-3-0320	22	2.5	N/A	N/A	N/A	SP	N	RT	W	N	CP	SE-NW	1.8	14.1	28	47	Yes	Yes
52-3-0322	11	20	N/A	N/A	S	SP	N	UVS	W	N	O	SE-NW	<0.1	<0.5	<1.0	<2.0	Yes	Yes
52-3-0323	6	3.5	3	63.00	SW	BF	N	LVS	W	N	O	SE-NW	<0.1	<0.5	<1.0	<2.0	No	No

Site Number	L (m)	W (m)	H (m)	Volm³	Aspect	Faces aspect	Art	Location	Wet / Dry	Location End LW	Locatio n in LW	DIR	SUBS	Tensile Strain	Comp Strain	Tilt	Previously Undermined	Previously Subsided
52-3-0325	3	2.5	1.2	9.00	NW	CW	Y	LVS	W	Y	M	SE-NW	1.4	8.6	17	29	Yes	Yes
Wonga East 4	10	4	10	24.00	S	CW	N	UVS	D	N	O	E-W	<0.1	<0.5	<1.0	<2.0	Yes	No
Wonga East 5	6	4	1	24.00	S	CW	N	UVS	W	N	O	E-W	<0.1	<0.5	<1.0	<2.0	Yes	No

Abbreviations

L	overhang / sandstone platform length (metres)
W	overhang / sandstone platform width (metres)
H	overhang height
Volm^3	Volume in metres cubed
Aspect	direction shelter faces
Faces aspect	main apparent formation process either block fall (BF) or cavernous weather (CW) or sandstone platform (SP)
Art	Art present (Y = present, N = absent)
Location	Topographic location (RT = ridgetop, UVS = upper valley slope, LVS = lower valley slope, VB = valley bottom)
Wet / dry	D = surfaces mainly not affected by water seepage, W = surface mainly affected by water seepage
Location End LW	Y = located within 100m of the end of a longwall, wither inside or outside the longwall, N = not located within 100m of the end of a longwall, wither inside or outside the longwall
Location In LW	O = located outside the longwall and chain pillar, CP = located under the longwall and chain pillar, E = located closer to the edge of the longwall than the middle (centre), M = located closer to the centre of the longwall than the end
DIR	Direction of the nearest longwall
SUBS	Maximum predicted subsidence
Tensile Strain	Maximum predicted tensile strain
Comp Strain	Maximum compressive strain
Tilt	Maximum tilt
Previously undermined	Has the site previously been undermined by extraction of the Bulli or Balgownie seams (Y = yes, N = no)
Previously subsided	Has the site previously been subsided by extraction of the Bulli or Balgownie seams (Y = yes, N = no)

3.6.6 Specific Site Impact Assessments

Based on the information in Tables 4, 5 and 6, the following impact assessment has been described in terms of 'risk of impact' for Aboriginal sites within the Study Area.

52-2-0083	Bulli Mine Shaft Site 7	Shelter with Deposit
The site is located along a 1-2m high cliff formation which is relatively short in length and has a predicted horizontal compression of less than 20mm/m. The site has been previously undermined as part of the Bulli Seam extraction works, but does not appear to have been subject to previous subsidence. Based on subsidence predictions for the preferred project, the site has very low maximum predicted systematic tensile strains of less than 500mm, an overall subsidence movement of less than 300 mm and is located 250m north of Longwall 11. The site has a small volume, less than 50 m³ and no water seepage is present.		
Location: Outside long wall panels but within 600m study area buffer		
Impact Assessment: Negligible		
52-2-0099	**Bulli Mine Shaft Site 8**	**Axe grinding grooves**
The site is mapped as occurring within a sandstone platform on the upper valley slope; however this site could not be relocated. Based on the mapped location, the site has been previously undermined as part of the Bulli Seam extraction works, but does not appear to have been subject to previous subsidence. Based on subsidence predictions for the preferred project and the mapped location, the site has maximum predicted systematic tensile strains of 4.2m, an overall subsidence movement of 500mm/m and is located within Longwall 11. Whilst the site is predicted to be subject to movement, as an open site it will not be subject to rock falls caused by horizontal compression along cliffs (predicted at 150mm per 20m section). There is a 20-30% potential for impacted through cracking of the sandstone platforms within which the site is located. As this site has not been located it is difficult to accurately determine precise impacts based upon the landform context and subsidence modelling. The current impact assessment is based upon the assumption that the site is located in its recorded location but has been obscured by vegetation cover which has significantly increased since the original recording (post-bush fire).		
Location: Centre of LW11		
Impact Assessment: Very Low		
52-2-0229	**Bulli Mine Shaft Site 12**	**Axe grinding grooves**
The site is mapped as occurring within a sandstone platform on the upper valley slope; however this site could not be relocated. The site has been previously undermined as part of the Bulli Seam extraction works, but does not appear to have been subject to previous subsidence. Based on subsidence predictions for the preferred project and the mapped location, the site has maximum predicted systematic tensile strains of 4.1m, an overall subsidence movement of 900mm/m and is located within Longwall 11. Whilst the site is predicted to be subject to movement, as an open site it will not be subject to rock falls caused by horizontal compression along cliffs (predicted at 150mm per 20m section). There is a 20-30% potential for impacted through cracking of the sandstone platforms within which the site is located. As this site has not been located it is difficult to accurately determine precise impacts based upon the landform context and subsidence modelling. The current impact assessment is based upon the assumption that the site is located in its recorded location but has been obscured by vegetation cover which has significantly increased since the original recording (post-bush fire).		
Location: Centre of LW11		
Impact Assessment: Very Low		
52-2-0233	**Bulli Mine Shaft Site 13**	**Axe grinding grooves**
The site is mapped as occurring within a sandstone platform on the upper valley slope; however this site could not be relocated. The site has been previously undermined as part of the Bulli Seam extraction works, but does not appear to have been subject to previous subsidence. Based on subsidence predictions for the preferred project and the mapped location, the site has maximum predicted systematic tensile strains of less than 500mm, an overall subsidence movement of less than 100mm and is located 50m north of Longwall 11. Whilst the site is predicted to be subject to movement, as an open site it will not		

be subject to rock falls caused by horizontal compression along cliffs (predicted at 150mm per 20m section). There is a limited potential for impacted through cracking of the sandstone platforms the site is located within due to its location outside of the longwall. As this site has not been located it is difficult to accurately determine precise impacts based upon the landform context and subsidence modelling. The current impact assessment is based upon the assumption that the site is located in its recorded location but has been obscured by vegetation cover which has significantly increased since the original recording (post-bush fire).

Location: Outside long wall panels but within 600m study area buffer

Impact Assessment: Negligible

52-2-0603	Bulli Mine Shaft Site 19	Shelter with Art and Artefacts

The site is located on a ridge top and forms part of a north to south aligned 90m cliffline ranging from 2 to 4m in height. The site has been previously undermined by the Bulli seam extraction works and has been subject to a maximum of subsidence of 0.3m and horizontal movement of 0.1m. There is no evidence of rock fall within the shelter and it is possible the sites location near the top of the ridgeline has reduced the horizontal compression exerted as a part of previous mining.

Based on subsidence predictions for the preferred project, the site is located at the centre of Longwall 11 and has maximum predicted horizontal compression of 250mm and an overall subsidence movement of 1.5m. The horizontal compression is likely to cause perceptible cracking in the vicinity of the site, with a 5-10% probability of rock fall along the cliff line associated with the site. The site has a small volume of 63 m^3 and water seepage is present.

Location: Centre of LW11

Impact Assessment: Moderate

52-2-3939	Wonga East 1	Shelter with Deposit

The site is located in an upper valley slope and is part of a 3-5m high sandstone cliff which protrudes from a general line of cliffs with a 6m overhang. The site has been previously undermined by the Bulli seam extraction which has resulted in approximately 0.2m of subsidence and tensile strains of 9mm.

Based on subsidence predictions for the preferred project, the site is located at the edge of Longwall 9 with a predicted maximum subsidence of 0.8m, horizontal compression of 350mm and tensile strains of 9mm/m. The site is relatively short in length and is located away from the general cliff line which limits the potential for impacts. The horizontal compression is likely to cause perceptible cracking in the vicinity of the site (predicted at 30%), with a 2% probability of rock fall along the cliff line associated with the site. The site has a small volume of 96 m^3 and no water seepage is present.

Location: Edge of LW9

Impact Assessment: Low

52-2-3940	Wonga East 2	Shelter with Deposit

The site is located in an upper valley slope and is part of an extended 100m long, 4-6m high sandstone cliff which runs east to west. The site appears to have been subject to rock fall either naturally or as part of the previous Bulli seam extraction. The Bulli seam extraction has resulted in approximately 0.1m of subsidence and horizontal compression of 0.1m.

Based on subsidence predictions for the preferred project, the site is located at the edge of Longwall 9 with a predicted maximum subsidence of 0.6m, horizontal compression of 250mm and tensile strains of 7mm/m. The site is considered vulnerable to further rock falls due to the long line of cliffs, some of which have been subject to collapse. The horizontal compression is likely to cause perceptible cracking in the vicinity of the site (predicted at 30%), with a 5% probability of rock fall along the cliff line associated with the site. The site has a large volume of 400 m^3 and no water seepage is present.

Location: Edge of LW9

Impact Assessment: Low

52-2-3941	Wonga East 3	Shelter with Deposit

The site is located in an upper valley slope and is part of a 3-4m high sandstone cliff; the site is formed through block fall which has separated the site from neighbouring cliff line. The site has been previously undermined by the Bulli seam extraction which has resulted in approximately 0.2m of subsidence and horizontal compression of 0.1m.

Based on subsidence predictions for the preferred project, the site is located at the edge of Longwall 9 with a predicted maximum subsidence of 1.2m, horizontal compression of 250mm and tensile strains of 7mm/m. The site is not considered vulnerable to further rock fall as it is detached from the cliff line and with a volume of 16 m³ is not large enough to experience significant lateral compression. No water seepage is present.		
Location: Centre of LW9		
Impact Assessment: Very Low		
52-3-0310	**Bulli Mine Shaft Site 18**	**Shelter with Art, Deposit and axe grinding grooves**
The site is located on an upper valley slope as part of an extended 400m long, 1-3m high cliff formation which has a predicted horizontal compression of less than 20mm/m. The site has been previously undermined as part of the Bulli Seam extraction works, but does not appear to have been subject to previous subsidence. Based on subsidence predictions for the preferred project, the site has very low maximum predicted systematic tensile strains of less than 500mm, an overall subsidence movement of less than 300 mm and is located 70m north of Longwall 11. The site has a volume greater than 50 m³, art panels but no identifiable water seepage is present. Despite the minimal impacts predicted, the shelters size and content elevates its impact assessment from negligible.		
Location: Centre of LW11		
Impact Assessment: Very Low		
52-3-0311	**Bulli Mine Shaft Site 20**	**Shelter with Deposit**
The site is located on an upper valley slope as part of an extended, 1-6m high cliff formation which has a predicted horizontal compression of less than 20mm/m. The site has been previously undermined as part of the Bulli and Balgownie seam extraction works, and has been subject to previous subsidence as part of the Balgownie seam extraction works. Based on subsidence predictions for the preferred project, the site has very low maximum predicted systematic tensile strains of less than 500mm, an overall subsidence movement of less than 300 mm and is located 175m north-east of Longwall 7. The site has a volume greater than 50 m³ and water seepage is present, however as the site is located outside of the long wall panels a negligible impact to heritage values is predicted..		
Location: Outside long wall panels but within 600m study area buffer		
Impact Assessment: Negligible		
52-3-0312	**Bulli Mine Shaft Site 23**	**Shelter with Deposit**
The site is located on an upper valley slope as part of an extended 500m long, 1-6m high cliff formation which has a predicted horizontal compression of less than 20mm/m. The site has been previously undermined as part of the Bulli seam extraction works and has been subject to previous subsidence. Based on subsidence predictions for the preferred project, the site has very low maximum predicted systematic tensile strains of less than 500mm, an overall subsidence movement of less than 300 mm and is located 535m north-east of Longwall 7. The site has a volume greater than 50 m³ and water seepage is present, however as the site is located outside of the long wall panels a negligible impact to heritage values is predicted.		
Location: Outside long wall panels but within 600m study area buffer		
Impact Assessment: Negligible		
52-3-0313	**Bulli Mine Shaft Site 29**	**Open Camp Site**
The site is located on an upper valley slope within a sandy deposit which has been subject to extensive erosion. The site has been previously undermined as part of the Bulli and Balgownie seam extraction works and has been subject to previous subsidence as a result of these actions. Based on subsidence predictions for the preferred project, the site has very low maximum predicted systematic tensile strains of less than 500mm, an overall subsidence movement of less than 300 mm and is located 100m east of Longwall 1. Whilst the site is predicted to be subject to movement, as an open site it will not be subject to rock falls caused by horizontal compression along cliffs. There is a limited potential for the movement of deposits which may impacted upon the in-situ preservation of the site.		
Location: Outside long wall panels but within 600m study area buffer		
Impact Assessment: Negligible		
52-3-0314	**Bulli Mine Shaft Site 21**	**Shelter with Art**

The site is located on a ridge top associated with an extended 60m long, 1-4m high cliff formation which has a predicted horizontal compression of less than 20mm/m. The site has been previously undermined as part of the Bulli seam extraction works and has been subject to previous subsidence.
Based on subsidence predictions for the preferred project, the site has very low maximum predicted systematic tensile strains of less than 500mm, an overall subsidence movement of less than 300 mm and is located 560m north-east of Longwall 7. The site has a volume greater than 50 m³ and water seepage is present, however as the site is located outside of the long wall panels a negligible impact to heritage values is predicted.

Location: Outside long wall panels but within 600m study area buffer

Impact Assessment: Negligible

52-3-0317	**Bulli Mine Shaft Site 22**	**Shelter with Deposit**

The site is located on an upper valley slope as part of an extended 500m long, 1-6m high cliff formation which has a predicted horizontal compression of less than 20mm/m. The site has been previously undermined as part of the Bulli seam extraction works and has been subject to previous subsidence.
Based on subsidence predictions for the preferred project, the site has very low maximum predicted systematic tensile strains of less than 500mm, an overall subsidence movement of less than 300 mm and is located 545m north-east of Longwall 7. The site has a volume greater than 50 m³ and water seepage is present, however as the site is located outside of the long wall panels a negligible impact to heritage values is predicted.

Location: Outside long wall panels but within 600m study area buffer

Impact Assessment: Negligible

52-3-0319	**Bulli Mine Shaft Site 24**	**Shelter with Deposit**

The site is located on an upper valley slope as part of an extended 500m long, 1-6m high cliff formation and has a predicted horizontal compression of less than 20mm/m. The site has been previously undermined as part of the Bulli seam extraction works and has been subject to previous subsidence.
Based on subsidence predictions for the preferred project, the site has very low maximum predicted systematic tensile strains of less than 500mm, an overall subsidence movement of less than 300 mm and is located 550m north-east of Longwall 7. The site has a volume greater than 50 m³ and water seepage is present, however as the site is located outside of the long wall panels a negligible impact to heritage values is predicted.

Location: Outside long wall panels but within 600m study area buffer

Impact Assessment: Negligible

52-3-0320	**Bulli Mine Shaft Site 25**	**Axe grinding grooves**

The site is mapped as occurring on the upper valley slope; however this site could not be relocated. Based on the mapped location, the site has been previously undermined as part of the Bulli Seam and Balgownie extraction works and does appear to have been subject to previous subsidence.
Based on subsidence predictions for the preferred project and the mapped location, the site has maximum predicted systematic tensile strains of 14.1m, an overall subsidence movement of 1.4m and is located within the chain pillar associated with Longwall 5. Whilst the site is predicted to be subject to movement, as an open site it will not be subject to rock falls caused by horizontal compression along cliffs (predicted at 450mm/m per 20m section). The sites recorded location places it over the goaf but within a detached boulder, this location if correct reduces the potential for impacts. As this site has not been located it is difficult to accurately determine precise impacts based upon the landform context and subsidence modelling. The current impact assessment is based upon the assumption that the site is located in its recorded location but has been obscured by vegetation cover which has significantly increased since the original recording (post-bush fire).

Location: Chain pillar associated with LW5

Impact Assessment: Very Low

52-3-0322	**Bulli Mine Shaft Site 31**	**Axe grinding grooves**

The site is located within a sandstone platform on the upper valley slope. The site has been previously undermined as part of the Bulli seam extraction works and does appear to have been subject to previous subsidence.
Based on subsidence predictions for the preferred project and the mapped location, the site has maximum predicted systematic tensile strains of less than 500mm, an overall subsidence movement of less than 100mm and is located 170m south-west of Longwall 4. The site is predicted to be subject to minimal movement, as an open site it

will not be subject to rock falls caused by horizontal compression along cliffs (predicted at 150mm per 20m section). There is a limited potential for impacted through cracking of the sandstone platforms the site is located within due to its location outside of the longwall.		
Location: Outside long wall panels but within 600m study area buffer		
Impact Assessment: Negligible		
52-3-0323	**Bulli Mine Shaft Site 26**	**Shelter with Deposit**
The site is located on a lower valley slope along an extended 600m long, 2-6m high cliff formation which has a predicted horizontal compression of less than 20mm/m. The site has not been previously undermined or to have been subject to previous subsidence. Based on subsidence predictions for the preferred project, the site has very low maximum predicted systematic tensile strains of less than 500mm, an overall subsidence movement of less than 300 mm and is located 230m southwest of Longwall 7. The site has a volume greater volume than 50 m³ and water seepage is present. Despite the minimal impacts predicted, the shelters size elevates its impact assessment.		
Location: Outside long wall panels but within 600m study area buffer		
Impact Assessment: Very Low		
52-3-0325	**Bulli Mine Shaft Site 27**	**Shelter with Art and Deposit**
The site is located on a lower valley slope; the shelter has been formed through block fall and is detached from the main cliff line, which is located 60m upslope. The site has been previously undermined as part of the Bulli seam extraction works and has been subject to previous subsidence. Based on subsidence predictions for the preferred project, the site is located within Long wall 7 with a predicted maximum subsidence of 1.4m, compressive strains of 86mm/m and tensile strains of 170mm/m. The site is detached from the cliff line and is unlikely to be subject to rock falls or perceptible cracking. The site has a small volume which is less than 50 m³ and water seepage is present. Despite the sites small volume its impact assessment is elevated by the presence of art and water seepage within the shelter.		
Location: Chain pillar associated with LW8		
Impact Assessment: Very Low		
n/a	**Wonga East 4**	**Shelter with Deposit**
The site is located on the upper valley slopes associated with an extended, 1-6m high cliff line which has a predicted horizontal compression of less than 20mm per 20 metres. The site has been previously undermined as part of the Bulli and Balgownie seam extraction works, but does not seem to have been subject to previous subsidence as part of these extractive works. Based on subsidence predictions for the preferred project, the site has very low maximum predicted systematic tensile strains of less than 500mm, an overall subsidence movement of less than 300 mm and is located 225m south of Longwall 9. The site has a small volume, less than 50 m³ and no water seepage is present.		
Location: Outside long wall panels but within 600m study area buffer		
Impact Assessment: Negligible		
n/a	**Wonga East 5**	**Shelter with Stone Arrangement**
The site is located on the upper valley slopes associated with an extended, 1-6m high cliff line which has a predicted horizontal compression of less than 20mm per 20 metres. The site has been previously undermined as part of the Bulli and Balgownie seam extraction works, but does not seem to have been subject to previous subsidence as part of these extractive works. Based on subsidence predictions for the preferred project. the site has very low maximum predicted systematic tensile strains of less than 500mm, an overall subsidence movement of less than 300 mm and is located 210 south of Longwall 9. The site has a small volume, less than 50 m³ and water seepage is present.		
Location: Outside long wall panels but within 600m study area buffer		
Impact Assessment: Negligible		

4. Response to Submissions

This section provides a response to submissions received on the Underground Expansion Project EA based on changes outlined in Section 2. Responses are provided to submission received from the general public (Section4.1) and from government agencies (Section 4.2).

4.1 Public submissions

No public submissions were received for Aboriginal cultural heritage.

4.2 Agency submissions

Submissions relevant to Aboriginal Cultural Heritage were received from the following agencies:

- Office of Environment and Heritage (OEH); and
- Wollongong City Council (WCC).

Submissions related to several key issues, including the relocation of sites and ongoing consultation with the Aboriginal community.

4.2.1 Office of Environment and Heritage

The NSW Office of Environment and Heritage provided comments on the original EA (ERM 2013). OEH raised the following concerns and recommendations:

Submissions	Response
Failure to relocate a number of sites – additional survey required	Biosis has now undertaken comprehensive survey for Aboriginal heritage sites in Wonga East. Survey was targeted to cliffs providing potential shelter sites using LiDAR mapping of cliffs. This resulted in the relocation of all shelter sites previously recorded, as well as the recording of two new shelter sites. Due to dense vegetation in comparison to when initial surveys were undertaken, only one axe grinding groove (52-3-0322) has been relocated. Extensive survey was undertaken for all sites; however the remaining sites could not be relocated. Given additional surveys undertaken by Biosis have relocated all shelter sites and recorded five new sites we consider the current survey effort to be comprehensive.
Potential for additional sites to occur within the Project area – additional survey effort required	Additional survey effort was undertaken using the above methodology. This has resulted in the recording of five new Aboriginal sites in the Wonga East area.

Submissions	Response
Further assessment of impacts based on revised subsidence predictions should be undertaken	Given the relocation and recording of several new sites a revised impact assessment, based upon SCT Consulting's (2013) subsidence modeling, has been undertaken for all sites within the Wonga East study area. This revised impact assessment includes an amended significance assessment and site specific impact predictions.
Recommendation to avoid impacts to Aboriginal sites, particularly the identified women's site 52-2-1183 in Wonga West	Wonga West has been removed from the current project application.
Requirement for archaeological monitoring of all known sites within the subsidence impact zones	Following Project Approval NRE will review and revise the current Heritage Management Plan (HMP) for Wonga East. This revised HMP will include monitoring of all Aboriginal sites located within the subsidence impact zone.
Ongoing consultation with the Aboriginal community throughout the life of the mine	NRE has undertaken additional consultation with the Aboriginal community following relocation of a number of additional sites by Biosis, including a visit to all relocated sites not previously visited and allowing for comments from the Aboriginal community on the significance of relocated sites. NRE commits to ongoing consultation with the Aboriginal community throughout the life of the mine. This will include discussion with the Aboriginal community on the management of Aboriginal sites, and a commitment to involve the Aboriginal community in proposed mitigation should sites be impacted as a result of mining activities.

4.2.2 Wollongong City Council

Wollongong City Council provided comments on the original EA (ERM 2013). Wollongong City Council raised the following concerns and recommendations:

Submissions	Response
Reduction in subsidence impacts to Aboriginal sites in Wonga East and West.	Wonga West has been removed from this application. In Wonga East the configuration of long walls has resulted in avoidance of impacts to 52-3-0311 and 52-3-0322. Impacts to other Aboriginal cultural heritage sites cannot be mitigated without compromising the viability of the project.
The EA should address Aboriginal cultural heritage issues in accordance with the departments EA requirements given the proposed	The ERM (2013) EA includes an assessment which complies with the Director Generals Requirements for the project. The assessment contains a detailed

Submissions	Response
impacts to Aboriginal cultural heritage.	summary of background and ethnographic research and aboriginal community consultation in accordance with contemporary guidelines. Weaknesses in the identification of Aboriginal cultural heritage within the study area have been addressed within this report and a revised significance and impact assessment has been presented.
It is recommended that proper consultation should take place with representatives from Council, the Illawarra Local Aboriginal Land Council and other local Aboriginal groups as well as any registered Native Title claimants(s).	NRE has undertaken additional consultation with the Aboriginal community throughout the project. Additional consultation with registered Aboriginal parties has been undertaken following relocation of a number of additional sites by Biosis, allowing for comments from the Aboriginal community on the significance of relocated sites. NRE commits to ongoing consultation with the Aboriginal community throughout the life of the mine. This will include discussion with the Aboriginal community on the management of Aboriginal sites, and a commitment to involve the Aboriginal community in proposed mitigation should sites be impacted as a result of mining activities.

5. Conclusions

Changes to the project, as outlined in Section 2 have resulted in a significant reduction in predicted impacts to Aboriginal cultural heritage sites. A summary of the reduced impact predictions is provided below:

- Removal of Wonga West from the program has resulted in reduced impacts to Aboriginal cultural heritage sites.
- The revision of the mine plan has resulted in site 52-03-0311 and 52-03-0313 no longer being undermined;
- Revised scientific and cultural significance assessments for all newly re-located and identified Aboriginal cultural heritage sites, this has confirmed the level of scientific and cultural significance attributed to sites which were not relocated by ERM (2012; 2013);
- Re-location of sites 52-2-0083 and 52-3-0310 which has lead to these sites being identified as outside of the proposed mine plan and being subject to a lower level of predicted impact to these sites;
- Revised subsidence impacts for sites 52-03-0320, 52-02-3939, 52-02-3940 and 52-03-3941; and
- The relocation of 52-2-0229 has resulted in the site being located within the mine plan and revised subsidence predictions have resulted in an increase in risk to this site.

In summary, site 52-2-0603 is considered to be at a moderate risk of impact. All other Aboriginal heritage sites in the study area are considered to be at low, very low or negligible risk of impact.

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ATTACHMENT D – Geological Report on the Wonga East Area

GUJARAT NRE No. 1 COLLIERY

GEOLOGICAL REPORT ON THE WONGA EAST AREA

GUJARAT NRE COKING COAL LIMITED

Prepared By – GUJARAT NRE Technical Services Department

Date – August 2013

GEOLOGICAL REPORT on the WONGA EAST AREA

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FIGURES

1. INTRODUCTION

Gujarat NRE Coking Coal Ltd owns and operates the NRE No.1 Colliery at Russell Vale which is approximately 8 km north of Wollongong within the Illawarra district of NSW.

The Colliery Holding covers approximately 63 km^2 and topographically the majority of the area west of the escarpment is a plateau of relatively undulating countryside incised by westerly to northwesterly flowing creeks. The major creeks flow into the Cataract Reservoir and Cataract River systems.

The NRE No. 1 Colliery was the former South Bulli Colliery and has a long history of operation extending over 120 years. During its history coal extraction has concentrated on the Bulli Seam, the upper most of the coal seams in the Illawarra Coal Measures. Mining in the Balgownie Seam, approximately 10 metres below the Bulli Seam, occurred from 1968 to 1982 and also in the period from 2001 to 2003.

Gujarat NRE purchased the mine in 2004 and identified the unmined Wongawilli Seam, some 30 metres below the Bulli Seam, as having potential to produce a high quality coking coal with a thermal coal by-product. Development from outcrop on the Illawarra escarpment commenced in 2008 with longwall mining using modern high capacity equipment beginning in 2012.

This report has been compiled to document the current level of knowledge and understanding of the geology of the current mining domain designated as the Wonga East Study Area. Within this area extensive extraction of the Bulli Seam has occurred and also the mining operations within the Balgownie Seam.

2. DEPOSIT GEOLOGY

2.1 Regional Geology

Gujarat NRE No.1 Colliery is located in the Southern Coalfield, which is the southern portion of the Permo-Triassic Sydney Basin, as shown in Figure 1, and contains the Illawarra Coal Measures of Late Permian Age. Overlying the Illawarra Coal Measures are sandstones, shales and mudstones of the Narrabeen Group, which in turn are overlain by the Hawkesbury Sandstone, a massive quartzose sandstone unit. The Wianamatta Group, stratigraphically above the Hawkesbury Sandstone, is the top most unit in the Southern Coalfield.

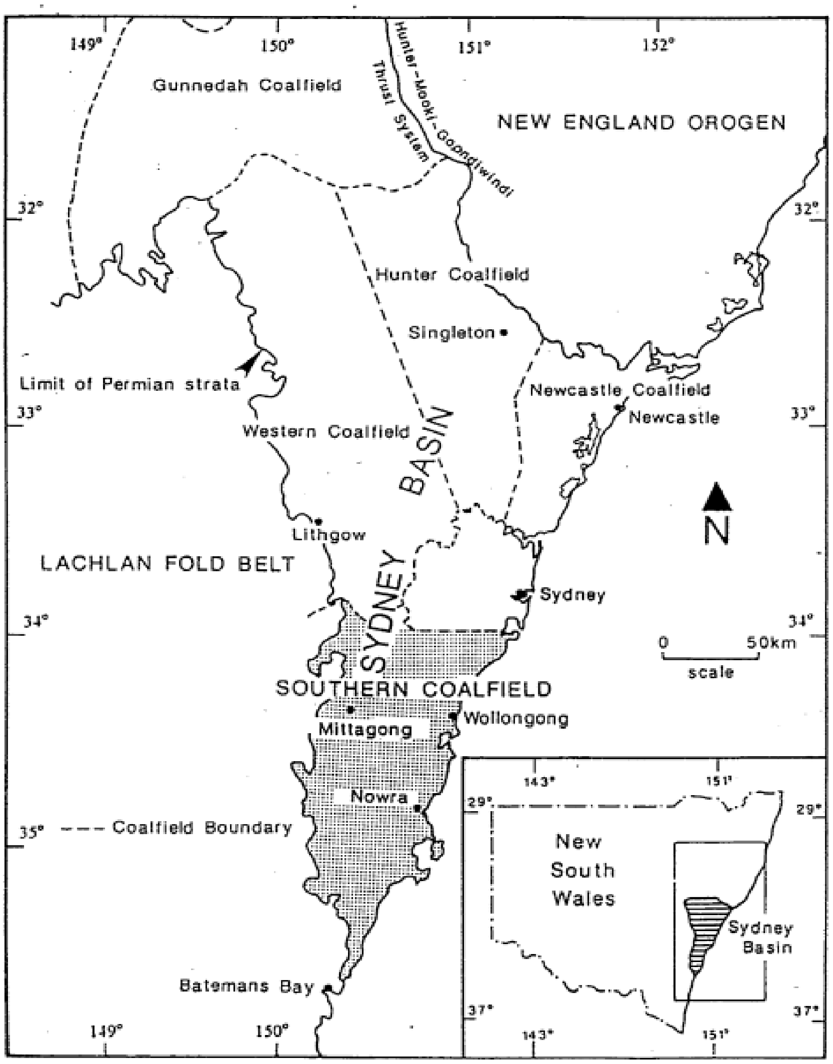


Figure 1 - Location of the Southern Coalfield

Within the Illawarra Coal Measures the Bulli Seam is the uppermost coal member and has been extensively mined across the Southern Coalfield. The Balgownie Seam, stratigraphically around 10 metres below the Bulli Seam, has been mined by the longwall method at South Bulli Colliery and in the 2000's by bord and pillar operations (Gibson's Colliery). There are currently no mining operations in the Balgownie Seam within the Southern Coalfield. The Bulli to Wongawilli Seam interval varies from approximately 24 to around 35 metres. Although generally consistent in thickness across the Coalfield at 8 to 11 metres, the Wongawilli Seam deteriorates in quality to the north when compared to the southern part of the Coalfield where a basal section is mined at Gujarat's Wongawilli Colliery and BHPB Dendrobium Colliery.

At the broad scale the Southern Coalfield is dominated by a north plunging syncline with associated northwest trending synclines and anticlines, shown in Figure 2. The overall structure of the Coalfield is defined from the Bulli Seam but the major structural trends of the Bulli Seam are generally thought to be mirrored through the coal measure sequence.

Large displacement faults in the Coalfield consist primarily of normal faults with dips of between 70 to 85 degrees, trending northwest or nor-nor-west and are the primary set. The exception to this rule is faults found in a northeast trending coastal fault zone. West of this zone northeast faulting still occurs but at a much wider spacing and as a secondary set (some of these are strike slip faults associated with dykes). The deformational history of the northwest fault system is complex and the pattern is the sum of several events that appear to have starting after the Permian although there is evidence of growth faulting indicating structural activity during coal deposition.

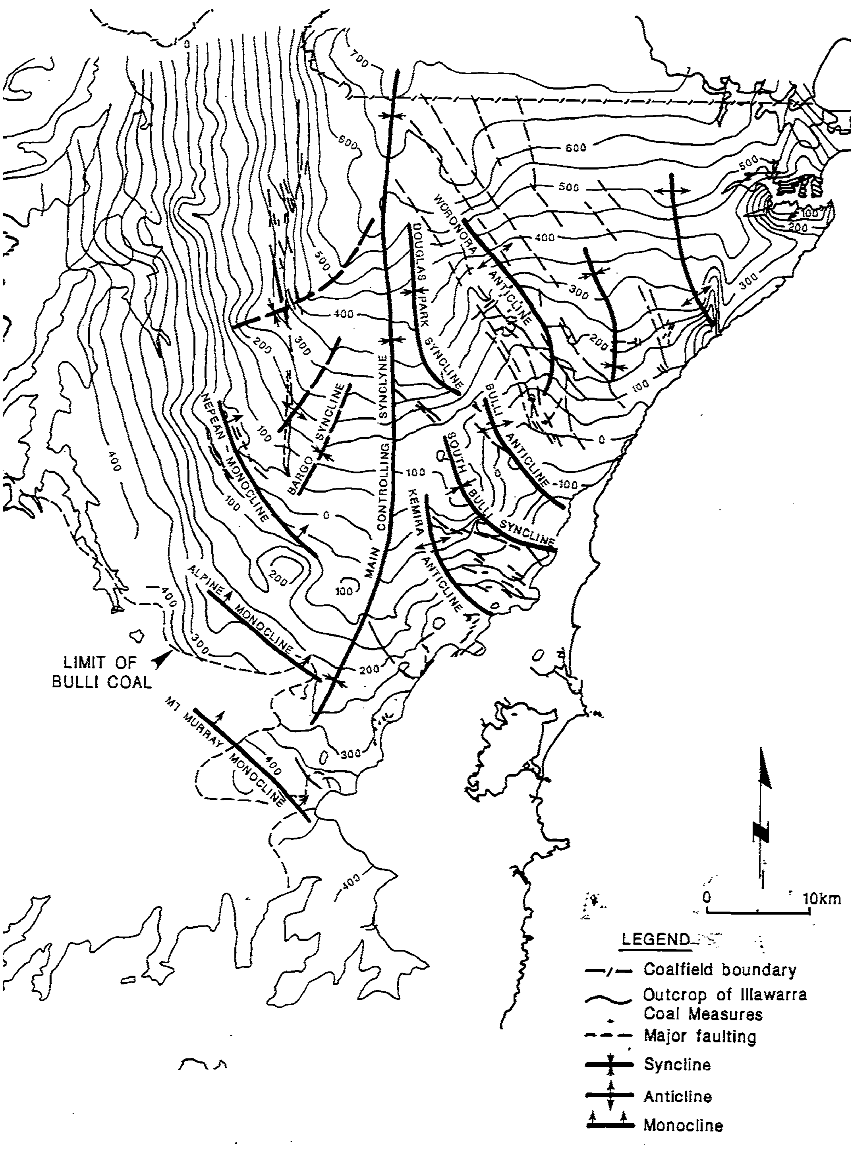


Figure 2 - Structural Elements of the Southern Coalfield

2.2 Stratigraphy

Figure 3 shows the stratigraphy of the Southern Coalfield and gives details of the coal seams present in the Illawarra Coal Measures.

AGE	GROUP	SUB-GRP	CODE	FORMATION & MEMBERS	
TRIASSIC	WIANAMATTA GROUP		WMSH	BRINGELLY SHALE MINCHINBURY SANDSTONE ASHFIELD SHALE	
				MITTAGONG FORMATION	
			HBSS	HAWKSBURY SANDSTONE	
	NARRABEEN GROUP	GOSFORD	GRFM	NEWPORT FORMATION GARIE FORMATION	
		CLIFTON	BACS	BALD HILL CLAYSTONE	
			BGSS	BULGO SANDSTONE	
			SPCS	STANWELL PARK CLAYSTONE	
			SBSS	SCARBOROUGH SANDSTONE	
			WBCS	WOMBARRA CLAYSTONE	
			CCSS	COAL CLIFF SANDSTONE	
PERMIAN	ILLAWARRA COAL MEASURES	SYDNEY	BUSM	BULLI COAL	
			UNM1	LODDON SANDSTONE	
			BASM	BALGOWNIE COAL	
			LRSS	LAWRENCE SANDSTONE	
				BURRAGORANG CLAYSTONE	
			CHSM UNM2	ECKERSLEY FORMATION	CAPE HORN UNNAMED MEMBER 2 HARGRAVE COAL WORONORA COAL NOVICE SANDSTONE
			WW01-11	WONGAWILLI COAL	
			KBSS	KEMBLA SANDSTONE	
			ACSM	ALLANS CREEK FORMATION	AMERICAN CK. COAL
			APFM	DARKES FOREST SANDSTONE (APPIN FORMATION)	
				BARGO CLAYSTONE	HUNTLEY CLAYST. AUSTIMER SANDST.
			TGSM	TONGARRA COAL	
			WTFM	WILTON FORMATION	
				WOONONA COAL MEMBER	
				ERINS VALE FORMATION	
		CUMBERLAND		PHEASANTS NEST FORMATION	FIGTREE COAL UNANDERRA COAL BERKELEY LATITE MINNAMURRA LATITE CALDERWOOD LATITE FIVE ISLANDS LATITE
	SHOALHAVEN GROUP			BROUGHTON FORMATION BERRY SILTSTONE NOWRA SANDSTONE WANDRAWANDIAN SILTSTONE SNAPPER POINT FORMATION PEBBLEY BEACH FORMATION	
	TALATERANG			CLYDE COAL MEASURES	
UNDIFFERENTIATED PALAEOZOIC (DEVONIAN, SILURIAN & ORDOVICIAN) ROCKS OF THE BASIN BASEMENT					
Information Sourced From - "Geological Survey Report No. GS1998/277 - R.S. Moffitt"					

Figure 3 - Generalised Stratigraphy of the Southern Coalfield

The following is a brief summary of the stratigraphic units of the Southern Coalfield within the NRE No.1 Colliery holding.

The Wianamatta Group is the uppermost unit in the stratigraphical sequence and is prominent in the north of the Coalfield. Within the lease area of NRE No.1 only two boreholes (SR16 and WB8) intersected the Wianamatta Shale. Its outcrop is restricted to a very small area in the far western portion of the lease and well outside of the Wonga East area.

The Hawkesbury Sandstone outcrops over most parts of the Coalfield and consists of thickly bedded or massive quartzose sandstone (with grey shale lenses up to several metres thick) with an average thickness of 154m in the lease area.

Within NRE No.1 Colliery the full Narrabeen Group sequence is about 275m thick.

The Gosford Formation (consisting of the Newport Formation of interbedded grey shales and sandstones and the Garie Claystone, a generally hard, grey-brown "oolitic" clay stone) is about 12m thick across the lease area.

The Bald Hill Claystone displays characteristic brownish-red coloured "chocolate shale", a physically weak but lithologically stable unit about 20m thick. The "chocolate shale" is an easily recognised marker horizon.

The Bulgo Sandstone, averaging 162m thick, consists of strong, thickly bedded, and medium to coarse-grained lithic sandstone with occasional beds of conglomerate or shale.

The Stanwell Park Claystone (thickness average 14m) consists of greenish-grey mudstones and sandstones. This "green shale" is very weak lithologically and frets easily on exposure.

The Scarborough Sandstone, averaging 36m in thickness, consists mainly of thickly bedded sandstone with shale and sandy shale lenses up to several metres thick.

Like the Stanwell Park Claystone the Wombarra Shale (thickness average 20m), consists of greenish-grey mudstones and sandstones. This "green shale" is also very weak lithologically and is prone to fretting on exposure.

The Coal Cliff Sandstone averages 10m in thickness. In the coastal region of the Coalfield the Coal Cliff Sandstone is a strong quartzose sandstone. Westward, away from the coast, dominance of the sandstone diminishes and in many areas the original roof strata of the Bulli Seam, a shale / mudstone unit, (which can become laminated in places) is prominent.

The Illawarra Coal Measures consist of interbedded shales, mudstones, lithic sandstones and coal seams of which ten named seams are identified and occur in the Coalfield.

2.2.1 Coal Seams

2.2.1.1 Bulli

The Bulli Seam is the most extensively worked coal seam in the Southern Coalfield, from outcrop mines on the coastal margins to current inland mines of BPB Billiton and Xstrata Coal. The seam produces a high quality hard coking coal (usually needing washing to obtain a coking and energy fraction) to achieve a marketable low ash coking coal. Resources of the Bulli Seam exist in the western portion of NRE No.1 Colliery. Average thickness is 2.2m and thickness variations across the Wonga East Study Area are shown on Figure 4.

2.2.1.2 Balgownie

The Balgownie Seam generally consists of medium to high ash coal with a transitional basal section of varying proportions of carbonaceous shale, mudstone and coal. Seam thickness averages 1.2m (varies from 0.2m to 1.7m) and thickness variations across the Study Area are shown on Figure 5.

Across the colliery the interval separating the Balgownie Seam from the overlying Bulli Seam (Loddon Sandstone) averages 9.5m (varies from approximately 5.2m to 13.8m). Figure 6 shows the thickness variations of the Loddon Sandstone in the Study Area.

2.2.1.3 Cape Horn

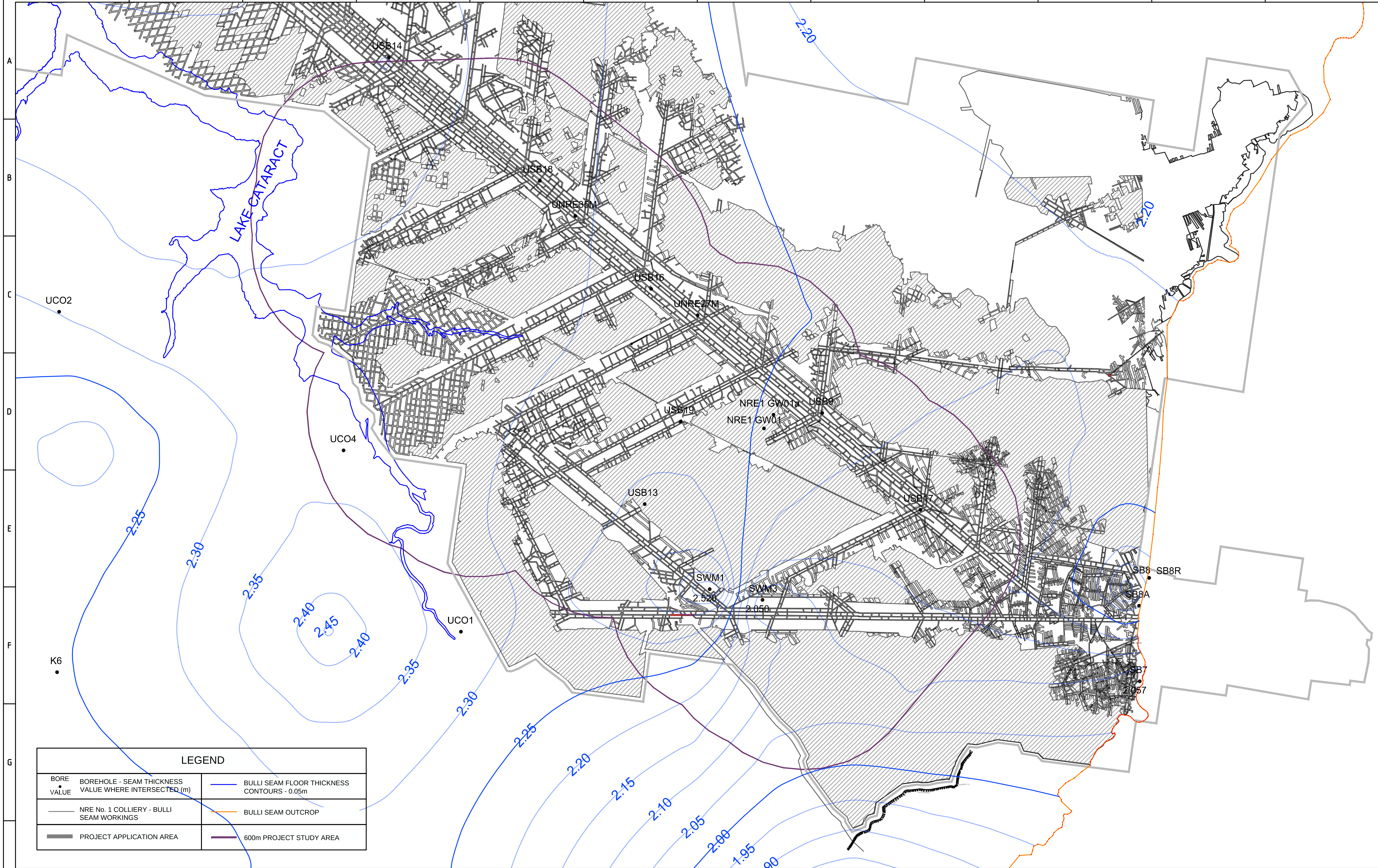
The Cape Horn Seam is uneconomic with thickness typically varying between 0.06m and 0.8m and varying in composition from carbonaceous shale to bright coal. It occurs about 9.5m below the Balgownie Seam and identification is facilitated by the occurrence of the overlying Lawrence Sandstone Member.

2.2.1.4 Hargrave

This seam is separated from the overlying Cape Horn Seam by about 2.5m of shale or mudstone and is not economic, varying in thickness from 0.1m to 0.50m and in composition from bright coal to carbonaceous shale.

2.2.1.5 Wongawilli

The Wongawilli Seam varies in thickness from 7.7m to 11.9m across the Colliery and consists of interbedded bands of brown mudstone or grey shales and coal plies.



REV	DESCRIPTION	DATE	DRN	CKD	REV	DESCRIPTION	DATE	DRN	CKD

NRE No. 1 Colliery

GUJARAT NRE Coking Coal Pty Ltd

Princess Highway & Bellmabi Lane, Russell Vale, NSW. 2517

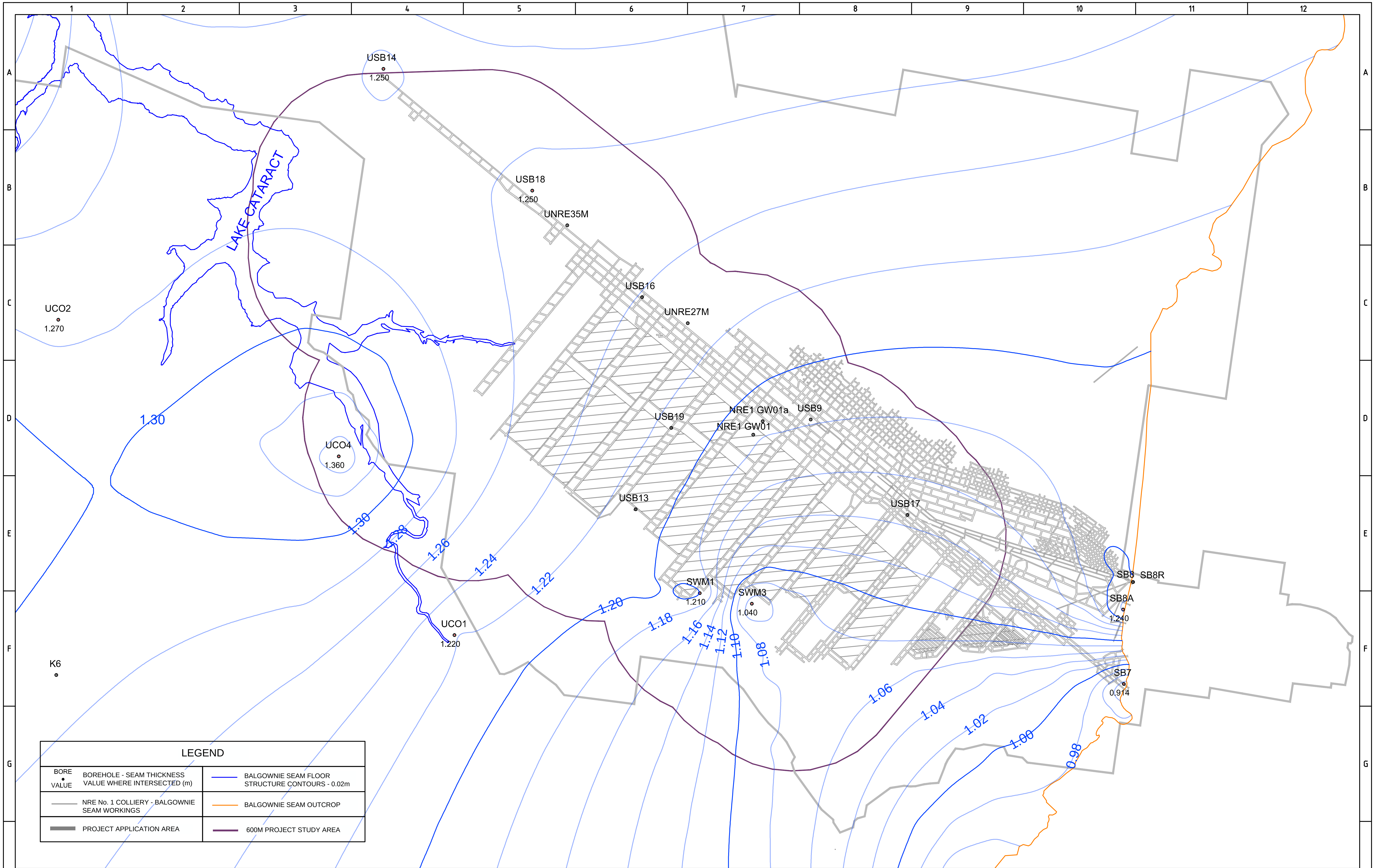
ABN 28 111 244 896

	Name	Date
DRN	RC	30.07.13
CKD		
APP	BC	
SCALE	1:15000	

Title NRE No. 1 COLLIERY - PART 3A APPLICATION PPR
BULLI SEAM THICKNESS
AREA - WONGA EAST

DRAWING NUMBER FIGURE 4

REV 0



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NRE No. 1 Colliery

GUJARAT NRE Coking Coal Pty Ltd

Princess Highway & Bellmabi Lane, Russell Vale, NSW. 2517

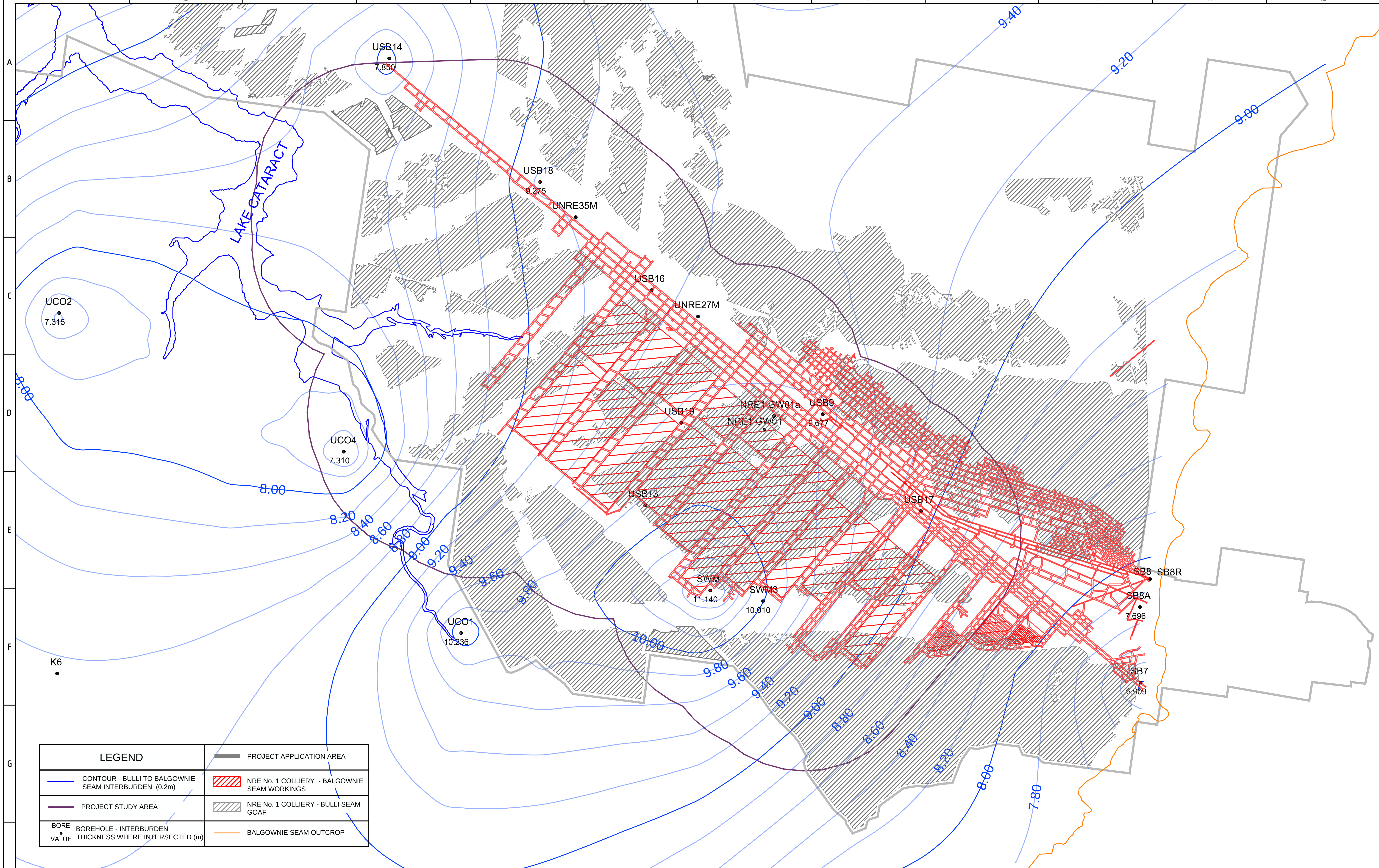
ABN 28 111 244 896

	Name	Date
DRN	RC	30.07.13
CKD		
APP	BC	
SCALE	1:15000	

Title: NRE No. 1 COLLIERY - PART 3A APPLICATION PPR
BALGOWNIE SEAM THICKNESS
AREA - WONGA EAST

DRAWING NUMBER: FIGURE 5

REV: 0



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NRE No. 1 Colliery

GUJARAT NRE Coking Coal Pty Ltd

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ABN 28 111 244 896

	Name	Date
DRN	RC	30.07.13
CKD		
APP	BC	
SCALE	1:15000	

Title: NRE No. 1 COLLIERY - PART 3A APPLICATION PPR LODDON SANDSTONE THICKNESS VARIATION AREA - WONGA EAST

DRAWING NUMBER: FIGURE 6

REV: 0

In the NRE No.1 Wonga East Study Area there is a basal mining section varying between 2.6m to 2.8m that has been identified as the economic longwall mining section. Figure 7 details the mining section thickness across the Wonga East area.

The interval between the Bulli Seam and the roof of the Wongawilli mining section averages around 32m in the NRE No.1 lease area. Figure 8 details this interburden thickness.

2.2.1.6 American Creek

Occurring about 10m below the Wongawilli Seam the seam varies between 0.4m and 3.6m thick, consisting mainly of carbonaceous and coaly shale and is uneconomic.

2.2.1.7 Tongarra

Occurs about 33m below the American Creek Seam the Tongarra Seam has no economic potential, consisting mainly of carbonaceous shale and mudstone bands with thin coaly plies. Averages thickness is about 1.8m.

2.2.1.8 Other Seams

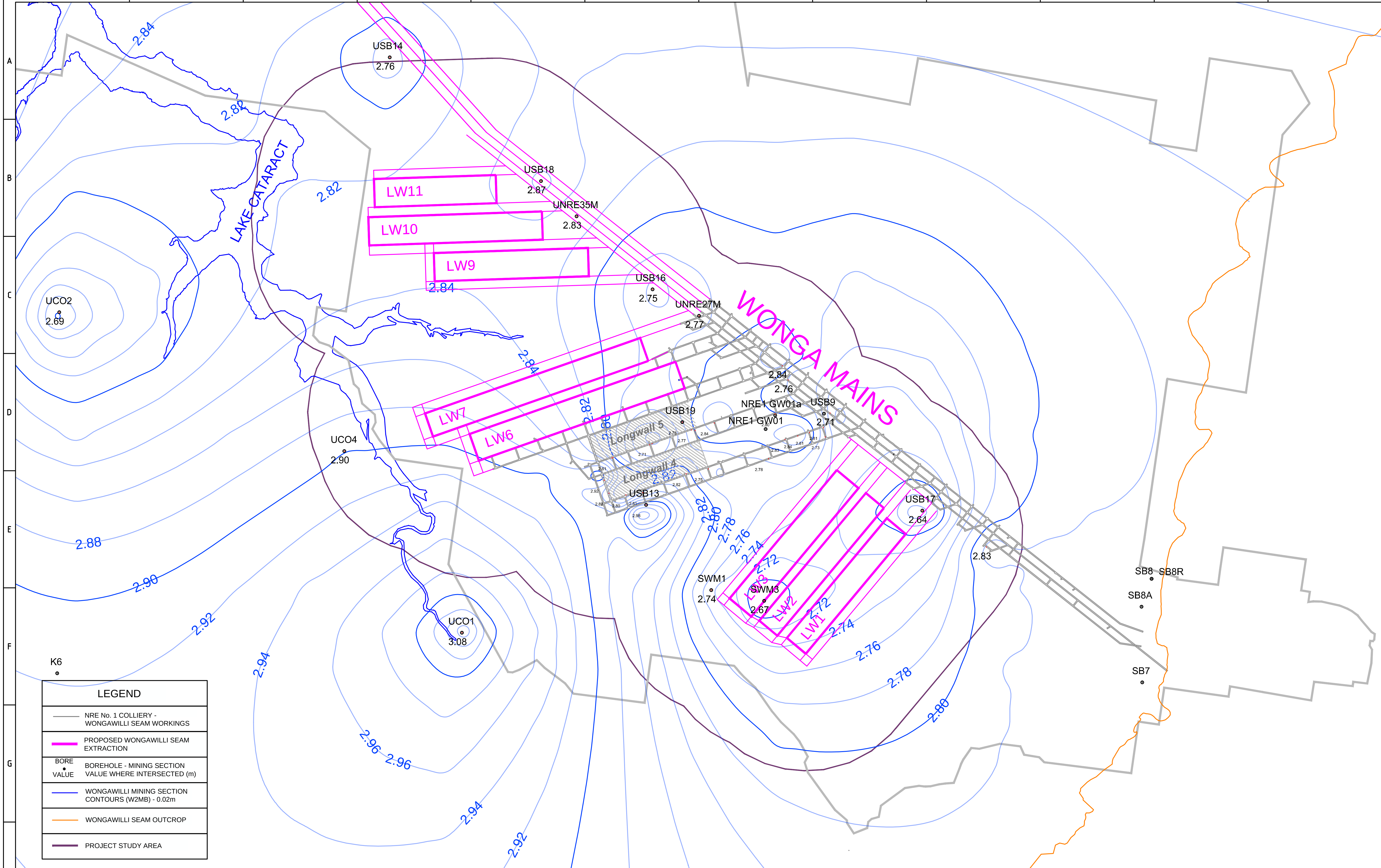
Three other seams are known to occur below the Tongarra Seam, namely the Woonona, Figtree and Unanderra Seams. Occurring about 17m below the Tongarra Seam the Woonona Seam is about 0.40m thick. Approximately 40m below the Woonona, the Figtree Seam is about 0.1m thick. The Unanderra Seam generally consists of numerous splits over an interval thickness of 9.5m and occurs some 17m below the Figtree Seam.

2.3 Depth of Cover

Topographic relief over NRE No.1 Wonga East Study Area consists of a series of ridges and plateaux that slope down into the Cataract Reservoir and its tributaries which incise the landscape. Figure 9 details the surface topography of the Study Area.

Over the Study Area the depth of cover varies from around 225m towards the escarpment to over 350m in the northwest of the Wonga East area The attached depth of cover plan, Figure 10, is to the roof of the Bulli Seam.

Depth of cover for the lower seams has similar trends to the Bulli Seam with the roof of the Balgownie Seam some 11.7m deeper than the Bulli Seam floor. For the Wongawilli Seam depth of



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NRE No. 1 Colliery

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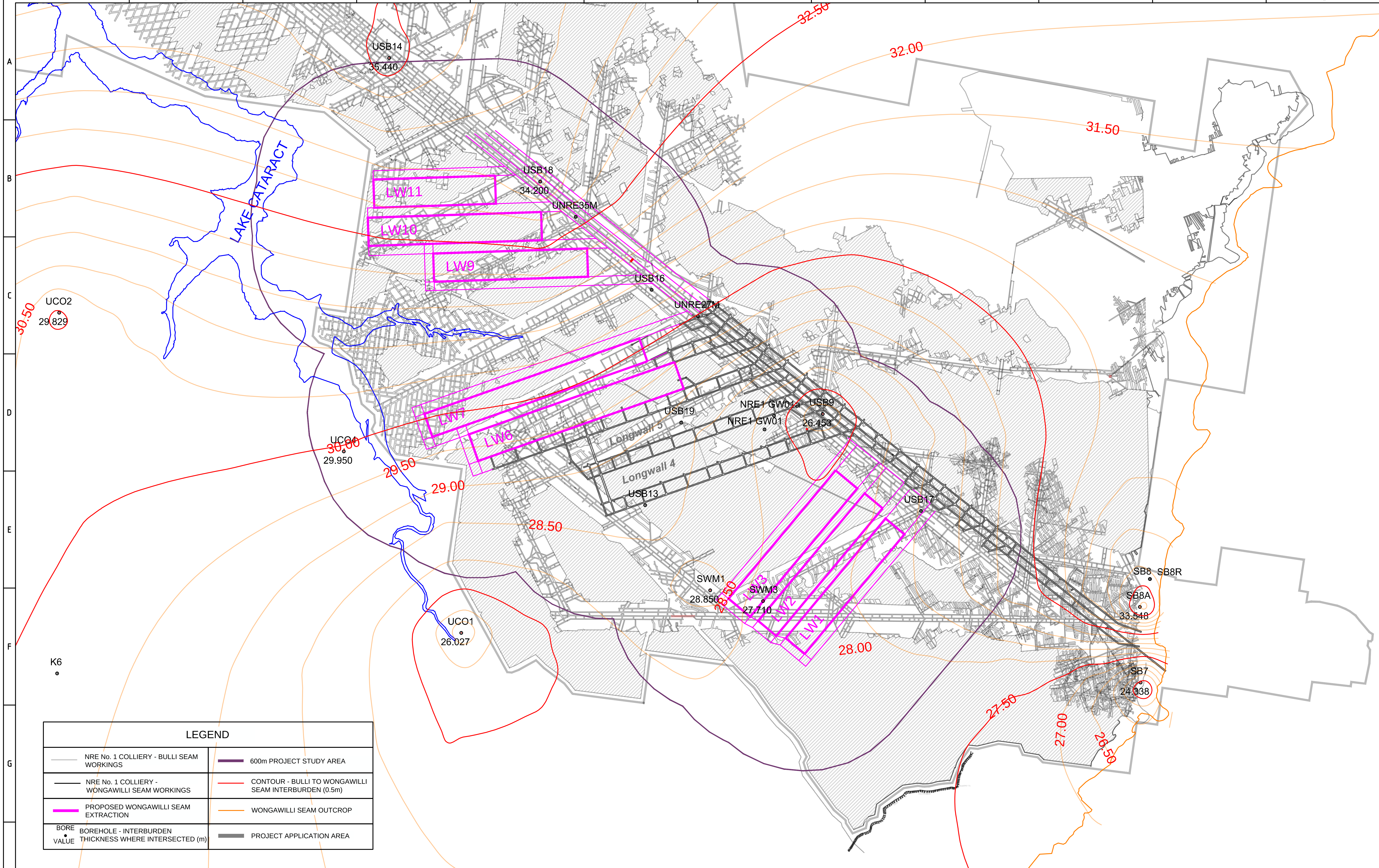
Princess Highway & Bellmabi Lane, Russell Vale, NSW. 2517
ABN 28 111 244 896

	Name	Date
DRN	RC	30.07.13
CKD		
APP	BC	
SCALE	1:15000	

Title
NRE No. 1 COLLIERY - PART 3A APPLICATION PPR
WONGAWILLI SEAM - MINING SECTION THICKNESS (W2MB)
AREA - WONGA EAST

DRAWING NUMBER: FIGURE 7
REV: 0



LEGEND

NRE No. 1 COLLIERY - BULLI SEAM WORKINGS	600m PROJECT STUDY AREA
NRE No. 1 COLLIERY - WONGAWILLI SEAM WORKINGS	CONTOUR - BULLI TO WONGAWILLI SEAM INTERBURDEN (0.5m)
PROPOSED WONGAWILLI SEAM EXTRACTION	WONGAWILLI SEAM OUTCROP
BORE / VALUE — BOREHOLE - INTERBURDEN THICKNESS WHERE INTERSECTED (m)	PROJECT APPLICATION AREA

REV	DESCRIPTION	DATE	DRN	CKD	REV	DESCRIPTION	DATE	DRN	CKD

NRE No. 1 Colliery

GUJARAT NRE Coking Coal Pty Ltd

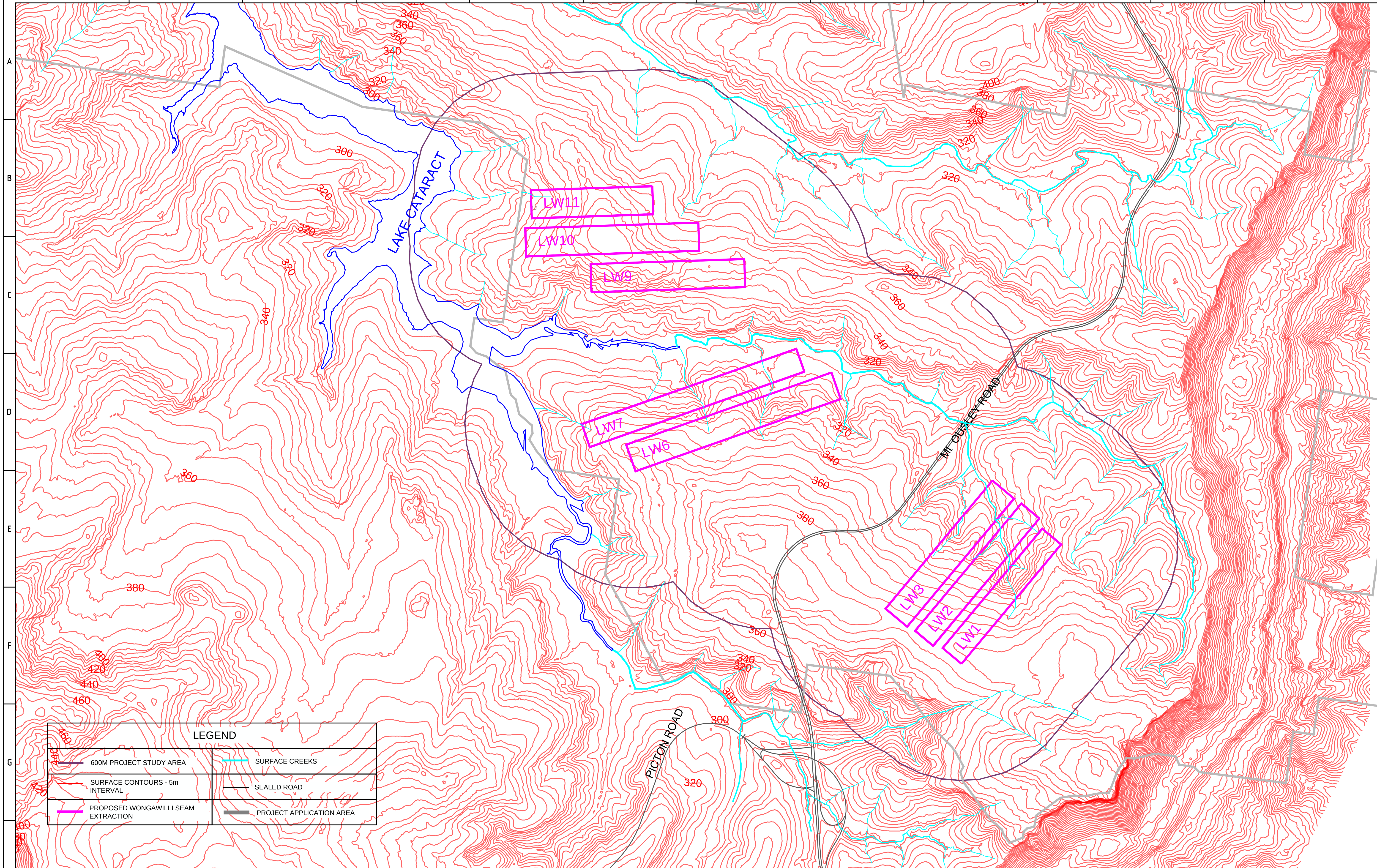
Princess Highway & Bellmabi Lane, Russell Vale, NSW. 2517
ABN 28 111 244 896

	Name	Date
DRN	RC	30.07.13
CKD		
APP	BC	
SCALE	1:15000	

Title: NRE No. 1 COLLIERY - PART 3A APPLICATION PPR
BULLI - WONGAWILLI SEAM INTERBURDEN
AREA - WONGA EAST

DRAWING NUMBER: FIGURE 8

REV: 0



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NRE No. 1 Colliery

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ABN 28 111 244 896

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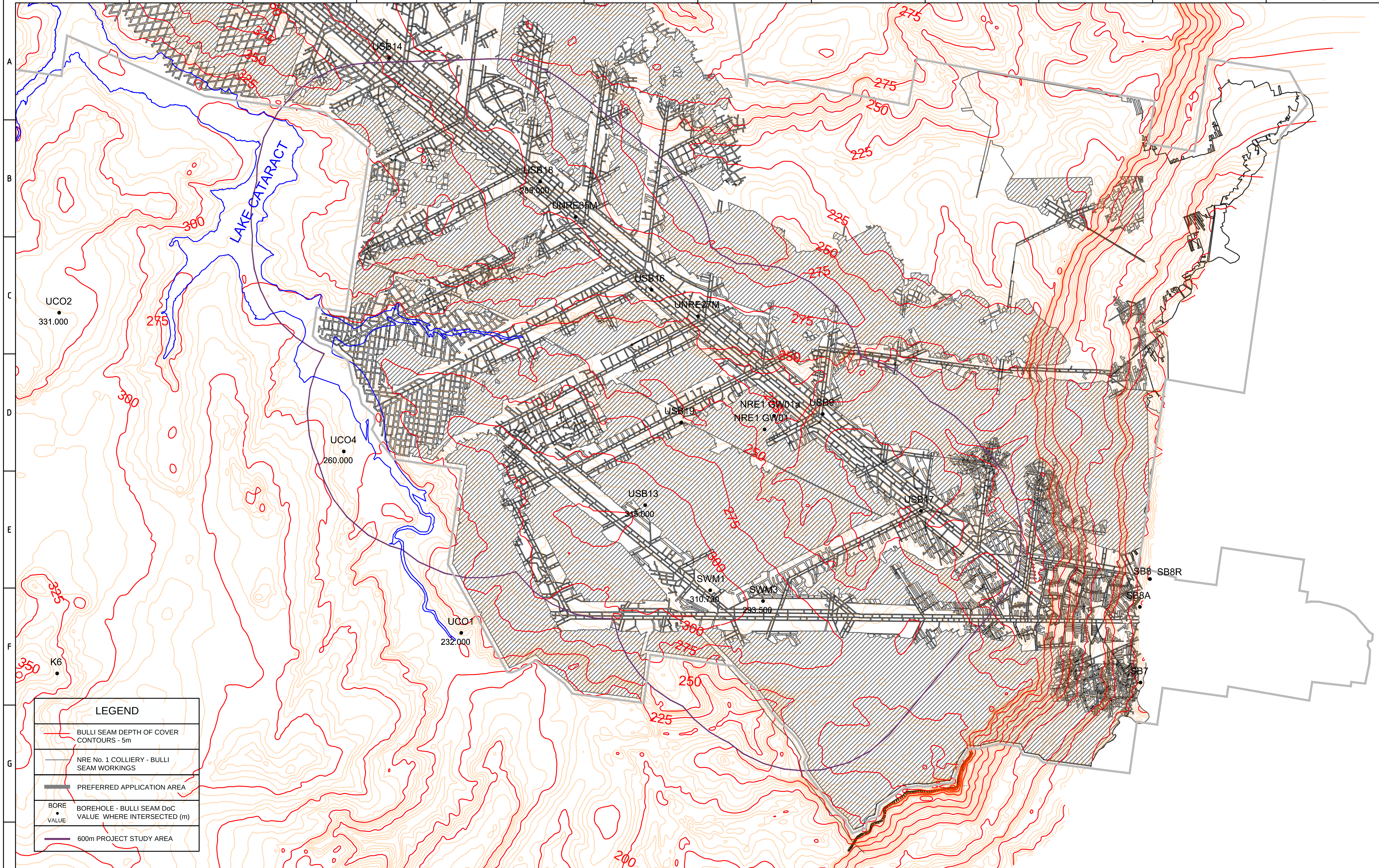
CKD		
APP	BC	
SCALE	1:15000	

Title: NRE No. 1 COLLIERY - PART3A APPLICATION PPR TOPOGRAPHIC DETAILS & SURFACE CREEKS AREA - WONGA EAST

DRAWING NUMBER: FIGURE 9

REV: 0



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NRE No. 1 Colliery

GUJARAT NRE Coking Coal Pty Ltd

Princess Highway & Bellmabi Lane, Russell Vale, NSW. 2517

ABN 28 111 244 896

	Name	Date
DRN	RC	10.07.13
CKD		
APP	BC	
SCALE	1:15000	

Title: NRE No. 1 COLLIERY - PART 3A APPLICATION PPR
BULLI SEAM - DEPTH OF COVER
AREA - WONGA EAST

DRAWING NUMBER: FIGURE 10

REV: 0

cover is taken to the top of the planned longwall extraction height which is 2.8m. Depth to the mining roof for the Wongawilli Seam from the Bulli Seam floor averages 32.5m.

2.4 Surface Geology

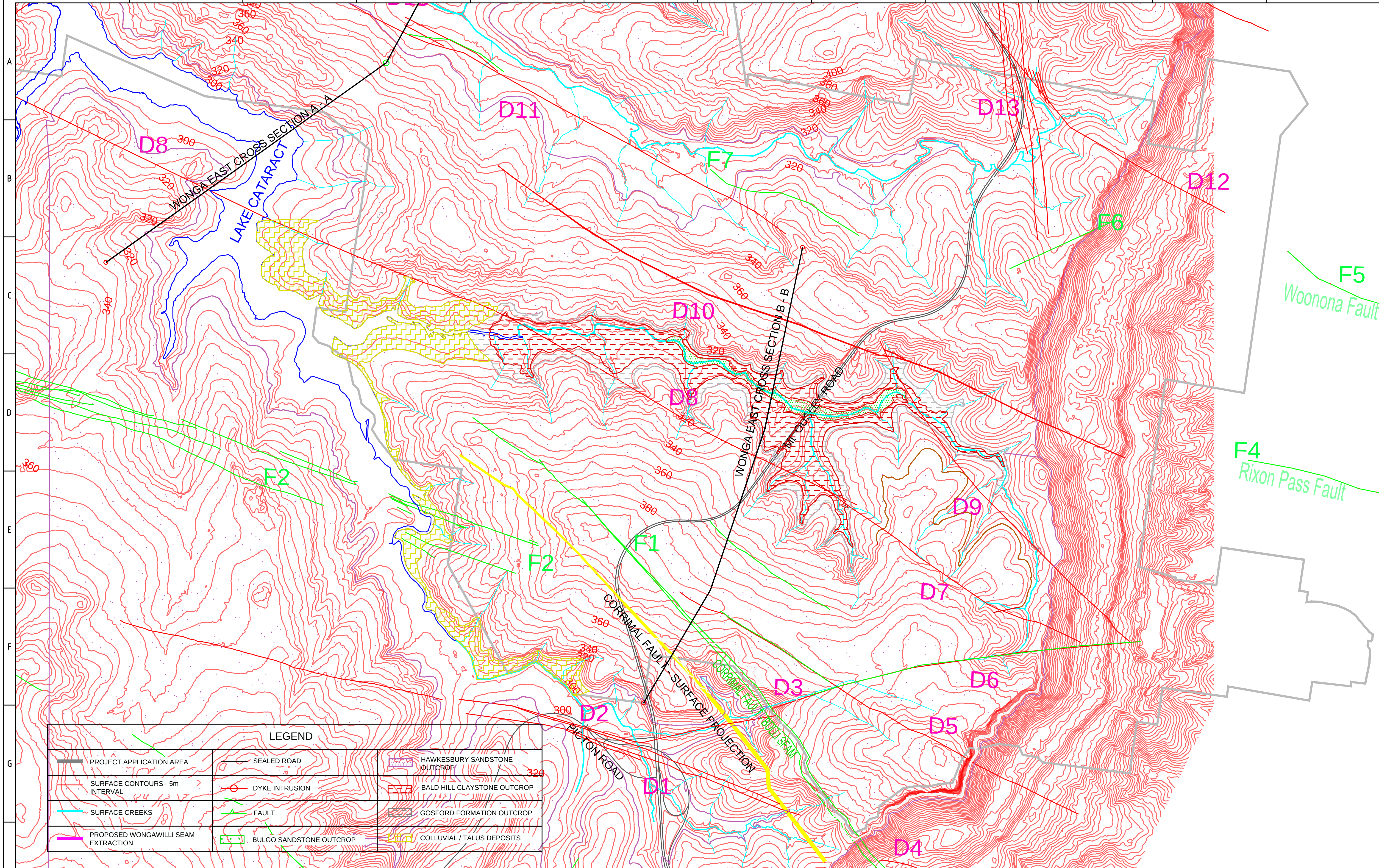
Surface geology in the Wonga East Study Area has been reviewed through ground proofing traverses, detailed Lidar surface topographic data at 1.0m contour intervals and aerial photography. Figure 11 details the understanding of the surface geology to date and the following section discusses the interpretation.

Dominant over the plateaux and ridges is the Hawkesbury Sandstone forming prominent cliff lines in some areas. Descending into the Cataract Reservoir foreshore the Hawkesbury Sandstone is still prominent on the eastern Reservoir shoreline where alluvium and colluvial deposits cover any outcrop of the lower stratigraphy. This colluvial deposit is still prominent toward Cataract Creek until the Gosford Formation, likely the lower Garie Formation, becomes evident. Further east along Cataract Creek the Bald Hill Claystone becomes evident in the creek bed. Approximately 800m west of Mt. Ousley Road the Bulgo Sandstone becomes evident in the creek bed. The Bulgo Sandstone appears to have undergone a small amount of erosion given the proximity of the Bald Hill Claystone boundary. The outcrop of the Bulgo Sandstone remains east of Mt. Ousley Road within the base of the Cataract Creek for about 500m, often covered by Bald Hill Claystone derived alluvium. East of Mt. Ousley Road the Bald Hill Claystone is prominent in the main tributaries of the Cataract Creek before ascending through the Gosford Formation to the widespread Hawkesbury Sandstone.

Figure 12 details two cross-sections within the Study Area, their traces are shown on Figure 11 as section lines A – A and B – B. These cross-sections show consistency in strata thickness across the Study Area with section B – B indicating a slight anticline across the northern section of the Study Area.

2.5 BULLI SEAM STRUCTURE

The contours of the floor level of the Bulli Seam (AHD) are based on surface drilling and Colliery workings and are shown in Figure 13. The extensive workings of the Bulli Seam and information from surrounding collieries (Bulli, Cordeaux and Corrimal) have been used to develop an understanding of



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NRE No. 1 Colliery

GUJARAT NRE Coking Coal Pty Ltd

Princess Highway & Bellmabi Lane, Russell Vale, NSW. 2517

ABN 28 111 244 896

	Name	Date
DRN	RC	10.07.13
CKD		
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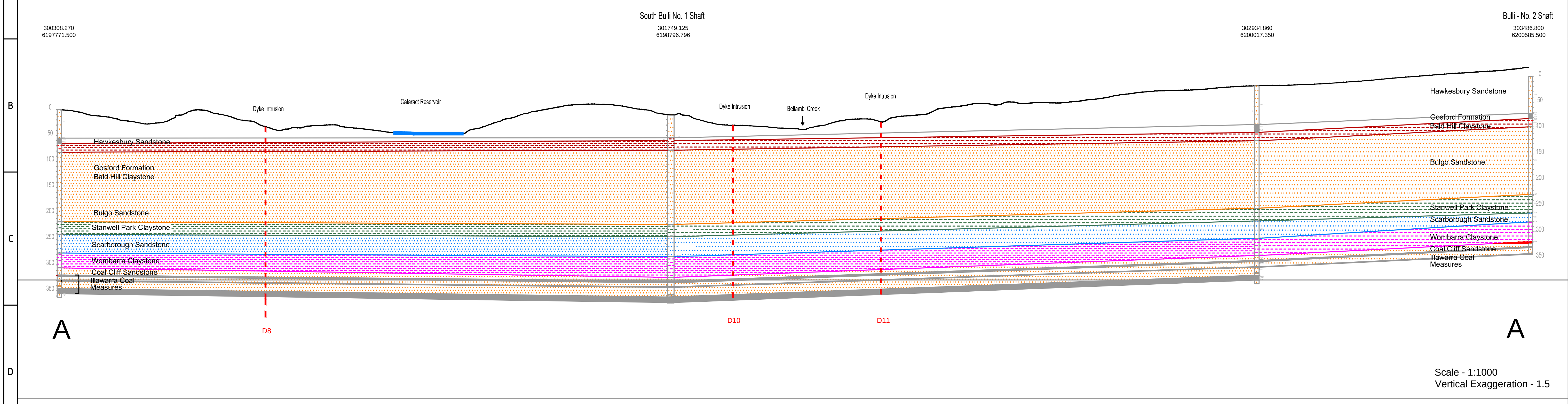
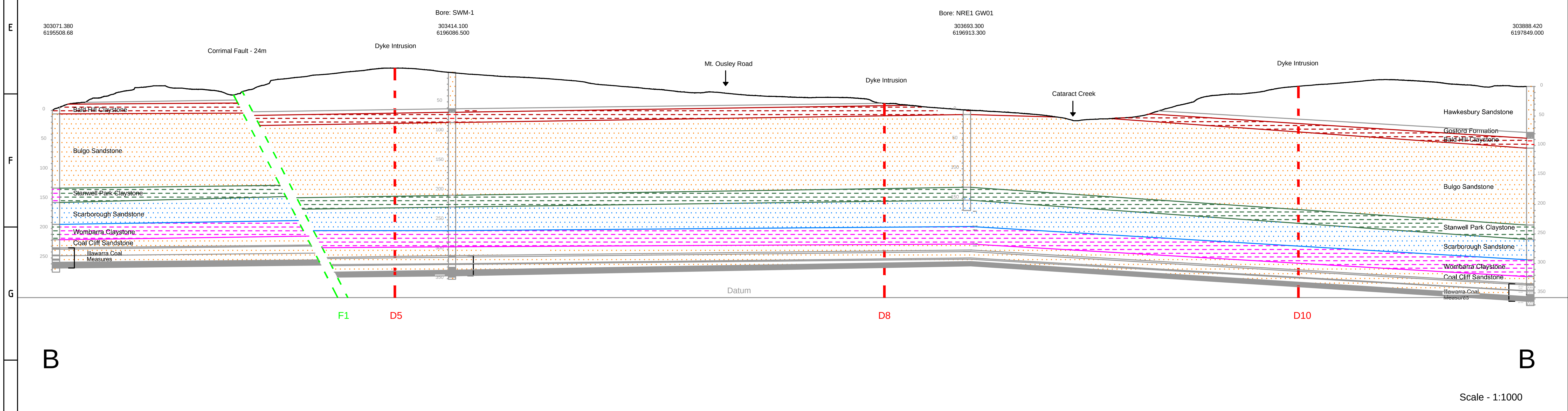
Title NRE No. 1 COLLIERY - PART 3A APPLICATION PPR

TOPOGRAPHIC DETAILS, SURFACE FEATURES & GEOLOGY AREA - WONGA EAST

DRAWING NUMBER FIGURE 11

REV 0





REV	DESCRIPTION	DATE	DRN	CKD	REV	DESCRIPTION	DATE	DRN	CKD

NRE No. 1 Colliery

GUJARAT NRE Coking Coal Pty Ltd

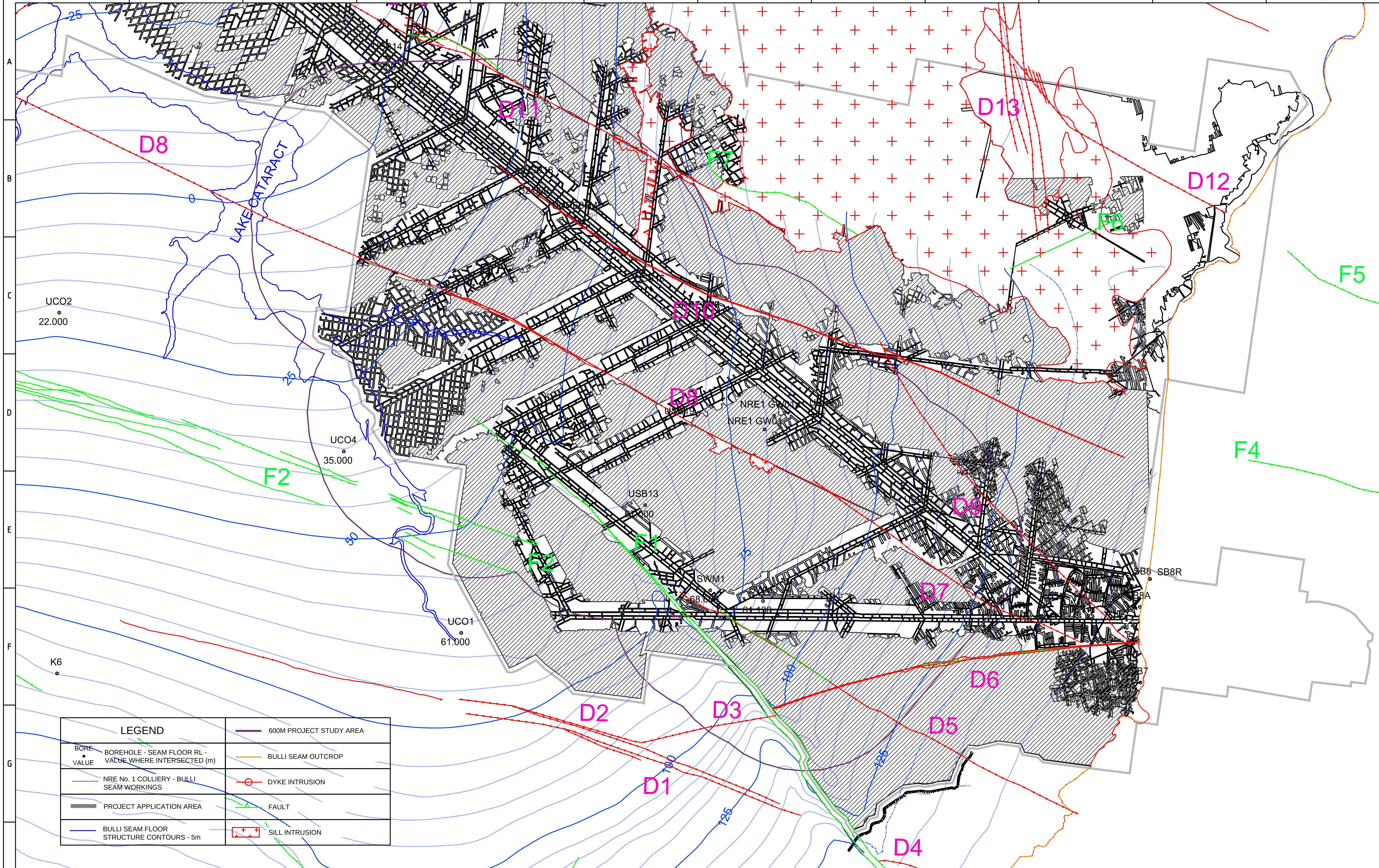
Princess Highway & Bellmabi Lane, Russell Vale, NSW. 2517
ABN 28 111 244 896

	Name	Date
DRN	RC	05.07.13
CKD		
APP		
SCALE	SHOWN	

Title
NRE No. 1 COLLIERY - PART 3A APPLICATION PPR
SECTION OF STRATA
AREA: WONGA EAST

DRAWING NUMBER
FIGURE 12

REV



REV	DESCRIPTION	DATE	DRN	CKD	REV	DESCRIPTION	DATE	DRN	CKD

NRE No. 1 Colliery

GUJARAT NRE Coking Coal Pty Ltd

Princess Highway & Bellmabi Lane, Russell Vale, NSW. 2517
ABN 28 111 244 896

	Name	Date
DRN	RC	10.07.13
CKD		
APP	BC	
SCALE	1:15000	

Title: NRE No. 1 COLLIERY - PART 3A APPLICATION PPR
BULLI SEAM STRUCTURE
AREA - WONGA EAST

DRAWING NUMBER: FIGURE13
REV: 0

the structural nature of the Bulli Seam in the NRE No.1 Wonga East Study Area. The Bulli Seam across this area dips to the west-nor-west from 1 in 25 to 1 in 30 and reflects the eastern section of a broad synclinal structure (South Bulli Syncline) and minor anticline structure toward the north of the Study Area.

Figure 14 details the known structures in the Bulli Seam for the Wonga East Study Area. These structures have been derived from detailed examination of available mine plans. Each structure is annotated for easy reference and discussed in the following sections on faulting and igneous intrusions.

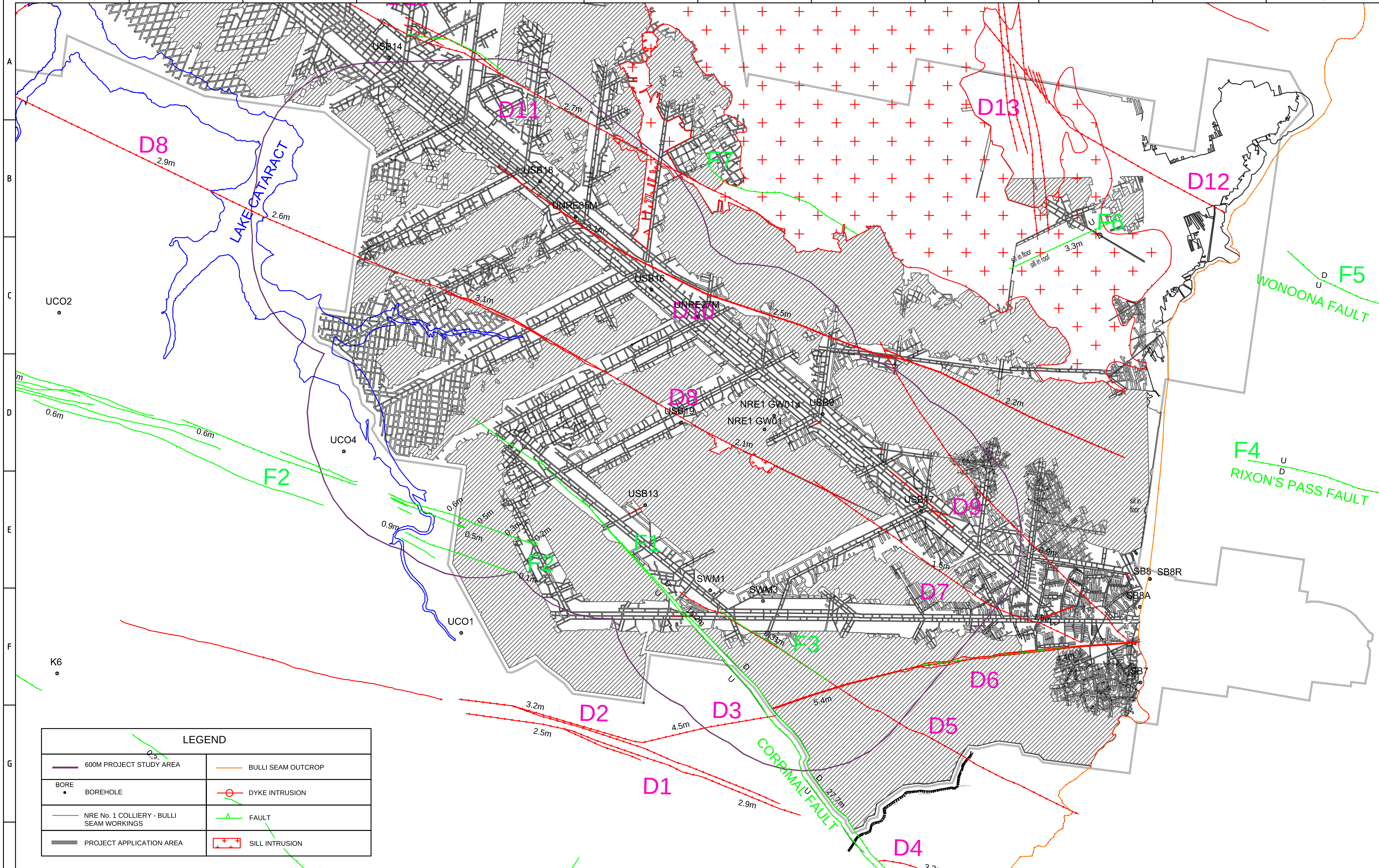
2.5.1 Faulting

Fault F1, commonly known as the Corrimal Fault, occurs from outcrop and extends approximately 3000m to the northwest (bearing 320 degrees) before dying out. Maximum recorded displacement has been measured at 28.7m with a fault width of approximately 20m. There are no records or documentation indicating moisture ingress being associated with the fault.

Fault F2 is a fault zone, some 170m wide, prominent in Corrimal Colliery and extending approximately 400m into the workings of South Bulli Colliery before dying out. Maximum displacement within the zone is 0.9m with the majority of the faults 0.6m or less and a range in displacements from 0.1m to 0.9m. Strike of the fault zone is 110 degrees.

Fault F3 is a short strike length feature (approximately 610m long) bearing 300 degrees and is associated with dyke D5. It has a recorded displacement of 0.31m downthrown to the north. It is probable the fault formed as a result of the forces occurring during the injection of the dyke due to its concurrence with the dyke and its short strike length.

Fault F4 is recognized as the Rixon's Pass Fault and is believed to have been intersected, possible in the Tongarra Seam, in a clay quarry east of the escarpment (Illawarra Brick Company Quarry). The fault is annotated as being downthrown to the south and bears 285 degrees. No record of displacement of the fault has been found. Detailed examination of the South Bulli mine plans indicate the fault does not project to the west into the workings. There is a possible correlation with a thin, soft dyke (dyke D10) within the South Bulli Colliery workings but there is no record of this dyke being associated with faulting.



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APP BC	
SCALE 1:15000	

NRE No. 1 Colliery

GUJARAT NRE Coking Coal Pty Ltd

Princess Highway & Bellmabi Lane, Russell Vale, NSW. 2517
ABN 28 111 244 896

Title
NRE No. 1 COLLIERY - PART 3A APPLICATION PPR
BULLI SEAM GEOLOGICAL PLAN
AREA - WONGA EAST

DRAWING NUMBER: FIGURE 14

REV: 0

REV	DESCRIPTION	DATE	DRN	CKD	REV	DESCRIPTION	DATE	DRN	CKD

Fault F5 is recognized as the Woonona Fault and occurs east of the escarpment. The fault is annotated as being downthrown to the north, arcuate (curved) in nature and bearing approximately 290 degrees. No recorded displacement of the fault has been sighted. The origin of the Woonona Fault is unknown. There is no record of the fault appearing in the South Bulli Colliery workings. It correlates closely with a thin, soft dyke (dyke D12) but again there is no record of faulting associated with the dyke.

Fault F6 is known from South Bulli Colliery workings with a recorded displacement of 3.3m. The fault has a strike length of approximately 500m and bears 60 degrees and may have an association with the major intrusion in the Bulli Seam, the Bulli Sill Complex, as the sill is in the roof to the southeast of the fault and in the floor to the northwest.

Fault F7 is known from South Bulli Colliery workings with a strike length of about 830m, bearing 290 degrees and has no recorded displacement but from the mine plans it did not appear to cause disruption to the workings. The inference from this is the fault was of a small displacement allowing workings to be developed through the fault.

2.5.2 Igneous Intrusions

2.5.2.1 Dykes

Within the South Bulli Colliery mine workings of NRE No.1 Wonga East Study Area and surrounding collieries igneous intrusions of dykes and sills have been intersected within the Bulli Seam. Dykes are the most common form of igneous intrusion and are generally oriented in a northeast – southwest direction, within the Study Area trending about 120 degrees. Igneous intrusions discussed here are shown and annotated in Figure 14.

Dykes D1 and D2 was intersected in Corrimal Colliery with thickness up to 3.2m, strike of 110 degrees and extent of over 3500m.

Dyke D3 is most likely a continuation of dyke D6, being offset across the Corrimal Fault. Thickness is 4.5m, strikes at 150 degrees and is 650m long.

Dyke D4 is most likely a continuation of either dykes D1 or D2 and again is offset across the Corrimal Fault. Thickness is 3.3m, strike of 110 degrees and extent of 650m to outcrop.

Dyke D5 extends from outcrop approximately 2300m before dying out near the Corrimal Fault. Thickness has been estimated from mine plans at about 1.5 to 1.6m. The dyke, striking 300 degrees, appeared to cause no disruption to mining based on the mine workings and is assumed to be a soft clay dyke.

Dyke D6 strikes at 80 degrees, strike length of 1890m and has a measured thickness of 4.4m and where it has silled into the Bulli seam appears to be about 10m which is likely to include the cinder zone and hardened coal. Mine workings skirted the dyke implying some degree of hardness.

Dyke D7 is estimated from mine plans to be about 1.6m thick and appears thin and soft from mine plan details. The dyke has a strike length of 1500m and strike direction of 300 degrees.

Dyke D8 is the most prominent dyke in the Bulli Seam workings in the Wonga East area and extends for over 7.0km to the northwest (bearing 300 degrees) before dying out. It has a thickness range of 2.1m to 3.1m and is associated with seam silling and cindering. The dyke is hard and possibly syenitic in nature.

Dyke D9 has a measured thickness of 0.9m and is soft clay. It has a strike length of 1900m and a bearing of 325 degrees.

Dyke D10 has a recorded thickness of up to 3.1m and is noted as soft. The dyke has a strike length of 3700m and bears 290 degrees. The dyke is associated with silling in the seam floor near the escarpment and dies out within the Wonga East Study Area.

Dyke D11 has a recorded thickness of 2.7m near its convergence with the Bulli Sill Complex. The dyke is soft and becomes thin and intermittent on its projection to the west-nor-west (bearing 300 degrees). Overall length is 2750m.

Dyke D12 has no recorded thickness but appears to be soft and did not hinder mine development to any major extent. The dyke has a strike length of 1650m before it loses its identity within the Bulli Sill Complex. The dyke may be correlated with the Woonona Fault but there is no indication the dyke has a fault component.

Dyke D13 is a swarm of thin and intermittent soft clay dykes that bear almost north south. The swarm is likely to be related to the Bulli Sill Complex. The dykes had minimal impact on mine development.

Dyke D14 has an east west strike and length of 1400m and is coincident with the northern colliery boundary between Old Bulli Colliery and NRE No.1. No information on the dyke has been sighted and the dyke dies out to the west within the South Bulli mine workings, being soft and thin.

Dyke D15 has a recorded thickness of 1.2m, striking parallel to dyke D11 for approximately 1400m and tapers out to the west-nor-west. The dyke appears to be soft and had no impact on mine development.

2.5.2.2 Silling

Sills have a far greater impact on mine development than dykes. Their lateral intrusive nature often means that large areas of coal seams (often hectares) can be rendered uneconomic due to complete replacement (ingestion) of the coal or cindering, alteration and/or loss of coking properties. Sills are erratic and the larger sills are often transgressive in nature (intrude across several seams) and historically their definition other than in a general way has been difficult to define prior to mining. Within the Wonga East Study Area there is a significant sill event, the Bulli Sill Complex which has an areal extent of over 13km^2. The sill complex is transgressive in nature, known to intrude the Bulli, Balgownie and Wongawilli seams in NRE No.1 and affecting other collieries to the north. Mine workings within the Bulli seam at various collieries have enabled an accurate boundary definition of the Sill complex to be established and this is shown in Figure 14.

2.6 BALGOWNIE SEAM STRUCTURE

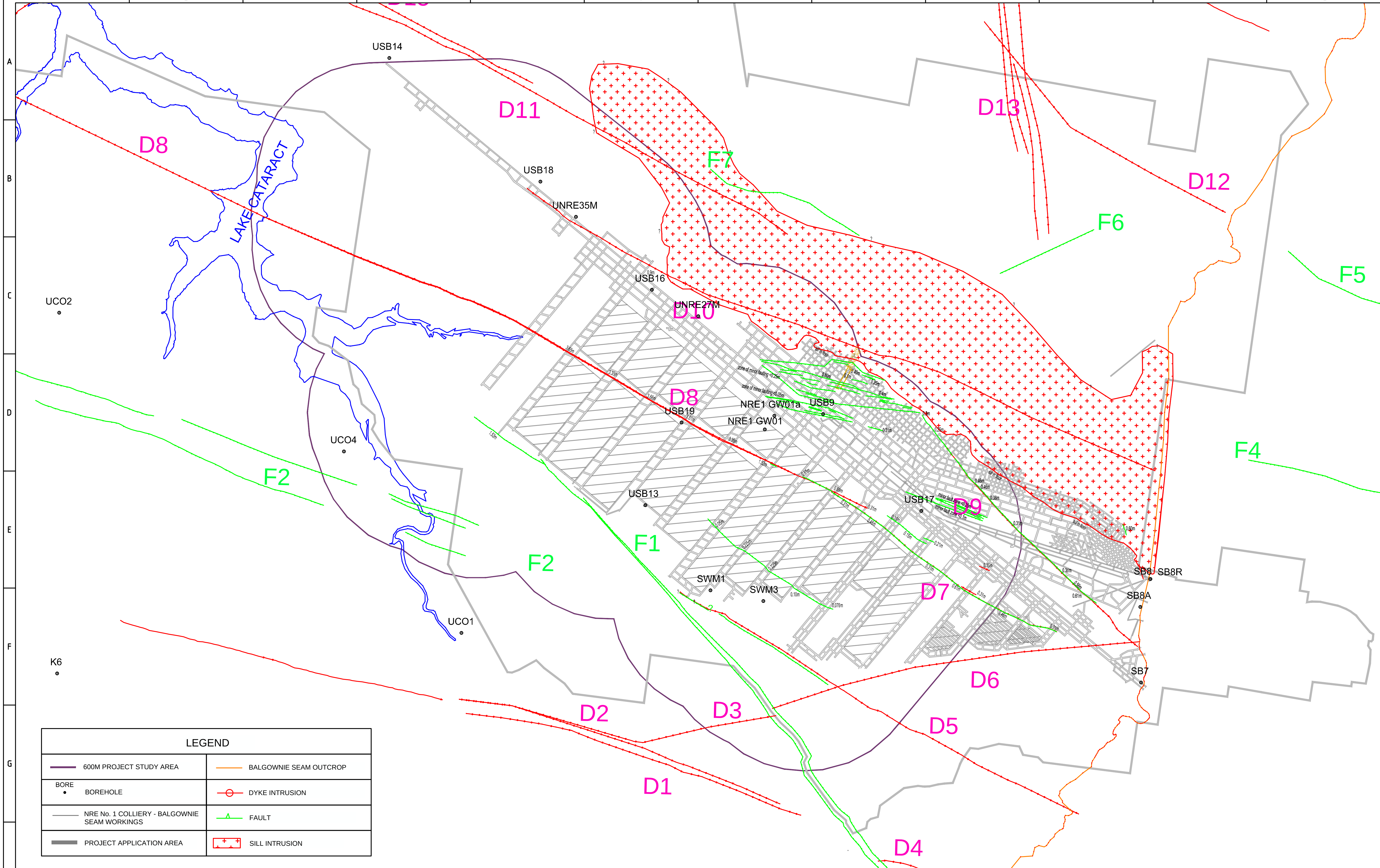
Mining within the Balgownie Seam in the Wonga East Study Area was undertaken between 1968 and 1982 (longwall method) and again in 2001 to 2003 (pillar driveage). Figure 15 details the mine workings and the known and interpreted geological structures within the seam.

2.6.1 Faulting

Faulting intersected by the Balgownie workings displays some correlation with known faulting in the overlying Bulli Seam.

Fault F1 in the Bulli Seam (Corrimal Fault) was intersected in a heading of gate road driveage and had a displacement of 1.53m and was offset 7.0m to the north from the fault position in the Bulli seam.

Fault F3 in the Bulli Seam was associated with dyke D5. Intersected in an overdrive heading the fault and dyke still appear together in a very similar location to the location in the Bulli Seam. This gives weight to the fault being formed during injection of the dyke as the fault has no offset to its position in the Bulli Seam.



REV	DESCRIPTION	DATE	DRN	CKD	REV	DESCRIPTION	DATE	DRN	CKD

NRE No. 1 Colliery

GUJARAT NRE Coking Coal Pty Ltd

Princess Highway & Bellmabi Lane, Russell Vale, NSW. 2517
ABN 28 111 244 896

	Name	Date
DRN	RC	10.07.13
CKD		
APP	BC	
SCALE	1:15000	

Title
NRE No. 1 COLLIERY - PART 3A APPLICATION PPR
BALGOWNIE SEAM GEOLOGICAL PLAN
AREA - WONGA EAST

DRAWING NUMBER
FIGURE 15

REV
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Additional faulting intersected in the Balgownie workings have no expression in the overlying Bulli Seam. This faulting, consisting of very small scale displacements, is generally less than 0.3m and primarily confined to the more recent 2001 to 2003 workings. It is suggested here that the faulting is a result of tensional deformation of the Balgownie Seam due to increased stress levels from goaf formation formed during longwall extraction in the Balgownie Seam and the interaction from overlying Bulli Seam pillars and goaf. The minor fault zones have a very limited strike length.

2.6.2 Igneous Intrusions

2.6.2.1 Dykes

Balgownie Seam workings have intersected 5 dykes. These dykes project through to the overlying Bulli Seam workings in almost the exact location indicating the dykes have been injected in a near vertical plane through the Coal Measure strata. The following dykes, annotated with the Bulli Seam nomenclature in Figure 15, were intersected in the Balgownie workings.

Dyke D5 was intersected by an overdrive heading. No indication of thickness or strike length is known from the Balgownie Seam workings.

Dyke D6 was intersected in initial Balgownie Seam workings. No indication of dyke thickness has been sighted. Dyke strike direction is the same as the dyke intersected in the overlying Bulli Seam workings.

Dyke D7 was intersected in many roadways and varied in thickness from about 0.31m to 0.61m and from the Balgownie mine plan appears to be a soft clay dyke. Thickness on this dyke from the Bulli Seam workings indicated 1.5m to 1.6m.Strike length and direction are similar to the Bulli Seam dyke position.

Dyke D8, prominent in the Bulli Seam workings, is also prominent in the Balgownie Seam workings. The dyke varies from about 0.31m thick where first intersected to 3.65m at its last measured intersection. In a similar location in the overlying Bulli Seam to its last measured thickness in the Balgownie Seam the dyke was measured at 3.7m thick. The dyke is hard and as it thickened the Balgownie Seam longwall was recovered and reinstalled on a new install heading to avoid mining through the dyke.

Dyke D9 was intersected by numerous roadways. Dyke thickness has a maximum of 0.56m and dies out to the west-nor-west as it does in the Bulli Seam where it has a thickness of 0.9m.

Dyke D10 was intersected over several roadways and measured at 0.9m thick. Its thickness in the Bulli Seam at a similar location was estimated at 3.1m.

2.6.2.2 Silling

Silling within the Balgownie Seam was intersected by workings driven during 2001 to 2003. The silling initially appeared in the floor of the seam and has affected the quality of the coal. The extent of the sill where intersected by workings can be seen in Figure 15. The northern extent of the silling is unknown due to a lack of data but it is believed that initial workings into the Balgownie Seam by Bulli Colliery intersected igneous material.

The complexity and multiple intrusion of the sill can be seen from the location of the sill in the Balgownie Seam when compared to the Bulli Seam. In the Balgownie Seam the edge of the silling as defined by the workings varies between 450m to 750m further south than the edge of the silling in the Bulli Seam.

Based on the above discussion and comparison of structures intersected in both the Bulli and Balgownie Seams it is justifiable to assume dykes intersected in Bulli Seam workings will be in the Balgownie Seam at similar locations. Dyke thickness generally appears to be thinner in the Balgownie Seam than the Bulli Seam and may be a result of the thinner Balgownie Seam being more confined thus restricting expansion of the igneous material during injection when compared to the thicker Bulli Seam.

Projection of faulting is not as clear from the Bulli to Balgownie Seams. Based on the above analysis and previous experience of multiple seam mining in Cordeaux and Kemira Collieries minor faulting in one seam will not necessarily project through to other seams. Based on this generalization, faulting of less than approximately 0.4m occurring in one seam is not projected through to other seams. Faulting of greater than 0.4m is projected to other seams, the projection requiring an understanding of the angle of dip (hade) of the faulting to improve accuracy. Where the hade is unknown projection at an angle of 80 degrees, dependent upon its sense of throw, is used as a “best” estimate of location in other seams. Figure 15 details the known and predicted structural geology of the Balgownie Seam based on the above synopsis.

2.7 WONGAWILLI SEAM STRUCTURE

Development within the Wongawilli Seam in the Wonga East Study Area consists of mains roadways, currently reaching 2.9km from outcrop, and gate road driveage for longwall extraction with one longwall extracted (LW4) and another (LW5) currently being extracted.

The contours of the floor level of the Wongawilli Seam are based on surface drilling and mine working levels and known floor data from the overlying Bulli and Balgownie Seams and are shown in Figure 16. The Wongawilli Seam across this area dips to the west-nor-west from 1 in 25 to 1 in 30 and generally reflects the Bulli Seam floor structure. Current and proposed mine workings are also shown in Figure 16

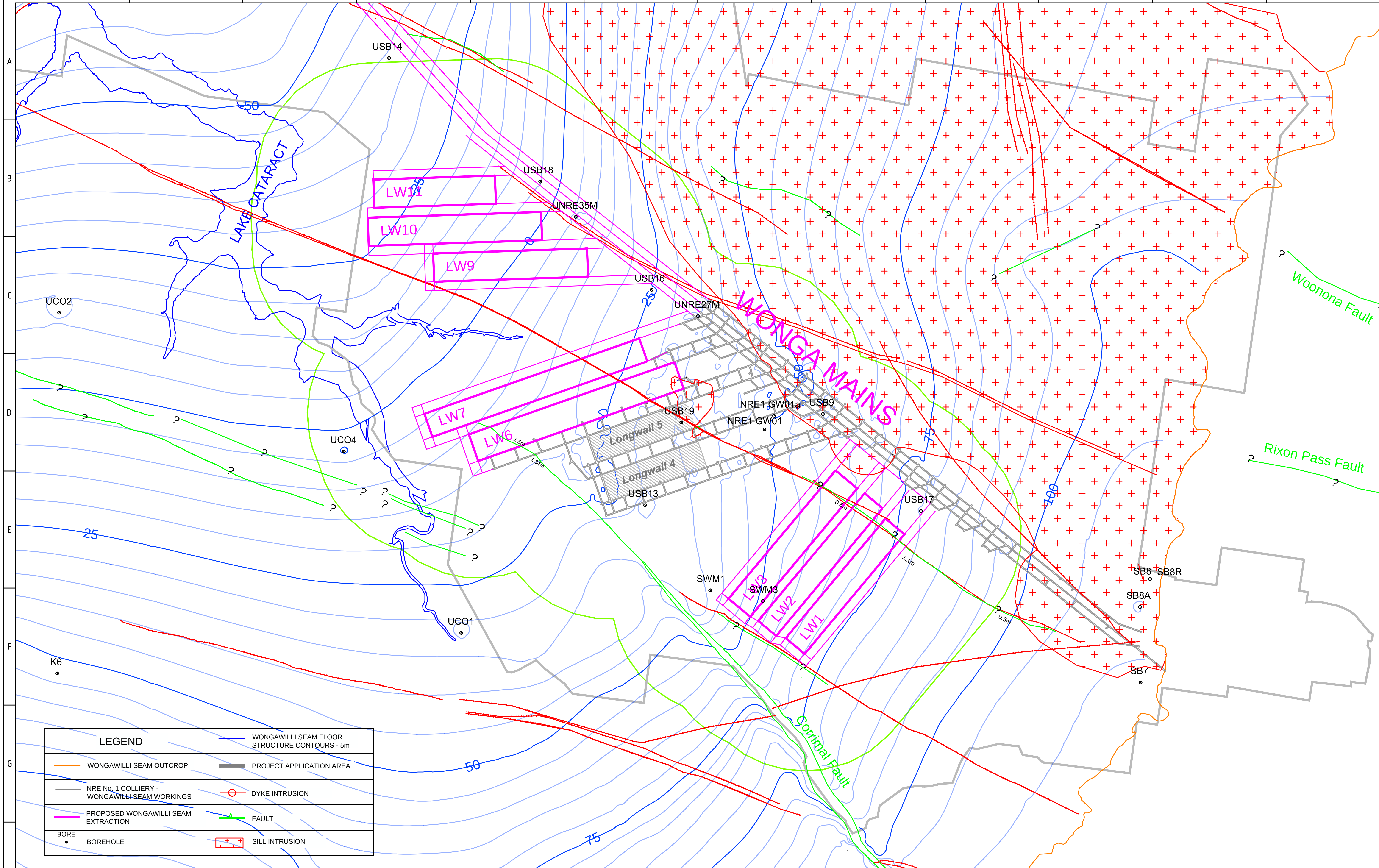
2.7.1 Faulting

Within the mine workings of the Wongawilli Seam the Corrimal Fault (Fault F1 in the Bulli seam) has been intersected. No other faulting of any significance has been intersected. The Corrimal Fault was intersected in Maingate 5 development and had displacement of 1.84m to 1.50m across the two headings, decreasing in displacement along its projected strike to the northwest. Characteristics of the fault are similar to those known from the Bulli and Balgownie Seams, being a normal fault down thrown to the north. Where intersected the fault had a measured dip of 35 degrees. The fault plane is offset approximately 24m to the north from its position in the Bulli Seam. Based on the decreasing displacement the fault is predicted to die out within a distance of less than 500m as shown in Figure 17.

2.7.2 Igneous Intrusions

2.7.2.1 Dykes

Only one dyke known from the Bulli Seam workings has been intersected by current Wongawilli Seam mine development. The dyke is D8 and has been intersected in three sets of longwall gate road driveage. The dyke has a maximum measured thickness of 4.1m and is hard and dry. It has been mined through in the current longwall 5 and was highly fractured and blocky in nature. No evidence of



REV	DESCRIPTION	DATE	DRN	CKD	REV	DESCRIPTION	DATE	DRN	CKD

NRE No. 1 Colliery

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APP	BC	
SCALE	1:15000	

Title

NRE No. 1 COLLIERY - PART 3A APPLICATION PPR

WONGAWILLI SEAM - SEAM STRUCTURE

AREA - WONGA EAST

DRAWING NUMBER FIGURE 16

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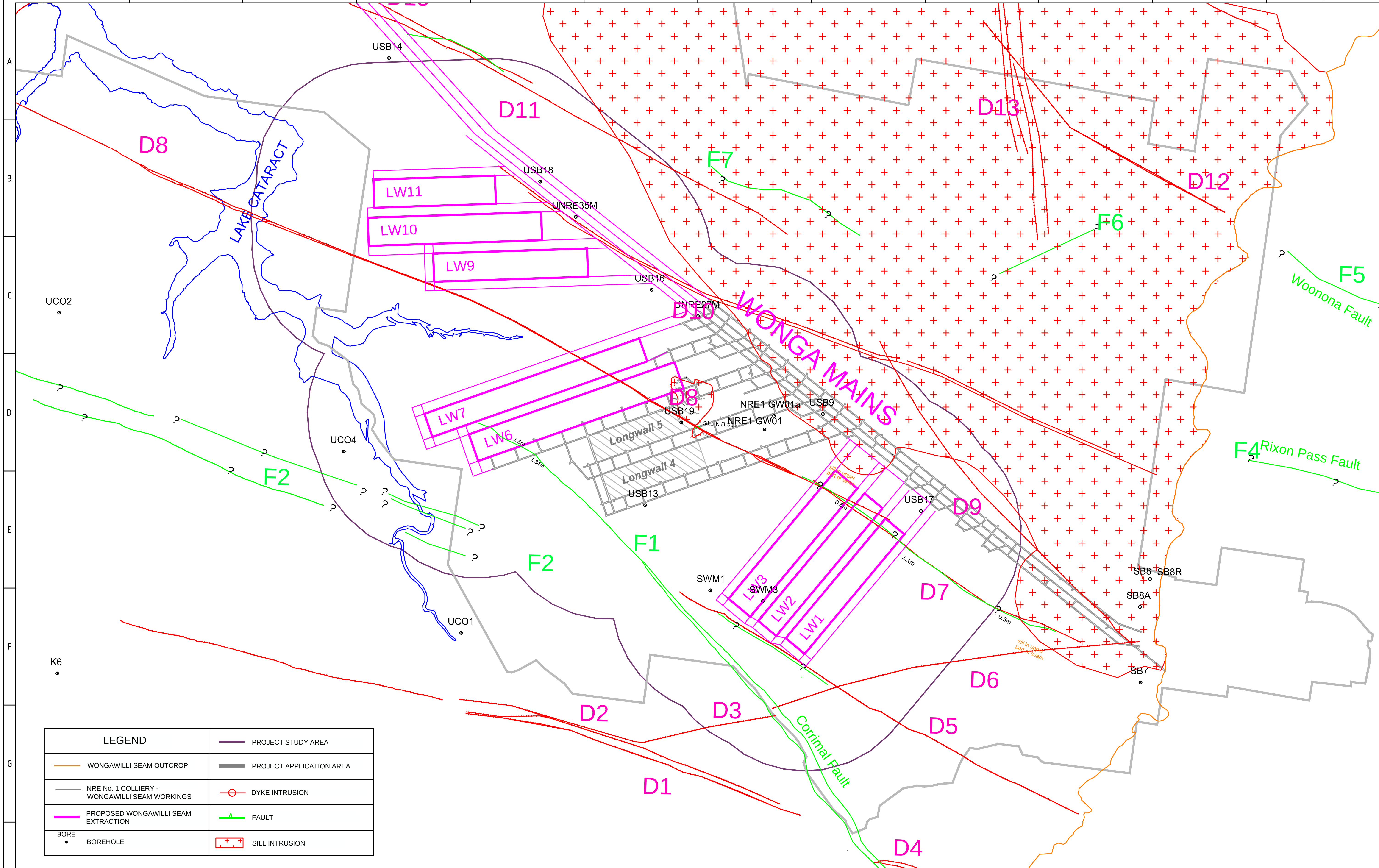

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Title: NRE No. 1 COLLIERY - PART 3A APPLICATION PPR
WONGAWILLI SEAM GEOLOGICAL PLAN
AREA - WONGA EAST

DRAWING NUMBER: FIGURE 17

REV: 0

water ingress about the dyke was evident. Silling within the basal 2.0m of the Wongawilli Seam on the northern side of the dyke has also been intersected.

Of the other potential dykes projected from the Bulli Seam dyke D6 was not recognized in early development and this is most likely due to silling occurring in the Wongawilli Seam at the expected location of the dyke.

Dyke D10 has not been intersected by mining but inseam drilling has detected the dyke approximately 75m ahead of current mine face location in C Heading, Wonga Mains. No details are available on its thickness but drilling indicated the dyke is soft.

2.7.2.2 Silling

Silling within the Wongawilli Seam was intersected early on in Wonga Mains driveage. The silling occurs in the roof on the northern most heading (C heading) and cuts across the seam to be in the floor in the southern most heading (A heading). The silling was intersected either in the mining section of the seam or determined to be above the mined roof by drilling and the sill extended over the first 745m of driveage. The sill was then not detected before reappearing again above the mining section in the roof at the 1600m mark and extended primarily above the mining horizon to the 2525m mark before no longer being detected.

A significant aspect of silling within the Wongawilli Seam, than in the Bulli and Balgownie Seams, is that due to the much thicker seam section the silling can, and does, occur in various sections within the seam. Thus the boundary of silling within the Wongawilli Seam as shown in Figure 17 represents a best estimate of silling within all sections of the seam. It is therefore not inconceivable that successful mining can take place within the boundary of silling where the sill is some distance above the mining section and does not impact coal quality or mining conditions.

The transgressive nature of the Bulli Sill Complex is again evident as the southern extent of the sill in the Wongawilli Seam is from between 800m to 1300m further south than the edge of the Sill Complex in the Bulli seam and between 500m to 720m south of the sill edge in the Balgownie seam.

3. DISCUSSION

A detailed review of the geological structure of the Wonga East Study Area has been undertaken as described in this report. Confidence has been established in the structural detail of the mine plans available of the workings of the South Bulli Colliery through comparison and analysis of coincident structures in the workings of the Balgownie and Wongawilli Seams.

The surface geology in the Wonga East Study Area has been reviewed through ground proofing traverses, detailed Lidar topographic data and aerial photography. Prominent structural features known from mine workings have been projected to the surface, either vertically for igneous dykes or at an angle for faulting determined by the hade of the fault. Figure 18 details the surface geology and any structural features that were identified as surface expressions.

In examination of the control on surface features by known geology there is some structural correlation but it is quite limited. The following section will review the projected structures and there implication on surface features.

3.1 Faults

Of the prominent faults in the Study Area there is a correlation of the Corrimal Fault (Fault F1) projected to the surface with two small upper tributaries feeding the upper Cataract River approximately 840m northwest of the escarpment. Field mapping could not identify the surface expression of the fault but a thickened section of Bald Hill Claystone on the southern side of the creek gully and apparent Hawkesbury Sandstone on the northern side imply evidence of the fault at this location.

Following the projected surface trace of the Corrimal Fault further to the northwest there is no other surface expression that is evident from ground proofing. As has been discussed in this report the validity of data on the old South Bulli mine plans has been confirmed as accurate thus confidence is high that the Corrimal Fault dies out within the Bulli Seam workings and the decreasing throw of the fault in the Balgownie and Wongawilli workings also support this. As such it is considered that any connection of the fault to surface waters of the Cataract Reservoir is not possible. Reactivation of the fault due to subsidence is considered remote with the main section of the fault well away from the main body of stored water. Subsidence lines along the middle of

Longwall 4 and current Longwall 5 have been traversed and no evidence of the fault trace or any movement that could be interpreted as a result of fault reactivation was found.

Small scale fault swarm F2 emanates from Corrimal Colliery and dies out in the old South Bulli workings. There appears to be a correlation with two bends in Cataract Reservoir / Cataract River. As no detail on the dip of the fault swarm is known an estimation of 80 degrees has been used. The surface expression of the projection of the fault swarm does not correspond with the river bends when projected to the surface. There is no surface feature that the projected fault swarm corresponds with hence there can be no connection with fault swarm F2 to the surface. It is more likely the surface expression of the reservoir is joint controlled within the Hawkesbury Sandstone outcrop.

There is no correlation of any surface feature with the Rixon's Pass Fault trace which, as discussed in the report, has no expression in any workings and as such is proposed not to exist west of the escarpment.

Within the Balgownie Seam there are several fault swarms with minor displacements. These fault swarms are confined to the Balgownie Seam and as previously discussed have no recorded expression in either the Bulli or Wongawilli Seams. There is no justification in any attempt to correlate these minor fault swarms with any surface features or with any other structural feature such as the Rixon's Pass Fault.

There is no other faulting of any significance that could impact on any surface features during extraction on the mine plan in the Study Area.

3.2 Dykes

Dykes D3 and D6 do correlate with stream directions near the escarpment. Dyke D6 correlates with a small tributary on the very upper drainage system for Cataract Creek. Along strike to the west-south-west dyke D6 and its equivalent across the Corrimal Fault, dyke D3 correlate with the upper most tributary of the Cataract River. As both these dykes were estimated to be hard and of reasonable thickness at coal seam level it is feasible to expect surface exposure. Field mapping has been undertaken and no evidence of the dykes at the surface was found.

Dyke D8 is exposed at the surface in an old bypassed section of Mt. Ousley Road at coordinate E303640, N6196780. The dyke was highly weathered to soft puggy clay. Dyke thickness was approximately 0.28m and had a strike of 320 degrees to the northwest. The projection of the dyke was traced along surface subsidence line 500 to location E303258 N6197006 where an open joint bearing 315 degrees to the northwest was located. No evidence of dyke D8 was found. The joint was approximately 0.3m wide. Across the Study Area there are no other surface evidence of the dyke and no apparent correlation with any surface feature. It is not until the dyke crosses into Corrimal Colliery that correlation with a notch on the western side of the Cataract Reservoir occurs. Workings of Corrimal Colliery have mined through the dyke about and under Cataract Reservoir with no apparent consequence to any form of water ingress. There is no indication on subsidence lines for longwall 4 and longwall 5 indicating any excessive movement on the projection of the dyke. Where the dyke has been mined through in workings, particularly recently by NRE No.1 in the Wongawilli Seam, the dyke does not show any water make at all.

3.3 Integrity of Structures

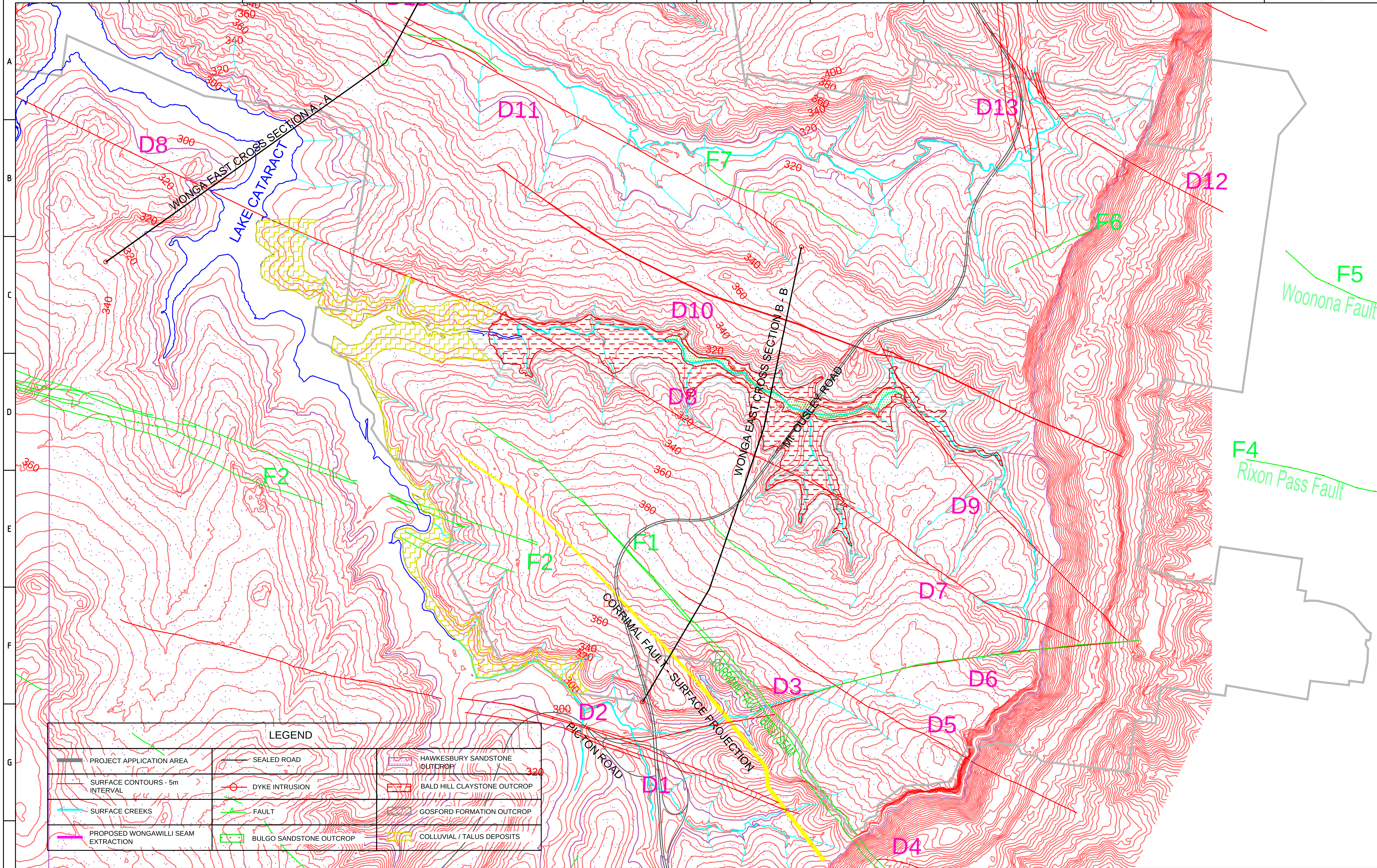
Within the Study area there are only two main geological structures that could have an impact on, or influence, the potential hydraulic connectivity of surface or near surface groundwater into mine workings.

The Corrimal Fault (fault F1) has been well documented and discussed in this report. It has been established the fault does not extend to the Cataract Reservoir. The only area where the fault has a surface relationship with surface features is with small upper tributaries of the Cataract River near the escarpment.

The Corrimal Fault has been intersected in the recent workings of NRE No.1 Colliery. The fault plane is a single, tight structure and has a displacement of 1.8m to 1.54m decreasing to the northwest. The fault is also intersected in the overlying Bulli and Balgownie Seams and there is obviously no water make occurring on the fault plane from these overlying workings or any potential migratory groundwater from overlying strata.

Reactivation along the fault plane by goaf formation appears to have very little substance. Longwall 4 has been extracted; the fault plane at seam level is approximately 140m away from the goaf. There is no evidence of reactivation on the surface. In fact there is no evidence the fault actually projects to the surface as its displacement decreases to the northwest.

The other main geological structure that intersects surface features is dyke D8. The dyke is prominent in the workings of all three coal seams and has an extensive strike length of over 7.0km. Ground proofing has noted the dyke at the surface near Mt Ousley Road where it was 0.28m thick and soft clay. No other actual surface exposure of the dyke has been found. Where dykes are weathered to soft, puggy clays they tend to act as seals to the movement of groundwater along their projections. As the dyke is prominent in all three seams no water ingress has been detected at any of the recent intersections in the workings of NRE No.1 Colliery. This could be taken to imply the dyke is not a conduit to water ingress from the coal seams above or overlying strata intersected by the dyke.



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NRE No. 1 Colliery

GUJARAT NRE Coking Coal Pty Ltd

Princess Highway & Bellmabi Lane, Russell Vale, NSW. 2517
ABN 28 111 244 896

	Name	Date
DRN	RC	10.07.13
CKD		
APP	BC	
SCALE	1:15000	

Title: NRE No. 1 COLLIERY - PART 3A APPLICATION PPR
TOPOGRAPHIC DETAILS, SURFACE FEATURES & GEOLOGY
AREA - WONGA EAST

DRAWING NUMBER: FIGURE 18

REV: 0

ATTACHMENT E – Fan Noise Report

BGMA Pty Ltd
ABN 55 101 186 805
Consulting Acoustical Engineers

Unit 31 / 12 Meadow Crescent,
Meadowbank NSW 2114
Ph: 02 98090745 Mob: 0405 493 726

Monday 10 September 2012

Gujarat NRE Coking Coal Ltd

Cnr Bellambi Lane & Princes Highway

Russell Vale, NSW 2517

Attn: Mr **Luke McNamara**

Introduction

BGMA Pty Ltd was engaged to carry out sound pressure level measurements of the noise emissions of the two (2) 90m^3 mine exhaust fans operating at NRE No.1 Colliery.

History

Previously on Tuesday 13 July 2010, The 40 m^3 twin axial mine exhaust fan was prepared for shut down. The component L_{Aeq} noise contribution was 59 dB(A) at 50 metres from the 40 m^3 twin axial mine exhaust fan.

On Sunday 18 July 2010, the first of the 90 m^3 mine exhaust fans took over from the 40 m^3 twin axial fan. The component L_{Aeq} noise contribution was 59 dB(A) at 50 metres from the first of the 90 m^3 mine exhaust fans.

Measurements

Noise levels were measured using a 01dB-Stell "Symphonie" (S/N #01481) attached to a Acer Aspire 3680 laptop computer, model ZR1 (S/N LXAP0506063604D772500) with 01dB-Stell pre-amplifier (S/N 011280) and microphone (S/N 18528). This sound level acquisition system conforms to appropriate Australian Standard for sound level meters, as a Type 1 precision sound meter. The calibration of the meter was checked before and after the measurement period with a Svantek SV 30A acoustical calibrator (S/N 7942). No significant system drift was observed.

All measurements were on a one-third octave band basis.

On Monday 3 September 2012, both 90 m^3 mine exhaust fans were operating. The component L_{Aeq} noise contribution was 58.1 dB(A) at 50 metres from the both 90 m^3 mine exhaust fans.

Locating the sound level metre at 50 metres places the meter well outside of the complex acoustic 'near field' conditions surrounding each mine exhaust fan installation, and allows direct measurement and cross-comparison of both fan installations.

One Third Octave Band Centre Frequencies									
25 31.5 40	50 63 80	100 125 160	200 250 315	400 500 630	800 1,000 1,250	1,600 2,000 2,500	3,150 4,000 5,000	6,300 8,000 10,000	dB(A)
64 63 63	62 61 60	59 56 54	55 53 53	51 52 49	47 46 47	44 44 45	45 43 40	36 29 21	58

Previous Measurements

These are compared with the previous measurements with only one 90 m3 mine exhaust fan operation with a component L_{Aeq} noise contribution was 58.9 dB(A) at 50 metres.

One Third Octave Band Centre Frequencies									
25 31.5 40	50 63 80	100 125 160	200 250 315	400 500 630	800 1,000 1,250	1,600 2,000 2,500	3,150 4,000 5,000	6,300 8,000 10,000	dB(A)
65 65 67	67 67 66	64 64 59	57 55 52	49 51 53	53 48 47	46 44 43	43 40 37	38 32 21	59

Discussion

Despite a doubling air flow capacity, the noise emissions have dropped 1 dB(A) at 50 metres.

Below the 315 Hz one-third octave band, and in the 630 Hz and 800 Hz one-third octave bands, there have been significant drops.

In the 315 Hz, 400 Hz and 500 Hz one-third octave bands, there have been slight increases. There has also been an increase of 2 to 3 dB in the 2500 Hz to5000 Hz one-third octave bands (inclusive). These increases are not a call for concern.

Conclusion

Based on frequency dependent air absorption, distance the "neutral" atmospheric profile, the predicted sound pressure to the nearest residences in Russell Vale is 30 dB(A).

This is a drop of 2.5 dB(A) at the community receivers.

The eastern edge of the workshop platform forms a barrier contributing a further reduction of about 10 dB. Adverse atmospheric conditions could accentuate the noise levels up by 1.5 to 5 dB(A).

Under "neutral" conditions the predicted level is 20 dB(A) but under "adverse conditions", the predicted level is 25 dB(A).

Based on frequency dependent air absorption, distance the "neutral" atmospheric profile, the predicted sound pressure to the nearest residences in Corrimal is 36 dB(A).

This also is a drop of 2.5 dB(A) at the community receivers.

The topography form forms a barrier contributing a further reduction of about 10 dB. Adverse atmospheric conditions could accentuate the noise levels by 1.5 to 4 dB(A).

Under "neutral" conditions the predicted level is 26 dB(A) but under "adverse conditions", the predicted level is 30 dB(A).

Measurement and calculations indicate that the two (2) 90 m^3 mine exhaust fan are operating within required noise constraints, and that they will not adversely impact on the acoustic amenity of the local community.

Brian Marston MAAS
Principal Acoustic Consultant
BGMA Pty Ltd

ATTACHMENT F – Golders Response to Submissions Report

MEMORANDUM

TO Dave Clarkson (Gujarat NRE Coking Coal Ltd) **DATE** 29 May 2013

CC Andrew Dawkins (GeoTerra Pty Ltd)

FROM Scott Weeks **PROJECT No.** 117636024-002-Rev0

GUJARAT NRE NO.1 COLLIERY GROUNDWATER MODEL

Dear Dave

This letter concerns queries (email, phone 20 May 2013) by GeoTerra Pty Ltd (GeoTerra) and Gujarat NRE Coking Coal Ltd (Gujarat) regarding feedback from the NSW Department of Planning and Infrastructure on the Groundwater Modelling undertaken by Golder Associates (Golder) for the Gujarat NRE No.1 Colliery Major Expansion.

Background

In 2010, Golder was commissioned by Gujarat to develop a numerical groundwater model of the NRE No.1 Colliery to assist in the assessment of the groundwater-surface water bodies that may already have been affected by mining to date and to predict possible effects associated with the proposed expansion of eleven longwall panels in the Wonga East area and seven longwall panels in the Wonga West area. The modelling was conducted to assess the relative changes in the groundwater regime and recharge to surface water bodies due to the proposed mining. Data acquisition and conceptualisation of the goaf and fractured zones above existing and proposed workings were not in Golder's scope of work but was undertaken by GeoTerra. A conceptual hydrogeological model developed by GeoTerra was provided to Golder and used as basis for the numerical groundwater model.

In 2010, Golder submitted its report "*NRE No.1 Colliery: Wonga East and Wonga West Groundwater Modelling*" (Document 107636001-003-Rev0) to Gujarat and GeoTerra. In 2012, upon request from GeoTerra, this report was re-issued with minor changes to text (qualitative description of the Bald Hill Claystone) and additional figures showing flow directions and drawdowns at other points in time. Model results and conclusions were not changed.

In May 2013, the NSW Department of Planning and Infrastructure (DP&I) received a draft report on *Groundwater Analysis for the Gujarat NRE No.1 Collier Major Expansion Part 3A Application* (Document GEOTLCOV24840AA-AB) from Coffey Geotechnics Pty Ltd (Coffey). Coffey's report includes a review of Golder's groundwater model. Below are Golder's responses to Coffey's comments concerning the numerical groundwater model, except where Coffey has stated that a particular model aspect is "reasonable" or "acceptable". Coffey's separate analysis of the nature or extent of subsidence and fracture zones, swamps or creeks are not addressed.

Response to Coffey 2013 comments

Section numbers correspond to those in Coffey's report, indented italicised text are excerpts from Coffey's report.

3.2 Impact Assessment Method

> *The assessment has used FEFLOW, a finite-element numerical groundwater flow model produced by DHI-WASY. It assumes laminar flow in its governing equation for saturated conditions. The use of this model is appropriate for the problem at hand. Models of this type are useful for predicting changes in the hydraulic head field outside collapsed zones, and for estimating changes in baseflow to, or leakage from, surface water bodies through changes in hydraulic head in the subsurface media, but are inappropriate where severe trauma occurs near the body.*

FEFLOW can accommodate both saturated and unsaturated flow, though modelling unsaturated flow requires additional (and uncertain) parameters (up to eight parameters) to represent the relative conductivity and capillary pressure relationships to be defined for each soil type in the model. *Severe trauma* (such as the voids of the extracted workings, which are represented in the model as boundaries) can be applied in FEFLOW as hydraulic head, pressure, seepage, saturation or moisture content boundary conditions.

> *These types of model are not appropriate for assessing hydraulic conductivity changes at the base of individual swamps.*

Agreed, but note that the model does not attempt to assess "*hydraulic conductivity changes at the base of individual swamps*". Changes in hydraulic conductivity were applied as values provided by GeoTerra.

3.2.1 Model Parameters

> *"The goaf zone immediately above the mined floor has extreme conductivity, and values selected for model simulation are considered very low"*

The values in the zones immediately above the goaf are two to three orders of magnitude (100x to 1000x) higher than the surrounding material. More extreme changes (four or more orders of magnitude) in hydraulic parameters caused numerical instability during simulation. All model elements representing the goaf had the boundary conditions applied that allowed water to be removed instantaneously from the model domain.

3.2.3 Model Calibration

> *A calibrated hydraulic head surface is presented in Figure 19 of Appendix D. The contoured quantity is called "resultant heads" and it is not known if it is the calibrated water table or the hydraulic head surface for some key depositional horizon. A correlation of observed and calibrated hydraulic heads is provided in Figure 20 of Appendix D, however no performance measure is provided.*

Figure 19 of Appendix D shows the calibrated water table. In Figure 20 of Appendix D, correlation is 95%.

> *"It appears that the model has been calibrated in steady state mode only, using only hydraulic head targets. Transient calibration, to a calibration target data set including (in addition to hydraulic head time series measurements) water course baseflow estimates and measured void discharges, has not been undertaken. This is considered a significant deficiency."*

Calibration of the model was conducted in steady-state mode to hydraulic head (predictive simulations were conducted in transient mode). This was because, at the time of model construction (2010), measured groundwater level data records were only available at one point in time. Data records of transient baseflow estimates and transient void discharge were not available at the time and were therefore not part of the steady-state calibration. However, following the steady-state calibration, modelled groundwater inflows to the existing workings were close (order of magnitude) to the observed volume of water pumped out of the workings at the time, and modelled baseflow values appeared reasonable (order of magnitude).

5.3 Model Calibration

> *The model is considered uncalibrated and model results cannot be used for impact assessment. If the proponent wishes to assess impacts using model results, the model will require simultaneous transient calibration to measured hydraulic heads (throughout the depth profile), estimated baseflow to water courses, and measured void discharges, as has been undertaken for other mines in the Southern Coalfield. Sufficient data are available for this to be undertaken, and to significantly reduce uncertainty and improve the reliability of model results. In conjunction with hydraulic heads, simultaneous calibration of surface discharges and deep discharges is a vital way of attempting to calibrate the crucial vertical hydraulic conductivity distribution of the subsurface, and the degree of insulation afforded by this distribution between shallow and deep flow processes.*

The model would certainly have benefited from transient calibration if the dataset comprising a suitable time series record of measured hydraulic heads (throughout the depth profile), baseflow to water courses, and measured void discharges was available at the time (see response to 3.2.3 above). To this dataset we would add that also required would be a suitable time series record of the conditions (flooded, dry, pumped) of existing workings both on and off site.

5.4 Assessment of Groundwater Exchange with Lake Cataract

> *Potential leakage induced from Lake Cataract will require a probabilistic assessment using the transiently calibrated model, as has been undertaken for other mines in the Southern Coalfield. This will require the probabilistic variation of key parameters (using random realisations of the parameter fields).*

Agreed. This is a relatively new approach in groundwater models and Golder has used this approach recently for projects in the CSG industry. Monte-Carlo simulations using groundwater models can be accomplished using such software as PEST which is a combined parameter estimation and predictive uncertainty tool. However, this approach is severely numerically intensive. If there is a large number of parameters that are considered key and subject to a probability distribution function, then simulation run-times are in the order of weeks. This is further compounded if one complete simulation has to be performed in separate stages (for example, a simulation of the Stage 1 conditions, which is then continued in a separate simulation for Stage 2 conditions which in turn is then continued in a separate simulation for the recovery stage).

Summary

Coffey's questioning of calibrating in steady-state mode appears to arise from the application of very recent (2012) changes in the regulatory sphere to groundwater models constructed before they came into effect. In the recent two years, the regulatory situation has undergone significant changes with respect to the use of modelling results in the approvals process, namely

- The 2012 Aquifer Interference Policy, issued by the NSW Office of Water and
- The 2012 Australian Groundwater Modelling Guidelines[1], issued by the National Water Commission.

The 2012 Australian Groundwater Modelling Guidelines has classified groundwater models into three categories, defined by model confidence level. Applying those guidelines, Coffey appears to suggest that Gujarat requires a Class 3 (highest confidence level) groundwater model. Class 3 models are required to satisfy the following criteria:

- Suitable for predicting groundwater responses to arbitrary changes in applied stress or hydrological conditions anywhere within the model domain
- Evaluation and management of potentially high-risk impacts
- Can be used to design complex mine-dewatering schemes
- Simulating the interaction between groundwater and surface water bodies to a level of reliability required for dynamic linkage to surface water models.

This places an increased emphasis on the quantity, quality and diversity of the dataset required for model development:

- Spatial and temporal distribution of groundwater head observations adequately define groundwater behaviour, especially in areas of greatest interest and where outcomes are to be reported
- Spatial distribution of bore logs and associated stratigraphic interpretations clearly define aquifer geometry

- Reliable metered groundwater extraction and injection data is available
- Rainfall and evaporation data is available
- Aquifer-testing data to define key parameters
- Streamflow and stage measurements are available with reliable baseflow estimates at a number of points
- Reliable land-use and soil-mapping data available
- Reliable irrigation application data (where relevant) is available
- Good quality and adequate spatial coverage of digital elevation model to define ground surface elevation

and model calibration:

- Long-term trends are adequately replicated where these are important.
- Seasonal fluctuations are adequately replicated where these are important.
- Transient calibration is current, i.e. uses recent data.
- Model is calibrated to heads and fluxes
- Observations of the key modelling outcomes dataset is used in calibration
- Model predictive time frame is less than 3 times the duration of transient calibration
- Stresses are not more than 2 times greater than those included in calibration
- Temporal discretisation in predictive model is the same as that used in calibration
- Mass balance closure error is less than 0.5% of total.

Current practice now (as opposed to the situation in 2010) requires a more thorough level of study. The 2012 Australian Groundwater Modelling Guidelines[1] recommend that the quantities for which the model is being developed to predict (for example groundwater inflows to mine workings) be included in the calibration process.

Unlike the situation in 2010, more data has become available so it may be possible to now conduct a transient calibration, though this would be almost totally dependent on the quantity, quality and diversity of available data, especially with respect to water volumes extracted from the mine workings, including those workings outside NRE No.1, and monitored streamflow records.

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[1] National Water Commission *Australian groundwater modelling guidelines*, June 2012, Waterlines Report Series No. 82.

ATTACHMENT G – August 1998 Floods Report

GUJARAT NRE

GUJARAT NRE COKING COAL LIMITED
A.B.N. 28 111 244 896
NRE No 1 Colliery

NRE No.1 Colliery
Investigation into August 1998 Floods and reoccurrence risk

Document Version	Revision				Revision Notes
	Date	Author	Checked	Release Date	
Rev 0	23/08/2013	K. Prajapati	D. Clarkson	03/09/2013	Final Draft

GLOSSARY OF TERMS AND ABBREVIATIONS

Abbreviations	
ARI	Average recurrence interval
DPI	Department of Planning & Infrastructure
DRE	NSW Department of Trade and Investment, Regional Infrastructure and Services, Division of Resources and Energy, Industry Co-ordination Unit
EPA	Environment Protection Agency
NRE	Gujarat NRE Coking Coal Limited

Term	**Definition**
Project Approval	Pt3A Major Project approval MP10_0046 as modified

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1 INTRODUCTION

1.1 Project Background

Gujarat NRE Coking Coal Ltd (NRE) operates the NRE No.1 Colliery in the Southern Coalfield of New South Wales (NSW). The mine is located at Russell Vale approximately 8 km north of Wollongong and 70 km south of Sydney, within the local government areas (LGAs) of Wollongong and Wollondilly in the Illawarra region of NSW.

On 13 October 2011, the Project Approval (MP 10_0046) for the No.1 Colliery Preliminary Works Project was granted by the Minister for Planning under Section 75(J) of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

In August 2012, NRE lodged a section 75W (s75W) Modification Application to the Preliminary Works Project Approval (MP 10_0046).

On 24 Decemeber 2012, the modification to the Project Approval (MP 10_0046) was approved by the Planning Asessment Commission of New South Wales, as delegate for the Minister for Planning and Infrastructure.

1.2 Purpose and Scope

This report has been prepared to review the causes of the incident that resulted in significant volumes of coal material being washed from the Pit Top during the August 1998 100 Year average recurrence interval (ARI) flood event.

A repeat of a high rainfall event similar to August 1998 remains a possibility and therefore may represent a potential risk for a repeat of the 1998 incident at NRE No.1 Colliery. NRE as the current owner of the mine has undertaken this investigation in order to understand and, if necessary, to develop reasonable options to mitigate future risk. This will be covered in greater detail in ***Section 3.3***.

Changes in Colliery personnel, coupled with the unavailability of the original incident reports created a situation where the initial risk mitigation solution proposed, primarily the realignment of Bellambi Gully adjacent to the current Stockpile Area 1, were based entirely on anecdotal information. Further more detailed investigation by NRE employees has been undertaken to ensure the solution proposed is appropriate to mitigate the risk. This report summarises the events of August 1998 but looks at the current configuration of the site and coal surface facilities and from this recommends site improvements required to mitigate the risk.

1.3 Distribution

This report will be submitted along with Preferred Project Report (PPR) for the Underground Expansion Project of NRE No.1 Colliery and distributed to:

- Department of Planning & Infrastructure (DPI);
- Environment Protection Authority (EPA); and
- Other relevant agencies.

Any revisions undertaken will be the responsibility of NRE and any notifications sent accordingly. NRE will not be responsible for maintaining uncontrolled copies beyond ensuring the most recent version is maintained on NRE's computer system, website, and hard copy at the NRE No.1 Colliery, 7 Princess Highway, Russell Vale.

2 LEGISLATIVE AND STATUTORY REQUIREMENTS

2.1 Relevant Legislation and Guideline

Key environmental legislation and Guideline relating to the management of soil and water includes:

- Protection of the Environment Operations Act 1997(POEO Act);
- Environment Planning and Assessment Act 1979 (EP&A Act) and Regulation 2000;
- Managing Urban Stormwater – Soils and Construction, Volume 1 (the Blue Book) (Landcom, 2004); and
- Managing Urban Stormwater – Soils and Construction, Volume 2E Mines and Quarries (DECC, 2008).

2.2 Statement of Commitments

The fifth dot-point row of the "Soil and Water' section of the Statement of Commitments ***(Appendix 3)*** of the Project Approval (MP 10_0046) relates to Bellambi Gully Creek realignment and states:

The underground pipe section of Bellambi Gully Creek will be replaced with a suitably designed and engineered open bypass channel constructed on the southern side of the coal stockpile area. This will include:

- a dissipation pond will be constructed at the end of the bypass channel to reduce the energy of flows back into Bellambi Gully Creek;
- upgrades to the existing channel including Reno mattresses and Gabion drop structures to reduce the velocity of water flowing down the gully; and
- regular maintenance to minimise scouring during major flow events.

3 INFORMATION SEARCH

Information searches have been conducted in NRE's environmental department filing system and yielded correspondence which is included as ***Appendix A*** to this report. Enquiries also have been made with NSW Department of Trade and Investment, Regional Infrastructure and Services, Division of Resources and Energy, Industry Co-ordination Unit (DRE). As the mine was owned and operated by Allied at the time, further records have been difficult to locate.

In addition to the above search, further discussion with both Don Jephcott (retired Environmental Manager and Phil Perkiss (Russell Vale Site Surface Manager) form the basis of the source information for this report.

More recently hydrology studies have been conducted by BECA (BECA, 2010) on the site to assist in defining the requirements for an upgrade to the existing water courses at the Russell Vale site.

3.1 Current Coal Surface Facilities and Bellambi Gully Creek

Currently, Run of Mine Coal (ROM) coal is stored in Stockpile Area 1 on a raw coal stockpile at the base of the escarpment within the Russell Vale site. This stockpile can accommodate up to 80,000 tonnes of coal. The current coal surface facilities and Bellambi Gully Creek are shown in ***Figure 1***.

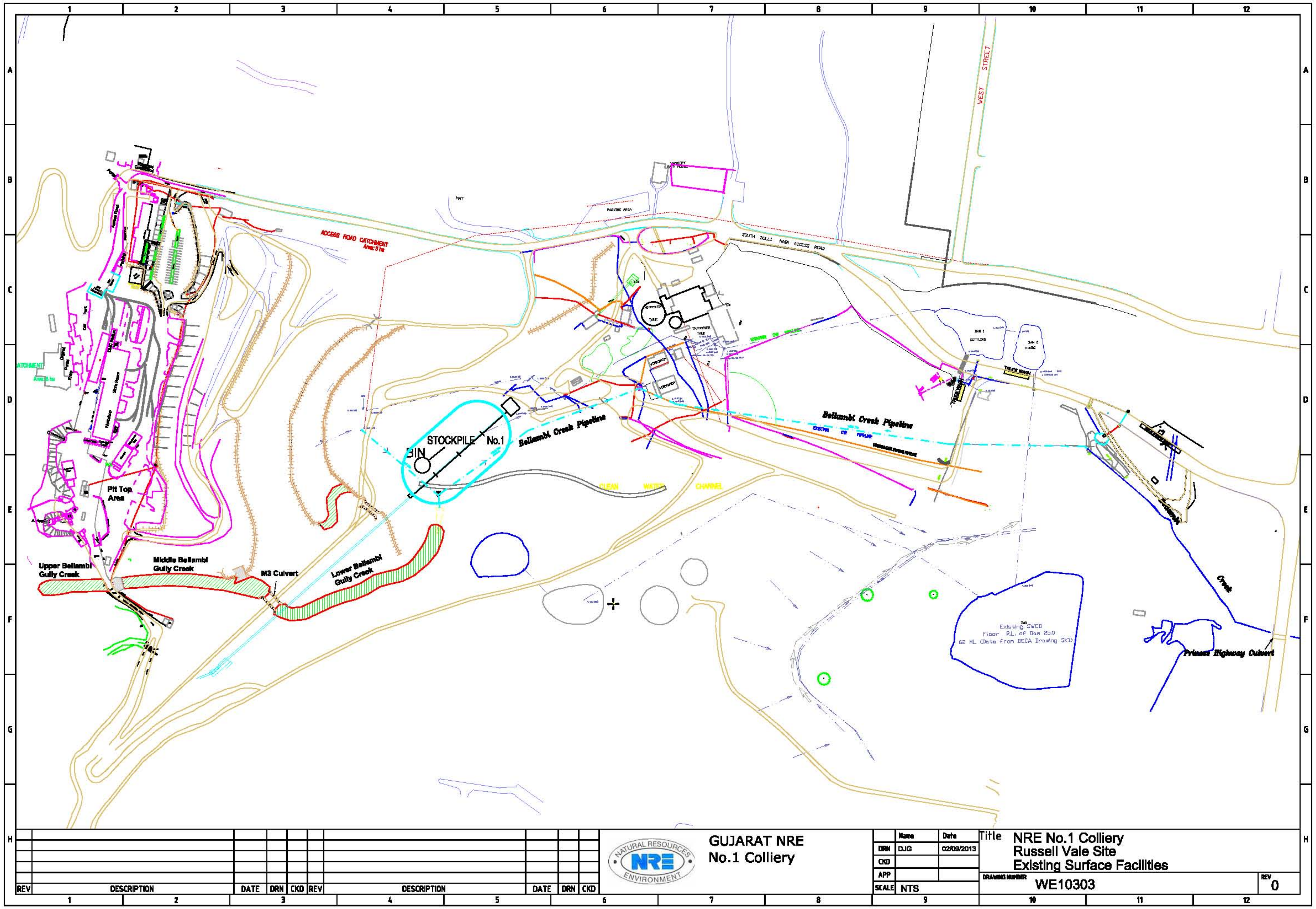

Figure 1: Current Coal Surface Facilities and Bellambi Gully Creek

3.1.1 Bellambi Gully Creek

The Bellambi Gully Creek runs to the south of Stockpile Area 1 and then passes beneath Stockpile Area 1 via an 1800mm diameter concrete pipe culvert and then reorients toward the east. Recently the two (2) operational conveyors (Bulli and Balgownie conveyors) from the original mine operations were removed however the concrete apron on which these conveyors operated on remain in place. ***Photo 1*** and ***Photo 2*** below show the removed conveyor alignment and the junction of the culvert (M3 culvert) with this alignment. A deep drain on the western side of the road transfers surface stormwater down this alignment towards the stockpile. In most rainfall events the drain manages to contain the stormwater within this drain and directs water to a clean water collection point which in turn is directed via a 600mm diameter pipe to Bellambi Gully Creek.

The Bellambi Gully Creek upstream of the 1800mm diameter pipe culvert has been divided into three areas as follows:

- Upper Bellambi Gully Creek occurring uphill of the pit top area;
- Middle Bellambi Gully Creek from the pit top area and the culvert beneath the concrete apron (M3 culvert); and
- Lower Bellambi Gully Creek from the concrete apron and the existing headwall for the 1800mm pipe that currently drains flows from the Bellambi Gully Creek under the Stockpile Area 1 to the culvert beneath the Princes Highway.

Bellambi Creek flows from the end of 1800mm pipe, under the Princes highway, past several industrial premises, under the northern distributer, through residential streets, under the railway line, through the Holy Spirit High School's ground, and then flows out into the ocean. The creek is comprised of culverts under main transport structures and roads, or disturbed creek beds through urban areas. According to the WBM Oceanics Australia report completed for Wollongong City Council in June 2005, the Bellambi Creek catchment area is approximately 427ha and the total creek length is 4.3km (Beca, 2011).

The Bellambi Gully Creek upstream of the 1800mm diameter pipe culvert is a steep sided vegetated gully with trees and large submerged boulders being evident. There is evidence of accumulation of rubble and debris in the invert of the gully.

Photo 1: Concrete Apron, Removed Conveyor Alignment and the Junction of the Culvert (M3 Culvert) with this Alignment

Photo 2: M3 Culvert looking from Middle Bellambi Gully Creek

3.2 Rainfall

The rainfall records for year 1998 and August 1998 are provided in ***Figure 2*** and ***Figure 3*** respectively as recorded by Bellambi AWS 068228, Bureau of Meteorology.

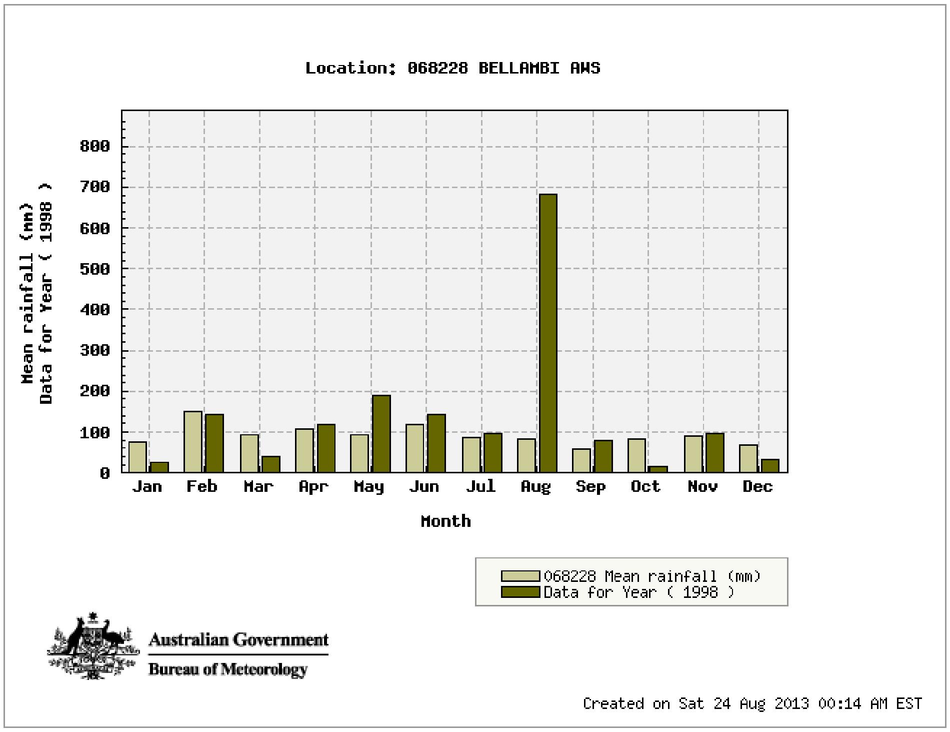

Figure 2: Bellambi AWS (68228) Year 1998 Rainfall Record

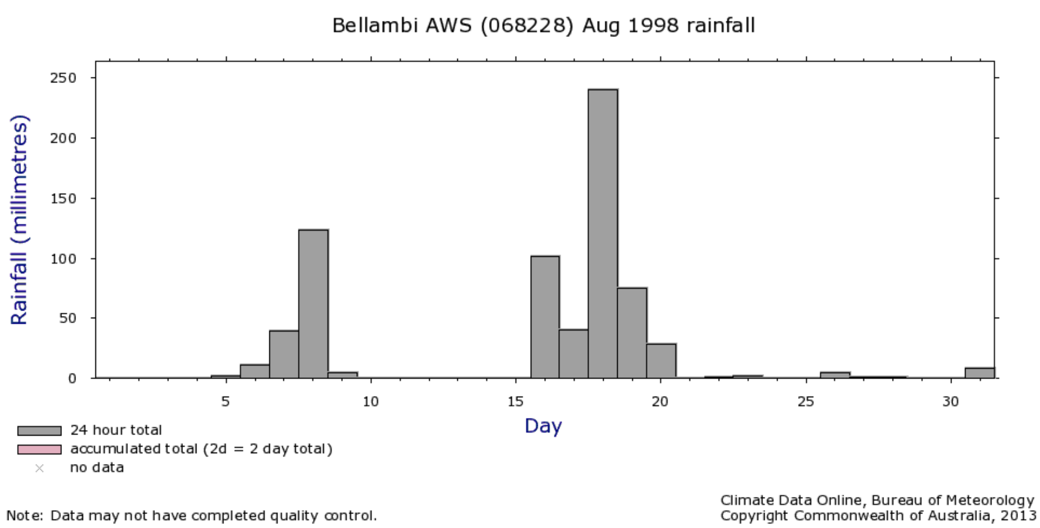

Figure 3: Bellambi AWS (68228) August 1998 Rainfall Record

3.3 Summary of Events – August 1998

During August 1998, the Illawarra region experienced a major storm event, which records for the Colliery indicate was in the vicinity of a 100 year average recurrence interval (ARI) event. Although, the existing site had diversion drains and a piped system, the storm water system failed and resulted in diversion of clean water through the coal stockpile causing considerable environmental damage downstream (Beca, 2010).

The particulars of the August 1998 storm event were sent to DRE and are provided as an ***Appendix A***.

3.3.1 Cause of Event

The extreme rainfall events of August 1998 resulted in major erosion and landslips along the Illawarra Escarpment upslope of our operations. The effect of this was that the headwaters of Bellambi Gully Creek carried the stormwater and associated debris for a period of time until it silted up and overflowed the bank at the M3 culvert. The stormwater and associated debris then travelled down to existing ROM stockpile at that time which became unstable and fluidised to the extent of being washed down Bellambi Lane and contaminated the Bellambi Gully Creek (Allied Bellambi Collieries Pty. Ltd, 1998 and communication with Don Jephcott).

3.3.2 Actions Proposed to Prevent a Re-occurrence of the Event during 1998

The following actions were proposed during 1998 to prevent a re-occurrence of the event (Allied Bellambi Collieries Pty. Ltd, 1998):

- More intensive remedial work to restore the open channels of the Bellambi Gully Creek;
- Inspections of the piped section of Bellambi Gully Creek; and
- Engagement of experts to provide advice on the event itself and how to prevent a re-occurrence of the incident.

3.3.3 NRE's Proposed Actions to Prevent a Re-occurrence of the Event

NRE is proposing following actions to prevent a re-occurrence of the event:

- Improvement works to the M3 Culvert. The design options under consideration for these improvement works are either:
    - ➢ Increase the diameter of pipe culvert and install an overflow path during in the event of pipe blockage with capacity of a 1 in 100 year rain event. The overflow path will also allow vehicles to pass. Additional work would be required to transition flows from this overflow path into the steep section of the lower Bellambi Gully Creek. A typical cross section of the overflow path is shown in ***Figure 4***.

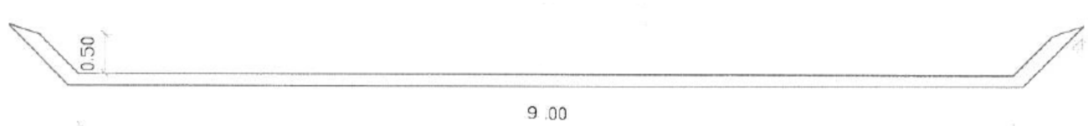

Figure 4: Cross Section of the Overflow Path

- An open culvert with sufficient cross section to allow large debris to pass through the culvert i.e. not become fully blocked and has a freeboard of 500mm above the 1 in 100 flow conditions. The culvert will provide for vehicle access and have open sections on either side of the vehicle path for clearing the culvert with excavation machinery. A typical cross section of an open culvert is shown in ***Figure 5.***

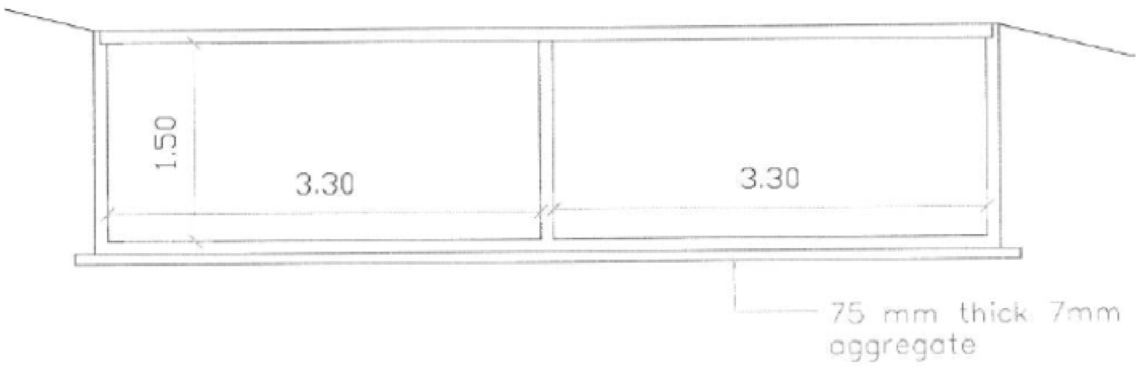

Figure 5: Cross Section of an Open Culvert

- NRE will review and revise the current Surface Facility Water Management Plan to identify and implement further mitigation measures to Bellambi Gully Creek if required.

4 REFERENCES

- Allied Bellambi Collieries Pty. Ltd (1998), Russell Vale Site Strom Incident Report.
- Beca (2010), Gujarat NRE Stormwater Hydrology Review.
- Beca (2011), Water Management Report, Gujarat NRE No.1 Colliery - Major Works Part 3A.
- Bellambi AWS (68228), Climate Data Online, Bureau of Metrology.
- Communication with Don Jephcott (retired Environmental Manager and Phil Perkiss (Russell Vale Site Surface Manager).

Appendix A - Allied Bellambi Collieries Pty Ltd – Russell Vale Site Strom Incident Report

ALLIED

ALLIED BELLAMBI
COLLIERIES
PTY LIMITED
A.C.N. 079 429 904
Head Office - Broker St. Russell Vale NSW 2517
PO Box 387 Corrimal NSW 2518
Telephone: (02) 4283 8023, Fax: (02) 4283 8025
Bellambi West Colliery - Picton Road Mount Keira
Colliery Phone: (02) 4225 1653 Colliery Fax: (02) 4225 1654

30 November 1998

DEPT. OF MINERAL RESOURCES
24133
- 2 DEC 1998
WOLLONGONG

Mr. C. Harvey
Senior Environmental Officer
NSW Department Of Mineral Resources
PO Box 674
Wollongong East 2520

Dear Sir,

Re: Allied Bellambi Collieries Pty. Ltd – Russell Vale Site
Storm Incident Report

Further to your letter of 28 September 1998 and your site inspection of 6 October 1998 we provide details as requested in your letter:

1 Brief Description Of Incident.

Extremely heavy rain in the area on 17 August 1998 resulted in major erosion and landslips along the Illawarra Escarpment upslope of our operations. The effect of this was that the headwaters of Bellambi Creek carried the stormwater and associated debris for a period of time until the line of the water courses changed as they silted up and overflowed their banks. This resulted in two flows of water leaving the premises.

1.1 A flow of storm water and debris occurred to the north of the stockpiles and Coal Preparation Plant. This water and debris travelled down the main access road to the mine and entered into Russell Vale via Broker Street.

1.2 The main Bellambi Creek watercourse broke its banks upstream of the Run of Mine stockpile and inundated this area. This resulted in washed coal stockpiles and the associated drainage systems further downstream being engulfed by the water/debris/coal combination which continued off the property via Bellambi Creek/Princes Highway and Bellambi Lane.

2 The Consequences And Impacts On Adjacent Land Owners.

The stormwater/debris/coal combination flowed down Bellambi Creek and surrounding areas where numerous properties were affected. The full extent of this storm event on the local area is not known in detail and thus further comment on the consequences and impacts cannot be made at this point in time.

3 Initial Or Interim Action Taken To Rectify The Situation

Concerted efforts were initially taken during the storm event, which took place over approximately a 10 hour period, to contain the rising water levels at the mine. Eventually as night came and the storm increased in its intensity little further effective action could be taken.

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As the storm eased off clean up action was taken from about 10pm on 17/8/98 and continued at an increasing rate for several days and then maintained for many days both off and on site.
On site the effort to restore the mine site to a safe condition as quickly as possible was of paramount importance as further rain was threatening at the time.
The clean up response off site was of major proportions too with the focus being to retrieve coal and coal contaminated storm debris wherever practicable. This work is continuing in accordance with the general requirements of our licence with the Environment Protection Authority and their specific requirement of a 'Storm Damage Remediation Action Plan' which we submitted to them on 26 August 1998. A copy of this report was forwarded to you as an attachment to our letter of 15 October 1998.

4 Proposed Action to Prevent A Re-occurrence.

Rectification of the storm damage which occurred to drainage systems, roads and other facilities is ongoing.

In view of the severe nature of the storm event careful assessment of the most appropriate action to prevent a re-occurrence is underway. Consultants are preparing advice on the event itself and this includes how we may best prevent a re-occurrence of the damage sustained to the mine and subsequent loss of coal off site.

However we stress the rainfall in question was of such an extreme nature we believe that we have taken all reasonable precautions in accord with lease conditions. Accordingly should similar circumstances arise, we are in no position to guarantee that stockpile losses will not re-occur.

Yours faithfully
Allied Belllambi Collieries Pty Ltd

DR Jephcott

D. R. Jephcott
Environmental Officer

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26 August 1998.

Mr. William Dove
Regional Officer – South Coast
P. O . Box 513
Wollongong East NSW 2520

Dear Sir,

Re: Allied Bellambi Collieries P/L Russell Vale Site
Storm Damage Remediation Action Plan

Further to our recent discussions on the above matter we attach a copy of the above Plan. We understand that this Plan will form the basis of a Notice Under Section 17D(3) of the Pollution Control Act 1970 which will be issued shortly.

Yours faithfully,
Allied Bellambi Collieries Pty. Ltd.

D. R. Jephcott
Environmental Officer

ALLIED BELLAMBI COLLIERIES P/L
STORM DAMAGE REMEDIATION ACTION PLAN AS AT 24 AUGUST 1998.

1 Objectives.
Reinstate plant, services, roadways and other facilities as quickly as possible to allow production to recommence and achieve compliance with licence conditions. This work to include restoring the environmental control facilities initially to a standard that will minimise impact on the environment of the operations and to progressively restore such facilities to the same or a better standard to that which existed prior to the storm of 17/8/98.

2 Tasks.

2.1 On Site.

2.1.1 Restore the Storm Water Control Dam (SWCD) to full operational condition.
2.1.2 Clean out solids in the 1200mm concrete line between the SWCD and Dam 2.
2.1.3 Clean solids out of Dams 1 and 2.
2.1.4 Unblock numerous other pipelines around the premises.
2.1.5 Restore the stockpile dust suppression pipelines and electrical cabling.
2.1.6 Clear storm debris from truck access road and truck washers and repair associated electrical systems.
2.1.7 Clear from around CPP workshops and spares areas most of the storm debris.
2.1.8 Desilt the solids collection sumps in the drainage lines around the CPP.
2.1.9 Repair major damage to sealed and unsealed roads on the site.
2.1.10 Repair relative minor damage to surface drainage lines in the RVEA.
2.1.11 Restore the immediate integrity of the Bellambi Creek drainage system open channel.
2.1.12 Determine the integrity of the closed section of Bellambi Creek by inspection and reporting. Based on these results undertake remedial work as recommended.
2.1.13 Commission consultants to prepare a rehabilitation plan for the Lower Development Area and undertake essential repair work as soon as practicable.
2.1.14 Repair damaged sewer lines.
2.1.15 Recover coal on grassed areas adjacent to Bellambi Creek and the Princes Highway.
2.1.16 Reshape all the eroded stockpiles and relocate the contaminated coal to the ROM stockpile for rewashing. This will improve drainage and subsequent safety of the roads around the stockpiles.

2.2 Off Site.
As a result of the storm a considerable amount of debris containing coal has been deposited off site. As far as practicable this material will be removed from:

a) Footpaths, roadways and other public areas.
b) Agreed residential driveways, gardenbeds, lawns and buildings.
c) Playing fields / local parks.
d) Agreed drainage lines – primarily Bellambi Creek plus some small tributaries.
e) Agreed commercial premises.

Epastormdamrpt1

3 Timing.
3.1 On Site
Immediately.

11.30pm 17/8/98 – Use of front end loader to make roads as safe as possible for trapped employees.

Short Term

Am 18/8/98 to Present – Intensive action taken using a wide range of earthmoving and other specialist equipment to make the stockpile areas safe, drainage systems operable and to repair damaged facilities generally.

Longer Term.

Continue the concerted effort to restore the mine to a productive level of operation as soon as practicable. To achieve this it is intended to have all but 3 of the items listed in 2.1 above completed by 30 September 1998. The exceptions are as follows:

Item 2.1.9 Repairs to all roads will be completed by 30 November 1998.

Item 2.1.11 For the open sections of Bellambi Creek more intensive remedial work is expected. A completion date for such work can not be given at this stage.

Item 2.1.12 The piped section of Bellambi Creek will need to be inspected and this will be carried out by 30 September 1998. Until the outcome of that inspection is known a completion date for any recommended remedial work can not be given.

3.2 Off Site.

Immediately.

11.30pm 17/8/98 – Use of front end loaders to clear Princes Highway of storm debris including coal.

Short Term.

Am 18/8/98 to Present – Intensive action taken using a wide range of equipment including 7 loaders, 10 trucks, 2 street sweepers, 1 water tanker, 2 vacuum suction tankers and up to 15 labourers.

Longer Term.

Continue clearing visible coal and coal associated debris as practicable from various areas including the creek bed, banks and adjoining land as referred to in 2.2 above. It is expected that the vast bulk of this work will be completed by 30 December 1998. This date is subject to a number of criteria being met such as:

* Ease of physical access to storm debris.
* Prevailing weather.
* Modus operandi of retrieval operations.
* Ability to reach agreement with the landholders on how and when to retrieve the storm debris.

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