THE Bloomfield GROUP

Bloomfield Colliery

Completion of Mining and Rehabilitation

Part 3A Environmental Assessment
Project Application 07_0087

Volume One

November 2008

Prepared by

business environment

EXECUTIVE SUMMARY

1. INTRODUCTION

Bloomfield Colliery ('Colliery') is an existing open cut mining operation located to the north of John Renshaw Drive, Buttai and east of Buchanan Road, Buchanan, approximately 20 km north-west of Newcastle (refer **Figure A**). Mining has occurred on the Colliery site for approximately 170 years.

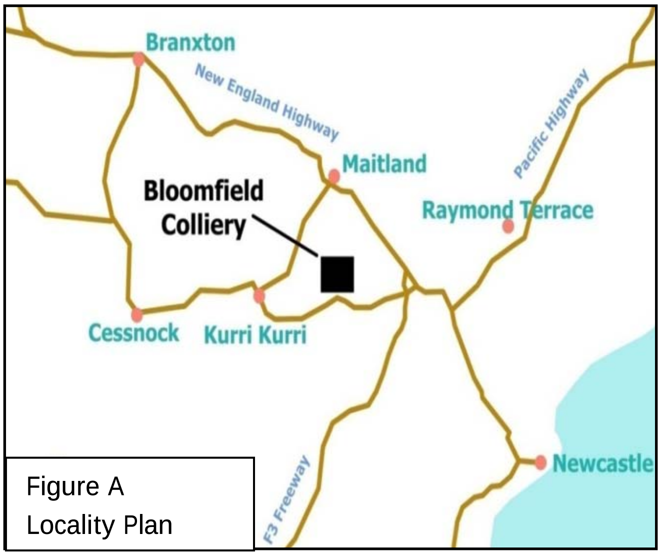

Figure A
Locality Plan

This Environmental Assessment ('EA') has been prepared to accompany a Project Application to enable the completion of mining and rehabilitation at Bloomfield Colliery ('the Project').

The EA has been prepared in accordance with Part 3A of the *Environmental Planning and Assessment Act 1979* and the *Environmental Planning and Assessment Regulation 2000*. The EA contains those items required to be addressed by the relevant legislation and the EA requirements issued by the Director-General of the NSW Department of Planning ('DoP') for the Project.

2. THE APPLICANT

The applicant for the Project is Bloomfield Collieries Pty Limited ('Bloomfield'), part of The Bloomfield Group of companies. Bloomfield is an Australian owned family company.

3. THE PROJECT AREA

The Project covers an area of approximately 317 hectares of which 299 hectares (95%) is presently disturbed by mining-related activities. All land within the Project Area is owned by Ashtonfields Pty Limited.

The site is located within the Cessnock Local Government Area, and zoned 1(a) Rural 'A' under the *Cessnock Local Environmental Plan 1989*.

4. PROJECT OVERVIEW

This Project Application and EA seeks approval for the continued operation of the following mine infrastructure and related activities to enable Bloomfield to complete its mining and rehabilitation schedule at the Colliery:

- the current and proposed open cut mine areas;
- the workshop;
- the road between the open cut pit areas and the ROM coal stockpile at the washery; and
- the road that links the workshop, open cut pits and washery.

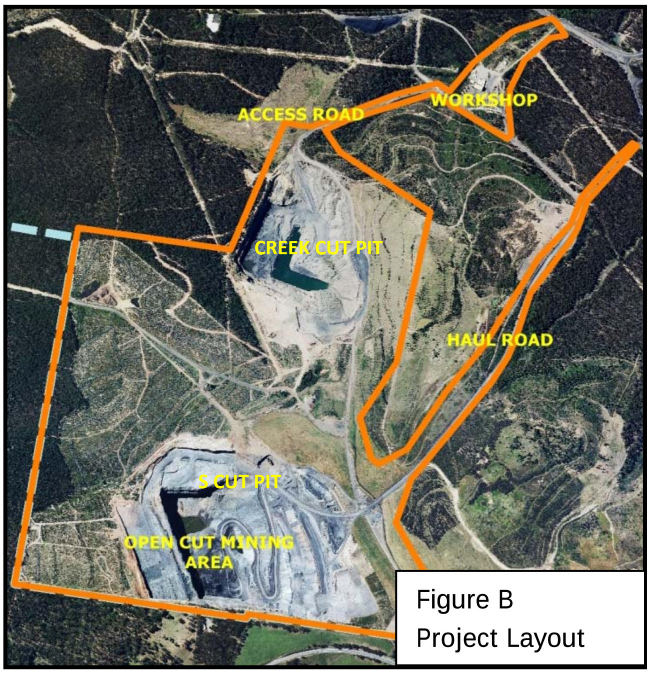

Figure B
Project Layout

The location of these elements of the Project is shown in **Figure B**.

Other mining infrastructure and activities at the Colliery have previously been approved under Project Approval 05_0139 for the Abel Underground Mine ('Abel Project Approval') granted by the Minister for Planning to Donaldson Coal Pty Limited on 7 June 2007. These infrastructure items and activities include the continued use of the washery and rail loading facility, management of water associated with the washery, coarse reject and tailings disposal and coal handling.

It is proposed to complete open cut mining over a 10 to 12 year period, which has been divided into 5 stages.

The first stage, representing current operations (the current 2007-2008 period), is for the mining of a maximum of 0.88 million tonnes per annum ('mtpa') run-of-mine ('ROM') coal. Stages 2, 3 and 4 (Years 1-5, 5-7 and 7-10 respectively) propose to mine up to a maximum of 1.3 mtpa ROM coal. Stage 5 (approximately Years 10-12) is for the completion of site rehabilitation. Current assessments of economically recoverable reserves have determined that there are approximately 14 million tonnes of ROM coal remaining in the Project Area.

The maximum annual mining rate provided for assessment purposes provides for flexibility in production rates over each year, enabling Bloomfield to respond to coal market fluctuations while enabling impact assessment studies to be based on maximum production scenarios.

The mine plan aims to extract the remaining economically recoverable reserves by extending the existing S Cut and Creek Cut mine pits. These pits, shown on **Figure B**, mine a range of coal seams within the Tomago Coal Measures.

A final void will remain at the end of mining which will be used as a reject emplacement area for the washery. The Abel Project Approval enables washery operations, including the emplacement of reject material, to continue after the completion of the Bloomfield Project.

5. THE MINING OPERATION

Mining is currently undertaken at the Colliery as a multi-seam truck and excavator or face shovel operation, conducted in sequential mining blocks. It is proposed to continue this existing method using the same or similar equipment. The majority of the Project Area has been previously cleared and additional clearing required for open cut mining is minimal.

ROM coal is trucked to the ROM coal stockpile at the Bloomfield washery for processing, which occurs under the Abel Project Approval.

Bloomfield Colliery operates 7 days per week, 24 hours per day operation. Approval is sought to continue the current hours of operation. Studies undertaken for this EA are based on these hours.

Bloomfield currently employs 66 personnel. This includes open cut mining and washery staff. It is proposed to continue operations with similar staffing levels.

6. INFRASTRUCTURE AND SUPPORTING FACILITIES

No new infrastructure is proposed to be constructed or brought onto the Project Area. Existing infrastructure (refer **Figure B**) that forms part of this Project includes:

- Open cut workshop, fuel storage area, offices and bathhouse;
- Temporary haul and access roads;
- Permanent roads linking major infrastructure components such as the open cuts, the workshop, and the ROM coal stockpile pad; and
- Water management system including ‘clean’ and mine water management structures.

The Project will not generate any additional vehicle movements. All product coal, once processed at the washery, is transported to Newcastle Port by rail from the Bloomfield rail loading facility.

7. INTEGRATION WITH OTHER MINING OPERATIONS

Integration of this Project with adjacent operations and any associated cumulative impact has been a key consideration in mine planning and in all impact assessment studies. Mining operations that are either in the vicinity of the Project or integrated with part of the Bloomfield Project include:

- Donaldson Open Cut Mine;
- Abel Underground Mine;
- Bloomfield washery and associated facilities (approved under the Abel Project Approval); and
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Key aspects of the Project that are integrated with the operations listed above include:

- Delivery of coal from the various mines to the ROM coal stockpile areas adjacent to the washery, which will continue after completion of the Project;
- Water management system components utilized by multiple operations, such as Bloomfield, Donaldson, Abel and the Bloomfield washery, with the open cut water management forming part of the overall integrated water balance;
- Provision of a final void that will be used for future management of washery reject and tailings;
- Integrated rehabilitation planning, considering the final land use proposed for multiple sites; and
- The Integrated Environmental Monitoring Program developed for these integrated operations under the Abel Project Approval.

The post-mining rehabilitation strategy also incorporates the requirements of the Abel Underground Mine and the washery, which will continue to operate after completion of the Project.

8. REHABILITATION & POST-MINING LAND USE

A key component of this Project is the completion of mining on the site and associated rehabilitation and development of post-mining land use.

Bloomfield will undertake progressive rehabilitation as per the Bloomfield Colliery Rehabilitation Plan in stages of landform reshaping, preparation of the ground surface, species planting and site monitoring and maintenance. Rehabilitation will follow the objectives and procedures provided by the Bloomfield Rehabilitation Management System.

Post-mining landform and land use requirements and design are influenced by the requirements of the land owner, various stakeholders including government agencies and the objectives of the Lower Hunter Regional Strategy (DoP, 2006), which provides concept plans for the site as part of 'future employment lands'. All infrastructure not required for ongoing washery operations or required by landowner will be removed at the end of the Project and the landform rehabilitated to a mix of grazing and habitat areas suitable to its rural zoning.

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9. IDENTIFICATION OF KEY ISSUES AND ENVIRONMENTAL ASSESSMENT

In order to undertake a comprehensive environmental assessment of the Project, Bloomfield has undertaken a consultation process and a comprehensive environmental risk assessment study. The consultation process involved discussions with various government agencies and active engagement with a community focus group that met during the project planning phase to discuss the various Project issues. A newsletter providing key information and mine contact details for feedback and questions was also provided to the local community as part of a comprehensive community 'door knock' programme undertaken by mine management.

The risk assessment assisted in identifying and prioritising potential environmental impacts associated with the Project so that key issues could be addressed and subjected to detailed assessment. Key issues were also provided by the DoP Director-General's requirements for the EA.

Detailed assessment has been undertaken for the following key issues:

- Flora, fauna & threatened species;
- Aboriginal & European heritage;
- Surface and ground water;
- Integrated management;
- Rehabilitation, post mining landform and final void management;
- Noise, blasting and vibration;
- Air quality;

- Greenhouse gases;
- Social and economic; and
- Visual.

The following sections provide a summary of the main findings arising from each of these assessment studies. Integrated management and rehabilitation, post mining landform and final void management are described in the previous sections.

10. FLORA, FAUNA & THREATENED SPECIES

A large part of the Project Area is cleared of vegetation and disturbed by mining. The survey therefore focussed investigations on two vegetated areas of approximately 9 hectares near the western boundary. Approximately 1.7 hectares of this vegetated area will be cleared for the Project. A total of 123 native plant species were recorded. Three vegetation communities were identified within the survey area, of which the *Lower Hunter Spotted Gum-Ironbark Forest* community is listed as an Endangered Ecological Community ('EEC') in the *Threatened Species Conservation Act 1995* ('TSC Act'). There is 0.8 hectares of this EEC in the Project Area.

73 native fauna species were recorded, of which 6 are listed as Vulnerable in the Schedules of the TSC Act. A further 5 species listed under the Schedules as being observed or recorded within 5 km of the Project Area were included in the assessment.

The study concluded that due to the nature of the existing environment and the implementation of the safeguards described below, there would be minimal impact on flora, fauna, threatened species and the *Lower Hunter Spotted Gum-Ironbark Forest* EEC.

Mitigation measures include the continuation of erosion and sediment control measures and pre-clearance protocols for protecting hollow dwelling fauna. A contribution by Bloomfield to research into the conservation of the *Lower Hunter Spotted Gum-Ironbark Forest* EEC in the Hunter Region may be appropriate if this 0.8 ha EEC area is to be cleared for mining.

11. ABORIGINAL & EUROPEAN HERITAGE

The Aboriginal Heritage Study was conducted in accordance with the DECC's *Interim Community Consultation Requirements for Applicants*.

The Project Area was divided according to land use history. In the "unmodified" area (the area proposed to be mined), 6 stone artefact sites were identified and assessed as being of low scientific significance. The remainder of the Project Area which has been previously mined was classed as "modified" and was considered to have negligible potential for heritage evidence.

The assessment concluded that, with the implementation of an Aboriginal Heritage Management Plan and continued consultation with registered Aboriginal stakeholders, potential impacts on Aboriginal heritage will be very low.

Searches of relevant databases and plans did not identify any recorded European heritage sites on or in close proximity to the Project Area.

12. NOISE, VIBRATION & BLASTING

The Noise, Vibration & Blasting assessment identified the potential impacts of noise, vibration and blasting of the Project, including the cumulative impact from nearby mining activities. Construction noise was not assessed as there will not be any construction associated with the Project.

Background noise levels were calculated for representative locations and project specific noise assessment criteria for each location were established in accordance with the Industrial Noise Policy. Prediction of noise sources using modelling was carried out for representative operational 'worst-case' scenarios of Year 1 (end Stage 1), Year 5 (end Stage 2), and Year 10 (end Stage 4) applying the following noise mitigation and management procedures:

- The excavator and dump site would be situated in a shielded location during night-time operation in Years 1, 5 and 10;
- No dozer operation at the drill location would occur during night and morning shoulder periods (i.e. between 10.00 pm and 7.00 am) in Years 1, 5 and 10; and
- The front end loader would replace the dozer at the dump site during the night-time period unless 4 dBA of noise suppression is achieved in Year 1 and 5.

Further noise assessment in consultation with the relevant government agencies will be undertaken during the project to determine whether these mitigation procedures require modification in the future.

The assessment study concluded that project specific noise criteria is likely to be met in all years with the exception of:

- Location G (Buchanan Rd) where an exceedance of 1 dBA is predicted during a prevailing south east wind during the evening period in Years 1, 5 and 10 and during the night-time period in Years 1 and 10; and
- Location M (John Renshaw Drive) where an exceedance of 1 dBA is predicted during a prevailing north west wind during the night-time period in Year 1.

These minor exceedances of up to 1 dBA are unlikely to be noticeable.

The Project will meet the sleep disturbance criteria at all locations surrounding the development during calm and prevailing weather conditions with the exception of Location G where a 1 dBA exceedance during the morning shoulder period is predicted during a south east wind in Year 10. This 1 dBA exceedance is unlikely to cause sleep disturbance at this location.

The predicted airblast and ground vibration levels will meet DECC guidelines at all residences surrounding the Project during all operational stages of the Project. Blasting will only be undertaken during the hours of 9.00 am to 5.00 pm Monday to Saturday. Blasting will not occur on Sundays or Public Holidays.

The cumulative noise, vibration and blasting impact is predicted to comply with the INP. With implementation of the proposed controls and management procedures, environmental risk associated with noise and vibration is considered to be low.

13. AIR QUALITY & GREENHOUSE GASES

The air quality assessment focused on the potential impacts of particulate matter emissions. Modelling indicated that no residences were likely to experience either dust deposition or particulate matter concentrations above DECC's assessment criteria. Bloomfield will prepare and implement an Air Quality Monitoring Program. Bloomfield will also undertake the following ongoing actions to minimise dust generation:

- All vehicles will be operated in accordance with the existing Mine Transport Management Plan;
- Disturbed areas will be minimised where possible;
- Regular dust suppression water spraying will be undertaken;
- All mobile equipment will be maintained in good working order;
- Adequate stemming will be used in blast holes; and
- Meteorological conditions will be considered in blast timing.

The Project will liberate Scope 1 & 2 greenhouse gases as a result of the combustion of diesel and petrol to power mining and other equipment, the use of explosives and the use of electrical energy. The most significant Scope 1 & 2 greenhouse gases for the Project are CO_2 and N_2O.

Depending on ROM coal production, the Project is estimated to liberate between 19.5 million tonnes ('Mt') and 30.4 Mt of CO_2 equivalent greenhouse gases (including Scope 3 emissions) over the life of the mine. The estimated annual emission of CO_2 equivalent greenhouse gases for Australia in 2005 using the Kyoto accounting procedures was 559 Mt. This did not include Scope 3 greenhouse gases liberated by the burning of the coal by the end user as they would be accounted for in the country in which the end user is located.

14. SURFACE HYDROLOGY AND WATER MANAGEMENT

The Project is located within the Four Mile Creek and Buttai Creek catchments. The surface water management system for the Project forms an integral part of the water management system for the Abel Underground Project.

The existing water management structures, facilities and systems are considered adequate to cater for the continued Bloomfield operation with minimal new works. The impacts of potential surface water issues associated with the Project are considered to be low. Safeguards include the implementation of an Erosion and Sediment Control Plan and ongoing water quality and quantity monitoring of as part of the Integrated Environmental Monitoring Program ('IEMP').

15. GROUNDWATER

Groundwater levels in the Project Area show the accumulated effects of long-term mining. Due to the long period of time mining has occurred on the site, there is no evidence to suggest what pre-mining groundwater levels might have been. However, the influence of mining on water levels is apparent by the marked differences in groundwater levels between shallow and deeper coal measures.

Groundwater in the vicinity of the Project Area is saline and of negligible value for beneficial users. No adverse impacts on groundwater supply, quality or any groundwater dependent ecosystems are expected as a result of the Project.

Dewatering associated with the Project is likely to lead to groundwater recovery levels occurring above present levels before the completion of the Project and then stabilizing within 20-30 years.

Small impacts on stream base flows are predicted for Wallis and Buttai Creeks with rapid recovery post-mining.

16. SOCIO-ECONOMIC IMPACTS

The mining industry is the largest employer within the Cessnock Local Government Area. The Project is predicted to have the following beneficial social and economic impacts:

- Continued employment of 66 employees;
- The continuation of direct and flow-on economic benefits;
- No additional need for additional accommodation and community services;

- Additional royalty and tax payments to State and Commonwealth governments; and
- Site rehabilitation enabling the land to be developed for other purposes.

Ongoing community consultation by Bloomfield will ensure that community concerns are addressed in a timely manner.

17. VISUAL AND LIGHTING

Residences near the Project Area are generally rural in nature and have existing rural and bushland views, with some viewing sections of existing mine disturbance. While the Project will be visible from some southern residences in its early stages, intervening vegetation and topography generally screens operations and the visual impact associated with the completion of mining is considered to be low.

Bloomfield will undertake the following measures to mitigate the visual impact of the Project:

- Priority will be given to rehabilitation along the southern boundary of the Project Area;
- Progressive rehabilitation will occur;
- Mobile lighting will be directed away from potential external viewpoints; and
- Mine contact details will be provided to the community to enable prompt action if issues with mobile lighting need to be addressed.

Progressive rehabilitation of the Project Area will improve the visual amenity of the site and will enable visual improvement of an area historically disturbed by mining.

18. ECOLOGICALLY SUSTAINABLE DEVELOPMENT ('ESD')

The design of the Project has addressed each of the ESD principles and it is concluded that the Project is consistent with the principles of ESD and achieves a sustainable outcome for the local and wider environment.

19. CUMULATIVE IMPACT

Due to the interaction of the Project with nearby operations such as the Bloomfield washery and rail loading facility, Donaldson Open Cut Mine and the Abel Underground Mine, cumulative impact has formed an integral part of each assessment study undertaken for this EA.

Bloomfield Colliery forms part of the Integrated Environmental Monitoring Program ('IEMP') that integrates monitoring stations and data between the Bloomfield, Donaldson and Abel Mines and to some degree Tasman Underground Mine to the south. The IEMP forms part of the Abel Project Approval and will be modified as necessary to take into account any additional requirements for the Bloomfield Project.

Each assessment study has concluded that potential impacts remain low when cumulative impacts are taken into account.

20. JUSTIFICATION FOR THE PROJECT

This Environmental Assessment for the Completion of Mining and Rehabilitation of Bloomfield Colliery has considered in detail potential impacts on the environment and potential benefits to the local and wider community.

An evaluation of the Project was undertaken by assessing the risks posed to the environment by Project activities currently and then with the implementation of controls to determine the residual risk. The Project was also evaluated according to the principles of ESD.

This evaluation found that many aspects of the Project would have a low to medium environmental risk, even when no environmental controls or mitigation measures were put in place. The application of additional mitigation measures by Bloomfield ensures a low environmental risk in all key assessment areas.

Bloomfield has provided a draft Statement of Commitments as part of this EA which commits it to a range of mitigation and monitoring measures that will further mitigate, manage and/or monitor any potential impact.

21. CONCLUSION

Approval of this Project will enable Bloomfield to extract the remaining economic reserves from the Project Area in a safe, efficient and controlled manner which minimises environmental impacts, while providing continued employment for their employees and numerous associated suppliers and contractors in the local and broader area. Approval will also enable Bloomfield to rehabilitate and enhance the site in accordance with the requirements of the various relevant stakeholders and policies in place for the Lower Hunter Region.

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Completion of Mining and Rehabilitation

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STATEMENT OF VALIDITY

<table>
<tr><td colspan="2">Environment Assessment prepared under Part 3A of the Environmental Planning and Assessment Act 1979 and Regulations (NSW).</td></tr>
<tr><td>This report has been prepared by:</td><td>Nicole Croker
B. App Sc (EAM) (Hons)
Director
Business Environment Pty Ltd
Suite 4, 80 Mann Street, Gosford NSW 2250</td></tr>
<tr><td>This report relates to:</td><td>Bloomfield Colliery Completion of Mining and Rehabilitation.</td></tr>
<tr><td>Applicant’s Name:</td><td>Bloomfield Collieries Pty Limited</td></tr>
<tr><td>Property Description:</td><td>North of John Renshaw Drive, Buttai & east of Buchanan Road, Buchanan, 20 km north-west of Newcastle.
Refer Appendix B for Lot and DP descriptions.</td></tr>
<tr><td>Declaration:</td><td>This Statement has been prepared in accordance with:
• Part 3A of the Environmental Planning and Assessment Act 1979 and Regulations (NSW); and
• the Director General’s requirements dated 8 October 2007 in relation to this environmental assessment.
This Statement contains all available information that is relevant to the environmental assessment of the development to which the Statement relates. To the best of my knowledge, the information contained in this report/documentation is not false or misleading.</td></tr>
<tr><td>Signed:</td><td>Nicole Croker</td></tr>
<tr><td>Name:</td><td>Nicole Croker</td></tr>
<tr><td>Date:</td><td>12 November 2008</td></tr>
</table>

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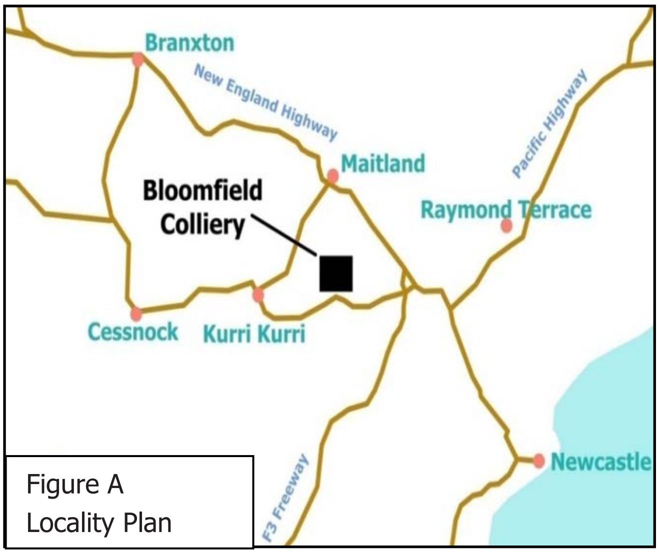

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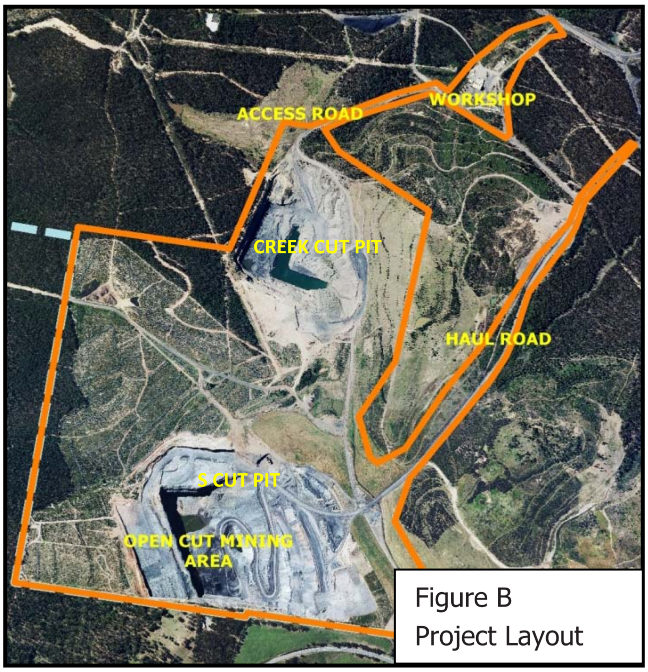

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11. ABORIGINAL & EUROPEAN HERITAGE

The Aboriginal Heritage Study was conducted in accordance with the DECC's *Interim Community Consultation Requirements for Applicants*.

The Project Area was divided according to land use history. In the "unmodified" area (the area proposed to be mined), 6 stone artefact sites were identified and assessed as being of low scientific significance. The remainder of the Project Area which has been previously mined was classed as "modified" and was considered to have negligible potential for heritage evidence.

The assessment concluded that, with the implementation of an Aboriginal Heritage Management Plan and continued consultation with registered Aboriginal stakeholders, potential impacts on Aboriginal heritage will be very low.

Searches of relevant databases and plans did not identify any recorded European heritage sites on or in close proximity to the Project Area.

12. NOISE, VIBRATION & BLASTING

The Noise, Vibration & Blasting assessment identified the potential impacts of noise, vibration and blasting of the Project, including the cumulative impact from nearby mining activities. Construction noise was not assessed as there will not be any construction associated with the Project.

Background noise levels were calculated for representative locations and project specific noise assessment criteria for each location were established in accordance with the Industrial Noise Policy. Prediction of noise sources using modelling was carried out for representative operational 'worst-case' scenarios of Year 1 (end Stage 1), Year 5 (end Stage 2), and Year 10 (end Stage 4) applying the following noise mitigation and management procedures:

- The excavator and dump site would be situated in a shielded location during night-time operation in Years 1, 5 and 10;
- No dozer operation at the drill location would occur during night and morning shoulder periods (i.e. between 10.00 pm and 7.00 am) in Years 1, 5 and 10; and
- The front end loader would replace the dozer at the dump site during the night-time period unless 4 dBA of noise suppression is achieved in Year 1 and 5.

Further noise assessment in consultation with the relevant government agencies will be undertaken during the project to determine whether these mitigation procedures require modification in the future.

The assessment study concluded that project specific noise criteria is likely to be met in all years with the exception of:

- Location G (Buchanan Rd) where an exceedance of 1 dBA is predicted during a prevailing south east wind during the evening period in Years 1, 5 and 10 and during the night-time period in Years 1 and 10; and
- Location M (John Renshaw Drive) where an exceedance of 1 dBA is predicted during a prevailing north west wind during the night-time period in Year 1.

These minor exceedances of up to 1 dBA are unlikely to be noticeable.

The Project will meet the sleep disturbance criteria at all locations surrounding the development during calm and prevailing weather conditions with the exception of Location G where a 1 dBA exceedance during the morning shoulder period is predicted during a south east wind in Year 10. This 1 dBA exceedance is unlikely to cause sleep disturbance at this location.

The predicted airblast and ground vibration levels will meet DECC guidelines at all residences surrounding the Project during all operational stages of the Project. Blasting will only be undertaken during the hours of 9.00 am to 5.00 pm Monday to Saturday. Blasting will not occur on Sundays or Public Holidays.

The cumulative noise, vibration and blasting impact is predicted to comply with the INP. With implementation of the proposed controls and management procedures, environmental risk associated with noise and vibration is considered to be low.

13. AIR QUALITY & GREENHOUSE GASES

The air quality assessment focused on the potential impacts of particulate matter emissions. Modelling indicated that no residences were likely to experience either dust deposition or particulate matter concentrations above DECC's assessment criteria. Bloomfield will prepare and implement an Air Quality Monitoring Program. Bloomfield will also undertake the following ongoing actions to minimise dust generation:

- All vehicles will be operated in accordance with the existing Mine Transport Management Plan;
- Disturbed areas will be minimised where possible;
- Regular dust suppression water spraying will be undertaken;
- All mobile equipment will be maintained in good working order;
- Adequate stemming will be used in blast holes; and
- Meteorological conditions will be considered in blast timing.

The Project will liberate Scope 1 & 2 greenhouse gases as a result of the combustion of diesel and petrol to power mining and other equipment, the use of explosives and the use of electrical energy. The most significant Scope 1 & 2 greenhouse gases for the Project are CO_2 and N_2O.

Depending on ROM coal production, the Project is estimated to liberate between 19.5 million tonnes ('Mt') and 30.4 Mt of CO_2 equivalent greenhouse gases (including Scope 3 emissions) over the life of the mine. The estimated annual emission of CO_2 equivalent greenhouse gases for Australia in 2005 using the Kyoto accounting procedures was 559 Mt. This did not include Scope 3 greenhouse gases liberated by the burning of the coal by the end user as they would be accounted for in the country in which the end user is located.

14. SURFACE HYDROLOGY AND WATER MANAGEMENT

The Project is located within the Four Mile Creek and Buttai Creek catchments. The surface water management system for the Project forms an integral part of the water management system for the Abel Underground Project.

The existing water management structures, facilities and systems are considered adequate to cater for the continued Bloomfield operation with minimal new works. The impacts of potential surface water issues associated with the Project are considered to be low. Safeguards include the implementation of an Erosion and Sediment Control Plan and ongoing water quality and quantity monitoring of as part of the Integrated Environmental Monitoring Program ('IEMP').

15. GROUNDWATER

Groundwater levels in the Project Area show the accumulated effects of long-term mining. Due to the long period of time mining has occurred on the site, there is no evidence to suggest what pre-mining groundwater levels might have been. However, the influence of mining on water levels is apparent by the marked differences in groundwater levels between shallow and deeper coal measures.

Groundwater in the vicinity of the Project Area is saline and of negligible value for beneficial users. No adverse impacts on groundwater supply, quality or any groundwater dependent ecosystems are expected as a result of the Project.

Dewatering associated with the Project is likely to lead to groundwater recovery levels occurring above present levels before the completion of the Project and then stabilizing within 20-30 years.

Small impacts on stream base flows are predicted for Wallis and Buttai Creeks with rapid recovery post-mining.

16. SOCIO-ECONOMIC IMPACTS

The mining industry is the largest employer within the Cessnock Local Government Area. The Project is predicted to have the following beneficial social and economic impacts:

- Continued employment of 66 employees;
- The continuation of direct and flow-on economic benefits;
- No additional need for additional accommodation and community services;

- Additional royalty and tax payments to State and Commonwealth governments; and
- Site rehabilitation enabling the land to be developed for other purposes.

Ongoing community consultation by Bloomfield will ensure that community concerns are addressed in a timely manner.

17. VISUAL AND LIGHTING

Residences near the Project Area are generally rural in nature and have existing rural and bushland views, with some viewing sections of existing mine disturbance. While the Project will be visible from some southern residences in its early stages, intervening vegetation and topography generally screens operations and the visual impact associated with the completion of mining is considered to be low.

Bloomfield will undertake the following measures to mitigate the visual impact of the Project:

- Priority will be given to rehabilitation along the southern boundary of the Project Area;
- Progressive rehabilitation will occur;
- Mobile lighting will be directed away from potential external viewpoints; and
- Mine contact details will be provided to the community to enable prompt action if issues with mobile lighting need to be addressed.

Progressive rehabilitation of the Project Area will improve the visual amenity of the site and will enable visual improvement of an area historically disturbed by mining.

18. ECOLOGICALLY SUSTAINABLE DEVELOPMENT ('ESD')

The design of the Project has addressed each of the ESD principles and it is concluded that the Project is consistent with the principles of ESD and achieves a sustainable outcome for the local and wider environment.

19. CUMULATIVE IMPACT

Due to the interaction of the Project with nearby operations such as the Bloomfield washery and rail loading facility, Donaldson Open Cut Mine and the Abel Underground Mine, cumulative impact has formed an integral part of each assessment study undertaken for this EA.

Bloomfield Colliery forms part of the Integrated Environmental Monitoring Program ('IEMP') that integrates monitoring stations and data between the Bloomfield, Donaldson and Abel Mines and to some degree Tasman Underground Mine to the south. The IEMP forms part of the Abel Project Approval and will be modified as necessary to take into account any additional requirements for the Bloomfield Project.

Each assessment study has concluded that potential impacts remain low when cumulative impacts are taken into account.

20. JUSTIFICATION FOR THE PROJECT

This Environmental Assessment for the Completion of Mining and Rehabilitation of Bloomfield Colliery has considered in detail potential impacts on the environment and potential benefits to the local and wider community.

An evaluation of the Project was undertaken by assessing the risks posed to the environment by Project activities currently and then with the implementation of controls to determine the residual risk. The Project was also evaluated according to the principles of ESD.

This evaluation found that many aspects of the Project would have a low to medium environmental risk, even when no environmental controls or mitigation measures were put in place. The application of additional mitigation measures by Bloomfield ensures a low environmental risk in all key assessment areas.

Bloomfield has provided a draft Statement of Commitments as part of this EA which commits it to a range of mitigation and monitoring measures that will further mitigate, manage and/or monitor any potential impact.

21. CONCLUSION

Approval of this Project will enable Bloomfield to extract the remaining economic reserves from the Project Area in a safe, efficient and controlled manner which minimises environmental impacts, while providing continued employment for their employees and numerous associated suppliers and contractors in the local and broader area. Approval will also enable Bloomfield to rehabilitate and enhance the site in accordance with the requirements of the various relevant stakeholders and policies in place for the Lower Hunter Region.

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1. INTRODUCTION

1.1 PROJECT OVERVIEW

Bloomfield Colliery ('Colliery') is an existing open cut mining operation located to the north of John Renshaw Drive, Buttai and east of Buchanan Road, Buchanan, approximately 20 km north-west of Newcastle (refer **Figure 1**).

The Colliery is operated by Bloomfield Collieries Pty Limited ('Bloomfield'), part of The Bloomfield Group of companies ('TBG'). TBG has interests in coal mining; heavy engineering; contract coal washing; diesel engine maintenance, repair and sales; motel operations and land development.

Coal has been mined on the site by both underground and open cut means for approximately 170 years. The current owners purchased the operation in 1937, with underground mining ceasing on the site in 1992. The current operation consists of open cut mining, an on-site Coal Handling and Preparation Plant (washery), a rail loading facility that loads processed coal for transporting to the Port of Newcastle, and various ancillary items such as an administration building, workshop and internal haul roads.

Bloomfield Colliery is located within Consolidated Coal Lease 761 ('CCL761'), granted under the *Mining Act 1992,* and mining operations are carried out in accordance with Environmental Protection Licence 396 ('EPL 396') issued under the *Protection of the Environment Operations Act 1997*, and a Mining Operations Plan ('Bloomfield MOP') lodged with the NSW Department of Primary Industries ('DPI') in 2004. The area covered by CCL761 is shown on **Figure 2**.

Bloomfield is working in accordance with its planned open cut mining program and is actively rehabilitating former mining areas on the site. Current assessment of economically recoverable reserves has determined that there is approximately 14 million tonnes of run-of-mine ('ROM') coal remaining on the site. ROM coal is a term used for 'raw' coal that has not been processed at the washery.

In recent years, the Colliery has produced coal at a rate of approximately 0.8 to 1.3 million tonnes per annum ('mtpa') ROM coal. It is proposed to continue mining at similar production rates and to complete mining over a 10 to 12 year period, which has been divided into 5 stages. In Stage 1, representing current operations (the current 2007-2008 period), mining is proposed to operate at a maximum of 0.88 mtpa ROM coal. In Stages 2, 3 and 4 (Years 1-5, 5-7 and 7-10 respectively), a maximum of 1.3 mtpa ROM coal is proposed. Stage 5 (approximately Years 10-12) is for the completion of site rehabilitation.

Mining operations at the Colliery have previously been carried out pursuant to existing use rights. The introduction of Part 3A of the *Environmental Planning and Assessment Act 1979* ('EP&A Act') and the *State Environmental Planning Policy (Major Projects) 2005* ('Major Projects SEPP') requires Bloomfield to obtain project approval under Part 3A in order to complete its proposed mining schedule and to rehabilitate mine areas.

Various mining items and activities at the Colliery have been approved as part of the Abel Project Approval (MP 05_0136), granted to Donaldson Coal Pty Limited. The Abel Underground Mine is located to the south-east of Bloomfield and was approved by the NSW Minister for Planning on 7 June 2007. Operation of the Abel Underground Mine requires use of some Bloomfield infrastructure and to enable this use, the Abel Project Approval includes the continued:

- operation of the coal washery and rail loading facility owned by Bloomfield;
- management of water associated with the washery;
- coarse reject and tailings disposal; and
- coal handling.

As the ongoing operation of these infrastructure items and activities is already approved, they do not form part of this Application. The Abel Project Approval area is shown on **Figure 26** (refer **Section 15.3**).

This application for project approval ('Application') and Environmental Assessment ('EA') relates to those infrastructure items and activities at the Colliery which are not included in the Abel Project Approval and which therefore require approval under Part 3A of the EP&A Act. These include:

- the current and proposed open cut mine areas;
- the unshaped and shaped overburden dump areas;
- the workshop;
- the road between the open cut pit areas and the ROM coal stockpile at the washery; and
- the road that links the workshop, open cut pits and washery.

The above areas that are the subject of this Application are referred to throughout this document as the 'Project Area'.

The Project Area is shown on **Figure 2**. The completion of open cut mining activities at Bloomfield Colliery has been designed to cater for the ongoing operation of the washery and the reject management system as outlined in detail in the Abel Project Approval.

1.2 PROJECT OBJECTIVES

The objectives of this Project are to:

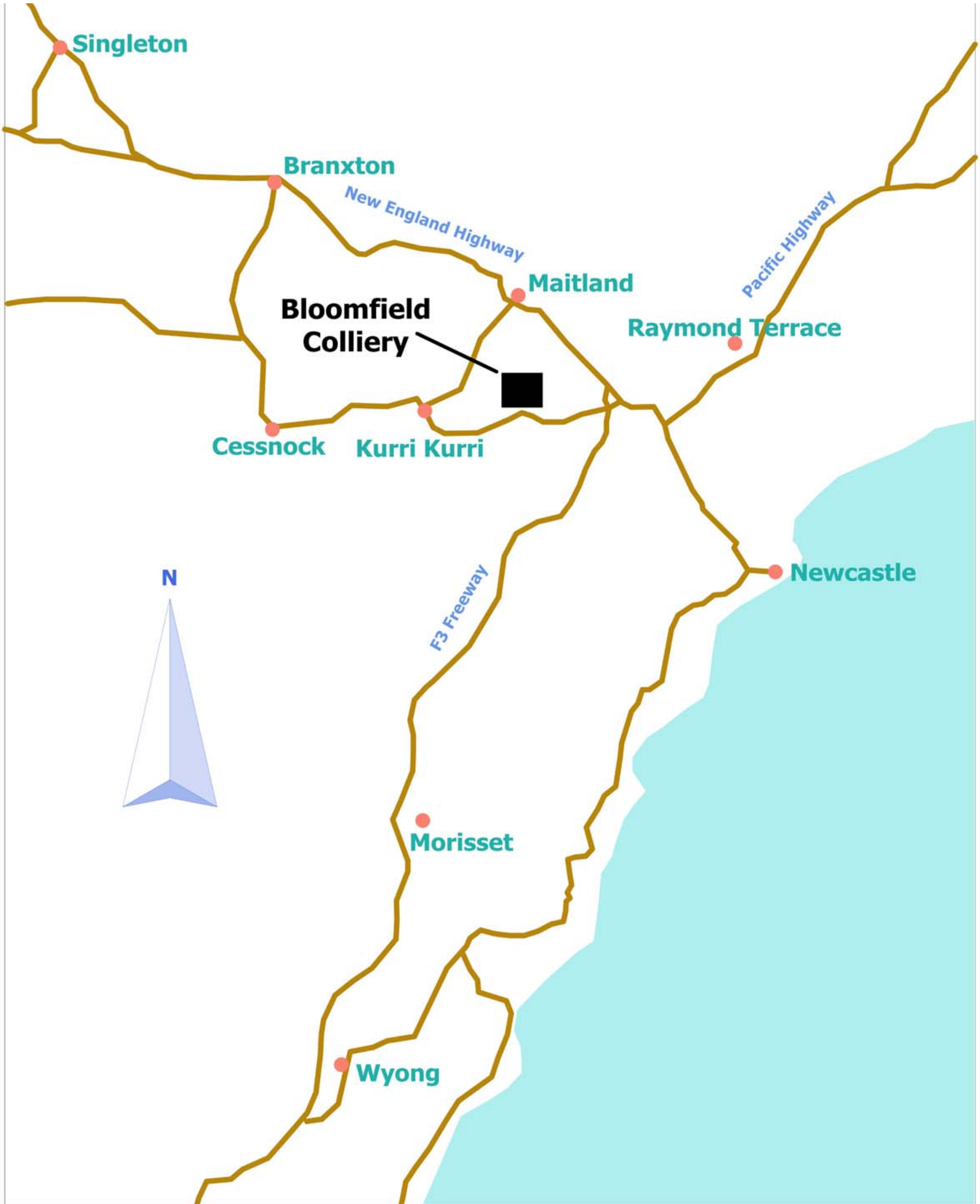
- Complete the program of open cut mining within Bloomfield Colliery, including operation of the associated workshop, haul road and access road that links the workshop, open cut pits and coal washery;
- Undertake rehabilitation of the site in accordance with commitments to the landowner, relevant regulatory requirements and planning considerations, including the Lower Hunter Regional Strategy (Department of Planning, 2006); and
- Liaise with local landholders to ensure community concerns are identified and addressed in the design and operation of the mining activities.

The purpose of this EA is to provide the documentation and information necessary to address and satisfy the requirements issued for the Project by the Director-General, in accordance with Part 3A of the EP&A Act.

1.3 THE APPLICANT

The applicant for this Project is Bloomfield Collieries Pty Limited ('Bloomfield'). Bloomfield is an Australian owned family company incorporated in 1952. Bloomfield is part of The Bloomfield Group of companies ('TBG'). TBG has exposure to a number of business activities through limited liability companies, ultimately controlled by Big Ben Holdings Pty. Coal mining operations are the primary source of revenue, with additional interests in mainly vertically integrated mining product and service providers.

Coal mining operations are carried out across two sites, Bloomfield Collieries (Four Mile Creek, Ashtonfield) and Rix's Creek (Singleton), with all mining tenements held by Bloomfield. Other mining prospects include Curlewis, Plashett and Bickham. TBG also undertakes toll washing for Donaldson Coal. TBG employs 425 people across all interests.



LEGEND

- BLOOMFIELD COLLIERY
- TOWN
- ROAD

FIGURE 1

LOCALITY PLAN

BLOOMFIELD COLLIERY
COMPLETION OF MINING AND REHABILITATION

SEPTEMBER 2008

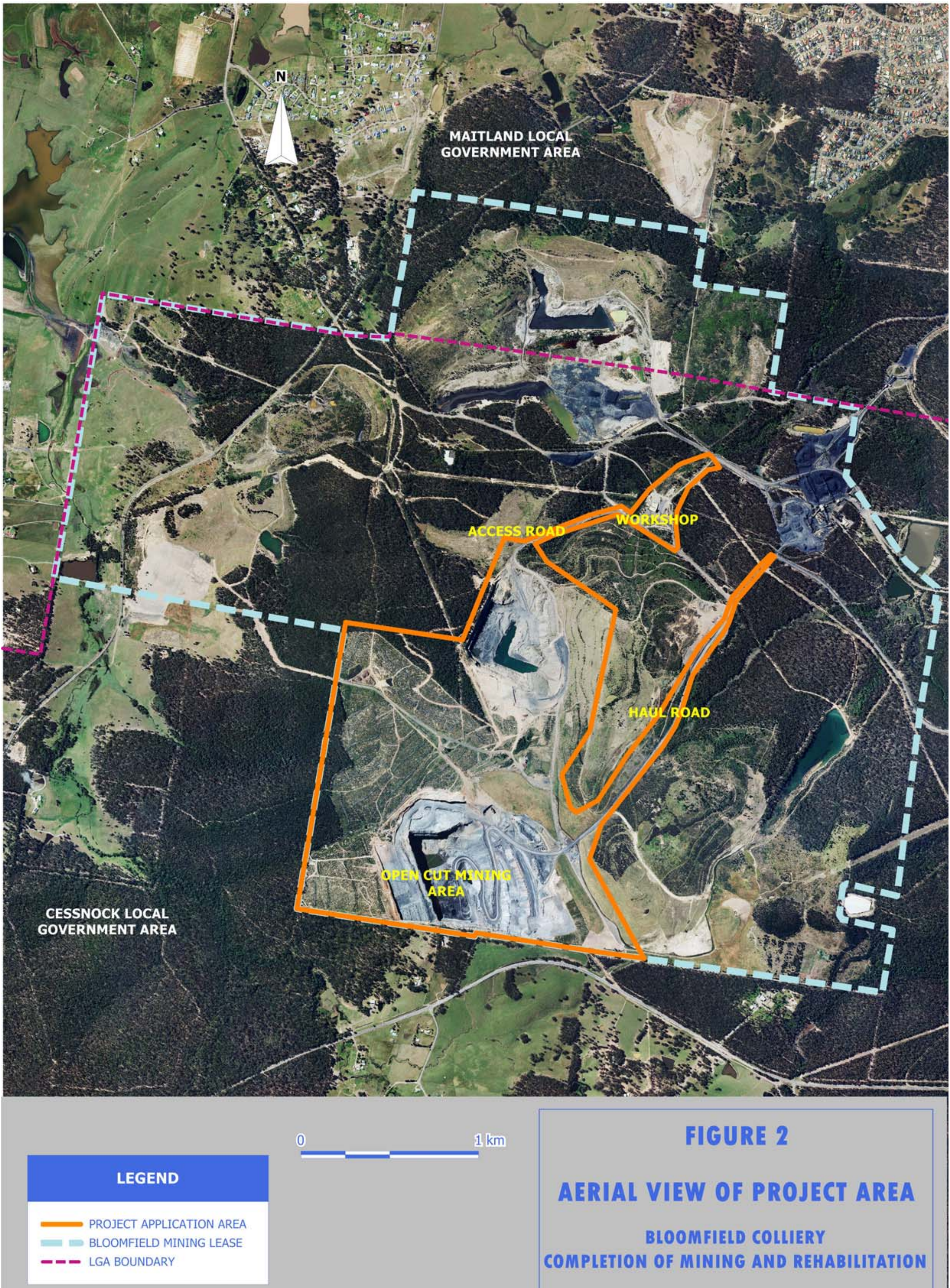


FIGURE 2

AERIAL VIEW OF PROJECT AREA

BLOOMFIELD COLLIERY
COMPLETION OF MINING AND REHABILITATION

SEPTEMBER 2008

1.4 PART 3A APPLICATION PROCESS

Mining operations at Bloomfield Colliery have previously been carried out pursuant to existing use rights. The introduction of Part 3A of the EP&A Act in 2005 effectively required Bloomfield to obtain ministerial approval to continue mining and undertake site rehabilitation.

As the Project is related primarily to the completion of mining and rehabilitation at Bloomfield Colliery, the Project is for the purpose of coal mining and is therefore classified as a Major Project under the Major Projects SEPP to which Part 3A of the EP&A Act applies. The approval of the Minister for Planning is therefore required.

The Part 3A process requires a Preliminary Assessment Report (PA Report) to accompany project approval applications made to the Minister for Planning via the NSW Department of Planning ('DoP'). A PA Report for this application was lodged with DoP in August 2007. The PA Report included a Preliminary Risk Assessment, which identified the key issues associated with the proposed development. On 8 October 2007, the Director-General of DoP released his Environmental Assessment Requirements for the Project Environmental Assessment ('EA'). These Requirements are provided in **Appendix A**, which also provides a table of where each requirement has been addressed in the EA.

This EA addresses all of the Director-General's Requirements for the EA. It also contains:

- a revised Risk Assessment incorporating changes in risk identified as a result of detailed technical studies undertaken for the EA;
- a detailed description of the proposed operation of the mine, rehabilitation procedures, and measures to mitigate, reduce, control or manage any predicted environmental impacts from the operation; and
- a draft Statement of Commitments, which are the commitments made by Bloomfield to ensure the operation is in accordance with the management and mitigation measures documented in this EA.

Once DoP has established the adequacy of this EA, the EA will be publicly exhibited for at least thirty (30) days, in accordance with EP&A Act requirements. During the exhibition period, the public will be invited to make submissions in relation to the Project. Following the exhibition period, DoP will review all documentation and submissions, and produce an assessment report relating to the Application for the consideration of the Minister for Planning.

Minor modifications have been made to the Project as described in the PA Report. Mine plans and scheduling have been modified in response to more detailed mine modelling and findings of studies undertaken for this EA. Changes made are generally minor. The modified description of the Project is provided in **Section 2** of this EA.

1.5 PROJECT TEAM

This EA has been prepared by Business Environment Pty Ltd on behalf of Bloomfield. Consultants listed in **Table 1** formed part of the Project Team, undertaking the various impact assessment studies required for the EA.

Table 1 Project Team

Area of Specialty	Consultant
Community Facilitation	Margaret McDonald-Hill
Risk Assessment	GSS Environmental
Flora, Fauna & Threatened Species Assessment	EcoBiological
Aboriginal Archaeology Assessment	SouthEast Archaeology
European Heritage Assessment	Business Environment
Noise, Vibration and Blasting Assessment	Heggies Pty Limited
Air Quality & Greenhouse Gas Assessment	Holmes Air Sciences
Surface Water Assessment & Water Balance	Evans & Peck
Groundwater Assessment	Aquaterra
Socio Economic Assessment	Hunter Valley Research Foundation
Visual Assessment	Business Environment

2. DESCRIPTION OF THE PROPOSED DEVELOPMENT

2.1 LOCATION AND SETTING

Bloomfield Colliery is an open cut mining operation located approximately 20 kilometres north-west of Newcastle. The site has been used for coal mining for approximately 170 years. Mining operations in the vicinity of the Project include:

- Donaldson Open Cut Mine, on the eastern boundary of Bloomfield Colliery;
- Abel Underground Mine to the south-east;
- Bloomfield washery and associated facilities (rail loading facility and tailings disposal areas) approved as part of the Abel Project Approval; and
- Tasman Underground Mine, located approximately 6.5 km south of Bloomfield Colliery but with product being brought to the Bloomfield washery and rail loading facility.

CCL761, granted 20 November 1991, forms the boundary of the current Bloomfield Colliery site, which includes the active open cut mining areas, rehabilitation areas, workshop, haul road, washery, water management structures and other ancillary items. These main elements are shown on **Figure 2**, an aerial plan of CCL761.

The Project Area (shown on **Figure 2**) is located within CCL761 and includes the following:

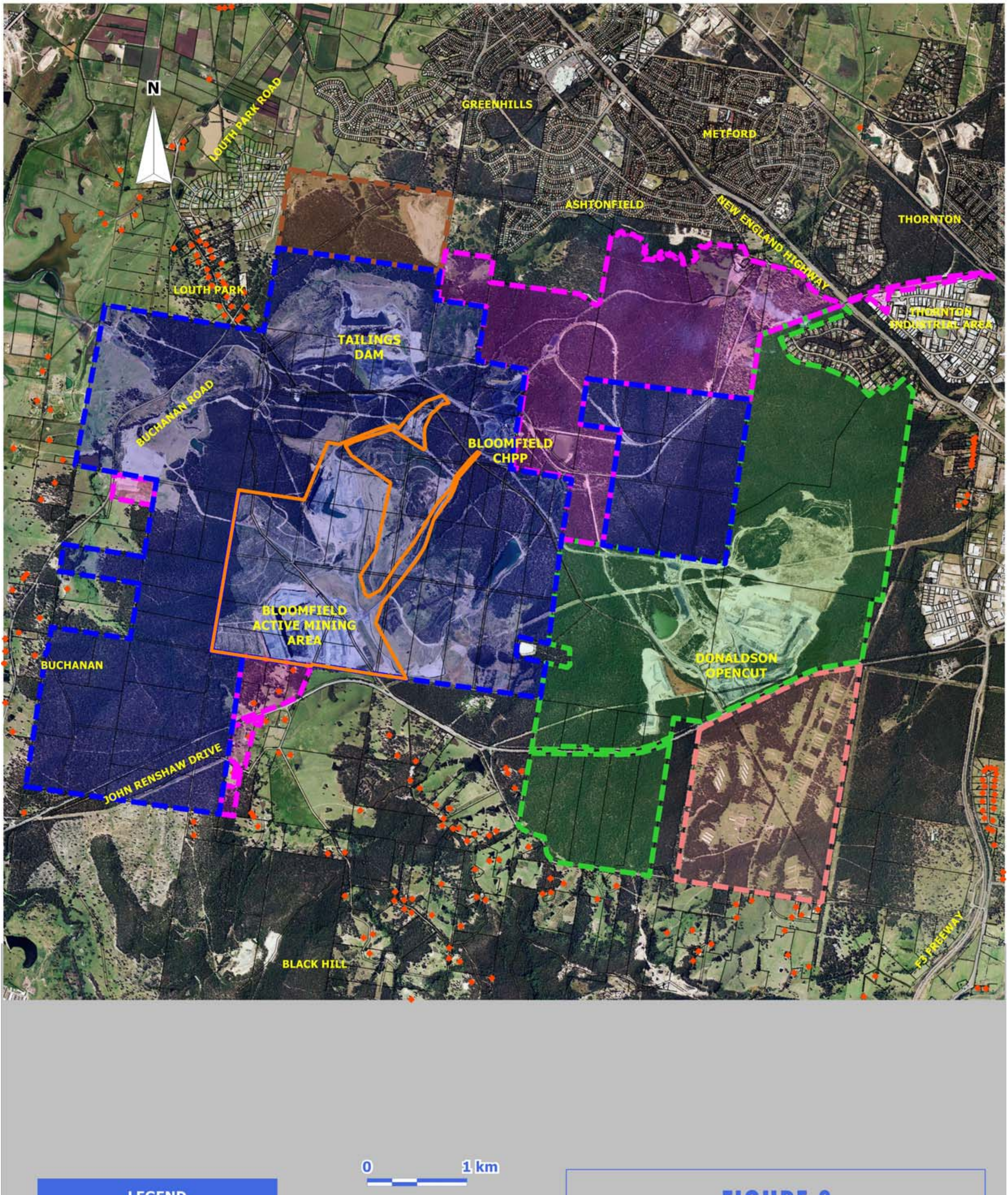
- The current and proposed active open cut coal mining areas;
- The unshaped and shaped overburden dump areas;
- Workshop and surrounding area used for maintenance and fuel storage;
- Road linking the current and proposed coal mining areas with the ROM coal stockpiles adjacent to the coal washery; and
- Road linking the current and proposed coal mining areas to the workshop.

Bloomfield washery (also referred to as the Coal Handling and Preparation Plant, or 'CHPP') and rail loading facility ('RLF') operations, including associated water management and process waste management, does not form part of this Project. These operations were approved by the Minister for Planning on 7 June 2007 as part of the Abel Project Approval.

Following approval of this Project application, it is proposed that a new surface mining lease will be sought for the Project Area. Where possible, cadastral boundaries have been followed in the formation of the Project Area, to assist in the development of the new mine lease.

All land within the Project Area is owned by Ashtonfields Pty Limited ('Ashtonfields'), an independent third party with a long standing relationship with Bloomfield, and is held by Bloomfield under a commercial lease. Land use within the Project Area is exclusively associated with the extraction, stockpiling and transport of coal. The land consists of active mining areas and associated infrastructure (i.e. hardstands, laydown areas, roadways, overburden stockpiles, dams, drains, etc), rehabilitated mined areas, and undisturbed vegetated areas. **Figure 3** is an aerial photograph showing the Project Area and its surrounds.

The land along the western boundary of the Project Area is mainly open forest. To the north and east, the Project Area is generally bounded by rehabilitated mined land. Land adjoining the south of the Project Area, near John Renshaw Drive, has been cleared for grazing. John Renshaw Drive is the nearest public road to the Project Area. A number of residences are located to the south of the Project Area. These are mainly rural residential properties adjacent to John Renshaw Drive and extending southwards along Lings Road and Browns Road. Residential properties are also located to the west adjacent to Buchanan Road and to the north-west at Louth Park. The nearest urban residential area is Ashtonfield, approximately 2.25 kilometres north-east of the workshop area. The nearest residence to the Project Area not owned by Bloomfield is located approximately 600 metres south of the southern boundary of the Project Area. **Figure 3** shows residences within the vicinity of the Project Area, as well as local land uses.



LEGEND

- PROJECT APPLICATION AREA
- BLOOMFIELD
- DONALDSON
- ASHTONFIELD
- ROMAN CATHOLIC CHURCH
- MAITLAND COUNCIL
- RESIDENCE

FIGURE 3
LAND USE, OWNERSHIP AND RESIDENCES

BLOOMFIELD COLLIERY
COMPLETION OF MINING AND REHABILITATION

SEPTEMBER 2008

2.2 COAL RESOURCE AND RESERVES

Bloomfield's open cut mine has been operating since 1962. An exploration drilling program was undertaken in October 2005 and the results were included in the Colliery geological model. Interpretation of the output from the model indicates that there is a measured coal resource of 28 million tonnes within the Project Area. Current economic assessment of the resource determined that approximately 14 million tonnes of recoverable coal reserves can be mined economically.

The coal bearing stratum occurring in the Project Area are the Tomago Coal Measures. These coal measures lie beneath the Newcastle Coal Measures and above the Maitland Group.

The coal seams worked by Bloomfield Colliery, in descending order, are as follows:

- Buttai Seams (E and F Seams);
- A, B, and C Seams;
- Whites Creek Seam;
- Elwells Creek Seam;
- Donaldson Seam;
- Big Ben Seam; and
- Rathluba Seam.

Seams present as either complete seams, a number of splits of the seam, or a collection of dispersed coal bands. Coal reserves in the Project Area are shown on **Figure 4**, with **Figure 5** showing cross sections of the seam sequence. The Rathluba Seam is not proposed to be mined in the current mine plans and has not been included in the estimated recoverable reserves.

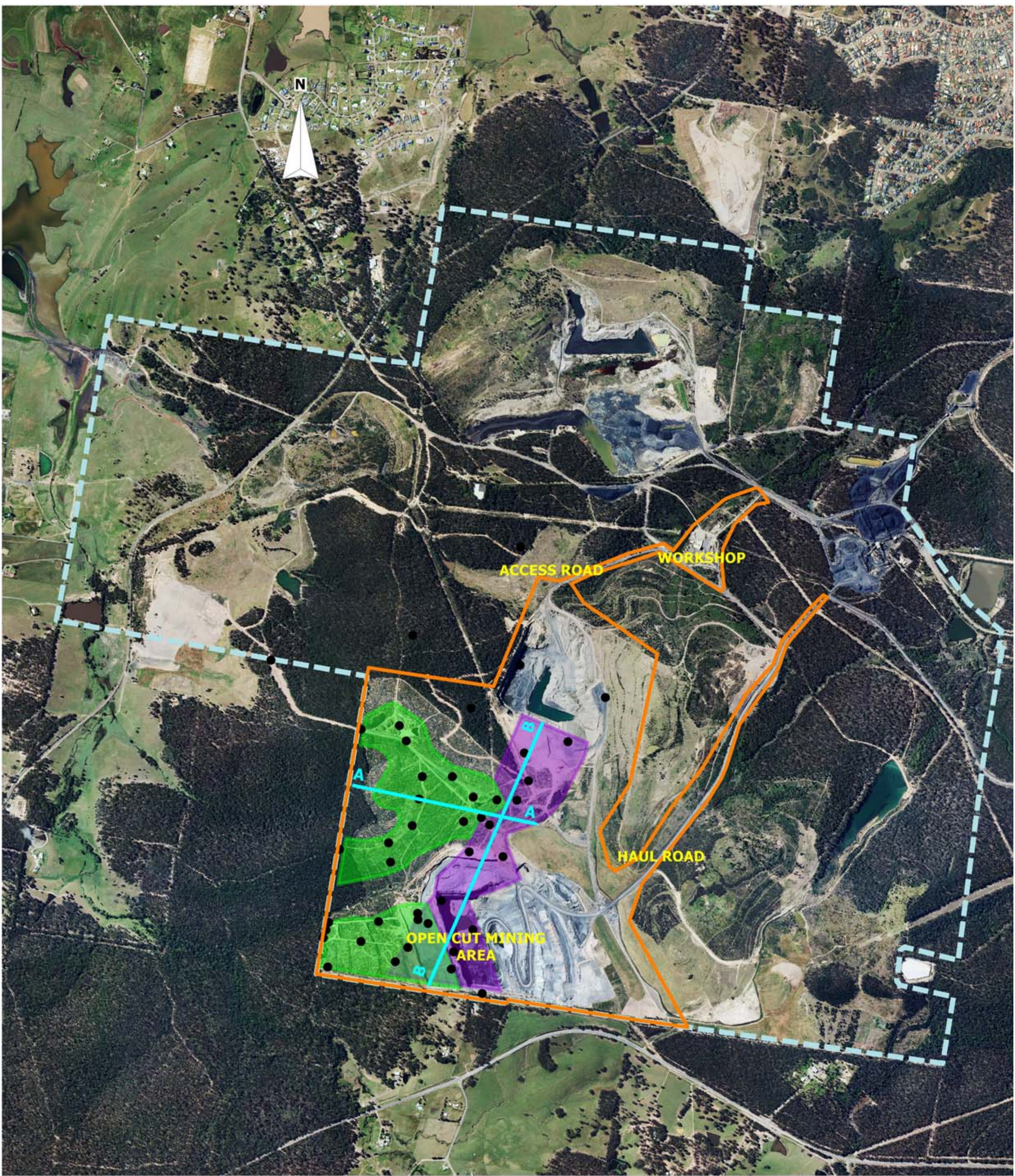
Site geology is typified by moderately dipping strata from the eastern and western sides of the lease, forming a syncline running axially from the north-east to the south-west of the lease. There is a well-defined dyke and fault structure running from the north-north-west to south-south-east through areas where mining has been completed through both open cut and underground methods. The remaining coal reserves have no known major geological impediments.

2.3 PAST AND PRESENT OPERATIONS

Mining of coal seams within the Tomago Coal Measures has been carried out in the Bloomfield area for over 170 years. The current owners commenced mining on the site in 1937. At various times the Donaldson, Big Ben and Rathluba Seams have been mined by underground methods. The extent and cross section of these seams is shown on **Figure 4** and **Figure 5.** All underground mining on the site ceased in 1992.

In 1962, a small open cut operation was commenced using bulldozers and tractor scrapers. The open cut has continued to expand and develop with the introduction of new machinery and technology as follows:

- 1978: P&H 2800 Electric Face Shovel with a fleet of 85 & 180 tonne rear dump trucks commissioned;
- 1981: P&H 5700 Electric Face Shovel commissioned;
- 1985: 2800 Electric Face Shovel decommissioned;
- 1986: P&H 2355 Dragline commissioned;
- 1991: Marion 305-M Dragline commissioned;
- 1998: Draglines decommissioned; and
- 2007: Hitachi EX5500 Excavator commissioned.



LEGEND

- PROJECT APPLICATION AREA
- BLOOMFIELD MINING LEASE
- BORE HOLE
- BUTTAI SEAM RESERVE
- BIG BEN SEAM RESERVE
- CROSS SECTION LINE (FIG 5)

0 1 km

FIGURE 4

COAL RESERVES

BLOOMFIELD COLLIERY
COMPLETION OF MINING AND REHABILITATION

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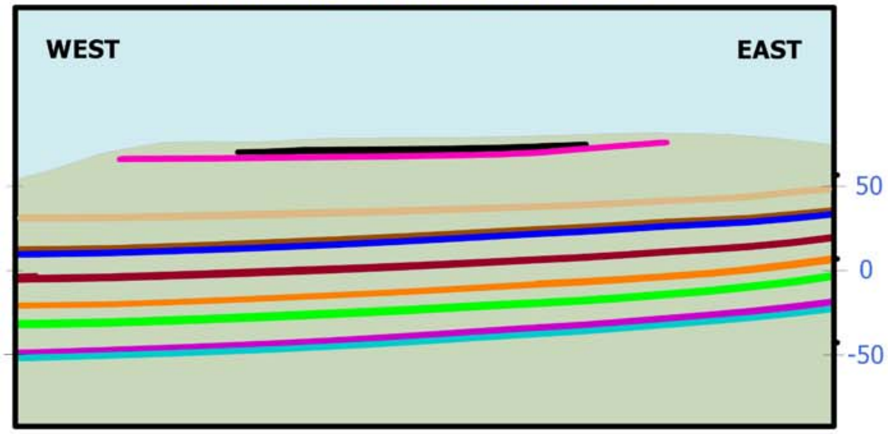
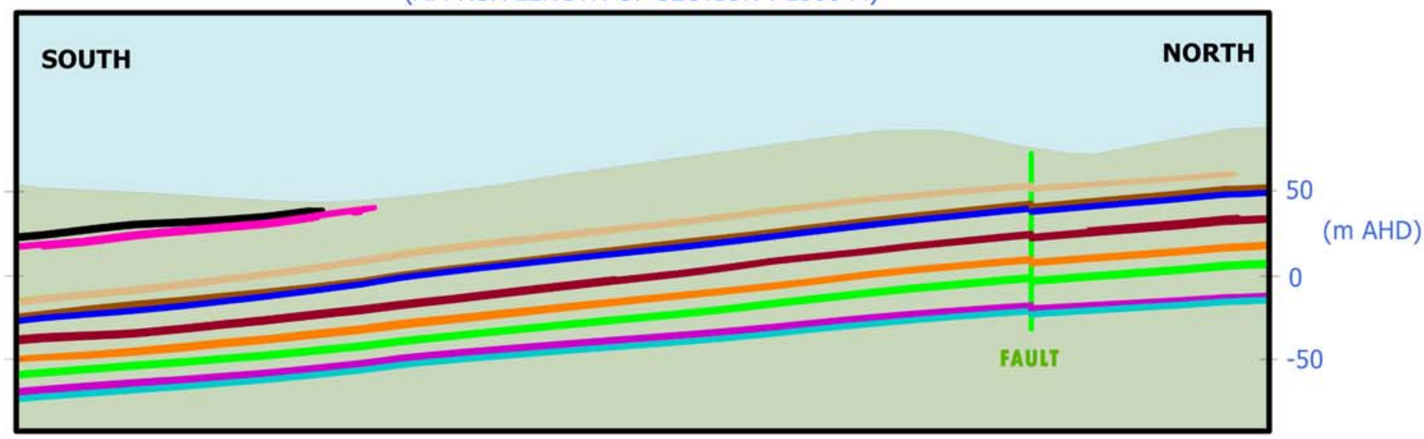
WEST TO EAST SECTION
VERTICAL EXAGGERATION : 2 TO 1
(APPROX LENGTH OF SECTION : 980 M)



SECTION A

SOUTH TO NORTH SECTION
VERTICAL EXAGGERATION : 2 TO 1
(APPROX LENGTH OF SECTION : 1500 M)



SECTION B

LEGEND

- F SEAM (BUTTAI)
- E SEAM (BUTTAI)
- C SEAM
- B SEAM
- A SEAM
- WHITES CREEK SEAM
- ELWELLS CREEK SEAM
- DONALDSON SEAM
- BIG BEN TOP SEAM
- BIG BEN BOTTOM SEAM

0 500 m

HORIZONTAL SCALE

FIGURE 5

COAL SEAMS

BLOOMFIELD COLLIERY
COMPLETION OF MINING AND REHABILITATION

SEPTEMBER 2008

Coal won from the open cut operation is predominantly thermal coal with some soft coking coal for the Asian export market. All coal is transported to the washery by internal haul roads and then by rail via the Bloomfield rail loading facility for export through the Port of Newcastle.

The Project will continue open cut mining operations on the site over five stages spanning the next 10 to 12 years, utilising methods and equipment similar to those currently used.

2.4 WORKFORCE AND HOURS OF OPERATION

Bloomfield Collieries currently employs 66 personnel. This includes open cut mining and washery staff. Nine additional staff is employed in management and administrative roles for The Bloomfield Group. It is proposed to continue operations at similar staffing levels.

The Colliery operates 7 days per week, 24 hours per day. Approval is sought to continue the current hours of operation. The environmental assessment studies undertaken for the Project are based on these hours of operation.

2.5 PROPOSED MINE PLAN AND SCHEDULING

The proposed mine plan is based on an exploratory drilling program undertaken by Bloomfield in October 2005 and the results of the updated Colliery geological model.

The area to be mined is located in the south-western section of CCL761 and corresponds to the area contained within the current Bloomfield MOP. The proposed mining sequence and stages are described as follows and are shown in **Figures 6** to **10**.

- Stage 1 (current mining-2007-2008 period) – (**Figure 6**): Mining consists of two active open cut pits referred to as 'S Cut' and 'Creek Cut';
- Stage 2 (approximately Years 1-5) – (**Figure 7**): Mining in S Cut will advance to the west and north, while mining in Creek Cut advances in a southerly direction;
- Stage 3 (approximately Years 5 to 7) – (**Figure 8**): Mining in S Cut continues north and west, whilst mining in Creek Cut continues southwards, eventually joining to create one pit;
- Stage 4 (approximately Years 7 to 10) – (**Figure 9**): Completion of mining in Creek Cut and western extensions of S Cut; and
- Stage 5 (approximately Years 10 to 12) – (**Figure 10**): Post Mining Rehabilitation.

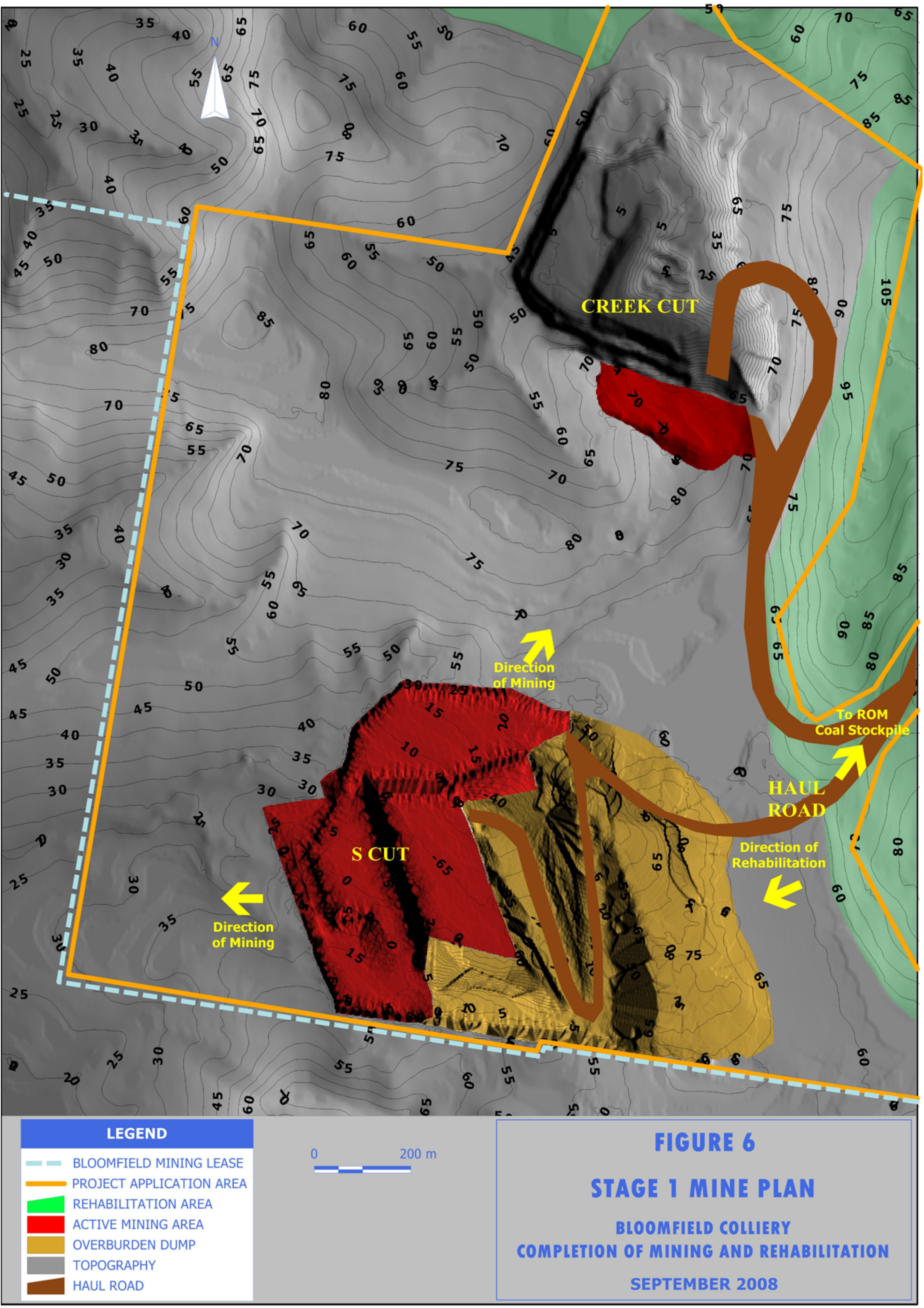


FIGURE 6

STAGE 1 MINE PLAN

BLOOMFIELD COLLIERY
COMPLETION OF MINING AND REHABILITATION

SEPTEMBER 2008

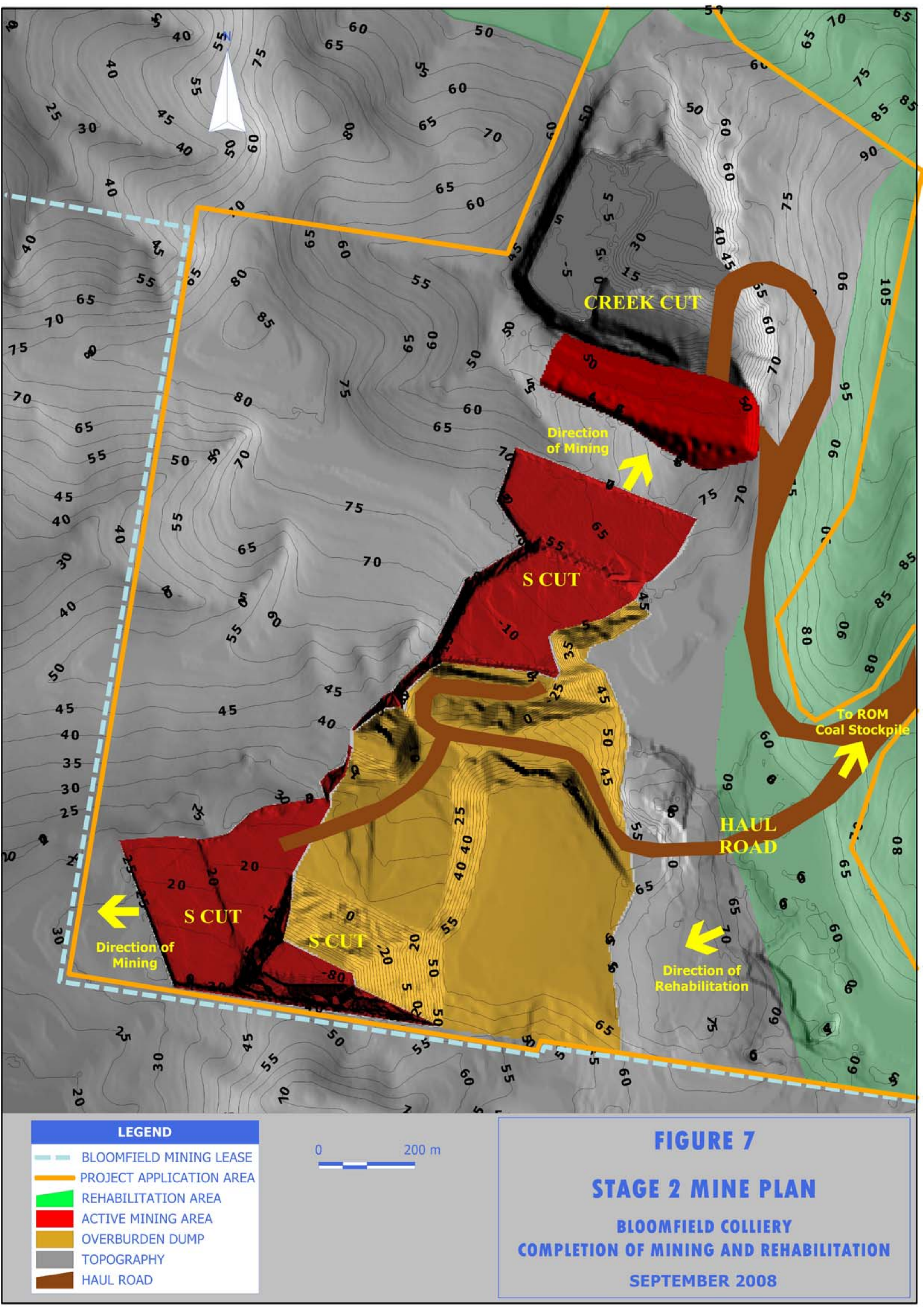


FIGURE 7

STAGE 2 MINE PLAN

BLOOMFIELD COLLIERY
COMPLETION OF MINING AND REHABILITATION

SEPTEMBER 2008

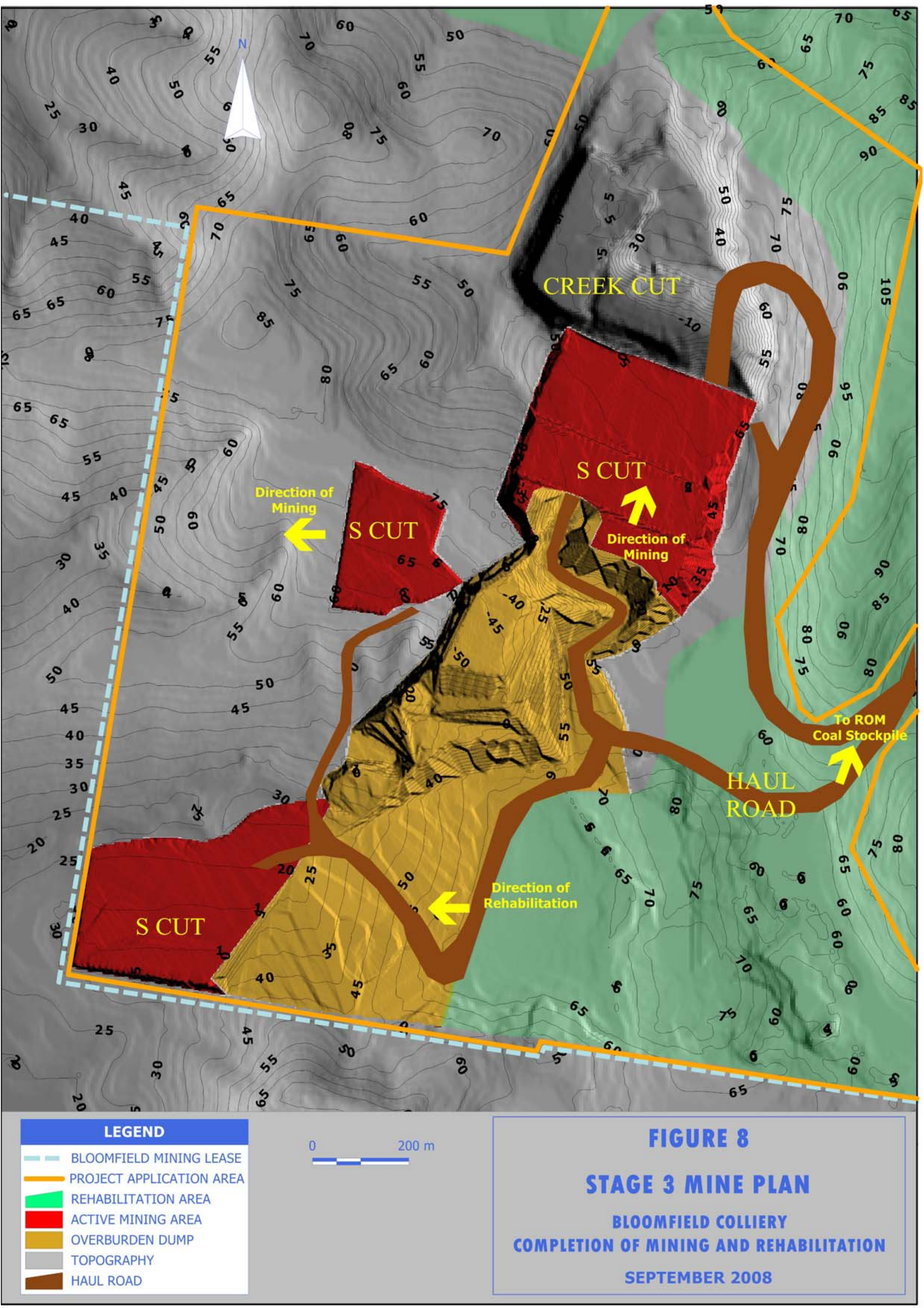


FIGURE 8

STAGE 3 MINE PLAN

BLOOMFIELD COLLIERY
COMPLETION OF MINING AND REHABILITATION

SEPTEMBER 2008

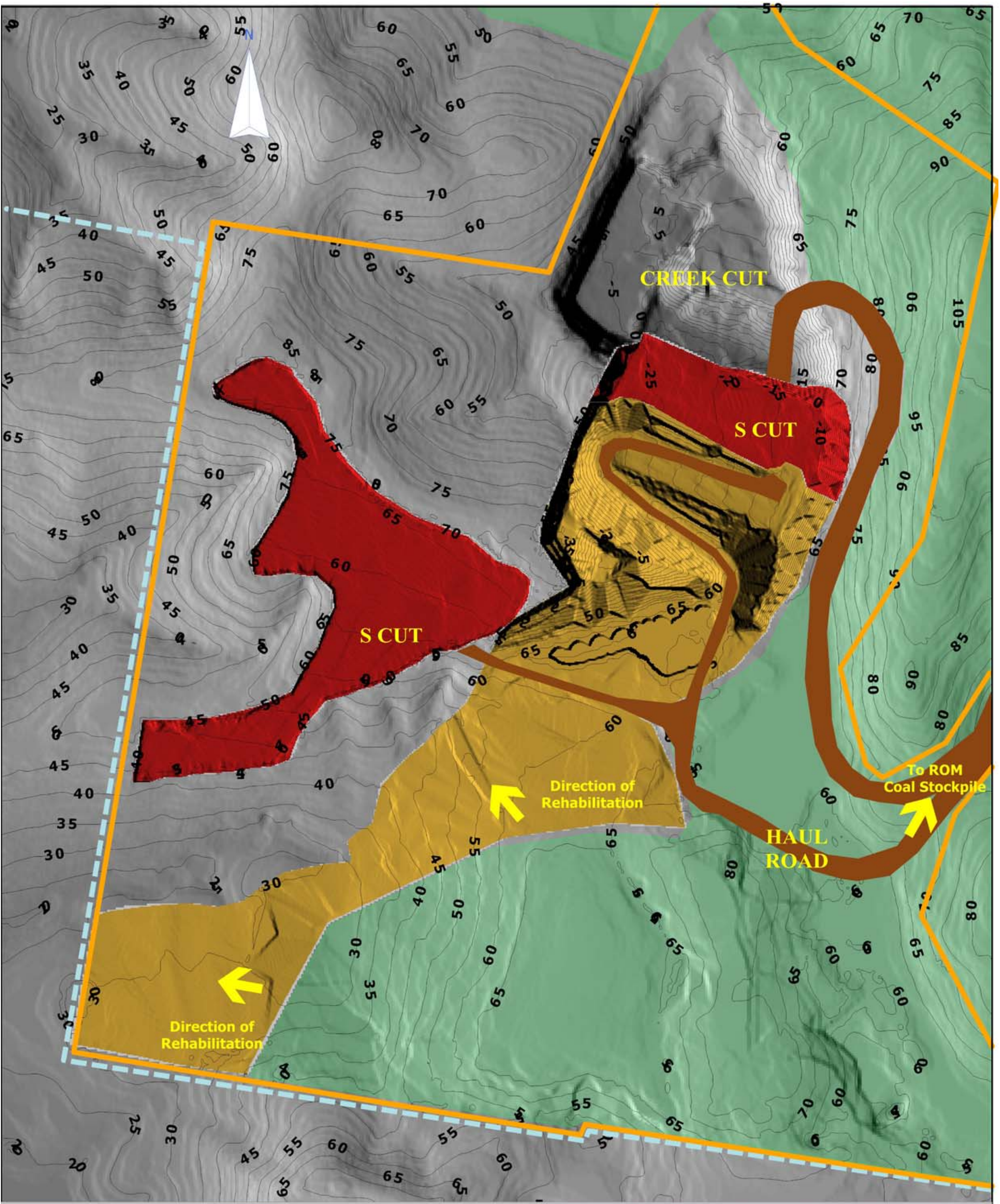


FIGURE 9

STAGE 4 MINE PLAN

BLOOMFIELD COLLIERY
COMPLETION OF MINING AND REHABILITATION

SEPTEMBER 2008

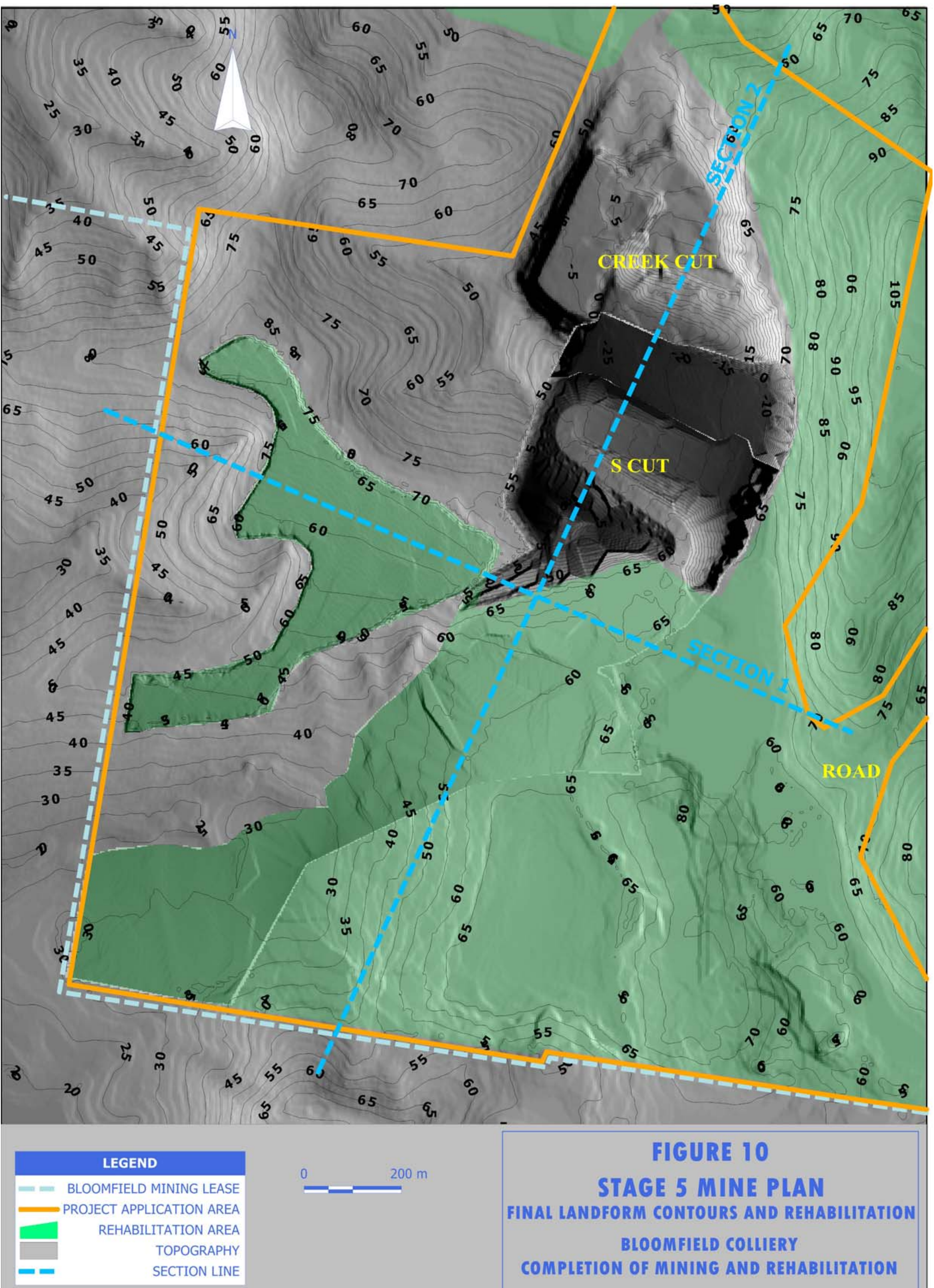


FIGURE 10

STAGE 5 MINE PLAN

FINAL LANDFORM CONTOURS AND REHABILITATION

BLOOMFIELD COLLIERY

COMPLETION OF MINING AND REHABILITATION

SEPTEMBER 2008

A final void will remain at the end of mining. This void will be used as a reject emplacement area for the washery. The Abel Project Approval enables washery operations to continue after the completion of the Project.

Multiple seams will be extracted in each cut, as described in **Section 2.2**.

It is proposed to mine the remaining reserves at a maximum rate of 0.88 mtpa ROM coal during Stage 1 and up to 1.3 mtpa ROM coal during Stages 2 to 4. Coal reserves that are currently economically recoverable have been estimated at approximately 14 million tonnes ROM coal. The maximum annual mining rate provides for flexibility in production rates over each year to enable Bloomfield to respond to coal market fluctuations and variations in quality and yield that occur over time. A maximum annual mining rate was generally used as the basis for impact assessment studies undertaken for the EA.

2.6 MINING METHOD AND EQUIPMENT

Mining at Bloomfield is generally undertaken as a multi-seam truck and excavator/face shovel operation, conducted in sequential mining blocks. It is proposed to continue with these existing methods of extraction.

2.6.1 Mining Methodology

The existing mining process for each block includes:

- Vegetation removal;
- Topsoil/pre-strip;
- Drilling and blasting;
- Overburden removal and stockpiling;
- Coal removal (followed by interburden removal and coal removal for lower seams); and
- Overburden reshaping and rehabilitation.

The majority of the area to be mined has previously been cleared of vegetation, with grasses and low vegetation allowed to regenerate to stabilize the surface until it is required for mining. An area of approximately 1.7 hectares of remnant vegetation will be cleared at the western and north-western limit of the S Cut workings. Vegetation is pushed up into windrows with dozers for placement under advancing overburden dumps.

Depending on topsoil/subsoil depth and quality, the material is pushed up with dozers and loaded onto haul trucks with front-end loaders, or excavated and loaded directly onto haul trucks with an excavator. It is then placed on reshaped overburden dumps in preparation for rehabilitation. Topsoil stockpiling is avoided where possible for operational and topsoil quality reasons. Lower unconsolidated (non-bedrock) horizons are free-dug as they do not require blasting prior to removal. They are then loaded onto rear dump trucks for hauling to overburden emplacements, as part of pre-strip operations.

Following topsoil/pre-strip removal, blast hole patterns are drilled into the overburden, in preparation for blasting. Blast pattern and hole depth is designed in accordance with excavator capability and safe blast design. The holes are then loaded with explosives and detonated.

After blasting, loose overburden material is removed by excavator/face shovel and placed onto rear dump haul trucks for hauling to overburden emplacements. Emplacement design will continue in a similar manner to the current operation.

The exposed coal seam is then ripped and pushed up with dozers, loaded onto coal trucks and transported to the ROM coal stockpile via internal haul roads.

The interburden/coal extraction process is repeated for each seam until the basal Big Ben seam has been removed. The resultant void is then available for backfilling with the overburden from subsequent mining blocks. Emplacements are reshaped by dozer to create the final contour shape.

A detailed description of the rehabilitation process is provided in **Section 3**. The sequence of mining showing extraction, backfilling and subsequent rehabilitation is shown in **Figure 11**.

2.6.2 Mining Equipment

Bloomfield currently uses an excavator or face shovel and a fleet of rear dump trucks for the removal of topsoil, prestrip, overburden and interburden material. Two drill rigs are used for blast hole drilling. A coaling fleet comprising a front-end loader or excavator, rear-dump trucks and a fleet of road trucks is used to transport the raw coal. It is proposed that the same, or similar, equipment will be used for the Project.

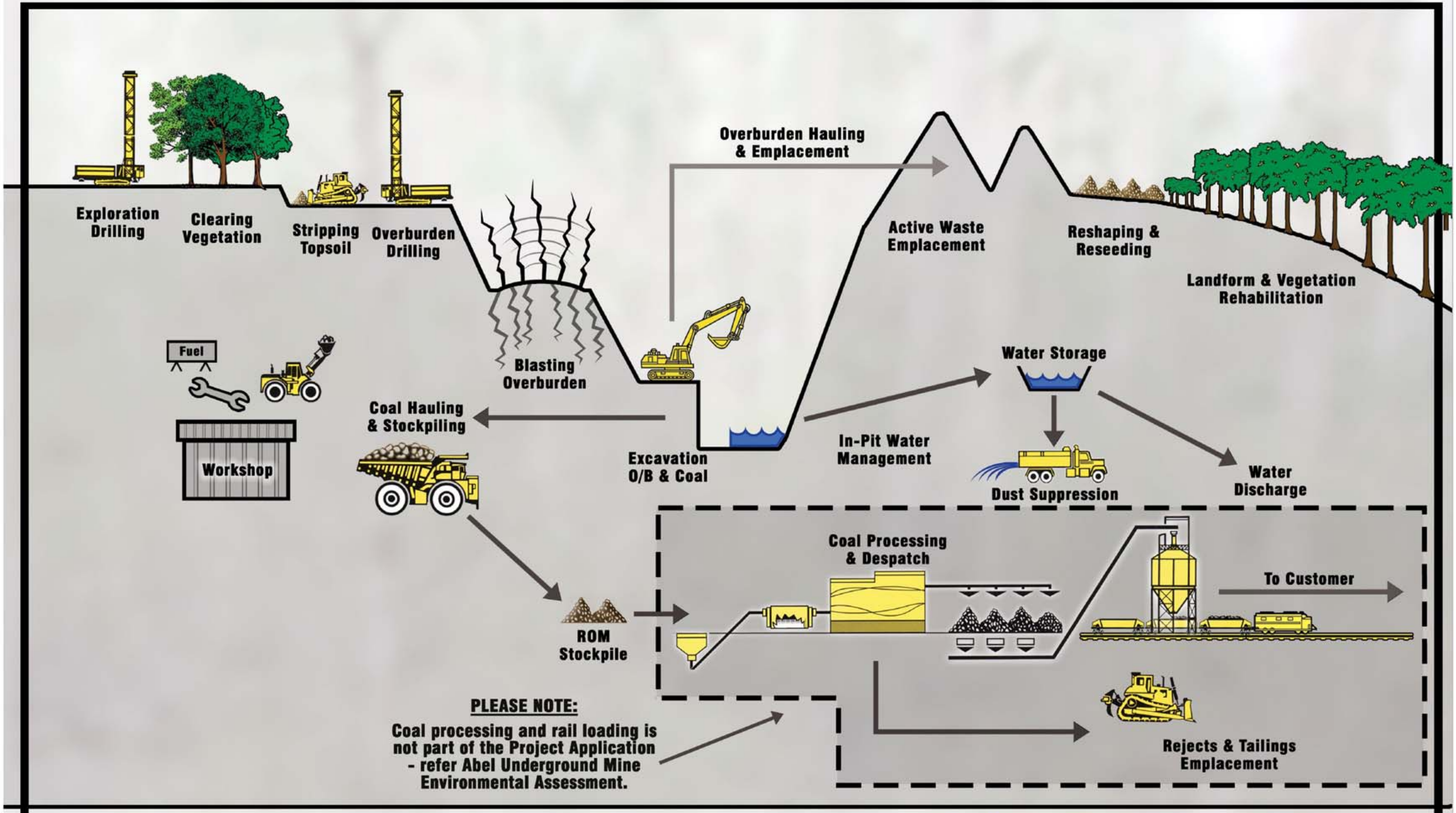


FIGURE 11

SCHEMATIC OF MINING PROCESS

BLOOMFIELD COLLIERY
COMPLETION OF MINING AND REHABILITATION

SEPTEMBER 2008

2.7 INFRASTRUCTURE AND SUPPORTING FACILITIES

Major infrastructure components in the Project Area, all of which currently exist, consist of the following:

- Open cut workshop, fuel storage area, offices and bathhouse;
- Temporary internal mine roads constructed as required to access mine areas;
- Permanent access roads linking major infrastructure components such as the workshop, and the ROM coal stockpile pad;
- Water management system including 'clean' and mine water management structures; and
- Dust suppression water tank storage.

The coal washery and associated facilities are approved under the Abel Project Approval.

Existing infrastructure is considered sufficient for the proposed remaining life of mine. No new infrastructure is proposed to be constructed or brought onto the site. Potential environmental impacts associated with the operation of this infrastructure are addressed in this EA.

2.8 ENVIRONMENTAL MANAGEMENT SYSTEM

The Bloomfield Mining Operations Environmental Management System ('EMS') has been developed generally in accordance with ISO 14001 principles. It contains an Environmental Policy as well as relevant environmental systems and procedures to guide current operations. This EMS, systems and procedures will continue to be applied to Project operations, until the completion of mining. Any additional requirements resulting from conditions of the Project Approval or Mining Lease will be incorporated into the existing EMS.

Bloomfield's Environmental Policy is as follows:

"*It is the policy of the Bloomfield Group and its subsidiary and associated companies to strive to achieve a high standard of care for the natural environment in all of the activities associated with our coal mining and engineering operations.*

We aim to conduct our operations in an ecologically sustainable manner through:

- *Minimising our impact on the environment by:*
  - *Managing the effect of our activities with regard to air, ground and water pollution;*
  - *Reducing noise associated with our activities to as low as reasonably practicable;*
  - *Controlling the waste associated with our activities and the identification of recycling opportunities;*
  - *Rehabilitating disturbed mining areas; and*
  - *Managing our energy consumption.*
- *Identifying, monitoring and, providing adequate resources to manage risks arising from our operations in accordance with the structure of our Environmental Management System, which establishes the appropriate objectives and targets related to the environmental risks relevant to the scope of our operations;*
- *Reviewing our environmental management activities and seeking to continually improve our production processes, waste management and the use of resources;*
- *Conducting our operations in compliance with all relevant environmental legislation, regulations and licences;*
- *Consulting with managers and employees about our aim and about their individual responsibilities;*
- *Informing our contractors, customers and suppliers of our aim and of their environmental responsibilities in relation to our business; and*
- *Consulting with the community and relevant government bodies with regard to our environmental performance, obligations and issues, as appropriate to their interests.*"

Existing systems and procedures that have been developed to manage the impacts and operation of activities on the site include:

- Mining Operations Plan;
- Maintenance Management System;
- Rehabilitation Management System;
- Environmental Water Management System;
- Draft Waste and Contamination Procedure;
- Draft Land Disturbance Management System;
- Aboriginal Heritage Management System;
- Mine Transport Management Plan;
- Shot Firing and Explosives Management System;
- Bushfire Management Plan; and
- Fuel and Bulk Oil Delivery Procedures.

Bloomfield operations are also included in the Integrated Environmental Monitoring Program ('IEMP') (refer **Section 2.12**) relating to the adjacent Abel and Donaldson operations. Systems have been established to ensure procedures are communicated, implemented and reported. These include such mechanisms as:

- Communication, inspection and reporting procedures;
- Employee consultation systems;
- Toolbox talks and inductions;
- Scheduled environmental inspections;
- Contractor Management System;
- Incident Notification and Reporting Procedure; and
- Complaints Protocol.

2.9 WATER MANAGEMENT

This section provides an overview of the water management system for the open cut operations. A detailed surface water management and assessment study has been completed by *Evans & Peck*. Details are provided in **Section 11** and **Appendix H**.

The Bloomfield surface water management system integrates water management for the open cut and the Bloomfield washery and has been assessed and approved under the Abel Project Approval. This section therefore discusses the system as approved, emphasising those areas that are most relevant to this Project.

The water management system includes the following:

- Existing surface water storages and sediment control dams (Lake Kennerson, Lake Foster, Possums Puddle and the Stockpile Dam) and the pipelines and drains that allow water to be transferred between these storages, or discharged offsite;
- Pumps for the supply of water from Lake Foster to the washery;
- Pumps for supply of groundwater extracted from old underground workings to supplement water supply to the washery when required;
- The washery associated stockpile areas and the Stockpile Dam;
- Previously mined areas including S Cut and Creek Cut used for disposal of wastes from the washery (coarse rejects and fine tailings) and the rehabilitation of these areas following completion of waste disposal; and
- Mine water discharge regime as per the existing EPL.

Water collected in-pit and from surrounding disturbed areas will continue to be directed to Lake Kennerson via existing pipelines and open drains. The Bloomfield water management system, as it exists, forms part of the Integrated Water Management System approved on 5 May 2008 for the Bloomfield, Abel and Donaldson mines.

2.10 ENERGY AND GREENHOUSE GAS MANAGEMENT

Bloomfield Colliery currently uses energy in the form of diesel and petrol for plant and equipment, electricity and explosive charges. The amounts of energy used and estimated emissions of greenhouse gases from this use are calculated in the Air Quality Assessment undertaken by Holmes Air Sciences, described in **Section 10** and **Appendix G**.

Bloomfield is currently registered as a participant in the Federal Government Energy Efficiency Opportunities ('EEO') and Greenhouse Challenge Plus programs. An Assessment and Reporting Schedule has been prepared under the EEO program and an Energy Assessment of open cut operations will be undertaken in accordance with the commitments made in that schedule. The EEO Energy Assessment will document current and proposed initiatives for the efficient supply and management of energy usage, as well as procedures for the reporting and management of greenhouse gases resulting from Scope 1 and 2 emissions, which are those emissions that are produced directly as a result of equipment use on site (Scope 1 emissions), and the use of electricity on the site (Scope 2 emissions).

Appendix G predicts that the Project will produce 28,489 tonnes of Scope 1 emissions and 14,214 tonnes of Scope 2 emissions in Stage 1. In Stages 2-4, 23,164-35,312 tonnes of Scope 1 emissions and 11,102–16,490 tonnes of Scope 2 emissions are estimated to be produced. The *National Greenhouse and Energy Reporting Act 2007* (NGER Act) requires corporations that control facilities emitting 25 kilotonnes (25,000 tonnes) or more of greenhouse gas (CO_2 equivalent) per year to register and report their greenhouse gas emissions. Bloomfield Colliery will therefore be required to monitor and report on its greenhouse gas emissions under the NGER Act. Such reports will be provided in the form required by the NGER Act.

Scope 3 greenhouse gas emissions are those indirect emissions that are a consequence of Bloomfield's operations, but are not from sources owned or controlled by Bloomfield, for example, the burning of Bloomfield's coal for energy by their customers.

Depending on ROM coal production, the Project is estimated to liberate between 19.5 Mt and 30.4 Mt of CO_2 equivalent greenhouse gases (including Scope 3) over the life of the mine, with an annual average of between 1.76 and 2.85 million tonnes. In 2005, Australia emitted an estimated 559 Mt of CO_2 equivalent greenhouse gases using the Kyoto accounting procedures. The Scope 3 emissions from the Project would not be included in the NSW inventory as the coal is for export and would be accounted for in the country in which the end user is located.

2.11 WASTE AND HAZARDOUS MATERIALS MANAGEMENT

Bloomfield Colliery has an existing *Draft Waste and Contamination Procedure* that specifies measures undertaken by Bloomfield to reduce waste, ensure regulatory compliance and reduce the risk of environmental impact from pollution.

Mining operations produce volumes of waste that require responsible management and disposal. As part of the mining process, potential pollutants (such as diesel, oils and chemicals) are also stored and used on-site. Bloomfield has an obligation, under the POEO Act to ensure that contaminated waste is handled responsibly and that the risk of pollution is managed in accordance with the requirements of EPL 396. Bloomfield also has a responsibility to the community to minimise pollution and reduce the total volume of general waste requiring disposal.

Bloomfield's existing policies and procedures for waste and hazardous materials management will continue to be used for this Project. The procedures include:

- Regulatory responsibilities and requirements;
- Disposal procedures for various waste streams;
- Controls for the storage, use and disposal of potential pollutants;
- Methods of reducing waste production;
- Methods of minimising risk of environmental, safety and health impacts;

- Communications and training with regard to the above requirements;
- Monitoring and reporting requirements; and
- Procedures for roles and responsibilities.

Process waste (for example, tailings and rejects) is the responsibility of the washery approved under the Abel Project Approval. Process waste therefore does not form part of this Project. The *CHPP & RLF Environmental Management Plan* provided under the Abel Project Approval describes the management and monitoring of process waste.

Bloomfield has adopted the waste management hierarchy as the principle upon which the site waste management strategy is based. In order to minimise the amount of non-recyclable waste being produced on-site, all waste management measures should reflect the waste hierarchy, which is to reduce, re-use, recycle and then responsibly dispose.

Bloomfield's *Draft Waste and Contamination Procedure* identifies waste hierarchy management responses for wastes such as:

- waste oil;
- hydrocarbon contaminated solids (eg: oily rags);
- hydrocarbon contaminated soil;
- hydrocarbon contaminated water;
- used hydraulic hoses;
- oil filters;
- batteries;
- empty drums;
- general wastes such as wood and plastics; and
- scrap steel.

Hazardous materials such as fuels, oils and chemicals are stored at the workshop area that forms part of the Project Area. These items are stored and used in accordance with existing site hazardous and dangerous materials guidelines which include the storage of all fuels within the bunded fuel farm and the collection and treatment of all potentially contaminated water within the workshop via an oily water separator with collection system. This system is discussed in the Surface Water Assessment (**Section 11.2**).

Initiating explosive products used in the mining operation are stored at a secure magazine not located within the Project Area.

2.12 INTEGRATION WITH OTHER MINING OPERATIONS

The Director General's requirements for this Project include a requirement to address integrated management. This is discussed in detail in **Section 15.2**.

Integration of this Project with adjacent operations has been a key consideration in mine planning and in all impact assessment studies. For example, open cut water management is an integral part of the overall water management system as it manages surface water from the Donaldson and Abel mines, and the Bloomfield washery. The post-mining rehabilitation strategy (refer **Section 3.7**) also incorporates the requirements of the Abel Mine and the washery, which will continue operating after the completion of this Project.

Key aspects of the Project that are integrated with the operations of adjacent projects include:

- Delivery of coal from the Project and other mines to the ROM coal stockpile areas adjacent to the washery, which will continue after completion of the Project;
- Water management system components utilised by multiple operations, such as the Bloomfield, Donaldson, and Abel mines and the Bloomfield washery, with the open cut water management forming part of the overall integrated water balance;
- Provision of a final void that will be used for future management of washery reject and tailings;
- Integrated rehabilitation planning, considering the final land use proposed for multiple sites; and
- Integrated environmental monitoring program for the adjacent sites (described as following).

Due to the proximity of other mining operations, relevant impact assessment studies (i.e. air quality and noise) have considered cumulative impact as part of their studies.

An Integrated Environmental Monitoring Program ('IEMP') developed as part of the Abel Project Approval has been approved by DoP and is currently being implemented as described in **Section 15.2**.

Impact assessment studies undertaken for this Project and recommended monitoring regimes have taken into consideration existing IEMP requirements.

3. REHABILITATION AND LANDSCAPE MANAGEMENT STRATEGY

3.1 INTRODUCTION

Rehabilitation is an integral part of the Bloomfield Project and will involve the following:

- placement and shaping of overburden material to form a suitable landform;
- preparation of the ground surface including placement of topsoil/topdressing material as required;
- planting of appropriate vegetation species; and
- monitoring and maintenance of the rehabilitated areas to ensure long-term success.

Rehabilitation is currently undertaken in accordance with a *Land Rehabilitation Management System* ('LRMS') developed by Bloomfield*.* The LRMS was prepared giving consideration to government requirements, industry standards and stakeholder consultation. This section describes these requirements, including the LRMS which will be adopted for rehabilitation of the Project Area. This section also provides a discussion on final land use options and a description of a preferable post mining landform and land use, as well as the treatment of the final void that will remain after mining has been completed.

Consideration of the most appropriate post mining landform and final void is integrated with the requirements of other projects or proposals (refer **Section 2.12** and **Section 15**). This includes the use of the final void for rejects disposal from the washery operations, as provided for by the Abel Project Approval. As washery operations have been approved to continue to 2028, this influences rehabilitation considerations for the final void. The Lower Hunter Regional Strategy (DoP, 2006), DPI requirements with regard to landform stability and safety, and landowner requirements are also key considerations in post mining landform selection and design These considerations are described in detail in **Section 3.6**.

3.2 REHABILITATION MANAGEMENT SYSTEM

Bloomfield Colliery currently undertakes site rehabilitation in accordance with its documented LRMS, developed in accordance with guidelines issued by the DPI.

The LRMS outlines the rehabilitation methodology implemented by Bloomfield for the preparation, management and relinquishment of rehabilitated lands at Bloomfield mining operations.

The system includes:

- Overall rehabilitation aim, objectives and criteria;
- Overview of regulatory requirements and guidelines;
- Information on roles and responsibilities for rehabilitation;
- Auditing, review and consultation; and
- A specific Rehabilitation Plan for each Bloomfield site (ie: Bloomfield Colliery, Rix's Creek, etc).

The LRMS will form the basis for continuing rehabilitation of the Bloomfield Project Area. A Rehabilitation Plan for Bloomfield Colliery is appended to the LRMS and incorporates commitments made in the current Bloomfield MOP.

A detailed Final Rehabilitation Plan and Mine Closure Plan will be prepared as part of the MOP process. The detailed content of these plans will reflect the overview of final rehabilitation and mine closure objectives, procedures, monitoring and maintenance documented in the following sections.

3.3 REHABILITATION AIM AND OBJECTIVES

The current aim of rehabilitation at Bloomfield Colliery is to provide a safe and stable landform, compatible with the surrounding landscape, which allows for a range of possible post-mining land-uses including mixed-use development.

The objectives of the current Rehabilitation Plan are as follows.

3.3.1 General Rehabilitation Objectives

- Land will be rehabilitated in accordance with relevant DPI standards applicable at the time of rehabilitation;
- Rehabilitated land will represent a minimal source of off-site environmental impacts, such as dust, water pollution, visual amenity and weeds;
- All infrastructure owned by Bloomfield Colliery must be removed under the terms of its Commercial Lease with the landowner (Ashtonfields);
- Rehabilitated land will require ongoing management inputs no greater than similar adjacent land; and
- Rehabilitation will be compatible with the proposed post-mining land-use (mixed-used development).

3.3.2 Landform Objectives

- Rehabilitated land will be safe and stable;
- Land capability will be returned to a class similar to that existing prior to the commencement of mining; and
- Mined land will be re-contoured to a landform compatible with the surrounding natural landscape.

3.3.3 Vegetation Objectives

- Rehabilitated land will be topdressed, fertilised and sown with grass seed and/or native vegetation species; and
- A sustainable vegetation cover will be established on rehabilitated land.

Each rehabilitation objective listed above is linked with specific completion criteria and progress indicators in Bloomfield's Rehabilitation Plan.

3.4 REHABILITATION PROCEDURES

Rehabilitation procedures are documented in the LRMS and are divided into the following stages:

- Landform reshaping;
- Preparation of the ground surface (eg: topdressing material application);
- Species selection; and
- Site monitoring and maintenance.

These procedures are described as follows.

3.4.1 Landform Reshaping

During open-cut mining, overburden is placed in progressive spoil dumps. These dumps are subsequently reshaped to re-establish a landscape that blends with the surrounding undisturbed topography. As a general rule, slopes are constructed at 10 degrees or less, with any exceptions pre-approved by DPI.

Figure 10 (provided in **Section 2**) provides the Mine Plan for Stage 5, which represents the post- mining phase. This figure illustrates the final post-mining landform contours and areas to be rehabilitated. Two cross-section lines (Section 1 and 2) are also shown on **Figure 10**.

These cross-sections are provided as **Figure 12**. These two sections show the final void and treatment of rehabilitation areas.

3.4.2 Preparation of the Ground Surface

After landform reshaping, the surface is rock raked and exposed surface rock is removed or buried prior to the spreading of topdressing material. Soil material stripped ahead of the mining is applied to the new surface. Where appropriate, bio-solids and mulch are used in the topdressing process. These materials are brought onto site by a licenced contractor and applied in accordance with the NSW Biosolids Guidelines (EPA, 1997).

The surface is then contour cultivated to integrate the topdressing layer with the underlying material and sown with pasture or tree seed mix. If bio-solids are not used, fertiliser may be spread with the pasture seed mix. Following sowing, the surface is rolled to encourage germination.

All of these works are performed as soon as is practical after spreading the topdressing material to minimise losses and preserve biological activity.

3.4.3 Species Selection

Rehabilitated areas are generally sown with pasture species to create a stable landscape potentially suitable for light grazing. Areas of tree planting are also incorporated into the rehabilitation scheme and are situated to assist with habitat enhancement and to visually blend former overburden dump areas with the surrounding landscape.

Typical species used in rehabilitation include:

<u>Pasture Mix:</u>

- Rhodes Grass
- Rye Wimmera
- Kikuyu
- Clover Haifa
- Couch
- Shirohie Millet
- Oats Coolabah

Native species/trees:

- *Acacia implexa, A. decurrens, A. falcate, A. longifolia, A. mearnsii, A. myrtifolia, A. ulicifolia, A. irrorata, A. sauveolens*
- *Angophora costata*
- *Casuarina torulosa*
- *Corymbia maculata*
- *Eucalyptus crebra, E. saligna, E. pilularis, E. resinifera, E. umbra, E. haemastoma, E. gummifera, E. paniculata, E. acmenioides*
- *Leptospermum polygalifolium*
- *Syncarpia glomulifera*

3.4.4 Site Monitoring and Maintenance

Maintenance of rehabilitated areas is ongoing to ensure rehabilitation objectives are met. Pasture growth is encouraged by slashing low density grazing and fertilizer application.

A weed control program assists the detection and treatment of any infestation.

All rehabilitated areas are inspected annually to identify areas requiring maintenance or further treatment. Any erosion occurrences are investigated to ascertain the cause of the problem and remedial actions are implemented to prevent recurrence. These actions may be in the form of respreading of topdressing material on minor rill erosion or remedial earthworks for more major occurrences.

3.5 FINAL VOID

A final void will be retained on the site after the completion of mining. The location of this final void is shown on **Figure 10** and **Figure 12**. (Note: **Figure 10** is located with the staged Mine Plans provided in **Section 2**.)

The final void will be at the northern extension of S Cut where it will join with Creek Cut. The final void will remain as part of an active disposal site for reject material from the washery, approved under the Abel Project.

Proposed rehabilitation of the final void, once filled with reject material, is described in the Environmental Assessment for the Abel Project. It states that rehabilitation "*will be undertaken in accordance with DPI guidelines which require the Bloomfield Mine Operations Plan, required as a condition of the Bloomfield mining lease, to provide details on proposed* *outcomes to be achieved through rehabilitation and final landform."* (Donaldson Coal, 2006, p. 2-19)

Bloomfield plans to rehabilitate the reject emplacement areas, once capacity has been reached, by shaping to a stable, undulating, self draining landform with mixed cover of pasture and native vegetation. These plans may in future be influenced by the needs of other projects that utilise the final void, as described in **Section 3.6** and therefore Bloomfield has selected a post-mining landform and land use option that best caters for the potential needs of these projects.

3.6 POST-MINING LANDFORM AND LAND USE

3.6.1 Factors Influencing Post-Mining Landform and Land Uses

Selection of an appropriate post-mining land use and development of a suitable post mining landform is an integral part of the Project. Factors influencing the selection of an appropriate post-mining landform and land use are:

- DPI requirements with regard to landform stability and safety;
- The Lower Hunter Regional Strategy (DoP, 2006) (LHRS) (refer **Section 4.4.3)** identifies the Project Area as part of a larger future development area incorporating a "future freight hub and employment lands providing an opportunity for the storage, transfer and distribution of containerized freight and associated employment" (location shown on **Figure 13** in **Section 4**). Therefore any decisions regarding the post-mining landform and land use will need to take this, and any additional detailed plans that may be prepared in the future, into consideration;
- The Project Area is owned by Ashtonfields and any decision regarding post mining landform and land use will take Ashtonfields' requirements into consideration;
- The Bloomfield washery, rail loading facility and associated infrastructure will continue to operate after the Project is scheduled to be completed, so active washery infrastructure and transport will *continue* in the Project Area; and
- Where relevant, other strategic planning and conservation studies may influence decisions regarding the type of land use or vegetation cover within the Project Area. Studies may include the draft Lower Hunter Regional Conservation Plan (described in **Section 4.4.4**), Hunter-Central Rivers Catchment Action Plan (refer **Section 4.4.6**), Wallis and Fishery Creek Total Catchment Management Strategy (refer **Section 4.4.7)** and Hunter and Central Coast Regional Environmental Management Strategy (refer **Section 4.4.5).**

3.6.2 Consideration of Alternative Final Landforms and Uses

A range of alternative final landforms and land uses for the Project Area have been considered by Bloomfield. Details of these alternatives, with respect to the considerations presented in **Section 3.6.1**, are provided as follows.

i. Residential Land Use

The current zoning of the Project Area is 1(a) Rural 'A', and as such no residential or rural residential development is currently permissible. There are no regional or local plans that currently identify the area as being required for residential land use. The *Lower Hunter Regional Strategy* (LHRS) does not identify the Project Area for future residential development.

However, land uses identified in the LHRS will require residential areas to support the requirements generated by the employment zone. As the LHRS is progressed, residential development may be included in those parts of the Project Area identified as reaching satisfactory safety and stability criteria associated with such development.

ii. Industrial Land Use

The LHRS identifies the Project Area as part of a 'future freight hub and employment lands'. This area extends eastward towards the New England Highway, as shown on **Figure 13**. The LHRS is a strategic land use planning document that aims to cater for the Lower Hunter Region's predicted growth over the next 25 years. The Strategy does not place a timeframe on the development of a freight hub, but it is assumed that, if approved, it would be constructed progressively as land areas became available post-mining.

Bloomfield's proposed project timing may enable southern and western sections of the Project Area to be made available for industrial purposes in ten to twelve years time (the time required to complete this Project). However, filling of the final void with reject material from the Bloomfield washery, as well as active operation of the washery, is expected to occur over the life of the adjacent Abel Mine project, which has consent to operate until 2028 (as stated by Schedule 3(5) of the Abel project approval). The final void area, which is located in the central section of the Project Area, would therefore need to be excised from any industrial development until the completion of the Abel Project.

Rehabilitation of the final void occurs after filling with reject material from the washery and forms part of the Abel Project approval. Filling of the void with material other than washery rejects, as part of an overall land rehabilitation strategy, is not possible as the void space is required as a location to dispose of reject material from the washery. If the objectives of the Abel Project altered in future or were not met, rehabilitation to appropriate final landforms would be completed with material from within the site. This would be considered in consultation with the land owner and relevant stakeholders as described in **Section 3.6.1**.

Bloomfield's current Commercial Lease with the landowner prohibits the emplacement of foreign material, not arising from the core mining activity of the tenant, on the Project Area. This requirement therefore excludes the importation of material from off site.

As the Project Area has been identified as having potential for industrial-type uses in the future, Bloomfield consider that the Project Area should be rehabilitated in such a way that does not conflict with this future land use. Such rehabilitation would mean providing a flat to undulating topography suitable for mixed use industrial, seeded with grasses to stabilize, together with areas of trees for habitat, until such time as detailed determinations are made regarding any future industrial use of the site. Should no such future development eventuate, the site would remain as a stable, rural landscape.

iii. Open Forest/Bushland

Previously mined areas adjacent to and parts of the Project Area have been rehabilitated to grazing land with areas of native vegetation as can be seen to the east of the Project Application Area on the aerial photograph provided as **Figure 2**.

The draft Lower Hunter Regional Conservation Plan prepared in 2006 (refer **Section 4.4.4** for detail) is a partner document to the LHRS and identifies a conservation corridor from the Watagan Ranges to Port Stephens, providing a significant link between the southern sandstone ranges and the coastal heaths and wetlands of Port Stephens. The corridor is also identified on LHRS plans. The corridor is mapped south of John Renshaw Drive and east of George Booth Drive, crossing the New England Highway where wetland areas provide a direct link to Hexham Wetlands and across to the Pacific Highway and Fullerton Cove. The corridor is not on the Project Area and is separated from it by John Renshaw Drive.

Due to the proximity of the Bloomfield Project Area to this corridor, visibility of parts of the Bloomfield site from outside areas, the proximity of bushland to the west and east and the desire to provide ongoing habitat opportunities for fauna, Bloomfield consider it important to incorporate areas of bushland into its rehabilitation plans.

As the LHRS identifies the Project Area as part of a future industrial development, Bloomfield considers that areas of tree planting identified in rehabilitation plans be carefully selected, considering any future development plans. If the objectives of the LHRS altered or the current planning strategy for industrial use of the Project Area was changed during the project timeframe, Bloomfield may re-consider its selected final landform and land use strategy to include additional bushland areas. This would be considered in consultation with the land owner and relevant stakeholders as described in **Section 3.6.1**.

iv. Undulating grazing land/rural landscape

This option would rehabilitate the Project Area to undulating grazing landform consistent with its pre-mining land capability, while still providing areas of native vegetation to enhance biodiversity and aesthetic values.

This option is compatible with the LHRS, provides local habitat opportunities and linkages with adjacent remnant native vegetation. This land use type allows Bloomfield to progressively rehabilitate the Project Area to a stable landform that minimises erosion and sedimentation.

3.6.3 Preferred Post-Mining Landform and Final Landuse

After consideration of the above options, Bloomfield has determined that rehabilitated land suitable for a variety of future land uses, whilst enabling the retention of habitat areas, is the most appropriate choice.

The Project Area is therefore proposed to be rehabilitated in accordance with its pre mining land capability to create a stable, undulating landscape with a mix of pasture and tree areas suitable for grazing and general habitat.

Post mining landform contours are shown on **Figure 10**. Cross sections of the proposed post mining landform are provided as **Figure 12**. The current pre-mining drainage pattern, which drains the western section of the Project Area towards Buttai Creek and the eastern section towards Four Mile Creek, will be modified by the mining process so that, during mining, all disturbed sections of the Project Area drain towards Four Mile Creek via Lake Kennerson. Contour drains, with sediment basins if required, will be incorporated into rehabilitated areas to direct the flow of clean water towards diversion drains that bypass mine water storages and drain to Four Mile Creek (refer **Section 11** for further details).

At the completion of mining in the Project Area, all infrastructure not required for the continued washery operations will be removed pursuant to the existing Commercial Lease. The landowner has, to date, requested that the major internal roads and power lines remain at the completion of mining.

Items that would remain operational include washery reject emplacement areas and the washery and its associated stockpiles and water management system components.

The staged mine plans provided as **Figures 6 to 10**, show conceptually how rehabilitation will progress as mining is completed. These plans show post-mining contours and areas to be rehabilitated. Detailed rehabilitation plans, showing specific areas to be planted with native vegetation and those areas to be seeded with grasses, will be prepared as part of the MOP process, which provides detailed mining information as the project advances.

3.7 INTEGRATION OF REHABILITATION WITH OTHER PROJECTS

The Bloomfield Project is integrated with nearby mining operations, including the Abel Mine, Donaldson Mine and Bloomfield washery. The Bloomfield Project Area is covered by the approved Abel Project Area for the integrated water management system that manages water across the Abel, Donaldson and Bloomfield projects, and for the use of the Bloomfield final voids and previous mine areas for rejects disposal from the Bloomfield washery, which form part of the Abel Project.

Open cut mining and rehabilitation on the Bloomfield Project Area does not form part of the Abel Approval. The completion of mining and rehabilitation, and associated activities required to undertake these actions is the subject of this current Application, referred to as the Bloomfield Project. Integration of the various projects is described in detail in **Section 15**.

The following describes the rehabilitation systems and plans that are approved for use or have been prepared for the various projects, and how they interact and are compatible.

The Abel Mine approval required a **Landscape Management Plan** to be prepared. This Plan was required to include a Final Void Management Plan, Integrated Mine Closure Plan and Rehabilitation Management Plan. The Landscape Management Plan, which has been approved by DoP, incorporates the Donaldson and Abel Project Areas, as these two projects share common components such as water management and some surface facilities. The Bloomfield Project Area is addressed in this Plan as follows:

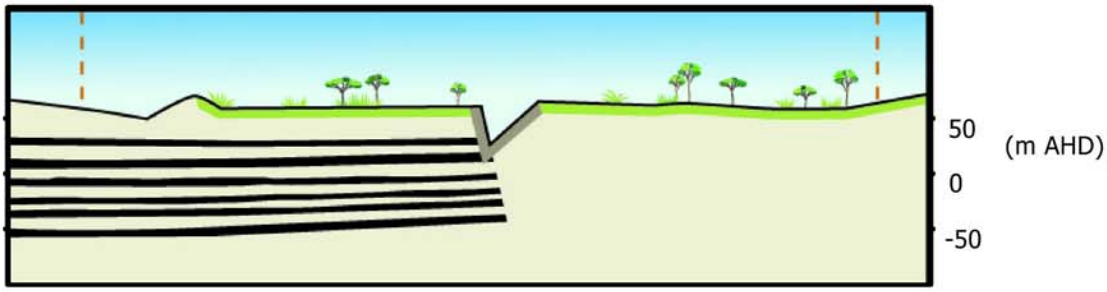
- **Final Void Management Plan** – this Plan addresses the Abel/Donaldson final void only and is not relevant to the Bloomfield Project;

- **Integrated Mine Closure Plan** – as part of the Abel Mine closure objectives, reference is made to the filling of *"former open cut areas within Bloomfield Colliery with tailings from the coal washing process…"* (GSS Environmental, 2007. p7 Section 1.5.2). The description provided is as per that quoted in **Section 3.5** of this EA. The Mine Closure Plan also refers to rehabilitation procedures for "*Domain 3: Bloomfield Colliery*" (GSS Environmental, 2007. p38, Section 8.1.3), which are the rejects disposal areas within the Bloomfield site, including the Bloomfield final void. This section states that *"While certain aspects of the Bloomfield Colliery are being utilized by Abel (ie: tailings disposal, CHPP, rail loadout, etc) the responsibility for mine closure and meeting the lease relinquishment requirements of the DPI-MR will be retained by Bloomfield."* A Closure and Rehabilitation Strategy for the relevant areas was provided by Bloomfield as part of the Integrated Mine Closure Plan.

- **Rehabilitation Management Plan –** This Plan was provided to DoP in two sections. The first was prepared by Donaldson Coal for the Abel and Donaldson project areas. The second, prepared by Bloomfield, was the **Land Rehabilitation Procedure** (which has subsequently evolved into the Land Rehabilitation Management System) for those areas of Bloomfield used for Abel Project rejects storage.

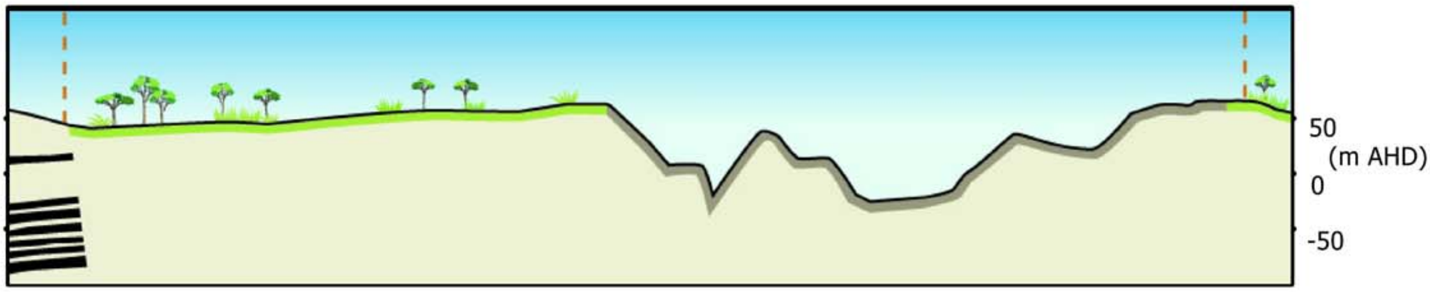
Bloomfield's LRMS provides detailed description and procedures on the current and proposed rehabilitation of the Bloomfield Colliery site. The rehabilitation aim, objectives and procedures outlined in this EA have been taken from this document, which is consistent with the rehabilitation content of Bloomfield's Mining Operations Plan.

WEST TO EAST SECTION
VERTICAL EXAGGERATION : 2 TO 1
(APPROX LENGTH OF SECTION : 1670 M)



SECTION 1

SOUTH TO NORTH SECTION
VERTICAL EXAGGERATION : 2 TO 1
(APPROX LENGTH OF SECTION : 2320 M)



SECTION 2

LEGEND

- PROJECT APPLICATION AREA
- REHABILITATION AREA
- FINAL VOID AREA
- COAL MEASURES

Refer Figure 10 for Location of Cross sections

0 500 m
HORIZONTAL SCALE

FIGURE 12

FINAL LANDFORM CROSS-SECTIONS

BLOOMFIELD COLLIERY
COMPLETION OF MINING AND REHABILITATION

SEPTEMBER 2008

4. STATUTORY PLANNING REQUIREMENTS

4.1 STATUTORY APPLICATION PROCESS

Mining operations at Bloomfield Colliery have previously been carried out pursuant to existing use rights. The introduction of Part 3A of the EP&A Act in 2005 required Bloomfield to obtain Project Approval for the Minister for Planning to continue mining and undertake site rehabilitation.

This Project, which is for the completion of mining and rehabilitation at the Colliery, is for the purpose of coal mining and is therefore classified as a Major Project under the Major Projects SEPP to which Part 3A of the EP&A Act applies. The approval of the Minister for Planning is therefore required, through DoP.

The Project Approval process under Part 3A requires a Preliminary Assessment ('PA') Report to accompany Project Applications to DoP. A PA Report for this Application was lodged with the Minister in August 2007. The PA Report included a Preliminary Risk Assessment, which identified the key issues associated with the proposed development. The Director-General of DoP subsequently issued the Environmental Assessment Requirements for the Project. These Requirements were issued on 8 October 2007 and are attached as **Appendix A**.

This EA has been prepared to comply with Part 3A of the EP&A Act, the EP&A Regulation and the Director-General's EA Requirements specific to this project.

Once the Director-General of DoP has established that the EA is adequate, the EA will be publicly exhibited for at least 30 days in accordance with EP&A Act requirements. During this time, members of the community and government agencies may provide comment on the EA. The EA and all comments submitted by the public are then reviewed. The Director-General of DoP will then prepare an Environmental Assessment Report to be submitted to the Minister for Planning. The Minister for Planning determines the Application following consideration of the Director-General's Environmental Assessment Report.

4.2 LOCAL GOVERNMENT AREA AND PERMISSIBILITY

The Project Area is located wholly within the Cessnock local government area. This area is shown on **Figure 2**. The Project Area is zoned 1(a) Rural 'A' under the *Cessnock Local Environmental Plan 1989*, which permits mining and associated surface activities with consent.

The objectives of the 1(a) Rural 'A' zone are as follows:

"(a) to enable the continuation of existing forms of agricultural land use and occupation,

(b) to ensure that potentially productive land is not withdrawn from production,

(c) to encourage new forms of agricultural land use,

(d) to enable other forms of development which are associated with rural activity and which require an isolated location, or which support tourism and recreation, and

(e) to ensure that the type and intensity of development is appropriate in relation to:

> *(i) the rural capability and suitability of the land,*
>
> *(ii) the preservation of the agricultural, mineral and extractive production potential of the land,*
>
> *(iii) the rural environment (including scenic resources), and*
>
> *(iv) the costs of providing public services and amenities."*

(Cessnock LEP, 1989)

The Project is compatible with these objectives, as it requires a relatively isolated location, enables agriculture on rehabilitated land and the land contains coal extractive production potential.

4.3 RELEVANT LEGISLATIVE REQUIREMENTS

4.3.1 Current Approvals

Current approvals held by Bloomfield include:

- Consolidated Coal Lease 761, ('CCL761'), issued 20 November 1991 and expiring 29 October 2010 – the Project Area is located wholly within CCL761. CCL761 also includes the washery and infrastructure that does not form part of this Project Application;
- Environment Protection Licence No. 000396 ('EPL 396') under the *Protection of the Environment Operations Act 1997* ('POEO Act')– issued for CCL761; and
- Notification of Dangerous Goods on Premises to WorkCover NSW, covering storage locations for distillate, petrol, lube and waste oils, gas cylinder stores and sodium hydroxide and MIBC reagent, ammonium nitrate, emulsion and blasting accessories.

Water licences (under Part 5 of the *Water Act 1912*) are currently under application. Open cut excavation, water extraction bores from old underground workings and monitoring bores will be covered by these applications. Application for the required water licences has been made under the *Water Act, 1912* rather than the *Water Management Act 2000* as the relevant Regulations for licensing under the *Water Management Act 2000* have not yet been gazetted.

An application for a licence to Store Dangerous Goods was lodged with WorkCover in May 2006.

4.3.2 Required Permits and Licences

Permits, approvals or licences that will be required for the Project include:

- approval under Part 3A of the *EP&A Act*;
- a Mining Lease from Department of Primary Industries issued under the *Mining Act 1992* for the continuing mining operations;
- an Environment Protection Licence ('EPL') under the POEO; and
- licences under the *Water Act 1912* and *Water Management Act 2000* for monitoring piezometers, groundwater extraction from the open cut bore and aquifer interference/intersection associated with open cut excavation. **Table 2** provides details of required water licences.

A mining lease issued under the *Mining Act 1992* entitles the leaseholder to mine the minerals specified in the lease. A Mining Lease will be issued by the DPI after approval has been granted by DoP.

Mining legislation specifies conditions which must be met with regard to safety, environmental management, waste disposal and payment of royalties to the State. A Mining Operations Plan ('MOP') is required as a condition of any new mining lease. Bloomfield will be required to submit Annual Environmental Management Reports ('AEMR') documenting annual environmental performance in relation to the MOP commitments. DPI regularly audits compliance with the MOP.

An EPL is required from DECC under the POEO Act as the proposal is a scheduled activity under the POEO Act. A licence is currently held and requires management within set standards and ongoing monitoring of air, water, waste and noise.

The current EPL 396 is a premise-based licence that includes the operation of the washery, rail loop and other areas that do not form part of this Project. It is considered appropriate that EPL 396 would continue, with the inclusion of any new requirements for this Project and an updated schedule of documents to make reference to this EA.

Water-related licences are detailed in the following **Table 2**. All natural catchment surface water that is captured by dams, etc on the Bloomfield site forms part of the integrated water management system approved by the Abel Project and therefore does not form part of the licensing requirements for the Bloomfield Project. Further details on water management and required licences is provided in **Section 2.9**.

Table 2 Water Management Licence Requirements

Structure/Facility	Licensing Details	Application Purpose
Groundwater monitoring piezometers located at: 1. 363804E 6370112N (Lot1/DP1045723)	All licensed under Pt 5 of the *Water Act 1912*. Licenses valid in perpetuity from 14 Oct 2008. Licence Number 20BL172024	Monitoring only
2. 365285E 6371009N (Lot1/DP982215)	Licence Number 20BL172025	
3. 366765E 6372059N (Lot1/DP995229)	Licence Number 20BL172026	
4. 367685E 6371037N (Lot4/DP11988)	Licence Number 20BL172028	
5. 366534E 6368071N (Lot44/DP755260)	Licence Number 20BL172029	
6. 365298E 6368267N (Lot36/DP755260)	Licence Number 20BL172030	
7. 364595E 6368658N (Lot35/DP722260)	Licence Number 20BL172031	
8. 363017E 6369040N (Lot18/DP755260)	Licence Number 20BL172032	
Open Cut borehole. Location: 365381E 6369267N (Lot28/DP 755260).	Under application. Licence application submitted on 12-Sep-2008.	Extraction of estimated 73ML of aquifer groundwater per annum.
Open cut excavation: initially two open cuts (S Cut and Creek Cut), merging to form a single cut in Yr 7 of project.	Under application. Licence application submitted on 12-Sep-2008.	Interception of groundwater at a rate of 1.4ML per day (averaged over life of project)

4.3.3 Commonwealth Legislation

i. Environment Protection and Biodiversity Conservation Act, 1999

The *Environment Protection and Biodiversity Conservation Act 1999* ('EPBC Act') requires the Commonwealth Minister for the Environment to approve any actions that may have a significant impact on matters of national environmental significance. These matters are:

- World Heritage properties;
- National heritage places;
- Wetlands of international importance (eg: RAMSAR wetlands);
- Threatened species and ecological communities;
- Migratory species;
- Commonwealth land and marine areas; and
- Nuclear actions (including uranium mining).

The only matter of possible relevance to the Project is threatened species and ecological communities. The Flora, Fauna and Threatened Species Assessment undertaken for this EA concluded that these matters are not of relevance in the Project Area. Therefore, approval under the EPBC Act is not required. Further detail is provided in **Appendix D**.

ii. Native Title Act 1993

The *Native Title Act 1993* is administered by the National Native Title Tribunal which is responsible for maintaining a register of native title claimants and bodies to whom native title rights have been granted. These native titleholders and claimants must be consulted prior to the granting of a mining lease over land to which the native title claim or right applies. All land within the Project Area has been assessed for possible native title claims. The land is made up of private land (owned by Ashtonfields), dedicated Crown Roads or dedicated Council Public Roads and as such is not subject to native title claim.

iii. Energy Efficiency Opportunities Act 2006

The *Energy Efficiency Opportunities Act 2006* ('EEO Act') took effect on 1 July 2006 and was amended in March 2007. It aims to improve the identification and evaluation of energy efficiency opportunities by large energy using businesses and, as a result, to encourage implementation of cost effective energy efficiency opportunities. Bloomfield registered on 31 March 2007 and has submitted an Assessment and Reporting Schedule.

In order to achieve its aim, the EEO Act requires large energy-using businesses to:

- undertake an assessment of their energy efficiency opportunities to a minimum standard to improve the way in which opportunities are identified and evaluated; and
- report publicly on the outcomes of that assessment in order to demonstrate to the community that those businesses are effectively managing their energy.

The EEO Act outlines the broad requirements for large energy using businesses, and allows for regulations to provide detailed requirements for assessment, reporting, verification and other elements of the EEO program.

The *Energy Efficiency Opportunities Regulations 2006* provide details of the EEO program's requirements. Proposed amendments in the *Energy Efficiency Opportunities Amendment Regulations 2008* aim to streamline energy use reporting with the Australian Government's National Greenhouse and Energy Reporting ('NGER') System making it easier for EEO registered companies to collect and report one set of energy use data, reducing potential duplication. Most companies will not be affected by the changes. However, for those companies that may have different sets of energy use under each scheme, the amendments will reduce the compliance burden and avoid duplicative reporting requirements. The amendments commenced on 1 July 2008, to coincide with the commencement of the NGER System.

iv. National Greenhouse and Energy Reporting Act 2007

The *National Greenhouse and Energy Reporting Act 2007* ('NGER Act') establishes a national framework for Australian corporations to report greenhouse gas emissions, reductions, removals and offsets, and energy consumption and production, from 1 July 2008. The NGER Act requires corporations that control facilities emitting 25 kilotonnes (25,000 tonnes) or more of greenhouse gas (CO_2 equivalent) per year to register and report their greenhouse gas emissions. The greenhouse gas assessment for the Project predicted that Bloomfield will exceed the threshold amount and is therefore required to register the site and report greenhouse gas emissions. This requirement is discussed further in **Section 2.9** and in the air quality assessment in **Section 10**.

4.3.4 NSW Legislation

In addition to the EP&A Act, various other items of legislation have been referred to in the assessment of potential impacts, or are required to be addressed at some stage of the Project. Where relevant to the planning process, the legislation has been addressed in the studies undertaken for each key issue.

Relevant legislation includes:

- *Threatened Species Conservation Act 1995*;
- *Threatened Species Conservation Regulation 2002*;
- *National Parks and Wildlife Act 1974*;
- *Environmentally Hazardous Chemicals Act 1985*;
- *Occupational Health and Safety Amendment (Dangerous Goods) Act 2003*;
- *Coal Mine Health and Safety Act 2002*;
- *Local Government Act 1993*;
- *Roads Act 1993*;
- *Water Management Act 2000*;
- *Water Act 1912*;
- *Native Vegetation Act 2003*;
- *Protection of the Environment Operations Act 1997*;
- *Mining Act 1992*;
- *Protection of the Environment Operations Amendment (Scheduled Activities and Waste) Regulation 2008*;
- *Occupation Health and Safety Act 2000*; and
- *Heritage Act 1977*.

4.3.5 Hunter Regional Environmental Plan 1989

Hunter Regional Environmental Plan 1989 ('HREP 1989'), which helps to guide development in the Hunter Region, has the following goals:

- *'To promote the balanced development of the region, the improvement of its urban and rural environments and the orderly and economic development and optimum use of its land and other resources, consistent with conservation of natural and man-made features and so as to meet the needs and aspirations of the community;*
- *To coordinate activities related to development in the region so there is optimum social and economic benefit to the community; and*
- *To continue to strive for a regional planning process that will serve as a framework for identifying priorities for further investigations to be carried out by the DoP and other agencies.'*

With regards to the HREP, the Project:

- occurs within the footprint of existing mining developments;
- is unlikely to increase the environmental impact of the existing operations;
- will result in continued economic benefit for the Hunter Region; and
- is consistent with the objectives of the HREP.

4.3.6 Hunter Regional Environmental Plan 1989 (Heritage)

The general aims and objectives of this plan are:

- To conserve the environmental heritage (including the historic, scientific, cultural, social, archaeological, architectural, natural and aesthetic heritage) of the Hunter Region;
- To promote the appreciation and understanding of the Hunter Region's distinctive variety of cultural heritage items and areas including significant buildings, structures, works, relics, towns, precincts and landscapes; and
- To encourage the conservation of the Region's historic townscapes which contain one or more buildings or places of heritage significance or which have a character and appearance that is desirable to conserve.

While the Plan applies to land within the Project Area, no items within the Project Area were listed as heritage items on its Schedules.

4.4 RELEVANT POLICIES AND GUIDELINES

4.4.1 Policies and Guidelines Used in Project Impact Assessment

Various policies and guidelines have been referred to in the preparation of this EA including:

- Management of Stream/Aquifer Systems in Coal Mining Developments (DIPNR, 2006);
- Guidelines for Fresh and Marine Water Quality (ANZECC);
- Managing Urban Stormwater: Soils and Construction (Landcom);
- NSW State Rivers and Estuaries Policy;
- NSW Wetlands Management Policy;
- State Groundwater Policy documents – various (DNR);
- NSW Industrial Noise Policy (EPA, 2000);

- Environmental Criteria for Road Traffic Noise (DEC);
- Environment Noise Control Manual (DEC);
- Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (DEC);
- Threatened Species Assessment Guidelines (DECC, 2007);
- NSW Groundwater Dependent Ecosystem Policy (DNR);
- Draft Guidelines for Aboriginal Cultural Heritage Assessment and Community Consultation (DEC); and
- Environmental Guidelines: Assessment and Classification and Management of Liquid and Non-Liquid Wastes (EPA, 1999).

4.4.2 State Environmental Planning Policies

State Environmental Planning Policies (SEPPs) that are relevant to the Project are:

- SEPP (Mining, Petroleum Production and Extractive Industries) 2007;
- SEPP (Major Projects) 2005;
- SEPP 33 - Hazardous and Offensive Development; and
- SEPP 44 – Koala Habitat Protection.

SEPP (Mining, Petroleum Production and Extractive Industries) 2007 is also referred to as the Minerals SEPP. It was gazetted on 16 February 2007. It repealed SEPP 37 – Continued Mines and Extractive Industries and SEPP 45 – Permissibility of Mining. The SEPP removed mining developments from Schedule 1 of SEPP 11–Traffic Generating Development. SEPP 11 has been repealed by *State Environmental Planning Policy (Infrastructure) 2007* which commenced on 1 January 2008.

The Minerals SEPP aims to:

- Provide for the proper management and development of mineral, petroleum and extractive material resources for the purpose of promoting the social and economic welfare of the State;
- Facilitate the orderly and economic use and development of land containing mineral, petroleum and extractive material resources; and
- Establish appropriate planning controls to encourage ecologically sustainable development through the Environmental Assessment, and sustainable management of the development of mineral, petroleum and extractive material resources.

With regards to mining, the Minerals SEPP outlines where various minerals activities are permissible both with and without development consent. The Minerals SEPP also defines mining developments that are prohibited, exempt or complying developments. These provisions do not affect the requirement for approval under Part 3A of the EP&A Act for the Project.

SEPP (Major Projects) 2005 identifies and provides the framework for major projects and the Part 3A process. The Project follows the Part 3A process.

SEPP 33 Hazardous and Offensive Development requires consideration of whether an industrial proposal is a potentially hazardous or a potentially offensive industry. A potentially hazardous industry is defined as a development that

> *'would pose a significant risk in relation to the locality:*
>
> *(a) to human health, life or property, or*
>
> *(b) to the biophysical environment,*
>
> *and includes a hazardous industry and a hazardous storage establishment'(Clause 3).*

A potentially offensive industry is defined as a development that:

> *'would have a significant adverse impact in the locality or on the existing or likely future development on other land, and includes an offensive industry and an offensive storage establishment' (Clause 3).*

Section 2.11 details the existing management procedures for fuels and other hazardous materials. An EPL will be obtained for the Project. DoP's Guidelines for Hazardous and Offensive Development (DoP, 1994) states that *'typically, the level of offence would not be considered significant if relevant EPA licences can be obtained'.* Therefore, it is considered that the Project is not considered to be an offensive industry.

SEPP 44 – Koala Habitat Protection applies to all LGAs listed in Schedule 1 of the SEPP, and restricts a Council from granting development consent on land identified as core koala habitat without the preparation of a plan of management. As Cessnock LGA is listed in Schedule 1 of the SEPP, the SEPP is relevant to this Project and is addressed in **Section 7**.

SEPP 44 requires that, for proposals on properties involving 1 hectare or more, the habitat should be evaluated for potential Koala Habitat and core Koala Habitat. A koala habitat assessment was completed as part of the Flora, Fauna and Threatened Species Assessment for this Project. Although it found the Koala feed tree species *Eucalyptus punctata* to be present, it did not constitute at least 15% of the tree species. Therefore, the assessment concluded that no core koala habitat was identified within the Project Area (refer to **Section 7**) and a Koala Management Plan is not required.

4.4.3 Lower Hunter Regional Strategy

The Lower Hunter Regional Strategy, prepared by DoP (2006), is a land use planning document that outlines the provision of sufficient, appropriately placed housing and employment land to cater for the Region's predicted growth over the next 25 years. The strategy is based on population growth projections forecasting an additional 160,000 people in the Region by 2031.

The Project Area lies on land which the Lower Hunter Regional Strategy identifies as part of land a '*future freight hub and employment lands*'. This land is shown on **Figure 13**. It will provide an opportunity for the storage, transfer and distribution of containerised freight and associated employment. At a community briefing held by Newcastle Council in 2006, the freight hub was described as an '*inter-modal freight facility*'. Discussions regarding the final land use for the site are an ongoing part of the Project and are being held between Bloomfield, the land owners and the relevant government agencies during the EA process. Rehabilitation of the Project Area as described in **Section 3** will enable future development of the Project Area consistent with this Strategy.

4.4.4 Draft Lower Hunter Regional Conservation Plan

This draft Plan (DEC 2006) sets out a 25-year program to direct and drive conservation efforts in the Lower Hunter Valley. It is a partner document to the Lower Hunter Regional Strategy (**Section 4.4.3**) and sets out the full range of Government planning priorities and identifies proposed areas for growth. The draft Plan includes announcements of significant Government conservation decisions and also seeks feedback on remaining key implementation and longer-term design issues.

The backbone of the major new conservation corridors identified in the Plan will be the new reserves formed by the dedication of private land considered to be of high conservation value lands. The most significant of these is the Watagan Ranges to Port Stephens proposal, which provides a highly significant link between southern sandstone ranges and the coastal heaths and wetlands of Port Stephens.

The Plan identifies private land for dedication into this corridor south of John Renshaw Drive and east of George Booth Drive. Final land use determinations for the Project Area will take this Plan into consideration. The rehabilitation strategy for this Project, to return the site to a rural character with tree and pasture areas, does not conflict with adjacent land use and vegetation type to the south. The ability and effectiveness of the proposed Green Corridor as referred to in the draft Plan is unlikely to be adversely affected by the proposed rehabilitation strategy for the Project Area.

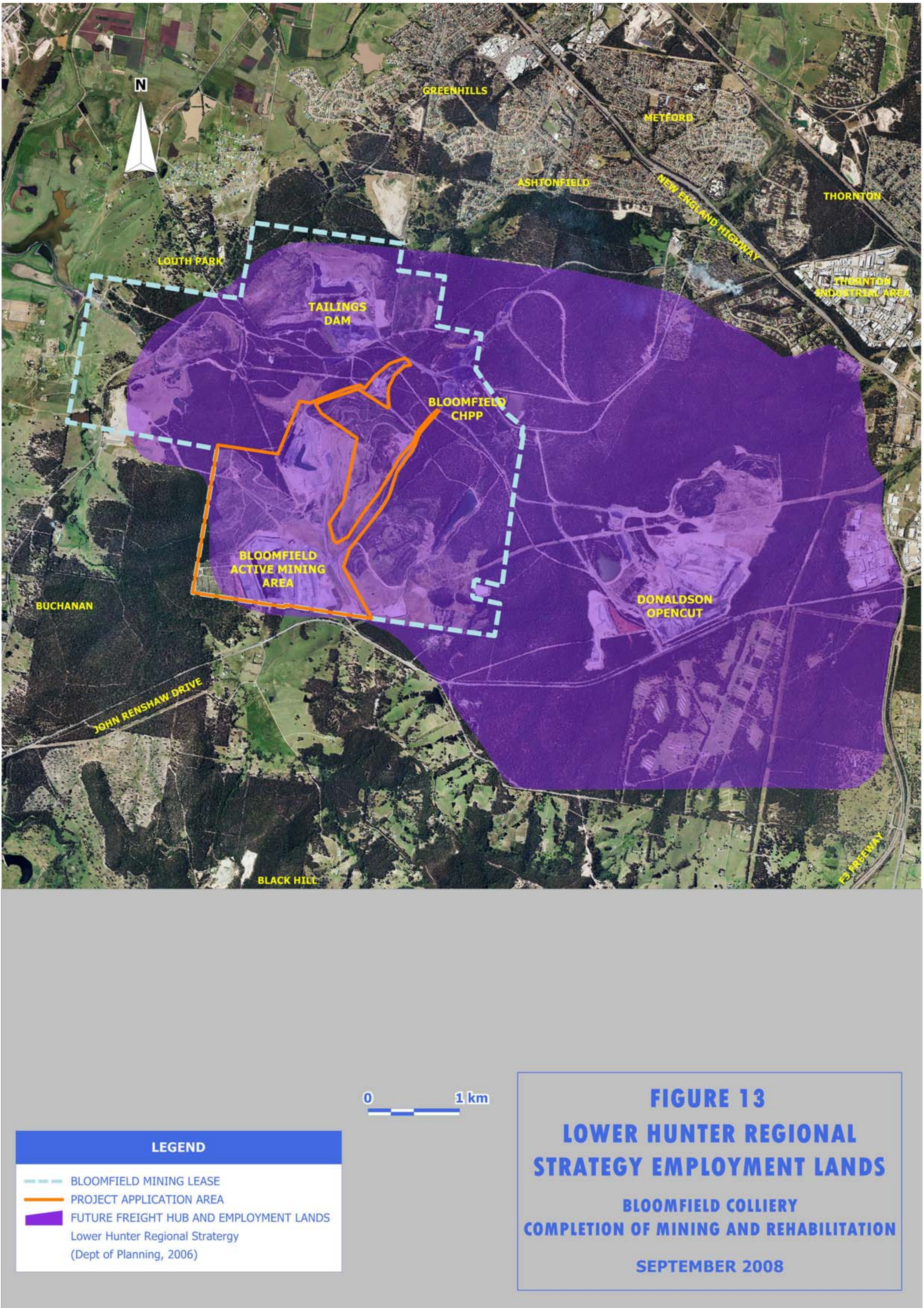


FIGURE 13
LOWER HUNTER REGIONAL STRATEGY EMPLOYMENT LANDS
BLOOMFIELD COLLIERY
COMPLETION OF MINING AND REHABILITATION
SEPTEMBER 2008

4.4.5 Hunter and Central Coast Regional Environmental Management Strategy

The Hunter and Central Coast Regional Environmental Management Strategy ('HCCREMS') is a regional initiative being implemented through the collaborative efforts of fourteen Councils in the Hunter, Central and Lower North Coast of NSW. It seeks to facilitate a regional approach to Ecologically Sustainable Development ('ESD') by actively encouraging greater co-operation between member Councils, State and Federal authorities, industry and community groups. HCCREMS has become widely regarded as a model approach to integrating local government planning and environmental management at the regional level. HCCREMS:

- provides a framework for coordinated action in relation to environmental management issues impacting on the region;
- addresses those environmental and natural resource issues that are best managed at a regional scale (e.g. biodiversity conservation and water quality management are key issues which require a broad management approach that transcends arbitrary institutional boundaries); and
- facilitates regional partnerships and resource sharing to address key environmental management issues in a coordinated, pro-active and efficient manner.

The Regional Biodiversity Conservation Strategy is a unique and multi-faceted project of HCCREMS. It aims to develop a strategy and implementation plan to protect the natural, biological diversity of the Lower Hunter & Central Coast in order to maintain existing ecological processes for future generations. This plan will provide a framework for enhancing the integration of biodiversity information into current and future land use planning processes, thereby providing greater certainty to land managers.

The document produced as part of HCCREMS, *Vegetation Survey, Classification and Mapping Lower Hunter and Central Coast Region* (NPWS 2000), has been incorporated in the Ecology Assessment (**Appendix D** and **Section 7**).

4.4.6 Hunter-Central Rivers Catchment Action Plan

The Hunter-Central Rivers Catchment Action Plan ('CAP') (HCRCMA, 2007) builds on the work of the Catchment Blueprints for the Central Coast, Hunter and Lower North Coast, which were endorsed by the NSW Government in February 2003. The CAP is a guide to protecting and improving the region's natural resources over the next 10 years and has been developed in consultation with local communities. It focuses on five natural resource management areas for protection and improvement namely; biodiversity, aquatic health, soils, estuarine health and marine health. Investigation of these areas for this EA demonstrates that the Project will not conflict with these priorities.

4.4.7 Wallis and Fishery Creek Total Catchment Management Strategy

The primary objective of this Total Catchment Management Strategy ('TCM Strategy') is to define issue specific strategies for the Wallis and Fishery Creek catchments to improve the health of the catchment. The TCM Strategy accommodates community attitudes and priorities, and identifies appropriate mechanisms to resolve issues confronting the future management of the catchments, including the sustainability of current land uses. The TCM Strategy Committee is responsible for implementing the TCM Strategy's recommendations. Committee members have been briefed on the Project and the objectives of the TCM Strategy have been considered in the development of mine plans, water management and rehabilitation objectives.

4.4.8 Draft Water Sharing Plan for Hunter Unregulated and Alluvial Water Sources

Water Sharing Plans are progressively being developed for rivers and groundwater systems with the introduction of the *Water Management Act 2000* ('WMA'). These plans provide a legal basis for sharing water between the environment and consumptive uses. They will provide water users with greater certainty over future access to water and increased trading opportunities.

The draft Plan for Hunter Unregulated and Alluvial Water Sources is currently being finalised. Bloomfield will conduct mining operations in accordance with the draft Plan once finalised. Once it commences, the licensing provisions of the WMA will also take effect in the Plan area. Existing *Water Act 1912* licences will be converted into access licences and water supply works and water use approvals under the WMA.

Under the WMA, extraction of water for basic domestic and stock rights from a river fronting a landholder's property or from groundwater underlying the property (known as basic landholder rights) does not require a water access licence. For groundwater extraction, DWE must still approve the bore. DWE is also developing a regulation to limit extractions under basic landholder rights to a reasonable volume. All other water extraction must be authorised under a water access licence.

Bloomfield Colliery lies within the Wallis Creek Water Source in the Hunter Extraction Management Unit of the Plan. Bloomfield currently operates eight monitoring bores and one extraction bore. Bores will be licensed as required as detailed in **Section 12**.

4.4.9 Thornton-Killingworth Sub-Regional Conservation and Development Strategy

This Strategy (Parsons Brinckerhoff, 2003) covers the interface area between the local government areas of Lake Macquarie, Newcastle, Maitland and Cessnock and includes the Project Area. The Strategy aims to *'identify important areas of conservation, map physical constraints to development, develop a summary of constraints and factors for consideration for possible new development areas and identify strategic directions for the area.'*

The Strategy notes that there is potential for open cut mining around John Renshaw Drive and George Booth Drive. The Project will not interfere with the Strategy objectives.

5. CONSULTATION

5.1 CONSULTATION OBJECTIVES

Consultation with government authorities and the local community has been undertaken throughout the planning phase for the Completion of Mining and Rehabilitation at Bloomfield. The objectives of the consultation program were to:

- Fully inform the local community about the proposal and address and include any community concerns in the Environmental Assessment;
- Provide technical information to the local community using methods that could be clearly understood and provide a forum for open questions and dialogue; and
- Involve government authorities, including Department of Primary Industries, Department of Planning, Cessnock and Maitland City Councils, in the planning process to best address their key considerations in project planning.

5.2 COMMUNITY CONSULTATION

A community consultation program was developed early in the Project to inform the surrounding community of the Project and involve them in the consideration of issues. This ongoing program includes the following elements:

- A **community focus group** was formed with representatives from the local community. This group, facilitated by an independent consultation specialist, had its first meeting on 18 April 2007 and subsequently four meetings have been held. These meetings presented the Project to the group and discussed the Project and mine matters generally. The group was also provided with presentations by specialist consultants on subjects such as risk assessment and the planning process and undertook a site inspection. The focus group included representatives from areas surrounding the mine site, including Buttai, Black Hill, Buchanan, Louth Park and Ashtonfield. Attendees were encouraged to discuss information provided at the meetings within their local communities and to suggest other members of their community who may have be interested in attending. Additional community members who expressed interest in attending were able to attend to hear presentations.
- **Mine management door knocked residences** surrounding the mine. If residents were home, the Project was discussed and any environmental impact concerns noted. Where residents were not home, a newsletter and mine contact details were left.

- A **newsletter** detailing the Project was left at each door-knocked residence with a note from the Bloomfield management encouraging them to contact the mine if they had any queries about the Project. Approximately 300 newsletters were distributed. Of these, 70 were given directly to residents with the remainder left in letter boxes.
- Occupants of unattended residences were encouraged to contact Bloomfield if they had any concerns regarding the Project. As a result, **16 meetings or telephone conversations with residents** occurred to discuss the Project and the application process. A record of these meetings is provided in **Appendix B**. Briefings and information have also been provided to individuals and organisations as requested throughout the planning phase.
- **Presentations** to the following organisations or community representatives:
  - Wallis, Fishery and Four Mile Creeks Catchment Management Forum (part of Hunter-Central Rivers Catchment Management Authority);
  - The Catholic Diocese of Newcastle-Maitland;
  - Donaldson Mine management;
  - Chris Parker – Greens candidate for Cessnock City Council; and
  - Ashtonfields Pty Limited.
- A new Bloomfield **website** was developed to provide information about the Project and its application process. The website address is www.bloomcoll.com.au.

Community feedback has generally been positive and interested in the process to complete mining and site rehabilitation. The community raised issues relating to past and existing operations, in particular blasting, air quality, visual impact and the proposed final land use options. Some residents were unaware of the mine and/or had minimal interest in its operations.

5.3 GOVERNMENT CONSULTATION

Authority consultation for the Project has included:

- Meetings with DPI in March and September 2007;
- Presentation to Cessnock City Council in April 2007;
- Presentations to Maitland City Council in April, May and June 2007;
- Discussions with NSW DoP Sydney and Newcastle throughout 2007 and 2008; and
- Meeting and site inspection with NSW Department of Water and Energy in September 2007.

6. IDENTIFICATION OF KEY ISSUES AND ENVIRONMENTAL ASSESSMENT

6.1 RISK IDENTIFICATION PROCESS

The Project Application and Preliminary Assessment lodged with the Department of Planning on 8 August 2007 identified the likely environmental issues through application of a risk analysis process. A Preliminary Risk Assessment was developed for the Project and risk values were allocated to all proposed aspects of the mine and potential impacts.

The risk assessment (**Appendix C**) was developed using the *Risk Management Guidelines Companion to AS/NZS 4360:2004* (Standards Australia, 2004). It provides the preliminary screening of potential environmental impacts to identify those impacts that have higher levels of risk and those impacts unlikely to result in significant risks to the environment. As such the risk assessment establishes the following:

- It provides an objective, informed basis for the identification of key issues, which are further examined in detail in the Environmental Assessment ('EA').
- It provides an objective basis for the identification of issues unlikely to result in significant risks to the environment and hence issues which are not further examined in detail in the EA.
- It enables the EA to quickly focus on key issues relevant to the decision making process, rather than resulting in an EA that accords the same level of attention to key and non-key issues, with often key issues obscured.
- It enables the EA to be a briefer and more succinct document without limiting its scientific credibility.
- It provides an EA more readily understandable to and capable of being appreciated by community stakeholders.
- It ensures the EA is a decision making tool rather than a catalogue of facts regarding a project, irrespective of their relevance to decision making.
- In using the abovementioned risk assessment methodology, it establishes a transparent basis for identification of key issues.

The Preliminary Risk Assessment was considered by DoP and other relevant agencies when establishing the Director-General's Requirements for the EA. This step provides a further level of confidence that the identification of key issues following the risk assessment is robust and independent. After completion of the detailed technical studies required determining potential impact assessment of the Project, the Preliminary Risk Assessment was re-examined and new controls included in the risk tables. The Risk Assessment Ratings were then modified as required to provide a final risk assessment rating for each activity.

The risk assessment process involved the following main steps:

- Establishment of the context for the risk assessment process;
- Identification of environmental risks;
- Analysis of risks;
- Evaluation of risks to determine significant issues;
- Consideration of significant issues and potential controls; and
- Re-evaluation of risks to determine a final risk rating for each activity.

After identifying each aspect of proposed operational works, an Environmental Risk Rating was applied to each aspect. This Risk Rating was based on Environmental Consequence Descriptions (Catastrophic, Major, Moderate, Minor, Insignificant) together with a 5 level probability rating for each aspect. This process provided an overall Risk Rating for each aspect, categorised as High, Medium or Low Risk.

For each Project aspect, three separate scenarios were then considered:

- No controls – which is a measure of 'raw' risk associated with an activity, or what may occur if no controls or mitigation measures are in place;
- Current controls – where applicable, as many aspects are already controlled as part of the environmental management of Bloomfield Mine; and
- Proposed controls – which were determined by the working group to form part of the proposed development, for example, a bund, diversion, mining method or management plan.

The Environmental Risk Register developed from the above process showed that many aspects of the proposed development, even with no controls, would be low or medium risk. Low Risk is categorised as 16 to 25 in the classification system. Controlled risk associated with Project aspects ranged from 17 to 24.

The Environmental Risk Assessment process was used to focus on key issues where the risk of environmental impact was considered higher. Although, after implementation of controls, all aspects were categorised as low level risk, focus was directed to those aspects that, without controls, presented a higher level of risk. After the completion of detailed technical studies that also included recommendations for further reduction of potential risks, the risk assessment was again reviewed and updated, and the risk rankings for key issues revised where appropriate. The outcome of this risk assessment concludes that with the mitigation and remediation measures proposed in this EA the Project has a low risk ranking for all key issues.

6.2 IDENTIFICATION OF KEY ISSUES

Key issues identified from the Risk Assessment process for further investigation were identified as:

- Those items that remain as a medium risk after implementation of controls (Nil items);
- Those items that were identified as High risk prior to implementation of controls; and
- Those items where risk categorisation required further investigation to confirm potential impact.

The Director-General's Requirements for the EA, together with the Environmental Risk Assessment process, identified the key issues for assessment as:

- Flora and Fauna;
- Heritage (both Aboriginal and non-Aboriginal);
- Surface and Ground Water;
- Integrated Management (with neighbouring mines);
- Rehabilitation, Post mining landform and Final Void Management;
- Noise;
- Blasting and Vibration;
- Air Quality;
- Greenhouse Gases; and
- Social and Economic.

As a result of preliminary community consultation, visual aspects were also included in the list of key issues.

Each of these key issues is assessed in detail in the following Chapters. After completion of the assessment studies for key issues, the risk register and risk ratings were reviewed to determine whether the risk ratings had increased or decreased as a result of detailed investigation. The risk rating allocated to a proposed activity after consideration of detailed studies and proposed management and mitigation measures is referred to as the 'residual risk'.

6.3 ASSESSMENT OF RESIDUAL RISK

In order for an aspect of the operation to be acceptable, the minimum requirement adopted for the Project was that the residual environmental risk should be a low level risk after additional impact assessment and implementation of the recommended controls was considered. Initially where a low level risk could not be achieved, additional controls were applied. In a number of cases this was achieved by adopting the controls already in place and documented (or proposed as amendments) to the proposed/existing Environmental Management Plans for the Bloomfield Mine (refer **Section 2.8**) or Integrated Management Plans with other mines including Abel, Donaldson and Tasman Mines (refer **Section 2.12**).

Where existing controls did not address the identified environmental impact, or where it was considered a low level residual risk could not be obtained through implementation of existing controls, additional controls were proposed by the specialist studies undertaken to assess specific impacts. These additional controls are in the draft Statement of Commitments (**Section 18**). For example, environmental risk associated with blasting vibration, if no controls were proposed, was considered generally to be a high risk. When controls are introduced, risk associated with all aspects, including blasting vibration, reduces to low.

After completion of the assessment studies for key issues, the risk register and risk ratings were reviewed and updated to determine whether the risk ratings had increased or decreased as a result of the detailed investigation undertaken for the EA. The risk rating allocated to a proposed activity after consideration of detailed studies and proposed management and mitigation measures is referred to as the 'residual risk' (a measure of the remaining environmental risk once appropriate controls and mitigation strategies have been applied).

All aspects of the proposal following assessment and implementation of appropriate controls as identified in the draft Statement of Commitments are categorised as having a 'low environmental risk' and considered acceptable. The draft Statement of Commitments provides a system whereby the key issues for the Project will be subject to various plans of management. Such plans provide for appropriate monitoring of these issues and various trigger levels which will require further action if the monitoring demonstrates impacts greater than those outlined in this EA.

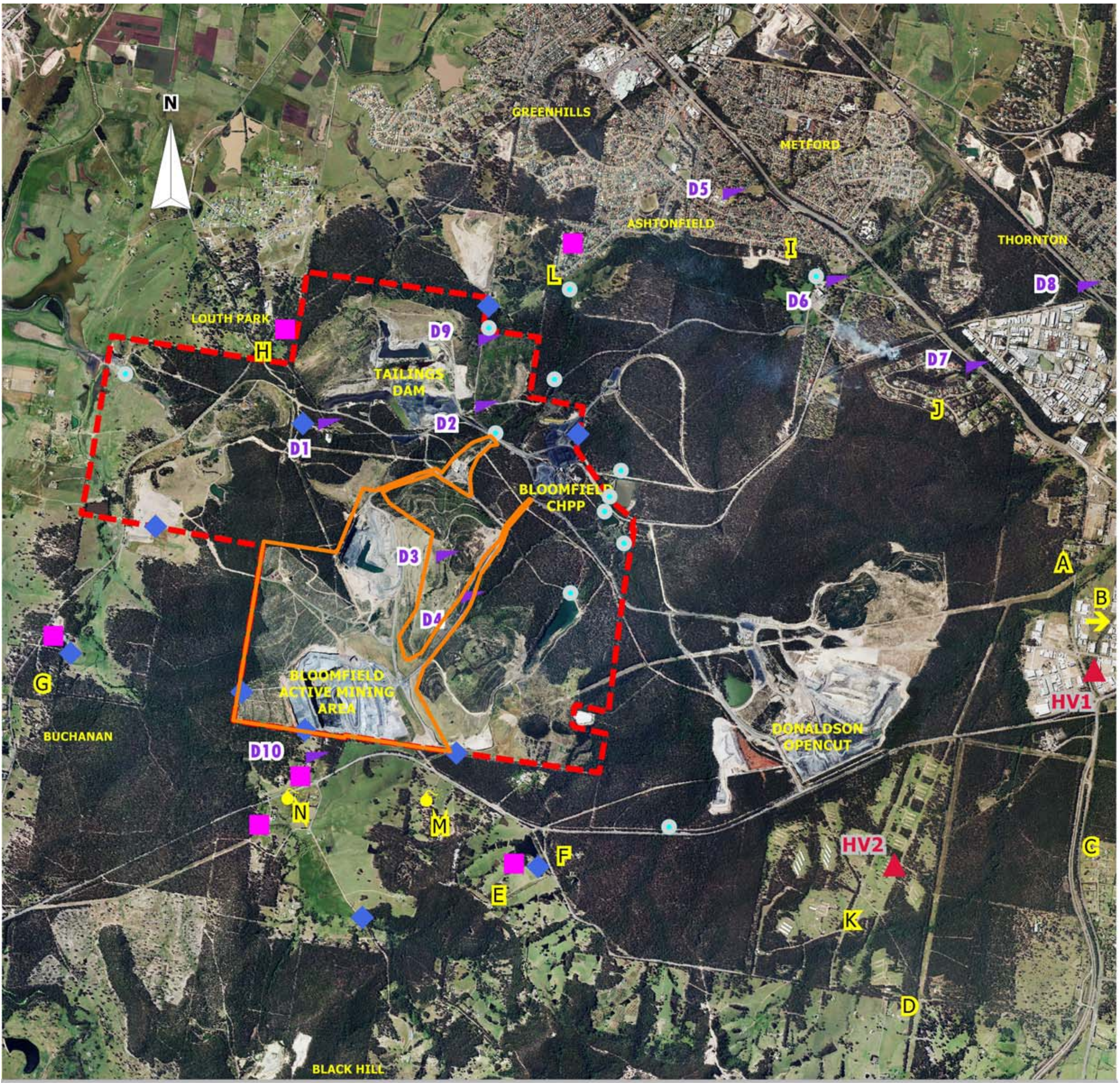
6.4 INTRODUCTION TO DETAILED ASSESSMENT STUDIES

All items identified as key issues were investigated in detail by specialist consultants with expertise in the assessment and management of these particular issues. Their detailed assessment studies are provided as Appendices to this EA. The following chapters provide a summary of each of the studies, with reference to the relevant Appendix where required for more detail. Some of the studies required monitoring to be undertaken to collect baseline data that could be used in the assessment of potential impact. The locations selected for monitoring or assessment purposes around the Project Area are shown on **Figure 14**. Visual impact assessment locations are provided on **Figure 20**.

The proposed description of the mining operation, together with mine equipment, methods and other relevant information was provided to the consultants. Minor changes to the mine plans were developed over the assessment timeframe and these were provided to the specialist consultants who then amended their studies as required. The final risk assessment was undertaken after receipt of all technical studies, to determine the final residual risk of the Project.

The various technical studies have used terminology and staging in their studies that may vary according to the needs of the assessment being undertaken, which in some cases included computer modelling of representative stages. While some studies have used representative years in their modelling, these representative years have been termed either 'years' or 'stages'. To assist understanding of the various studies, the following describes which mine stages correspond with years provided by the studies:

- **Stage 1** represents the current situation of mining at Bloomfield, ie: Year 1;
- **Stage 2** represents approximately Years 1 to 5 of mining;
- **Stage 3** represents approximately Years 5 to 7 of mining;
- **Stage 4** represents approximately Years 7 to 10 of mining, with some specialist studies including rehabilitation in this stage. The air quality study refers to this stage as Year +10; and
- **Stage 5** is the post-mining rehabilitation stage, after mining has been completed. This represents approximately Years 10 to 12. Some specialist studies include this stage in their Stage 4, or refer to it simply as 'post-mining' or 'rehabilitation stage'.



LEGEND

- BLOOMFIELD MINING LEASE
- PROJECT APPLICATION AREA
- NOISE MONITORING
- PIEZOMETERS
- WATER MONITORING
- D1 DUST MONITORING
- BLAST MONITORING
- A REPRESENTATIVE RESIDENCES
- HV1 HIGH VOLUME AIR SAMPLING

0 1 km

FIGURE 14
MONITORING AND ASSESSMENT LOCATIONS

BLOOMFIELD COLLIERY
COMPLETION OF MINING AND REHABILITATION

SEPTEMBER 2008

7. ECOLOGY

7.1 INTRODUCTION

The Flora, Fauna and Threatened Species Assessment undertaken by *EcoBiological* is provided as **Appendix D**. The following provides a summary of the report identifying and describing existing flora and fauna species and communities on and surrounding the Project Area, including the conservation significance of species, communities and habitats on site. SEPP 44–Koala Habitat Protection and the requirements of Section 5(a) of the EP&A Act with regard to threatened species, populations, and ecological communities, and their habitats, are also addressed.

The investigation focused on two areas of vegetation, each approximately 9 hectares, of which approximately 1.7 hectares of vegetation will be cleared for the Project. The Assessment concludes that there would be minimal impact on flora, fauna, threatened species or Endangered Ecological Communities.

The requirements of the following legislation were considered in the preparation of this assessment:

- *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* ('EPBC Act');
- NSW *Threatened Species Conservation Act 1995* ('TSC Act');
- NSW *Threatened Species Conservation Regulation 2002*;
- NSW *National Parks and Wildlife Act 1974* ('NP&W Act');
- NSW *Environmental Planning and Assessment Act 1979* ('EP&A Act'); and
- NSW SEPP 44 Koala Habitat Protection.

The assessment methods used are consistent with the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI 2005) and *Threatened Species Survey and Assessment: Guidelines for Developments and Activities* (working draft DEC 2004). Under the EA provisions of the EPBC Act, actions that are likely to have a significant impact on a matter of national environmental significance are subject to an assessment and approval process. Action includes any project, development, activity, or series of activities. The Act identifies seven matters of national environmental significance as:

- World Heritage properties;
- National heritage places;

- Wetlands of international importance (Ramsar wetlands);
- Threatened species and ecological communities;
- Migratory species;
- Commonwealth marine areas; and
- Nuclear actions (including uranium mining).

7.2 SURVEY METHODS

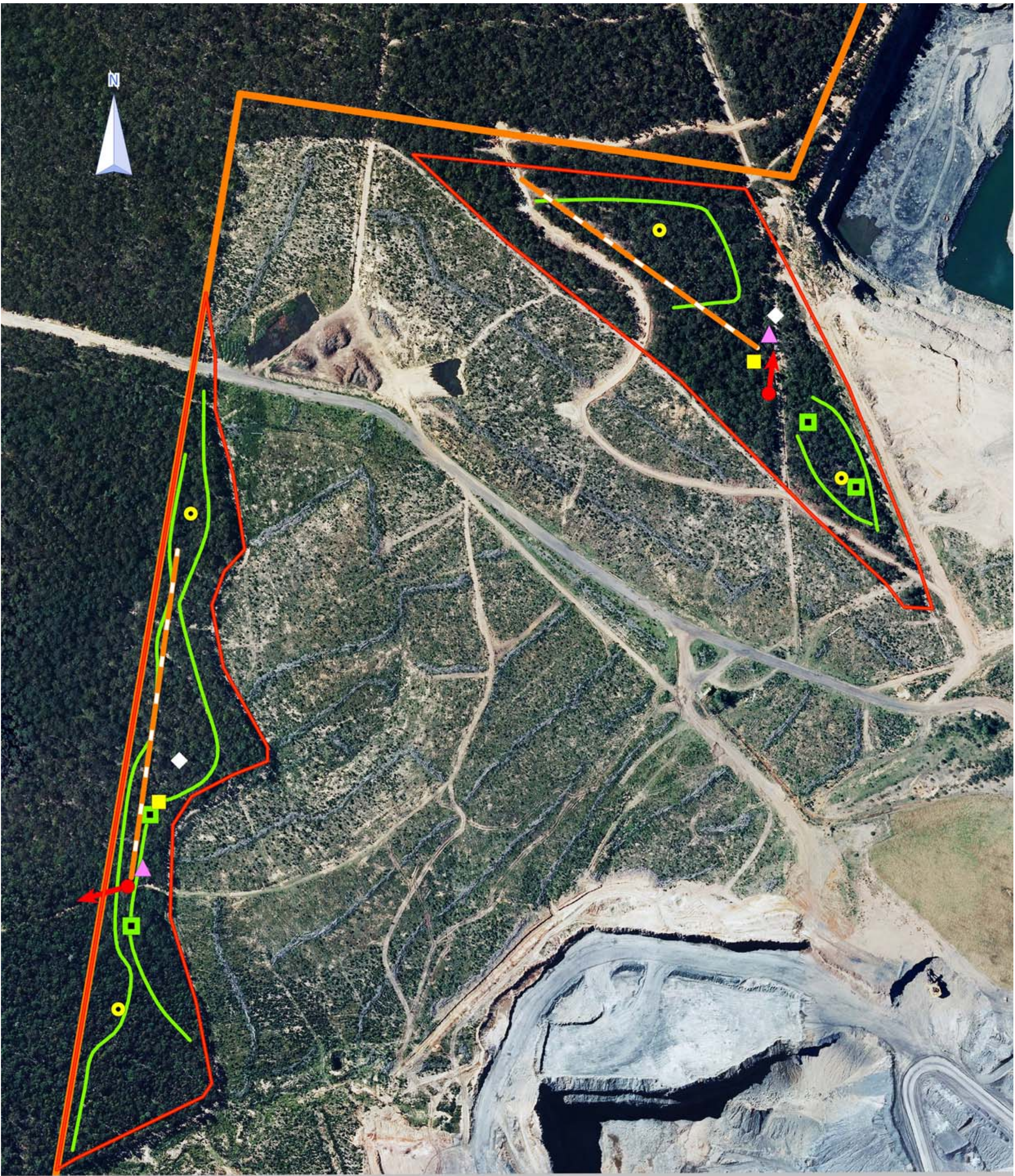
7.2.1 General

Table 3 lists the survey methodology for each survey target. These methods are detailed in **Appendix D**. Flora and flora survey locations are shown on **Figure 15.**

Table 3 Survey Methodology

Target	Survey Methods
Arboreal Mammals	• Spotlighting from dusk for 3 hours; • Trapping over four day and night period; and • Diurnal inspection of tree hollows.
Terrestrial Mammals	• Spotlighting from dusk for 3 hours; • Trapping over four day and night period; and • Diurnal searches for the presence of fauna activity such as diggings, scats or scratch marks.
Bats	• Bat surveys (using Anabat).
Birds	• Diurnal survey using visual and call identification; • Opportunistic diurnal sightings; and • Nocturnal aural survey and search for owl pellets.
Amphibians	• Diurnal dip netting and visual searches; • Aural survey; and • Nocturnal spotlighting.
Reptiles	• Funnel traps; and • Diurnal suitable habitat inspection for occupancy, scats or other detectable traces.
Habitat Hollows	• Diurnal hollow survey to assess the number and size of

Target	Survey Methods
	hollows present; and • If hollows present, visual survey at dusk to determine use.
Flora	• Systematic transect searches (improved likelihood of finding rare or threatened species); and • Standard 0.04 ha floristic plots placed in a representative part of each community.
Vegetation Community Type Determination	• Ground-truthing of previous mapping; and • Using GPS to determine community boundaries.



LEGEND

- Project Application Area
- Investigation area boundaries
- Floristic transect
- Mammal trapping transects
- Floristic plot
- Harp trap
- Reptile trap locations
- Owl call-playback location
- Anabat recording and direction
- Bird survey locations

0 200 m

FIGURE 15

ECOLOGY SURVEY LOCATIONS

BLOOMFIELD COLLIERY
COMPLETION OF MINING AND REHABILITATION

SEPTEMBER 2008

7.2.2 Threatened Species, Endangered Ecological Communities and Key Threatening Processes

Table 4 lists the results of a search of the NPWS Atlas of NSW Wildlife for threatened species and endangered ecological communities recorded within 5 km of the Project Area. Based on the habitat requirements of these species, the likelihood of any of the reported threatened species occurring on the site or using the habitat of the site as an essential part of a foraging range was determined. A field survey was then conducted using the list as a guide to species likely to occur on the site. The survey was expanded to include any species listed on Schedules 1 and 2 of the TSC Act considered likely to occur in the type of vegetative habitat present on the site. This information was used to narrow the initial list to determine for which species an impact assessment was required. The likelihood of any 'key threatening processes' occurring on the subject site was also assessed.

Table 4 The Likelihood of Threatened Flora and Fauna Species Recorded Within 5 km Occurring on the Subject Site.

Scientific Name	Common Name	Likelihood of being found on the subject site	Impact assessment required?
Acacia bynoeana	Bynoe's Wattle	Not likely-unsuitable habitat	No
Eucalyptus parramattensis decadens	Drooping Redgum	Not likely-unsuitable habitat	No
Grevillea parviflora	Small-flower Grevillea	Not likely-unsuitable habitat	No
Tetratheca juncea	Black-eyed Susan	Not likely-unsuitable habitat	No
Phascolarctus cinereus	**Koala**	**Likely –suitable habitat**	**Yes**
Petaurus australis	Yellow-bellied Glider	Not likely-unsuitable habitat	No
Petaurus norfolcensis	**Squirrel Glider**	**Likely –suitable habitat**	**Yes**
Pteropus poliocephalus	**Grey-headed Flying-fox**	**Likely –suitable habitat**	**Yes**
Saccolaimus flaviventris	**Yellow-bellied Sheathtail Bat**	**Present on subject site**	**Yes**
Mormopterus norfolkensis	**Eastern Freetail-bat**	**Present on subject site**	**Yes**
Miniopterus australis	**Little Bent-wing Bat**	**Present on subject site**	**Yes**
Miniopterus schreibersii oceanensis	**Eastern Bent-wing Bat**	**Present on subject site**	**Yes**
Scoteanax rueppellii	**Greater Broad-nosed Bat**	**Present on subject site**	**Yes**
Rostratula benghalensis australis	Painted Snipe	Not likely-unsuitable habitat	No
Ephippiorhynchus asiaticus	Black-necked Stork	Not likely-unsuitable habitat	No
Irediparra gallinacea	Comb-crested Jacana	Not likely-unsuitable habitat	No
Callocephalon fimbriatum	**Gang Gang Cockatoo**	**Possible-suitable foraging habitat**	**Yes**

Scientific Name	Common Name	Likelihood of being found on the subject site	Impact assessment required?
Neophema pulchella	**Turquoise Parrot**	**Likely –suitable habitat**	**Yes**
Pomatostomus temporalis temporalis	Grey-crowned Babbler	Not likely-unsuitable habitat	No
Ninox connivens	Barking Owl	Not likely-unsuitable habitat	No
Tyto tenebricosa	Sooty Owl	Not likely-unsuitable habitat	No
Ninox strenua	**Powerful Owl**	**Present on subject site**	**Yes**

7.3 SEPP 44 KOALA HABITAT PROTECTION

SEPP 44 requires that, for proposals involving 1 hectare or more, the habitat should be evaluated for potential Koala Habitat and core Koala Habitat. Potential Koala Habitat is defined as areas of native vegetation where the trees listed in Schedule 2 (of SEPP 44) '*constitute at least 15% of the total number of trees in the upper and lower strata of the tree component*'. Should potential Koala Habitat be found, further investigation for the existence of core Koala Habitat should be undertaken. If this habitat is found to be present, then a detailed Plan of Management should be prepared for the Koala colony in the area. Schedule 2 feed tree species are listed in **Appendix D**.

7.4 FIELD SURVEY RESULTS

7.4.1 Flora

A floristic list (refer **Appendix D**) was compiled for each vegetation community from the transect searches and from the standard 0.04 hectare floristic plot placed in a representative part of each community in each vegetation area. The plots were marked out using a 20 by 20 metre quadrat. Within each plot, all vascular plant species were recorded and assigned a cover abundance score using a six point Braun-Blanquet scale (Poore 1955). A total of 123 native plant species were recorded in the areas, comprising flowering plants (including trees, shrubs, climbers, herbs and grasses), ferns, and cycads. **Table 5** lists the total number of flora species recorded in each vegetation community.

Plants listed under the Rare or Threatened Australian Plants ('ROTAP') Scheme (Briggs and Leigh 1996) were considered along with species and vegetation deemed to be of local conservation significance. The ROTAP list and associated coding system was developed and has been maintained by CSIRO since 1979, and lists species that are Presumed Extinct, Endangered, Vulnerable, Rare or Poorly Known at the national level. No threatened flora species were found in the areas.

7.4.2 Vegetation Communities

Previous remnant vegetation mapping of the Project Area by Driscoll and Bell (2006) provided the basis for the determination of the vegetation communities present. Vegetation communities were classified according to the LHCCREMS model (refer **Section 4.4.5**).

Three vegetation communities were determined to be present and **Figure 16** shows these communities in the context of the surrounding vegetation. One of the communities, *Lower Hunter Spotted Gum - Ironbark Forest*, is listed as an Endangered Ecological Community ('EEC') in the TSC Act. The Project will clear 0.8 hectares of this community. **Table 5** provides data on species diversity, area and condition for each vegetation community. Detailed descriptions of each vegetation community are provided in **Appendix D**.

Table 5 Vegetation Types Recorded in the Bloomfield Study Area

Community	Total species recorded	Condition	Area (ha)
Eastern Block			
MU17 Lower Hunter Spotted Gum - Ironbark Forest	55	undisturbed disturbed	6.38 0.79
MU30 Coastal Plains Smooth - barked Apple Woodland	68	undisturbed disturbed	2.42 0.50
Western Block			
MU17 Lower Hunter Spotted Gum - Ironbark Forest	58	undisturbed	3.21
MU15 Coastal Foothills Spotted Gum – Ironbark Forest	68	undisturbed disturbed	5.33 0.40

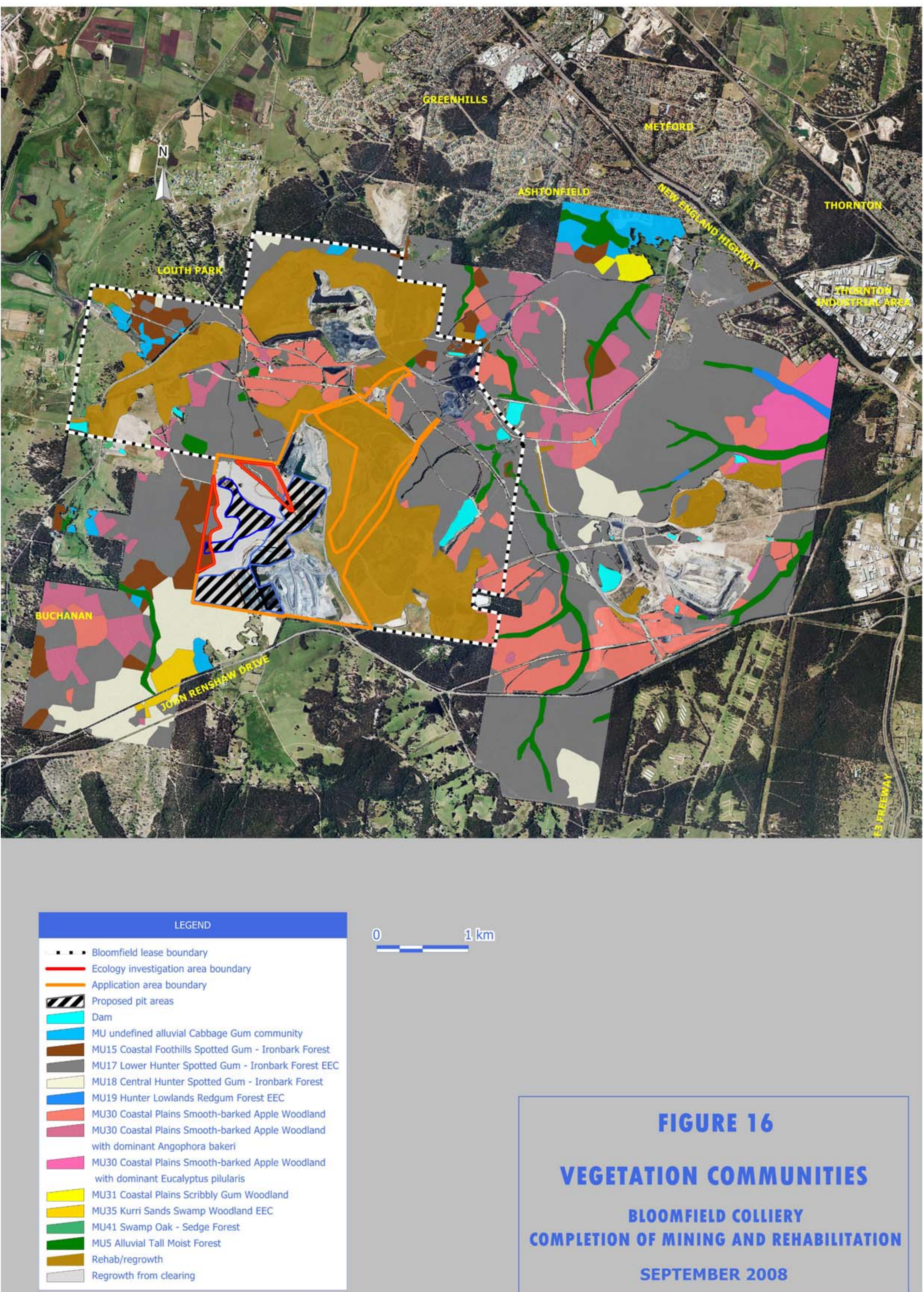


FIGURE 16

VEGETATION COMMUNITIES

BLOOMFIELD COLLIERY
COMPLETION OF MINING AND REHABILITATION

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7.4.3 Fauna

A list of fauna species and the habitat(s) in which they were recorded was compiled during the field surveys with a total of 73 native vertebrate fauna species recorded, comprising 45 birds, 1 arboreal mammal, 3 terrestrial mammals, 14 bats, 7 reptile and 2 frog species. Of these, 6 are listed as Vulnerable under the TSC Act as shown in **Table 6**. One introduced mammal, the rabbit, was also recorded in the study area.

Table 6 Threatened Fauna Recorded on the Subject Site

Scientific Name	Common Name
Ninox strenua	Powerful Owl
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat
Mormopterus norfolkensis	East Coast Freetail Bat
Miniopterus australis	Little Bent-wing Bat
Miniopterus schreibersii	Common Bent-wing Bat
Scoteanax rueppellii	Greater Broad-nose Bat

7.4.4 Habitat Hollows

A total of 55 trees with potential hollows were mapped with 135 hollows recorded. The location of trees having potential habitat hollows is shown on Figure 6 in **Appendix D**.

7.4.5 SEPP 44 Koala Habitat Protection

The only listed feed tree species present was *Eucalyptus punctata* which did not constitute at least 15% of the total number of trees. Potential Koala habitat was therefore not present and no further investigation required.

7.4.6 Groundwater Dependent Ecosystems

No groundwater dependent ecosystems were found in either area during field surveys. Both areas were on elevated ground and while there were shallow drainage lines, there was little change between vegetation at these locations and the surrounding vegetation.

7.5 THREATENED SPECIES, COMMUNITIES, AND THREATENING PROCESSES IMPACT ASSESSMENT

7.5.1 Threatened Species Conservation Act 1995

In NSW, threatened species are defined as those listed on Schedules 1 (Endangered) and 2 (Vulnerable) of the TSC. Threatened species include those which are considered of conservation concern because of restricted distributions or habitat requirements, significant population or distributional range declines, and where threats to species' survival still prevail.

An impact assessment was conducted according to the *Draft Guidelines for Threatened Species Assessment* (DEC & DPI 2005). **Appendix D** provides the full assessment process. **Table 6** lists the threatened fauna species recorded during fieldwork. Adding species considered likely to be found onsite due to suitable habitat (species **bolded** on **Table 4**), a total of 11 threatened species required assessment. The assessment of these species and the EEC show that there would be no significant impact on any threatened species or the EEC resulting from the works associated with the Project.

7.5.2 Commonwealth EPBC Act 1999

Consideration of the matters of national significance protected under the EPBC as outlined in **Section 7.1** concluded that none of these matters would be involved in the Project. In particular, there were no wetlands, no migratory species, and none of the listed threatened species or ecological communities present.

7.6 MITIGATION

The assessment concluded that due to the destructive nature of open cut mining, mitigation measures should be directed towards preventing any impacts in the surrounding habitat as well as providing compensation for lost habitat. The amount of vegetation loss would be small, approximately 1.3 ha in the eastern block and 0.4 ha in the western block as shown on **Figure 16**. The following measures should be implemented to minimise any impact associated with this loss:

- Provide effective erosion and sediment control measures in order to protect all flow-off areas. These measures would particularly apply to the western portion; the disturbance/forest edge of the eastern portion is below its surroundings;
- Prepare and implement a pre-clearance protocol; and
- Provide commensurate support of a relevant DECC approved research program in response to the loss of any of the 0.8 ha of Lower Hunter Spotted Gum – Ironbark Forest EEC. Initial discussion with DECC has indicated that a suitable strategy could be the contribution by Bloomfield to research appropriate to the conservation of this EEC community in the Hunter Region.

7.7 CONCLUSION

The Flora, Fauna and Threatened Species Assessment concluded that there would be minimal impact on flora, fauna, threatened species and the *Lower Hunter Spotted Gum - Ironbark Forest EEC*.

Mitigation measures including erosion and sediment control measures, pre-clearance protocols for protecting hollow dwelling fauna and a contribution strategy for the EEC will be provided.

Clearing will follow existing strategies as outlined in **Section 2.8** to minimise environmental harm.

8. HERITAGE

8.1 EUROPEAN HERITAGE

Searches of the following did not find any recorded heritage sites on or in close proximity to the Project Area:

- Register of the National Estate;
- State Heritage Register and Inventory;
- Register of the National Trust (NSW);
- Hunter Regional Environmental Plan ('REP') 1989; and
- Cessnock Local Environmental Plan ('LEP') 1989.

The NSW *Heritage Act 1977* defines a relic as *"any deposit, object or material evidence:*

(a) which relates to the settlement of the area that comprises New South Wales, not being Aboriginal settlement, and

(b) which is 50 or more years old."

Mining has occurred in various locations and using both underground and open cut methods on the Bloomfield site for approximately 170 years. Therefore, various relics are likely to be on the site in the form of buried disused equipment or other infrastructure. Under the *Heritage Act 1977* an excavation permit may be required if relics are to be disturbed, excavated, exposed, moved, damaged or destroyed. However, under the provisions of Section 75U of the EP&A Act, the requirement to obtain an excavation permit does not apply to Major Projects assessed under Part 3A of the Act.

8.2 ABORIGINAL HERITAGE

8.2.1 Introduction

An Aboriginal Heritage Impact Assessment was undertaken by *South East Archaeology* in accordance with the relevant DECC policies and DoP requirements and in association with the local Aboriginal community. It is presented as **Appendix E**.

8.2.2 Study Objectives and Scope

The objectives of the assessment were to:

- Identify and record any Aboriginal heritage evidence, areas of potential evidence and cultural values within the study area in consultation with the Aboriginal community;
- Assess the potential impacts of the Project upon any identified or potential Aboriginal heritage evidence or cultural values;
- Assess the significance of any Aboriginal heritage evidence or cultural values identified;
- Provide details of any Aboriginal heritage evidence in accordance with DECC requirements;
- Consult with the local Aboriginal community as per the DECC policy entitled Interim Community Consultation Requirements for Applicants;
- Present recommendations for the management of any identified Aboriginal heritage evidence, potential heritage resources or cultural values; and
- Prepare a formal archaeological report to meet the requirements of DECC and DoP.

The assessment involved:

- Research into the environmental and archaeological background of the Project Area;
- Searches of the DECC Aboriginal Heritage Information Management System ('AHIMS'), Register of the National Estate, National Heritage List or Commonwealth Heritage List, NSW State Heritage Inventory, the Hunter REP 1989 (Heritage), Cessnock LEP 1989, the Aboriginal and Torres Strait Islander Heritage Protection Act 1984 and the EPBC Act;
- Development of a predictive model of Aboriginal site location for the heritage investigation areas;
- Field survey of the Project Area after division into "modified" and "unmodified" areas (refer **Section 8.3**);
- Consultation with the local Aboriginal community; and
- Preparation of a report outlining the results of the investigation and a description of measures that would be implemented to avoid, minimise, mitigate, offset, manage and/or monitor any impacts of the Project (**Appendix E**).

8.3 PREDICTIVE MODEL OF SITE LOCATION

A model was constructed to identify areas of high archaeological potential. The Project Area was divided into two categories: "modified" and "unmodified" based on past and existing land use.

"Modified" applies to land that has been extensively impacted by past mining activities, earthmoving works or building, such that there is negligible potential for any Aboriginal heritage to survive. *South East Archaeology* found no potential for heritage evidence to exist in these areas using this model.

"Unmodified" applies to land yet to be mined in which there remains some potential for heritage evidence. However high levels of ground disturbance due to the removal of vegetation has reduced the levels of archaeological visibility and effective survey coverage. The removal of vegetation has also substantially lowered the potential for most other forms of heritage evidence (eg. carved trees, scar trees and stone arrangements).

The predictive model indicates within the "unmodified" area, there is generally a high potential for stone artefacts to occur. **Table 7** details the prediction of Artefacts in the "unmodified" area.

Table 7 Comparison of Predictive Model for Site Location of Artefacts in "Unmodified" Area and Survey Results

Artefact	Prediction	Survey results
Artefact Scatters	high	high
Bora/ceremonial sites	very low	very low or negligible
Burials	very low	very low
Carved Trees	very low	very low or negligible
Grinding Grooves	low to moderate in drainage depressions and very low elsewhere	very low or negligible
Lithic Quarries	low to moderate	very low or negligible
Mythological/Traditional Sites	low	cannot be discounted
Scarred Trees	very low	very low or negligible
Stone Arrangements	very low	very low or negligible

8.4 RESULTS

A total of six Aboriginal heritage sites, B2, B16, B18, B19, B20 and B22, comprising nineteen loci of identified evidence were recorded within the "unmodified" area. These were all stone artefact occurrences, containing 53 lithic items in a very low density distribution. These sites were assessed as being of low scientific significance within a local context, due to their common nature, low representative value, low integrity and limited potential for deposits that may be in situ and/or of research value. **Table 7** gives a comparison of results from the predictive model and field survey. Details of each site are provided in **Appendix E** with their locations shown on **Figure 17**.

8.5 REASSESSMENT OF PREDICTIVE MODEL OF SITE LOCATION

In view of the survey results, the predictive model of site location was re-assessed (refer to **Section 8.3**). **Table 8** compares the initial Predictive Model with the re-assessed Predictive Model.

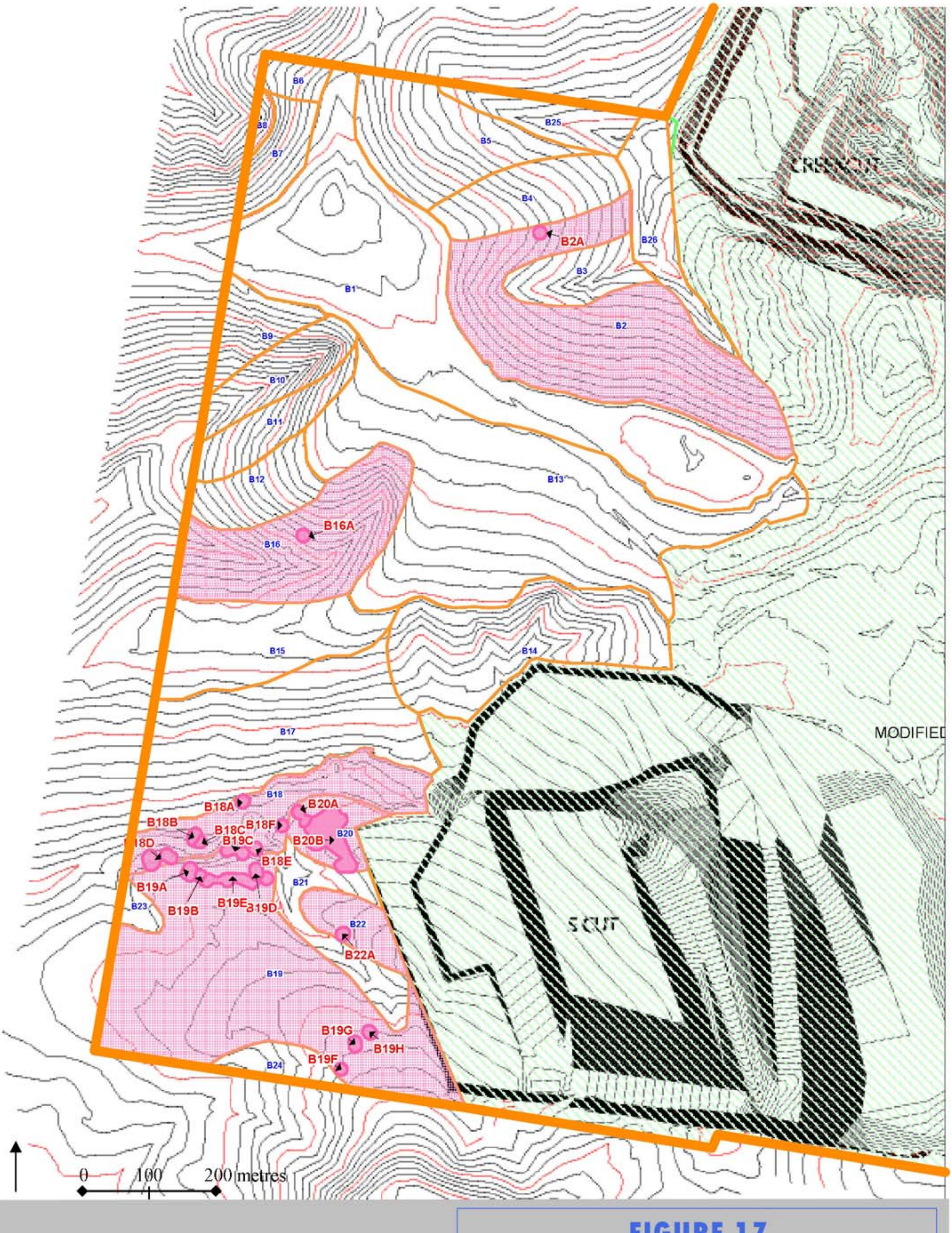
Table 8 Comparison of Predictive Model for Site Location of Artefacts with the Reassessed Predictive Model

Artefact	Initial Prediction	Re-assessed Prediction
Artefact Scatters	high	high
Bora/ceremonial sites	very low	very low or negligible
Burials	very low	very low
Carved Trees	very low	very low or negligible
Grinding Grooves	low to moderate in drainage depressions and very low elsewhere	very low or negligible
Lithic Quarries	low to moderate	very low or negligible
Mythological/Traditional Sites	low	cannot be discounted
Scarred Trees	very low	very low or negligible
Stone Arrangements	very low	very low or negligible

Further artefacts are expected to occur across the "unmodified" area in a distribution and density consistent with these results, particularly in areas that were obscured by vegetation or not directly sampled during the survey (apart from areas totally impacted by recent land use, in which potential for evidence is negligible). However the potential for sub-surface deposits that may be in situ and/or of research value is considered to be low to very low.

8.6 CONSULTATION

The Project Area lies within the boundaries of the Mindaribba Local Aboriginal Land Council ('LALC') and within an area of potential interest to other indigenous persons and organisations. These include the Awabakal, Worimi and Wonnarua groups.



LEGEND

- PROJECT APPLICATION BOUNDARY
- SURVEY AREAS
- BROAD SITE AREAS
- SITE LOCI

FIGURE 17

LOCATION OF ARCHAEOLOGICAL SURVEY AREAS AND ABORIGINAL HERITAGE EVIDENCE

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Aboriginal cultural values may be associated with the Project Area, relating to both traditional and contemporary use. Consultation with the relevant Aboriginal community is the primary means of identifying cultural values and a consultation process in accordance with the DECC *Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation* (2005).

Consultation and involvement of the Aboriginal community was undertaken as per the requirements of *Interim Community Consultation Requirements for Applicants* (DECC, 2004). Field inspection was undertaken with representatives of the Mindaribba LALC present. All registered stakeholders were forwarded a detailed statement of the Project methodology for comment and invited to attend an inspection of the Project Area. Copies of the draft report were forwarded to Aboriginal stakeholders and their comments sought and addressed.

The NP&W Act provides the primary basis for the legal protection and management of Aboriginal heritage sites within NSW by providing various controls for the protection, management and destruction of Aboriginal objects. Under the Part 3A Major Project amendments to the EP&A Act, subsequent to approval being granted, Section 90 Consent under the NP&W Act may not be required to impact Aboriginal objects. The draft Statement of Commitments (**Section 18**) outlines the proposed heritage management and mitigation measures to ensure there will not be significant impact on Aboriginal heritage sites and that appropriate consultation occurs in relation to these sites.

8.7 SIGNIFICANCE ASSESSMENT

8.7.1 Criteria

The significance of Aboriginal heritage evidence was assessed along the widely used criteria for Aboriginal heritage management derived from the relevant aspects of the *ICOMOS Burra Charter* (ICOMOS, 2000) and *State Heritage Inventory Evaluation Criteria and Management Guidelines*. It includes scientific (archaeological) value, importance to Aboriginal people (cultural value), educational value, historic value, and aesthetic value. These criteria are fully described in **Appendix E**.

8.7.2 Significance of Heritage Evidence

South East Archaeology concluded that the Aboriginal heritage sites shown on **Figure 17** do not surpass the threshold for significance in terms of educational, historic or aesthetic value. Mindaribba LALC expressed their interest in the identified evidence and its cultural value. They were assessed as being of low scientific significance within the local and regional context as the:

- Sites are of low representative value within a regional context. Similar evidence exists elsewhere throughout the Hunter Valley and the identified artefacts do not represent rare or unusual types;
- Sites generally exhibit a limited range of artefact and stone material types and the artefacts occur at very low densities;
- Sites have been substantially affected by post-depositional processes, particularly the extensive vegetation clearance works and earthmoving works, and are consequently of low integrity; and
- As a result of extensive levels of ground disturbance, there is limited potential for further heritage evidence to occur in the form of artefact deposits that are in situ and/or of research value.

8.8 MANAGEMENT AND MITIGATION MEASURES

The Aboriginal Heritage Assessment has concluded that potential impacts of the Project on Aboriginal heritage will be low. The proposed management and mitigation measures are:

- An Aboriginal Heritage Management Plan ('AHMP') will be formulated in consultation with the relevant Aboriginal stakeholders (Mindaribba LALC, Lower Hunter Wonnarua Council and Awabakal Traditional Owners Aboriginal Corporation) prior to any Project impacts occurring, to specify the policies and actions required to mitigate and manage the potential impacts of the proposal on Aboriginal heritage. The plan will include procedures for ongoing Aboriginal consultation, mitigation measures for the identified and potential Aboriginal evidence, and management procedures for any previously unrecorded evidence or skeletal remains. The Plan will comprise a detailed Statement of Commitments that will guide management of the Aboriginal heritage resource in lieu of a Section 90 Consent. The primary elements of the Plan are outlined in Section 10 in **Appendix E**; and
- Bloomfield will continue to consult with and involve the registered Aboriginal stakeholders, particularly the LALC's, in the ongoing management of the heritage resources within the Project Area as per the AHMP.

8.9 CONCLUSION

Impacts of the Project on Aboriginal heritage may occur directly through mining operations, maintenance or use of surface facilities. Most impacts will be confined to the "unmodified" Project Area and existing areas of ground disturbance in which the potential for heritage evidence is negligible. However, where impacts do occur to ground in which there are

9. NOISE, VIBRATION AND BLASTING

9.1 INTRODUCTION

An assessment of noise and blasting issues associated with the proposed Bloomfield Completion of Mining and Rehabilitation Project was undertaken by *Heggies Pty Ltd*. The complete study is provided as **Appendix F**. The assessment aimed to identify the potential impacts of noise, vibration and blasting from the Project, including consideration of cumulative impact from nearby mining activities including Donaldson, Abel and the Bloomfield washery and rail loading facility. Construction noise has not been assessed as construction activities will not occur as part of the Project.

The noise assessment has been prepared with reference to AS1055:1997 *Description and Measurement of Environmental Noise Parts 1, 2 and 3* and in accordance with DECC's *NSW Industrial Noise Policy* ('INP') (DECC, 2000). Where issues relating to noise are not addressed in the INP, such as sleep disturbance, reference is made to the NSW *Environmental Noise Control Manual* ('ENCM') (DECC, 1994).

The noise assessment is based on modelling of three representative operational stages of mining. The representative stages described by the noise assessment are Year 1, Year 5 and Year 10. **Section 2.5** of this report describes five mine stages. The representative years provided by the noise assessment correlate with the end of Stage 1 (Year 1), end of Stage 2 (Year 5) and end of Stage 4 (Year 10). For the purpose of this summary the representative years used in the Noise Assessment in **Appendix F** have been used.

9.2 DEVELOPMENT OF NOISE MANAGEMENT STRATEGY

Selecting an appropriate noise management strategy for the Project involved the following steps:

- Determining the noise reduction required to achieve Project-specific noise levels;
- Identifying the specific characteristics of the industry and the site that would indicate a preference for specified measures;
- Examining the mitigation strategies chosen by similar industries on similar sites with similar requirements for noise reduction; and considering that strategy's appropriateness for the subject development;
- Considering the range of noise-control measures available; and
- Considering community preferences for particular strategies.

The preference ranking (from most preferred to least preferred) for noise mitigation strategies is listed in Section 2 of **Appendix F**.

9.3 IMPACT ASSESSMENT PROCEDURES

The various assessment procedures used in accordance with the INP are as follows:

9.3.1 Assessing Intrusiveness

The background noise level must be measured. The equivalent continuous noise level (‘L_{Aeq}’) of the source should not be more than five decibels above the measured background level (‘L_{A90}’).

9.3.2 Amenity Assessment

This is based on noise criteria specific to land use and associated activities. The criteria relate only to industrial-type noise and do not include road, rail or community noise. The existing noise level from industry is measured. If it approaches the criterion value, then noise levels from new industries need to be designed so that the cumulative effect does not produce noise levels that would significantly exceed the criterion.

Amenity criteria for receivers such as residences, schools, etc are provided in **Appendix F**. For residential receivers, different criteria are provided for day-time, evening and night-time. The INP definition of day-time, evening and night-time is as follows:

- Daytime: 7.00 am to 6.00 pm (8.00 am to 6.00 pm Sundays and Public Holidays);
- Evening: 6.00 pm to 10.00 pm (same for Sundays and Public Holidays); and
- Night-time: 10.00 pm to 7.00 am (10.00 pm to 8.00 am Sundays and Public Holidays).

9.3.3 Sleep Disturbance

DECC has acknowledged that the relationship between maximum noise levels and sleep disturbance is not currently well defined. Criteria for assessing sleep disturbance has not been identified under the INP and hence, sleep arousal has been assessed using the guidelines set out in the ENCM. To avoid the likelihood of sleep disturbance, the ENCM recommends that the $L_{A1(1\ minute)}$ noise level of the source under consideration should not exceed the background noise level (‘L_{A90}’) by more than 15 dBA when measured outside the bedroom window of the receiver during the nighttime hours.

9.4 EXISTING ACOUSTICAL AND METEOROLOGICAL ENVIRONMENT

9.4.1 Ambient Background Noise Monitoring

Ambient noise surveys were conducted to characterise and quantify the acoustical environment in the area surrounding the Project Area as well as the Abel and Donaldson Mines. Monitoring and assessment locations are shown on **Figure 14**.

The ambient noise survey was used to define a morning shoulder period between 6.00 am and 7.00 am for the area surrounding the mine. During this period the rating background noise levels ('RBL's') were typically higher than those during the day due to the significant influence of peak traffic flows on surrounding roads including John Renshaw Drive, Weakleys Drive, the F3 Freeway and, New England Highway. The morning shoulder period RBL's have been calculated using actual measurements undertaken during the morning shoulder period.

9.4.2 Effects of Meteorology on Noise Levels

i. Wind

Wind has the potential to increase noise at a receiver when it is light and stable and blows from the direction of the noise source. As the wind strength increases the noise produced by the wind will obscure noise from most industrial and transport sources. Where wind blows from the source to the receiver at speeds up to 3 m/s for more than 30% of the time in any season, then wind is considered to be a feature of the area and noise level predictions must be made under these conditions.

Weather data was obtained, for a period of 12 months, from a DECC weather station located near Beresfield. This data was used in favour of that collected at the Donaldson mine site as the Donaldson station is shielded by trees resulting in lower than normal wind speeds being recorded. The Beresfield data was analysed to determine the frequency of occurrence of winds up to speeds of 3 m/s for daytime, evening and night in each season. It found that certain winds, typically from the southern sector in the evening and night and north western sector at night, are a feature of the area.

ii. Temperature Inversion

Temperature inversions occur predominantly at night during the winter months and have the ability to increase noise levels by focusing sound waves. For a temperature inversion to be a significant characteristic of the area it needs to occur for approximately 30% of the total night-time during winter, or about two nights per week.

Analysis of Meteorological data from Beresfield found that temperature inversions are not a feature of the area as the occurrence of inversion does not exceed the 30% threshold. Therefore, the occurrence of temperature inversion during the night-time period has not been considered as part of this noise assessment.

9.5 NOISE CONTROLS

The following noise mitigation and management procedures have been incorporated into the noise model with the aim of achieving Project specific noise criteria. These noise controls, developed for three representative years of the Project, are:

Year 1 (end Stage 1)

- The excavator and dump site would be situated in a shielded location during night-time operation;
- No dozer operation at the drill location would occur during night and morning shoulder periods (i.e. between 10.00 pm and 7.00 am); and
- The front end loader would replace the dozer at the dump site during the night-time period unless 4 dBA of noise suppression is achieved.

Year 5 (end Stage 2)

- The excavator and dump site would be situated in a shielded location during night-time operation;
- No dozer operation at the drill location would occur during night and morning shoulder periods (i.e. between 10.00 pm and 7.00 am); and
- The front end loader would replace the dozer at the dump site during the night-time period unless 4 dBA of noise suppression is achieved.

Year 10 (end Stage 4)

- The excavator and dump site would be situated in a shielded location during night-time operation; and
- No dozer operation at the drill location would occur during night and morning shoulder periods (i.e. between 10.00 pm and 7.00 am).

9.6 PROJECT SPECIFIC NOISE CRITERIA

9.6.1 Operational Noise Design Criteria

The acoustical environment typifies that of urban, suburban and commercial environments. Residences in the general area have been assessed under the relevant receiver type i.e. urban, suburban or commercial. The intrusive and amenity noise assessment criteria based on the INP for the assessment localities are presented in **Appendix F** and provided in **Table 9, Table 10** and **Table 11**.

The intrusive criterion for the morning shoulder period (6.00-7.00 am) is based on measured results during the survey period. The INP states that these criteria have been selected to protect at least 90% of the population, living in the vicinity of industrial noise sources, from the adverse effects of noise for at least 90% of the time. Provided the criteria in the INP are achieved, it is unlikely that most people would consider the resultant noise levels excessive.

9.6.2 Sleep Disturbance Noise Goals

To minimise the potential for sleep disturbance in the morning shoulder period (6.00 and 7.00 am) night-time RBL's have been used to set criteria instead of those recorded during the morning shoulder period. Sleep disturbance criteria used for the assessment is provided in **Appendix F** and **Table 12, Table 13** and **Table 14**.

9.7 OPERATIONAL NOISE MODELLING AND RESULTS

9.7.1 Operational Noise Modelling Parameters

A computer model was used to predict noise emissions from the operation of the Project. A three-dimensional digital terrain map giving all relevant topographic information was used in the modelling process. The model used this map, together with noise source data, ground cover, shielding by barriers and/or adjacent buildings and atmospheric information to predict noise levels at the nearest potentially affected receivers.

Topographic contours and operational mine plans were supplied by Bloomfield for the purpose of modelling noise from the Project. Prediction of noise sources were carried out, under calm and prevailing atmospheric conditions (prevailing winds), for three representative operational scenarios namely;

- Year 1 (end Stage 1);
- Year 5 (end Stage 2); and
- Year 10 (end Stage 4).

Atmospheric parameters under which noise predictions were made include temperature, humidity, wind speed, wind direction and temperature gradient. Full data is provided in **Appendix F**. Other assumptions made relating to the mine operation in the modelling process include:

- All acoustically significant plant and equipment operates simultaneously.
- Mobile noise sources, such as haul trucks, were modelled at typical locations and assumed to operate in repetitive cycles.
- All noise control measures described in **Section 9.5** are implemented.

9.7.2 Operational Scenario - Noise Model Summary

The operational scenario modelled during each period is likely to represent an acoustically worst-case scenario. The model incorporated the type and number of pieces of equipment in operation during the relevant period, and the sound power levels of relevant equipment.

9.7.3 Operational Noise Modelling Results and Discussion

Noise emission levels were predicted from the proposed operation for the typical operational scenario including the noise controls described in **Section 9.5**. Noise from all sources that contribute to the total noise from the site have been examined to identify characteristics that may cause greater annoyance (for example tonality, impulsiveness etc). The appropriate modifying factors, as outlined in the INP, have been applied where these characteristics are considered to be present. A summary of the predicted operational noise levels from representative years for worst case receiver locations are within **Table 9**, **Table 10** and **Table 11**.

Table 9 Predicted Bloomfield Project Noise Levels Year 1 (end of Stage 1)

Location	Period	Predicted Noise Level LAeq(15minute) (dBA)			Project Specific Noise Criteria (LAeq)
		Calm	NW Wind	SE Wind	
E Browns Road Black Hill	Day	<30	N/A	N/A	41 dBA
	Evening	<30	N/A	<30	40 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	40	<30	44 dBA
F Black Hill Road Black Hill	Day	<30	N/A	N/A	41 dBA
	Evening	<30	N/A	<30	40 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	41	<30	47 dBA
G Buchanan Road Buchanan	Day	37	N/A	N/A	43 dBA
	Evening	37	N/A	**42**	41 dBA
	Night	<30	<30	**37**	36 dBA
	Morning Shoulder	37	30	40	45 dBA
H Mt Vincent Rd Louth Park	Day	<30	N/A	N/A	43 dBA
	Evening	<30	N/A	32	41 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	<30	32	42 dBA
I Lord Howe Dr. Ashtonfield	Day	<30	N/A	N/A	44 dBA
	Evening	<30	N/A	<30	45 dBA
	Night	<30	<30	<30	38 dBA
	Morning Shoulder	<30	<30	<30	47 dBA
J Kilarney Street Avalon Estate (Thornton)	Day	<30	N/A	N/A	49 dBA
	Evening	<30	N/A	<30	47 dBA
	Night	<30	<30	<30	40 dBA
	Morning Shoulder	<30	<30	<30	53 dBA
K Catholic Diocese (Former Bartter) K1,K2,K3	Day	<30	N/A	N/A	41 dBA
	Evening	<30	N/A	<30	40 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	32	<30	47 dBA
L Kilshanny Avenue Ashtonfield	Day	<30	N/A	N/A	46 dBA
	Evening	<30	N/A	34	46 dBA
	Night	<30	<30	<30	40 dBA
	Morning Shoulder	<30	<30	34	48 dBA

Location	Period	Predicted Noise Level LAeq(15minute) (dBA)			Project Specific Noise Criteria (LAeq)
		Calm	**NW Wind**	**SE Wind**	
M John Renshaw Drive Buttai	Daytime	39	N/A	N/A	45 dBA
	Evening	39	N/A	36	43 dBA
	Night	<30	**37**	<30	36 dBA
	Morning Shoulder	39	47	36	48 dBA
N Lings Road Buttai	Daytime	42	N/A	N/A	45 dBA
	Evening	42	N/A	42	43 dBA
	Night	34	34	33	36 dBA
	Morning Shoulder	42	42	43	48 dBA

Table 10 Predicted Bloomfield Project Noise Levels Year 5 (end of Stage 2)

Location	Period	Predicted Noise Level LAeq(15minute) (dBA)			Project Specific Noise Criteria (LAeq)
		Calm	**NW Wind**	**SE Wind**	
E Browns Road Black Hill	Day	<30	N/A	N/A	41 dBA
	Evening	<30	N/A	<30	40 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	39	<30	44 dBA
F Black Hill Road Black Hill	Day	<30	N/A	N/A	41 dBA
	Evening	<30	N/A	<30	40 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	41	<30	47 dBA
G Buchanan Road Buchanan	Day	37	N/A	N/A	43 dBA
	Evening	31	N/A	**42**	41 dBA
	Night	<30	<30	36	36 dBA
	Morning Shoulder	38	33	43	45 dBA
H Mt Vincent Rd Louth Park	Day	<30	N/A	N/A	43 dBA
	Evening	<30	N/A	32	41 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	<30	33	42 dBA

Location	Period	Predicted Noise Level LAeq(15minute) (dBA)			Project Specific Noise Criteria (LAeq)
		Calm	NW Wind	SE Wind	
I Lord Howe Dr. Ashtonfield	Day	<30	N/A	N/A	44 dBA
	Evening	<30	N/A	<30	45 dBA
	Night	<30	<30	<30	38 dBA
	Morning Shoulder	<30	<30	<30	47 dBA
J Kilarney Street Avalon Estate (Thornton)	Day	<30	N/A	N/A	49 dBA
	Evening	<30	N/A	<30	47 dBA
	Night	<30	<30	<30	40 dBA
	Morning Shoulder	<30	<30	<30	53 dBA
K Catholic Diocese (Former Bartter) K1,K2,K3	Day	<30	N/A	N/A	41 dBA
	Evening	<30	N/A	<30	40 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	31	<30	47 dBA
L Kilshanny Avenue Ashtonfield	Day	<30	N/A	N/A	46 dBA
	Evening	<30	N/A	33	46 dBA
	Night	<30	<30	<30	40 dBA
	Morning Shoulder	<30	<30	34	48 dBA
M John Renshaw Drive Buttai	Daytime	38	N/A	N/A	45 dBA
	Evening	38	N/A	35	43 dBA
	Night	<30	36	<30	36 dBA
	Morning Shoulder	38	48	36	48 dBA
N Lings Road Buttai	Daytime	34	N/A	N/A	45 dBA
	Evening	31	N/A	34	43 dBA
	Night	<30	32	<30	36 dBA
	Morning Shoulder	35	42	36	48 dBA

Table 11 Predicted Bloomfield Project Noise Levels Year 10 (end of Stage 4)

Location	Period	Predicted Noise Level LAeq(15minute) (dBA)			Project Specific Noise Criteria (LAeq)
		Calm	NW Wind	SE Wind	
E Browns Road Black Hill	Day	32	N/A	N/A	41 dBA
	Evening	31	N/A	<30	40 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	31	40	<30	44 dBA
F Black Hill Road Black Hill	Day	30	N/A	N/A	41 dBA
	Evening	<30	N/A	<30	40 dBA
	Night	<30	32	<30	36 dBA
	Morning Shoulder	<30	42	<30	47 dBA
G Buchanan Road Buchanan	Day	39	N/A	N/A	43 dBA
	Evening	34	N/A	**42**	41 dBA
	Night	<30	<30	**37**	36 dBA
	Morning Shoulder	34	33	43	45 dBA
H Mt Vincent Rd Louth Park	Day	<30	N/A	N/A	43 dBA
	Evening	<30	N/A	34	41 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	<30	33	42 dBA
I Lord Howe Dr. Ashtonfield	Day	<30	N/A	N/A	44 dBA
	Evening	<30	N/A	<30	45 dBA
	Night	<30	<30	<30	38 dBA
	Morning Shoulder	<30	<30	<30	47 dBA
J Kilarney Street Avalon Estate (Thornton)	Day	<30	N/A	N/A	49 dBA
	Evening	<30	N/A	<30	47 dBA
	Night	<30	<30	<30	40 dBA
	Morning Shoulder	<30	<30	<30	53 dBA
K Catholic Diocese (Former Bartter) K1,K2,K3	Day	<30	N/A	N/A	41 dBA
	Evening	<30	N/A	<30	40 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	32	<30	47 dBA
L Kilshanny Avenue Ashtonfield	Day	<30	N/A	N/A	46 dBA
	Evening	<30	N/A	35	46 dBA
	Night	<30	<30	<30	40 dBA
	Morning Shoulder	<30	<30	35	48 dBA

Location	Period	Predicted Noise Level LAeq(15minute) (dBA)			Project Specific Noise Criteria (LAeq)
		Calm	NW Wind	SE Wind	
M John Renshaw Drive Buttai	Daytime	39	N/A	N/A	45 dBA
	Evening	39	N/A	36	43 dBA
	Night	<30	36	<30	36 dBA
	Morning Shoulder	39	46	35	48 dBA
N Lings Road Buttai	Daytime	31	N/A	N/A	45 dBA
	Evening	<30	N/A	<30	43 dBA
	Night	<30	33	<30	36 dBA
	Morning Shoulder	<30	37	<30	48 dBA

Modelling shows that operational noise levels from the Project are predicted to meet the Project specific noise criteria at all receiver locations under calm and prevailing weather conditions with the exception of:

- **Location G** (Buchanan Road) where an exceedance of 1 dBA is predicted during a prevailing south east wind during the evening period in Years 1, 5 and 10 and during the night-time period in Years 1 and 10; and
- **Location M** (John Renshaw Drive, Buttai) where an exceedance of 1 dBA is predicted during a prevailing northwest wind during the night-time period in Year 1.

These minor exceedances of up to 1 dBA are unlikely to be noticeable by most people. Since the operational scenario modelled is likely to represent an acoustically worst-case scenario, actual operational noise levels from the proposed Bloomfield Project are likely to be less than those predicted.

9.7.4 Sleep Disturbance Analysis

In assessing sleep disturbance, typical L_{Amax} noise levels of plant and equipment to be used at the subject site during the night was used as input to the ENCM acoustic model and predictions were made at the nearest residential areas under adverse weather conditions at night. The use of the L_{Amax} noise level provides a worst-case prediction since the L_{A1} noise level of a noise event is likely to be less than the L_{Amax}. A summary of the predicted maximum noise levels at the most affected locations are contained within **Table 12, Table 13** and **Table 14**.

Table 12 Predicted Maximum Noise Levels at Night during Adverse Weather Year 1 (end of Stage 1)

Location	Period	Predicted Noise Level LAmax (dBA)		Sleep Disturbance Criteria (LAeq)
		NW Wind	SE Wind	
E Browns Road Black Hill	Night	34	<30	46 dBA
	Morning Shoulder	34	<30	46 dBA
F Black Hill Road Black Hill	Night	38	32	46 dBA
	Morning Shoulder	39	32	46 dBA
G Buchanan Road Buchanan	Night	<30	39	46 dBA
	Morning Shoulder	<30	39	46 dBA
H Mt Vincent Rd Louth Park	Night	<30	31	46 dBA
	Morning Shoulder	<30	31	46 dBA
I Lord Howe Dr. Ashtonfield	Night	<30	<30	48 dBA
	Morning Shoulder	<30	<30	48 dBA
J Kilarney Street Avalon Estate (Thornton)	Night	<30	<30	50 dBA
	Morning Shoulder	<30	<30	50 dBA
K Catholic Diocese (Former Bartter) K1,K2,K3	Night	42	<30	46 dBA
	Morning Shoulder	42	<30	46 dBA
L Kilshanny Avenue Ashtonfield	Night	<30	<30	53 dBA
	Morning Shoulder	<30	<30	53 dBA
M John Renshaw Drive Buttai	Night	41	31	46 dBA
	Morning Shoulder	46	31	46 dBA
N Lings Road Buttai	Night	41	36	46 dBA
	Morning Shoulder	41	36	46 dBA

Table 13 Predicted Maximum Noise Levels at Night during Adverse Weather Year 5 (End of Stage 2)

Location	Period	Predicted Noise Level LAmax (dBA)		Sleep Disturbance Criteria (LAeq)
		NW Wind	SE Wind	
E Browns Road Black Hill	Night	<30	<30	46 dBA
	Morning Shoulder	32	<30	46 dBA
F Black Hill Road Black Hill	Night	36	<30	46 dBA
	Morning Shoulder	36	<30	46 dBA
G Buchanan Road Buchanan	Night	31	43	46 dBA
	Morning Shoulder	32	43	46 dBA
H Mt Vincent Rd Louth Park	Night	<30	<30	46 dBA
	Morning Shoulder	<30	33	46 dBA
I Lord Howe Dr. Ashtonfield	Night	<30	<30	48 dBA
	Morning Shoulder	<30	<30	48 dBA
J Kilarney Street Avalon Estate (Thornton)	Night	<30	<30	50 dBA
	Morning Shoulder	<30	<30	50 dBA
K Catholic Diocese (Former Bartter) K1,K2,K3	Night	<30	<30	46 dBA
	Morning Shoulder	<30	<30	46 dBA
L Kilshanny Avenue Ashtonfield	Night	<30	<30	53 dBA
	Morning Shoulder	<30	34	53 dBA
M John Renshaw Drive Buttai	Night	45	<30	46 dBA
	Morning Shoulder	45	36	46 dBA
N Lings Road Buttai	Night	38	30	46 dBA
	Morning Shoulder	38	36	46 dBA

Table 14 Predicted Maximum Noise Levels at Night during Adverse Weather Year 10 (end of Stage 4)

Location	Period	Predicted Noise Level LAmax (dBA)		Sleep Disturbance Criteria (LAeq)
		NW Wind	SE Wind	
E Browns Road Black Hill	Night	36	<30	46 dBA
	Morning Shoulder	40	<30	46 dBA
F Black Hill Road Black Hill	Night	42	<30	46 dBA
	Morning Shoulder	42	<30	46 dBA
G Buchanan Road Buchanan	Night	35	45	46 dBA
	Morning Shoulder	40	**47**	46 dBA
H Mt Vincent Rd Louth Park	Night	<30	32	46 dBA
	Morning Shoulder	<30	31	46 dBA
I Lord Howe Dr. Ashtonfield	Night	<30	<30	48 dBA
	Morning Shoulder	<30	<30	48 dBA
J Kilarney Street Avalon Estate (Thornton)	Night	<30	<30	50 dBA
	Morning Shoulder	<30	<30	50 dBA
K Catholic Diocese (Former Bartter) K1,K2,K3	Night	<30	<30	46 dBA
	Morning Shoulder	32	<30	46 dBA
L Kilshanny Avenue Ashtonfield	Night	<30	<30	53 dBA
	Morning Shoulder	<30	<30	53 dBA
M John Renshaw Drive Buttai	Night	46	30	46 dBA
	Morning Shoulder	46	32	46 dBA
N Lings Road Buttai	Night	40	30	46 dBA
	Morning Shoulder	43	31	46 dBA

Modelling shows that L_{Amax} noise levels at night are predicted to meet the sleep disturbance criteria at all receiver locations under calm and prevailing weather conditions with the exception of Location G (Buchanan Road) where an exceedance of 1 dBA is predicted during a prevailing south east wind during the morning shoulder period in Year 10. This 1 dBA exceedence is considered unlikely to cause sleep disturbance at this location.

9.7.5 Cumulative Noise Assessment

Existing and proposed mining in the vicinity of the Project includes the existing Bloomfield washery and rail loading facility, Donaldson Mine, Abel Mine and Tasman Mine. Due to its remote location, the noise impact of the Tasman Mine will be negligible and therefore has not been considered as part of this assessment.

The potential for the simultaneous operation of the Project, Abel and Donaldson Mines to exceed the acceptable and maximum noise amenity criteria can be assessed on a worst case scenario basis by adding the predicted noise levels from the existing and proposed operations together. The cumulative intrusive level is then adjusted (by -3 dBA) to the equivalent amenity level for comparison with the relevant amenity criteria for each location.

The results of the cumulative noise assessment, during calm and adverse weather conditions, shows that the cumulative impact of mining in the area surrounding the Bloomfield Project will comply with the relevant amenity criteria set in accordance with the INP. The results are provided in **Appendix F**.

9.8 USE OF EXPLOSIVES

Existing blast designs at Bloomfield Mine vary depending on the location of the blast in relation to sensitive residences.

DECC has set down guidelines for blasting based on human comfort levels. These have been adapted from the ANZECC Guidelines (1990) *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* and are as follows:

- Airblast
  - "*The recommended maximum level for airblast is 115 dB Linear Peak.*
  - *The level of 115 dB may be exceeded on up to 5% of the total number of blasts over a period of 12 months. However, the level should not exceed 120 dB Linear Peak at any time.*"
- Ground Vibration
  - "*The recommended maximum level for ground vibration is 5 mm/s (peak particle velocity [ppv]). It is recommended that a level of 2 mm/s be considered as a long term regulatory goal.*
  - *The ppv level of 5 mm/s may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 10 mm/s at any time.*"

- Times and Frequency of Blasting
  - "*Blasting should only generally be permitted during the hours of 9.00 am to 5.00 pm Monday to Saturday. Blasting should not take place on Sundays or Public Holidays.*
  - *Blasting should generally take place no more than once per day.*"

9.8.1 Assessment of Blasting Impacts

In order to predict the levels of blast emissions (ground vibration and airblast) at the surrounding receivers from the Project, the measured ground vibration and airblast levels from recent blasting operations conducted in 2006 and 2007 were used to develop blast emissions site laws for each of the three stages of mine development considered, assuming current blasting practice. The maximum instantaneous charge ('MIC') will vary, and be limited, depending on the location of the area being mined and its relation to the nearest affected receiver. Site laws are currently used to design the MIC for each individual blast based on the limit at the nearest affected receiver. This will continue to be the practice for future mine development. Currently, MIC levels near the southern boundary of the development vary up to 200 kg depending on the orientation and depth of face being fired.

A summary of the results for the closest affected receivers is provided in **Appendix F**. The results reflect the levels that would be experienced when blasting at the nearest point to residential receivers during each stage of development. The blast prediction results demonstrate that predicted airblast and ground vibration levels will meet the DECC guidelines for blasting at all residences surrounding the development during all operational stages of the Project.

9.9 CONCLUSION

9.9.1 Operational Noise Predictions

Operational noise levels are predicted to meet the Project specific noise criteria at all receiver locations under calm and prevailing weather conditions with the exception of:

- **Location G** where an exceedance of 1 dBA is predicted during a prevailing south east wind during the evening period in Years 1, 5 and Year 10 and during the night-time period in Years 1 and 10; and
- **Location M** where an exceedance of 1 dBA is predicted during a prevailing north west wind during the night-time period in Year 1.

These minor exceedances of up to 1 dBA are unlikely to be noticeable by most people. Since the operational scenario modelled is likely to represent an acoustically worst-case scenario, actual operational noise levels from the Project are likely to be less than those predicted.

9.9.2 Sleep Disturbance Assessment

The predicted LAmax noise levels from the Project will meet the sleep disturbance criteria at all locations surrounding the development during calm and prevailing weather conditions with the exception of:

- **Location G** where a 1 dBA exceedance during the morning shoulder period is predicted during a south east wind in Year 10.

This 1 dBA exceedance is unlikely to cause sleep disturbance at this location.

9.9.3 Blasting Assessment

The blast prediction results presented in **Section 9.8.1** demonstrate that predicted airblast and ground vibration levels will meet the DECC guidelines for blasting at all residences surrounding the development during all operational stages of the Project.

9.9.4 Cumulative Impact Assessment

The cumulative impact of mining in the area surrounding the Bloomfield Project including the existing Donaldson Mine, Abel Mine and existing Tasman Mine is predicted to comply with the relevant amenity criteria set in accordance with the INP.

With implementation of the stated controls and management procedures, environmental risk associated with noise and vibration is considered to be low.

10. AIR QUALITY

10.1 INTRODUCTION

An assessment of potential air quality issues was undertaken by Holmes Air Sciences. The assessment follows the "*Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*" (DECC, 2005) using a Level 2 assessment. It uses the ISCMOD dispersion model with estimated emissions (taking account of control measures) and local meteorological data to predict dust concentration and deposition levels arising from the Project. After making appropriate allowances for existing levels of dust, the predicted values were then compared with the assessment criteria published by the DECC.

10.2 IDENTIFICATION OF ISSUES

The continuation of existing mining operations will result in the liberation of a number of classes of particulate matter ('PM'), consisting of total suspended particulate matter ('TSP'), particulate matter with equivalent aerodynamic diameters of 10 μm or less ('PM_{10}') and particles with equivalent aerodynamic diameters of 2.5 μm and less ('$PM_{2.5}$'). These emissions would occur primarily as fugitive dust from open cut mining operations.

There will also be exhaust emissions from diesel-powered haul trucks and other mining equipment. These emissions will include carbon monoxide ('CO'), minor quantities of sulphur dioxide ('SO_2'), nitrogen dioxide ('NO_2') and PM_{10}. Greenhouse gases (including CO_2) are addressed in **Section 10.9**. In practice, the gaseous emissions will be minor and the sources too widely dispersed across the mine site to cause ambient concentrations that could give arise to environmental impacts. Emissions of particulate matter from the exhausts of diesel-powered mining equipment are automatically taken into account in the assessment of dust emissions. This is because they are included in the estimates of emissions when the emission-factor equations used for estimating fugitive emissions are applied.

Because of the low concentrations of gaseous emissions compared with the assessment criteria, the focus of the assessment will be on the potential impacts due to emissions of particulate matter.

The proposal deals with the continuation of mining and rehabilitation in the Project Area over five stages, as described in **Section 2.5**. The four mining stages (Stages 1-4) have been assessed to determine the change in air quality effects with time as mining and waste emplacement areas progress.

Although some rehabilitation will occur in Stage 4, it has been assessed that the emissions from this will be less than that from active mining. Model simulations for Stage 1 have been made to allow the model predictions to be compared with historical monitoring data, assisting in establishing background levels for particulate matter.

The assessment assumes a ROM coal production maximum of 0.88 mtpa for Stage 1 after which a maximum of 1.3 mtpa will be mined. Overburden ratios will vary over the mine stages. Emissions from the nearby Donaldson and Abel mines and from the ROM coal processed at the Bloomfield washery have been included in the cumulative modelling.

Figures 3 and 4 in **Appendix G** show the source locations used in the modelling. These figures can be used to precisely identify the locations of the mining areas and the haul routes assumed for each of the model runs. Each numbered point shows the location of a dust emission source used in the model.

10.3 AIR QUALITY ASSESSMENT CRITERIA

10.3.1 Particulate Matter ('PM')

PM_{10} criteria are used to relate predicted concentrations to potential health effects. These criteria relate to the total PM burden in the air. Thus it is necessary to consider the effects of PM emissions from other mining operations and sources of PM, as well as Bloomfield emissions. The criteria used to assess the significance of predicted deposition and concentration levels are:

- Annual mean TSP of 90 $\mu g/m^3$;
- 24 hour maximum PM_{10} of 50 $\mu g/m^3$;
- Annual mean PM_{10} of 30 $\mu g/m^3$; and
- 24 hour average PM_{10} of 50 $\mu g/m^3$ with 5 exceedences permitted per year.

10.3.2 Dust Deposition

In addition to health impacts, airborne dust also has the potential to cause nuisance impacts by depositing on surfaces, for example, washing, motor cars, verandas, outdoor furniture and on vegetation/crops. The DECC (2005) criteria for dust (insoluble solids) fallout is:

- Annual average maximum increase in deposited dust of 2 g/m^2/month; and
- Annual average maximum total deposited dust level of 4 g/m^2/month.

10.4 EXISTING AIR QUALITY

10.4.1 Dust (insoluble solids) Deposition

Bloomfield's existing network of dust deposition gauges is shown on **Figure 14**. All dust gauges, except for D4, have recorded annual average dust deposition levels lower than DECC's criteria of 4 g/m^2/month. D4 is situated within the existing mine and is well removed from residential areas. Monitoring data from gauges is provided in **Appendix G**. PM exists in the local area due to existing operations at Bloomfield and Donaldson as well as from traffic and emissions from industrial and domestic activities in Newcastle and surrounding urban and industrial areas.

10.4.2 Dust Concentration Data

Continuous data on PM_{10} concentrations was provided by DECC's Beresfield monitoring station. TSP and PM_{10} concentrations (one-day-in-six-basis) were also provided by Donaldson's monitors at Blackhill. Data from December 1999 to October 2007 shows 31 occasions when the 24-hour average PM_{10} concentration at Beresfield exceeded the DECC's criteria of 50 $\mu g/m^3$ with only one such occasion in the past 12 months (October 2007). Similarly, since December 1999, there have been nine occasions when 24-hour average PM_{10} concentration (one-day-in-six-basis) has exceeded 50 $\mu g/m^3$ at the Blackhill monitor. None of these occurred in the last 12 months. These observations include the effects of existing mining operations and any other sources.

Although the annual average PM_{10} concentration at Beresfield exceeded DECC's 30 $\mu g/m^3$ criterion from late 2002 to the end of 2003, it has been below the criterion since that time. The annual average PM_{10} concentration at Blackhill has not exceeded the criterion since monitoring commenced in December 1999. The annual average TSP concentration at Blackhill has also been lower than the DECC 90$\mu g/m^3$ criterion since monitoring commenced.

Although emissions from mining at Donaldson and Bloomfield will theoretically contribute to concentrations of PM_{10} and TSP at the Beresfield and Blackhill sites, emissions modelling presented in the Donaldson EIS indicates that these contributions are likely to be small and unlikely to have caused, or contributed significantly to the measured exceedances. The higher concentrations at both sites occurred on the same days. Therefore the highest concentrations measured are most likely to be due to regional air pollution from bushfires or other, non-mining, events that cause elevated levels over wide areas.

10.5 METEOROLOGICAL CONDITIONS

10.5.1 Wind Speed and Wind Direction

Modelling used data from the Beresfield meteorological station as the Donaldson Station, built for the Donaldson Mine, does not comply with AS2923-1987 due to its shielding by trees. The wind roses show that over the year the most common winds are from the west, west-northwest, east-southeast and southeast. Westerlies are most common in winter and the south-easterlies in summer. Autumn and spring show an intermediate pattern between that which applies in summer and winter. Since the closest residences are to the south of the Project Area, the use of the Beresfield data is considered to be conservative.

10.5.2 Temperature and Rainfall

Bureau of Meteorology data from the East Maitland Bowling Club provides the longest record of temperature, humidity and rainfall data. January is the warmest month with a mean daily maximum temperature of 30.7°C and July is the coolest with a mean daily minimum temperature of 5.8°C. The Bureau of Meteorology's data is provided in **Appendix G**.

Rainfall data, in particular the number of rain days that can be expected per year, is of particular importance in estimating dust emissions from wind erosion. Over 82 years of records, there have been approximately 84.7 rain days per year.

10.6 ASSESSMENT APPROACH

The assessment followed the DECC's *Approved Methods of the Modelling and Assessment of Air Pollutants in New South Wales* (DECC, 2005). It specifies how assessments based on the use of air dispersion models should be undertaken and include guidelines for the preparation of meteorological data to be used in dispersion models and the relevant air quality criteria for assessing the significance of predicted concentration and deposition rates from the proposal. The only deviation relates to the use of the ISCMOD model instead of the AUSPLUME, CALPUFF and TAPM models which are named models in the approved methods. ISCMOD has been specially developed from the US EPA's ISCST3 model to give improved performance in the prediction of short-term PM_{10} concentrations. DECC has accepted it for a number of recently completed mining and quarry assessments, where the modifications are particularly relevant. Further detail on modelling methods is provided in **Appendix G.**

10.7 ESTIMATING EMISSIONS

A discussion of the emissions for each stage of the Project is provided in **Appendix G**. **Table 15** provides a summary of emissions for each stage and activity while

Table 16 provides summary of emissions for nearby mines.

Table 15 Summary of Emissions for Bloomfield (kg)

(OB refers to activities involving overburden handling; CL refers to activities involving coal handling; and WE refers to activities involving wind erosion)

Activity	Stage 1	Stage 2	Stage 3	Stage 4
OB - Stripping topsoil - Creek cut	235	291	454	-
OB - Stripping topsoil - S cut	325	269	106	560
OB - Drilling - Creek cut	4,769	10,386	16,179	19,974
OB - Drilling - S cut	6,586	9,588	3,795	-
OB - Blasting - Creek cut	3,614	7,872	12,262	15,138
OB - Blasting - S cut	4,991	7,266	2,876	-
OB - Sh/Ex/FELs loading - Creek cut	20,275	44,157	68,783	-
OB - Sh/Ex/FELs loading - S cut	27,999	40,760	16,134	84,918
OB - Hauling to emplacement - from Creek cut	49,009	106,737	166,263	-
OB - Hauling to emplacement - from S cut	67,680	98,526	39,000	205,263
OB - Emplacing at dumps - Creek cut	20,275	44,157	68,783	-
OB - Emplacing at dumps - S cut	27,999	40,760	16,134	84,918
OB - Dozers on O/B - Creek cut	-	63,512	107,176	-
OB - Dozers on O/B - S cut	132,316	68,805	25,140	132,316
OB - Dozers on Rehabilitation - Creek cut	-	31,252	52,737	65,107
OB - Dozers on Rehabilitation - S cut	65,107	37,762	12,370	-
CL - Dozers ripping - Creek cut	29,163	36,106	56,242	69,435
CL - Dozers ripping - S cut	40,272	33,329	13,193	-
CL - Loading ROM to trucks -Creek cut	31,074	56,834	99,460	109,297
CL - Loading ROM to trucks - South Pit	42,912	52,462	20,766	-
CL - Hauling ROM coal to dump hopper - Creek cut	54,516	119,990	189,540	269,750
CL - Hauling ROM coal to dump hopper - S cut	91,872	118,560	47,548	-
CL - unloading ROM coal at stockpile/hopper Creek cut	Emissions from approved activities at CHPP are taken into account in the cumulative assessment			
CL - unloading ROM coal at stockpile/hopper S cut				
CL - Rehandle ROM coal at stockpile/hopper				
CL - Handling coal at CHPP				
CL - Dozers at CHPP				
CL - Loading rejects (too wet)				
CL - Loading product coal stockpile				
CL - Loading coal to trains				
WE - OB spoil area - Creek cut	-	16,983	-	-
WE - OB spoil area - S cut	123,835	161,586	212,288	187,521
WE - Open pit - Creek cut	14,153	38,212	63,686	91,991
WE - Open pit - S cut	88,453	95,176	63,686	-
WE - ROM stockpiles	Emissions from approved activities at CHPP are taken into account in the cumulative assessment			
WE - Product stockpiles				
Grading roads	13,516	13,516	13,516	13,516
Total (kg)	**960,946**	**1,354,854**	**1,388,118**	**1,349,703**
ROM coal production (t)	**880,000**	**1,300,000**	**1,300,000**	**1,300,000**
TSP emission per tonne of ROM coal produced (kg/t)	**1.09**	**1.04**	**1.07**	**1.04**

Table 16 Summary of Emissions for Nearby Mines (kg)

Surrounding mines contribution	1,123,655	84,444	84,444	84,444
Donaldson (only in 2007), Abel and Bloomfield emissions from Bloomfield CHPP	531,364	282,390	282,390	282,390

10.8 ASSESSMENT OF RESULTS

The modified version of the ISC model ('ISCMOD') was used together with estimated emissions for Stages 1, 2, 3 and 4 and meteorological data for 2005 to model the dispersion and deposition of emissions for the Project.

Results provided estimated:

- maximum 24-hour PM_{10} concentrations;
- annual average PM_{10} concentrations;
- annual average TSP concentrations; and
- annual average dust (insoluble solids) deposition rates.

A summary of the modelling results is provided as **Table 17**. It shows that no residences are predicted to experience either dust deposition or PM concentrations above the DECC's assessment criteria. Resident ID referred to in **Table 17** is the location of residences as shown on **Figure 14**.

Table 17 Summary of Model Predictions

Summary of predicted particulate matter levels at residential locations for the Project in isolation and cumulatively									
Stage	**Resident ID (refer Figure 14)**	**Project in isolation**				**Project combined with other sources and background**			
		24hr PM_{10}	**Annual Average PM_{10}**	**Annual Average TSP**	**Annual Average Dust Deposition**	**24hr PM_{10}**	**Annual Average PM_{10}**	**Annual Average TSP**	**Annual Average Dust Deposition**
		µg/m³	**µg/m³**	**µg/m³**	**g/m²/month**	**µg/m³**	**µg/m³**	**µg/m³**	**g/m²/month**
DECC goal		**50**	**30**	**90**	**4**	**-**	**30**	**90**	**4**
Current	E	22.4	2.7	3.3	0.5	NA	15.3	31.3	1.0
	F	16.4	3.2	4.1	0.8	NA	20.3	37.6	1.3
	G	8.5	1.2	1.4	0.1	NA	11.5	26.7	0.6
	H	14.5	2.2	2.3	0.1	NA	13.6	28.9	0.6
	I	5.8	0.3	0.4	0.0	NA	11.9	27.0	0.5
	K	5.7	1.0	1.1	1.1	NA	18.9	36.5	1.6
	L	9.7	1.0	1.1	0.1	NA	14.9	30.2	0.6
	M	45.5	6.4	8.4	1.2	NA	19.2	36.7	1.7
	N	28.2	2.9	3.8	0.2	NA	13.8	29.7	0.7
+5 years	E	20.4	2.8	3.4	0.4	NA	12.9	28.5	0.9
	F	20.0	3.4	4.2	0.5	NA	14.1	30.1	1.0
	G	9.7	1.5	1.8	0.1	NA	11.3	26.4	0.6
	H	23.1	4.1	4.5	0.1	NA	14.2	29.6	0.7
	I	9.5	0.5	0.6	0.0	NA	10.7	25.6	0.5
	K	7.3	1.3	1.5	0.1	NA	12.4	27.9	0.8
	L	16.9	1.5	1.6	0.0	NA	12.3	27.4	0.6
	M	32.7	5.6	7.3	0.9	NA	15.7	32.3	1.4
	N	28.5	3.5	4.4	0.3	NA	13.3	29.2	0.8

Summary of predicted particulate matter levels at residential locations for the Project in isolation and cumulatively									
Stage	**Resident ID (refer Figure 14)**	**Project in isolation**				**Project combined with other sources and background**			
		24hr PM_{10}	**Annual Average PM_{10}**	**Annual Average TSP**	**Annual Average Dust Deposition**	**24hr PM_{10}**	**Annual Average PM_{10}**	**Annual Average TSP**	**Annual Average Dust Deposition**
		µg/m³	**µg/m³**	**µg/m³**	**g/m²/month**	**µg/m³**	**µg/m³**	**µg/m³**	**g/m²/month**
DECC goal		**50**	**30**	**90**	**4**	**-**	**30**	**90**	**4**
+7 years	E	22.6	2.9	3.5	0.4	NA	13.6	29.3	0.9
	F	20.3	3.5	4.3	0.5	NA	16.2	32.8	1.2
	G	13.4	1.7	2.0	0.1	NA	11.6	26.7	0.6
	H	21.4	3.4	3.7	0.1	NA	13.7	29.0	0.6
	I	9.4	0.5	0.5	0.0	NA	10.8	25.8	0.5
	K	8.2	1.3	1.6	0.1	NA	13.6	29.5	0.9
	L	14.8	1.4	1.5	0.0	NA	12.7	27.9	0.6
	M	35.6	5.7	7.3	0.9	NA	16.3	33.0	1.4
	N	28.7	3.8	4.9	0.4	NA	13.9	29.9	0.9
+10 years	E	18.2	2.6	3.2	0.3	NA	12.7	28.2	0.7
	F	25.1	3.5	4.3	0.4	NA	14.3	30.3	0.9
	G	12.1	1.5	1.8	0.1	NA	11.3	26.5	0.6
	H	19.2	3.5	3.9	0.1	NA	13.6	28.9	0.6
	I	9.0	0.5	0.6	0.0	NA	10.7	25.6	0.5
	K	9.5	1.4	1.7	0.1	NA	12.6	28.1	0.7
	L	14.4	1.6	1.7	0.0	NA	12.6	27.7	0.6
	M	33.0	4.6	5.8	0.6	NA	14.7	30.9	1.0
	N	22.1	2.8	3.6	0.3	NA	12.6	28.4	0.8

10.9 GREENHOUSE GAS EMISSIONS

Greenhouse gas inventories are calculated by a number of different methods. The procedures specified under the Kyoto Protocol to the United Nations Framework Convention on Climate Change are the most common. The protocol identifies greenhouse gases as carbon dioxide ('CO_2'), methane ('CH_4'), nitrous oxide ('N_2O'), hydrofluorocarbons ('HFCs'), perfluorocarbons ('PFCs') and sulphur hexafluoride ('SF_6'). CO_2 and N_2O are formed and released during the combustion of gaseous, liquid and solid fuels.

The Project will liberate greenhouse gases as a result of the combustion of diesel and petrol to power mining and other equipment, the use of explosives and the use of electrical energy. The most significant gases for the Project are CO_2 and N_2O. Different gases have different greenhouse warming effects (potentials) and emission factors take into account the global warming potentials of the gases created during combustion. Inventories of greenhouse gas emissions can be calculated using published emission factors.

When the global warming potentials are applied to the estimated emissions then the resulting estimate is referred to in terms of CO_2 equivalent emissions. The emission factors published by the Australian Greenhouse Office ('AGO') (2006) have been used to convert fuel usage and electricity consumption into CO_2 equivalent emissions. These are provided in **Appendix G** as is the methodology used to estimate emissions for the Project in terms of Scope 1, 2 and 3 emissions.

Scope 1 emissions are produced directly as a result of fuel burning equipment use on site, Scope 2 from the use of electricity on the site, and Scope 3 from the use of equipment and facilities that have generated greenhouse gases in their production prior to purchase. Scope 3 emissions also include the use of the coal mined on the site by other parties, ie: the customer.

The estimation of greenhouse gas emissions was undertaken for ROM coal production of 800,000 tpa and 1.3 mtpa. It is considered more appropriate to model greenhouse gas emissions on the average ROM coal production over the life of the mine, which is expected to be closer to 800,000 tpa than 1.3 mtpa.

The Project is estimated to liberate 28,489 tonnes of Scope 1 emissions and 14,214 tonnes of Scope 2 emissions in Stage 1. In Stages 2-4, 23,164-35,312 tonnes of Scope 1 emissions and 11,102–16,490 tonnes of Scope 2 emissions are estimated to be liberated.

The *National Greenhouse and Energy Reporting Act 2007* ('NGER Act') requires corporations that control facilities emitting 25,000 tonnes or more (CO_2 equivalent) per year to register and report their Scope 1 and 2 greenhouse gas emissions. Bloomfield Colliery will be required to monitor and report on its greenhouse gas emissions, and report in the form required by the Act.

Bloomfield is currently registered as a participant in the Federal Government Energy Efficiency Opportunities ('EEO') and Greenhouse Challenge Plus programs. An Assessment and Reporting Schedule has been prepared under the EEO program and an Energy Assessment of open cut operations will be undertaken in accordance with the commitments made in that schedule. The EEO Energy Assessment will document current and proposed initiatives for the efficient supply and management of energy usage, as well as procedures for the reporting and management of greenhouse gases resulting from Scope 1 and 2 emissions.

Depending on ROM coal production, the Project is estimated to liberate between 19.5 Mt and 30.4 Mt of CO_2 equivalent (including Scope 3) over the life of the mine, or average between 1.76 and 2.85 mtpa. This is small when compared with the estimated annual emission of 559 Mt of CO_2 equivalent for Australia in 2005 using the Kyoto accounting procedures. The Scope 3 emissions from the Project would not be included in the NSW inventory as the coal is for export and would be accounted for in the country in which the end user is located.

10.10 SUMMARY AND CONCLUSIONS

Holmes Air Sciences assessed the air quality impacts associated with the operation of the Project. Modelling simulations of the dispersion of dust emissions for the four mining stages have been undertaken. Model predictions show the effects of the mine in isolation and when the mine is considered with other sources of dust (cumulative impact). No exceedences of any long-term assessment criteria are predicted.

The assessment also provides estimates of the greenhouse gas emissions from the operation. The Project is estimated to liberate between 19.6 Mt and 30.4 Mt, or an average of between 1.76 and 2.85 mtpa CO2-equivalent gases over its life.

11. SURFACE HYDROLOGY AND WATER MANAGEMENT

11.1 INTRODUCTION

An assessment of the surface water issues was undertaken by *Evans & Peck* in consultation with the Groundwater assessment by *Aquaterra*. It is provided as **Appendix H**.

The surface water management system for the Project forms an integral part of the water management system approved by the Abel Project Approval. This is shown schematically on **Figure 18.** It involves the management of all surface runoff and groundwater sources associated with the Abel, Bloomfield and Donaldson mines, ensuring continuous supply to the Bloomfield washery whilst minimising discharge to Four Mile Creek from the operating areas. The lettering on each of the catchment areas identified on **Figure 18** represents the designation used for water balance analysis detailed in **Appendix H**.

Relevant elements of the Integrated Water Management System cannot be considered in isolation and are therefore referred to in this Project. Water management facilities included in the Abel Project Approval and operated by Bloomfield are:

- Existing surface water storages and sediment control dams (Lake Kennerson, Lake Foster, Possums Puddle and the Stockpile Dam) and the pipelines and drains that allow water to be transferred between these storages, or discharged offsite;
- Pumps for the supply of water from Lake Foster to the washery;
- Pumps for supply of groundwater extracted from old underground workings to supplement water supply to the washery when required;
- The washery associated stockpile areas and the Stockpile Dam;
- Previously mined areas including S Cut and Creek Cut used for disposal of wastes from the washery (coarse rejects and fine tailings) and the rehabilitation of these areas following completion of waste disposal; and
- Mine water discharge regime as per the existing EPL. (Refer **Section 2.9**)

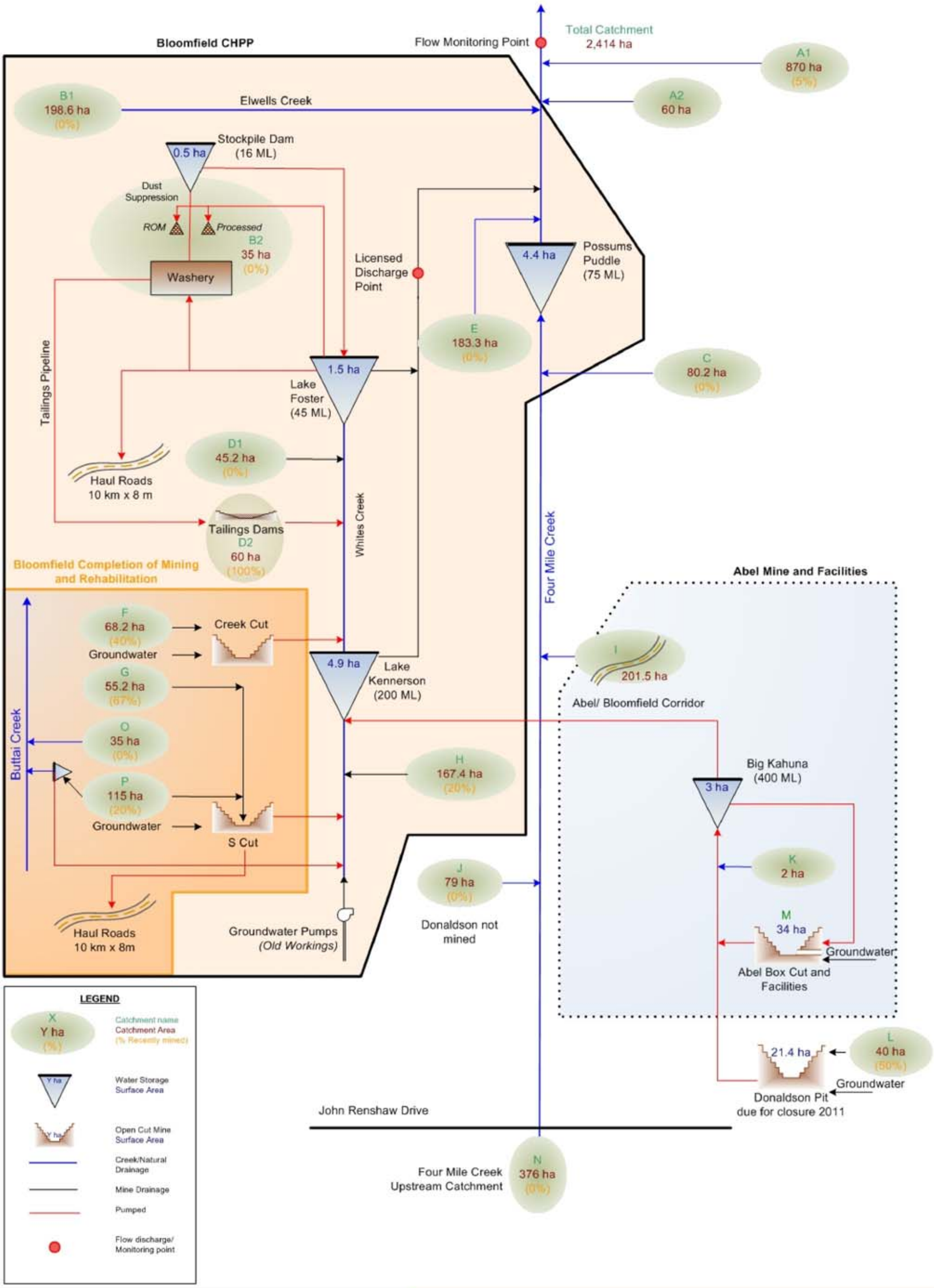

FIGURE 18

INTEGRATED WATER MANAGEMENT SYSTEM SCHEMATIC OF BLOOMFIELD, ABEL AND DONALDSON MINES

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11.2 EXISTING OPERATIONS AND WATER MANAGEMENT

The existing water management system for the Bloomfield Mine is detailed in **Appendix H**. The following provides a summary of the existing water management system as shown on **Figure 18**.

Mining currently occurs in the S Cut and Creek Cut pits. All surface runoff and groundwater that drains to S Cut is transferred to Lake Kennerson. From Lake Kennerson it is either transferred to Lake Foster for use in the washery or, in the event of there being excess water held in Lake Kennerson, discharged to Four Mile Creek in accordance with an existing EPL. Water from Creek Cut is directly transferred to Lake Foster.

All drainage from active overburden dumps currently drains either to the active pits (S Cut and Creek Cut) or to Lake Kennerson. Surface runoff draining to the pits, as well as groundwater inflow to the pits, is pumped to Lake Kennerson which serves as a sediment control dam as well as a key part of the Bloomfield water management system. Routine monitoring of water quality since 1996 shows an average total suspended solids ('TSS') concentration of 9.5 mg/L and a 90th percentile concentration of 19 mg/L indicating Lake Kennerson achieves a high level of sediment capture.

Existing haul roads connect the active pits to the workshop area and the ROM coal stockpile area. Runoff from the haul roads drains into the existing water management systems located within the Bloomfield Mine lease area.

The layout of the existing workshop area and the boundary of the catchment that drains to the workshop sediment dam are shown on **Figure 19.** The main access road between Creek Cut and the ROM coal stockpile forms the southern boundary of the workshop area. This road is drained, via a table drain, to a low (vegetated) detention basin on the southern side of road. This detention basin acts as a sediment control pond. Once the basin is sufficiently full, water overflows through a culvert under the access road and discharges into the drainage line that flows along the western side of the workshop area. This drainage line eventually becomes Elwells Creek.

The facilities and the stormwater drainage arrangements for the workshop area comprise:

- A covered workshop in which all machinery maintenance and repair is undertaken. Roof runoff from the workshop is directed to the ground adjacent to the building.
- Roads and machinery parking area to the immediate south and southeast of the workshop building drain via a slightly depressed drainage path around the eastern side of the workshop building towards the main sediment dam. A small localised catchment drains to a small sediment control basin (marked as "Collection Area" on

Figure 19). If filled to capacity, this collection area overflows into the drain that diverts water around the eastern side of the workshop.

- Surface runoff from the roads and car park areas to the north and east of the workshop drain to a culvert under the sealed access road, before draining into a sediment dam. This sediment dam overflows into the Elwells Creek drainage line.
- The entrance to the workshop is ramped up, to divert surface runoff around the workshop entrance. All internal drainage from within the covered workshop drains through an internal grease trap and sediment control sump, then through an external triple baffle oily water separator. Retained oily water is diverted to a storage tank and emptied periodically by a licenced contractor. The storage tank has a flashing beacon to indicate when near capacity and requiring evacuation. A licensed contractor pumps out the tank.
- A tank farm, located immediately west of the workshop, has a series of fuel tanks that store bulk diesel and oil (total capacity of 128,000 L). The tank farm is contained within a bunded area designed in accordance with AS1940. The bunded area has a locked valve overflow line. Surface runoff from the bunded area drains to a sump. The sump pump operates automatically pumping to a triple chamber oil/water separator. Separated oily water flows to a holding tank (with flashing warning beacon). A licensed contractor pumps out the tank.
- Decanting of fuel is carried out in a dished pad. Underflow from the dished pad flows to an automatically draining holding tank and into the triple chamber oil/water separator. Separated oily water flows to the holding tank (with flashing warning beacon). A licensed contractor pumps out the tank.
- Minor volumes of oils and greases are stored on a raised storage platform located at the northeastern corner of the workshop building. A catch tray that drains to the triple baffle oily water separator surrounds the storage platform.
- The prill bin and pad is surrounded by 150 mm concrete guttering, which directs surface runoff via a sediment retention sump into a below-ground concrete holding tank. The tank is equipped with a float switch that triggers a red flashing beacon when requiring pumping out. A licensed contractor pumps out the tank.

The local catchment surrounding the prill bin drains, via a small sediment pond, into Elwells Creek. This sediment pond is inspected and cleaned out periodically. The local catchment is largely undisturbed bushland and overflow of surface runoff from the prill pad would only occur in very high rainfall events, when the pad would not be operating.

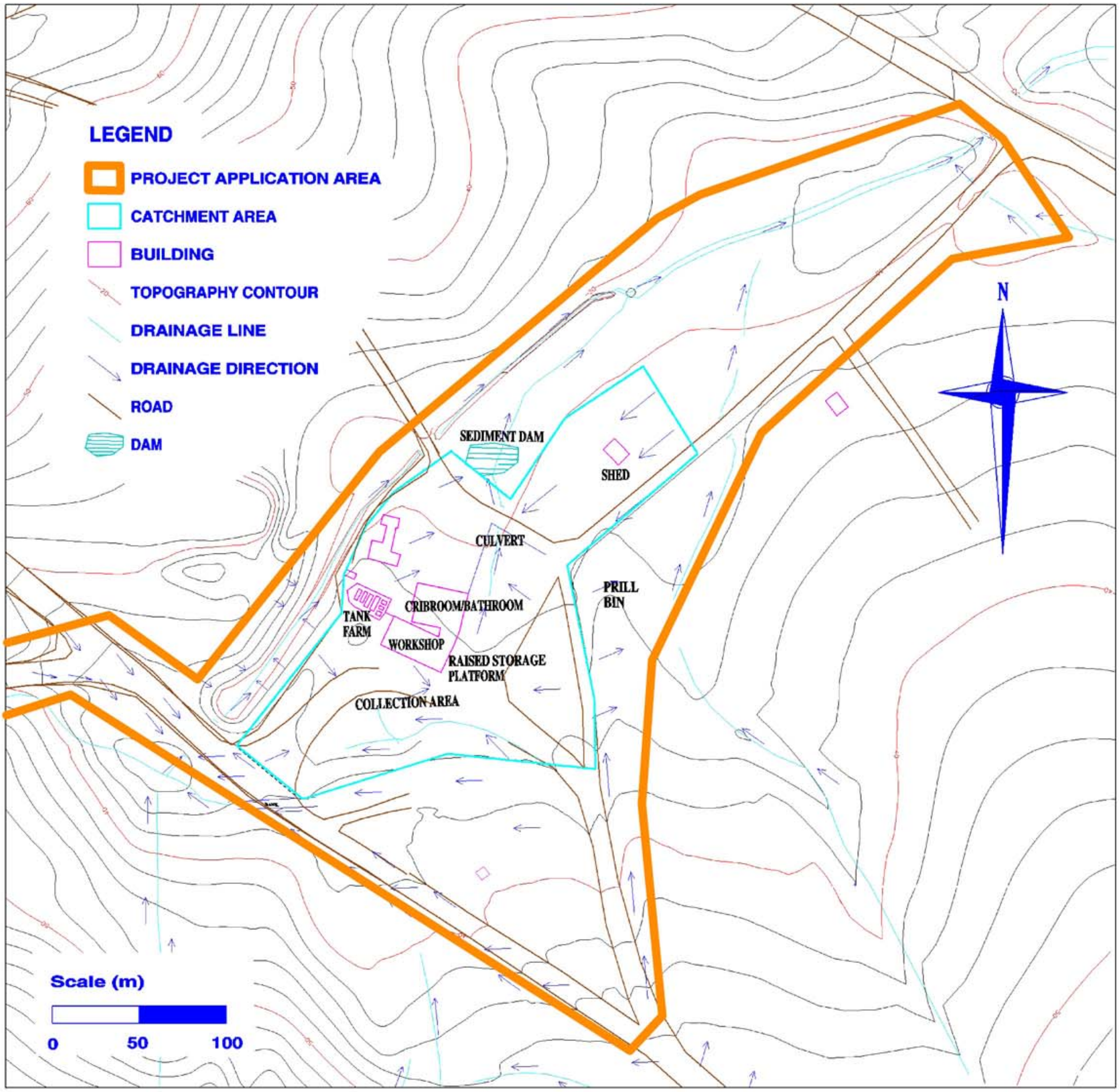

FIGURE 19

WORKSHOP SURFACE WATER PLAN

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Management actions to ensure appropriate operation of the pollution control systems in the vicinity of the workshop area include:

- All water storage tanks are emptied by a licenced contractor on a routine basis. The contractor is on call to undertake additional pump-out if a flashing warning light indicates that pump-out is required.
- All hydrocarbon management infrastructure is subject to quarterly documented maintenance inspections.
- The sediment dam is inspected quarterly and cleaned out as necessary to maintain sediment capture capacity.
- A water quality monitoring point is located on Elwells Creek about 350 m downstream of the sediment dam to which the workshop area drains. This monitoring point also receives runoff that drains via sediment traps from the haul road located immediately adjacent to the monitoring point.

11.3 ALTERATIONS TO EXISTING OPERATION

The Project will involve only minor alterations to the existing operation of the water management system.

11.3.1 Mining Areas

The Project covers an area to the west and north of S Cut extending as far north as the Creek Cut. Proposed mining will occur concurrently westward from the existing S Cut and northward to link with the existing Creek Cut.

The existing S Cut encroaches approximately 48 hectares into the headwaters of Buttai Creek. As mining progresses approximately 118 hectares of the Buttai Creek Catchment will be affected by mining and measures will be put in place to protect Buttai Creek. These measures include directing all runoff from the area affected by mining into the mine water management system away from Buttai Creek until rehabilitation is complete. At the completion of mining, all areas draining to Buttai Creek will be rehabilitated and runoff directed back to Buttai Creek.

Overburden placement and rehabilitation will follow the mining sequence. Until Stage 3 of the Project, runoff from all active overburden dumps and rehabilitated areas will drain to active pit areas from where it will be pumped to Lake Kennerson. After this stage, a series of diversion drains and a sediment dam (as shown on **Figure 18**) will be constructed on the overburden dumps. Diversion drain design calculations are presented in **Appendix H**.

An Erosion and Sediment Control Plan ('ESCP') will be implemented to ensure that no undue pollution of receiving waters occurs during the Project. The ESCP will be prepared in accordance with guidelines in *Managing Urban Stormwater: Soils and Construction* (Landcom 2004) and *Managing Urban Stormwater Soils and Construction - Volume 2E: Mines and Quarries* (draft DECC and Sydney Metropolitan CMA 2007).

Areas to the west of mining disturbance will be protected from runoff from the overburden areas until rehabilitation is complete. Once rehabilitation is completed on each area, the relevant diversion drain will be filled-in and rehabilitated with the exception of the drain along the north-western edge of S Cut. This is shown on Figure 4.1 in **Appendix H**. It will be retained to direct runoff into the sediment dam retained as a water storage dam with all water captured pumped to Lake Kennerson. Until rehabilitation is completed, all runoff from the overburden dumps that is directed to mine pits or to the sediment dam will be pumped to Lake Kennerson as for current operations. Each diversion drain will have an operating life of about 5 years. Design calculations for diversion drains, sediment dam and spillway in accordance with *Managing Urban Stormwater: Soils & Construction* are provided in **Appendix H**.

11.3.2 Workshop

Stormwater pollution control arrangements and management regime in the vicinity of the workshop and prill bin have been reviewed and are considered to be in line with current standards. No modifications are proposed.

11.4 SURFACE WATER ASSESSMENT AND IMPACTS

11.4.1 Water Balance Analysis

A detailed water balance analysis has been undertaken that takes account of all surface and groundwater sources that would enter the water management systems on the Bloomfield, Donaldson and Abel Mine sites.

The water balance model results indicate that by adopting the proposed target operating water levels, the existing water management facilities within the Bloomfield and Donaldson mine areas can be operated to achieve the following objectives:

- Maintain water supply for the CHPP and dust suppression at all times;
- Minimise discharge from the Stockpile Dam (washery); and
- Minimise discharge from Lake Kennerson.

The water balance model has been used to develop a feasible set of operating rules that demonstrate the adequacy of the water management facilities to achieve these objectives. It is anticipated that the operating rules will be regularly reviewed and refined in the light of operating experience.

The water balance estimates show the following features:

- Water supply for all mine purposes can be provided by the water management system without extracting water from old Bloomfield underground workings at a greater rate than has been extracted historically.
- The demand for water supply from the Bloomfield underground workings will gradually reduce as additional water becomes available from the Abel underground workings.
- Some discharge from Lake Kennerson is likely to continue under most climate conditions. However the discharge volume for Lake Kennerson is estimated to be significantly less than historical rates.
- The Stockpile Dam would not overflow in any of the three representative climate years. (Refer **Appendix H**).

11.4.2 Impacts on Flow Regime

Given all the other influences of mine activities, the increase in the catchment area draining into Four Mile Creek catchment as a result of encroachment into Buttai Creek catchment (maximum of 118 ha out of a total of 2,467 ha) is not expected to lead to any perceptible increase in flow in Four Mile Creek.

The location of the existing high wall of the S Cut approximately coincides with the catchment divide between Four Mile Creek to the east and Buttai Creek to the west. As the S Cut progressively extends to the west it will encroach into two small tributary catchments (36 ha and 114 ha respectively) of the Buttai Creek catchment.

The area draining into the pits will alter as mining progresses. The maximum area affected will be about 118 ha by Stage 3. Approximately 32 ha will not be affected by mining. The anticipated impact on flow into Buttai Creek catchment at Buchanan Road would be a reduction in the average annual flow by 3% in Stage 1, rising to 7% by Stage 3 and remaining at that level until rehabilitation is complete (Stage 5). Once rehabilitation is completed, the area excluded from Buttai Creek catchment will be restored to the catchment.

The catchment area that will be temporarily excised from the Buttai Creek catchment comprises the steeper upper reaches of the catchment from which the main runoff process is surface runoff immediately following rainfall. Accordingly, based on previous modelling of the flow regime in Four Mile creek and other local creeks, the majority of the estimated reduction in annual runoff volume will occur as a result of flows in the flow range up to the 20^{th} percentile. This portion of the catchment can therefore be expected to have minimal effect on base flow in Buttai Creek.

The tributary creeks that drain from the mine lease area join Buttai Creek upstream of Buchanan Road. About 2 km downstream of the road Buttai Creek drains into a large ephemeral wetland area which drains into Wallis Creek. From the 1:25,000 topographic map, the wetland appears to have a maximum area of about 35 ha. However, inspection of aerial photographs and observations by Bloomfield Colliery staff over a number of years indicate that the actual water area varies significantly in response to rainfall and runoff.

From a hydrologic perspective, the wetland acts as a large shallow water storage area which only spills into Wallis Creek after heavy rainfall such as that which occurred in June 2007. The predicted maximum 7% reduction in annual flow as a result of the mine is not expected to have any significant impact on the wetland, because the wetland only requires about 150 ML/year offsetting the loss by evaporation. It follows that, even if the Bloomfield expansion reduces the average annual flow in Buttai Creek from about 1,550 ML/year to 1,445 ML/year, there will still be sufficient water to maintain the wetland.

Because the wetland only spills into Wallis Creek in high flows, the encroachment of mining into the Buttai Creek catchment is not expected to have any noticeable effect on the flow regime in Wallis Creek which has a catchment area of about 15,000 ha upstream of the Buttai Creek junction.

11.4.3 Impacts on Surface Water Quality

- The Project is expected to have the following impacts on water quality:
- Reduced salt load discharged to Four Mile Creek on account of the anticipated deduction on discharge volume from Lake Kennerson;
- Continuation of the existing low level of discharge of sediment to Four Mile Creek as all sediment laden water from recently rehabilitated areas will be collected in the pits or sediment dam and transferred to Lake Kennerson which has demonstrated capacity to provide low levels of TSS in any discharge (average 12 mg/L); and
- No discharge of sediment to Buttai Creek as all runoff collected in the pits and the sediment dam will be transferred to Lake Kennerson.

11.4.4 Impacts on Existing Surface Water Users

The reduction in flow associated with mining is temporary and is not expected to effect any downstream water users.

11.5 DRAFT SURFACE WATER MANAGEMENT PLAN

With the exception of a small sediment dam on the headwaters of Buttai Creek, the water management systems that support the existing and proposed mining at Bloomfield are part of the Integrated Water Management System ('IWMS') provided for the Bloomfield, Abel and Donaldson mines as part of the Abel Project Approval. This draft Surface Water Management Plan is consistent with the IWMS.

New pits and sediment dams proposed as part of the Project will be operated in the same way as the S Cut pit is currently operated and will not require any new facilities other than a small sediment dam constructed near the western boundary of the Project Area for Stage 3. The objectives for the IWMS are to set out in **Section 11.2**.

11.6 WATER MANAGEMENT FACILITIES AND OPERATIONS

Based on the water balance modelling, existing water management facilities will not require any modification in terms of size or operating regime to cater for the proposed completion of mining at Bloomfield. Target operating levels of various storages are provided in **Appendix H.** Management actions to ensure appropriate operation of the pollution control systems in the vicinity of the workshop area are described in **Section 11.2**.

11.6.1 Proposed Surface Water Monitoring

The surface water monitoring program as per the Abel Project Approval includes the following sites relevant to the Project:

- Four Mile Creek at John Renshaw Drive;
- Four Mile Creek upstream of the Bloomfield lease area ('CCL761');
- Four Mile Creek at the New England Highway; and
- Buttai Creek at Lings Road.

It is proposed to add a monitoring site on Buttai Creek immediately upstream of Buchanan Road. The existing and proposed monitoring locations are shown on **Figure 14.**

The following monitoring regime is proposed:

- Monthly field testing for Temperature, pH, EC, DO and Turbidity;
- Monthly grab samples for laboratory analysis of TSS, TDS, pH and EC;
- Quarterly grab samples for laboratory analysis of Chlorides, Sulfates, Alkalinity, Calcium, Magnesium, Sodium and Potassium;
- Daily water grab samples from the discharge point when there is controlled discharge from Lake Kennerson. A grab sample will also be collected at the flow gauging station behind the Four Mile Workshops. These samples will be analysed for EC, pH, TSS and Filterable iron in accordance with the EPA licence; and
- Daily water grab samples of any overflow from the Stockpile Dam. These samples will be analysed for TSS, TDS, pH and EC.

11.6.2 Proposed Surface Water Response Plan

The procedure to be followed in the event of unforeseen surface or groundwater impacts being detected during the Project is as follows:

1. The nature of the suspected impact and all relevant monitoring data will be immediately referred to an independent qualified hydrologist or hydro-geologist as appropriate for assessment.
2. An assessment will be made of the potential magnitude of the impact and the level of risk.
3. Alternative response and mitigation measures will be detailed for discussion with DWE, DECC and/or DPI-Minerals as appropriate.
4. A response/mitigation plan will be implemented to the satisfaction of DWE, DECC and/or DPI-Minerals.

11.7 CONCLUSION

The surface water assessment notes that the proposed operations form an integral part of the IWMS. Minimal alterations to this system are required to cater for the Project. A detailed water balance analysis has been undertaken which indicates that existing water management facilities and systems can cater for the continued Bloomfield operation with minimal new works. The impacts of potential surface water issues associated with the Proposal are therefore considered to be low.

12. GROUNDWATER

12.1 INTRODUCTION

A groundwater impact assessment was undertaken by *Aquaterra Consulting Pty Ltd* and is provided as **Appendix I**. The study was in consultation with the Surface Water assessment by Evans & Peck. The objectives of the assessment were to:

- Assess and describe the existing groundwater environment of the Project and its vicinity;
- Identify key potential risks to the environment from the Project;
- Evaluate the potential impacts of the Project on the regional and local groundwater resources, incorporating any necessary management and mitigation strategies; and
- Assess the residual post-Project impacts and any ongoing management requirements.

The study was undertaken with reference to the following relevant policies:

- NSW State Rivers and Estuaries Policy;
- NSW Wetlands Management Policy;
- NSW Groundwater Policy Framework Document – General;
- NSW Groundwater Quantity Management Policy;
- NSW Groundwater Quality Protection Policy;
- NSW Groundwater Dependent Ecosystem Policy;

and the following relevant best practice guidelines:

- Groundwater Flow Modelling Guideline (MDBC, 2001);
- Independent Inquiry into the Hunter River System (Healthy Rivers Commission, 2002);
- Guidelines for Management of Stream/Aquifer Systems in Coal Mining Developments – Hunter Region (DNR, 2005); and
- Groundwater Monitoring Guidelines for Mine Sites within the Hunter Region (DIPNR, 2003).

The *Draft Water Sharing Plan for Hunter Unregulated and Alluvial Aquifer Sources*, released in March 2008 (refer **Section 4.4.8**) has been considered. Although unlikely to be adopted prior to lodgment of this EA, Bloomfield proposes to conduct mining operations in accordance with the draft Plan.

12.2 GROUNDWATER INVESTIGATIONS

A search of the Department of Water and Energy ('DWE') groundwater bore database identified thirteen existing registered bores within approximately 5 km of the Project. Summary details of these bores are in **Appendix I**. Following analysis of hydrographs for all bores, the groundwater levels in the Bloomfield mining area show the accumulated effects of long-term mining activity in the area. Although there is no evidence to suggest what pre-mining groundwater levels might have been, the influence of mining on water levels is apparent by the marked differences in groundwater levels between shallow and deeper coal measures.

Twenty-four piezometers were installed at eight sites around the Bloomfield mine area to enable separate sampling, testing and monitoring of the main coal seams involved in past or proposed mining, as well as the shallow alluvium and/or regolith zone. A limited amount of historical information was also available from several old piezometers on the site however, in most cases the construction details were uncertain. Regional information was obtained where possible from piezometers on adjacent mining projects.

A hydraulic testing program was carried out on the standpipe piezometers to determine aquifer permeabilities. Water samples were collected for detailed chemical and physico-chemical analysis. Follow-up water quality sampling was carried out six months after the initial testing, as part of the ongoing baseline monitoring program. The baseline program also involves monthly measurement of water levels in all Bloomfield piezometers.

Water samples were collected in May and December 2007 from the Bloomfield standpipe piezometers, and submitted for detailed chemical analysis. Electrical conductivity ('EC') and pH were measured in the field at the time of sampling.

The existing hydrogeological environment covering climate, geology, hydrogeology, recharge and discharge, groundwater quality and usage and the groundwater-surface water interaction is described in **Appendix I** along with detailed information on the study methodology, investigations and analysis results.

12.3 ASSESSMENT OF POTENTIAL IMPACTS

The Creek Cut and S Cut voids have been assumed to remain as permanent open voids in the groundwater modelling, so that the impact of the Project can be assessed (as far as possible) separately from the impacts of neighbouring mining projects. One of these projects, the Abel Mine, is approved to continue for several years after completion of mining at Bloomfield. However, with ongoing processing of coal at the washery, the final voids will be progressively backfilled by deposition of washery rejects.

A numerical groundwater flow model based on the MODFLOW package, used in conjunction with the SURFACT module, was used to assess the potential impacts of the Project. The model area was approximately 200 km^2. A full account of the model set-up, the assumed hydraulic parameters, modelling methods, model calibration, and sensitivity analysis are provided in **Appendix I**.

12.3.1 Predictive Modelling

The potential impacts of the Project were assessed by running the calibrated model in transient mode. The model was configured with annual changes in the area and base level(s) of mining, by altering the hydraulic parameter values of model cells within mined and/or backfilled areas, and with drain cells activated in all active open cut areas. To accommodate parameter changes using MODFLOW, the modelling was conducted as a series of sequential model runs, with parameter changes between successive runs in accordance with the mining schedule.

Because of the proximity of nearby Donaldson and Abel projects, these operations were also simulated in the model. The Donaldson Project has been in operation since 2001 and is due for completion in another 3-4 years, and the Abel Project is currently under development and projected to continue for 10 years after completion of mining at Bloomfield.

The predicted mine dewatering rate from the prediction modelling ranged between 0.4 and 2.1 ML/d, with the maximum occurring in Year 6 (during Stage 3) and minimum in Year 11 (Stage 4). Predicted average rate over the 11 years modelled was 1.4 ML/d. These rates are of similar magnitude to current and recent dewatering rates. A detailed account of the predictive modelling results is presented in **Appendix I**.

12.3.2 Recovery Modelling-Post-Mining Impacts

The post-mining recovery of groundwater levels was modelled for 100 years after completion of mining. Aquifer parameter values for the mined out and backfilled open cut areas were modified to values appropriate for either waste backfill or voids. The pit voids will continue to be backfilled by deposition of rejects from the washery, with this ongoing activity forming part of the Abel Project Approval. Therefore, for the post-mining recovery, it was assumed that the final voids would remain intact through the 100 year recovery period.

The recovery model run showed that groundwater levels in all model layers are predicted to recover to higher than current (2007-2008) levels. This result is due to the fact that after completion of mining at Abel (some years after completion of Bloomfield) the groundwater levels will recover not just from the impacts of mining during the period modelled in this study, but also from the significant effects of past mining as well.

The recovery modelling shows that virtual full recovery of groundwater levels over the entire model area will occur within 60 years of completion of mining at Bloomfield and on the Bloomfield lease area itself, recovery will be substantially completed within 20-30 years, and to groundwater levels higher than at present. Post-mining groundwater levels are predicted to stabilise at around 18-35 metres AHD within the Bloomfield mine area, compared with maximum 2006 levels around 25 metres AHD predicted by the steady-state calibration model.

12.3.3 Potential Impacts on Surficial Groundwater

Plots of drawdown at the completion of the Project show a decline in groundwater levels after completion of mining, relative to the model-predicted levels at 2006.

The plot for the surficial aquifer Layer 1 (alluvium and regolith layer) shows a very limited area of drawdown at the location of the final S Cut pit void, and a more extensive area of groundwater recovery or draw-up (compared with 2006 levels) near the south western corner of the Bloomfield lease, and extending beyond the lease boundary for a maximum distance of approximately 500m. Groundwater levels were already depressed in the vicinity of the S Cut pit in 2007, due to many years of dewatering pumping from the S Cut sump area (shown on Figure 3). A much larger area of drawdown impact is predicted for the Abel project area to the south-east of Bloomfield.

Drawdowns from the Bloomfield mining were predicted to reach a maximum at Year 7, at which time mining from the southern end of S Cut is scheduled to cease, and groundwater levels would start to recover. Drawdown contours for Layer 1 at the end of Year 7 are shown on Figure 21 in **Appendix I**. It is seen that drawdown of 1m or more is predicted to extend approximately 1km to the west to the edge of alluvium associated with Buttai Creek. The potential for impacts on groundwater storage in the alluvium will be monitored at shallow piezometers at Sites 1 and 8 (Figure 21 in **Appendix I**).

Predicted drawdowns in Layer 1 further south from Site 8 (Figure 21 in **Appendix I**) are influenced more by the Abel project than Bloomfield.

Hydrographs for Bloomfield monitoring bores show that within a year or two of completion of mining, groundwater levels in the surficial aquifer will recover to above the model-predicted 2006 levels. The recovery model run shows that ultimately groundwater levels will stabilise at levels well above the 2006 levels.

The predicted drawdown impacts on the surficial aquifer are not expected to have any adverse impact on groundwater dependent ecosystems, because the groundwater levels are already well below ground surface, the groundwater in the surficial aquifer is saline and none were found on the Project Area during the Flora, Fauna and Threatened Species Assessment (refer **Section 7.4.6**).

12.3.4 Potential Impacts on Wallis Creek and Buttai Creek

The combined effects of Bloomfield, Donaldson and Abel are predicted to mutually interact and have small impacts on stream baseflows. It is therefore not possible to totally isolate the effects of Bloomfield from the combined impact. However, due to proximity, the Wallis and Buttai Creek baseflows will be more sensitive to Bloomfield than to Donaldson or Abel.

The model shows that there will be only minimal reduction in baseflows to Wallis Creek and Buttai Creek as a result of completion of mining. The maximum baseflow reduction in Wallis Creek is predicted to be 19 kL/d (0.2 L/s), which equates to 2% of the current modelled baseflow. A much smaller baseflow reduction is predicted for Buttai Creek, reaching a maximum of just 5.1 kL/d (0.06 L/s) in Year 8, or 35% of the current model-predicted baseflow. Nil baseflow impact is predicted for all the smaller tributary streams.

Monitoring of baseflow impacts at Buttai Creek is considered impractical due to the buffering effect of the wetlands on flow measurement and because a reduction of 5 kL/d would be too small to detect. It is recommended that baseflow impacts in Buttai and Wallis Creeks are assessed by reference to the groundwater model predictions, in conjunction with groundwater level monitoring at Sites 1 and 8 (as shown on Figure 21 in **Appendix I**). Drawdown impacts significantly greater than those predicted by groundwater modelling should trigger an investigation by an approved hydrogeologist, and if necessary, a re-run of the groundwater model to determine possible baseflow impact.

Like groundwater levels, the recovery modelling also predicted that baseflows in Wallis Creek and Buttai Creek would recover to higher than current levels. Rapid recovery is predicted to occur in both streams in the first 20 years post-mining, and baseflows would be fully stabilised at above 2006 levels within 60 years after completion of mining at Bloomfield.

12.3.5 Potential Impacts on Groundwater Quality

The groundwater in the Project vicinity is saline and of negligible beneficial use value. No adverse impacts on groundwater quality are expected as a result of the Project.

Longer-term, it is possible that some local improvement in groundwater quality may occur due to increased rates of recharge into former pit areas that have been backfilled with waste. If evaporation from any water bodies that form in the residual pit voids exceeds recharge from direct rainfall, the voids could become groundwater sinks. The balance between recharge and evaporation will depend on the relative sizes of the water surfaces (evaporation) and the void catchment areas (recharge). This balance will be dependent on the rate of ongoing deposition of washery rejects after completion of the Project, which is discussed in the Abel Project EA.

12.3.6 Potential Impacts of Tailings and Coarse Rejects Disposal

It is proposed that washery tailings and coarse rejects will continue to be deposited into abandoned open cuts on the Project Area. This will in time include the final pit voids remaining at the completion of the Project.

Water draining from the tailings deposited into the open cuts is currently making its way through old voids and directly through the coal seams into the former underground workings in the Big Ben Seam, from where it is recovered by pumping from the "Big Ben Borehole" and transferred into the water supply circuit for re-use in the washery. The tailings disposal has caused the development of a slight mound near the northern part of the Bloomfield lease and recovery from the Big Ben Bore has, in conjunction with pit dewatering, led to the formation of a pronounced cone of depression near the central southern part of the lease. This pattern is expected to continue until completion of mining.

After completion of mining at Bloomfield, the washery will continue to operate, and tailings/rejects disposal to the former open cuts will continue, and water will continue to be recycled from the tailings by recovery from the Big Ben Bore or by other means. Therefore, the current pattern of a small groundwater mound or mounds (in disposal areas) and small depression (around water recovery areas) is expected to continue. The depth of the cone of depression is expected to diminish over time, due to the cessation of dewatering pumping from the open cuts, other than for recycling of washery tailings water.

The rate of operation of the washery, and therefore the rate of backfilling of final voids, tailings and rejects disposal and water recovery, is discussed in the Abel Project EA. However, the pattern of behaviour described above is considered likely to apply.

12.4 MONITORING AND MANAGEMENT

The monitoring program currently operating at the Bloomfield mine will be continued and will be integrated with the surface water monitoring program. As required, monitoring bores will be licenced under the *Water Act 1912* and/or the *Water Management Act 2000*. Monitoring will include:

- Three monthly measurement of water levels in all piezometers;

- Six-monthly sampling of all standpipe piezometers for EC, TDS and pH;
- Annual sampling from all standpipe piezometers for physical properties (EC, TDS and pH), major cations and anions, nutrients, and dissolved metals;
- Monthly measurement of the volume of mine water pumped from the open cuts and from the former underground workings. Separate inflow rates will be monitored if two or more separate mining areas are active at any time; and
- Monthly measurement of EC and pH of mine water pumped from the open cuts.

The following response plan will be implemented in the event of significant unforeseen variances from the predicted inflow rates and/or groundwater level impacts:

- Additional sampling and/or water level measurements to confirm the variance from expected behaviour.
- Immediate referral to a qualified hydrogeologist for assessment of the significance of the variance. The review hydrogeologist would be requested to recommend an appropriate remedial action plan or amendment to the mining or water management approach. If appropriate, this recommended action plan would be discussed with DWE and other agencies for endorsement.

12.5 CONCLUSIONS

The groundwater investigations led to the following principal conclusions:

- Groundwater quality is variable, with salinity ranging from less than 1000 mg/L to more than 13000 mg/L TDS. pH is generally close to neutral.
- Groundwater is present in most lithologies in the area, but significant permeability is generally only present in association with cleat fracturing in the principal coal seams in the Permian coal measures. Groundwater levels generally fall to the east and west from a central ridge coinciding approximately with the axis of the Four Mile Creek Anticline. Water levels range from around 35 metres AHD near the central northern end of the Project Area to around 10-15 metres AHD along the eastern boundary, and around 15-20 metres AHD at the north-western corner. The groundwater levels in the Permian coal measures are unrelated to the local topography, and are frequently artesian (i.e. above ground level) in low-lying areas.
- Surficial groundwater levels in the alluvium/colluvium, probably including the thin upper highly weathered zone of the Permian coal measures, are strongly controlled by the local topography, and appear to be unrelated to the groundwater in the underlying less weathered Permian coal measures. Thus the surficial groundwater

water levels are above the Permian groundwater levels in elevated locations and below the Permian levels in low-lying areas.

- The dewatering operations at Bloomfield and Donaldson have caused noticeable cones of drawdown in groundwater levels along the southern margin of the Bloomfield Open Cut. This appears to have had negligible impact on groundwater levels in the alluvium/colluvium, or in the Permian coal measures lithologies that are stratigraphically above the zones that have been directly intersected by the open cut.
- Dewatering will continue to be required as part of the Project. The total groundwater inflow rate is predicted to average 1.4 ML/d (500 ML/yr), peaking at 2.1 ML/d (770 ML/yr) in Year 6 (during Stage 3). These inflow rates are similar to those currently occurring. Sensitivity modelling suggests that the maximum inflow rates could be between about 2.0 and 2.3 ML/d.
- Dewatering associated with the Project is predicted to impact groundwater levels in the strata above the Big Ben. Maximum drawdowns of approximately 40m are predicted in the coal measures near the southern end of the lease, but as the pit retreats to the north in later years, groundwater levels are predicted to recover to above the present (2007-8) levels even before completion of mining at Bloomfield.
- Recovery of groundwater levels after completion of mining have been assessed by 100 years of post mining simulations. Recovery modelling has predicted that groundwater levels will recover to well above current levels, and recovery will stabilise over the Bloomfield lease area within 20-30 years after completion of mining.
- Small impacts on stream baseflows are predicted to occur in Wallis Creek and Buttai Creek baseflows. No other surface streams are predicted to be impacted by the Bloomfield proposal. Modelling predicts rapid recovery post-mining.
- No adverse impacts on surface water quality are expected.
- No existing groundwater supplies are expected to be impacted.
- No adverse impacts are expected on any groundwater dependent ecosystems.

13. SOCIO-ECONOMIC ASPECTS

13.1 THE COAL MINING INDUSTRY

The minerals industry is one of the largest industry sectors in NSW, estimated by the NSW Minerals Council to produce approximately $12 billion of resources each year and with exports worth more than $8 billion. The industry annually contributes more than $1 billion to government in royalty payments and state and federal taxes. As the largest customer of the NSW rail network and the ports of Newcastle and Port Kembla, the industry also pays over $500 million to government towards the cost of these facilities as well as other service costs such as water and electricity. **Table 18** shows the strong growth of the mining industry and the taxes paid by the mining industry.

Table 18 Growth of the Australian Mining Industry

	1996-1997 ($M)	2006-2007 ($M)
Value of mining exports Australia (1)	17,937.2	62,741.0
Total tax Expense by mineral companies (2)	1,783	8,035

(1) Source: ABS 5368.0 International Trade in Goods and Services.
(2) Includes direct and indirect taxes. Source: Mineral Council of Australia-Minerals Industry Survey Report.

13.2 REGIONAL PROFILE

The Project lies wholly within the Cessnock LGA. According to the 2006 Census, the population of Cessnock LGA is 48,265. Approximately 7.7% of the population are employed in mining. This is larger than the 3.5% of the population of the Hunter Statistical Division. **Table 19** provides a comparative distribution of employment in various industry sectors in Cessnock LGA, with the state of NSW, and Australia wide. It shows that the mining, manufacturing, retail and accommodation sectors in the Cessnock economy are of greater relative importance than they are to the NSW economy in general. In addition, the local importance of coal mining is shown in the comparison of the regional economy and the national economy.

Table 19 Comparative Employment Distributions from 2006 Census

2006 Census Sector	Cessnock LGA	Australia	2006 Census Sector	Cessnock LGA	NSW
	% of population (calculated average)			% of population (calculated average)	
Coal mining	6.6	0.3	Agriculture, Forestry and Fisheries	2.3	2.7
Hospitals	3.0	3.3	Mining	7.7	0.7
Accommodation	3.3	1.3	Manufacturing	14.1	9.6
School Education	3.1	4.5	Retail	13	1.2
Cafes, Restaurants and Takeaway Services	3.9	3.6	Accommodation and Food Services	9.5	6.5

(Source: Australian Bureau Statistics www.abs.gov.au)

13.3 ECONOMIC AND SOCIAL IMPACT ASSESSMENT

The key benefits of the Project include the continuation of economic benefits to the local region and NSW associated with ongoing employment, operational expenditure and employee expenditure. The flow-on effects contribute to a range of sectors including wholesale and retail trade, accommodation, cafes, restaurants, rail and road transport, agriculture and mining machinery sector, electricity supply, and community services.

A quantification of the economic impact of Bloomfield coal mining operations on the economy of the Hunter Region was undertaken by the Hunter Valley Research Foundation (HVRF, 2008). The detailed report is provided in **Appendix J**. Bloomfield draws on the services provided by another company in the Bloomfield Group, known as Four Mile P/L. It provides engineering support services to two mines in the Bloomfield Group, Bloomfield Collieries and Rix's Creek near Singleton.

13.4 DATA AND METHODOLOGY

Data was provided from Bloomfield Colliery and Four Mile Pty Limited as a proportion of the operations of the Four Mile Pty Limited subsidiary have been included in this analysis. Any reference to Four Mile Pty Limited only refers to the proportion of activity which is attributable to the operation of Bloomfield Collieries. The information was provided based on operational expectations for 2008 which was also assumed to be typical of the future activities of Bloomfield Collieries and Four Mile Pty Limited. Although the assessment focused on one year, the results outlined represent the annual initial and flow-on benefits that will accrue to the Hunter Region economy for each year of operation.

The analysis was based on the HVRF 2001 input output ('I-O') model of the Hunter Region economy. The I-O model was developed for the Hunter Region economy and uses multipliers to assess the impacts on the regional economy that would result from the operation of Bloomfield Collieries and Four Mile Pty Limited. The model makes assumptions that may act to reduce the extent of any impacts. These are provided in **Appendix J**.

13.5 RESULTS

Data supplied by Bloomfield Colliery shows that almost all mine employees live in the Lower Hunter, and 95% of Bloomfield Colliery suppliers are located in the Hunter Region. This direct support of the local community results in flow-on impacts as shown in **Table 20**.

Table 20 Flow-on Output Impacts of Bloomfield Collieries for 2008

Type of impact (base year = 2008)	**$M**
Multiplier impacts	
Production (Combined repairs and mining)	33.0
Consumption (Combined repairs and mining)	16.5
Total flow-on (multiplier impact)	**49.5**

As a result of the operation of Bloomfield Collieries (together with Four Mile Pty Limited) flow-on employment benefits will be generated in the regional economy from the production and consumption induced impacts. **Table 21** summarises these benefits. It should be noted that in **Section 2.4**, the number of employees of Bloomfield is given as 66, and that administration, management and washery staff, which were not include in **Section 2.4,** have been included in **Table 21.**

Table 21 Flow-on Employment Impacts of Bloomfield Collieries for 2008

Type of impact	Number of jobs
Initial – repairs (Four Mile Pty Limited)	30
Initial – mining (Bloomfield Collieries)	75
Multiplier impacts	
Production (Combined repairs and mining)	110
Consumption (Combined repairs and mining)	94
Total flow-on (multiplier impact)	204
Total output impact	**309**

(Job=one year and full-time)Total flow-on (multiplier impact)

13.6 ROYALTIES

In exchange for the right to extract minerals in NSW, royalties are paid to the Crown by the leaseholder of the mining operation. NSW legislation identifies the rate and point at which royalties are charged. Leaseholders determine the royalties owed and submit regular assessments and payments to the NSW DPI. These assessments are regularly audited by the Department.

The assessment excluded the value of royalties generated from Bloomfield Collieries as the payment of these royalties goes into Government revenue. Unlike expenditures paid to other industries, in return for the direct production of goods or delivery of a specific service, there is no clear product or service that is produced because of royalties. However, these royalties are documented as an additional benefit from the Project. The expenditure of this money by the Government will generate economic activity, but is beyond the scope of the report by HVRF to analyse the activity such revenue could generate. However, based on existing rates, HVRF predicts royalties to be approximately $3 million in each year Bloomfield Collieries operates. This rate was calculated on the coal price at the time of preparation of the EA. As royalty payments are linked to coal prices, which vary greatly over time, royalty payments from the Bloomfield Project could be lower or higher.

13.7 COMPLETION OF MINING AND REHABILITATION IMPACTS

As this Project is for the completion of mining and rehabilitation of the site, it is unlikely to result in any staff increases. This will not place additional stress on the local community for provision of additional housing/accommodation, health, education or social services.

The growth of mining sector in the region and state will ensure staff can be absorbed into other projects. The diversity of skills amongst staff will ensure they are not competing for similar jobs and will enhance reemployment opportunities. Some staff may choose to retire from the industry.

The ability of Bloomfield to complete mining operations and rehabilitate the site will provide an improvement in the visual quality of the area and reduce risks associated with erosion and sedimentation, and dust from unvegetated land. The ability to then develop the land for other purposes, including those outlined by the Lower Hunter Regional Strategy (refer to **Section 4.4.3**) will enable further economic growth for the region.

13.8 COMMUNITY ISSUES AND INVOLVEMENT

The impacts identified by community consultation related to dust, noise and lighting from the mine, and their visual amenity. The environmental issues raised by the community as part of the consultation program have been subject to specialist assessment as part of this EA. Management and mitigation activities to address each of these concerns are discussed in the relevant sections, Noise and Vibration-**Section 9**, Air Quality-**Section 10** and Visual Amenity-**Section 14**.

A range of mitigation and ongoing monitoring measures have been identified to address the predicted social impacts and issues raised by the community. Positive feedback was received regarding Bloomfield's existing community consultation process as discussed in **Section 5**. As part of the Bloomfield's ongoing community relations program, regular contact is undertaken with close neighbours and information provided in response to questions or issues raised. There is also scope for ongoing consultation with the community through the Bloomfield Colliery Community Focus Group and the distribution of the community newsletters. It is intended to prepare a newsletter for distribution on lodgement of the EA. The EA will also be placed on the Bloomfield website for public access.

13.9 CONCLUSION

The Project will continue to provide direct and indirect benefits to the local, regional and state economy. Proactive community consultation by Bloomfield Colliery will ensure minimised impact on the community from the Project. Rehabilitation of the site will enable it to be developed for other purposes including those outlined in the Lower Hunter Regional Strategy for continued economic growth for the region.

14. VISUAL AND LIGHTING ASSESSMENT

14.1 INTRODUCTION

An assessment of the visual environment including lighting was undertaken following community consultation that identified them as areas of concern. In particular, night lighting of existing operations was identified as an issue for the local community. Visual was not identified as an issue of high risk by the preliminary risk assessment. This assessment does not address the visual impacts of the washery, which forms part of the Abel Project Approval.

Visual amenity and lighting have been considered in more detail in this EA. The objectives of the visual assessment were to:

- Determine the visual qualities of the Project Area and surrounds;
- Identify viewing points around the site with the potential to view proposed operations within the site, in particular, residences or other places of public access, such as roads or public buildings or facilities, both for day and night-time operations;
- Determine the visual impact from these viewing points, in terms of scale, distance, change to landscape attributes, for both day-time and night-time operations; and
- Identify potential options to prevent, reduce or manage any identified visual impact.

The Project consists of four main visual elements:

1. The proposed open cut mining area, consisting of the active mine pits, emplacement areas, haul ramps and areas of active rehabilitation;
2. Haul road for the transportation of ROM coal from the open cut mining area to the ROM coal stockpile at the washery;
3. Access road from the open cut mining area to the workshop; and
4. The workshop area consisting of the workshop/maintenance shed, fuel farm and hard stand area for equipment storage.

14.2 ASSESSMENT METHODOLOGY

14.2.1 Visual Impact Factors

The assessment of overall visual impact took into account Visual Sensitivity and Visual Effect. Visual Sensitivity is a measure of how a change to the existing landscape is viewed by people from difference land use areas in the vicinity of the Project. Residences generally have a higher visual sensitivity than other land uses including industrial, agriculture or transport corridors. However, the sensitivity of individual residences may range from high to low depending on:

- The screening effects of any intervening topography, buildings or vegetation. Residences with well screened views of the Project have a lower sensitivity than those with open views;
- The viewing distance from the residence to visible areas of the Project. The longer the viewing distance, the lower the sensitivity; and
- The use of the view. Residences with active visual orientation towards the Project (living rooms, verandahs etc) have a higher sensitivity than those not orientated towards it and do not make use of the views towards it.

Visual Effect is the measure of the level of visual contrast and integration of the Project with the existing visual environment. The magnitude of the visual effect is determined by:

- Screening by topography and vegetation at, or adjacent to, the proposed visually affected area;
- The level of contrast and integration between the Project and the current landscape; and
- The proportion of the view occupied by the visible area of the Project.

Generally, a high visual effect will result if a visible area of the Project has a high visual contrast to the surrounding landscape and occupies a large proportion of the field of view. A low or very low visual effect will occur is there is minimal contrast between the visible areas of the Project and the existing landscape setting.

The visual impact of the Project is determined by considering both its visual effect and the visual sensitivity of viewers in surrounding area. Using this methodology, locations A-F in **Table 22** have been assigned a Visual Impact Level.

14.2.2 Map and Field Analysis

A review of topographic maps and aerial photography was completed to illustrate the visual screening effects of topography. Vegetation is also a key factor associated with visual screening with the dominant height of the vegetation in the area between 6-10 metres. Tree cover heightens the screening effect of the topography where it occurs. All topographic considerations were field checked to ensure accuracy of location and viewing points.

14.2.3 Visibility from the East and the West

The Project Area cannot be viewed from the east due to intervening ridgelines and vegetation. A vegetated ridgeline to the west prevents close views from this direction, although some distant views from Kurri Kurri may be had to the site. These are at such a distance that it is difficult to determine the site location in the overall view. An area of Buchanan Road to the west has views of current rehabilitation occurring to the north west of the Project Area.

14.2.4 Visibility from the North

Some Louth Park, East Maitland and Ashtonfield residences to the north and north-east have views to the disturbed grassland areas that form part of the Tailings Management System that does not form part of the Project. Most views are limited by an east-west running ridgeline to RL85 (shown on **Figure 25**) which is to be retained. Some existing general site disturbance can also be viewed.

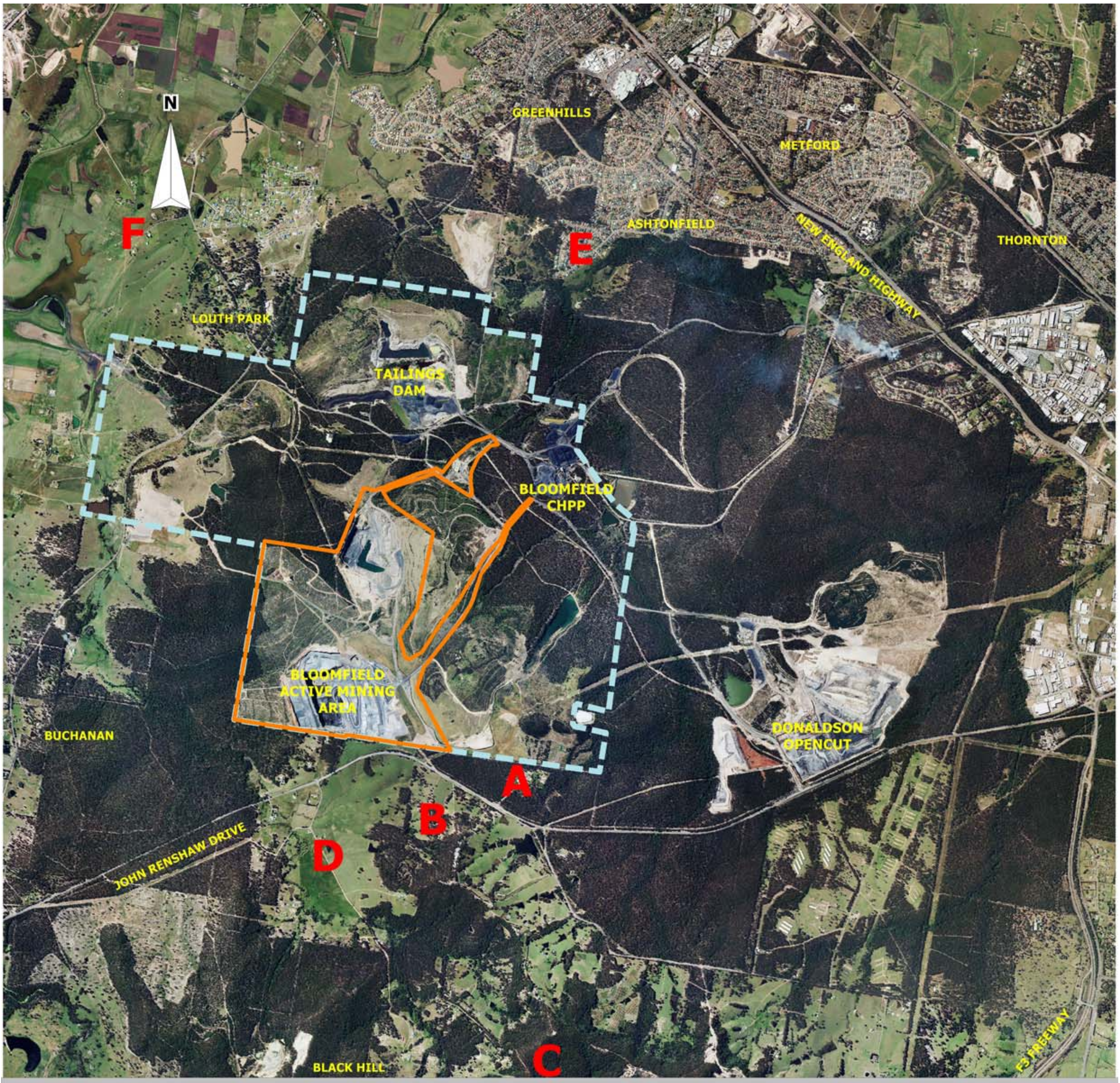
14.2.5 Visibility from the South

To the south of the existing mine boundary, rural residences are located along John Renshaw Drive, Lings Road, Black Hill Road and Browns Road. Browns Road rises to an elevation of 120 metres AHD and some residences along this road have extensive views to the north and north-east, some towards Port Stephens. They are able to view Donaldson operations. Bloomfield operations are generally screened by native vegetation and an intervening ridgeline south of John Renshaw Drive which includes Elliotts Hill. As the rehabilitation progresses, the mine operations will be increasingly screened by landform and revegetation.

Residences along Lings Road have views towards the proposed operations blocked by the vegetated Elliotts Hill which is located between the current mine and John Renshaw Drive, at an elevation of 70 metres AHD. Elliotts Hill will screen the majority of future operations from these residences, as this hill lies between the residences and the western extension of open cut operations. Residents may have minor views of some pre-stripping operations where elevation reaches 80 metres AHD. These operations will be of short duration and would not be viewed once the first level of extraction enables equipment to operate from a lower elevation within the pit.

14.2.6 Application of Study Method

For this assessment, a number of sites from the areas noted above were selected as representative viewing locations with reference to field assessment, aerial photography, topographic plans and community input. These sites are shown on **Figure 20**.



LEGEND

BLOOMFIELD MINING LEASE

PROJECT APPLICATION AREA

A VISUAL ASSESSMENT LOCATION

FIGURE 20

VISUAL ASSESSMENT SITE LOCATIONS

BLOOMFIELD COLLIERY COMPLETION OF MINING AND REHABILITATION

SEPTEMBER 2008

While there will be some variation in the impacts on specific viewing locations, an overall assessment of the visual impact on selected locations is considered to be representative for the majority of views.

Figure 21 to Figure 25 show photographs taken at selected locations during field inspections. These photographs were used to show current visual impact and predict impact as the Project progresses to completion.

14.3 VISUAL ISSUES

14.3.1 Landscape Setting

The landscape and visual setting of the Project Area and its surrounds is defined by undulating rural hills. Three major visual features of this landscape are the existing Bloomfield Colliery including washery and tailings dam, Donaldson Open Cut Mine and the natural feature of Elliotts Hill. There are extensive small rural landholdings surrounding the mine to the north, south and west. Residential areas of Ashtonfield are visible to the north.

14.3.2 Residential Areas (Ashtonfield)

These areas include both older and recent subdivisions in the suburb of Ashtonfield. These are generally located at the edges of urban development and viewers are likely to expect views of natural areas and bushland beyond the urban limits to be retained.

A ridgeline between the existing and proposed mining areas blocks views of potential disturbance from higher elevated residences at Ashtonfield (South Seas Drive, Tipperary Drive and Kilshanny Avenue). Residences that can view the washery and former mining areas around U Cut to the north of the Project Area will not view proposed operations due to this vegetated ridgeline, which is located within the Bloomfield Lease Area.

14.3.3 Rural Residential Areas (Black Hill Ridge)

The Black Hill Ridge area includes rural residential properties and small rural businesses which are concentrated in small groups along Black Hill Road and its side roads, such as Browns Road. Views are minimised by existing native vegetation and most residences are oriented to the north-east, whereas Bloomfield is to the north-west. Despite the prominent positions of many of the Black Hill Ridge residences in the landscape, those that may view parts of the Project would view it as part of a distant vista of established mining disturbance in the area. Views would improve as rehabilitation was completed.

14.3.4 Buttai Valley

The Buttai Valley lies south of the existing mine lease and Project Area. It is dominated by rural residential properties along John Renshaw Drive, Lings Road, and Old Buttai Road. Although views of the southern boundary of the existing mine area are minimised by existing topography and vegetation remnants, residents currently see some lights, trucks, and the active rehabilitation of the mine along the southern boundary. Similar to Ashtonfield and Black Hill, mining is an established land use in the area and, to a degree, the Buttai Valley residents would be used to seeing evidence of mining in their view. The visual impact is restricted to works along the southern boundary and will be reduced by the viewing distance and intervening topography as the existing mine moves northwards and rehabilitation occurs in the southern section of S Cut.

14.3.5 Viewers along John Renshaw Drive

Viewers along John Renshaw Drive will generally be limited to motorists. John Renshaw Drive is a State Road and provides a regional link between Cessnock and Kurri Kurri to the F3 Freeway near Beresfield, carrying significant amounts of traffic. The perceptibility of motorists is an important factor. Travelling at high speed, motorists are unable to perceive a great level of detail, particularly small elements and details. They are more likely to be sensitive to changes that affect long, horizontal elements which are more important in shaping the visual character of a road, as they can be more easily perceived as the motorist drives along the road corridor. Such elements include the stands of native vegetation along the road which take on an almost horizontal nature when seen by the motorist.

The road functions primarily as a link road and a large proportion of motorists along John Renshaw Drive would use the road to commute to work (including accessing other industrial and/or commercial facilities in the region) or to transport goods. This suggests that they would be less sensitive to changes in the visual environment than, for example, recreational users or tourists, especially to the Hunter Valley Vineyards. Views towards the mine site are restricted to works along the southern boundary which, when rehabilitated early in the Project, will block views of active mining operations as they progress northwards.

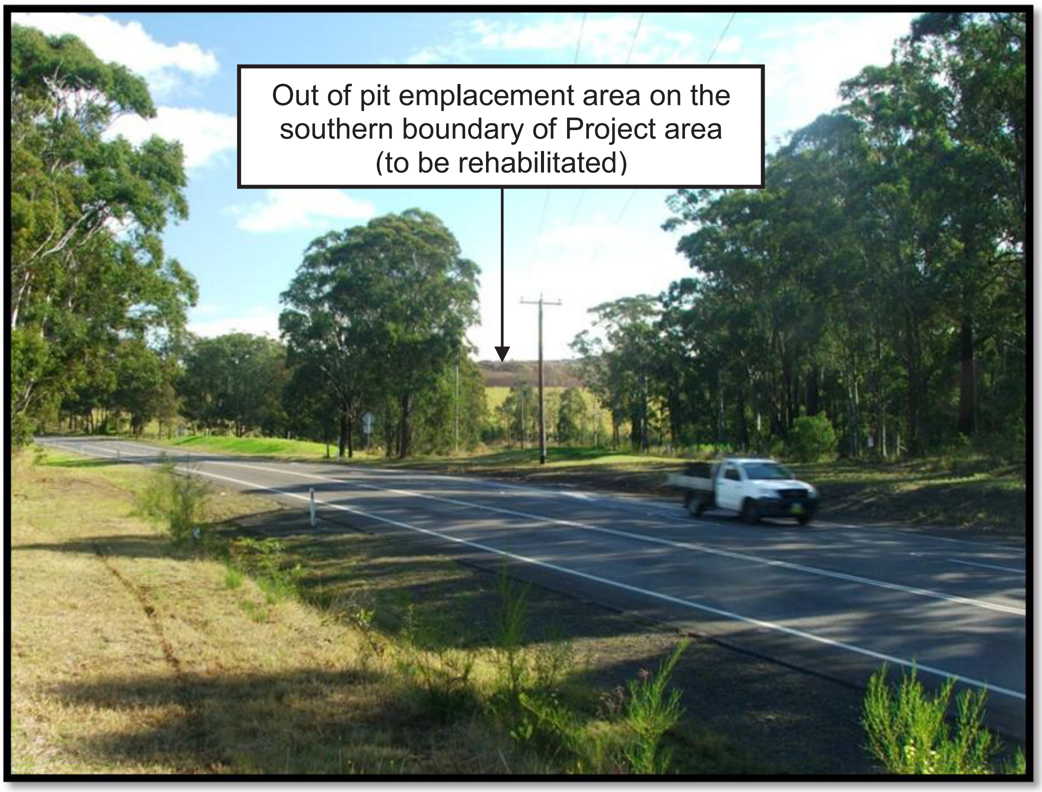


Figure 21: View North West from John Renshaw Drive Towards South Eastern Boundary of Mine Lease.

Figure 22: View of Southern Boundary of Mine Lease from Lings Road.

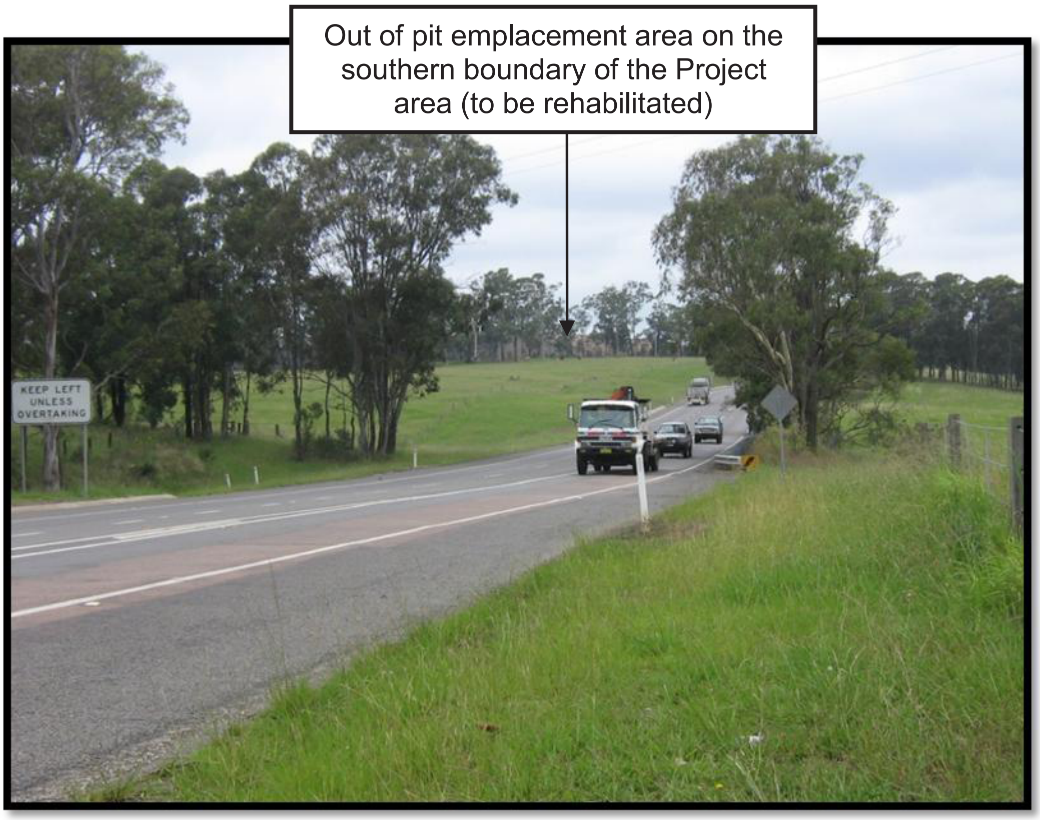


Figure 23: View North East Along John Renshaw Drive Towards Southern Boundary of Mine Lease.

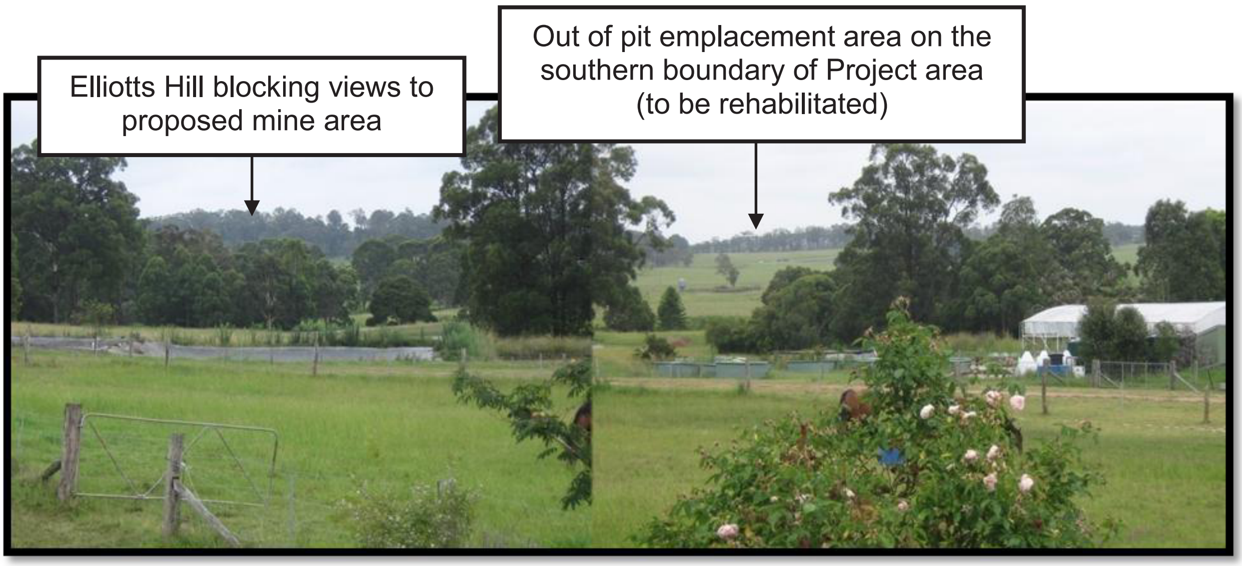


Figure 24: View North East from Property in Buttai Valley Showing Stockpiles Along Southern Boundary of Mine Lease.

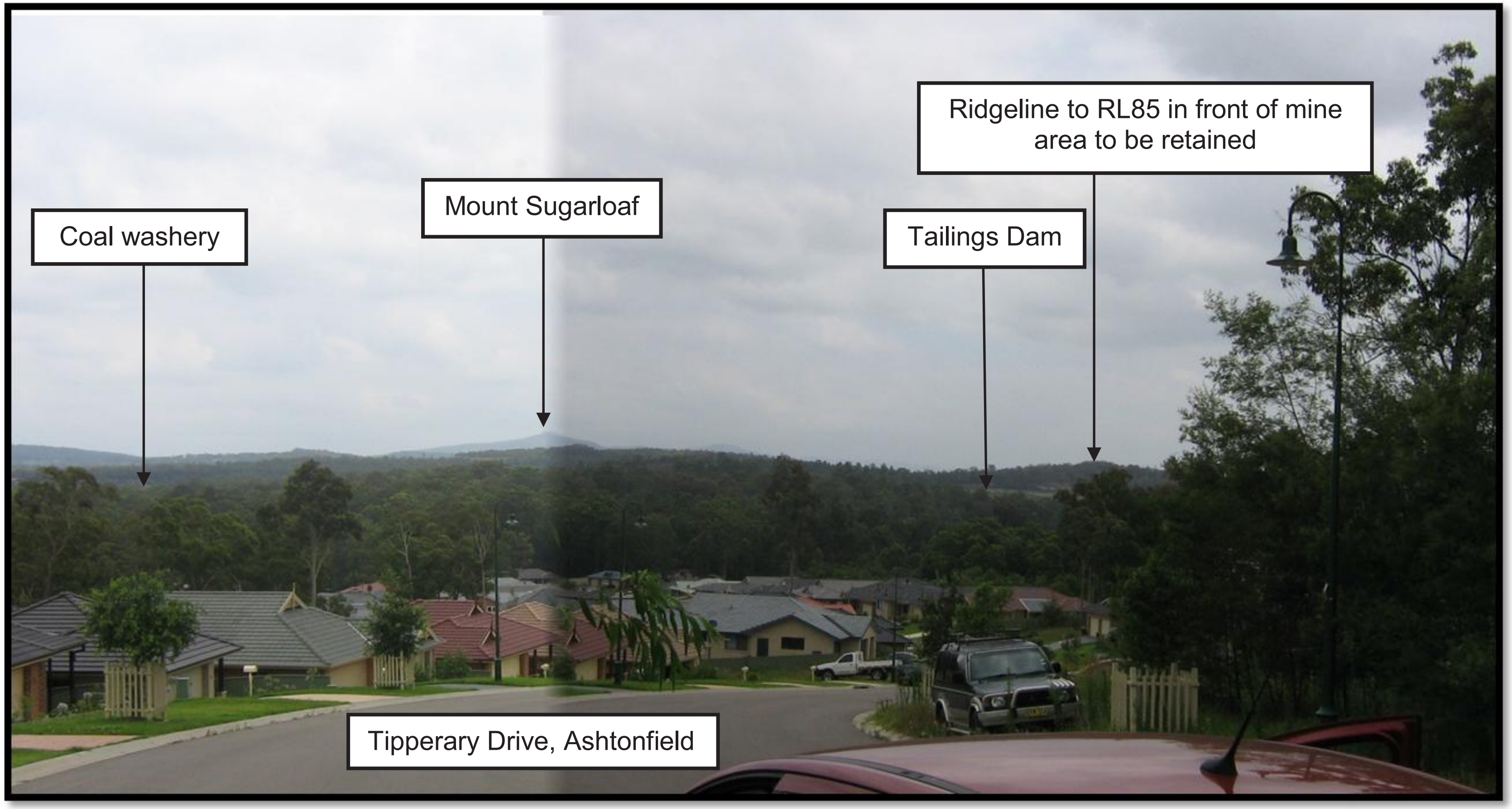


Figure 25: View South-South West from the Junction of Tipperary Drive and Kilshanny Ave, Ashtonfield.

14.4 LIGHTING IMPACTS

14.4.1 Introduction

The visual impact of lighting will be influenced by the location of operations on-site, the relative level at which the viewing location is situated and the presence of any off-site barriers such as topographic features and/or vegetation. There are two types of lighting effects.

- The first effect where the light source is directly visible and if there is a direct line of sight between a viewing location and the light source.
- The second effect relates to the general night-glow (diffuse light) that results from light of sufficient strength being reflected into the atmosphere. This type of effect will create a strong local focal point and the effect will vary with distance and atmospheric conditions such as fog, low cloud and/or dust particles which all reflect light.

14.4.2 Direct Light Effects

Locations that would have direct line of sight to night lighting for the Project Area are Buttai Valley and, at a further distance, Black Hill to the south. This will occur during the early stages of mining close to the southern boundary. Close consultation with residents and attention to the direction of fixed site lighting will reduce the impact on residents.

The visual effect of lighting associated with the Project would be at a similar level to that currently experienced. During focus group discussions, residents on the southern side of Old Buttai Road raised the issue of lighting from night-time operations shining towards their residences. This issue was immediately resolved by re-directing lighting.

14.4.3 Diffuse Light Effects

Most operational areas and machinery night lighting will not be directly visible from most locations due to the screening effect of topography and vegetation. Rather, a diffuse effect of light and its interaction with atmospheric conditions may from time to time create a glow around the Project Area. Due to the existing mining on and around the Project Area, the visual impact of the diffuse light associated with the Project will be reduced.

The diffuse night lighting effect of the Project will be similar to that which is currently experienced with the Bloomfield Colliery and would include illumination created by other nearby industrial developments.

14.5 VISUAL IMPACT ASSESSMENT

The results of the visual impact assessment of the area surrounding the Project Area are shown in **Table 22**. The Visual Impact Level is referred to as Low, or Moderate to Low.

Table 22 Visual Assessment of the Area Surrounding Bloomfield Mine

Locations (as shown on Figure 20)	Visual Impact Stages		
	Current	**During Operations**	**At Completion of Project**
A North of John Renshaw Drive	Most views prevented by trees to W-NW. Residence is approx 725m from East and South corner of Project Area, and approx 1.36km from nearest area of disturbance (overburden dump (OD)) to the NW.	Most views prevented by trees to W-NW. View of OD will diminish as OD migrates west and is progressively rehabilitated. Lights from trucks will be negligible due to height of reshaped areas.	Most views prevented by trees to W-NW. When rehabilitation is complete, visual effects will be low and become very low when informal tree and shrub planting is completed.
Visual Impact Level	Low	Low	Low
B South of John Renshaw Drive	Views prevented by trees to N-NW and topography to west. Residences are 700-800m from southern boundary of Project Area, and 800-1200m from nearest area of disturbance (OD) to the NW-NNW.	Visual impact will diminish over time as rehabilitation progresses west out of their line of sight behind Elliotts Hill. May see lights from trucks and pit.	When rehabilitation is complete, visual effects will be low and become very low when revegetation is completed.
Visual Impact Level	Low	Low	Low
C Black Hill (Browns Road)	Views prevented by trees and topography to N-NW. Residences are approx 2.8km from southern boundary of Project Area, and approx 3.1km from nearest area of disturbance (OD) to the NW.	Visual impact increases as area of OD increases.	When rehabilitation is complete, visual affects will be low and become very low when revegetation is completed.
Visual Impact Level	Low	Low	Low
D Buttai Valley (south of John Renshaw Drive)	Residences lie 580m to 1.45km from southern boundary of Project Area, and from nearest area of disturbance (OD) to the N. Can see southern extremity of OD through a thin band of mature Eucalypts along the southern boundary of Project Area. Some residences have more trees in valley between them and mine to block views.	Visual impact will diminish over time as OD and rehabilitation progresses west out of their line of sight behind Elliotts Hill. OD will be top dressed in short term and all workings will be screened by this.	When rehabilitation is complete, visual effects will be low and become very low when re-vegetation is completed.
Visual Impact Level	Moderate	Moderate-Low	Low

Locations (as shown on Figure 20)	Visual Impact Stages		
	Current	**During Operations**	**At Completion of Project**
E Ashtonfield	These residences are approx 3km from the northern boundary of the Project Area and from the nearest area of disturbance (existing washery) to the SW. Existing ridgeline intervenes.	View unlikely to change significantly as work areas screened by topography and existing vegetation.	View unlikely to change significantly as work areas screened by topography and existing vegetation.
Visual Impact Level	Low	Low	Low
F North west of Louth Park	These residences are approx 3km from the northern boundary of the Project Area and 4.5km from the nearest area of disturbance (OD) to the SE.	View unlikely to change significantly as work areas screened by topography and existing vegetation.	View unlikely to change significantly as work areas screened by topography and existing vegetation.
Visual Impact Level	Low	Low	Low

14.6 MANAGEMENT AND MITIGATION OF VISUAL IMPACT

14.6.1 Visual Impact

Ongoing rehabilitation by Bloomfield Colliery will improve the visual quality for residences with a view of the current mining operations, especially to the south of the Project Area. Residences who currently view current mining areas within the Project Area will see an improvement in visual quality as rehabilitation progress.

Priority will be given to the completion of rehabilitation along the southern boundary of the Project Area. This would reduce any potential visual impact, especially for residents in the Buttai Valley and users of John Renshaw Drive.

14.6.2 Lighting Impacts

Lighting impacts should be kept to the minimum necessary for operational and safety needs. Where possible, lights should be utilised at the lowest effective level and directed away from incoming views, in particular, Buttai Valley, John Renshaw Drive and Ashtonfield. All lighting should be directed to the ground and to within the work area and avoid being cast skyward or over long distances.

Procedures are in place to ensure lighting does not shine directly toward residences in any direction, particularly to the south. Staff and management should continue to be trained in the management of night lighting, as is currently practised. All potentially affected residences have been provided with mine contact details so that they may contact the mine and resolve any lighting issues as soon as possible.

14.7 CONCLUSION

The visual impact of the Project is considered to be low due to the limited visibility, low sensitivity of all but a few viewing locations and the short timeframe with which any visual effect can be reduced from moderate to low and eventually to very low impacts.

The proposal will greatly improve visual quality of the mine lease area as rehabilitation will re-shape and revegetate areas disturbed by previous mining operations.

15. PROJECT INTEGRATION & CUMULATIVE IMPACT ASSESSMENT

15.1 INTRODUCTION

The Bloomfield Project is integrated with components of nearby mining operations, including the Abel Mine, Donaldson Mine and Bloomfield washery. Cumulative impact, or the change in degree of impact that may occur when nearby projects are taken into consideration, has therefore formed an integral part of each assessment study undertaken for this EA.

The detailed assessment studies provided as Appendices in **Volumes 2** and **3** should be referred to for detailed information on potential cumulative impact. This section provides an overview of the results of these studies with regard to cumulative impact. Each study has concluded that, when cumulative impacts are taken into account, potential impacts remain low.

This section also discusses the management relationships between the various projects, in terms of who is responsible for the various integrated components. As shown on **Figure 26**, the Bloomfield Project Area lies within the approved Abel Project Area. This section explains this overlap and how the various components will be managed.

15.2 BLOOMFIELD AND ABEL PROJECT BOUNDARIES

Figure 26 shows that the approved Abel Project Area included land that is also within the Bloomfield Project Area. The integrated water management system that manages water across the Abel, Donaldson and Bloomfield projects formed part of the Abel Project approval and is located across all three sites. The use of the Bloomfield final voids and previous mine areas for rejects disposal from the Bloomfield washery also formed part of the Abel Project approval.

Open cut mining and rehabilitation within the Bloomfield Project Area does not form part of the Abel Approval. The completion of mining and rehabilitation, and associated activities required to undertake these actions is the subject of this current Application, referred to as the Bloomfield Project.

15.3 BLOOMFIELD PROJECT INTEGRATION

Key aspects of the Bloomfield Project that are integrated with the operations of adjacent projects include:

- Delivery of coal from the Project to the washery which also processes coal from other operations and which will continue after completion of the Project;
- Water management system components utilised by multiple operations, such as the Bloomfield, Donaldson, and Abel mines and the Bloomfield washery, with the open cut water management forming part of the overall integrated water balance;
- Provision for a final void that will be used for future management of washery reject and tailings;
- Integrated rehabilitation planning, considering the final land use proposed for multiple sites; and
- Integrated environmental monitoring program for the adjacent sites.

These aspects are described as follows, with **Table 23** providing a summary of planning approval responsibilities for the various components. In **Table 23**, the tick (√) allocates planning approval responsibility (including the satisfying of the various consent conditions) to each of the aspects described in Column 1. Responsibility is allocated either to Bloomfield as part of this Project Application, or to the Abel Project, approved by DoP in 2007 (MP 05_0139).

It is important to note that while an approval may be provided under the Bloomfield or Abel Project, commercial agreements may be made between the different entities allocating responsibilities for the actions required under those Project consents.

Table 23: Summary of Responsibilities – Relationship Between This Application and the Abel Project Approval

Project/Operational Aspect	Responsibility of this Bloomfield Application	Responsibility of Abel Project Approval (MP 05_0139)
Completion of mining at Bloomfield Colliery	√	
Bloomfield open cut coal delivery to the washery (ROM coal stockpile pad)	√	
Operation of the washery		√ (operated by Bloomfield)
Rehabilitation of Bloomfield Project mining areas	√	
Filling of Bloomfield final voids with washery reject material		√
Rehabilitation of final voids		√
Integrated Environmental Monitoring Plan		√ (some actions undertaken by Bloomfield)

15.3.1 Coal Delivery and Washery Operation

This Application includes the transport of coal to the ROM coal stockpile pad at the washery via internal haul roads. The operation of the washery (to process the coal) and management of the ROM coal stockpile pads was approved by the 2007 Abel Project Approval. The rail loading facility used to load coal for transport by rail to the Port of Newcastle also operates under the Abel Project Approval. The washery and rail loading facility are used by the various nearby mines, including the Abel, Donaldson and Tasman Mines, as well as the Bloomfield Mine.

Bloomfield currently operates the washery and rail loading facility, under the Abel Project Approval.

15.3.2 Water Management

With the exception of a sediment dam on the headwaters of Buttai Creek, introduced specifically to assist the management of water for the Bloomfield Project, the water management system that supports the existing and proposed mining at Bloomfield forms part of the Integrated Water Management System (IWMS) provided for the Bloomfield, Abel and Donaldson mines. This IWMS was approved under the Abel Project and is shown schematically on Error! Reference source not found..

The IWMS involves the management of all surface runoff and groundwater sources associated with the Abel, Bloomfield and Donaldson mines, ensuring continuous supply to the Bloomfield washery whilst minimising discharge to Four Mile Creek from the operating areas.

Water management structures included in the Abel Project Approval and managed by Bloomfield are detailed in **Section 11.6**.

15.3.3 Final Void Management

A final void will remain on the site after completion of Bloomfield mining. Its location is shown on **Figure 10** and **Figure 12.** The final void will be used as an active disposal site for reject material from the washery, as approved by the Abel Project. The rate of backfilling of the final void, tailings and rejects disposal and water recovery, is described in the Environmental Assessment for the Abel Project. It states that rehabilitation of rejects emplacements "*will be undertaken in accordance with DPI guidelines which require the Bloomfield Mine Operations Plan, required as a condition of the Bloomfield mining lease, to provide details on proposed outcomes to be achieved through rehabilitation and final landform.*" (Donaldson Coal, 2006, p. 2-19)

Bloomfield plans to rehabilitate reject emplacement areas, once capacity has been reached, by shaping to a stable, undulating, self draining landform with mixed cover of pasture and native vegetation. These plans may in future be influenced by the needs of other projects that utilise the final void, as described in **Section 3.7**. Final void rehabilitation objectives and land use options are described in detail in **Section** Error! Reference source not found..

15.3.4 Rehabilitation

Rehabilitation of the Project Area will occur progressively throughout the life of the Bloomfield Project. Bloomfield is responsible for land rehabilitation within all parts of the Project Area, with the exception of the final void, which forms part of the Abel Project approval. An agreement between Bloomfield and Abel management will determine who undertakes final void rehabilitation. This agreement will depend on timeframes and any future plans for the site.

A detailed description of timing and schedules for the various projects and how this affects rehabilitation options is provided in **Section** Error! Reference source not found..

15.3.5 Integrated Environmental Management Program (IEMP)

An Integrated Environmental Monitoring Program (IEMP) developed as part of the Abel Project Approval has been approved by DoP and is currently being implemented as described in **Section 15.4**. Impact assessment studies undertaken for this Project and recommended monitoring regimes have considered the existing IEMP requirements.

15.4 INTEGRATED MONITORING

Bloomfield Colliery operations are included in an Integrated Environmental Monitoring Program (IEMP) that integrates monitoring stations and data between the Bloomfield, Donaldson and Abel Mines and to some degree the Tasman Underground Mine to the south. The IEMP was developed as part of the Abel Project Approval. The IEMP will be modified as necessary to take into account any additional requirements for the Bloomfield Project. The post-mining rehabilitation strategy also incorporates Abel Mine and washery requirements, as these will continue operating after the completion of the Bloomfield Project.

The aims of the IEMP are to:

- assist in the development of a sub-regional model of environmental data collection from a wider area;
- reduce duplication of monitoring on individual sites; and
- identify sensitive areas that may be between mine sites that require monitoring to enable more effective sub-regional data sets.

Data sharing across the operations provides a more accurate indication of the condition of the environment and is considered important in creating further management and mitigation measures. The increased data set is also important in determining cumulative impacts from the operations on the sub–regional environment.

The integrated monitoring equipment is operated, maintained and installed by a joint arrangement between Donaldson Coal Pty Limited and Bloomfield Collieries Pty Limited. All data from the IEMP will be made available to both parties.

The various monitoring programs that make up the IEMP have been prepared in consultation with key government departments and agencies including Department of Water and Energy (DWE), Department of Environment and Climate Change (DECC) and Maitland and Cessnock Councils.

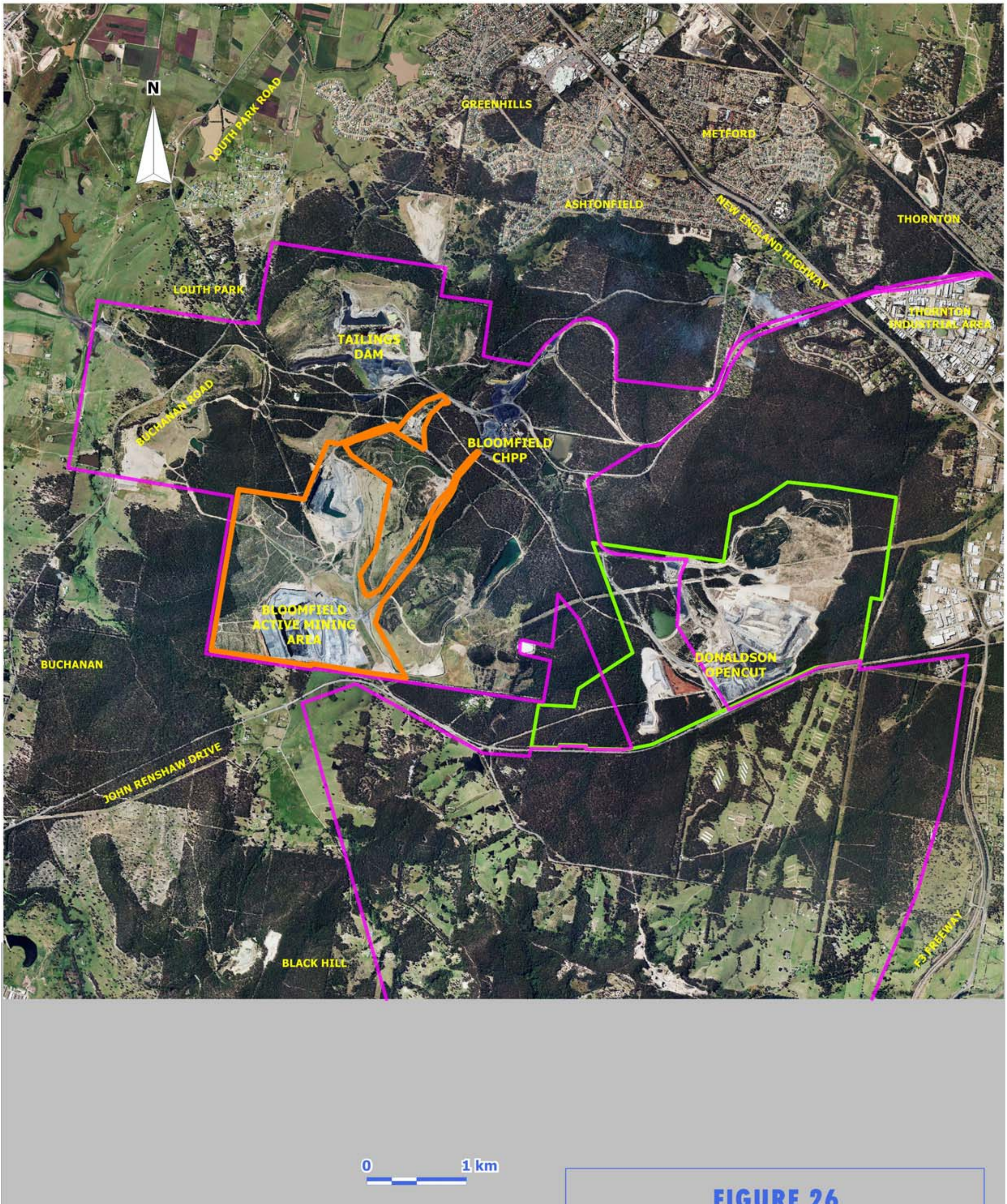
The primary objectives of the IEMP are to ensure that:

- monitoring locations provide adequate coverage when considered collectively, and are not unnecessarily duplicated;
- monitoring parameters are consistent across the sites;
- monitoring techniques are consistent across the sites; and
- monitoring frequencies are consistent across the sites, with the timing of monitoring synchronised where suitable.

Monitoring in the IEMP includes:

- Noise;
- Blasting;
- Air Quality;
- Surface Water and Groundwater;
- Meteorological;
- Flora and Fauna; and
- Aboriginal and Cultural Heritage.

Impact assessment studies and recommended monitoring regimes provided for this Project have taken into consideration existing IEMP requirements and reviewed their suitability for the Bloomfield Project, as well as any additional items that may be required.



LEGEND

- PROJECT APPLICATION AREA
- ABEL MINE PROJECT AREA
- DONALDSON MINE PROJECT AREA

FIGURE 26

THE BLOOMFIELD PROJECT AND ADJACENT MINE PROJECTS

BLOOMFIELD COLLIERY
COMPLETION OF MINING AND REHABILITATION

SEPTEMBER 2008

15.5 CUMULATIVE IMPACT ASSESSMENT

The following provides a summary of cumulative impact considerations for each of the impact assessment studies undertaken for the project. Details are provided in the various studies (**Volumes 2 and 3**).

The Flora, Fauna and Threatened Species Assessment took into consideration habitat requirements and ecological communities across the broader area of the Bloomfield, Donaldson and Abel Mine sites as well as adjacent landholdings. The study concluded that the Bloomfield Project would not fragment habitat as vegetation to be cleared in the eastern block is already surrounded by cleared land and the clearing in the western block would be a small portion taken out from the cleared edge. There is over 2000 ha of relatively unbroken vegetation in the vicinity of the proposed cleared area.

Although, the Project may result in the loss of 0.8 ha of the *Lower Hunter Spotted Gum – Ironbark Forest* Endangered Ecological Community (EEC), there is approximately 145 ha of this community in the immediate vicinity of the potential disturbance area and the loss of 0.8 ha would not have a significant impact on the remaining community.

The Heritage assessment concluded that, given the high levels of existing impacts within the study area and the low to very low potential for any sub-surface deposits that may be in situ or of research value, the cumulative effect of the Project on the identified and potential Aboriginal heritage resources of the region is low.

The Noise, Blasting and Vibration study included an assessment of cumulative impact from mining-related operations in the area surrounding the Bloomfield Project. This included the nearby Donaldson and Abel Mines and the Bloomfield washery and rail loading facility. The assessment of cumulative impact concluded that the Project would comply with the relevant amenity criteria set in accordance with the INP.

Air Quality modelling also addressed the presence of nearby operations and included these sources in modelling. The air quality study predicted that when the Project is combined with mining and non-mining sources, no residences would experience either dust deposition or particulate matter concentrations above the DECC's assessment criteria.

The water management systems that support the existing and proposed mining at Bloomfield are part of the Integrated Water Management System (IWMS) for the Bloomfield, Abel and Donaldson mines approved under the Abel Project Approval. The relationship between the mines is shown on **Figure 18**. The draft Surface Water Management Plan which forms part of this EA is consistent with the IWMS and is detailed in **Section 11.5**.

Analysis of potential impact of the Bloomfield Project on the IWMS and water balance indicates that the available water storage and conveyance items within the approved system are adequate to deal with any anticipated changes to water inflows to the Bloomfield pits, while maintaining supply to the washery and minimising discharge to Four Mile Creek. Accordingly, the proposed Project activities can be undertaken without the need to alter the existing approved water management facilities or water management regime.

The predictive groundwater modelling addressed cumulative impacts from the Project by considering the nearby Donaldson and Abel Mines in the overall groundwater model. Predicted impacts were generated by the model for the period up to the completion of mining, and then for a post-mining period of 100 years. It was concluded that:

- The combined effects of Bloomfield, Donaldson and Abel are predicted to have small impacts on stream baseflows in Wallis and Buttai Creeks;
- No adverse impacts on groundwater quality are expected;
- It is possible for some local improvement in groundwater quality in the longer term;
- The recovery model run shows that ultimately groundwater levels will stabilise at levels well above the 2006 levels;
- The predicted drawdown impacts on the surficial aquifer are not expected to have any adverse impact on groundwater dependent ecosystems;
- Post-mining, groundwater levels in all model layers are predicted to recover to levels higher than current (2007-2008) levels as after completion of mining at Abel (some years after completion of Bloomfield), the groundwater levels will recover not just from the impacts of mining during the period modelled in this study (2007 to 2017), but also from the significant effects of past mining as well.

The cumulative visual impact of the Project on the surrounding area was considered. It was concluded that potential visual impact remained low when considered with nearby operations, as the Bloomfield Project is part of an existing mine adjacent to other mining operations and is shielded by vegetation or landform from many locations. Completion of the Project will greatly improve visual quality of the mine lease area as rehabilitation will re-shape and revegetate areas disturbed by previous mining operations.

The design of the Project has addressed each of the Ecologically Sustainable Development (ESD) principles, and it is concluded that the Project will achieve a sustainable outcome for the local and regional environment.

16. PROJECT ALTERNATIVES

16.1 INTRODUCTION

The Project description provided in this EA was developed after consideration of various alternatives. A description of these alternatives, together with reasons for their rejection or adoption is provided in this Section.

Bloomfield Colliery has been operating for a long period of time and therefore its options for alternative mine layouts, methods and transport are limited by its existing infrastructure (**Section 2.7** and **Figure 2**) and the remaining coal resource (**Section 2.2.** and **Figure 4**).

Use of existing infrastructure (such as the workshop) is a key part of the Project. Using existing infrastructure is more economical and reduces impacts that may be associated with additional clearing and construction.

16.2 ALTERNATIVE MINE METHODS, LAYOUTS AND SCHEDULING

This Project is for the continuation of mining on the Bloomfield site and as such no new mining methods are proposed to be used. Current or similar equipment (**Section 2.6**) will be used as it is available on site, is capable of providing the necessary mining service and existing staff (**Section 2.4**) are trained in its maintenance.

As **Figure 4** illustrates, the main coal reserves remaining within CCL761 are within and to the west of the existing pit operations. The area to the west was previously planned for future mining and has generally been cleared of vegetation. Areas to the east have previously been mined and rehabilitated. Areas to the north, around the tailings area, have previously been mined and will be rehabilitated after tailings and reject emplacement is complete. **Figure 2** shows that CCL761 includes an area to the west of Buchanan Road. Sections of this area have previously been mined by underground operations and remaining economically recoverable coal reserves are limited.

The Project Area has been selected after discussions with DPI and includes the remaining coal reserves on CCL761 that are recoverable under current economic conditions.

It is proposed to mine a number of coal seams from the surface to and including the Big Ben Seam. These seams can be most economically mined by open cut methods, and the mining method to be used will be that currently used on the site. The Rathluba Seam lies beneath the Big Ben Seam as shown on **Figure 5**. The ratio of interburden to coal between the base of the Big Ben and the Rathluba is such that open cut methods are not currently feasible.

Bloomfield has previously mined the Rathluba Seam by underground mining methods and these proved not to be economically viable. There are no current plans to mine the Rathluba Seam by either mining method.

The proposed mine plan, which extends S Cut operations to the west and north, eventually joining up with Creek Cut, was selected as it is the most efficient method of mining the last remaining economically viable coal seams on the site. The selected mine plan also provides for one final void at Creek Cut, instead of two final voids. Mining in the western extension of S Cut is to the uppermost Buttai Seams. All seams are present in this area however, the Big Ben Seam has previously been worked by underground mining and pillar extraction has been undertaken.

This Project aims to extract up to a maximum of 1.3 mtpa ROM coal over a period of approximately ten years. This rate is the same or similar to historical operations. More rapid extraction could be undertaken to remove more material per year, thereby completing mining on the site over a shorter timeframe. Bloomfield, however, blends coal from both the Bloomfield operations and Rix's Creek Mine (located near Singleton) to meet market specifications. Rix's Creek and Bloomfield are both multi seam, open cut mining operations with varying coal qualities and yields.

The scheduling of coals to be mined from the various locations in the Bloomfield mine plan is designed to provide flexibility to meet changes in coal quality from Rix's Creek and/or changes in market requirements. As minor variations to the sequencing and scheduling of mining blocks may be required over the life of the Project to meet individual shipments and fulfill Bloomfield and Rix's Creek market volume and quality obligations, a maximum annual ROM coal tonnage has been provided for the purposes of impact assessment.

16.3 ALTERNATIVE TRANSPORT METHODS

Overburden is currently removed from the pit via dump truck and placed on emplacement areas which are then shaped and rehabilitated. Coal is removed from the pits by the coaling fleet and transported via an internal haul road to the ROM coal stockpile at the Bloomfield washery. It is proposed to continue using this method and the existing haul road, with some extensions to enable pit access in the northern areas. This haul road provides direct access to the ROM coal stockpile and its impact in terms of noise and dust has been modelled and considered to have minimal impact outside the Project Area (**Sections 9.9** and **10.8** respectively).

An alternative to this current transport method would be to provide an in-pit crushing system feeding a conveyor that transports coal to the ROM coal Stockpile pad at the washery. This would require Bloomfield to maintain a central extraction point, which is not possible as

Bloomfield requires flexibility in extraction areas due to the multi-seam environment and varying coal quality requirements.

16.4 REHABILITATION AND FINAL LAND USE CONSIDERATIONS

Rehabilitation methods have been developed in accordance with standard industry practice and policy. Consideration of final land use is influenced by the needs of the various government stakeholders, objectives of the Lower Hunter Regional Strategy, which identifies future potential land uses for the site and its surrounding area, and also the requirements of the landowner via the Commercial Lease. These factors are discussed in **Section 3.6.1**.

A range of alternative final landforms and land uses for the Project Area have been considered by Bloomfield, with several being investigated in detail in the past either by Bloomfield or the landowner. Consideration of these alternatives in view of the various stakeholder requirements or recommendations is provided in **Section 3.6.1.** Consideration of the options for final land use of residential, industrial, open forest/bushland or undulating grazing land/rural landscape are detailed in **Section 3.6.2**.

After consideration of the options for a final post-mining landform and land use, the preferred plan is one that rehabilitates the site in a way that it will be suitable for a variety of future land uses whilst enabling the most likely long-term retention of habitat areas. This is detailed in **Section 3.6.3**.

The various rehabilitation plans and procedures prepared for the Abel, Donaldson and Bloomfield projects need to consider the plans and procedures of each project so that they are compatible. The integration of rehabilitation systems and plans that are approved for use or have been prepared for the various projects, and how they interact and are compatible are described in **Section 3.7**.

As detailed plans for the site in relation to the Strategy have not yet been released, the site will be rehabilitated to a standard acceptable to DPI and the landowner. Alternative land uses were therefore not considered for this EA, but may be in future in response to the requirements of detailed Strategy Plans or changed requirements by the land owner.

17. ECOLOGICALLY SUSTAINABLE DEVELOPMENT

17.1 INTRODUCTION

Australia's National Strategy for Ecologically Sustainable Development ('NSESD'), endorsed by all Australian jurisdictions in 1992, defines Ecologically Sustainable Development ('ESD') as:

"using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased." (Australian Government, 1992)

The core objectives of NSESD are:

- To enhance individual and community well-being and welfare by following a path of economic development that safeguards the welfare of future generations;
- To provide for equity within and between generations; and
- To protect biological diversity and maintain essential ecological processes and life-support systems.

For a Project to achieve ESD outcomes consistent with the objectives stated above requires the integration of short and long-term economic, social and environmental effects in all decision-making relating to the Project. Thus, to be consistent with ESD principles, "*resources not only need to be used sustainably, but how they are used, who benefits and when, along with the impacts of their use, all need to be evaluated*" (Fletcher, 2002).

NSESD's widely accepted principles underpinning the consideration of economic, social and environmental effects are:

- The precautionary principle - if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation;
- Social equity - the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations;
- Conservation of biological diversity and ecological integrity – a full and diverse range of plant and animal species should be maintained; and
- Improved valuation, pricing and incentive mechanisms – these mechanisms would enable environmental factors to be included in the valuation of assets and services.

The Hunter and Central Coast Regional Environmental Management Strategy ('HCCREMS'- refer **Section 4.4.5**) is a regional initiative to facilitate a regional approach to ESD. The Strategy:

- provides a framework for coordinated action in relation to environmental management issues impacting on the region;
- addresses those environmental and natural resource issues that are best managed at a regional scale (e.g. biodiversity conservation and water quality management are key issues requiring a broad management approach that transcends arbitrary institutional boundaries); and
- facilitates regional partnerships and resource sharing to address key environmental management issues in a coordinated, pro-active and efficient manner.

The following sections address each of the NSESD's principles as they relate to the Bloomfield Project.

17.2 THE PRECAUTIONARY PRINCIPLE

17.2.1 Introduction

To satisfy this principle of ESD, emphasis must be placed on anticipation and prevention of environmental damage, rather than reacting to it. During the planning phase for the Project and throughout the preparation of this EA, specialist consultants examined the existing environment, predicted possible impacts and recommended controls, safeguards and/or mitigation measures to ensure that the level of impact would satisfy statutory requirements and/or reasonable community expectations. An anticipatory approach to impacts was adopted, particularly for irreversible ecological damage, by undertaking an analysis of the risks posed by the Project and providing an appropriate level of research and baseline investigation. The controls, safeguards and/or mitigation measures have therefore been planned with a comprehensive knowledge of the existing environment and any potential risk of environmental degradation posed by the Project.

The implementation of the environmental safeguards, controls and mitigation measures is presented as the draft Statement of Commitments in **Section 18**. Best practice scientific modelling has been used for all studies to predict potential impacts. Assessment studies for all key issues for the Project have included measures to prevent environmental degradation, based on 'worst case' scenarios. An Integrated Environmental Monitoring Program ('IEMP') (**Section 17.5.3**) will monitor actual impacts for comparison against predicted impacts, and the management plans and mine plans will be adjusted accordingly if it is found that actual impacts differ from predictions.

17.2.2 Objectives of the Project

The Project has been designed to continue operations in a safe and environmentally responsible manner, and one which meets the requirements of local and State government agencies, accepted industry standards and reasonable community expectations. Bloomfield recognises that only through comprehensive environmental assessment and an environmentally responsible approach can the risk of harm to the environment be minimised.

17.2.3 Design of Project Components

Several design aspects of the Project were modified during the planning stage in order to ensure the requirements of local and State government agencies, accepted industry standards and wherever possible, reasonable community expectations were met. These included the following:

- Surface water – additional sediment control measures were included;
- Noise and vibration equipment and operational methods were selected to achieve acceptable noise and vibration outcomes;
- Out-of-pit emplacement areas have been designed to provide visual screening of the site from the residents;
- The post mining landform will be designed to provide for the re-establishment of land suitable for agriculture whilst integrating the requirements of the HCCREMS (**Section 4.4.5**) and the Lower Hunter Regional Strategy ('LHRS') (**Section 4.4.3**).

17.2.4 Integration of Safeguards and Procedures

The framework for ongoing environmental management, operational performance and rehabilitation of the Project Area will be provided through the Project approval and be managed in accordance with the DPI Mining, Rehabilitation and Environmental Management Process, both of which involve input from relevant State and local government agencies. Plans will be periodically updated and will include any required monitoring and review results. In addition:

- All on-site procedures will be regularly reviewed, in response to monitoring results, if required;
- Surface water, groundwater, noise and vibration, and air quality will be monitored to ensure continued compliance with goals outlined in this EA; and
- The principles outlined in the surface water management plan will be adopted to minimise any impact on water quality or quantity exiting the Project Area. Wherever

possible, areas not required for mining or associated activities will remain grassed to assist in minimising erosion and reducing the sediment load in surface water flows.

17.2.5 Rehabilitation and Subsequent Land Use

Long term adverse impacts on the local environment will be avoided through the design and rehabilitation of a landform suitable for the establishment/maintenance of pasture and trees with an option for future development as described by the LHRS.

17.2.6 Conclusion

The precautionary principle has been considered during all stages of the design and assessment of the Project. The approach adopted, i.e. initial assessment, consultation, specialist investigations and safeguards design, provides a high degree of certainty that the Project will not result in any major unpredicted impacts.

17.3 SOCIAL EQUITY

17.3.1 Introduction

This principle embraces concepts of justice and fairness to ensure that the basic needs of all sectors of society are met and there is a fair distribution of costs and benefits to the community. It includes both intergenerational (between generations) and intragenerational (within generations) equity considerations. Intragenerational equity requires that the economic and social benefits of the development be distributed appropriately among all members of the community. Intergenerational equity requires the present generation to ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.

Both elements are addressed through the Project's design, the implementation of operational safeguards to mitigate any short-term or long-term environmental impacts, and the rehabilitation of the Project Area.

The assessment of each key issue included consideration of protecting the existing environment to conserve it for current as well as future generations. Rehabilitation will enhance the Project Area and improve its environmental health and productivity.

17.3.2 Identification of Project Objectives

The Project has been designed with the objective to ensure the continued viability of surrounding land uses throughout and beyond the life of the mine. The Project will continue to provide employment opportunities to residents of the Lower Hunter Region. The economic and social flow-on effects of the mine are discussed in **Section 13**.

17.3.3 Design of Project Components

The Project has been designed to maintain social equity and recognises that mining is a relatively short-term land use. The Project aims to ensure that components of the existing biological, social and economic environment available to existing generations would also be available to future generations.

Proposed management and mitigation strategies will ensure that any disturbance to the *Lower Hunter Spotted Gum - Ironbark Forest* EEC (**Section 7.6** and **Figure 16)** is minimised, and Aboriginal heritage items are managed in accordance with the Aboriginal Heritage Management Plan ('AHMP') (**Section 8.8**).

The availability of groundwater to surrounding landholders, although not predicted to be affected by the Project, will be monitored throughout the life of the mine. Rehabilitation has been designed to return the land to a stable landform similar to pre-mining conditions.

17.3.4 Integration of Safeguards and Procedures

Bloomfield recognises that members of the local community should benefit from the Project either directly or indirectly. In order to ensure a realistic distribution of benefits, Bloomfield will continue to consult with the local community and maintain a pro-active approach to issues of interest under its existing Complaints Protocol (**Section 2.8**).

17.3.5 Rehabilitation and Subsequent Land Use

The post mining landform will be shaped and rehabilitated following the Rehabilitation Management System (**Section 3**) to create a land capability similar to that prior to mining, with an option for future development in accordance with the LHRS (**Section 4.4.3**), or others, thereby providing the basis for continuing economic activity.

17.3.6 Conclusion

The Project will continue to contribute to the economic activity of the Lower Hunter Region and surrounding communities through the continuation of employment and continued demand for local goods and services and flow-on effects. As such, the benefits will continue to be distributed throughout the wider community. The Project will ensure that elements of the existing environment available to this generation, including agricultural land, water and local biodiversity will continue to be available to future generations. Bloomfield will continue its pro-active approach to identifying and addressing any concerns identified by the local community.

17.4 CONSERVATION OF BIOLOGICAL DIVERSITY AND ECOLOGICAL INTEGRITY

17.4.1 Introduction

It is important that developments do not threaten the integrity of the ecological system as a whole or the conservation of any threatened species or community in the short or long term. Conservation of biological diversity and ecological integrity has been considered by the flora and fauna assessment for the Project, which concludes that potential impacts on flora and fauna will be minimal with the implementation of the daft Land Disturbance Management System (**Section 2.8**) and other recommended mitigation measures.

17.4.2 Identification of Project Objectives

Bloomfield is committed to undertaking activities in an environmentally responsible manner, and recognises the need to ensure that changes to natural components of the environment do not adversely affect biological diversity or ecological integrity. As such, the Project has been designed to incorporate measures that will minimise impacts on any flora and fauna in the Project Area, whilst allowing the extraction of an economically viable resource, and ultimately result in improvements in the extent of vegetation habitat available, through progressive rehabilitation by the Rehabilitation Management System (**Section 3**).

17.4.3 Design of Project Components

Bloomfield has provided for the conservation of biological diversity and ecological integrity through the following design elements:

- Surface water management structures have been designed to ensure that any water discharged into Four Mile Creek is within DECC licence criteria;
- Minimisation of dust from roads under the Mine Transport Management Plan (**Section 2.8**);
- The placement of overburden avoid disturbance to areas of previously uncleared native vegetation;
- The use of existing internal roads will minimise disturbance to native vegetation and existing rehabilitated areas;
- Progressive rehabilitation of the Project Area following the MOP and Rehabilitation Management System (**Section 3**); and
- Precautions to prevent oil and fuel spills under Fuel and Bulk Oil Delivery Procedures (**Section 2.8**).

17.4.4 Integration of Safeguards and Procedures

Bloomfield will implement the following safeguards and procedures to maximise the conservation of biological diversity and ecological integrity on and surrounding the Project Area:

- Draft Land Disturbance Management System (**Section 2.8**);
- Post-mining rehabilitation of the Project Area as per **Section 3**;
- Monitoring will be undertaken throughout the Project in accordance with various management plans including the IEMP (**Sections 2.8** and **2.12**); and
- Weed eradication programs will be continued and, if required, expanded.

17.4.5 Rehabilitation and Subsequent Land Use

The post mining landform has been designed to provide for sustainable vegetation cover but with an emphasis upon the requirements of the owner and to allow for development in accordance with the LHRS (**Section 4.4.3**).

17.4.6 Conclusion

The Project addresses the principle of conservation of biological diversity and ecological integrity through:

- The minimisation of disturbance to areas of native vegetation including the *Lower Hunter Spotted Gum – Ironbark Forest* EEC;
- Water and air quality maintenance;
- Implementation of Bloomfield's existing Pre-clearance protocol;
- Weed eradication programs as appropriate; and
- Rehabilitation of the site post mining.

17.5 IMPROVED VALUATION AND PRICING OF ENVIRONMENTAL RESOURCES

17.5.1 Introduction

This principle requires that environmental factors be included in the valuation of assets and services, including the need for pollution generators to be responsible for the cost of containment, avoidance and abatement. It also addresses the need for full life cycle costings for goods and services to be considered and establishing cost effective and incentive-based mechanisms to develop solutions and responses to environmental problems.

17.5.2 Identification of Project Objectives

Bloomfield's principal objective is to operate in a profitable, safe and environmentally responsible manner, which demonstrates that an appropriate value has been placed on elements of the existing environment.

17.5.3 Design of Project Components and Integration of Safeguards and Procedures

The Project includes actions to contain pollution on site. These actions and related costs involved in rehabilitation and waste management form part of the Project and will be required as part of the new Mining Lease.

Bloomfield is part of an Integrated Environmental Monitoring Program that will provide improved monitoring across the Tasman, Abel, Donaldson and Bloomfield Mines and reduce costs associated with monitoring and reporting.

Where possible, Bloomfield will utilise innovative opportunities to prevent or mitigate environmental impacts, for example, by maximising recycling, investigating fuel efficiencies of existing fleet and investigating new technologies that may come about during mining to determine whether they can provide better environmental protection or management.

17.5.4 Rehabilitation and Subsequent Land Use

The design of the post mining landform to integrate current and future uses consistent with LHRS and LHCCREMS illustrates the value placed by Bloomfield and the landowner on future agricultural, economic and ecological elements of the Project Area.

17.5.5 Conclusion

The value placed by Bloomfield on environmental resources is evident in the identification of Project objectives, extent of site-specific research, planning and environmental safeguards and measures to be implemented to prevent irreversible damage to the environment on and surrounding the Project Area.

17.6 ESD CONCLUSION

The approach taken in planning the Project has been multi-disciplinary, involving consultation with potentially affected local residents and various government agencies and emphasis on the application of safeguards to minimise potential environmental, social and economic impacts.

The Project will continue to employ approximately 66 people and create significant royalties and taxes for the NSW Government. The selected mining process incorporates a range of measures to protect, mitigate and manage environmental impacts.

A risk assessment process has been used to identify all activities associated with the Project and their potential environmental impacts. Mitigation measures and controls have been identified and applied to these activities, and a resulting environmental risk rating applied to determine the key project issues. Studies on these key issues have been completed to determine potential impacts and develop mitigation and management strategies. All studies predict that any impacts will not be significant and that the risk of environmental impact will be low. Studies will continue to be updated through further investigation and monitoring to ensure predictions remain accurate.

The Project has key features that provide a unique Lower Hunter Region opportunity to remove high grade coal with minimal environmental impact. These are:

- The use of existing Mine infrastructure (CHPP, roads and workshop as per the Abel Project Approval) and areas of disturbance to minimise surface impacts;
- The majority of Project Area has previously been disturbed with only 1.7 ha of remnant vegetation to be cleared; and
- An Integrated Environmental Monitoring Program to monitor potential impacts over a wider area, with greater data sharing and management to assist in providing a more comprehensive regional data set for items such as air and water quality.

The mine plan was designed to include the needs of the landowner and to also be compatible with the LHRS and LHCCREMS planning strategies for future land use.

This Project offers a unique opportunity to extract coal with minimal site environmental impacts, whilst minimising new surface disturbance and maximising the efficient use of existing surface facilities so additional facilities with associated environmental impacts do not need to be constructed.

The implementation of the environmental safeguards, controls and mitigation measures is presented as the draft Statement of Commitments in **Section 18**. The design of the Project has addressed each of the ESD principles, and on balance, it is concluded that the Project achieves a sustainable outcome for the local and wider environment.

18. DRAFT STATEMENT OF COMMITMENTS

The Director-General's Requirements for the Project state that the Part 3A Environmental Assessment shall include a draft Statement of Commitments outlining the measures proposed by the Company for environmental management, mitigation and monitoring measures for the Project.

The following draft Statements provide a summary of the Project commitments made by Bloomfield throughout the EA documentation. The first column provides a draft Statement of Commitments reference number, with the third column providing a reference to which section of the EA the draft Statement is discussed in more detail.

REF.	COMMITMENT	EA SECTION No. (Refer for further detail)
1.	**General**	
1.1	Bloomfield Collieries Pty Limited ('Bloomfield') will carry out the proposed development generally in accordance with this Part 3A Environmental Assessment ('EA'). If there is any inconsistency between this draft Statement of Commitments and the EA, the draft Statement of Commitments will prevail to the extent of the inconsistency.	1.4
1.2	Bloomfield will undertake mining within the Project Area, as defined by Figure 2 of the EA. The Project Area includes the following items and their associated mining activities: • The current and proposed active open cut coal mining areas; • The unshaped and shaped overburden dump areas within the Project Area; • The workshop and surrounding area used for maintenance and fuel storage; • The road linking the current and proposed coal mining areas with the ROM coal stockpiles adjacent to the coal washery; and • The road linking the current and proposed coal mining areas to the workshop.	1.1, 2.1

REF.	COMMITMENT	EA SECTION No. (Refer for further detail)
2.	**Production**	
2.1	A maximum of 0.88 mtpa ROM coal will be mined from the Bloomfield Mine during Stage 1 with a maximum of 1.3 mtpa ROM coal mined during Stages 2 to 4.	2.5
2.2	Active mining will occur over 4 stages, which total approximately 10 to 12 years. The final (5^{th}) stage is the completion of site rehabilitation.	2.5
2.3	All Run-of-Mine ('ROM') coal will be transported by internal haul roads to the approved ROM coal stockpiles at the Bloomfield washery.	2.6.1
3.	**Hours of Operation**	
3.1	Bloomfield Mine will operate 24 hours per day, seven days per week.	2.4
4.	**Rehabilitation**	
4.1	All site rehabilitation, including monitoring and maintenance will be undertaken in accordance with procedures documented in the EA and the existing Bloomfield Rehabilitation Management System.	3.2
4.2	Any additional rehabilitation requirements and plans for this Project will be included in the existing Bloomfield Rehabilitation Management System.	3.2
4.3	Land that has been mined will be rehabilitated to a safe and stable form with a land capability similar to that existing prior to mining, and with a landform compatible with the surrounding landscape.	3.3.2
4.4	Post mining landform and land use plans will be developed in consultation with the landowner and with reference to the objectives of the Lower Hunter Regional Strategy (DoP, 2006).	3.6.1

REF.	COMMITMENT	EA SECTION No. (Refer for further detail)
5.	**Final Void**	
5.1	The final void will be retained for the deposition of washery reject material in accordance with the Abel Project Approval.	3.5
6.	**Environmental Management Systems and Plans**	
6.1	Bloomfield's existing environmental management systems, plans and procedures will be applied to this Project and will be amended where relevant to incorporate additional items required to manage, mitigate, or monitor impacts associated with this Project.	2.8, 2.11, 3.2
7.	**Environmental Monitoring and Reporting**	
7.1	Bloomfield will undertake ongoing environmental monitoring as detailed in this EA.	2.8
7.2	Bloomfield will implement and participate in the actions required for the Integrated Environmental Monitoring Program ('IEMP') that forms part of the Abel Project Approval and which includes elements of the Bloomfield Project.	2.8, 2.12, 15.2
7.3	An Annual Environmental Management Report ('AEMR') will be prepared and forwarded to relevant government departments, including DoP. The AEMR will include a summary of all monitoring undertaken during the year, including a discussion of any exceedances and responses taken to ameliorate these exceedances.	4.3.2
8.	**Consultation**	
8.1	Bloomfield will continue to consult with the local community throughout the life of the Project.	5
8.2	A specific representative of Bloomfield will be nominated and contact details provided so that members of the community may contact the mine with questions or complaints if required.	5
8.3	A record of any complaints received regarding the Project will be retained by Bloomfield for the duration of the Project.	2.8

REF.	COMMITMENT	EA SECTION No. (Refer for further detail)
9.	**Flora and Fauna**	
9.1	A Flora and Fauna Management Plan will be developed and implemented prior to any clearing occurring as part of the Project.	7.6
9.2	The existing Bloomfield pre-clearance protocol will be implemented prior to any clearing occurring as part of the Project.	7.6, 7.7
9.3	Bloomfield will commit to commensurate support of a relevant DECC approved research program in response to the loss of any *Lower Hunter Spotted Gum Ironbark Forest Endangered Ecological Community* in the Project Area.	7.6, 7.7
10.	**Aboriginal Heritage**	
10.1	An Aboriginal Heritage Management Plan ('AHMP') will be prepared in consultation with the registered Aboriginal stakeholders (Mindaribba LALC, Lower Hunter Wonnarua Council and Awabakal Traditional Owners Aboriginal Corporation) prior to any Project impacts occurring. This Plan will specify the policies and actions required to mitigate and manage the potential impacts of the Project on Aboriginal heritage. The plan will include: • Procedures for ongoing Aboriginal consultation and involvement; • Mitigation measures for the identified and potential Aboriginal evidence; • Management procedures for any previously unrecorded evidence or skeletal remains; • Cultural awareness training for relevant staff and contractors; and • Review of the plan.	8.8

REF.	COMMITMENT	EA SECTION No. (Refer for further detail)
10.2	The AHMP will include a program of salvage to be undertaken in the Project Area with representatives of the registered Aboriginal stakeholders (Mindaribba LALC, Lower Hunter Wonnarua Council and Awabakal Traditional Owners Aboriginal Corporation) collecting identified stone artefacts from sites B2, B16, B18, B19, B20 and B22 prior to any development impacts occurring.	8.8
10.3	Should any skeletal remains be detected during the Project, work in that location will cease immediately and the finds will be reported to the appropriate authorities, including the Police, DECC and Mindaribba LALC.	8.8
10.4	In the event that Aboriginal objects are located during the Project, a protocol to ascertain the value of such finds, in consultation with the Aboriginal community representatives and a qualified archaeologist will be implemented and used to inform any management decision. DECC will be informed of any finds using the appropriate site recording cards.	8.8
10.5	Further consultation with and continued involvement of the registered Aboriginal stakeholders will be continued through the Project, in relation to the contents and recommendations of Aboriginal Heritage studies.	8.8
10.6	An Aboriginal Cultural Education Program will be developed and delivered as part of the induction of personnel and contractors involved in any construction activities on the site. This program will be developed in collaboration with the Aboriginal community and incorporated into the AHMP.	8.8
11.	**Noise Management and Monitoring**	
11.1	A Noise Management Plan will be prepared and implemented for the Project. The Plan will include mitigation and monitoring requirements for the Project.	9.2
11.2	The following noise controls will be implemented to achieve noise criteria identified in this EA: During Year 1 (End of Stage 1): • The excavator and dump site will be situated in a	9.5

REF.	COMMITMENT	EA SECTION No. (Refer for further detail)
	shielded location during night-time operation; • No dozer operation at the drill location will occur during night and morning shoulder periods; and • The front end loader will replace the dozer at the dump site during the night-time period unless 4 dBA of noise suppression is achieved. During Year 5 (End of Stage 2): • The excavator and dump site will be situated in a shielded location during night-time operation; • No dozer operation at the drill location will occur during night and morning shoulder periods; and • The front end loader will replace the dozer at the dump site during the night-time period unless 4 dBA of noise suppression is achieved. During Year 10 (End of Stage 4): • The excavator and dump site will be situated in a shielded location during night-time operation; and • No dozer operation at the drill location will occur during night and morning shoulder periods.	
11.3	Bloomfield may undertake a noise monitoring and investigation program during the Project, in consultation with DECC and DoP, to determine whether relevant noise criteria can be achieved without the use of the noise controls listed in 11.2. If such a study concludes that relevant criteria can be achieved, the above controls will be modified or removed.	9.5
11.4	Noise complaints received will be dealt with in accordance with Bloomfield's existing complaints protocol.	2.8
12.	**Blasting**	
12.1	Bloomfield will continue to consult with nearby residents regarding their blasting program, consistent with current practice and the Shot Firing and Explosives Management Plan.	2.8

REF.	COMMITMENT	EA SECTION No. (Refer for further detail)
12.2	Blasting will only be undertaken during the hours of 9.00 am to 5.00 pm Monday to Saturday. Blasting will not occur on Sundays or Public Holidays.	9.8
12.3	Blasts will be designed in consideration of vibration and airblast limits, wind speed and direction.	9.8
12.4	Blast monitoring will be conducted over the life of the mine in accordance with requirements provided by the Shot Firing and Explosives Management Plan.	2.8
12.5	All relevant personnel will be trained in Bloomfield's environmental obligations in relation to blasting controls.	2.8
13.	**Air Quality**	
13.1	An Air Quality Monitoring Program will be prepared and implemented for the Project. The Air Quality Monitoring Program will include monitoring at locations as described in the EA.	2.12
13.2	Dust generation on the Project Area will be minimised by implementation of the following: • All vehicles will be operated according to Mine Transport Management Plan, which requires vehicles to remain on specified routes; • Disturbed areas will be minimised where possible; • Dust suppression water spraying will be used on all active haul roads and stockpile areas where required; • All mobile equipment will be maintained in good working order; • Adequate stemming will be used in blast holes; and • Meteorological conditions will be considered in the timing of blasts to minimise impacts of blast generated dust.	2.8

REF.	COMMITMENT	EA SECTION No. (Refer for further detail)
14.	**Greenhouse Gas Monitoring and Energy Efficiency**	
14.1	Bloomfield will assess the viability of improving energy efficiency and reducing greenhouse gas emissions from its operations, including the mining fleet, stationary equipment and mining processes.	10.9
14.2	Bloomfield will monitor greenhouse gas emissions in accordance with the requirements of the current EEO and Greenhouse Challenge Plus programs and comply with any reporting requirements under the *NGER Act 2007*.	10.9
15.	**Surface Water Management**	
15.1	Surface water management for the Project will be undertaken in accordance with Bloomfield's existing Environmental Water Management System ('EWMS'). The EMWS will be modified to address the additional requirements for this Project provided in the Draft Water Management Plan (**Appendix H**).	2.8, 11.5
15.2	An Erosion and Sediment Control Plan will be prepared that will form part of the EWMS.	2.8, 11.3, 11.5
16.	**Surface Water Monitoring Program**	
16.1	Bloomfield's existing EWMS incorporates a Surface Water Monitoring Program which will be implemented for this Project and updated to include the additional monitoring point proposed for this Project.	11.5.2
16.2	A response/mitigation procedure will be developed as part of the EWMS for unforeseen surface or groundwater impacts being detected during the Project.	11.5.3, 12.4
17.	**Groundwater Monitoring**	
17.1	Bloomfield's existing EWMS will incorporate a Groundwater Monitoring Program and will be implemented for the Project and will include those items detailed in this EA.	2.8, 12.4

REF.	COMMITMENT	EA SECTION No. (Refer for further detail)
18.	**Visual Amenity**	
18.1	Visual impacts of the Bloomfield Mine will be mitigated by the following strategies: • Rehabilitation of the southern boundary of the Project Area adjacent to John Renshaw Drive will be given priority during the early stages of mining; • Mobile directional lighting in active mine areas will be directed away from neighbouring properties and roadways; and • Complaints regarding lighting will be investigated by Bloomfield during the relevant shift.	14.6.1, 14.6.2
18.2	Tree areas will be incorporated into rehabilitation to assist the visual blending of overburden dumps with the surrounding landscape.	3.4.3
19.	**Staff Training**	
19.1	Bloomfield will ensure that all personnel receive training in their responsibilities to mitigate, manage and monitor potential environmental impacts.	2.8, 2.11, 3.2

19. CONCLUSION

Bloomfield Colliery is an open cut coal mine located approximately 20 km north-west of Newcastle. The Colliery is operated by Bloomfield Collieries Pty Limited ('Bloomfield'), part of The Bloomfield Group.

Bloomfield currently operates the Colliery under Consolidated Coal Lease 761 ('CCL761') and in accordance with a Mining Operations Plan ('MOP') and an Environmental Protection Licence issued under the *Protection of the Environment Operations Act 1997*. Operations have previously been carried out on the site pursuant to existing user rights. The introduction of Part 3A of the *Environmental Planning and Assessment Act 1979* ('EP&A Act') and *State Environmental Planning Policy (Major Projects) 2005* requires Bloomfield to obtain approval to complete its mining schedule and undertake site rehabilitation.

This document is the Environmental Assessment prepared by Bloomfield for the completion of mining and rehabilitation at Bloomfield Colliery. It has been prepared to assess any potential impacts associated with the Project, in accordance with the requirements of the EP&A Act. This Environmental Assessment will be lodged as part of a Project Application with the NSW Department of Planning.

Bloomfield proposes to complete its mining schedule over 5 stages, covering a period of 10 to 12 years. Mining methods and equipment will be similar to that used in the existing operation. Stage 1, representing 1 year of operation, has a maximum production rate of approximately 0.88 mtpa. Stages 2 to 4 have a maximum production rate of 1.3 mtpa ROM coal. Stage 5 is for the completion of site rehabilitation. Employee numbers and hours of operation will also remain similar to existing arrangements.

Key issues were identified for the Project through a process of preliminary investigation, consultation and risk assessment. These issues, which have been investigated in detail for this EA, include:

- Disturbance of threatened flora and fauna species, and potential disturbance of an Endangered Ecological Community;
- Disturbance of Aboriginal and European heritage;
- Noise and blasting impacts;
- Air quality impacts;
- Surface water and groundwater impacts;
- Socio-economic aspects; and

- Visual aspects.

Studies investigated in detail any potential key environmental impacts that may result from the Project and have concluded that any potential impacts would be minimal. They also detail management and monitoring systems that will be put in place to control, manage, mitigate or offset any potential impact. These systems are summarised in the draft Statement of Commitments provided in **Section 18**.

A key consideration of this Project is its interaction with neighbouring mines and their operations, and any cumulative impact associated with these operations as a whole. The Water Management System forms an integral part of the Abel and Donaldson Mine operations as well as the Bloomfield washery, which was approved as part of the Abel Project Approval. Due to the proximity of these mining activities to the Bloomfield Project, cumulative impact assessment and integration of monitoring activities has formed a part of each assessment study and the Project description overall. The Integrated Environmental Monitoring Program (IEMP), detailed in **Section 2.12**, will be expanded to include any additional monitoring required in this EA.

Another key component of this Project is the rehabilitation of the site after completion of mining. A rehabilitation plan for the site has been developed in consultation with the land owner, local community and relevant government authorities and considers the objectives of the *Lower Hunter Regional Strategy* and the interaction of the site with neighbouring mines, including the Abel and Donaldson Mines.

Approval of this Project will enable Bloomfield to extract the remaining economic reserves from the site in a safe, efficient and controlled manner which minimises environmental impacts, while providing continued employment for their employees and numerous associated suppliers and contractors in the local and broader area. Approval will also enable Bloomfield to rehabilitate and enhance the site in accordance with the requirements of the various relevant stakeholders and policies in place for the Lower Hunter region.

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21. LIST OF ABBREVIATIONS

ACARP	Australian Coal Association Research Program
AEMR	Annual Environmental Management Review
AHD	Australian height datum
AHIMS	Aboriginal Heritage Information Management System
ANZECC	Australian & New Zealand environment & conservation council
ARI	Average recurrence interval
AS/NZS	Australian standard/New Zealand standard
Avg	Average
CAP	Catchment Action Plan
CCL761	Consolidated Coal Lease 761
CH4	Methane
CHPP	Coal handling and preparation plant ('washery')
CL	refers to activities involving coal handling
CO	Carbon monoxide
CO2	Carbon dioxide
dB/dBA	Decibel
DECC	Department of Environment and Climate Change, NSW
DEUS	Department of Energy, Utilities and Sustainability (now DWE)
DG	Director-general
DIPNR	Department of Infrastructure Planning and Natural Resources, NSW (Now DNR and DOP)
DLWC	Department of Land and Water Conservation (now DNR)
DoP	Department of Planning, NSW
DNR	Department of Natural Resources, NSW
DPI	Department of Primary Industries, NSW
DPI-MR	Department of Primary Industries-Mineral Resources
DWE	Department of Water and Energy (formerly DEUS)
E	Endangered
EA	Environmental assessment
EC	Electrical conductivity
EEC	Endangered Ecological Community

EEO	Energy Efficiency Opportunities
EL	Exploration licence
EMS	Environmental Management System
ENCM	Environmental Noise Control Manual (NSW)
EPA	Environment Protection Authority (now DECC)
EP&A Act	Environmental Planning and Assessment Act 1979
EPBC	Environment Protection and Biodiversity Conservation Act 1999
EPL	Environmental Protection Licence
ESAP	Energy Savings Action Plan
ESCP	Erosion and Sediment Control Plan
ESD	Ecologically Sustainable Development
G	Grams
GDE	Groundwater dependent ecosystems
GIS	Geographic information system
g/m2/month	Grams per square metre per month
GPS	Global positioning system
HCCREMS	Hunter and Central Coast Regional Environmental Strategy
HFC	Hydro fluorocarbons
ICOMOS	International Council on Monuments and Sites
IEMP	Integrated Environmental Management Program
INP	Industrial Noise Policy
ISO	International Organisation for Standardisation
Kg	Kilograms
kL/d	Kilo litres per day
Km	Kilometres
KV	Kilovolt
LA1	1 minute
LA90	Measured background level
LAeq	Equivalent continuous noise level
LALC	Local Aboriginal Land Council
LAmax	Maximum continuous noise level
LGA	Local government area
LHCCREMS	Lower Hunter and Central Coast Regional Environmental Management Strategy

L/s	Litres per second
M3	Cubic metres
M	Metres
MAHD	Metres above the Australian Height Datum
Max	Maximum
mg/L	Milligrams per litre
MIC	Maximum Instantaneous Charge
ML	Megalitres ALSO Mining Lease
ML/d	Megalitres per day
Mm	Millimetres
mm/m	Millimetres per metre
m/s	Metres per second
MODFLOW	A modular three-dimensional groundwater flow model which was developed by the USGS (McDonald and Harbaugh, 1988).
MOP	Mining Operations Plan
Mt	Million tonnes
mtpa	Million tonnes per annum
NATA	National Association of Testing Authorities
NGER Act	National Greenhouse and Energy Reporting Act 2007
NO	Nitrous oxide
NO2	Nitrogen dioxide
NPWA	National Parks and Wildlife Act 1974
NPWS	NSW National Parks and Wildlife Service (now DECC)
NSW	New South Wales
OB	refers to activities involving overburden handling
PFC	Perfluorocarbons
pH	See Glossary
PM	Particulate matter
PM2.5	Particulate matter with a diameter less than 2.5 micrometres
PM10	Particulate matter with a diameter less than 10 micrometres
POEO Act	Protection of the Environment Operations Act 1997
Ppv	Peak particle velocity
RBL	Rating background noise level
REP	Regional environment plan

RLF	Rail loading facility
ROM	Run of mine (See Glossary)
ROTAP	Rare or Threatened Australian Plants
SEPP	State Environmental Planning Policy
SF6	Sulphur hexafluoride
SO2	Sulphur dioxide
T	Tonnes
TBG	The Bloomfield Group
TCM	Total Catchment Management
TDS	Total dissolved solids (See Glossary)
TSP	Total suspended particulates (See Glossary)
TSS	Total suspended solids (See Glossary)
µg/m3	Micrograms per cubic metre
Um	Micrometre
WE	refers to activities involving wind erosion

22. GLOSSARY OF TERMS

Alkalinity The extent to which a solution is alkaline. See **pH**

Alluvial aquifer A geological formation which holds water in sufficient quantity to provide a source of water that can be tapped by a bore that is made from sediment deposited by a flowing stream, e.g., clay, silt, sand, etc.

Alluvium Usually sands and gravels which have been transported by water and then deposited.

Amenity An agreeable feature, facility or service which makes for a comfortable and pleasant life.

Amphibian A cold-blooded, smooth-skinned vertebrate of the class Amphibia, such as a frog or salamander, that characteristically hatches as an aquatic larva with gills. The larva then transforms into an adult having air-breathing lungs. An animal capable of living both on land and in water.

Anabat Bat detection system

Analytes The substance in an analysis that is being identified or determined.

Anion A negatively charged ion

Aquifer system A system of porous and permeable body of rock that can yield significant quantities of groundwater.

Arboreal An animal that lives in or among trees.

Archaeology The systematic study of any culture, especially a prehistoric one, by excavation and description of its remains.

Artefacts Any object made by humans with a view to subsequent use.

Average Recurrence Interval (ARI) The statistically calculated interval likely to be exceeded once in a given period of time. A term used in hydrology, also known as return period.

Background Noise Existing noise in the absence of the sound under investigation and all other extraneous sounds.

Baseline A basic standard or level, usually regarded as a reference point for comparison: baseline data.

Batter The excavated or constructed face resulting from earthmoving operations.

Bedrock The rock on which gravel or detrital matter rests.

Biodiversity/biological diversity The variety of life forms: the different plants, animals and micro organisms, the genes they contain and the ecosystems they form.

Biosolids Nutrient rich organic materials obtained from wastewater treatment and used beneficially, as for fertilizer.

Braun-Blanquet A system for classifying Australian vegetation based on its structure. The system is based on the life form occupying the tallest vegetation layer (stratum), the height of that stratum, and the percentage cover it provides.

Buffer areas/zone Area of land set aside to provide a buffer from impacts.

Bund/bunding Earth material or concrete placed to form a barrier – for example, a noise or visual bund would be a long elevated earthen area, a fuel farm bund would be constructed to hold and contain fuels in the event of a spill.

Calibrated When an instrument has been checked for accuracy.

Call playback A loud speaker system used to play natural calls of some nocturnal animals can prompt a response to detect their presence.

Catchment The area from which a river or stream receives its water.

Cation A positively charged ion

Claystone beds A fine-grained sedimentary rock composed predominately of clay minerals and small amounts of quartz and other minerals of clay size.

Climate change A change in the long-term average condition of the weather in a given area.

Coal Lease A lease which may be granted under Section 41 of the Mining Act 1992 to allow the holder to extract coal from a certain area and to a certain depth.

Coal measures Stratigraphic geological structure that contains coal seams.

Coal Reserves Those parts of the Coal Resources for which sufficient information is available to enable detailed or conceptual mine planning and for which such planning has been undertaken.

Coal Resources All of the potentially useable coal in a defined area, based on geological data at certain points and extrapolations from these points.

Coarse rejects Rock material that is separated from the coal during the washing process.

Coking Coal Moderate to high volatility hard coal and low ash semi-soft coal used in the production process of iron and steel.

Colliery Coal mine

Colluvium Loose and incoherent deposits, usually at the foot of a slope or cliff line and brought by gravity.

Commercial Lease The Lease over designated demised premises at Ashtonfield NSW, between the Lessor (Ashtonfields Pty. Limited) and the co-lessee, Bloomfield Collieries Pty. Limited.

Cone of depression A cone like depression in the water table formed when water is pumped out of a well more rapidly than it can flow through the aquifer

Conglomerate A rock type comprising greater than 50 per cent rounded water-worn fragments (>2 mm in size) of rock or pebbles cemented together by another mineral substance.

Conservation The management of natural resources in a way that will preserve them for the benefit of both present and future generations.

Cover depth The distance between the surface of the land and the mine workings.

Decibel (dB) A unit for expressing the relative intensity of sounds on a logarithmic scale from zero (for average least perceptible sound) to about 130 (for the average pain level).

Decibel dBA A modified decibel scale which is weighted to take account of the frequency response of the normal human ear.

Dewatering The process of removing water from an underground mine by a series of pipes – generally flowing into a surface dam.

Drawdown The lowering of the water level or the potentiometric head in an aquifer due to the removal of water from a nearby bore or excavation.

Dyke A wall-like intrusive igneous rock (formed when molten rock solidifies), filling a fissure.

Ecological communities An assemblage of species occupying a particular area.

Ecologically sustainable development Using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained and quality of life for both present and future generations is increased.

Ecosystem Organisms of a community together with its non-living components through which energy and matter flow.

Electrical Conductivity The measure of electrical conduction through water or a soil-water suspension generally measured in millisiemens per centimetre or microsiemens per centimetre. An approximate measure of soil or water salinity.

Elliot trap A small elongated box made of aluminium which collapses flat for easy transport. The trap is operated by providing a lure bait and setting the treadle at one end. When a small animal enters the trap and steps on the treadle it triggers the door of the trap to close.

Endangered ecological community Community listed in the Schedules of the *Threatened Species Conservation Act 1995*.

Environment Protection and Biodiversity Conservation Act 1999 Commonwealth legislation that regulates development proposals that have an actual or potential impact on matters of national environmental significance.

Environmental impact assessment A procedure for considering the potential environmental effects of a proposed development or land use

Environmental management system Tool for managing the impacts of an organisation's activities on the environment. It provides a structured approach to planning and implementing environment protection measures.

Environmental Planning and Assessment Act 1979 NSW Government Act to provide for the orderly development of land in NSW.

Environmental Risk Register The list of site activities and potential risks associated with these activities, together with a rating of the probability of these risks occurring and their potential consequences.

Environmentally Hazardous Chemicals Act 1985 NSW legislation administered by DEC which oversees the assessment and control of the use of chemicals and their impact on the environment

Ephemeral Lasting only a day or a very short time; short-lived; transitory. Usually used in relation to stream flow.

Erosion The process by which the surface of the earth is worn away by the action of water, glaciers and winds.

Fault A fracture or fracture zone along which there has been displacement of the sides relative to one another. Displacement can be vertical and/or horizontal.

Fauna All vertebrate animal life of a given time and place.

F class (noise) An atmospheric condition in which temperature increases by 3°C, per 100m above ground.

Firing The process of setting off an explosive charge.

First flush The first amount of water that enters a channel, pipe or stream at the beginning of a rainfall event – usually containing more sediment or possible contaminants such as oils.

Flora The plants of a particular region or period, listed by species

Floristic Refers to the species composition of a plant community.

Geographical Referring to a characteristic of a certain locality, especially in reference to its location in relation to other places.

Geological The geological features of a locality

Geometry The shape of a surface or solid.

Geomorphic Of or relating to the figure of the earth, or the forms of its surface.

Geotechnical Relates to the form, arrangement and structure of geology.

Grade (Coal) a degree or step in a scale, as of quality.

Greenhouse Gas Emissions Greenhouse gas es are atmospheric gases including carbon dioxide and methane, that absorb and re-radiate the sun's warmth, and maintain the Earth's surface temperature at a level necessary to support life. Greenhouse Gas Emissions are the release of these gasses from human activities such as burning fossil fuels (coal, oil and natural gas), agriculture and land clearing.

Grinding groove A groove found in a rock that was used for sharpening objects by Aboriginals.

Groundwater Sub-surface water which is within the saturated zone and can supply wells and springs. The upper surface of this saturated zone is called the water table.

Habitat The environment in which a plant or animal lives; often described in terms of geography and climate.

Hair tubes Tubes from 4 to 15 cm in diameter that have sticky strips applied along the inside and a bait to lure the animal at the end of the funnel generally behind a mess plate. The sticky strips collect hairs from any animal that puts its head in the funnel. The sticky strips are then sent away to be analysed to determine which animals are present in that particular area.

Harp trapping A method of catching insectivorous bats. It consists of a network of fine nylon string pulled tightly between to horizontal poles with a purpose made canvas bag at the bottom of the strings where the bats fall when fly into the network of string.

Horizons The surface separating two beds of rock.

Hydrocarbon storage area Bunded storage area for greases, oils, etc constructed in accordance with DECC Guidelines.

Hydrogeological The relation of hydrological phenomena to the surface geology.

Hydrographs A linear plot of water level versus time.

Insectivorous Feeds on insects.

Inter-modal freight facility A proposal by the State Government to site a facility on part of the rehabilitated Bloomfield Open Cut Mine in the future, consisting of a range of industries that transport goods.

I-O assessment Input-output model used for economic assessment.

Ion An atom with an electrical charge.

Kilo Volt (kV) One thousand volts.

L_{A1} Noise Level The noise level exceeded for one per cent of the time. It is used in assessment of sleep disturbance.

L_{A10} Noise Level The noise level, measured in dBA, which is exceeded for 10 per cent of the time, which is approximately the average of the maximum noise levels.

L_{A90} Noise Level The noise level, measured in dBA, exceeded for 90 per cent of the time, which is approximately the average of the minimum noise levels. The L90 level is often referred to as the "background" noise level and is commonly used to determine noise criteria for assessment purposes.

L_{Aeq} Noise Level The average noise energy, measured in dBA, during a measurement period.

L_{Amax} Noise Level The maximum noise energy, measured in dBA, during a measurement period.

Land Capability The ability of land to accept a type and intensity of use permanently, or for specific periods under specific management, without permanent damage.

Landform Any one of the various features that make up the surface of the earth.

Level A certain horizon in a deep mine. Usually referred to by the depth in metres, feet or fathoms (6′) from the surface.

Lithic Relating to or consisting of stone.

Lithology The physical characteristics of rock, with reference to qualities such as colour, composition and texture.

Macro-invertebrates Large animals without a backbone, such as insects, crustaceans, molluscs, spiders and worms.

Marsupial Mammals in which the young are born in an undeveloped state and move to a pouch where they develop.

Mean The average value of a particular set of numbers.

Megachiropteran Bats Large insectivorous bats.

Megalitre (ML) One million litres.

Meteorological Phenomena of the atmosphere or weather.

Microchiropteran Bats Small insectivorous bats.

Micro-climate The meteorological conditions, or climate, in small areas such as the north or south side of a rock.

Migratory species Animals that move from one area to another to feed or breed.

Mining Act 1992 NSW legislation to regulate the prospecting and mining of minerals in the State of NSW. Department of Mineral Resources administers the legislation, which places controls on methods of exploration and mining as well as the disposal of mining wastes, land rehabilitation and environmental management.

Mining Height The height at which the seam is mined or extracted.

Mitigation To lessen in force, intensity or harshness. To moderate in severity.

MODFLOW A modular three-dimensional groundwater flow model which was developed by the USGS (McDonald and Harbaugh, 1988).

Mudstones Rock composed of clay and silt.

National Parks and Wildlife Act 1974 NSW legislation administered by DECC that aims to conserve nature including habitat, ecosystems, biodiversity, landforms and landscapes of significance. It also aims to conserve objects, places or features of cultural value.

Native Belonging to the natural flora or fauna in a region.

Open cut void The hole created by surface mining activity.

Outcrop Bedrock exposed at the ground surface.

Overburden material The soil or rock overlying a mineral deposit (eg: coal), that is removed to access the deposit.

Particulates Fine solid particles which remain individually dispersed in gases.

Percolation To filter through; permeate.

Permeability A measure of the ease with which fluid can travel through porous material.

Permian Relating to the latest Palaeozoic geological period or system.

pH Scale used to express acidity and alkalinity. Values range from 0-14 with seven representing neutrality. Numbers from seven to zero represent increasing acidity whilst seven to fourteen represent increasing alkalinity.

Piezometer A small diameter bore lined with a slotted tube used for determining the standing water level of groundwater.

Piper Trilinear diagram Allows each sample to be plotted at a unique point on the basis of the relative concentrations of the major ions in solution – the cations calcium, magnesium, sodium and potassium, and the anions carbonate/bicarbonate, sulphate and chloride. This plot allows an assessment of the recharge-discharge processes, and also allows a comparison of water samples derived from different environments within the hydrological cycle. It can also be used to assess the possible mixing of waters from different sources.

Pollution control ponds A dam or depression formed in the landscape to capture runoff that could potentially be contaminated with pollution, such as soil, fuel or other contaminants.

Prediction modelling A method of predicting certain outcomes using a mathematical calculation.

Pressure head The height of a column of fluid of specific weight.

Prill Pelletised ammonium nitrate used in mine blasting.

Project Area Areas that are the subject of this 3A application.

Protection of Environment Operations Act 1997 The NSW legislation administered by the DECC that regulates discharges to land, air and water.

Quadrats A sampling frame or an area marked out for sampling plants and animals.

Recharge To provide more water or return water to an item, for example, to recharge a dam means to return water to the dam.

Rehabilitation The process of restoring to a condition of usefulness. In regard to mining, relates to restoration of land from a degraded or mined condition to a stable and vegetated landform.

Regolith The layer of loose rock resting on bedrock, constituting the surface of most land. Also called *mantle rock*.

Rock shelter The rock-backed area under a large overhanging rock as used by Indigenous Australians for protection from sun and rain and for ritual painting.

Run of Mine (ROM) Bulk material extracted from a mine, before it is processed in any way.

Sandstone A cemented or otherwise compacted sedimentary rock composed predominantly of sand-size quartz grains.

Salinity The concentration of salts in soil or water.

Scar tree Scars are wounds from deliberate impacts to a tree that cause damage to living plant tissue on a trunk or limb. Where the tissue is damaged it stops any further growth and so the tree bears a permanent scar. Aboriginal scarred trees are trees that have been scarred by the deliberate removal of bark or wood to be used for shelter or construction of water craft.

Scope 1 Greenhouse gas emissions that are produced directly as a result of an activity on site.

Scope 2 Indirect greenhouse gas emissions from the generation of purchased electricity.

Seam An identifiably discrete coal unit.

Sedimentary rock Formed when the weathered and eroded particles of pre-existing rocks are transported by wind or water and deposited elsewhere.

Sedimentation The deposition or accumulation of sediment.

Siltstone A rock comprised of compacted silt.

Site Laws Site specific formulae developed from modelling and trial blasts to aid blast emission prediction and optimise shot design.

Species A group of similar plants of animals that are capable of interbreeding and producing fertile offspring.

Spoil Soil, rock and other waste material excavated during mining.

Spotlighting A field survey method used to detect arboreal mammals, nocturnal birds as well as birds roosting in trees. A powerful torch is used in a particular fashion to detect the presence of animals.

Stage 1 current operations undertaken at Bloomfield (Year 1)

Stage 2 Approximately Years 1 to 5 of the Bloomfield project.

Stage 3 Approximately Years 5 to 7 of the Bloomfield project.

Stage 4 Approximately Years 7 to 10 of the Bloomfield project.

Stage 5 Approximately Years 10 to 12 of the Bloomfield project.

State survey marks Markers placed at various locations around NSW that enable surveyors to accurately determine location and elevation.

Strata Plural for stratum meaning a single bed of sedimentary rock, generally consisting of one kind of matter representing continuous deposition.

Stratigraphically The distribution, deposition and age of sedimentary rocks.

Subcrop A unit of material that occurs just below the soil profile.

Sump An excavation to collect drainage water, commonly at the bottom of a shaft or at a suitable place on levels.

Surface drainage system The method used for runoff to move over the land – in channels, creeks, etc.

Survey To view in detail, especially to inspect or examine formally or officially in order to ascertain condition

Tailings Fine residual waste material separated in the coal preparation process.

Temperature Inversion Condition in which the temperature of the atmosphere increases with altitude in contrast to the normal decrease with altitude. When temperature inversion occurs, cold air underlies warmer air at higher altitudes.

Terrestrial Relating to the land and also used to mean ground dwelling.

Thermal Coal (general) Includes medium to high ash, low sulphur coals used for domestic power generation and medium to low ash high energy coals which are exported.

Threatened Species Conservation Act 1995 NSW legislation administered by DECC to protect and conserve plants and animals that may be endangered with extinction.

Tonnage-based coal royalties An amount of money paid to the government to enable a company to extract coal – the fee is based on a per tonne amount.

Tool box talks A training talk provided by a supervisor to a group of mine workers to update knowledge on particular work procedures.

Topdressing The application of sand, soil, fertiliser or other material to established or establishing vegetation to maintain the supply of nutrients and/or to provide an improved soil environment for the continued growth of desirable plants.

Topography The surface features of a geographical area.

Total Dissolved Solids (TDS) A measure of salinity expressed in milligrams per litre (mg/L).

Total Suspended Particulates (TSP) A measure of the total amount of un-dissolved matter in a volume of water or air usually expressed in milligrams per litre (mg/L) (for water) or micrograms per cubic metre (ug/m) for air.

Transect A line, or narrow strip used to conduct a census of plants or animals in a given area.

Tributaries Streams contributing its flow to a larger stream or other body of water.

U Cut A previous open cut pit to the north of Creek Cut.

Washery A place at which ore, coal, or crushed stone is freed from impurities.

Water table The upper surface of a body of ground water at the top of the zone of saturation and below the zone of aeration.

Appendix A

Department of Planning Director-General's Requirements

Bloomfield Colliery Completion of Mining and Rehabilitation

Part 3A Environmental Assessment

November 2008

Director-General's Requirements

Section 75F of the *Environmental Planning and Assessment Act 1979*

Application number	07_0087
Project	The proposed Bloomfield Colliery Completion of Mining and Rehabilitation project, which includes: • continuation of existing mining operations, including current open cut pits, overburden emplacement areas, assorted infrastructure, haul and access roads; • extending current open cut mining to recover an additional 9 million tonnes of run-of-mine (ROM) coal, at a rate of up to 1.3 million tonnes of ROM coal a year; and • progressively rehabilitating the site.
Location	Approximately 20 kilometres northwest of Newcastle.
Proponent	Bloomfield Collieries Pty Limited
Date of Issue	8 October 2007
Date of Expiration	8 October 2009
General Requirements	The Environmental Assessment (EA) must include • an executive summary; • a detailed description of the project including the: – need for the project; – alternatives considered; and – various components and stages of the project, including the interaction between the proposed activities and existing operations; • consideration of any relevant statutory provisions, including an assessment of the consistency of the project with the objects of the *Environmental Planning and Assessment Act 1979*; • a general overview of the environmental impacts of the project, identifying the key issues for further assessment, and taking into consideration the issues raised during consultation; • a detailed assessment of the key issues specified below, and any other significant issues identified in the general overview of environmental impacts of the project (see above), which includes: – a description of the existing environment; – an assessment of the potential impacts of the project including cumulative impacts (particularly on noise, air quality, surface water, and groundwater) that may arise from the combined operation of the project, together with the other existing and approved mines in the area; – a description of the measures that would be implemented to avoid, minimise, mitigate, offset, manage, and/or monitor the impacts of the project; • a draft Statement of Commitments, outlining environmental management, mitigation and monitoring measures; • a conclusion justifying the project, taking into consideration the environmental impacts of the project, the suitability of the site, and any social, economic and/or environmental benefits that may arise as a result of the project; and • a signed statement from the author of the Environmental Assessment certifying that the information contained in the report is neither false nor misleading.
Key Issues	• **Flora and Fauna** – including impacts on critical habitats (including riparian habitat and groundwater dependent ecosystems), threatened species, populations, ecological communities and native vegetation; • **Heritage** – both Aboriginal and non-Aboriginal;

	• **Surface and Ground Water** – including detailed modelling of potential surface and groundwater impacts; a site water balance; a salinity balance; and a detailed description of final void management; • **Integrated Management** – including proposals for noise, air quality, surface and ground water monitoring and management to be integrated with neighbouring mining operations, in particular the Abel and Donaldson Coal Mines; • **Rehabilitation, Final Landform and Final Void Management** – including a detailed Rehabilitation and Landscape Management Strategy that describes how the site would be progressively rehabilitated and integrated into the landscape, taking into consideration the rehabilitation plans of existing and approved mines in the area, and any other relevant strategic land use plans and objectives (including the Lower Hunter Regional Strategy, the draft Lower Hunter Regional Conservation Plan, the Hunter Catchment Blueprint, the Wallis and Fisheries Creek Total Catchment Management Strategy, and the Hunter and Central Coast Regional Environmental Management Strategy). The strategy should also describe what measures would be put in place for the long term protection and management of the site following cessation of mining; • **Noise**; • **Blasting and Vibration**; • **Air Quality**; • **Greenhouse Gases** – a greenhouse gas assessment (including a quantitative analysis of greenhouse gas emissions associated with the combustion of product coal, and a qualitative assessment of the impacts of these emissions on the environment); and • **Social and Economic**.
References	The Environmental Assessment should take into account relevant State government technical and policy guidelines. While not exhaustive, guidelines which may be relevant to the project are included in the attached list.
Consultation	During the preparation of the Environmental Assessment, you should consult with the relevant local, State or Commonwealth government authorities, service providers, community groups or affected landowners. The consultation process and the issues raised must be described in the Environmental Assessment. In particular you should consult with: • Department of Environment and Climate Change; • Department of Water and Energy; • Department of Primary Industries; • Cessnock Council; and • Maitland Council.
Deemed refusal period	60 days

State Government Technical and Policy Guidelines - For Reference

Aspect	Policy /Methodology
Flora and Fauna	
	• draft *Guidelines for Threatened Species Assessment* (DEC); • *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities* (DEC); • *NSW Groundwater Dependent Ecosystem Policy* (DNR)
Heritage	
	• draft *Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation* (DEC); • *Aboriginal Cultural Heritage Standards and Guidelines Kit* (DEC); • *NSW Heritage Manual* (NSW Heritage Office); • *Archaeological Assessment Guidelines* (NSW Heritage Office)
Soil and Water	
	• *Design Manual for Soil Conservation Works - Technical Handbook No. 5* (DoL); • *Managing Urban Stormwater: Soils & Construction* (Landcom); • *Guidelines for Fresh and Marine Water Quality* (ANZECC); • *Approved Methods for the Sampling and Analysis of Water Pollutants in NSW* (DEC); • *Rehabilitation Manual for Australian Streams* (Land and Water Resources Research and Development Corporation); • *Works and Watercourse Design Guideline* (DNR); • the various *State Groundwater Policy* documents (DNR); • *MDBC Groundwater Sampling Quality Guidelines* (MDBC); • *MDBC Groundwater Flow Modelling Guidelines* (MDBC)
Noise	
	• *NSW Industrial Noise Policy* (DEC); • *Environmental Criteria for Road Traffic Noise* (DEC); • *Environmental Noise Control Manual* (DEC)
Rehabilitation	
	• *Mine Rehabilitation – A Handbook For The Coal Mining Industry* (NSW Coal Association); • *Mine Rehabilitation – Leading Practice Sustainable Development Program for the Mining Industry* (Commonwealth of Australia); • *Mine Closure and Completion – Leading Practice Sustainable Development Program for the Mining Industry* (Commonwealth of Australia)
Blasting and Vibration	
	• *Technical Basis for Guidelines to Minimise Annoyance due to Blasting and Ground Vibration* (ANZECC); • *AS 2187.2-2006 Explosives – Storage and Use – Use of Explosives* (Standards Australia); • *Assessing Vibration – A Technical Guideline* (DEC)
Air Quality	
	• *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC); • *Approved Methods for the Sampling and Analysis of Air Pollutants in NSW* (DEC)
Greenhouse Gases	
	• *AGO Factors and Methods Workbook* (Australian Greenhouse Office)

Appendix A - Section of EA Addressing Director-General's Requirements

GENERAL REQUIREMENTS	Section
The Environmental Assessment (EA) must include: • An executive summary;	Front of EA
• A detailed description of the project including: - Need for the project;	19
- Alternatives considered; and	16
- Various components and stages of the project, including the interaction between the proposed activities and existing operations;	2.5, 2.7, 2.8, 2.12, 3.7
• Consideration of any relevant statutory provisions, including an assessment of the consistency of the project with the objects of the *Environmental Planning and Assessment Act 1979;*	4
• A general overview of the environmental impacts of the project, identifying the key issues for further assessment, and taking into consideration the issues raised during consultation;	5.2, 5.3, 6
• A detailed assessment of the key issues specified below, and any other significant issues identified in the general overview of environmental impacts of the project (see above), which includes: - a description of the existing environment;	2.1-2.2, impact assessment studies
- an assessment of the potential impacts of the project including cumulative impacts (particularly on noise, air quality, surface water, and groundwater) that may arise from the combined operation of the project, together with the other existing and approved mines in the area;	7.5, 8.7, 9.7, 10.8, 11.4, 12.3, 14.5, 15
- a description of the measures that would be implemented to avoid, minimise, mitigate, offset, manage, and/or monitor the impacts of the project;	7.4, 8.8, 9.5, 10.9, 11.5, 12.4, 14.6, 18
• A draft Statement of Commitments, outlining environmental management, mitigation and monitoring measures;	18
• A conclusion justifying the project, taking into consideration the environmental impacts of the project, the suitability of the site, and any social, economic and/or environmental benefits that may arise as a result of the project; and	19
• A signed statement from the author of the Environmental Assessment certifying that the information contained in the report is neither false nor misleading.	Front of EA

Appendix A - Section of EA Addressing Director-General's Requirements

KEY ISSUES	Section
• **Flora & Fauna** – including impacts on critical habitats (including riparian habitat and groundwater dependent ecosystems), threatened species, populations, ecological communities and native vegetation;	7, Appendix (App.) D
• **Heritage** – both Aboriginal and non-Aboriginal;	8, App. E
• **Surface & Ground Water** – including detailed modelling of potential surface and groundwater impacts; a site water balance, a salinity balance; and a detailed description of final void management;	11 and 12, App. H, I
• **Integrated Management** – including proposals for noise, air quality, surface and ground water monitoring and management to be integrated with neighbouring mining operations, in particular the Abel and Donaldson Coal Mines;	2.12, 3.7, 15, various Apps
• **Rehabilitation, Final Landform and Final Void Management** – including a detailed Rehabilitation and Landscape Management Strategy that describes how the site would be progressively rehabilitated and integrated into the landscape, taking into consideration the rehabilitation plans of existing and approved mines in the area, and any other relevant strategic land use plans and objectives including:	3
- the Lower Hunter Regional Strategy;	4.4.3
- the draft Lower Hunter Regional Conservation Plan;	4.4.4
- the Hunter Catchment Blueprint (now Hunter-Central Rivers Catchment Action Plan);	4.4.6
- the Wallis and Fishery Creek Total Catchment Management Strategy;	4.4.7
- the Hunter and Central Coast Regional Environmental Management Strategy;	4.4.5
• The strategy should also describe what measures would be put in place for the long term protection and management of the site following cessation of mining;	3.4.4, 3.5-3.7
• **Noise;**	9, App. F
• **Blasting & Vibration;**	9, App. F
• **Air Quality;**	10, App. G
• **Greenhouse Gases** – a greenhouse gas assessment (including a quantitative analysis of greenhouse gas emissions associated with the combustion of product coal, and a qualitative assessment of the impacts of these emissions on the environment); and	10.9, App. G
• **Social and Economic.**	13, App. J

Appendix A - Section of EA Addressing Director-General's Requirements

REFERENCES	Section
• The Environmental Assessment should take into account relevant State government technical and policy guidelines. While not exhaustive, guidelines which may be relevant to the project are included in the attached list.	EA & Apps
CONSULTATION	
• During the preparation of the Environmental Assessment, you should consult with the relevant local, State or Commonwealth government authorities, service providers, community groups or affected landowners. The consultation process and the issues raised must be described in the Environmental Assessment.	5
In particular you should consult with: • - Department of Environment and Climate Change;	5.3
• - Department of Water and Energy;	5.3
• - Department of Primary Industries;	5.3
• - Cessnock Council; and	5.3
• - Maitland Council.	5.3

Appendix B

Community Consultation & Property Title Information

Bloomfield Colliery Completion of Mining and Rehabilitation

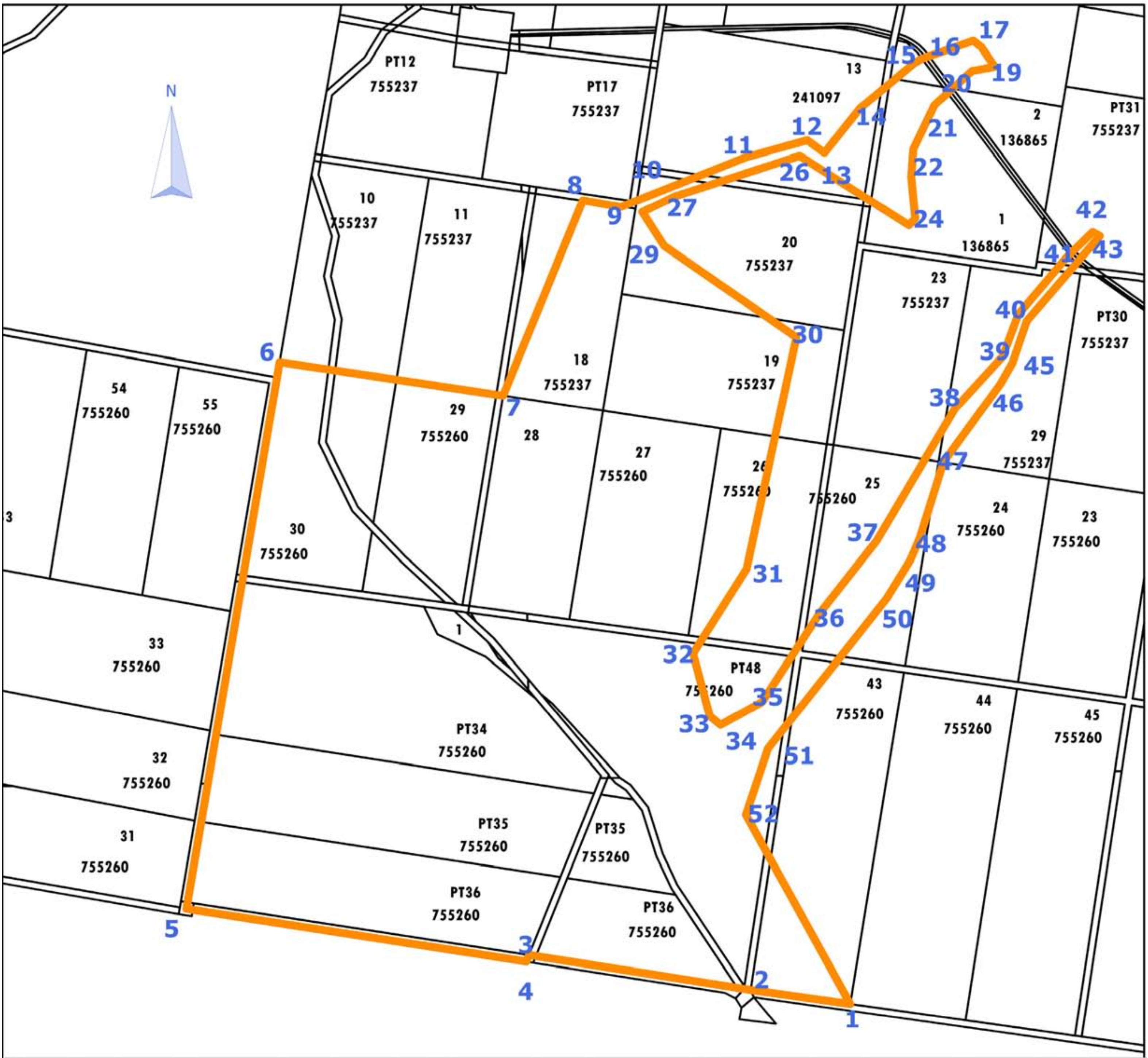
Part 3A Environmental Assessment

November 2008

APPENDIX B

Lot and DP Descriptions for Bloomfield Colliery Project Application Area

LOT	DP	PART OF BLOCK	COMMENTS
36	755260	All	
35	755260	All	
34	755260	All	
48	755260	Part	
30	755260	All	
29	755260	All	
28	755260	All	
27	755260	All	
26	755260	Part	
43	755260	Part	
25	755260	Part	
24	755260	Part	
18	755237	Part	
19	755237	Part	
20	755237	Part	
23	755237	Part	
29	755237	Part	
13	241097	Part	
1	136865	Part	
3	1045720	Part	
31	755237	Part	
4	241097	Part	Pipe line
5	241097	Part	Pipe line
1	617909	Part	Pump station
1	722210	All	Road
1	42349	Part	Roads
6	241097	Part	Pipe line
Council			Roads
Crown			Road
Hunter Water			Pipe line



MGA CO-ORDINATES (Zone 56)					
PT	EASTING	NORTHING	PT	EASTING	NORTHING
1	366474	6368098	27	365958	6370477
2	366180	6368140	28	365862	6370431
3	365528	6368242	29	365926	6370331
4	365521	6368223	30	366315	6370062
5	364520	6368378	31	366169	6369380
6	364795	6369989	32	366011	6369130
7	365452	6369890	33	366060	6368947
8	365686	6370465	34	366092	6368920
9	365798	6370446	35	366214	6368988
10	365857	6370468	36	366686	6369248
11	366166	6370592	37	366551	6369463
12	366347	6370643	38	366782	6369852
13	366398	6370606	39	366923	6370007
14	366503	6370737	40	366968	6370129
15	366662	6370871	41	367108	6370294
16	366686	6370884	42	367187	6370372
17	366836	6370936	43	367208	6370360
18	366860	6370917	44	366993	6370110
19	366899	6370859	45	366952	6369988
20	366832	6370847	46	366916	6369925
21	366722	6370747	47	366747	6369693
22	366659	6370616	48	366678	6369470
23	366653	6370535	49	366650	6369404
24	366665	6370412	50	366581	6369293
25	366646	6370392	51	366232	6368852
26	366325	6370596	52	366167	6368656

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LEGEND

PROJECT APPLICATION AREA
CADASTRAL BOUNDARY

APPENDIX B

PROJECT AREA CADASTRAL MAP

BLOOMFIELD COLLIERY
COMPLETION OF MINING AND REHABILITATION

SEPTEMBER 2008

Community Consultation Brochure Distributed during EA Process

Bloomfield Colliery Completion of Mining and Rehabilitation

Part 3A Environmental Assessment

November 2008

Community Information

Newsletter One

THE Bloomfield GROUP

Introduction

Figure 1

Bloomfield Collieries is applying for consent to complete mining operations and rehabilitation work on their existing site.

Bloomfield Collieries Pty Limited (Bloomfield) is an Australian owned, family company that has been operating on the same site since 1937. It is located south of East Maitland, lying generally within the area bounded by the New England Highway, John Renshaw Drive and Mt Vincent/Buchanan Road as shown in red in Figure 1.

The site has a long mining history and coal has been extracted by various means in the area since the mid 1800's. Bloomfield Open Cut Mine has been operating from 1962 to the present day. Bloomfield employs 66 people for open cut and CHPP operations as well as administration and management.

There are sufficient open cut coal reserves remaining within CCL761 to continue mining at the current rate for approximately 10 years. Bloomfield currently produces at an average of 500,000 tonnes per annum of saleable coal and mining will continue in a similar manner to the existing operation.

Bloomfield operates under "existing user" provisions of the Environmental Planning and Assessment Act 1979 (EP&A Act). Changes to that legislation in 2005 has provided an opportunity and framework for Bloomfield to modernise consent for its future operations. Under these changes Bloomfield will also formalise its environmental monitoring and reporting practises.

The EP&A Act was amended in 2005 by the addition of a new Part 3A to handle major projects and infrastructure.

Bloomfields Main Office at Four Mile Creek Road

This newsletter has been produced to ensure that all neighbouring residents and community in the local area are informed of:

- **the proposed project application;**
- **the process being followed with respect to the environmental assessment and the project application; and**
- **how the residents and members of the surrounding area can comment on the project or obtain further information.**

The Application Process

It is under this new Part 3A that Bloomfield is applying for approval from the NSW Department of Planning for its current and future operations.

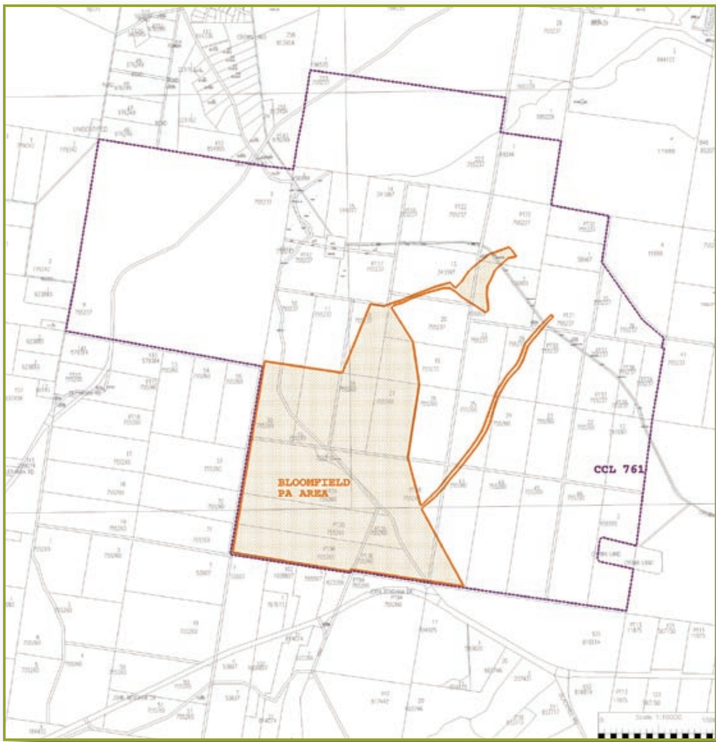
Approval to continue use of the existing coal processing infrastructure, including the Coal Handling Preparation Plant (CHPP) and rail loading facility is currently being applied for by the Abel Underground Mine project, proposed by Donaldson Coal.

Bloomfield's application applies to the current and future open cut mining operations that will occur within the Project Application Area (PA) marked in orange in Figure 2.

Bloomfield currently operates within Consolidated Coal Lease 761 (CCL761), shown in mauve in Figure 2

Part 3A of the EP&A Act requires the project to complete an Environmental Assessment (EA), including the identification of key environmental issues that will be addressed in the EA. Key environmental issues are identified through the preparation of a Project Application with Preliminary Assessment.

Figure 2



Topdressing operations on rehabilitation

After key issues have been determined, a more detailed Environmental Assessment will be undertaken.

To assist in identifying the key environmental issues, an Environmental Risk Assessment has been prepared and a Risk Register developed.

The Project

Semi-trailer used for Bloomfied washed coal c1940

Past and Present Operations

The Rathluba underground mine was closed in May 1992. In 1962, a small open cut mine commenced operations using bulldozers and tractor scrapers. The open cut has continued to develop with the introduction of electric face shovels and rear dump trucks, and the use of draglines to remove overburden from 1986 to 1991. Recently the P&H 5700 Face Shovel was replaced with an Hitachi EX 5500 Hydraulic Excavator.

Coal extracted from the Bloomfield lease is predominantly thermal coal with some soft coking coal for the Asian export market. All coal is transported by rail and exported through the Port of Newcastle using existing coal processing and rail loading infrastructure.

EX 5500 loading topsoil for stockpiling

Future Operations

While it is planned to continue extraction of the economically viable coal remaining within the PA, Bloomfield is not proposing to change the general manner in which the coal is extracted from current operations.

Operations related to the stockpiling and washing of coal and the management of reject material has been addressed in the Development Consent for the Abel Project, lodged with the NSW Department of Planning in October, 2006.

Hours of Operation

Mining operations, rehabilitation and maintenance are carried out 24 hrs per day 7 days per week as required, and it is proposed to continue this arrangement for future works.

Surface Facilities and Infrastructure

The major infrastructure components on site consist of the following:

- Open cut workshop;
- Bathhouse facilities; and
- Water management systems, including drainage structures, dams and mine recycling systems.

Existing infrastructure is well maintained and in good order and as such is considered sufficient for the proposed life of mine. No construction of major infrastructure is proposed as part of this application.

Operational staff at Bloomfield Open Cut

Preparation of the Environmental Assessment

Bloomfield has selected a team of specialist consultants to assist them with undertaking the various studies required for the Environmental Assessment.

These include specialists in:

- Environmental risk assessment;
- Surface hydrology (water studies);
- Groundwater investigations;
- Air quality;
- Noise and vibration study;
- Ecology;
- Archaeology;
- Soils and land capability;
- Visual aspects;
- Socio-economic aspects;
- Greenhouse gas impacts; and
- Community consultation.

5 year old tree plantings on rehabilitated spoil piles

S Cut rehabilitation of spoil piles

Each of these studies will examine the existing environment, proposed completion of mining operations and rehabilitation and any impacts that may occur. They will also include any measures that will be required to control or reduce impacts. Information provided by the community on local issues is taken into consideration in the preparation of these studies.

Communication and Consultation

To date Bloomfield has undertaken consultation with the owners of land within the PA, Local Government, State Government Departments and other Statutory Bodies. An independently chaired Focus Group has been formed to assist in guiding the Community Consultation process.

Bloomfield personnel will be visiting landowners in the immediate area outside of the PA to discuss the project and answer any questions the community may have regarding the proposal. As specialist studies are completed the results of these studies and any proposed controls will also be discussed.

A Bloomfield website is under final construction. When completed information relating to this application will be posted on the site. This will include:

- Community Newsletters
- The Project Application (when lodged)
- The various Environmental Assessments as listed earlier in this newsletter

The web address is www.bloomcoll.com.au and will be available in the near future.

Further Information

If you have any comment on the project or wish to obtain further information please do not hesitate to contact Mr Steve Dunn at Bloomfield Collieries. Steve may be contacted as follows:

Steve Dunn
General Manager Technical Services
THE BLOOMFIELD GROUP

Post PO Box 4
East Maitland NSW 2323

Telephone 61 2 4930 2623

Facsimile 61 2 4933 8940

Email sdunn@bloomcoll.com.au

THE Bloomfield GROUP

Appendix C

Environmental Risk Assessment

Bloomfield Colliery Completion of Mining and Rehabilitation

Part 3A Environmental Assessment

November 2008

Bloomfield Collieries Pty Limited

FINAL

Environmental Risk Assessment (ERA) and Establishment of a Site Based Risk Register for the Completion of Mining and Rehabilitation Project

Bloomfield Collieries

September 2008

BLC1-06-01 Bloomfield BBRA

GSS ENVIRONMENTAL
Environmental, Land and Project Management Consultants

ISSUE AND AMENDMENT CONTROL HISTORY

Issue	Date	Description	Author	QA/QC
1	03.11.2006	Final Draft Report	Chrissie Eckersley	Andrew Hutton
2	17.11.2006	Final Report following client comments	Chrissie Eckersley	Andrew Hutton
3.	08.05.2007	Final Report	Andrew Hutton	Klay Marchant
4	27.06.2008	Final Report revised following the completion of the Environmental Assessments	Andrew Hutton	Chrissie Eckersley
5.	3.09.2008	Review of the Final Draft Report	Chrissie Eckersley	Andrew Hutton

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APPENDICES

1.0 INTRODUCTION

GSS Environmental (GSSE) was engaged by Steve Dunn on behalf of the Bloomfield Colliery (Bloomfield) to undertake an Environmental Risk Assessment (ERA) and develop an Environmental Risk Register for Bloomfield's *Project Area* as part of the Bloomfield Collieries Project (the project).

The project was undertaken to provide the basis for identifying issues prior to the commencement of the environmental impact assessment phase of the project.

A **qualitative risk assessment** methodology was developed by GSSE in accordance with the requirements of the Australian Standard ***AS/NZS 4360:2004 – Risk Management.***

An initial site inspection was undertaken on the 30 June 2006 to identify the various issues for consideration in the Risk Assessment and to ensure appropriate consideration was given to those issues with potentially the highest risk.

GSSE assembled a project team utilising key stakeholders as this was considered the most appropriate way to help define context and identify the possible risks which needed some consideration throughout the process. A stakeholder workshop session was held at Monte Pio, Maitland on 19 July 2006. The workshop was facilitated by Andrew Hutton, Principal Environmental Consultant.

On the 31 January 2008, a second workshop was held at the Monte Pio, Maitland to review the initial Risk Register following completion of the preliminary environmental assessment documents. The purpose of this review was to reassess the risks, particularly where initially there were knowledge gaps identified during the first workshop session. Following this workshop the Risk Register was updated.

This report summarises the aims and objectives of the ERA, describes the methodology used throughout the ERA process, as well as detailing the various findings and presenting them as an Environmental Risk Register as it was reviewed throughout the environmental assessment (attached as **Appendix 1**).

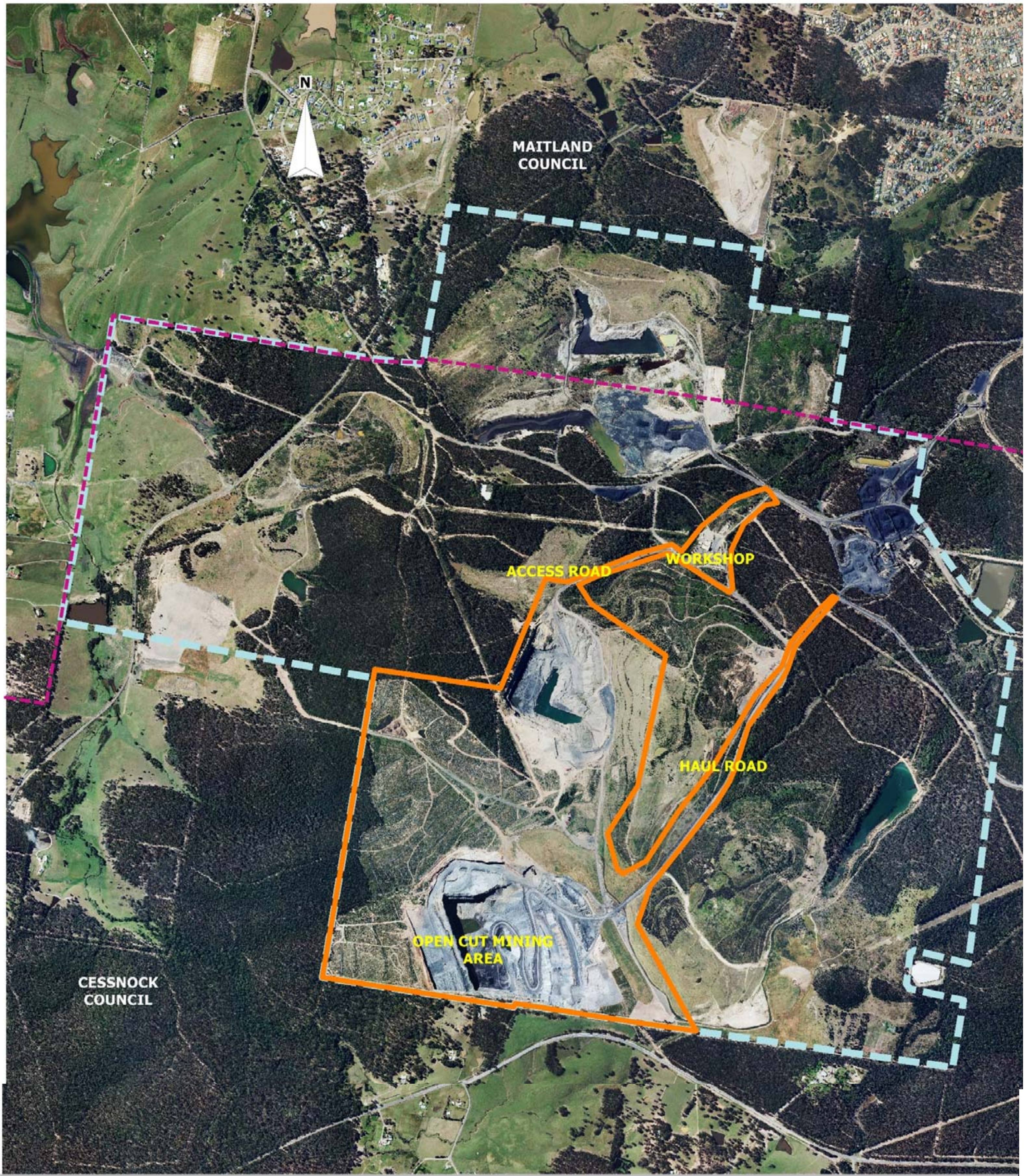
1.1 Background to the Project

Bloomfield Colliery (Bloomfield) is located approximately 20 kilometres north-west of Newcastle, as shown on **Figure 1**. Coal has been mined on the site for approximately 170 years, with the current owners purchasing the Bloomfield operation in 1937. Underground mining ceased on the site in 1992 and the current operation consists of open cut mining, an on-site Coal Handling and Preparation Plant ('washery') and a rail loading facility that transports processed coal to the Port of Newcastle.

Bloomfield is currently in the final stages of its planned open cut mining program and is actively rehabilitating former mining areas on the site. Coal extraction is proposed to be at a maximum rate of 0.88 million tonnes per annum (Mtpa) for Stage 1, and a maximum rate of 1.3 Mtpa of run-of-mine (ROM) coal in subsequent years. This production rate will be continued for the life of the mine to assist the completion of the mining and rehabilitation program on the site.

The Colliery currently operates under Consolidated Coal Lease 761 (CCL 761) and works are in accordance with a Mining Operations Plan (MOP) and an Environmental Protection Licence issued under the Protection of the Environment Operations Act, 1997. Operations are permissible under 'Existing Use Rights' as defined by Division 10, Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act). This Division of the Act enables certain mining development on pre-existing mines as specified by Clause 35 and Item 7 of Schedule 1 of the Environmental Planning and Assessment Model Provisions, 1980.

The introduction of Part 3A of the Environmental Planning and Assessment Amendment (Infrastructure and Other Planning Reform) Act, 2005 provided a new framework for Bloomfield Colliery to regularise its consent to enable it to complete its operations and undertake rehabilitation.



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LEGEND

PROJECT APPLICATION AREA
BLOOMFIELD MINING LEASE
COUNCIL BOUNDARY

FIGURE 1

AERIAL VIEW OF PROJECT AREA

BLOOMFIELD COLLIERY
COMPLETION OF MINING AND REHABILITATION

SEPTEMBER 2008

The remaining open cut mining activities at Bloomfield Colliery are classified as a major project under the State Environmental Planning Policy (Major Projects) as it is a coal mine. Part 3A amendments to the EP&A Act therefore require that a Project Application with Environmental Assessment be completed which identifies key issues requiring further investigation to determine any potential environmental impacts. This report provides the Environmental Risk Assessment that has been prepared to assist the investigation of key issues and identify risks associated with any potential environmental impacts for the completion of open cut mining and rehabilitation at Bloomfield Colliery.

The continued use of the coal washery and rail loading facility (including the management of water associated with the washery, reject disposal and coal handling) does not form part of this project as it was approved by the Abel Project Consent on 7 June 2007.

The completion of open cut mining activities at Bloomfield will be designed to cater for the reject management system as outlined in detail in the Abel Underground Mine Environmental Assessment.

2.0 AIMS & OBJECTIVES

The aim of the ERA is to formally identify and present effective management protocols for all environmental risks associated with the coal operations at Bloomfield's *Project Area*. GSSE followed four (4) fundamental steps during the ERA process:

(a) Establish the context for the risk assessment process;

(b) Identify the environmental risks;

(c) Analyse the risks; and

(d) Evaluate the risks to determine the significant issues.

The following specific aims and objectives have been established for this ERA:

- To assemble the key stakeholders in the project to identify the activities, aspects and possible environmental impacts associated with the operation at the *Project Area* of Bloomfield;
- To consider these activities in isolation of any controls and determine a potential raw risk rating;
- To identify the current controls (that are already in place) to mitigate or minimise the potential for the impacts in order to reduce the risk to as low as reasonably practicable;
- To identify potential future controls that may assist to either eliminate or mitigate other likely impacts;
- To Provide the basis for the development of an action plan which identified the various issues requiring further consideration during the environmental impact assessment phase of project; and
- Determine the residual risk and ensure that is it appropriately low enough given the sensitivities of the project location. This was undertaken following consideration of the controls/mitigation strategies already in place and others that may be proposed.

3.0 SCOPE

The ERA only covers the Bloomfield *Project Area*. The ERA includes a detailed review of the key activities such as Exploration, Pre-Stripping, Main Dig, Rehabilitation, Field Maintenance & the Open-Cut Workshop, and Supply.

Table 1 below describes the six (6) distinct activities associated with the project and details what is included within each of the activities.

Table 1 – List of key phases of the project considered in the ERA

PROJECT PHASE	PROCESS BOUNDARY	ACTIVITIES
Exploration	Exploration of the resource and development of mining tenures	Survey of drill locations, clearing of drill lines and establishment of drill site, establishing the drill rig and undertaken drilling, traffic movement, open holes and pits and rehabilitation of the drill sites...
Pre-Stripping	Works associated with the establishment of site for the commencement and actual mining operations onsite.	Clearing of vegetation, stripping top-dressing material, drilling the overburden, blasting, excavation of the overburden, mining of coal, hauling material within the pit, hauling of material to overburden dumps.
Main Dig	Mining operations	Interburden drilling, blasting; excavation of the interburden, the mining of coal, hauling coal material to the CHPP, hauling overburden within the pit or to the overburden dumps.
Rehabilitation Areas	The re-shaping, topdressing of disturbed areas including the overburden emplacement areas as they become available.	Reshaping of the available overburden dump areas, top-dressing material spreading and ripping, and revegetation
Maintenance/Workshop	The service and maintenance of equipment undertaken in the pit area or at a workshop facility away from the active working coal mine.	Waste Management, Bulk fuel storage, the refuelling bay, oil storage area, transformers, parts washers, oil water separator, workshop and field maintenance.
Supply	Provision, storage and transport of raw materials to support exploration, mining, rehabilitation and maintenance activities.	Bulk Fuel storage and the transfer of fuel from road transport.

4.0 METHODOLOGY

4.1 Process/Operational Flow Chart

A process/operational flow chart was developed for the Bloomfield *Project Area*. A copy of the process/operational flow chart used during the ERA has been included as **Appendix 2** to this report.

4.2 Workshop Session

The formulation of a key working group was integral in developing a thorough ERA as well as establishing a high level of site ownership for the process. This enabled the risks to be assessed by those who have experience in the area, understand the project and have the authority to action key "findings" that may have resulted from the ERA process. These personnel were also able to provide the best insight into the environmental effects of the activity, the frequency that the activity is undertaken, comment on the effectiveness of current controls, and suggest suitable and practical potential support control solutions where required.

The following table shows the workshop attendees who attended the initial workshop on the 30 June 2006, including their responsibilities within the Project team.

Table 2 – Workshop Session and List of Attendees

Workshop Session held at Monte Pio, Maitland on 19 July 2006		
1).	John Richards	*Director, Bloomfield Collieries*
2).	Reg Crick	*Mine Manager/Superintendent, Bloomfield Collieries*
3).	John Hindmarsh	*Environmental Officer, Bloomfield Collieries*
4).	Max Geyer	*Group Manager-Safety Systems, Bloomfield Collieries*
5).	Nicole Croker	*Environmental Consultant, Business Environment*
6).	Jim Eccelston	*Plant Operator, Bloomfield Collieries*
8).	Andrew Hutton	*Principal Environmental Consultant, GSSE*
7).	Kylie Gallaher	*Administration Representative, GSSE*
8).	Steve Dunn	*Manager - Mine Planning, Bloomfield Collieries*

4.3 Determination and Assigning the Environmental & Community Risk Rating

4.3.1 Outline of General Approach

The following section outlines the approach used by GSSE to assign a specific Risk Rating to each aspect of the Bloomfield *Project Area*. Risk assessment is the formalised means by which the aspects of the project and their associated impacts are systematically identified, assessed, ranked according to perceived risk and addressed by means of appropriate and effective controls or management outcomes.

Risk is the chance of something happening that will have either a positive or negative impact upon the environment and/or the community. It involves consideration of the sources of the risk (i.e. open-cut mining) assessing the consequences and considering the likelihood that an event might occur which could give rise to a consequence. The impact may vary in consequence from ***Catastrophic*** *-a major event which could cause severe impact to the environment or the community* through to ***Insignificant*** *-no detrimental impact on the environment or the community is measured or envisaged*. The Environmental Risk Rating assigned to the activity during this process is measured in terms of both consequence (severity) and likelihood (probability) of the event occurring.

4.3.2 Compliance with AS/NZS 4360:2004 Risk Assessment – Qualitative Risk Assessments

A qualitative risk assessment methodology was developed by GSSE in accordance with the requirements of the Joint Australian & New Zealand Standard ***AS/NZS 4360:2004 - Risk Management.***

It is intended that this **qualitative** assessment be used as an initial *screening* activity being the basis for identifying issues prior to the commencement of the environmental impact assessment phase of the project.

GSSE applied the following five (5) basic steps during the Risk Assessment process including:

- Establishing the internal and external context for the environmental risk assessment process, including developing consequence criteria and defining the structure of the risk assessment process. This is important to ensure that the objectives defined for the risk management process take into account the issues specific to the project as well as the external environment.
- Identifying the environmental related risks, including what could happen, when and where;
- Analysing the risks using a qualitative risk approach (i.e. identifying existing controls, determining specific consequences / likelihoods table (see **Table 3**) and then determining the level of risk;
- Evaluating the risks to determine the significant issues. The purpose of risk evaluation is to make decisions, based on the outcomes of the risk assessment, about which risks need controls or mitigation strategies and to assign priorities;
- Establishing the controls to mitigate/treat the risks identified as part of the process.

4.3.3 Environmental Consequence

The allocation of an Environmental Risk Rating was based on the Consequence descriptions contained in **Table 3.** The descriptions in the table were developed by GSSE through experience undertaking previous Risk Assessment exercises and have been designed such that the working group could make a subjective assessment of the consequence using a series of assumptions or descriptors. The magnitude of the consequence of an event was assessed using these descriptors and assigned a Rating of 1 to 5.

Table 3 – Environmental Consequence Descriptions

1	**Catastrophic**	**A major event which could cause severe or irreversible damage to the natural and/or human environment.** • Major Closure Costs (i.e. estimated closure costs > $5M). • Permanent premature closure of the mine. • Severe or irreversible damage to natural environment. • Could kill or permanently disable people. • Actual or potential loss of credibility with key stakeholders (community / government). • Long term environmental liability/legacy to the Company. • Loss of global reputation for the Company. • Regulatory intervention, prosecution would occur (ie. Fines). • Negative publicity/complaints (National & Global media exposure). • Pollution event causes major downstream damage that is rectified by a long term remediation program over 12 months (e.g. failure of major tailings dam that pollutes *international* waters). • Total destruction of Cultural Heritage Sites and Artefacts.
2	**Major**	**An event which could have a substantial and permanent consequence to the natural and / or human environment.** • Major Closure Costs (i.e. estimated closure costs $1M - $5M). • Could cause temporary or long term closure of mine. • Substantial and permanent consequences to the natural environment. • Could cause serious injury or disease to people • Potential loss of credibility with key stakeholders (community / government) • Reported incident, regulatory intervention which would result in prosecution the result of which could lead to a substantial fine. • Adverse publicity and community complaints (National media exposure). • Pollution event which causes serious downstream damage that is rectified by a medium term remediation program over 1-12 months (e.g. failure of major tailings dam that pollutes *regional/national* waters). • Major permanent unrepairable damage to Cultural Heritage Sites and Artefacts.
3	**Moderate**	**An event which could create substantial temporary or minor permanent damage to the natural and / or human environment.** • Moderate Closure Costs (ie. estimated closure costs $500K - $1M). • Could cause temporary closure of the mine or disruptions to the operation. • Substantial temporary or minor permanent damage to the natural environment. • A reportable incident with the potential to result in prosecution the result of which could lead to a moderate fine. • Could cause typical lost time injury (LTI) to people • Potential loss of credibility with key stakeholders (community / government) • Adverse local publicity and community complaints (Local media exposure). • Event which causes substantial temporary damage that is rectified by medium term remediation program over 3 – 6 months (i.e. earthworks to fix surface cracking under public roads or works required to stop water leaking from water storage structures). • Substantial permanent unrepairable damage to Cultural Heritage Sites and Artefacts.
4	**Minor**	**An event which could have temporary and minor effects to the natural and / or human environment.** • Minor Closure Costs (ie. estimated closure costs $100K - $500K). • Temporary minor damage to the natural environment. • Could cause a first aid injury to people. • Complaints received from near neighbours. • An incident which is either not reportable or if reportable could lead to a minor fine. • Event which causes temporary minor damage which may require some minor rectification works (i.e. cracking on surface causing minor erosion in drainage lines). • Minor repairable damage to Cultural Heritage Sites and Artefacts.
5	**Insignificant**	**No detrimental impact on the natural and / or human environment is measured or envisaged.** • Minor Closure Costs (ie. estimated closure costs <$100K) • No detrimental impact to the natural environment. • Couldn't cause injury or disease to people. • No detrimental impacts to Cultural Heritage Sites and Artefacts.

4.3.4 Probability of an Incident occurring

The likelihood of an event occurring was considered by the working group. The likelihood (or probability) of an impact occurring was rated according to the following descriptions on **Table 4.**

Table 4 – Qualitative Measures of Likelihood (Probability)

PROBABILITY:	
A	Almost certain to happen
B	Likely to happen at some point
C	Moderate: possible, heard of so it might happen
D	Unlikely: not likely to happen
E	Rare: practically impossible

4.3.5 Environmental Risk Matrix

The Risk Rating was assigned by combining the consequence with the probability that the consequence would occur. A numerical Risk Ranking between 1 and 25 was allocated for each aspect of the proposal using the "*Environmental Risk Matrix*" included as **Table 5** below.

Table 5 – Environmental Risk Rating Matrix

		Probability				
		A	**B**	**C**	**D**	**E**
Maximum Reasonable Consequence	**1**	1	2	4	7	11
	2	3	5	8	12	16
	3	6	9	13	17	20
	4	10	14	18	21	23
	5	15	19	22	24	25

4.3.6 Risk Classification System

Depending on the numerical Risk Ranking, a Risk Rating Class was then applied to each aspect using the Risk Classification System. **Table 6** shows the different classes of the Risk Classification System.

Table 6 – Risk Classification System

Risk Classification System	
High Risk (H)	1 to 6 (Red)
Medium Risk (M)	7 to 15 (Yellow)
Low Risk (L)	16 to 25 (Green)

In accordance with this Risk Classification System, one of the following Environmental Risk Ratings was assigned to each aspect:

- **H (high)** being a *Class 1 Risk* - requires immediate management attention, a stop/stand down until rectified if deemed necessary.
- **M (moderate)** being a *Class 2 Risk* - acceptable with current controls but requires attention if controls absent or ineffective, and where practicable develop other controls to mitigate the risk.
- **L (low)** being a *Class 3 Risk* – acceptable risks are assessed and controlled as required.

4.3.7 Assessment of Effectiveness of Controls

Risk Rankings were allocated for each aspect of the existing operation, based on three (3) separate scenarios. The first considering **no controls,** which is a measure of the *raw* risk associated with the activity. The second considered the risk rating with **current controls** in place. The third included consideration of the effect of potential future controls, as suggested by the working group.

In the context of this ERA, a control is considered to be either a hard engineering control (e.g. bunds, diversions, etc) or administrative control (e.g. work procedure(s) and/or management plan).

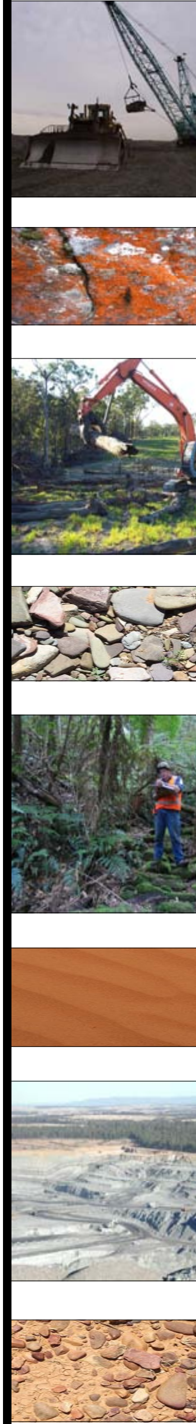
5.0 RISK REGISTER

GSSE has compiled the following Risk Register (see **Appendix 1**) to document the risk assessment outcome(s) for all aspects identified throughout the ERA process. The Risk Register has been separated into the six (6) key phases identified for the project.

The key Aspects included in the Risk Register are typical of an open cut mine of this nature and are summarised below:

- Disturbance of Aboriginal Heritage
- Disturbance of European Heritage
- Erosion and sedimentation
- Fire Hazard
- Dust
- Noise
- Contamination of surface and ground water resources
- Storage and management and hydrocarbons including spills and leaks
- Introduction of weeds.

RISK REGISTER FOR BLOOMFIELD COLLIERY



APPENDIX 1

BLOOMFIELD COLLIERY ENVIRONMENTAL RISK REGISTER - EXPLORATION																
Process Area	Activity	Aspect	Raw (potential risk)				Existing Controls	Existing Controls				Proposed Controls	Residual Risk			
			C	P		R		C	P		R		C	P		R
Exploration	Survey of the drill locations	Damage to vegetation	5	c	5c	22 (L)	1. Employee Inductions 2. Experienced people 3. Use of existing tracks where possible	5	d	5d	24 (L)					
		Disturbance of Aboriginal heritage	2	d	2d	12 (M)		2	d	2d	12 (M)	1. Employee Inductions 2. Surveys completed to identify sites and assess significance. 3. Aboriginal Groups have been consulted 4. All known artefacts have been fenced off 5. The sites will be salvaged with the Aboriginal Community prior to the area being disturbed by mining. 6. Aboriginal Heritage Management System.	2	e	2e	16 (L)
		Disturbance of European heritage	2	d	2d	12 (M)		2	d	2d	12 (M)	1. Employee Inductions 2. Surveys completed to identify sites and assess significance. 3. No heritage items have been identified.	5	e	5e	25 (L)
		Wheel track erosion	3	d	3d	17 (L)	1. Use existing tracks where possible 2. Draft Erosion & Sediment Control Management Plan 3. Scheduled Environmental Inspections 4. Systems audits 5. Environmental Protection Licence 6. Existing Sediment Control Dams	4	e	4e	23 (L)					
		Fire hazard	3	d	3d	17 (L)	1. Employee Inductions 2. Hazard reduction program 3. Competent employees 4. Bushfire Management Plan 5. Onsite fire fighting capabilities	4	d	4d	21 (L)					
		Dust	3	d	3d	17 (L)	1. Employee Inductions 2. Land Disturbance Management System (dust) 3. Water cart availability 4. Complaints Protocol 5. Mindful of weather (wind) conditions.	5	e	5e	25 (L)					
		Potential for spills of hydrocarbons from vehicle accident.	4	d	4d	21 (L)	1. Mine Transport Management Plan 2. Bushfire Management Plan 3. Scheduled Environmental Inspections 4. Contractor Management System 5. Incident Notification and Reporting Procedure 6. Emergency Response Procedure	4	e	4e	23 (L)					
		Injury to or loss of threatened flora and fauna *(note work area mostly cleared)*	4	d	4d	21 (L)	1. Mine Transport Management Plan 2. Employee Inductions 3. Daylight operations	4	e	4e	23 (L)					
		Potential to introduce weeds	5	e	5e	25 (L)	1. Vehicle wash at entrance 2. Employee inductions 3. Scheduled Environmental Inspections 4. Weed Control Contractors	5	e	5e	25 (L)	not considered an issue				
	Clearing of drill lines and Site establishment and Digging Pits	Injury to or loss of threatened flora and fauna *(note work area mostly cleared)*	4	c	4c	18 (L)	1. Mine Transport Management Plan 2. Employee Inductions 3. Daylight operations	4	d	4d	21 (L)					
		Sediment leaving the site	3	c	3c	13 (M)	1. Use existing tracks where possible 2. Draft Erosion & Sediment Control Management Plan 3. Scheduled Environmental Inspections 4. Systems audits 5. Environmental Protection Licence 6. Existing sedimentation dam on boundary	4	d	4d	21 (L)					
		Loss of top dressing material	4	c	4c	18 (L)	1. Mining Operations Plan 2. Minimal surface disturbance	4	d	4d	21 (L)					
		Disturbance of Aboriginal heritage	2	c	2c	8 (M)		2	c	2c	8 (M)	1. Employee Inductions 2. Surveys completed to identify sites and assess significance. 3. Aboriginal Groups have been consulted 4. All known artefacts have been fenced off 5. The sites will be salvaged with the Aboriginal Community prior to the area being disturbed by mining. 6. Aboriginal Heritage Management System.	2	e	2e	16 (L)
		Disturbance of European heritage	2	c	2c	8 (M)	1. Non existent in area under investigation	2	c	2c	8 (M)	1. Employee Inductions 2. Surveys completed to identify sites and assess significance. 3. No heritage items have been identified.	5	e	5e	25 (L)
		Potential to introduce weeds	5	e	5e	25 (L)	1. Vehicle wash at entrance 2. Employee inductions 3. Scheduled Environmental Inspections 4. Weed Control Contractors	5	e	5e	25 (L)	not considered an issue				
		Noise	4	d	4d	21 (L)	1. Daylight activity 2. Employee Inductions 3. Maintenance Management System 4. Complaints Protocol	4	e	4e	23 (L)					
		Dust	3	c	3c	13 (M)	1. Mindful of weather (wind) conditions 2. Employee Inductions 3. Land Disturbance Management System (dust) 4. Water cart availability 5. Complaints Protocol 6. Supervisor Inspections	5	e	5e	25 (L)					
		Fire hazard	3	d	3d	17 (L)	1. Employee Inductions 2. Hazard reduction program 3. Competent employees 4. Bushfire Management Plan 5. Onsite fire fighting capabilities	4	d	4d	21 (L)					

BLOOMFIELD COLLIERY ENVIRONMENTAL RISK REGISTER - EXPLORATION

Process Area	Activity	Aspect	Raw (potential risk)				Existing Controls	Existing Controls				Proposed Controls	Residual Risk			
			C	P		R		C	P		R		C	P		R
		Hydraulic hose oil spill	3	c	3c	13 (M)	1. Maintenance Management System 2. Environmental Emergency Response Procedure 3. Spill kits 4. Employee Inductions 5. Employee Consultation Systems 6. Incident Notification and Reporting Procedure	4	d	4d	21 (L)					
	Establish drill rig and drilling (including demobilisation)	Erosion with sediment leaving site (wheel tracks)	4	d	4d	21 (L)	1. Use existing tracks where possible 2. Draft Erosion & Sediment Control Management Plan 3. Scheduled Environmental Inspections 4. Systems audits 5. Environmental Protection Licence 6. Existing sedimentation dam on boundary 7. Contractor Management System 8. Contractor Inductions	5	d	5d	24 (L)					
		Hydrocarbon storage	3	c	3c	13 (M)	1. Mobile equipment 2. Contract Management System 3. Contractor Induction 4. Onsite spill kits 5. Bushfire Management Plan 6. Supervisor Inspections 7. Incident Notification and Reporting Procedure	4	d	4d	21 (L)					
		Potential to introduce weeds	4	c	4c	18 (L)	1. Vehicle wash at entrance 2. Contractor inductions 3. Scheduled Environmental Inspections 4. Weed Control Contractors 5. Supervisor Inspections	4	d	4d	21 (L)					
		Injury to or loss of threatened flora and fauna *(note work area mostly cleared)*	5	e	5e	25 (L)	1. Mine Transport Management Plan 2. Employee Inductions 3. Daylight operations	5	e	5e	25 (L)	not considered an issue				
		Hydraulic hose oil spill	3	c	3c	13 (M)	1. Mobile equipment 2. Contract Management System 3. Contractor Induction 4. Onsite spill kits 5. Bushfire Management Plan 6. Supervisor Inspections 7. Incident Notification and Reporting Procedure	4	d	4d	21 (L)					
		Spillage of hydrocarbons during transfer from the service truck.	3	c	3c	13 (M)	1. Mobile equipment 2. Contractor Management System 3. Contractor Induction 4. Onsite spill kits 5. Bushfire Management Plan 6. Incident Notification and Reporting Procedure	4	d	4d	21 (L)					
		Hydrocarbon leaking from tank	3	c	3c	13 (M)	1. Mobile equipment 2. Contractor Management System 3. Contractor Induction 4. Onsite spill kits 5. Bushfire Management Plan	4	d	4d	21 (L)					
		Noise	4	c	4c	18 (L)	1. Daylight activity 2. Employee Inductions 3. Maintenance Management System 4. Complaints Protocol 5. Supervisor Inspections 6. Contractors Management Systems 7. Contractor Inductions	4	d	4d	21 (L)					
		Dust	3	c	3c	13 (M)	1. Employee Inductions 2. Land Disturbance Management System (dust) 3. Water cart availability 4. Complaints Protocol 5. Supervisor Inspections 6. Contractors Management Systems 7. Contractor Inductions 8. Mindful of weather (wind) conditions.	3	d	3d	17 (L)					
		Fire hazard	4	d	4d	21 (L)	1. Hazard reduction program 2. Bushfire Management Plan 3. Onsite fire fighting capabilities 4. Supervisor Inspections	5	d	5d	24 (L)					
		Waste management e.g. oily rags, empty drums	4	b	4b	14 (M)	1. Contractor Management System 2. Contractor Induction 3. Onsite waste bins 4. Supervisor Inspections	5	d	5d	24 (L)					
	Traffic movement e.g. water cart, geologist, driller, logger	Potential to introduce weeds	4	d	4d	21 (L)	1. Vehicle wash at entrance 2. Employee inductions 3. Scheduled Scheduled Environmental Inspections 4. Weed Control Contractors	5	d	5d	24 (L)					
		Wheel track erosion	4	b	4b	14 (M)	1. Use existing tracks where possible 2. Draft Erosion & Sediment Control Management Plan 3. Scheduled Environmental Inspections 4. Systems audits 5. Environmental Protection Licence 6. Contractor Management System 7. Supervisor Inspections 8. Contractor Induction	4	d	4d	21 (L)					
		Fire hazard	4	d	4d	21 (L)	1. Hazard reduction program 2. Bushfire Management Plan 3. Onsite fire fighting capabilities 4. Supervisor Inspections 5. Contractor Management System 6. Contractor Induction	5	d	5d	24 (L)					
		Noise	4	c	4c	18 (L)	1. Daylight activity 2. Employee Induction 3. Maintenance Management System 4. Complaints Protocol 5. Supervisor Inspections 6. Contractor Management System 7. Contractor Induction	4	d	4d	21 (L)					

BLOOMFIELD COLLIERY ENVIRONMENTAL RISK REGISTER - EXPLORATION																
Process Area	**Activity**	**Aspect**	**Raw (potential risk)**				**Existing Controls**	**Existing Controls**				**Proposed Controls**	**Residual Risk**			
			C	**P**		**R**		**C**	**P**		**R**		**C**	**P**		**R**
		Dust	3	c	3c	13 (M)	1. Employee Induction 2. Land Disturbance Management System (dust) 3. Water cart availability 4. Complaints Protocol 5. Supervisor Inspections 6. Contractor Management System 7. Contractor Induction 8. Mindful of weather (wind) conditions.	4	d	4d	21 (L)					
		Potential for spills of hydrocarbons from vehicle accident.	4	d	4d	21 (L)	1. Mine Transport Management Plan 2. Bushfire Management Plan 3. Scheduled Environmental Inspections 4. Incident Notification and Reporting Procedure 5. Contractor Management System 6. Contractor Induction 7. Incident Notification and Reporting Procedure	4	e	4e	23 (L)					
		Injury to or loss of threatened flora and fauna *(note work area mostly cleared)*	5	e	5e	25 (L)	1. Mine Transport Management Plan 2. Employee Inductions 3. Daylight operations	5	e	5e	25 (L)	not considered an issue				
		Loss of radiation source	4	d	4d	21 (L)	1. Contractor Management System 2. Contractor Induction 3. Use of NATA approved contractor	4	e	4e	23 (L)					
	Open holes and pits after drilling	Injury to or loss of threatened flora and fauna *(note work area mostly cleared)*	4	d	4d	21 (L)	1. Fill in pits and cap holes 2. DPI guidelines 3. Mining Lease Conditions	5	e	5e	25 (L)	not considered an issue				
		Aquifer contamination	4	d	4d	21 (L)	1. Dry area 2. Capping holes 3. Deep hard rock aquifer 4. No alluvial aquifers involved 5. Poor water quality	5	e	5e	25 (L)	not considered an issue				
	Rehabilitation	Potential to introduce weeds	4	c	4c	18 (L)	1. Vehicle wash at entrance 2. Employee inductions 3. Scheduled Environmental Inspections 4. Weed Control Contractors	4	d	4d	21 (L)					
		Erosion with sediment leaving site	4	d	4d	21 (L)	1. Use existing tracks where possible 2. Draft Erosion & Sediment Control Management Plan 3. Scheduled Environmental Inspections 4. Systems audits 5. Licence 6. Existing sedimentation dam on boundary	5	d	5d	24 (L)					
		Noise	4	d	4d	21 (L)	1. Daylight activity 2. Employee Inductions 3. Maintenance Management System 4. Complaints Protocol 5. Supervisor Inspections 6. Contractors Management Systems 7. Contractor Inductions	4	e	4e	23 (L)					
		Dust	3	c	3c	13 (M)	1. Employee Inductions 2. Land Disturbance Management System (dust) 3. Water cart availability 4. Complaints Protocol 5. Supervisor Inspections 6. Contractors Management Systems 7. Contractor Inductions 8. Mindful of weather (wind) conditions	5	e	5e	25 (L)					
		Hydraulic hose oil spill	4	d	4d	21 (L)	1. Maintenance Management System 2. Emergency Spill Response 3. Spill kits 4. Employee Inductions 5. Employee Consultation Systems 6. Incident Notification and Reporting Procedure	5	d	5d	24 (L)					
		Fire hazard	4	d	4d	21 (L)	1. Inductions 2. Hazard reduction program 3. Competent employees 4. Bushfire Management Plan 5. Onsite fire fighting capabilities	5	d	5d	24 (L)					

BLOOMFIELD COLLIERY ENVIRONMENTAL RISK REGISTER - PRE-STRIPPING

Process Area	Activity	Aspect	Raw (potential risk) C	P	R			Existing Controls	Existing Controls C	P	R			Proposed Controls	Residual Risk C	P	R		
Pre-stripping	Clearing of vegetation - *note: site predominantly cleared*	Injury to or loss of threatened flora and fauna	2	b	2b	5	(H)	1. Draft Land Disturbance Management System 2. Work area mostly cleared.	3	d	3d	17	(L)	1. Assessment has been made on the presence / absence of threatened species 2. No threatened species were identified within the area to be disturbed 3. A relevant DECC approved research program will be committed to by Bloomfield commensurate to the loss of any Lower Hunter Spotted Gum Ironbark Forest Endangered Ecological Community within the Project area.	3	d	3d	17	(L)
		Disturbance of Aboriginal heritage sites	2	c	2c	8	(M)		2	c	2c	8	(M)	1. Employee Inductions 2. Surveys completed to identify sites and assess significance. 3. Aboriginal Groups have been consulted 4. All known artefacts have been fenced off 5. The sites will be salvaged with the Aboriginal Community prior to the area being disturbed by mining. 6. Aboriginal Heritage Management System.	2	e	2e	16	(L)
		Disturbance of European heritage sites	2	c	2c	8	(M)		2	c	2c	8	(M)	1. Employee Inductions 2. Surveys completed to identify sites and assess significance. 3. No heritage items have been identified.	5	e	5e	25	(L)
		Dust	3	b	3b	9	(M)	1. Mindful of weather (wind) conditions 2. Employee Inductions 3. Land Disturbance Management System (dust) 4. Water cart availability 5. Complaints Protocol 6. Supervisor Inspections 7. Supervisor Audits	4	d	4d	21	(L)						
		Noise	4	d	4d	21	(L)	1. Employee Inductions 2. Maintenance Management Systems 3. Complaints Protocol 4. Supervisor Inspections 5. Supervisor Audits 6. Altered operating conditions at set times (ie. night time) to reduce noise.	4	e	4e	23	(L)						
		Erosion with sediment leaving site	4	c	4c	18	(L)	1. Employee Inductions 2. Internal drainage 3. Existing Sediment Control Dam 4. Draft Erosion & Sediment Control Plan 5. Mining Operations Inspection System 6. Scheduled Environmental Inspections	4	d	4d	21	(L)						
		Spillage of hydraulic oil from damaged hose	4	b	4b	14	(M)	1. Maintenance Management System 2. Emergency Spill Response 3. On-site Spill Kits 4. Employee Inductions 5. Employee Consultation Systems 6. Incident Notification and Reporting Procedure 7. Supervisor Inspections 8 Supervisor Audits	5	d	5d	24	(L)						

BLOOMFIELD COLLIERY ENVIRONMENTAL RISK REGISTER - PRE-STRIPPING

Process Area	Activity	Aspect	Raw (potential risk)				Existing Controls	Existing Controls				Proposed Controls	Residual Risk			
			C	P	R			C	P	R			C	P	R	
		Potential to introduce weeds	4	d	4d	21 (L)	1. Weed Control Contractors 2. Scheduled Environmental Inspections 3. Vehicle wash at entrance 4. Employee Inductions 5. Employee Consultation Systems 6. Contractor Induction 7. Supervisor Inspections 8. Supervisor Audits 9. Contractor Management System	5	d	5d	24 (L)					
		Disposal of cleared timber (potential loss of habitat)	3	b	3b	9 (M)	1. Pre-clearance protocol	4	e	4e	23 (L)					
		Spillage of hydrocarbons when transferring from service truck	4	b	4b	14 (M)	1. Maintenance Management System 2. Emergency Spill Response 3. On-site On-site Spill Kits 4. Employee Inductions 5. Employee Consultation Systems 6. Incident Notification and Reporting Procedure 7. Mobile equipment 8. Competency Management System	4	d	4d	21 (L)					
	Stripping of Top-dressing Material	Disturbance of Aboriginal heritage sites	2	c	2c	8 (M)		2	c	2c	8 (M)	1. Employee Inductions 2. Surveys completed to identify sites and assess significance. 3. Aboriginal Groups have been consulted 4. All known artefacts have been fenced off 5. The sites will be salvaged with the Aboriginal Community prior to the area being disturbed by mining. 6. Aboriginal Heritage Management System.	2	e	2e	16 (L)
		Potential to introduce weeds	4	d	4d	21 (L)	1. Vehicle wash at entrance 2. Employee inductions 3. Scheduled Environmental Inspections 4. Weed Control Contractors 5. Contractor Management System 6. Contractor Inductions	5	d	5d	24 (L)					
		Disturbance of European heritage sites	2	c	2c	8 (M)		2	c	2c	8 (M)	1. Employee Inductions 2. Surveys completed to identify sites and assess significance. 3. No heritage items have been identified.	5	e	5e	25 (L)
		Dust	3	b	3b	9 (M)	1. Mindful of weather (wind) conditions 2. Employee Inductions 3. Land Disturbance Management System (dust) 4. Water cart availability 5. Complaints Protocol 6. Supervisor Inspections 7. Supervisor Audits	3	d	3d	17 (L)					
		Noise	4	b	4b	14 (M)	1. Employee Inductions 2. Maintenance Management Systems 3. Complaints Protocol 4. Supervisor Inspections 5. Supervisor Audits 6. Altered Operating Conditions at set times (ie night time) to reduce noise.	4	e	4e	23 (L)					

BLOOMFIELD COLLIERY ENVIRONMENTAL RISK REGISTER - PRE-STRIPPING

Process Area	Activity	Aspect	Raw (potential risk) C	P	R			Existing Controls	Existing Controls C	P	R			Proposed Controls	Residual Risk C	P	R
		Erosion with sediment leaving site	3	b	3b	9	(M)	1. Employee Inductions 2. Internal drainage for part of the area 3. Existing Sediment Control Dam 4. Draft Erosion & Sediment Control Plan 5. Mining Operations Inspection System 6. Scheduled Environmental Inspections	4	d	4d	21	(L)				
		Spillage of hydraulic oil from damaged hose	4	b	4b	14	(M)	1. Maintenance Management System 2. Emergency Spill Response 3. On-site On-site Spill Kits 4. Employee Inductions 5. Employee Consultation Systems 6. Incident Notification and Reporting Procedure 7. Supervisor Inspections 8. Supervisor Audits 9. Mine Transport	5	d	5d	24	(L)				
		Spillage of hydrocarbons when transferring from service truck	4	b	4b	14	(M)	1. Maintenance Management System 2. Emergency Spill Response 3. On-site Spill Kits 4. Employee Inductions 5. Employee Consultation Systems 6. Incident Notification and Reporting Procedure 7. Supervisor Inspections 8 Supervisor Audits	4	d	4d	21	(L)				
		Loss of top dressing material	3	b	3b	9	(M)	1. Mining Operations Plan 2. Employee awareness and supervision 3. Employee consultation system 4. Scheduled Environmental Inspections 5. Competency Management System	4	d	4d	21	(L)				
		Quality of top dressing material reduced through damage to soil structure	4	c	4c	18	(L)	1. Direct placement wherever possible 2. Top dressing material stockpile management 3. Mining Operations Plan 4. Employee awareness and supervision 5. Employee consultation system 6. Scheduled Environmental Inspections 7. Competency Management System	4	e	4e	23	(L)				
	Overburden drilling	Noise	3	c	3c	13	(M)	1. Employee Inductions 2. Maintenance Management Systems 3. Complaints Protocol 4. Supervisor Inspections 5. Supervisor Audits 6. Altered operating conditions at set times (ie. night time) to reduce noise.	3	d	3d	17	(L)				

BLOOMFIELD COLLIERY ENVIRONMENTAL RISK REGISTER - PRE-STRIPPING

Process Area	Activity	Aspect	Raw (potential risk)				Existing Controls	Existing Controls				Proposed Controls	Residual Risk			
			C	P	R			C	P	R			C	P	R	
		Dust	3	c	3c	13 (M)	1. Dust Extraction Systems 2. Curtains and water on drill 3. Employee Inductions 2. Land Disturbance Management System (dust) 3. Water cart availability 4. Complaints Protocol 7. Supervisor Inspections 8. Supervisor Audits 9. Mindful of weather (wind) conditions	4	d	4d	21 (L)					
		Spillage of hydrocarbons when transferring from service truck	4	b	4b	14 (M)	1. Maintenance Management System 2. Emergency Spill Response 3. On-site Spill Kits 4. Employee Inductions 5. Employee Consultation Systems 6. Incident Notification and Reporting Procedure 7. Supervisor Inspections 8 Supervisor Audits	4	d	4d	21 (L)					
		Spillage of hydraulic oil from damaged hose	4	c	4c	18 (L)	1. Maintenance Management System 2. Emergency Spill Response 3. On-site Spill Kits 4. Employee Inductions 5. Employee Consultation Systems 6. Incident Notification and Reporting Procedure 7. Supervisor Inspections 8. Supervisor Audits 9. Mine Transport Management Plan	5	d	5d	24 (L)					
	Blasting	Noise/ overpressure	2	b	2b	5 (H)	1. Shot Firing and Explosives Management System 2. Competent, experienced employees 3. Inhouse Mining Engineer 4. Access to external specialist input 5. Supervisor Inspections 6. Supervisor Audits 7. Complaints Protocol	3	d	3d	17 (L)					
		Vibration	2	b	2b	5 (H)	1. Shot Firing and Explosives Management System 2. Competent, experienced employees 3. Inhouse Mining Engineer 4. Access to external specialist input 5. Supervisor Inspections 6. Supervisor Audits 7. Complaints Protocol	4	d	4d	21 (L)					
		Dust	3	b	3b	9 (M)	1. Shot Firing and Explosives Management System 2. Access to external specialist input 3. Inductions 4. Land Disturbance Management System (dust) 5. Water cart availability 6. Complaints Protocol 7. Supervisor Inspections 8. Supervisor Audits 9. Mindful of weather (wind) conditions	4	c	4c	18 (L)					
		Noxious gas released to atmosphere *(unusual to experience wet holes in pre-strip)*	4	d	4d	21 (L)	1. Shot Firing and Explosives Management System 2. Access to external specialist input	5	e	5e	25 (L)					

BLOOMFIELD COLLIERY ENVIRONMENTAL RISK REGISTER - PRE-STRIPPING

Process Area	Activity	Aspect	Raw (potential risk) C	P	R		Existing Controls	Existing Controls C	P	R		Proposed Controls	Residual Risk C	P	R	
	Excavation of overburden (using the excavator)	Noise	3	b	3b	9 (M)	1. Employee Inductions 2. Maintenance Management Systems 3. Complaints Protocol 4. Supervisor Inspections 5. Supervisor Audits 6. Altered operating conditions at set times (ie. night time) to reduce noise.	3	d	3d	17 (L)					
		Dust	3	b	3b	9 (M)	1. Mindful of weather (wind) conditions 2. Employee Inductions 3. Land Disturbance Management System (dust) 4. Water cart availability 5. Complaints Protocol 6. Supervisor Inspections 7. Supervisor Audits	4	d	4d	21 (L)					
		Visual	3	c	3c	13 (M)	1. Progressive Rehabilitation 2. Mine Planning 3. Timber screening 4. Informal Operational procedures (night lighting) 5. Community Consultation 6. Complaints Protocol	3	d	3d	17 (L)					
		Spillage of hydraulic oil from damaged hose	4	c	4c	18 (L)	1. Maintenance Management System 2. Emergency Spill Response 3. On-site Spill Kits 4. Employee Inductions 5. Employee Consultation Systems 6. Incident Notification and Reporting Procedure 7. Supervisor Inspections 8 Supervisor Audits	5	d	5d	24 (L)					
		Spillage of hydrocarbons when transferring from service truck	4	b	4b	14 (M)	1. Maintenance Management System 2. Emergency Spill Response 3. On-site Spill Kits 4. Employee Inductions 5. Employee Consultation Systems 6. Incident Notification and Reporting Procedure 7. Supervisor Inspections 8 Supervisor Audits	4	d	4d	21 (L)					
		Taking coal with overburden (sponcom in rehabilitation)	4	e	4e	23 (L)	1. Burial of oxidised coal material 2. Supervisor Audits 3. Mining Operation Plan 4. Supervisor Inspections 5. Mining Operations Inspection Management System	5	e	5e	25 (L)	not considered an issue				
		Waste Management (during service days)	5	b	5b	19 (L)	1. Environmental Protection Licence 2. Onsite Waste bins 3. Use of Licensed Contractor for waste removal 4. Contractor Management System 5. Contractor Inductions 6. Supervisor Inspections 7. Maintenance	5	d	5d	24 (L)					

BLOOMFIELD COLLIERY ENVIRONMENTAL RISK REGISTER - PRE-STRIPPING

Process Area	Activity	Aspect	Raw (potential risk)				Existing Controls	Existing Controls				Proposed Controls	Residual Risk			
			C	P	R			C	P	R			C	P	R	
		Major shut downs (contractor)	5	b	5b	19 (L)	1. Environmental Protection Licence 2. Onsite Waste bins 3. Use of Licensed Contractor for waste removal 4. Contractor Management System 5. Contractor Inductions 6. Supervisor Inspections 7. Supervisor Audits	5	d	5d	24 (L)					
	Mining of coal	Noise	3	c	3c	13 (M)	1. Employee Inductions 2. Maintenance Management Systems 3. Complaints Protocol 4. Supervisor Inspections 5. Supervisor Audits 6. Altered operating conditions at set times (ie. night time) to reduce noise.	3	d	3d	17 (L)					
		Dust	3	b	3b	9 (M)	1. Mindful of weather (wind) conditions 2. Employee Inductions 3. Land Disturbance Management System (dust) 4. Water cart availability 5. Complaints Protocol 6. Supervisor Inspections 7. Supervisor Audits	4	d	4d	21 (L)					
		Spillage of hydrocarbons when transferring from service truck	4	b	4b	14 (M)	1. Maintenance Management System 2. Emergency Spill Response 3. On-site Spill Kits 4. Employee Inductions 5. Employee Consultation Systems 6. Incident Notification and Reporting Procedure 7. Supervisor Inspections 8. Supervisor Audits 9. Competency Management System	4	d	4d	21 (L)					
	Hauling with rear dump trucks	Noise	3	b	3b	9 (M)	1. Employee Inductions 2. Maintenance Management Systems 3. Complaints Protocol 4. Supervisor Inspections 5. Supervisor Audits 6. Altered operating conditions at set times (ie. night time) to reduce noise.	3	d	3d	17 (L)					
		Dust	3	b	3b	9 (M)	1. Mindful of weather (wind) conditions 2. Employee Inductions 3. Land Disturbance Management System (dust) 4. Water cart availability 5. Complaints Protocol 6. Supervisor Inspections 7. Supervisor Audits	4	d	4d	21 (L)					
		Spillage of hydraulic oil from damaged hose	4	c	4c	18 (L)	1. Maintenance Management System 2. Emergency Spill Response 3. On-site Spill Kits 4. Employee Inductions 5. Employee Consultation Systems 6. Incident Notification and Reporting Procedure 7. Supervisor Inspections 8. Supervisor Audits 9. Emergency Response Procedure	5	d	5d	24 (L)					

BLOOMFIELD COLLIERY ENVIRONMENTAL RISK REGISTER - PRE-STRIPPING

Process Area	Activity	Aspect	Raw (potential risk) C	P	R		Existing Controls	Existing Controls C	P	R		Proposed Controls	Residual Risk C	P	R	
		Spillage of hydrocarbons when transferring from service truck	4	b	4b	14 (M)	1. Maintenance Management System 2. Emergency Spill Response 3. On-site Spill Kits 4. Employee Inductions 5. Employee Consultation Systems 6. Incident Notification and Reporting Procedure 7. Supervisor Inspections 8 Supervisor Audits	4	d	4d	21 (L)					
		Exhaust emissions	4	b	4b	14 (M)	1. Original Equipment Manufacturer Standards 2. Maintenance Management System 3. Defect Management System 4. Supervisor Inspections 5. Supervisor Audits	4	e	4e	23 (L)					
	Hauling with on-highway trucks	Noise	3	c	3c	13 (M)	1. Contractor Management System 2. Engineer's Audits 3. RTA registered trucks 4. Six monthly shaker tests 5. Maintenance Management Systems 6. Complaints Protocol 7. Supervisor Inspections 8. Contractor Induction 9. Altered operating conditions at set times (ie. night time) to reduce noise.	3	d	3d	17 (L)					
		Dust	3	b	3b	9 (M)	1. Mindful of weather (wind) conditions 2. Employee Inductions 3. Land Disturbance Management System (dust) 4. Water cart availability 5. Complaints Protocol 6. Supervisor Inspections 7. Contractor Management System 8. Contractor Induction 9. Supervisor Audits	4	d	4d	21 (L)					
		Spillage of hydraulic oil from damaged hose	4	c	4c	18 (L)	1. Contractor Management System 2. Emergency Spill Response 3. On-site On-site Spill Kits 4. Employee Inductions 5. Employee Consultation Systems 6. Incident Notification and Reporting Procedure 7. Supervisor Inspections 8. Supervisor Audits	5	d	5d	24 (L)					
		Spillage of hydrocarbons when transferring from service truck	4	b	4b	14 (M)	1. Contractor Management System 2. Emergency Spill Response 3. On-site Spill Kits 4. Employee Inductions 5. Employee Consultation Systems 6. Incident Notification and Reporting Procedure 7. Supervisor Inspections 8. Supervisor Audits 9. Contractor Induction	4	d	4d	21 (L)					
		Exhaust emissions	4	b	4b	14 (M)	1. Original Equipment Manufacturer Standards 2. Supervisor Audits 3. Defect Management System 4. Supervisor Inspections 5. Contractor Management System	4	e	4e	23 (L)					

BLOOMFIELD COLLIERY ENVIRONMENTAL RISK REGISTER - PRE-STRIPPING

Process Area	Activity	Aspect	Raw (potential risk) C	P	R			Existing Controls	Existing Controls C	P	R			Proposed Controls	Residual Risk C	P	R	
	Overburden dumping area (includes tipping with trucks)	Dust	3	b	3b	9	(M)	1. Mindful of weather (wind) conditions 2. Employee Inductions 3. Land Disturbance Management System (dust) 4. Water cart availability 5. Complaints Protocol 6. Supervisor Inspections 7. Supervisor Audits	4	d	4d	21	(L)					
		Noise	3	b	3b	9	(M)	1. Employee Inductions 2. Maintenance Management Systems 3. Complaints Protocol 4. Supervisor Inspections 5. Supervisor Audits	3	d	3d	17	(L)					
		Lighting of the dumps being directed into the residents houses resulting in visual impact issues.	4	b	4b	14	(M)	1. Direction of lights are changed so that they are not pointed towards the residents 2. Opportunity to enable dumping in an alternative dump or location on the dump after dark.	4	d	4d	21	(L)					

BLOOMFIELD COLLIERY ENVIRONMENTAL RISK REGISTER - MAIN DIG																
Process Area	**Activity**	**Aspect**	**Raw**				**Existing Controls**	**Existing Controls**				**Proposed Controls**	**Residual Risk**			
			C	**P**	**R**			**C**	**P**	**R**			**C**	**P**	**R**	
Main Dig	Interburden drilling	Noise	3	d	3d	17 (L)	1. Employee Inductions 2. Maintenance Management Systems 3. Complaints Protocol 4. Supervisor Inspections 5. Supervisor Audits 6. Altered Operating Conditions at set times (ie night time) to reduce noise.	3	e	3e	20 (L)					
		Dust	3	c	3c	13 (M)	1. Mindful of weather (wind) conditions 2. Employee Inductions 3. Land Disturbance Management System (dust) 4. Water cart availability 5. Complaints Protocol 6. Supervisor Inspections	4	d	4d	21 (L)					
		Spillage of Hydrocarbons when transferring from Service Truck	4	b	4b	14 (M)	1. Maintenance Management System 2. Emergency Spill Response 3. On-site Spill Kits 4. Employee Inductions 5. Competency Management System 6. Incident Notification and Reporting Procedure 7. Supervisor Inspections 8 Supervisor Audits	4	d	4d	21 (L)					
		Spillage of hydraulic oil from damaged hose	4	c	4c	18 (L)	1. Maintenance Management System 2. Emergency Spill Response 3. On-site Spill Kits 4. Employee Inductions 5. Competency Management System 6. Incident Notification and Reporting Procedure 7. Supervisor Inspections 8 Supervisor Audits	5	d	5d	24 (L)					
	Blasting	Noise/ overpressure	2	c	2c	8 (M)	1. Shot Firing and Explosives Management System 2. Competent, experienced employees 3. Inhouse Mining Engineer 4. Access to external specialist input 5. Supervisor Inspections 6. Supervisor Audits 7. Complaints Protocol 8. Altered Operating Conditions at set times (ie night time) to reduce noise.	3	d	3d	17 (L)					
		Vibration	2	b	2b	5 (H)	1. Shot Firing and Explosives Management System 2. Competent, experienced employees 3. Inhouse Mining Engineer 4. Access to external specialist input 5. Supervisor Inspections 6. Supervisor Audits 7. Complaints Protocol	4	d	4d	21 (L)					
		Dust	3	c	3c	13 (M)	1. Shot Firing and Explosives Management System 2. Access to external specialist input 3. Inductions 4. Land Disturbance Management System (dust) 5. Water cart availability 6. Complaints Protocol 7. Supervisor Inspections 8. Mindful of weather (wind) conditions	4	d	4d	21 (L)					
		Noxious gas released to atmosphere *(unusual to experience wet holes in pre-strip)*	4	d	4d	21 (L)	1. Shot Firing and Explosives Management System 2. Access to external specialist input	5	e	5e	25 (L)					
	Excavation of interburden	Noise	3	c	3c	13 (M)	1. Maintenance Management System 2. Competent, experienced employees 3. Supervisor Inspections 4. Supervisor Audits 5. Complaints Protocol 6. Altered Operating Conditions at set times (ie night time) to reduce noise.	3	d	3d	17 (L)					

BLOOMFIELD COLLIERY ENVIRONMENTAL RISK REGISTER - MAIN DIG																
Process Area	Activity	Aspect	Raw				Existing Controls	Existing Controls				Proposed Controls	Residual Risk			
			C	P		R		C	P		R		C	P		R
		Dust	3	c	3c	13 (M)	1. Mindful of weather (wind) conditions 2. Employee Inductions 3. Land Disturbance Management System (dust) 4. Water cart availability 5. Complaints Protocol 6. Supervisor Inspections 7. Supervisor Audits	4	d	4d	21 (L)					
		Spillage of hydraulic oil from damaged hose	4	c	4c	18 (L)	1. Maintenance Management System 2. Emergency Spill Response 3. On-site Spill Kits 4. Employee Inductions 5. Incident Notification and Reporting Procedure 6. Supervisor Inspections 7. Supervisor Audits	5	d	5d	24 (L)					
		Spillage of Hydrocarbons when transferring from Service Truck	4	b	4b	14 (M)	1. Maintenance Management System 2. Emergency Spill Response 3. On-site Spill Kits 4. Employee Inductions 5. Competency Management System 6. Incident Notification and Reporting Procedure 7. Supervisor Inspections 8 Supervisor Audits	4	d	4d	21 (L)					
		Taking coal with overburden (sponcom in rehabilitation)	4	d	4d	21 (L)	1. Burial of oxidised coal material 2. Internal Audit Management System 3. Mining Operation Plan 4. Supervisor Inspections 5. Supervisor Audits	5	e	5e	25 (L)					
		Waste Management (during service days)	5	b	5b	19 (L)	1. Environmental Protection Licence 2. Onsite Waste bins 3. Use of Licensed Contractor for waste removal 4. Contractor Management System 5. Contractor Inductions 6. Supervisor Inspections 7. Employee Inductions	5	d	5d	24 (L)					
		Major shut downs (contractor)	5	b	5b	19 (L)	1. Environmental Protection Licence 2. Onsite Waste bins 3. Use of Licensed Contractor for waste removal 4. Contractor Management System 5. Contractor Inductions 6. Supervisor Inspections 7. Employee Inductions	5	d	5d	24 (L)					
	Mining of coal	Noise	3	d	3d	17 (L)	1. Employee Inductions 2. Maintenance Management Systems 3. Complaints Protocol 4. Supervisor Inspections 5. Supervisor Audits 6. Competency Management System 7. Altered Operating Conditions at set times (ie night time) to reduce noise.	3	e	3e	20 (L)					
		Dust	3	c	3c	13 (M)	1. Mindful of weather (wind) conditions 2. Employee Inductions 3. Land Disturbance Management System (dust) 4. Water cart availability 5. Complaints Protocol 6. Supervisor Inspections	4	d	4d	21 (L)					
		Groundwater	3	c	3c	13 (M)	1. Experience mining in the area.	4	d	4d	21 (L)	*1. Groundwater Assessment 2. Groundwater Model Note: Groundwater quality not suitable for use (ie. saline, deep)*	4	d	4d	21 (L)

BLOOMFIELD COLLIERY ENVIRONMENTAL RISK REGISTER - MAIN DIG

Process Area	Activity	Aspect	Raw C	Raw P	Raw	Raw R	Existing Controls	Existing Controls C	Existing Controls P	Existing Controls	Existing Controls R	Proposed Controls	Residual Risk C	Residual Risk P	Residual Risk	Residual Risk R
		Spillage of hydraulic oil from damaged hose	4	c	4c	18 (L)	1. Maintenance Management System 2. Emergency Spill Response 3. On-site Spill Kits 4. Employee Inductions 5. Toolbox Talks 6. Incident Notification and Reporting Procedure 7. Supervisor Inspections 8 Supervisor Audits	5	d	5d	24 (L)					
		Spillage of Hydrocarbons when transferring from Service Truck	4	b	4b	14 (M)	1. Maintenance Management System 2. Emergency Spill Response 3. On-site Spill Kits 4. Employee Inductions 5. Toolbox Talks 6. Incident Notification and Reporting Procedure 7. Supervisor Inspections 8 Supervisor Audits	4	d	4d	21 (L)					
		Hydrocarbon contamination of pit-water (pumps, spills)	3	c	3c	13 (M)	1. Maintenance Management System 2. Emergency Spill Response 3. On-site Spill Kits 4. Employee Inductions 5. Toolbox talks 6. Dedicated Experienced employee 7. Incident Notification and Reporting Procedure 8. Supervisor Inspections 9 Supervisor Audits	4	d	4d	21 (L)					
	Hauling with rear dump trucks	Noise	3	c	3c	13 (M)	1. Employee Inductions 2. Maintenance Management Systems 3. Complaints Protocol 4. Supervisor Inspections 5. Supervisor Audits 6. Competency Management System 7. Altered Operating Conditions at set times (ie night time) to reduce noise.	3	d	3d	17 (L)					
		Dust	3	c	3c	13 (M)	1. Mindful of weather (wind) conditions 2. Employee Inductions 3. Land Disturbance Management System (dust) 4. Water cart availability 5. Complaints Protocol 6. Supervisor Inspections 7. Supervisor Audits	4	d	4d	21 (L)					
		Visual	3	c	3c	13 (M)	1. Progressive Rehabilitation 2. Mine Planning 3. Timber screening 4. Informal Operational procedures (night lighting) 5. Community Consultation 6. Complaints Protocol	3	d	3d	17 (L)					
		Spillage of hydraulic oil from damaged hose	4	c	4c	18 (L)	1. Maintenance Management System 2. Emergency Spill Response 3. On-site Spill Kits 4. Employee Inductions 5. Toolbox Talks 6. Incident Notification and Reporting Procedure 7. Supervisor Inspections 8. Supervisor Audits	5	d	5d	24 (L)					
		Spillage of Hydrocarbons when transferring from Service Truck	4	b	4b	14 (M)	1. Maintenance Management System 2. Emergency Spill Response 3. On-site Spill Kits 4. Employee Inductions 5. Toolbox Talks 6. Incident Notification and Reporting Procedure 7. Supervisor Inspections 8 Supervisor Audits	4	d	4d	21 (L)					
		Exhaust emissions	4	b	4b	14 (M)	1. Original Equipment Manufacturer Standards 2. Maintenance Management System 3. Defect Management System 4. Supervisor Inspections	4	e	4e	23 (L)					

BLOOMFIELD COLLIERY ENVIRONMENTAL RISK REGISTER - MAIN DIG																
Process Area	**Activity**	**Aspect**	**Raw**				**Existing Controls**	**Existing Controls**				**Proposed Controls**	**Residual Risk**			
			C	**P**		**R**		**C**	**P**		**R**		**C**	**P**		**R**
	Hauling with on-highway trucks	Noise	3	c	3c	13 (M)	1. Contractor Management System 2. Engineer's Audits 3. RTA registered trucks 4. Six monthly shaker tests 5. Maintenance Management Systems 6. Complaints Protocol 7. Supervisor Inspections 8. Contractor Inductions 9. Altered Operating Conditions at set times (ie night time) to reduce noise.	3	e	3e	20 (L)					
		Dust	3	b	3b	9 (M)	1. Mindful of weather (wind) conditions 2. Contractor Inductions 3. Land Disturbance Management System (dust) 4. Water cart availability 5. Complaints Protocol 6. Supervisor Inspections 7. Supervisor Audits	4	d	4d	21 (L)					
		Spillage of hydraulic oil from damaged hose	4	c	4c	18 (L)	1. Maintenance Management System 2. Emergency Spill Response 3. On-site Spill Kits 4. Contractor Inductions 5. Contractor Management System 6. Incident Notification and Reporting Procedure 7. Supervisor Inspections 8. Supervisor Audits 9. Toolbox Talks	5	d	5d	24 (L)					
		Spillage of Hydrocarbons when transferring from Service Truck	4	b	4b	14 (M)	1. Maintenance Management System 2. Emergency Spill Response 3. On-site Spill Kits 4. Contractor Inductions 5. Contractor Management System 6. Incident Notification and Reporting Procedure 7. Supervisor Inspections 8. Supervisor Audits 9. Toolbox Talks	4	d	4d	21 (L)					
		Exhaust emissions	4	b	4b	14 (M)	1. Original Equipment Manufacturer Standards 2. Maintenance Management System 3. Defect Management System 4. Supervisor Inspections 5. Contractor Management System 6. Contractor Inductions 7. RTA Approval (Rego check) 8. Engineers Audits	4	e	4e	23 (L)					
	Overburden dump (in pit)	Dust	3	b	3b	9 (M)	1. Mindful of weather (wind) conditions 2. Employee Inductions 3. Land Disturbance Management System (dust) 4. Water cart availability 5. Complaints Protocol 6. Supervisor Inspections 7. Supervisor Audits	4	d	4d	21 (L)					
		Noise	3	c	3c	13 (M)	1. Employee Inductions 2. Maintenance Management Systems 3. Complaints Protocol 4. Supervisor Inspections 5. Supervisor Audits 6. Altered Operating Conditions at set times (ie night time) to reduce noise.	3	d	3d	17 (L)					
	In pit water management	Broken leaking pipes (on surface)	4	b	4b	14 (M)	1. Maintenance Management System 2. Scheduled Environmental Inspections 3. Inspection Management System 4. Supervisor Inspections 5. Engineering principles applied to design 6. Incidents Reporting Procedure 7. Dedicated Experienced person 8. Supervisor Audits	4	d	4d	21 (L)					

BLOOMFIELD COLLIERY ENVIRONMENTAL RISK REGISTER - MAIN DIG																		
Process Area	Activity	Aspect	Raw					Existing Controls	Existing Controls					Proposed Controls	Residual Risk			
			C	P		R			C	P		R			C	P		R
		Discharge from open drains (dirty water system)	2	c	2c	8	(M)	1. Scheduled Environmental Inspections 2. Inspection Management System 3. Supervisor Inspections 4. Engineering principles applied to design 5. Incidents Reporting Procedure 6. Dedicated Experienced person	2	e	2e	16	(L)					
		Cross contamination of water segregation under extreme rainfall conditions	2	c	2c	8	(M)	1. Managing the level of Lake Foster 2. Discharge Water Management System 3. EPA Licence 4. Site Inspections 5. Scheduled Environmental Inspections 6. Nominated Experienced person	3	d	3d	17	(L)					
		Failure of clean water segregation	2	d	2d	12	(M)	1. Scheduled Environmental Inspections 2. Inspection Management System 3. Supervisor Inspections 4. Engineering principles applied to design 5. Incidents Reporting Procedure 6. Nominated Experienced person	3	d	3d	17	(L)					
	Bulk fuel storage	Bulk fuel storage (Portable Fuel Storage 1 x 40,000L, 1 x 15,000L, 2 x 5,000L) - Damage to side wall resulting in leak (NB: 40000L used for refuelling, others for supply and pumps)	2	c	2c	8	(M)	1. Towed empty only 2. Towed over prepared surfaces and under supervision only 3. Ensure tanks are always within the site 4. Supervisor Audits 5. Located in a temporary earth containment area 6. Scheduled Environmental Inspections 7. Maintenance Management System 8. Isolated storage area	3	d	3d	17	(L)					
		Spillage from the fuel fill point during filling of equipment	4	b	4b	14	(M)	1. Maintenance Management System 2. Emergency Spill Response 3. On-site Spill Kits 4. Employee Inductions 5. Toolbox Talks 6. Incident Notification and Reporting Procedure 7. Supervisor Inspections 8 Supervisor Audits	4	d	4d	21	(L)					
		Spillage from tank as a result of hose being pulled off by equipment	2	c	2c	8	(M)	1. Maintenance Management System 2. Emergency Spill Response 3. On-site Spill Kits 4. Employee Inductions 5. Toolbox Talks 6. Incident Notification and Reporting Procedure 7. Supervisor Inspections 8 Supervisor Audits 9. Emergency Cut off valve	4	d	4d	21	(L)					
	Sewerage treatment plant	Contamination of water ways (1 x main office, 1 x open cut workshop)	4	b	4b	14	(M)	1. Maintenance Management System 2. Emergency Spill Response 3. Scheduled Environmental Inspections	4	d	4d	21	(L)					

BLOOMFIELD COLLIERY ENVIRONMENTAL RISK REGISTER - REHABILITATION																	
Process Area	**Activity**	**Aspect**	**Raw**					**Existing Controls**	**Existing Controls**					**Proposed Controls**	**Residual Risk**		
			C	**P**	**R**				**C**	**P**	**R**				**C**	**P**	**R**
Rehabilitation	Reshaping (Overburden dumps)	Dust	3	b	3b	9	(M)	1. Mindful of weather (wind) conditions 2. Employee Inductions 3. Land Disturbance Management System (dust) 4. Water cart availability 5. Complaints Protocol 6. Supervisor Inspections 7. Competency Management System 8. Toolbox Talks	4	d	4d	21	(L)				
		Noise	3	b	3b	9	(M)	1. Employee Inductions 2. Maintenance Management System 3. Complaints Protocol 4. Supervisor Inspections 5. Supervisor Audits 6. Toolbox Talks	3	d	3d	17	(L)				
		Spillage of hydraulic oil from damaged hose	4	c	4c	18	(L)	1. Maintenance Management System 2. Emergency Spill Response 3. On-site Spill Kits 4. Employee Inductions 5. Toolbox Talks 6. Incident Notification and Reporting Procedure 7. Supervisor Inspections 8 Supervisor Audits	5	d	5d	24	(L)				
		Spillage of Hydrocarbons when transferring from Service Truck	4	b	4b	14	(M)	1. Maintenance Management System 2. Emergency Spill Response 3. On-site Spill Kits 4. Employee Inductions 5. Competency Management System 6. Incident Notification and Reporting Procedure 7. Supervisor Inspections 8. Supervisor Audits 9. Toolbox Talks	4	d	4d	21	(L)				
		Erosion and sediment control	4	c	4c	18	(L)	1.Draft Erosion and Sediment Control Plan 2. Scheduled Environmental Inspections 3. External Audits (including Government) 4. Environmental Protection Licence 5. Existing Sediment Control Dams	5	d	5d	24	(L)				
	Top dressing material spreading and contour ripping	Dust	3	b	3b	9	(M)	1. Mine Transport Management Plan 2. Inductions 3. Land Disturbance Management System (dust) 4. Water cart availability 5. Complaints Protocol 6. Supervisor Inspections 7. Supervisor Audits 8. Mindful of weather (wind) conditions	4	d	4d	21	(L)				
		Noise	3	b	3b	9	(M)	1. Employee Inductions 2. Maintenance Management Systems 3. Complaints Protocol 4. Supervisor Inspections	3	d	3d	17	(L)				
		Spillage of hydraulic oil from damaged hose	4	c	4c	18	(L)	1. Maintenance Management System 2. Emergency Spill Response 3. On-site Spill Kits 4. Employee Inductions 5. Toolbox Talks 6. Incident Notification and Reporting Procedure 7. Supervisor Inspections 8. Supervisor Audits	5	d	5d	24	(L)				
		Spillage of Hydrocarbons when transferring from Service Truck	4	b	4b	14	(M)	1. Maintenance Management System 2. Emergency Spill Response 3. On-site Spill Kits 4. Employee Inductions 5. Toolbox talks 6. Incident Notification and Reporting Procedure 7. Supervisor Inspections 8. Supervisor Audits	4	d	4d	21	(L)				

BLOOMFIELD COLLIERY ENVIRONMENTAL RISK REGISTER - REHABILITATION

Process Area	Activity	Aspect	Raw				Existing Controls	Existing Controls				Proposed Controls	Residual Risk			
			C	P	R			C	P	R			C	P	R	
		Erosion and sediment control	4	c	4c	18 (L)	1. Draft Erosion and Sediment Control Plan 2. Scheduled Environmental Inspections 3. External Audits (including Government) 4. Environmental Protection Licence 5. Supervisor Inspections 6. Existing Sediment Control Dams	5	d	5d	24 (L)					
		Lime and gypsum dust	4	c	4c	18 (L)	1. Control moisture levels of lime	5	d	5d	24 (L)					
		Biosolids / runoff (incl odour)	3	c	3c	13 (M)	1. Use of DECC guidelines 2. Bunded storage areas	3	d	3d	17 (L)					
	Revegetation	Erosion with sediment leaving site	4	c	4c	18 (L)	1. internal drainage for part of the area 2. Draft Erosion & Sediment Control Plan 3. Existing Sediment Control Dams	5	d	5d	24 (L)					
		Potential to introduce weeds	4	c	4c	18 (L)	1. Buy certified seed from reputable supplier 2. Vehicle wash at entrance 3. Employee inductions 4. Scheduled Environmental Inspections 5. Weed Control Contractors	4	d	4d	21 (L)					
		Failure of seed to germinate and establishment	4	c	4c	18 (L)	1. Buy certified seed from reputable supplier 2. Employee and Contractor Inductions	5	d	5d	24 (L)					
		Bush fire hazard burning revegetated areas	3	c	3c	13 (M)	1. Employee Induction 2. Hazard reduction program 3. Competent employees 4. Bushfire Management Plan 5. Onsite fire fighting capabilities 6. Contractor Induction	4	d	4d	21 (L)					
		Sponcom in rehabilitated areas (odour)	4	d	4d	21 (L)	1. Burial of oxidised coal material 2. Supervisor Inspections 3. Mining Operation Plan 4. Mining Operations Inspection Management System	5	e	5e	25 (L)					

BLOOMFIELD COLLIERY ENVIRONMENTAL RISK REGISTER - MAINTENANCE

Process Area	Activity	Aspect	Raw				Existing Controls	Existing Controls				Proposed Controls	Residual Risk			
			C	P		R		C	P		R		C	P		R
Maintenance / Open Cut Workshop	Waste Management	General Refuse (incl oily rags)	4	b	4b	14 (M)	1. Licensed Waste Contractor 2. Contractor Management System 3. Employee Inductions 4. Environmental Protection Licence 5. Toolbox Talks 6. Scheduled Environmental Inspections	5	d	5d	24 (L)					
		Scrap steel	5	b	5b	19 (L)	1. Licensed Recycling Contractor 2. Contractor Management System 3. Employee Inductions 4. Environmental Protection Licence 5. Toolbox Talks 6. Scheduled Environmental Inspections	5	e	5e	25 (L)					
		Contaminated Wastes	4	b	4b	14 (M)	1. Licensed Recycling Contractor 2. Contractor Management System 3. Employee Inductions 4. Environmental Protection Licence 5. Incident Reporting Procedure 6. Toolbox Talks 7. Scheduled Environmental Inspections	5	d	5d	24 (L)					
		Oil spills on ground	4	b	4b	14 (M)	1. On-site Spill Kits 2. Employee Inductions 3. Employee Consultation Systems 4. Emergency Response Procedure 5. Incident Reporting Procedure 6. Toolbox Talks 7. Scheduled Environmental Inspections	5	d	5d	24 (L)					
		Tyres	4	b	4b	14 (M)	1. Disposed of in the pit at depth	5	d	5d	24 (L)					
	Bulk fuel storage area (fuel farm)	Spills and leaks	3	b	3b	9 (M)	1. AS1940 approved area 2. Work Cover notified 3. On-site Spill Kits 4. Employee Inductions 5. Toolbox Talks 6. Emergency Response Procedure 7. Incident Reporting Procedure	4	d	4d	21 (L)					
		Damage to above ground pipes (fuel and oil)	3	b	3b	9 (M)	1. AS1940 approved area 2. Work Cover notified 3. Incident Reporting Procedure 4. Emergency Response Procedure 5. Scheduled Environmental Inspections 6. Toolbox Talks	4	d	4d	21 (L)					
		Bunded area filling with storm water reducing containment and resulting in bund breach during major spill	4	b	4b	14 (M)	1. AS1940 approved area 2. Work Cover notified 3. Maintenance Management System 4. Bilge Pump system in place in bunded areas 5. Incident Reporting Procedure 6. Emergency Response Procedure 7. Scheduled Environmental Inspections 8. Toolbox Talks	5	d	5d	24 (L)					
	Refuelling bay (conducted in Workshop - 3 x 30,000L tanks)	Spills and leaks	3	b	3b	9 (M)	1. AS1940 approved area 2. WorkCover notified 3. On-site Spill Kits 4. Employee Inductions 5. Toolbox Talks 6. Emergency Response Procedure 7. Incident Reporting Procedure 8. Scheduled Environmental Inspections	4	d	4d	21 (L)					
		Damage to above ground pipes (fuel and oil)	3	b	3b	9 (M)	1. AS1940 approved area 2. Work Cover notified 3. Incident Reporting Procedure 4. Scheduled Environmental Inspections	4	d	4d	21 (L)					
		Hose coming away from bowser (vehicle drives away with hose still attached)	2	b	2b	5 (H)	1. AS1940 approved area 2. Work Cover notified 3. Employee Inductions 4. Automatic shut-offs 5. Incident Reporting Procedure 6. Toolbox Talks	4	d	4d	21 (L)					

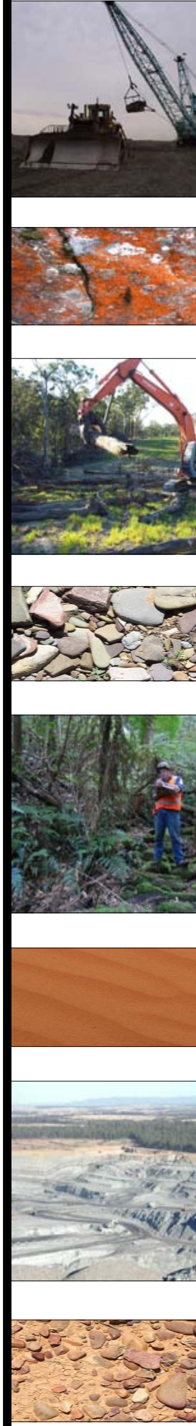
BLOOMFIELD COLLIERY ENVIRONMENTAL RISK REGISTER - MAINTENANCE

Process Area	Activity	Aspect	Raw C	Raw P	Raw R		Existing Controls	Existing Controls C	Existing Controls P	Existing Controls R		Proposed Controls	Residual Risk C	Residual Risk P	Residual Risk R	
	Oil storage area	Spills and leaks	4	b	4b	14 (M)	1. AS1940 approved area 2. Work Cover notified 3. On-site Spill Kits 4. Employee Inductions 5. Toolbox Talks 6. Emergency Response Procedure 7. Incident Reporting Procedure 8. Scheduled Environmental Inspections	5	d	5d	24 (L)					
	Transformers	Release of PCB's in transformer oil	2	b	2b	5 (H)	1. PCB Disposal Procedure 2. Transformers in bunded areas 3. Following check on site found that no known PCB's on site.	5	e	5e	25 (L)					
		Oil spills	4	b	4b	14 (M)	1. Recycled 2. On-site Spill Kits 3. Employee Inductions 4. Transformers in bunded areas 5. Incident Reporting Procedure 6. Scheduled Environmental Inspections	5	d	5d	24 (L)					
	Parts washer	Failure and release degreasers/contaminants to the environment	4	b	4b	14 (M)	1. Serviced by licensed contractor 2. Contractor Management System 3. On-site Spill Kits 4. Employee Inductions 5. Incident Reporting Procedure	5	d	5d	24 (L)					
	Oil water separator	Failure and release of oil	4	b	4b	14 (M)	1. Waste oil tank with overflow monitor 2. Scheduled Environmental Inspections 3. Serviced by licensed contractor 4. Contractor Management System 5. On-site Spill Kits 6. Employee Inductions 7. Incident Reporting Procedure	5	d	5d	24 (L)					
	Workshop	Noise	3	d	3d	17 (L)	1. Isolated location 2. Employee Induction 3. Complaints Protocol 4. Supervisor Inspections 5. Supervisor Audits	3	e	3e	20 (L)					

BLOOMFIELD COLLIERY ENVIRONMENTAL RISK REGISTER - MAINTENANCE																				
Process Area	Activity	Aspect	Raw					Existing Controls	Existing Controls					Proposed Controls	Residual Risk					
			C	P	R				C	P	R				C	P	R			
	Field Maintenance 1. Scheduled shut downs 2. breakdowns/running repairs	Noise	3	d	3d	17	(L)	1. Where ever possible maintenance conducted off site 2. Employee Induction 3. Complaints Protocol 4. Supervisor Inspections 5. Supervisor Audits	3	e	3e	20	(L)							
		Contaminated Waste Material	4	b	4b	14	(M)	1. Licensed Waste Contractor 2. Contractor Management System 3. Employee Inductions 4. EPL 5. Toolbox Talks 6. Maintenance Management System 7. Supervisor Inspections 8. Supervisor Audits	5	d	5d	24	(L)							
		Spills and leaks	4	b	4b	14	(M)	1. AS1940 approved area 2. WorkCover notified 3. On-site Spill Kits 4. Employee Inductions 5. Toolbox Talks 6. Emergency Response Procedure 7. Incident Notification and Reporting Procedure 8. Maintenance Management System 9. Supervisor Inspections 10. Supervisor Audits	5	d	5d	24	(L)							
		Transfer of diesel and lubes around site in service truck (accident - rollover)	3	c	3c	13	(M)	1. Mine Transport Management Plan 2. Employee Inductions 3. Purpose designed service truck 4. Compartmentalised tank 5. Competency Standard for service truck 6. Emergency Response Procedure 7. Bushfire Management Plan 8. Incident Notification and Reporting Procedure	4	d	4d	21	(L)							

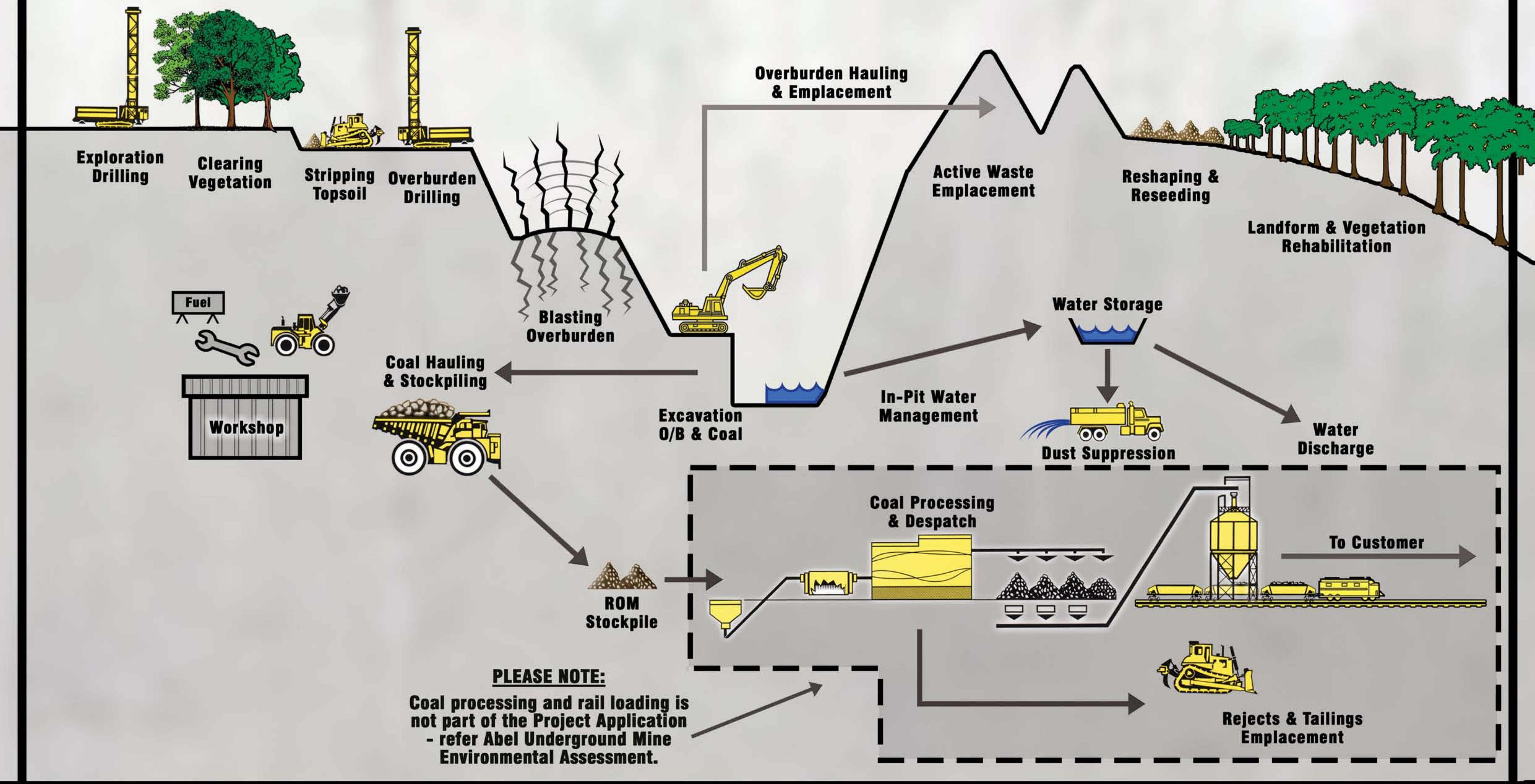
BLOOMFIELD COLLIERY ENVIRONMENTAL RISK REGISTER - SUPPLY

Process Area	Activity	Aspect	Raw (potential risk)				Existing Controls	Existing Controls				Proposed Controls	Residual Risk			
			C	P		R		C	P		R		C	P		R
Supply	Bulk Fuel Storage	***(See Maintenance)***														
	Transfer of fuel from road transport	Spillage of fuel during delivery of bulk fuel and oil	2	c	2c	8 (M)	1. Fuel & Bulk Oil Delivery Procedures 2. Contractor Management System 3. Contained delivery point 4. Use of competent delivery contractor 5. System audits 6. Incident Notification and Reporting Procedure 7. Scheduled Environmental Inspections 8. Emergency Response Procedure	3	d	3d	17 (L)					
		Damage to transport vehicle on site at refuelling point (eg. Light vehicle running into fuel truck)	3	c	3c	13 (M)	1. Engineering separation from earthworking equipment 2. Delivery trucks have segregated tanks 3. Emergency Response Procedure 4. Tanks located away from traffic areas	4	e	4e	23 (L)					
		Release of fuel to the environment as a result of a vehicle involved in accident on site	2	c	2c	8 (M)	1. Mine Transport Management Plan 2. Fuel & Bulk Oil Delivery Procedures 3. Contractor Management System 4. Safety Core Risk Assessment 5. Toolbox Talks 6. Competency Management System 7.Emergency Response Procedure	4	d	4d	21 (L)					
		Fuel transfer truck driving away from fill point with out disconnecting fuel supply hose	3	c	3c	13 (M)	1. Contractor has cut-off system whereby they cannot start the vehicle if a hose is still connected 2. Use of competent contractor 3. Contractor Management System 4. Bunded Area (AS1940) 5. Emergency Response Procedure 6. Fuel & Bulk Oil Delivery Procedures	5	e	5e	25 (L)					



BLOOMFIELD FLOW CHART

APPENDIX 2



Bloomfield Colliery

COMPLETION OF MINING AND REHABILITATION

Figure 2

MINING PROCESS

11/8/2008

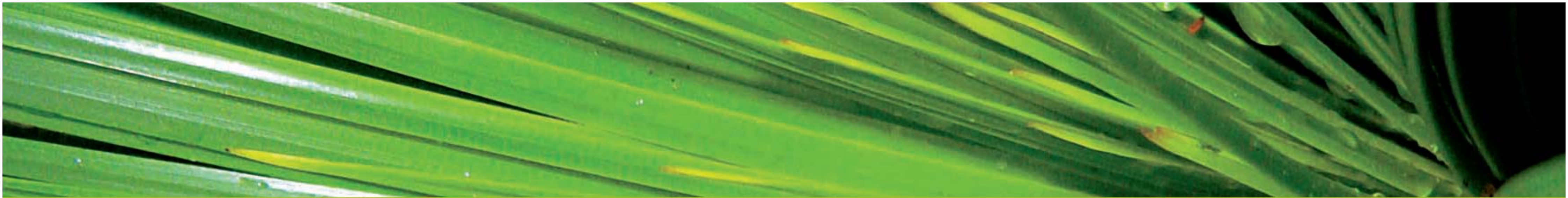
Appendix D

Flora, Fauna & Threatened Species Assessment

Bloomfield Colliery Completion of Mining and Rehabilitation

Part 3A Environmental Assessment

November 2008



ecobiological

survey & assessment

BLOOMFIELD COLLIERIES

FLORA, FAUNA AND THREATENED SPECIES ASSESSMENT

FLORA, FAUNA AND THREATENED SPECIES ASSESSMENT: Bloomfield Opencut Coalmine, Beresfield.

Report prepared for Bloomfield Collieries.

This report was prepared for the sole use of the proponents, their agents and any regulatory agencies involved in the development application approval process. It should not be otherwise referenced without permission.

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EXECUTIVE SUMMARY

EcoBiological was commissioned by Bloomfield Collieries to prepare an assessment of fauna, flora and threatened species for the completion of its open cut mining operations. The investigation focussed on two areas of vegetation, each about 9 hectares, out of which approximately 1.7 hectares of vegetation would be cleared.

A list of threatened flora and fauna reported from an area of 5km radius from the subject site was extracted from data obtained from the National Parks and Wildlife Service (NPWS) database, the Atlas of NSW Wildlife.

Four threatened plant species and 19 threatened fauna species had been recorded within a 5-kilometre radius of the subject site. Subsequent assessment revealed that 11 fauna species could possibly occur on the subject site. It was assessed that the habitat was unsuitable for any of the three threatened flora species.

A field survey was conducted directed at locating any species or communities listed as threatened in the NSW *Threatened Species Conservation Act 1995* and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

Results of the field surveys showed that the subject site supported three plant communities. One Endangered Ecological Community (EEC), *Lower Hunter Spotted Gum – Ironbark Forest* was present. Fauna recorded on the site comprised: 2 frogs, 7 reptiles, 45 birds, 14 bats, 1 arboreal mammal and 4 terrestrial mammals. Of these, 6 are listed as significant (Vulnerable) under the TSC Act.

An impact assessment concluded that there should be no impact by the proposed activities on the viability of any local occurrence of the EEC or on any local populations of threatened fauna. No matters of national significance as described in the Commonwealth EPBC Act were found to occur.

Mitigation of any impacts can be achieved through erosion and sediment control measures, pre-clearance protocols for protecting hollow dwelling fauna and compensation for any loss of an EEC.

GLOSSARY

Allopatric – species of the same genus occupying different areas. Opposed to sympatric.

Arboreal – living in a tree or trees. Contrasted with *terrestrial*, living on the ground; *aquatic*, living in water; *amphibious*, living on land and in the water.

Aquatic – living in the water.

Amphibious – having two distinct life phases, one of which involves living on land and one of which involves living in water.

Benthic – bottom dwelling. In reference to *aquatic* organisms.

Browse – to feed on the leaves and twigs of trees and shrubs, not grasses. Compare with *Graze*.

Carnivorous – feeding on other animals. In practice, a distinction is often made between *carnivores* (flesh eaters) and *insectivores* (eaters of insects and other arthropods).

Cryptic – hidden. A cryptic species is one that hides effectively from zoologists.

Distribution – the overall area in which a species is known to occur. It is not implied, and is very rarely the case, that a species occurs in all parts of the area defined by its distribution.

Diurnal – pertaining to the day. An animal that is active by day is said to be diurnal.

Drey – the nest of an arboreal mammal.

EPBC Act – *Commonwealth* Environment Protection and Biodiversity Conservation Act 1999.

Epiphyte – a plant that grows upon another plant (usually a tree) and does not have roots reaching into the soil

Exudate – a substance that has been exuded. Used here mainly to refer to the gums of certain trees and the nutritious excreta of some sap sucking insects.

Folivorous – feeding on the leaves of trees.

Frugivorous – fruit eating.

Graze – to eat grass or herbs.

Habitat – an area providing the physical (rainfall, temperature, rock or soil structure, etc.) and biological (plants and animals) conditions required by a particular species. The habitat of a species is usually far less in extent than distribution indicated on a map.

Herbivorous – feeding on plants. Herbivores may be further divided into *frugivores* (fruit eaters), *folivores* (eaters of the leaves of trees), and into *browsers* and *grazers*.

Home range – the area habitually traversed by an individual animal. It may be exclusive or overlap with the home ranges of other individuals of the same species.

Insectivorous – feeding on insects and other arthropods.

Jaw sheaths – used here in reference to the hard, black sheath of keratin (similar to fingernails or horn) over the upper and lower jaw cartilage in tadpole mouthparts.

Lentic – living in still water.

Lotic – living in flowing water.

Nocturnal – pertaining to the night. An animal that is active by night is said to be nocturnal.

Opportunistic – used, in reference to diet, to denote the eating of any of a wide variety of foods, depending upon their availability. In respect of reproduction, it refers to a pattern of breeding that is linked with irregular favourable conditions (particularly unpredictable rainfall in arid areas) rather than to season.

Papillae – small, nipple-like, fleshy projections around a tadpole oral disk.

Patagium – an expanse of skin between the fore- and hind limbs used in gliding.

Range – this term has the same meaning as *distribution*, which is a better term.

Relict – surviving from the past. A relict species is one, or one of a few, surviving from a group that was once more numerous and/or widespread.

Riparian – pertaining to the banks of a river.

Sclerophyll – pertaining to plants with tough leaves. Here used mainly to distinguish between two major types of eucalypt forest: *dry sclerophyll* forest which is open and *wet sclerophyll* forest which has a closed canopy. The two types intergrade.

Speciation – the evolutionary processes by which new species arise.

Spiracle – referred to here as the external tube which expels water used fro respiration from the gills of tadpoles.

Subspecies – an interbreeding population within a species, differing measurably from one or more other populations and usually geographically separate from these.

Sympatric – living in the same area. Here used in respect of species of the same genus. Usually these occupy different areas and are then said to be *allopatric*.

Taxon – the scientific name of a category of animals. The practice and study of naming organisms is known as *taxonomy*.

Terrestrial – living on the ground.

Territory – an area occupied by one or more individuals and defended against other members of the species. A territory is usually centred on a more or less permanent nest, burrow, and den or resting place.

TSC Act – NSW *Threatened Species Conservation Act 1995.*

Type locality- the location from which the first specimen, or *type holotype*, of a new species is formally described for the first time.

Type specimen – when a species is formally described for the first time, one of the specimens described is lodged in a museum to provide a permanent reference. It is known as the *type specimen* or *type holotype*. Other specimens of the species lodged at the same time as the holotype are referred to as *paratypes*.

1. INTRODUCTION

Bloomfield Collieries wish to complete their current open-cut coal mining operation which is located about 20km northwest of Newcastle (Figure 1) and this is a report of the ecological attributes of the final operations area. The proposed works will necessitate the clearing of a small amount of remnant vegetation and two blocks of vegetation were investigated (Figure 2). Throughout this report the overall disturbance area will be referred to as the 'subject site' and the individual blocks of vegetation as the 'eastern' or 'western block'.

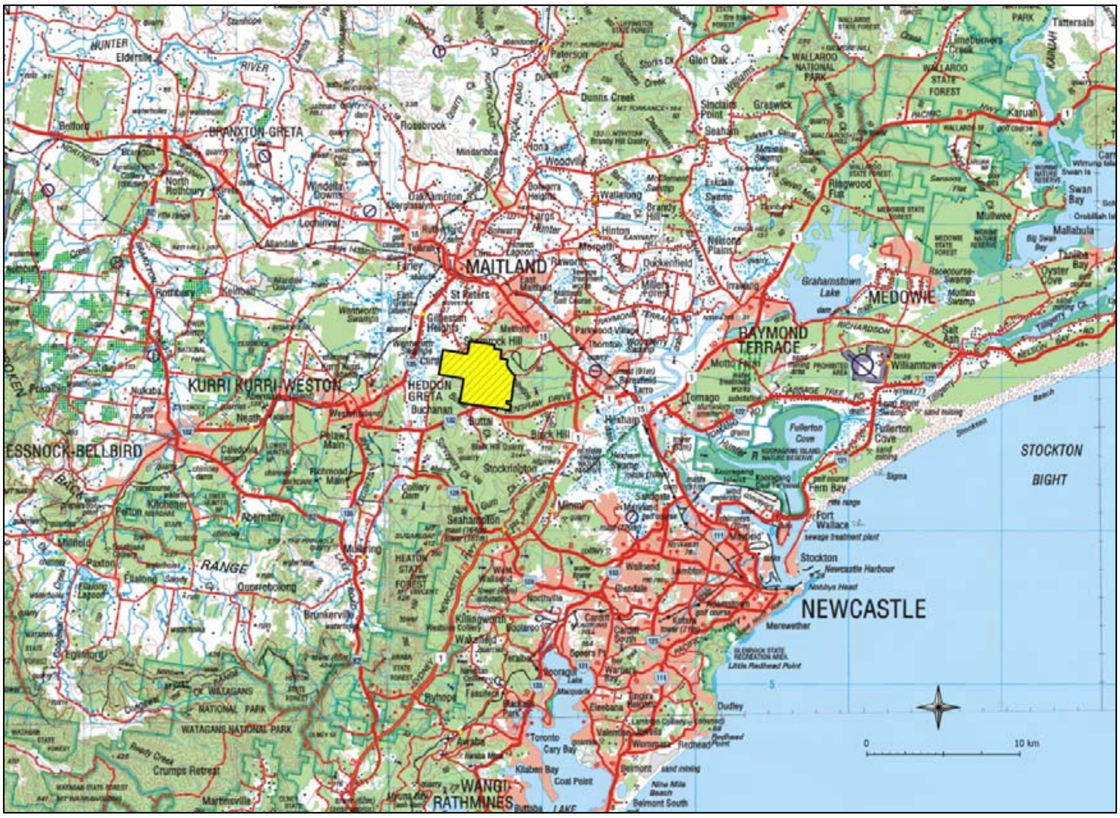

Figure 1 **The Bloomfield mine lease (yellow) in a regional context**

The subject site is located over Permian geology, Sydney Basin Newcastle sequence, characterised by siltstone, sandstone, coal, tuff, claystone, conglomerate (DMR 1999). The derived soils are comprised of the Shamrock Hill erosional landscape in the northern half of the subject site and the Beresfield residual landscape in the southern half (Matthei 1995). The elevation of the vegetated blocks is from about 40m to 80m AHD.

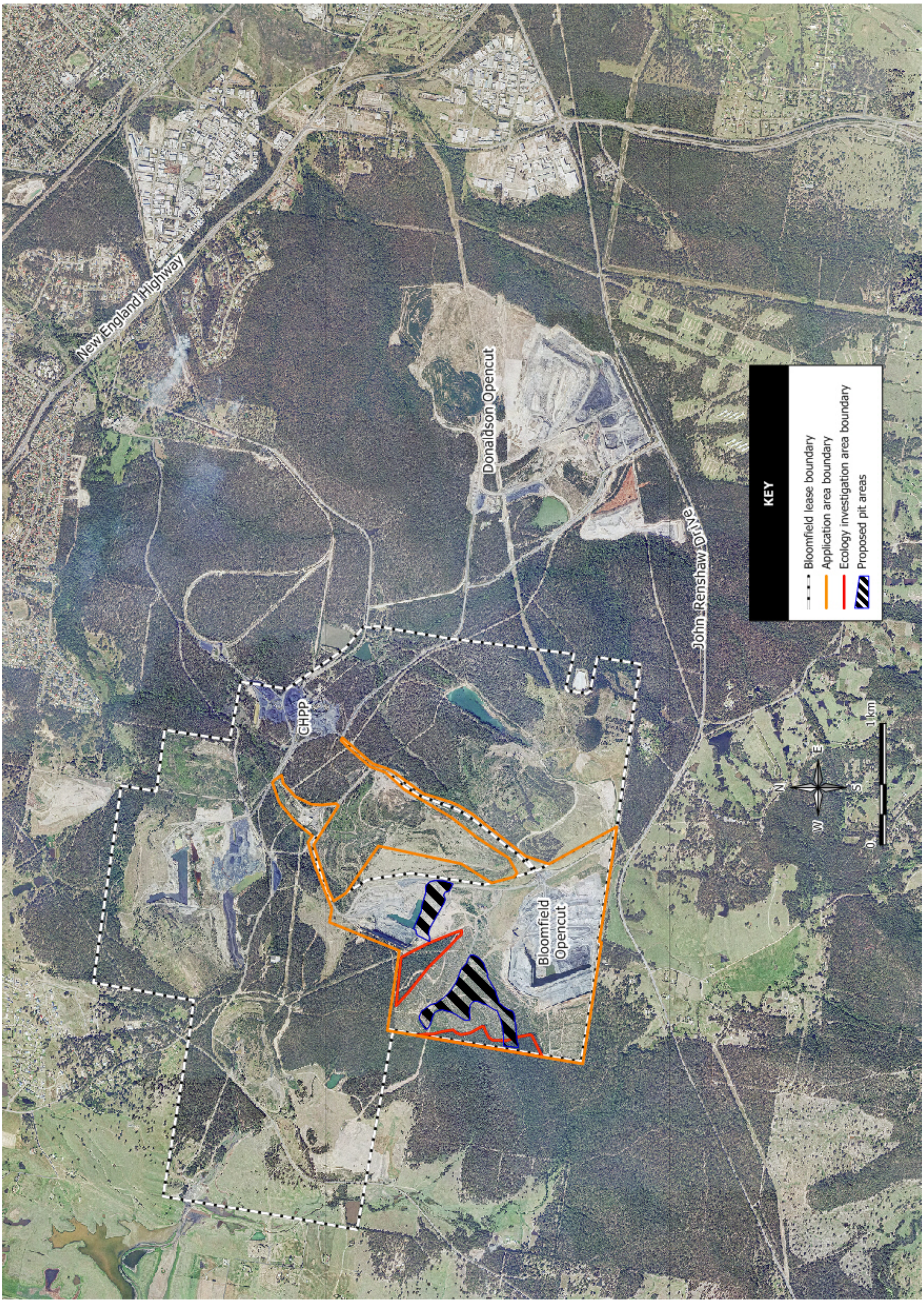

Figure 2 **The Bloomfield mine lease and the two vegetated investigation areas**

1.1. REPORT FRAMEWORK

This ecological investigation and report has been framed to account for the requirements of the following

- *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act);
- *NSW Threatened Species Conservation Act 1995* (TSC Act);
- *NSW Threatened Species Conservation Amendment Act 2002*;
- *National Parks and Wildlife Act 1974* (NP&W Act);
- *Environmental Planning and Assessment Act 1979* (EP&A Act);
- State Environment Planning Policy 44 (SEPP44) Koala Habitat Assessment;
- DEC 2004, *Threatened Species Survey and Assessment: Guidelines for developments and activities (working draft),* New South Wales Department of Environment and Conservation, Hurstville, NSW;
- DEC & DPI, 2005, *Draft Guidelines for Threatened Species Assessment for Part 3A applications*;
- DLWC 2002, *The NSW State Groundwater Dependent Ecosystems Policy*.

2. METHODS

2.1. THREATENED SPECIES AND ECOLOGICAL COMMUNITIES AND KEY THREATENING PROCESSES

Schedules 1 and 2 of the TSC Act contain lists of flora and fauna species and communities, which have been determined by the NSW Scientific Committee as being under threat of serious decline that could ultimately lead to extinction. The DEC & DPI (2005) guideline for the assessment of threatened species for Part 3A applications provides a test for the impact of any proposal on threatened species occurring or considered as likely to occur in the investigation area.

Schedule 3 of the TSC Act contains a list of 'key threatening processes' deemed to be processes that have a negative impact on threatened species, populations or communities.

An assessment of the threatened species and endangered communities that could possibly occur on the subject site was made using NPWS Atlas of NSW Wildlife records from within a 5km radius of the subject site. Next, based on information available concerning the habitat requirements of these species, an assessment was made as to the likelihood of any of the reported threatened species occurring on the subject site or using the habitat of the subject site as an essential part of a foraging range.

A field survey was then conducted using the list of threatened species as a guide to species potentially likely to occur on the subject site. The survey was however, not limited to the species reported on the database extract. Searches were carried out for any species listed on Schedules 1 and 2 of the TSC Act that were considered likely to occur in the type of vegetative habitat present on the subject site.

The likelihood of any 'key threatening processes' occurring on the subject site was also assessed.

2.2. FLORA

Each of the two vegetated blocks under investigation were sufficiently small to allow systematic transect searches across the whole area. This method improves the likelihood of finding any rare or threatened species. A floristic list was compiled for each different vegetation community from the transect searches as well as from a standard .04ha floristic plot placed in a representative part of each community in each vegetation block (using the Braun-Blanquet 1-6 scale for cover-abundance).

Floristic nomenclature was based on Harden (1992, 1993, 2000, 2002) with subsequent revisions as published on PlantNet (http://plantnet.rbgsyd.nsw.gov.au). Targeted searches were conducted for those threatened plant species that were identified during the preliminary assessment as likely to occur on the subject site. Plants listed under the ROTAP scheme (Briggs and Leigh 1996) were also considered in this assessment along with species and vegetation deemed to be of local conservation significance.

2.3. VEGETATIVE COMMUNITY TYPE DETERMINATION

The remnant vegetation for the whole of the Bloomfield, Ashtonfield and Donaldson areas has been mapped previously (Driscoll & Bell 2006) however while this mapping was ground-truthed, further detail was needed to describe the two vegetated blocks. This was achieved by plotting community boundaries with a hand-held GPS and using these points in a GIS to plot boundaries.

2.4. GROUNDWATER DEPENDENT ECOSYSTEMS

Groundwater Dependent Ecosystems (GDE) are ecosystems in which the ecological function and biological process are determined by the presence of groundwater. Examples of GDE’s are: hanging swamps; riparian vegetation dependent on baseline flow; or ecosystems located over aquifers. The vegetation in both blocks was assessed for the presence of GDE’s as indicated by any changes to typical vegetation.

2.5. STATE ENVIRONMENT PLANNING POLICY 44 (SEPP 44) – KOALA HABITAT

SEPP 44 requires that for proposals on properties involving 1 hectare or more, the habitat should be evaluated for potential Koala habitat and core Koala Habitat. Potential Koala habitat is defined as *'areas of native vegetation where the trees listed in Schedule 2 (of SEPP 44) 'constitute at least 15% of the total number of trees in the upper and lower strata of the tree component'*. Should potential Koala habitat be found, further investigation of the existence of core Koala habitat should be undertaken and if this habitat is found to be present then a detailed Plan of Management should be prepared for the Koala colony in the area. A list of Schedule 2 feed trees is provided in Table 1 below.

Table 1 SEPP 44, Schedule 2 - Koala Feed Tree Species

Scientific Name	Common Name
Eucalyptus tereticornis	Forest Red Gum
Eucalyptus microcorys	Tallowwood
Eucalyptus punctata	Grey Gum
Eucalyptus viminalis	Ribbon or Manna Gum
Eucalyptus camaldulensis	River Red Gum
Eucalyptus haemastoma	Broad-leaved Scribbly Gum
Eucalyptus signata	Scribbly Gum
Eucalyptus albens	White Box
Eucalyptus populnea	Bimble Box or Poplar Box
Eucalyptus robusta	Swamp Mahogany

2.6. FAUNA

The assessment of fauna occurred across both vegetated blocks and the following fauna groups were surveyed. Spotlighting for arboreal mammals and amphibians as well as bat surveys (using Anabat) was conducted over one night.

2.6.1. Arboreal Mammals

Two trapping transects of 390m in length running north – south were designed to assess the presence of arboreal and terrestrial mammals utilising the subject site. The location of these transects occurred across each of the two vegetation types. For arboreal mammals, Elliot B traps and hair tubes were placed in trees at heights of 3m or above, along two transects and baited with a mixture of rolled oats, honey, peanut butter and treacle. The trunks of trees with the traps were sprayed with a honey and water mixture. These traps were check daily for arboreal species and wafers from the hair tubes were collected after the four-night period and checked for the presence of hair samples. Hair identification methods followed those of Brunner *et al.* (2002).

Spotlighting was undertaken from dusk for a 3-hour period on one night to identify the presence of any arboreal mammals. Trees were inspected (during daylight hours) for the presence of habitat hollows and if present these were watched at dusk to see if any nocturnal birds or mammals emerged.

2.6.2. Terrestrial Mammals

In order to identify any terrestrial mammals, Elliot A traps, Elliot B traps and Cage traps were placed along two transects at regular intervals. The location of these transects occurred across each of the two vegetation types. All traps were baited with a mix of rolled oats, honey, peanut butter and treacle. The traps were set in position for four consecutive nights and checked each morning.

Spotlighting from dusk for a 3-hour period on one night was also undertaken to identify the presence of any terrestrial mammals. Careful daytime searches were also conducted for the presence of fauna activity such as diggings, droppings or scratch marks.

2.6.3. Bats

An Anabat II bat-call recorder (Titley Electronics, Ballina) was used to record the calls of any Microchiropteran bats feeding in the area. The unit was set up at dusk and recording occurred for 2 hours continuous on one night at two locations. Spotlighting searches of blossoming trees were undertaken to identify any Megachiropteran bat species.

2.6.4. Birds

The method employed to survey diurnal birds was an area search of vegetation on the subject site. Four plots, each approximately 1ha in size, were surveyed for 30 minutes. Birds were identified either visually, with the aid of binoculars, or by call interpretation. Surveys were conducted in the morning when bird activity is maximised (Bibby *et al*. 2000). Opportunistic sightings were also recorded and listed separately to actual survey results (Appendix 2). Other data recorded included the field site number, coordinates of the location using a handheld GPS unit, location description, start and finish times, as well as the temperature, relative humidity and wind speed using a Kestrel 4000 portable weather unit.

After dark, the calls of threatened owl species were broadcast over a megaphone in an attempt to encourage a response. The subject site was also searched to locate any regurgitated owl pellets. If any pellets were found, their size, shape and content would be used in an attempt to determine the species of owl from which the pellet originated as well as the prey species the owl had been feeding on. Analysis methods followed those of Brunner *et al*. (2002) and Triggs (1996).

2.6.5. Amphibians

General surveys for the detection of frog species present were undertaken over two nights and days. During diurnal surveys dip netting and visual searches were carried out to locate any basking adults or any tadpoles present in water bodies. During nocturnal surveys, spotlight searches were carried out by walking lengths of suitable habitat and using head torches to search for frogs by eye shine or by physical sightings. Aural surveys were also conducted to detect the presence of amphibian species by mating calls.

Adult frogs encountered were identified by visual confirmation or by the detection of their distinct advertisement calls. Tadpoles were keyed out using diagnostic features including mouth parts (tooth rows, jaw sheaths and papillae), pigmentation, body size, tail structure (musculature, fin depth, fin shape, tip shape), eye direction and spacing, pupil pigmentation, nare shape and spacing, spiracle height and direction, vent length and direction, and tadpole behaviour. The key used was that of Anstis (2002).

2.6.6. Reptiles

Type IV funnel traps were set in along both sides of two 20m runs of drift fence. Trapping lines were left for four consecutive days and nights and traps were checked daily.

During survey periods on the subject site suitable reptile habitat was inspected to detect the presence of any reptile species by way of occupancy, scats or other detectable traces. Suitable habitat included roadsides, rock outcrops and crevices, any fallen hollow logs and limbs, burrows and suitable rubbish items such as sheets of tin.

2.6.7. Habitat Hollows

Hollows are an important resource utilised by a variety of forest fauna. Vertebrate and invertebrate species use hollows as diurnal or nocturnal shelter sites, for rearing young, feeding, thermoregulation and to facilitate ranging behaviour and dispersal (Gibbons & Lindenmayer 2002). Approximately 400 Australian species potentially use hollows either on a permanent or opportunistic basis. Many threatened species are obligate users, requiring the presence of hollows to survive in the landscape (Gibbons & Lindenmayer 2002).

A hollow survey was conducted in both vegetated blocks to provide an assessment of the number and size of habitat hollows present.

3. THREATENED SPECIES PRELIMINARY ASSESSMENT

The records of threatened species, listed in the Atlas of NSW Wildlife (as of 30 May 2008), previously recorded within a 5-kilometre radius of the subject site are detailed in the following sections.

3.1. FLORA

Three threatened flora species were previously recorded within a 5-kilometre radius of the subject site (Table 2)

Table 2: Threatened flora species recorded within a 5-kilometre radius of the subject site.

Scientific Name	Common Name	Legal Status	Last Date Recorded
Acacia bynoeana	Bynoe's Wattle	E1	20/08/2004
Eucalyptus parramattensis decadens		V	20/08/2004
Grevillea parviflora	Small-flower Grevillea	V	31/10/2002
Tetratheca juncea	Black-eyed Susan	V	2/08/2004

E = Endangered; V = Vulnerable (NSW TSC Act 1995)

3.2. FAUNA

A total of sixteen threatened fauna species, comprising eight birds and eight mammals were previously recorded within a 5-kilometre radius of the subject site (Table 3).

Table 3: Threatened fauna species recorded within a 5-kilometre radius of the subject site.

Class/Scientific Name	Common Name	Legal Status	Last Date Recorded
Aves			
Oxyura australis	Blue-billed Duck	V	3/11/2005
Rostratula benghalensis australis	Painted Snipe (Australian subspecies)	E	1/02/1992
Ephippiorhynchus asiaticus	Black-necked Stork	E	19/01/1990
Irediparra gallinacea	Comb-crested Jacana	V	20/01/1990
Callocephalon fimbriatum	Gang-gang Cockatoo	V	20/10/1982
Neophema pulchella	Turquoise Parrot	V	1/01/1982
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subsp.)	V	1/10/2002
Ninox connivens	Barking Owl	V	11/09/2001
Tyto tenebricosa	Sooty Owl	V	30/11/2002
Ninox strenua	Powerful Owl	V	5/10/2001
Mammalia			
Phascolarctos cinereus	Koala	V	3/08/2000
Petaurus australis	Yellow-bellied Glider	V	13/2/1996
Petaurus norfolcensis	Squirrel Glider	V	15/11/2002
Pteropus poliocephalus	Grey-headed Flying Fox	V	1/10/2002
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	12/08/2002
Mormopterus norfolkensis	Eastern Freetail-bat	V	1/10/2002
Miniopterus australis	Little Bent-wing Bat	V	1/10/2002
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	29/10/2003
Scoteanax rueppellii	Greater Broad-nosed Bat	V	3/08/2000

E = Endangered; V = Vulnerable (NSW TSC Act 1995)

3.3. THREATENED SPECIES PROFILES AND DETERMINATION

The following section provides summary information on the habitat requirements and distribution of threatened flora and fauna that were listed in the Atlas of NSW Wildlife preliminary assessment.

3.3.1. Acacia bynoeana

Woodlands of *Eucalyptus haemastoma* or *E. racemosa* Scribbly Gums (MU31:NPWS 2000) with an open, heathy understorey and ground cover dominated by graminoids, in particular *Ptilothryx deusta* and *Entolasia stricta*, appear to be the preferred habitat of this small wattle (less than 20cm tall) in the Central Coast (Bell & Driscoll 2003). The significant known populations in the Central

Coast occur in the Lake Macquarie LGA with smaller populations reported from Wyong and Gosford LGA. A substrate of lateritic sand derived from Narrabeen sandstone appears to be the preferred soil medium.

Recently (Bell & Driscoll unpub. 2004), substantial populations have been found associated with the endangered ecological community Kurri Sand Swamp Woodland which is broadly similar to the sand-based habitat in the Castlereagh Woodland in Sydney where *Acacia bynoeana* is also present. The species is also present on Hawkesbury sandstone plateaus in Yengo NP (Bell & Driscoll unpub. 2003).

3.3.2. Eucalyptus parramattensis **subsp***. decadens*

This is a small smooth barked tree, which is locally frequent in dry sclerophyll woodland on low, often wet sites with sandy soils (Hill 1991). Occurrences can vary from waterlogged sites where it may grow with scattered *Melaleuca quinquenervia* or *M.sieberi* and a dense sedge understorey, to relatively dry sandy soils with a sclerophyllous and shrubby understorey (pers. obs.). Sizeable stands on the Tomago Sandbeds are currently informally protected as part of Hunter Water's sand aquifer for Newcastle’s backup water supply.

Within the region, this species is restricted to the Tomago Sandbeds in Port Stephens LGA, and around the Kurri area in Cessnock LGA (Hill 1991). Small portions are conserved within Lower Hunter National Park (Bell 2001).

3.3.3. Grevillea parviflora **subsp.** *parviflora*

Grevillea parviflora subsp. *parviflora* is a dense spreading low shrub growing barely to 1m in height, occurring from Prospect and the lower Georges River, to Camden, Appin and Cordeaux Dam area. Disjunct northern populations also occur near Putty, Cessnock and Cooranbong (Makinson 2002). The species reportedly occurs in heath and shrubby woodland, in sandy or lightly clay soils usually over thin shales (Olde & Marriot 1995; Makinson 2002).

In the National context, *Grevillea parviflora* subsp. *parviflora* is legally protected under Schedule 2 (Vulnerable) of the *NSW Threatened Species Conservation Act 1995 (TSC Act)* and is also listed as Vulnerable under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999. The species is lignotuberous and is capable of resprouting following fire and other disturbances. Regionally, *Grevillea parviflora* subsp. *parviflora* is known to occur within Karuah Nature Reserve (Port Stephens Shire: Bell 2002a) and Lower Hunter National Park (Cessnock Shire; Bell 2001), although no information is available on population sizes.

3.3.4. Tetratheca juncea

Tetratheca juncea Smith (Tremandraceae) is a terrestrial herbaceous plant endemic to NSW and listed under Schedule 2 of the NSW *Threatened Species Conservation Act* 1995 as Vulnerable and having a ROTAP coding of 3VCa (Briggs and Leigh 1995). It is also listed as Vulnerable in the *Commonwealth Environment Protection and Biodiversity Conservation Act* 1999. Thompson (1976), in a revision of the *Tetratheca* genus, noted that there were records from the late 1800’s of the plant occurring in suburbs of Sydney, from Port Jackson and suburbs to the south. *T. juncea* is now known to exist only from the Wyong area to Bulahdelah and inland to the edge of the main ranges with the greatest concentration of records being from the Wyong and Lake Macquarie local government areas (Payne 2000).

Tetratheca juncea propagates through both rhizomal spread and seed development and germination (Thompson 1976, Payne 2000). Propagation by seed appears to be limited by a dispersal mechanism that is most probably by ants collecting the seed for the lipid rich elaiosome (Brew *et al.* 1989, Boeswinkel 1999).

Tetratheca juncea is distinguished from other members of the *Tetratheca* genus by having generally leafless stems that have a distinctly angular, winged structure (Thompson 1976). The flowers of *T. juncea* however share the four-petalled, pink form that is characteristic of the genus. The flowering period for *T. juncea* is generally reported as being from mid to late winter through to late summer (Gardner & Murray 1992). The flowers grow from nodes on the mostly leafless stem and are commonly solitary but occasionally in pairs with each flower facing downward, suspended on a peduncle of about 10mm length. The four petals range in colour from mauve through pink to almost white (Thompson 1976, Payne 2000).

Driscoll (2003) used GIS analysis of 400 records (compiled from Payne 2000, Bartier *et al.* 2001, and S. Bell & C. Driscoll unpub) and showed that *T. juncea* has been reported from 16 separate, and often widely differing, vegetation community types as defined in NPWS (2000) and Eco Logical (2002). However over 60% of records were from within *Coastal Plains Smoothbarked Apple Woodland* (MU30) about 14% from *Coastal Plains Scribbly Gum Woodland* (MU31) and about 11% from *Coastal Foothills Spotted Gum-Ironbark Forest* (MU15). These results indicate that within the range of its occurrence, *T. juncea* should be considered as possibly occurring in most common vegetation communities.

3.3.5. Blue-billed Duck (Oxyura australis)

The Blue-billed Duck has been reported from south west, central, and south east Australia including Tasmania with little change in reporting rate over the last 20 years (Barrett *et al* 2003). The preferred habitat is in large, deep, well-vegetated swamps where they spend almost all of their time in the water often in large flocks. Rarely they can be found using creeks, rivers and farm dams for foraging and breeding (Frith 1977). The Blue-billed Duck was listed as vulnerable in the NSW *Endangered Fauna (Interim Protection) Act 1991* and this status was carried into the NSW *Threatened Species Conservation Act 1995* (Lunney *et al* 2000). Nationally the Blue-billed Duck is classed as of 'least concern' because of the very large flocks that inhabit large artificial wetlands (Garnett & Crowley 2000) although threats are noted as being the draining and pollution of wetlands (Marchant & Higgins 1990).

3.3.6. Black-necked Stork (Ephippiorhynchus asiaticus)

The Black-necked Stork is a conspicuously large (110-137cm) long-legged stork with a glossy black head and neck, long deep pointed bill and red legs (Marchant & Higgins 1990). The species may inhabit permanent freshwater wetlands including margins of billabongs, swamps, shallow floodwaters, and adjacent grasslands and savannah woodlands. The species can also be found occasionally on inter-tidal shorelines, mangrove margins and estuaries. Feeds in shallow, still water on a variety of prey including fish, frogs, eels, turtles, crabs and snakes (Marchant & Higgins 1990; DEC 2004). The Black-necked Stork breeds in or near wetlands usually in the top of large (live or dead) trees and constructs a huge nest of sticks, lined with grass tufts, rushes, reeds and paperbark (Marchant & Higgins 1990).

The Black-necked Stork occurs mostly across coastal northern Australia from Pilbara, Western Australia to eastern Queensland and New South Wales (Marchant & Higgins 1990; Barrett *et al.* 2003). In NSW, the species occurs near coastal areas from the Queensland/NSW border south to the central coast. In Australia, the species has, since the 1980s, declined in the southern end of its range and is now listed as Endangered under Schedule 1 of the *NSW Threatened Species Conservation Act 1995* (Dorfman *et al.* 2001). Threats to the species include; disturbance and loss of habitat via the clearing of remnant vegetation and individuals trees, wetland modification as well as collision with powerlines (Garnett & Crowley 2000; DEC 2004).

3.3.7. Painted Snipe (Rostratula benghalensis australis)

The Australian subspecies of Painted Snipe inhabits shallow, vegetated, temporary or infrequently filled wetlands, sometimes where there are trees such as River Red Gum *Eucalyptus camaldulensis* or Poplar Box *E. populnea* or shrubs such as Lignum *Muehlenbeckia florulenta* or samphire (Vestjens 1977; Leach *et al*. 1987). This species generally feeds at the water's edge and on mudflats, taking seeds and invertebrates, including worms, insects, molluscs and crustaceans. The polyandrous female lays 3-6 eggs, which are incubated by the male, in a shallow scrape nest (Lowe 1963; Marchant & Higgins 1993).

Painted Snipe are irregularly recorded from wetlands throughout Australia with fewer than 100 records of the species since 1990. Most records of this species are from the Murray-Darling drainage system with the majority of breeding records also from the south-east of Australia. However, sightings have been recorded in other parts of Australia including the Barkly Tablelands, north-eastern and south-eastern Queensland and the Kimberley (Lowe 1963; Leach *et al*. 1987; Jaensch 1989, 1994). Recent analysis suggests numbers of this subspecies have decreased over the last 40 years, particularly in southern Australia. Painted Snipe are threatened primarily by wetland drainage, or the diversion of water from rivers, which means that shallow wetlands never form (Garnett & Crowley 2000).

3.3.8. Comb-Crested Jacana (Irediparra gallinacea)

The Comb-crested Jacana, also known as the 'Lotusbird', is an obligate freshwater species (Garnett *et al.* 2001) that occupies permanent territories all year round. The species inhabits freshwater wetlands on coastal floodplains, particularly those with abundant vegetation, such as waterlilies (*Nymphaea* spp.) and the introduced Water Hyacinth (*Eichhornia crassipes*). The species requires this floating vegetation as a means of walking over it while foraging for food and for breeding in which they construct a small floating platform supported by aquatic vegetation. The species breeds as solitary pairs, which vigorously defend their nesting territory (Smith 1991). Comb-crested Jacanas eat a wide variety of invertebrate and plant material with seeds of waterlilies and aquatic moth larvae being particularly important (Dostine & Morton 2000).

Within Australia the Comb-crested Jacana is confined to the coastal and sub-coastal fringes of the north and north-east of the continent (Blakers *et al*. 1984; Marchant & Higgins 1993). The species is most abundant and widespread in NSW in the floodplain wetlands along the Richmond and Clarence Rivers (Smith 1991). The Comb-crested Jacana is listed as vulnerable in the *NSW Threatened Species Act 1995*. Threats include the loss of wetland habitat through clearing and draining for flood mitigation and agriculture (Marchant & Higgins 1993).

3.3.9. Gang-gang Cockatoo (Callocephalon fimbriatum)

The Gang-gang Cockatoo is distributed from southern Victoria through south- and central-eastern NSW (Shields & Crome 1992). The species formerly occurred on King Island, Tasmania, but is now locally extinct. A small introduced population occurs on the western tip of Kangaroo Island, South Australia (Higgins 1999). In NSW, the Gang-gang Cockatoo is distributed from the south-east coast to the Hunter region, and inland to the Central Tablelands and south-west slopes. It occurs regularly in the Australian Capital Territory. Isolated records are known from as far north as Coffs Harbour and as far west as Mudgee (Chambers 1995).

In summer, the Gang-gang Cockatoo occupies tall montane forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. The species may also occur in sub-alpine Snow Gum *Eucalyptus pauciflora* woodland and occasionally in temperate rainforests (Forshaw 1989). In winter, the Gang-gang Cockatoo occurs at lower altitudes in drier, more open eucalypt forests and woodlands, particularly in box-ironbark assemblages, or in dry forest in coastal areas (Shields & Crome 1992). At this time the species may be observed in urban areas including parks (Harden 1981). Gang-gang Cockatoos feed on the seeds of native and introduced trees and shrubs, including Eucalyptus, Acacia, as well as berries, nuts, fruits, insects and insect larvae. The birds will return to a single site each day until the food supply is exhausted, leaving debris littered beneath the tree (Forshaw 1981). The breeding season is from October to January when the species generally nests in a hole in the trunk or dead branch of a tall tree (Forshaw 1981). This species is adversely affected by clearing of old growth vegetation, which support hollow bearing trees.

3.3.10. Turquoise Parrot (Neophema pulchella)

The Turquoise Parrot is a small (20cm) temperate woodland species that occurs from south-east Queensland through NSW to east and north-east Victoria. Generally, the distribution of the Turquoise Parrot is patchy, determined by areas of suitable habitat. Such habitat is usually steep, rocky ridges and gullies, rolling hills, valleys and river-flats comprised of eucalypt woodland and open forests with a ground cover of grasses and low understorey of shrubs. The Turquoise Parrot is an obligate granivore feeding on the seeds of grasses, herbaceous plants and shrubs and requires a reliable supply of water (Higgins 1999). Breeding occurs from August to January, usually nesting less than two metres above the ground. Nests are located in the hollows of small trees, dead eucalypts or in holes or stumps.

The Turquoise Parrot is a resident or partially nomadic species with movements usually a result of seasonal fluctuations in the distribution and availability of food. The species mostly occurs as pairs or small parties of 6-8 birds. In NSW, the species mainly occurs on or at the foothills of the Great Divide from Moree south to Dubbo, Griffith and Wagga Wagga. The species is listed as vulnerable under the *NSW Threatened Species Conservation Act 1995* (Blakers *et al.* 1984; Barrett *et al.* 2003). Threats to the Turquoise Parrot include loss of habitat through clearing, intensive logging, burning and grazing; the destruction of nest sites; and, inappropriate fire regimes which remove nesting and feeding resources (Garnet and Crowley 2000).

3.3.11. Barking Owl (Ninox connivens)

The Barking Owl is a medium-sized brown hawk-like owl, spotted white on the wings, with barring in the wings and tail, and coarsely streaked brown on white underneath. It has prominent yellow eyes in a flat face and fully feathered legs with large yellow feet. It is approximately 35-45 cm in length with a wingspan of 85-100cm and weighs between 425-510g. Its voice is extremely characteristic; a loud and remarkably dog-like double bark, 'wuf wuf' or 'wuk wuk' (Hollands 1991, Higgins 1999). This bark is always preceded by a short, low groan but this is audible only at close quarters (Hollands 1991). The Barking Owl takes a wide range of prey including diurnal bird species, rabbits, gliders, small possums, bats, rodents and insects (Kavanagh *et al*. 1995).

Its habitat is typically dominated by eucalypts, often red gum species and, in the tropics, paperbarks *Melaleuca* species (Higgins 1999). It usually roosts in or under dense foliage in large trees including rainforest species and typically breeds in hollows of large eucalypts or paperbarks, usually near watercourses or wetlands (Kavanagh *et al*. 1995). This large Owl is now sparsely distributed through its historic range from Victoria through New South Wales to Cooktown in Queensland. The Barking Owl is listed as vulnerable under the *NSW Threatened Species Conservation Act 1995*. The main threats to the Barking Owl include habitat loss and degradation; loss of native hollow bearing trees and coarse woody debris; removal of dead wood, dead trees and logs; competition from feral honeybees; and possibly, predation by the fox and feral cat (Garnett & Crowley 2000).

3.3.12. Powerful Owl (Ninox strenua)

The Powerful Owl is a large (60cm) forest owl that inhabits forest and woodlands of the coastal, escarpment, tablelands and western slopes in NSW (Kavanagh 2002b). Habitat for the Powerful Owl comprises tall, moist productive eucalypt forests and a mosaic of wet and dry sclerophyll occurring on undulating, gentles terrain near the coast. Optimal habitat includes a tall, shrub layer and abundant hollows supporting high densities of arboreal mammals (DEC 2005). The Powerful Owl preys on arboreal mammals, particularly the Common Ringtail Possum in the lowlands and the Greater Glider in the highlands. These two species comprise more than 80% of the species' diet. Other prey species include the Sugar Glider, the Common Brushtail Possum, Grey-headed Flying Fox as well as some diurnal bird species such as the Pied Currawong (DEC 2005).

The Powerful Owl roosts in dense mid-canopy trees or tall shrubs in sheltered gullies, while nesting occurs in hollows of old eucalypts in unlogged, unburnt gullies and lower slopes within 100m of streams or minor drainage lines (DEC 2005). The species is faithful to nesting hollows (Kavanagh 1997; Higgins 1999; Kavanagh 2002b). The home range of the Powerful Owl is variable, depending on habitat productivity, however, is generally between 300 and 1500ha (Kavanagh 1997). The species systematically 'farms' this territory rather than regularly hunting across the entire home range. The breeding season of the Powerful Owl is from mid-May to mid-July (Kavanagh 1997; Kavanagh 1998; Kavanagh 2002a, 2000b; Kavanagh & Stanton 2002).

3.3.13. Sooty Owl Tyto tenebricosa

This is one of the Barn Owls with a mask-shaped face. Its has a coastal range from southern Queensland to southern Victoria with a preferred habitat of closed and tall open forests and in particular gullies (Kavanagh 1997). It roosts by day on branches in dense trees, in hollows or in caves and at night it feeds through the tree canopy with its prey being medium sized marsupials such as the Ring-tailed Possum or the gliding possums. The Sooty Owl has a more diverse diet than the other large owls and includes both arboreal marsupials and a substantial numbers of terrestrial mammals such as bandicoots.

3.3.14. Grey-crowned Babbler (Pomatostomus temporalis)

The Grey-crowned Babbler is a temperate forest and woodland and tropical woodland bird species (Garnett & Crowley 2000). The Grey-crowned Babbler inhabits open forests and woodlands, requiring an open shrub layer with sparse ground cover and fallen timber and leaf litter (Blakers *et al*. 1984). The species builds communal nests although occasionally nests will be built in the open branches of taller trees. The birds are primarily invertebrate feeders but include the occasional small lizard in their diet. They feed by turning litter on the ground or by lifting pieces of bark on trees and fallen logs (Blakers *et al*. 1984). Their dependence on the insect and arthropod fauna within the litter layer, branches and logs makes these birds vulnerable to frequent fire or firewood collection (Adam & Robinson 1996).

In NSW, the Grey-crowned Babbler occurs mostly west of the Great Divide, in suitable habitat on the edges of State Forests and in the Liverpool Plains region (Ekert 2002, 2004). In the Hunter Region, the Grey-crowned Babbler mostly occurs in the central, western and northern parts of the region including Clarencetown, Gloucester, Seaham, Cessnock, Maitland, Branxton, Kurri Kurri, Singleton, Paterson, Dungog and Wingen

(HBOC 1997, 1998). The species is listed as vulnerable in the *NSW Threatened Species Conservation Act 1995*.

3.3.15. Koala (Phascolarctos cinereus)

The Koala generally occurs from the Townsville district in northern Queensland, south along the coast and ranges into Victoria and part of South Australia. Within New South Wales and Queensland, this distribution extends into the western slopes and plains. The Koala lives entirely on a diet of leaves of both eucalypt and non-eucalypt trees and it has been shown that within its range there are local and regional preferences for the tree species used for feeding from. Examples of eucalypts used as feed trees are *E. camaldulensis*; *E. viminalis*; *E. ovata*; *E. tereticornis*; *E. microcorys*; *E. punctata*. Non eucalypts recorded have been *Allocasuarina torulosa*; *Melaleuca quinquenervia*; and *Lophostemon confertus*. Throughout its range the Koala suffers from either a lack of numbers or severe over-population where problems such as eye disease and reproductive tract bacterial disease caused by *Chlamydia psittaci* become prevalent. (Martin & Handasyde 2000; Moore & Foley 2000; Phillips & Callaghan 2000; Phillips, Callaghan & Thompson 2000).

3.3.16. Squirrel Glider (Petaurus norfolcensis)

Occurs on the coast and ranges of eastern Australia, from northern Queensland to the Victorian/ South Australian border, and also extends into the western slopes and plains. The Squirrel Glider inhabits dry sclerophyll forest and woodland, and is generally absent from the more densely vegetated coastal ranges. More recently, however, the species has been recorded in a number of coastal locations and confusion with the similar Sugar Glider is attributed as the main reason for the apparent lack of historical coastal records.

One of the reasons that the Squirrel Glider has been considered vulnerable in NSW is that its diet is specialised. It will eat insects and the occasional birds egg, however, the greater part of the diet is nectar, pollen and gum exudates particularly from wattles. The amount of habitat that supports these food resources has been significantly reduced. The Squirrel Glider requires hollows in standing trees for roosting and nesting purposes and home ranges from 2-3ha to 13ha have been reported. (Quinn 1995; SWC 1996; Rowston 1998; Suckling 2000; Holland 2001; Smith 2002).

3.3.17. Yellow-bellied Glider (Petaurus australis)

This is the largest of the Petaurid gliders and they can be found in mid dense to closed forest in which the trees are of sufficient age to have developed suitable hollows for the gliders to nest in. In undisturbed habitat these gliders will maintain their presence in the same area for many years; for example one population has been observed in the same area of the Watagan NP for over 25 years (Driscoll pers obs). The diet of the Yellow-bellied Glider consists of invertebrates, nectar and pollen from blossoming eucalypts in particular, although they are primarily exudate feeders feeding on sap from selected trees, which they obtain by gnawing grooves in the bark of the tree The home range of these gliders has been estimated at 35 hectares and they will travel up to 2 kilometres in a night of foraging (Carthew *et al* 1999; Russel 2000).

3.3.18. Grey-headed Flying-fox (Pteropus poliocephalus)

This species occurs along the eastern seaboard of Australia roosting in communal colony sites, which are used permanently, annually, or occasionally depending on food availability (Tidemann 2000). Colonies can vary considerably in size from hundreds to many thousands of individuals, and fluctuate according to food resources (Parry-Jones & Augee 1991; Tidemann 2000). Fruits from numerous rainforest trees and other myrtaceous species form a large component of their diet, and consequently mass nomadic movements occur throughout their range in response to fruit availability. Large colonies are very vocal even during the day, and can significantly damage roost trees by their sheer weight of numbers.

> "The Grey-headed flying fox must be acknowledged as being highly significant to the health and maintenance of many ecosystems in eastern Australia. The species performs the ecosystem services of pollination and seed dispersal for a wide range of native trees, including commercially important hardwood and rainforest species. It thus contributes directly to reproduction, regeneration and the evolutionary processes of forest ecosystems. Flying-foxes are unique in the large distances they disperse pollen and seeds. The population of Grey-headed flying fox must be of sufficient size for this to continue. If numbers were reduced to small or localised groups, then rainforest seed dispersal and hardwood pollination processes would be severely curtailed (Eby 2000)".

3.3.19. Yellow-bellied Sheathtail Bat (Saccolaimus flaviventris)

This bat is to be found in a wide range throughout Australia only being absent from the southwest quarter of SA to southern WA and throughout this range it inhabits a similarly wide range of vegetative habitat. They are an adaptive roosting species and have been found under eaves of houses, in animal burrows in the ground and in tree hollows for example. Its reported rarity may be in part due to the fact that it flies high and fast and is not often captured (Churchill 1998, Richards 2000).

3.3.20. Eastern Free-tail Bat (Mormopterus norfolkensis)

While this bat is regarded as a separate species, the taxonomy is yet to be resolved. It can be found along the eastern seaboard from central Victoria to north Queensland and can only be found in Australia. The bat can be found in a wide range of forest and woodland habitats where it forages for insects. It prefers tree and limb hollows for denning (Churchill 1998; Allison & Hoye 2000).

3.3.21. Little Bentwing-bat (Miniopterus australis)

This species occurs along the east coast of Australia from Cape York south to coastal northern NSW. The species also occurs in New Caledonia, New Guinea, the Philippines, and the Indo-Malayan archipelago. The Little Bent-wing Bat generally occupies well-wooded habitats throughout its range, roosting during the day in caves and similar locations. As with other Bentwing-bats, this species depends on specific nursery sites in which to raise its young, and only five of these sites were known of in 1983. In central Queensland one of these nursery colonies numbers 100,000 adult bats. They forage for insects in generally well-wooded habitat of a variety of forms from swamp forest, dry forest to rain forest (Churchill 1998, Dwyer 2001).

3.3.22. Eastern Bentwing-bat (Miniopterus schreibersii oceanensis)

This species is widely distributed on the coast and ranges of eastern Australia, from Cape York Peninsula, south to Victoria and eastern South Australia. The species is also present in northern Western Australia and the Northern Territory. Within New South Wales, it extends from the coast to the western slopes of the Great Dividing Range. These bats roost in caves and man-made structures such as culverts, mine shafts and farm sheds. They are territorial, moving within a 300 km radius of a maternity cave. They forage for insects in generally well-wooded habitat of a variety of forms from swamp forest, dry forest to rain forest (Churchill 1998, Dwyer 2001).

3.3.23. Greater Broad-nosed Bat (Scoteanax rueppellii)

This species occurs along the coast and ranges of eastern Australia, from northern Queensland to the New South Wales/Victorian border. This bat appears to be most frequent in the river systems draining the Great Dividing Range. Tree-lined creeks, and the junctions of woodland and cleared paddocks, are favoured hunting areas for the Greater Broad-nosed Bat, although it may also forage in rainforest environments, flying as low as one metre above the surface of a creek. The species normally roosts in tree hollows, but roosting records in the ceilings of old buildings also exist (Churchill 1998; Hoye & Richards 2000).

3.4. SUMMARY OF THREATENED SPECIES DETERMINATION

The following table (Table 4) is an assessment of the likelihood of threatened flora and fauna species recorded within 5 kilometres of the property, occurring on the subject site.

Table 4 An assessment of the likelihood of selected threatened flora and fauna species occurring on the subject site.

Class/Scientific Name	Common Name	Likelihood of being found on the subject site	Impact assessment required
Flora			
Acacia bynoeana	Bynoe's Wattle	Not likely- unsuitable habitat	No
Eucalyptus parramattensis decadens	Drooping Redgum	Not likely- unsuitable habitat	No
Grevillea parviflora	Small-flower Grevillea	Not likely- unsuitable habitat	No
Tetratheca juncea	Black-eyed Susan	Not likely- unsuitable habitat	No
Mammalia			
Phascolarctos cinereus	Koala	Likely – suitable habitat	Yes
Petaurus australis	Yellow-bellied Glider	Not likely- unsuitable habitat	No
Petaurus norfolcensis	Squirrel Glider	Likely – suitable habitat	Yes
Pteropus poliocephalus	Grey-headed Flying-fox	Likely – suitable habitat	Yes
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	Present on subject site	Yes
Mormopterus norfolkensis	Eastern Freetail-bat	Present on subject site	Yes
Miniopterus australis	Little Bent-wing-bat	Present on subject site	Yes
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	Present on subject site	Yes
Scoteanax rueppellii	Greater Broad-nosed Bat	Present on subject site	Yes
Aves			
Rostratula benghalensis australis	Painted Snipe (Australian subspecies)	Not likely – unsuitable habitat	No
Ephippiorhynchus asiaticus	Black-necked Stork	Not likely – unsuitable habitat	No
Irediparra gallinacea	Comb-crested Jacana	Not likely – unsuitable habitat	No
Callocephalon fimbriatum	Gang-gang Cockatoo	Possible – suitable foraging habitat	Yes
Neophema pulchella	Turquoise Parrot	Likely – suitable habitat	Yes
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subsp.)	Not likely – unsuitable habitat	No
Ninox connivens	Barking Owl	Not likely – unsuitable habitat	No
Tyto tenebricosa	Sooty Owl	Not likely – unsuitable habitat	No
Ninox strenua	Powerful Owl	Likely – suitable foraging habitat	Yes

A total of 11 threatened species; comprising three birds and eight mammals were assessed as likely to occur on the subject site.

4. FIELD SURVEY RESULTS

Figure 3 shows the locations of the various investigations carried out in the two vegetation blocks.

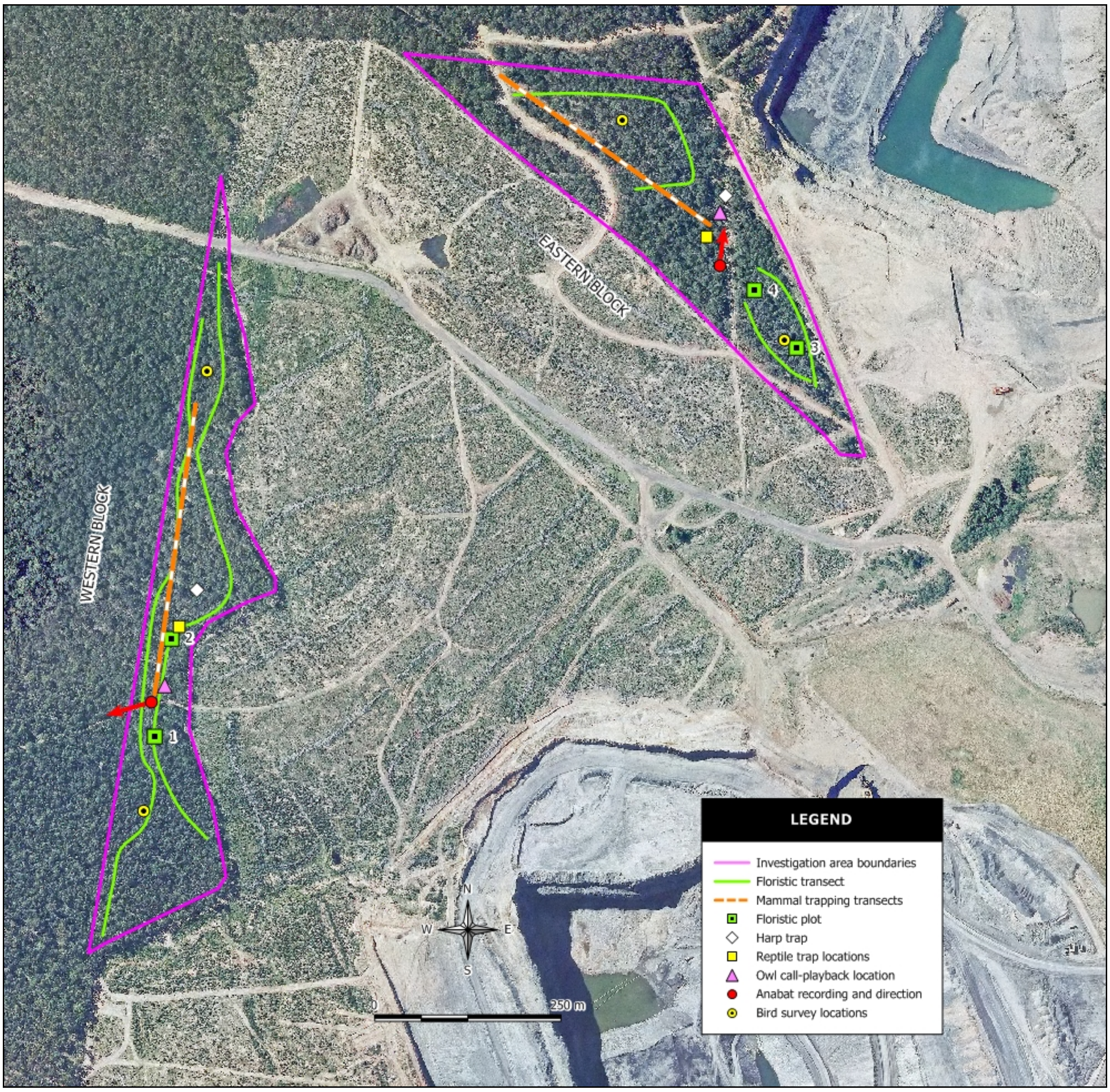

Figure 3 **The field investigation location details**

4.1. WEATHER CONDITIONS AND SURVEY ACTIVITIES

Many fauna exhibit seasonal and daily patterns in their behaviour in response to the prevailing weather conditions. For example, amphibians are ectothermic and lose water through their skin so, in temperate regions, they are most active in the warmer months when the ambient temperature is higher and it is less costly metabolically to be active (Duellman and Treub 1994). Within the warmer months amphibians typically exhibit a response to daily weather conditions such as high wind and rainfall (Duellman and Treub 1994). Many Microchiropteran bats also differ seasonally and daily in their activity levels according to the prevailing weather conditions (Speakman & Thomas 2003). Hence properly conducted field surveys to determine the abundance and diversity of fauna in an area are usually conducted in spring and summer. Within these months daily weather conditions may influence the number of species and individuals detected. Hot, dry days and nights are ideal for detecting reptiles, Microchiropteran bats and arboreal and terrestrial mammals, whereas warm, wet nights are generally ideal for frog surveys (pers. obs J. Harty). Thus, field survey results should always be interpreted within the context of the weather conditions occurring during the survey period.

The prevailing weather conditions throughout the field survey period were warm, clear to partly cloudy days with light to moderate winds and warm, clear, calm nights (Table 5). The mean minimum temperature was 12 – 16 º C, and the mean maximum temperature was 19 – 32º C. It did not rain in Beresfield during the survey periods detailed in Table 5.

Table 5 **Schedule of activities and weather conditions during the survey period.**

Activity	Day	Date	Weather Conditions
Fauna			
Elliott Trapping	Tuesday - Friday	17/10 – 20/10/06	Clear to partly cloudy, no rain, no wind
Anabat 1 & 2	Wednesday – 1900 - 2100	18/10/06	Clear sky, no rain, no wind
Spotlighting	Wednesday	18/10/06	Clear sky, no rain, no wind
Nocturnal call playback	Wednesday	18/10/06	Clear sky, no rain, no wind
Reptile Search	Wednesday	18/10/06	Clear sky, no rain, no wind
Bird Survey	Tuesday	24/10/06	Clear sky, no rain, no wind
Frog Survey	Thursday	12/10/06	Clear sky, no rain, no wind
Habitat Hollow Survey	Wednesday	26/10/06	Clear sky, no rain, no wind
Habitat Hollow Survey	Monday	13/11/06	Partly cloudy, no rain, no wind
Flora			
Vegetation communities and floristics lists		25/01/08 30/01/08 31/01/08	

4.2. FLORA

The total transect lengths surveyed were: Eastern Block >700m and Western Block >1700m. Appendix 1 provides floristic lists for each vegetation community in each of the two vegetated blocks as well as the detailed floristic plot data. Table 6 summarises this data.

Table 6 **Total flora species recorded in each community and each vegetation block**

Community	Total species recorded
Eastern Block	
MU17 Lower Hunter Spotted Gum-Ironbark Forest	55
MU30 Coastal Plains Smooth-barked Apple Woodland	68
Western Block	
MU17 Lower Hunter Spotted Gum - Ironbark Forest	58
MU15 Coastal Foothills Spotted Gum – Ironbark Forest	68

4.3. VEGETATIVE COMMUNITY TYPE AND MAPPING

Three vegetation communities were determined to be present and Figure 5 shows these communities in the context of the surrounding vegetation. One of the communities, *Lower Hunter Spotted – Gum Ironbark Forest* is listed as an Endangered Ecological Community in the NSW TSC Act. The vegetation was in relatively undisturbed condition having been protected for many years within the bounds of the Bloomfield properties.

1. Lower Hunter Spotted Gum – Ironbark Forest. (MU17)

Overstorey: dominated by *Corymbia maculata* (Spotted Gum), *Eucalyptus fibrosa* (Red Ironbark) and *Eucalyptus umbra* (Bastard Mahogany). Other overstorey species were *Eucalyptus punctata* (Grey Gum), *Syncarpia glomulifera* (Turpentine), *Angophora costata* (Smooth-barked Apple) and *Allocasuarina torulosa* (Forest Oak).

Shrub layer: Dominated by *Bursaria spinosa* and *Daviesia ulicifolia*.

Ground layer: Dominated by *Joycea pallida*, *Themeda australis* and *Entolasia stricta*.

2. Coastal Foothills Spotted Gum – Ironbark Forest (MU15)

Overstorey: dominated by *Corymbia maculata* (Spotted Gum), *Eucalyptus siderophloia* (Grey Ironbark), *Eucalyptus umbra* (Bastard Mahogany), *Syncarpia glomulifera* (Turpentine) and *Allocasuarina torulosa* (Forest Oak).

Shrub layer: Dominated by *Bursaria spinosa* and *Daviesia ulicifolia, Acacia elongata.*

Ground layer: Dominated by *Joycea pallida*, *Themeda australis* and *Entolasia stricta*.

3. Coastal Plains Smooth-barked Apple Woodland.

Overstorey: dominated by Angophora costata (Smooth-barked Apple), Corymbia gummifera (Red Bloodwood), *Eucalyptus umbra* (Bastard Mahogany), *Eucalyptus punctata* (Greygum) and *Allocasuarina torulosa* (Forest Oak).

Shrub layer: Dominated by *Leptospermum trinervium, Banksia spinulosa, Ceratopetaum gummiferum, Astrotricha obovata,* and Maytenus *silvestris*.

Ground layer: Dominated by *Entolasia stricta, Imperata cylindrica, Joycea pallida,* along with *Adiantum aethiopicum, Lomandra filiformis subsp coriacea*.

Table 7 Areas of each vegetation community in each vegetation block

Community		Area
Eastern Block		
MU17 Lower Hunter Spotted Gum-Ironbark Forest	undisturbed	6.38
	disturbed	0.79
MU30 Coastal Plains Smooth-barked Apple Woodland	undisturbed	2.42
	disturbed	0.50
Western Block		
MU17 Lower Hunter Spotted Gum - Ironbark Forest	undisturbed	3.21
MU15 Coastal Foothills Spotted Gum – Ironbark Forest	undisturbed	5.33
	disturbed	0.40

disturbed = to be cleared for mining

Figure 5 shows an area, described as *Regrowth from clearing,* between the existing void and the vegetated blocks (Figure 4). This area (about 77ha) had been cleared at some stage in the recent past and was naturally regenerating with sapling heights of around 2 – 4m. No assessment was made as to the vegetation communities represented in this regrowth.

Figure 4 A view across a part of the regrowth from recent clearing looking south. The current void is to the left and the western vegetation block is to the right.

4.4. GROUNDWATER DEPENDENT ECOSYSTEMS

No GDE's were present in either vegetation block. Both blocks were on elevated ground and while there were shallow drainage lines there was little change between vegetation at these locations and the surrounding vegetation.

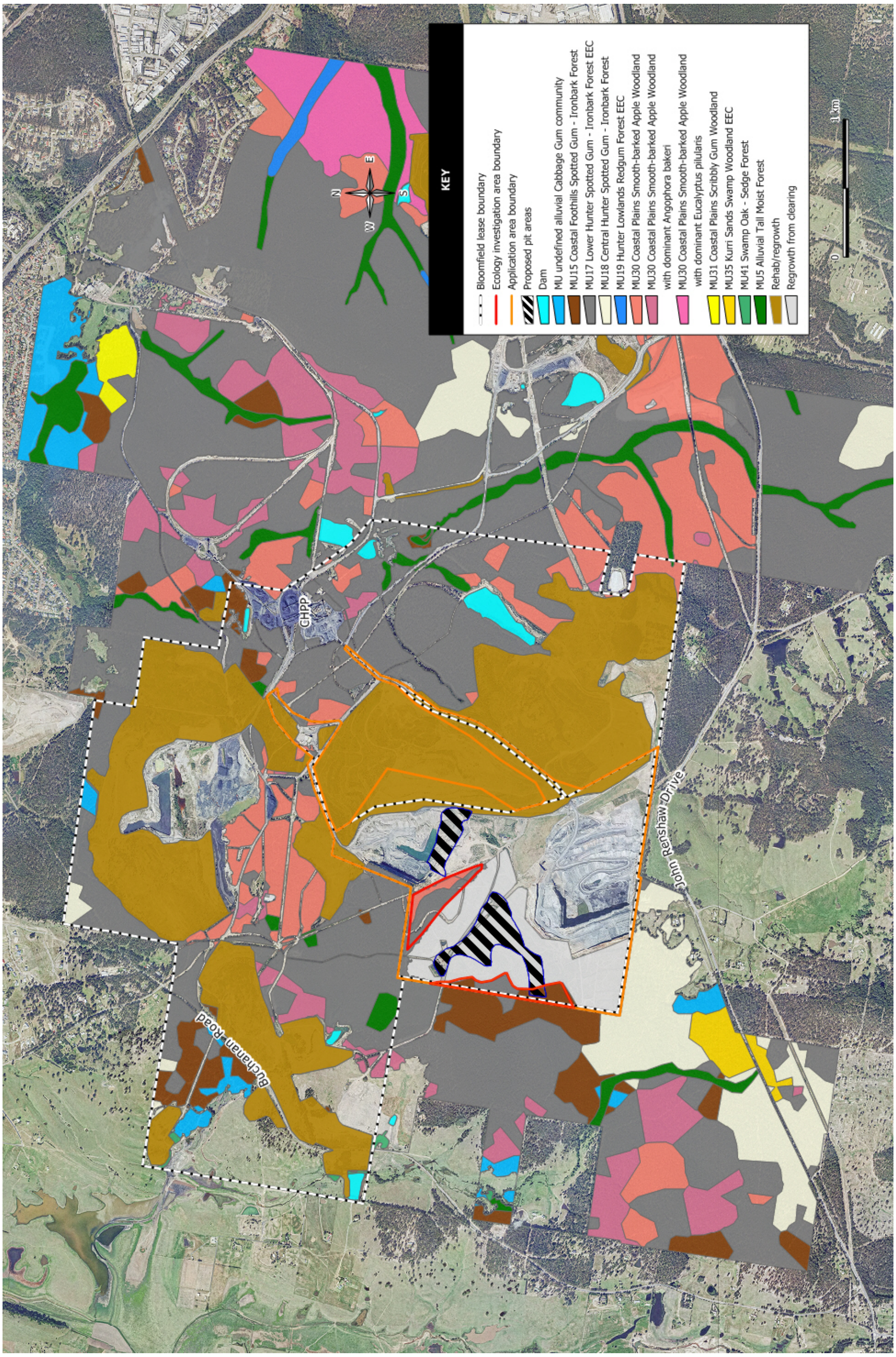

Figure 5 **Vegetation communities**

4.5. HABITAT HOLLOWS

A total of 54 trees having potential habitat hollows were mapped in the two vegetated blocks (Figure 6). Of the 135 hollows recorded, the majority were small, 38 were medium-sized and one large hollow was present (Figure 7). Only 4 potential habitat trees were located in, or very close to, the proposed pit extension area (western block).

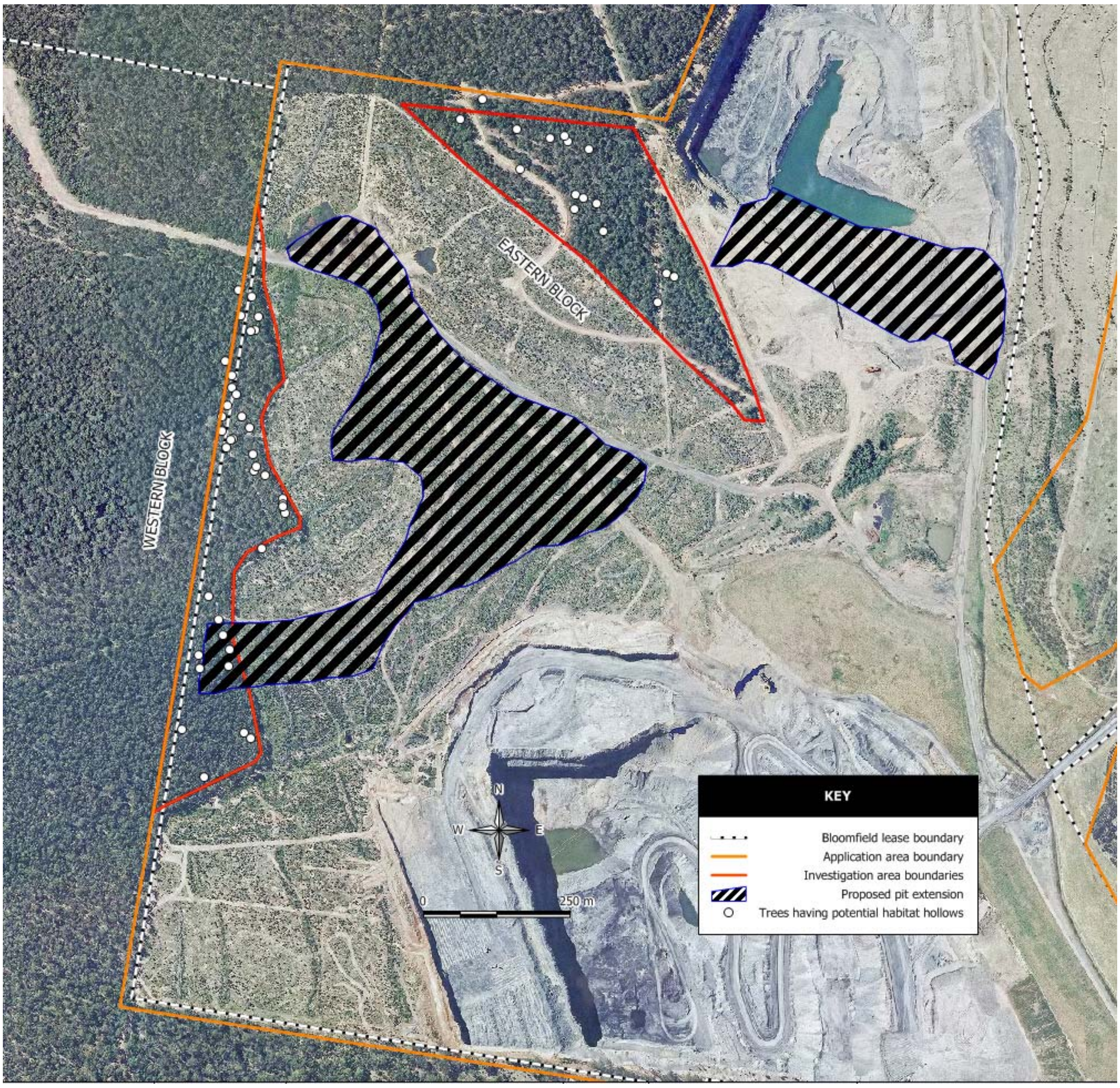

Figure 6 **The location of trees having potential habitat hollows.**

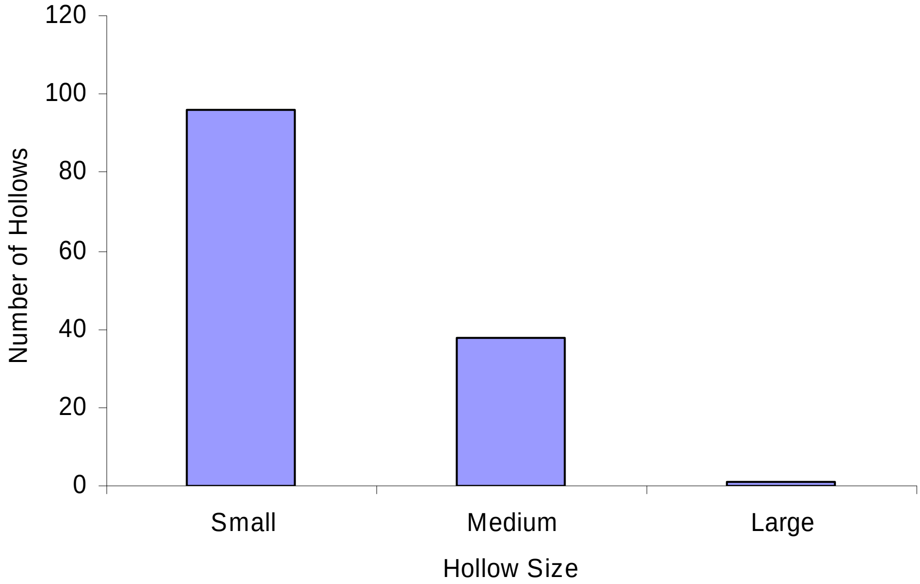

Figure 7 **The distribution of hollow sizes**

4.6. SEPP 44 KOALA HABITAT

Of the listed feed trees, only *Eucalyptus punctata* was present and at less than 15% of the total number of trees. This meant that potential Koala habitat was not present and that further investigation was not required.

4.7. FAUNA

The details of trapping effort are shown in Table 8.

Table 8 Fauna trapping details

Trap type	Traps	Nights	Trap nights
Elliot A	40	4	160
Elliot B Tree	14	4	56
Elliot B Ground	20	4	80
Cage	6	4	24
Hair Tubes	10	4	40
Harp Trap	2	4	8
Type IV Funnel Traps	12	4	48

A total of 73 fauna species were recorded on the subject site. A list of these species is shown in Appendix 2. These species comprised: 2 frogs, 7 reptiles, 45 birds, 14 bats, 1 arboreal mammal and 4 terrestrial mammals. Of these, 6 are listed as significant (Vulnerable) under the TSC Act (Table 9).

Table 9 Threatened fauna species recorded on the subject site.

Scientific Name	Common Name	Method	Habitat	Site	Legal Status
Ninox strenua	Powerful Owl	Call Playback	Open forest	Western site	V
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat	Anabat	Open forest	Western site	V
Mormopterus norfolkensis	East Coast Freetail Bat	Anabat	Open forest	Western & Eastern Site	V
Miniopterus australis	Little Bent-wing Bat	Anabat	Open forest	Eastern Site	V
Miniopterus schreibersii	Large Bent-wing Bat	Anabat	Open forest	Western & Eastern Site	V
Scoteanax rueppellii	Greater Broad-nosed Bat	Anabat	Open forest	Western & Eastern Site	V

5. THREATENED SPECIES, COMMUNITIES AND THREATENING PROCESSES ASSESSMENT OF IMPACT

An impact assessment is conducted according to the Draft Guidelines for Threatened Species Assessment (DECC & DPI 2005). A review of the threatened species profiles shows that there were threatened species that could be found on the subject site under different conditions to those prevailing at the time of this investigation or could be found in similar habitat in the immediate region. An impact assessment was applied to these species, threatened flora and fauna species and any endangered ecological communities that were recorded during the field surveys.

5.1. ENDANGERED ECOLOGICAL COMMUNITY ASSESSMENT OF IMPACT

<u>**Lower Hunter Spotted Gum – Ironbark Forest**</u>

1. **How is the proposal likely to affect the lifecycle of a threatened species and/or population?**

Not applicable.

2. **How is the proposal likely to affect the habitat of a threatened species, population or ecological community?**

The proposed mining will result in the loss of about 0.8 ha of this community. However there is about 145 ha of this community in the immediate vicinity of the proposed disturbance area and the loss of 0.8 ha would not have a significant impact on the remaining community.

3. **Does the proposal affect any threatened species or populations that are at the limit of its known distribution?**

Not applicable.

4. **How is the proposal likely to affect current disturbance regimes?**

Very little change to current disturbance regimes as the habitat is on the edge of a cleared mining area.

5. **How is the proposal likely to affect critical habitat?**

No critical habitat was present.

6. **How is the proposal likely to affect habitat connectivity?**

The areas to be cleared are at the edge of larger areas of remnant forest and their clearing will not break any habitat connectivity.

5.2. FLORA ASSESSMENT OF IMPACT

No threatened flora species were recorded during a comprehensive search of each of the proposed disturbance areas.

5.3. FAUNA ASSESSMENT OF IMPACT

Threatened fauna that were present or considered as possibly occurring in the type of habitat represented both on and in the locality of the subject site are discussed below. The potential impact of the proposal is considered in the context of there being 1.3 ha of vegetation clearing required in the eastern vegetation block and 0.4 ha in the western vegetation block.

Neophema pulchella **- Turquoise Parrot**

1. How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The habitat at the forest/cleared interface is marginal for these birds with little grassland foraging available and none of these birds were recorded during the investigation. The small amount of clearing required would not have any impact on the life cycle of these birds were they present at the subject site.

2. How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal would not affect the potential habitat for this bird.

3. Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Turquoise Parrot is not at the known limit of its distribution at this location.

4. How is the proposal likely to affect current disturbance regimes?

There would be very little change to current disturbance regimes as the habitat is on the edge of a cleared mining area.

5. How is the proposal likely to affect habitat connectivity?

The proposal would not fragment habitat. The vegetation to be cleared in the eastern block is already surrounded by cleared land and the clearing in the western block would be a small portion taken out from the cleared edge. In both cases there are over 2000ha of relatively unbroken vegetation behind the proposed cleared area.

6. How is the proposal likely to affect critical habitat?

No critical habitat for this species occurs at this location.

Callocephalon fimbriatum **– Gang-gang Cockatoo**

1. How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The small amount of clearing required would have no impact on the life-cycle of the Gang-gang Cockatoo.

2. **How is the proposal likely to affect the habitat of a threatened species, population or ecological community?**

The proposal would not affect the potential habitat for this bird.

3. **Does the proposal affect any threatened species or populations that are at the limit of its known distribution?**

The Gang-gang Cockatoo is not at the known limit of its distribution at this location.

4. **How is the proposal likely to affect current disturbance regimes?**

Very little change to current disturbance regimes as the habitat is on the edge of a cleared mining area.

5. **How is the proposal likely to affect habitat connectivity?**

The proposal would not fragment habitat. The vegetation to be cleared in the eastern block is already surrounded by cleared land and the clearing in the western block would be a small portion taken out from the cleared edge. In both cases there are over 2000ha of relatively unbroken vegetation behind the proposed cleared area.

6. **How is the proposal likely to affect critical habitat?**

No critical habitat for this species occurs at this location.

Ninox strenua – Powerful Owl

1. **How is the proposal likely to affect the lifecycle of a threatened species and/or population?**

The Powerful Owl home range is around 1000 ha. The small amount of vegetation that is proposed to be cleared does not contain essential habitat features for this bird i.e. there were no trees with suitable breeding hollows and no vegetation suitable for daytime roosting.

2. **How is the proposal likely to affect the habitat of a threatened species, population or ecological community?**

The proposal would not affect the potential habitat for this bird.

3. **Does the proposal affect any threatened species or populations that are at the limit of its known distribution?**

The Powerful Owl is not at the known limit of its distribution at this location.

4. **How is the proposal likely to affect current disturbance regimes?**

Very little change to current disturbance regimes as the habitat is on the edge of a cleared mining area.

5. **How is the proposal likely to affect habitat connectivity?**

The proposal would not fragment habitat. The vegetation to be cleared in the eastern block is already surrounded by cleared land and the clearing in the western block would be a small portion taken out from the cleared edge. In both cases there are over 2000ha of relatively unbroken vegetation behind the proposed cleared area.

6. **How is the proposal likely to affect critical habitat?**

No critical habitat for this species occurs at this location.

Petaurus norfolcensis **– Squirrel Glider**

1. **How is the proposal likely to affect the lifecycle of a threatened species and/or population?**

No Squirrel Gliders were recorded during the field work although they are known to be in the area having been recorded elsewhere on Bloomfield as well as on Donaldson to the east. The proposed clearing would not place any local population of Squirrel Gliders under threat.

2. **How is the proposal likely to affect the habitat of a threatened species, population or ecological community?**

The proposal would not affect the potential habitat for this glider.

3. **Does the proposal affect any threatened species or populations that are at the limit of its known distribution?**

The Squirrel Glider is not at the known limit of its distribution at this location.

4. **How is the proposal likely to affect current disturbance regimes?**

Very little change to current disturbance regimes as the habitat is on the edge of a cleared mining area.

5. **How is the proposal likely to affect habitat connectivity?**

The proposal would not fragment habitat. The vegetation to be cleared in the eastern block is already surrounded by cleared land and the clearing in the western block would be a small portion taken out from the cleared edge. In both cases there are over 2000ha of relatively unbroken vegetation behind the proposed cleared area.

6. **How is the proposal likely to affect critical habitat?**

No critical habitat for this species occurs at this location.

Pteropus poliocephalus **– Grey-headed Flying Fox**

1. **How is the proposal likely to affect the lifecycle of a threatened species and/or population?**

There were no breeding colonies of this flying fox present and the small amount of vegetation proposed to be cleared would not impact on the available foraging resources of the species.

2. **How is the proposal likely to affect the habitat of a threatened species, population or ecological community?**

The proposal would not affect the potential habitat for this flying fox.

3. **Does the proposal affect any threatened species or populations that are at the limit of its known distribution?**

The Grey-headed Flying Fox is not at the known limit of its distribution at this location.

4. **How is the proposal likely to affect current disturbance regimes?**

Very little change to current disturbance regimes as the habitat is on the edge of a cleared mining area.

5. **How is the proposal likely to affect habitat connectivity?**

The proposal would not fragment habitat. The vegetation to be cleared in the eastern block is already surrounded by cleared land and the clearing in the western block would be a small portion taken out from the cleared edge. In both cases there are over 2000ha of relatively unbroken vegetation behind the proposed cleared area.

6. **How is the proposal likely to affect critical habitat?**

No critical habitat for this species occurs at this location.

Phascolarctos cinereus **– Koala**

1. **How is the proposal likely to affect the lifecycle of a threatened species and/or population?**

The vegetation to be cleared does not contain potential Koala habitat and the clearing would not impact on the life-cycle of Koala if they were present.

2. **How is the proposal likely to affect the habitat of a threatened species, population or ecological community?**

The small amount of proposed clearing would not involve suitable Koala habitat.

3. **Does the proposal affect any threatened species or populations that are at the limit of its known distribution?**

The Koala is not at the known limit of its distribution at this location.

4. **How is the proposal likely to affect current disturbance regimes?**

Very little change to current disturbance regimes as the habitat is on the edge of a cleared mining area.

5. **How is the proposal likely to affect habitat connectivity?**

The proposal would not fragment habitat. The vegetation to be cleared in the eastern block is already surrounded by cleared land and the clearing in the western block would be a small portion taken out from the cleared edge. In both cases there are over 2000ha of relatively unbroken vegetation behind the proposed cleared area.

6. **How is the proposal likely to affect critical habitat?**

No critical habitat for this species occurs at this location.

Cave Roosting *Microchiropteran* Bats

- ***Miniopterus australis*** **- Little Bent-wing Bat**
- ***Miniopterus schreibersii oceanensis*** **- Eastern Bent-wing Bat**

1. **How is the proposal likely to affect the lifecycle of a threatened species and/or population?**

The proposed action would remove foraging habitat from the home ranges of both species and potential current and future roosting habitat for *M. australis*. However, the area of clearing involved in the proposed development would not likely impact on the life cycle of the species in such a way that either species would be at risk of localised extinction.

2. **How is the proposal likely to affect the habitat of a threatened species, population or ecological community?**

The proposal would not affect the potential habitat for these bats.

3. **Does the proposal affect any threatened species or populations that are at the limit of its known distribution?**

Neither species of bat are at the known limit of their distributions at this location.

4. **How is the proposal likely to affect current disturbance regimes?**

Very little change to current disturbance regimes as the habitat is on the edge of a cleared mining area.

5. How is the proposal likely to affect habitat connectivity?

The proposal would not fragment habitat. The vegetation to be cleared in the eastern block is already surrounded by cleared land and the clearing in the western block would be a small portion taken out from the cleared edge. In both cases there are over 2000ha of relatively unbroken vegetation behind the proposed cleared area.

6. How is the proposal likely to affect critical habitat?

No critical habitat for this species occurs at this location.

Tree Roosting *Microchiropteran* Bats

- ***Mormopterus norfolkensis*** **– Eastern Little Mastiff Bat**
- ***Saccolaimus flaviventris*** **– Yellow-bellied Sheathtail Bat**
- ***Scoteanax rueppellii*** **– Greater Broad-nosed Bat**

1. How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The small area of clearing involved in the proposed development would not impact on the life cycle of these species.

2. How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal would not affect the potential habitat for these bats.

3. Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

None of the species of bat are at the known limit of their distributions at this location.

4. How is the proposal likely to affect current disturbance regimes?

Very little change to current disturbance regimes as the habitat is on the edge of a cleared mining area.

5. How is the proposal likely to affect habitat connectivity?

The proposal would not fragment habitat. The vegetation to be cleared in the eastern block is already surrounded by cleared land and the clearing in the western block would be a small portion taken out from the cleared edge. In both cases there are over 2000ha of relatively unbroken vegetation behind the proposed cleared area.

6. How is the proposal likely to affect critical habitat?

No critical habitat for this species occurs at this location.

5.4. COMMONWEALTH EPBC ACT ASSESSMENT

Matters of national significance protected under the EPBC Act 1999 are as follows:

- World Heritage properties
- National heritage places
- Wetlands of international importance (Ramsar wetlands)
- Threatened species and ecological communities
- Migratory species
- Commonwealth marine areas
- Nuclear actions (including uranium mining)

None of these matters would be involved in the proposed pit expansion operation. In particular there were: no wetlands; no migratory species; and, none of the listed threatened species or ecological communities were present.

6. MITIGATION

Because by its nature opencut mining results in the total destruction of any surface vegetation, mitigation measures should be directed towards preventing any impacts in the surrounding habitat as well as providing compensation for lost habitat. Under the expansion proposal the amount of vegetation loss would be small: approximately 1.3 ha in the eastern block and 0.4 ha in the western block. The following measures should be implemented:

1. Provide **effective** erosion and sediment control measures in order to protect all flow-off areas. 'Effective' means that the measures should be sufficient to withstand extreme storm events and that the measures are regularly inspected and their function maintained. These measures would particularly apply to the western portion; the disturbance/forest edge of the eastern portion is below its surroundings.

2. Prepare and implement a pre-clearance protocol directed towards protecting any hollow-using fauna prior to and during clearing.

3. Provide commensurate support of a relevant, DECC approved, research program, in response to the loss of any Lower Hunter Spotted Gum Ironbark Forest Endangered Ecological Community in the Project area.

7. CONCLUSION

One EEC and 6 threatened (TSC Act) fauna species were recorded in the vegetated disturbance areas. No species listed as threatened in the Commonwealth EPBC Act were found. An assessment of the impact of the loss of habitat on the EEC and the threatened species concludes that there would be no impact that would place any local populations at risk of extinction.

Mitigation measures of erosion and sediment control measures, pre-clearance protocols for protecting hollow dwelling fauna and a compensation strategy for any EEC loss are recommended.

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Appendix 1 Flora

Flora species recorded in each vegetation community

Eastern MU17

Common Name	Scientific Name	Family Name
Pastel Flower	*Pseuderanthemum variabile*	**Acanthaceae**
Mulga Fern	*Cheilanthes sieberi*	**Adiantaceae**
	Tricoryne elatior	**Anthericaceae**
	Chrysocephalum semipapposum	**Asteraceae**
	Lagenifera stipitata	**Asteraceae**
	Ozothamnus diosmifolius	**Asteraceae**
Fuzzweed	*Vittadinia cuneata*	**Asteraceae**
Wonga Vine	*Pandorea pandorana subsp. pandorana*	**Bignoniaceae**
Forest Oak	*Allocasuarina torulosa*	**Casuarinaceae**
	Lepidosperma laterale	**Cyperaceae**
	Ptilothrix deusta	**Cyperaceae**
	Hibbertia empetrifolia subsp. empetrifolia	**Dilleniaceae**
	Leucopogon juniperinus	**Epacridaceae**
Coffee Bush	*Breynia oblongifolia*	**Euphorbiaceae**
	Phyllanthus hirtellus	**Euphorbiaceae**
	Daviesia squarrosa	**Fabaceae (Faboideae)**
Gorse Bitter Pea	*Daviesia ulicifolia*	**Fabaceae (Faboideae)**
	Dillwynia retorta	**Fabaceae (Faboideae)**
	Glycine clandestina	**Fabaceae (Faboideae)**
	Glycine microphylla	**Fabaceae (Faboideae)**
False Sarsaparilla	*Hardenbergia violacea*	**Fabaceae (Faboideae)**
	Acacia elongata	**Fabaceae (Mimosoideae)**
	Acacia falcata	**Fabaceae (Mimosoideae)**
	Acacia parvipinnula	**Fabaceae (Mimosoideae)**
	Goodenia rotundifolia	**Goodeniaceae**
	Gonocarpus teucrioides	**Haloragaceae**
Whiteroot	*Pratia purpurascens*	**Lobeliaceae**
	Lomandra filiformis subsp. coriacea	**Lomandraceae**
Spotted Gum	*Corymbia maculata*	**Myrtaceae**
Red Ironbark	*Eucalyptus fibrosa*	**Myrtaceae**
White Mahogany	*Eucalyptus umbra*	**Myrtaceae**
	Dianella longifolia var. longifolia	**Phormiaceae**
	Dianella tasmanica	**Phormiaceae**
Apple Dumplings	*Billardiera scandens var. scandens*	**Pittosporaceae**
	Bursaria spinosa var. spinosa	**Pittosporaceae**
	Anisopogon avenaceus	**Poaceae**
Threeawn Speargrass	*Aristida vagans*	**Poaceae**
	Aristida warburgii	**Poaceae**
Wallaby Grass	*Austrodanthonia fulva*	**Poaceae**
	Dichelachne sieberiana	**Poaceae**
	Digitaria ramularis	**Poaceae**
Hedgehog Grass	*Echinopogon ovatus*	**Poaceae**
Wiry Panic	*Entolasia stricta*	**Poaceae**
	Eragrostis brownii	**Poaceae**

	Microlaena stipoides var. stipoides	**Poaceae**
	Panicum simile	**Poaceae**
	Paspalidium distans	**Poaceae**
Kangaroo Grass	*Themeda australis*	**Poaceae**
Narrow-leaved Geebung	*Persoonia linearis*	**Proteaceae**
	Boronia polygalifolia	**Rutaceae**
	Dodonaea triquetra	**Sapindaceae**
	Hybanthus stellarioides	**Violaceae**
Grass Tree	*Xanthorrhoea latifolia subsp. latifolia*	**Xanthorrhoeaceae**
	Macrozamia reducta	**Zamiaceae**

Eastern MU30

Common Name	**Scientific Name**	**Family Name**
Pastel Flower	*Pseuderanthemum variabile*	**Acanthaceae**
Maiden Hair Fern	*Adiantum aethiopicum*	**Adiantaceae**
Mulga Fern	*Cheilanthes sieberi*	**Adiantaceae**
	Tricoryne elatior	**Anthericaceae**
	Astrotricha obovata	**Araliaceae**
Elderberry Ash	*Polyscias sambucifolia*	**Araliaceae**
Wonga Vine	*Pandorea pandorana subsp. pandorana*	**Bignoniaceae**
Forest Oak	*Allocasuarina torulosa*	**Casuarinaceae**
Orange Bark	*Maytenus silvestris*	**Celastraceae**
	Ceratopetalum gummiferum	**Cunoniaceae**
Swordgrass	*Gahnia clarkei*	**Cyperaceae**
	Lepidosperma concavum	**Cyperaceae**
	Lepidosperma laterale	**Cyperaceae**
	Hypolepis muelleri	**Dennstaedtiaceae**
Bracken Fern	*Pteridium esculentum*	**Dennstaedtiaceae**
	Hibbertia empetrifolia subsp. empetrifolia	**Dilleniaceae**
Cheese Tree	*Glochidion ferdinandi*	**Euphorbiaceae**
	Phyllanthus hirtellus	**Euphorbiaceae**
Gorse Bitter Pea	*Daviesia ulicifolia*	**Fabaceae (Faboideae)**
	Dillwynia retorta	**Fabaceae (Faboideae)**
	Glycine clandestina	**Fabaceae (Faboideae)**
	Gompholobium latifolium	**Fabaceae (Faboideae)**
	Hovea linearis	**Fabaceae (Faboideae)**
	Pultenaea villosa	**Fabaceae (Faboideae)**
	Acacia elongata	**Fabaceae (Mimosoideae)**
	Acacia linifolia	**Fabaceae (Mimosoideae)**
	Gonocarpus teucrioides	**Haloragaceae**
Lacy Wedge Fern	*Lindsaea microphylla*	**Lindsaeaceae**
Whiteroot	*Pratia purpurascens*	**Lobeliaceae**
Whiteroot	*Pratia purpurascens*	**Lobeliaceae**
	Lomandra filiformis subsp. coriacea	**Lomandraceae**
	Lomandra multiflora subsp. multiflora	**Lomandraceae**
Fishbone	*Lomandra obliqua*	**Lomandraceae**
Muttonwood	*Rapanea variabilis*	**Myrsinaceae**
Smooth-barked Apple	*Angophora costata*	**Myrtaceae**
Red Bloodwood	*Corymbia gummifera*	**Myrtaceae**

Spotted Gum	*Corymbia maculata*	**Myrtaceae**
Red Ironbark	*Eucalyptus fibrosa*	**Myrtaceae**
	Eucalyptus globoidea	**Myrtaceae**
	Eucalyptus punctata	**Myrtaceae**
	Eucalyptus siderophloia	**Myrtaceae**
White Mahogany	*Eucalyptus umbra*	**Myrtaceae**
	Leptospermum polygalifolium subsp. polygalifolium	**Myrtaceae**
	Leptospermum trinervium	**Myrtaceae**
Native Olive	*Notelaea longifolia*	**Oleaceae**
	Dianella caerulea var. caerulea	**Phormiaceae**
	Dianella longifolia var. longifolia	**Phormiaceae**
	Dianella tasmanica	**Phormiaceae**
Apple Dumplings	*Billardiera scandens var. scandens*	**Pittosporaceae**
Hairy Pittosporum	*Pittosporum revolutum*	**Pittosporaceae**
	Anisopogon avenaceus	**Poaceae**
Threeawn Speargrass	*Aristida vagans*	**Poaceae**
Wallaby Grass	*Austrodanthonia fulva*	**Poaceae**
	Cymbopogon refractus	**Poaceae**
Hedgehog Grass	*Echinopogon caespitosus var. caespitosus*	**Poaceae**
Wiry Panic	*Entolasia stricta*	**Poaceae**
Bladey Grass	*Imperata cylindrica var. major*	**Poaceae**
	Joycea pallida	**Poaceae**
	Microlaena stipoides var. stipoides	**Poaceae**
Kangaroo Grass	*Themeda australis*	**Poaceae**
	Banksia spinulosa var. collina	**Proteaceae**
	Lomatia silaifolia	**Proteaceae**
Narrow-leaved Geebung	*Persoonia linearis*	**Proteaceae**
Woody Pear	*Xylomelum pyriforme*	**Proteaceae**
	Ripogonum album	**Ripogonaceae**
	Pomax umbellata	**Rubiaceae**
	Pimelea linifolia subsp. linifolia	**Thymelaeaceae**
	Macrozamia reducta	**Zamiaceae**

Western MU17

Common Name	**Scientific Name**	**Family Name**
Blue Trumpet	*Brunoniella australis*	**Acanthaceae**
Pastel Flower	*Pseuderanthemum variabile*	**Acanthaceae**
Mulga Fern	*Cheilanthes sieberi subsp. sieberi*	**Adiantaceae**
	Alternanthera denticulata	**Ameranthaceae**
Pale Grass-lily	*Caesia parviflora var. parviflora*	**Anthericaceae**
Elderberry Ash	*Polyscias sambucifolia*	**Araliaceae**
	Chrysocephalum semipapposum	**Asteraceae**
	Tricoryne simplex	**Athericaceae**
Wonga Vine	*Pandorea pandorana subsp. pandorana*	**Bignoniaceae**
Forest Oak	*Allocasuarina torulosa*	**Casuarinaceae**
Orange Bark	*Maytenus silvestris*	**Celastraceae**
	Lepidosperma laterale	**Cyperaceae**
	Hibbertia empetrifolia subsp. empetrifolia	**Dilleniaceae**
	Hibbertia obtusifolia	**Dilleniaceae**
	Leucopogon juniperinus	**Epacridaceae**
	Acrotriche divaricata	**Ericaceae**
Coffee Bush	*Breynia oblongifolia*	**Euphorbiaceae**
	Phyllanthus hirtellus	**Euphorbiaceae**
Gorse Bitter Pea	*Daviesia ulicifolia*	**Fabaceae (Faboideae)**
	Desmodium rhytidophyllum	**Fabaceae (Faboideae)**
	Dillwynia sieberi	**Fabaceae (Faboideae)**
	Glycine microphylla	**Fabaceae (Faboideae)**
Prickly Shaggy Pea	*Podolobium ilicifolium*	**Fabaceae (Faboideae)**
	Pultenaea retusa	**Fabaceae (Faboideae)**
	Pultenaea spinosa	**Fabaceae (Faboideae)**
	Acacia elongata	**Fabaceae (Mimosoideae)**
	Acacia falcata	**Fabaceae (Mimosoideae)**
	Acacia parvipinnula	**Fabaceae (Mimosoideae)**
	Goodenia rotundifolia	**Goodeniaceae**
Whiteroot	*Pratia purpurascens*	**Lobeliaceae**
	Lomandra filiformis subsp. coriacea	**Lomandraceae**
	Lomandra multiflora subsp. multiflora	**Lomandraceae**
Scrambling Lily	*Geitonoplesium cymosum*	**Luzuriagaceae**
Muttonwood	*Rapanea variabilis*	**Myrsinaceae**
Smooth-barked Apple	*Angophora costata*	**Myrtaceae**
Red Bloodwood	*Corymbia gummifera*	**Myrtaceae**
Spotted Gum	*Corymbia maculata*	**Myrtaceae**
Red Ironbark	*Eucalyptus fibrosa*	**Myrtaceae**
	Eucalyptus punctata	**Myrtaceae**
White Mahogany	*Eucalyptus umbra*	**Myrtaceae**
A Paperbark	*Melaleuca nodosa*	**Myrtaceae**
	Notelaea venosa	**Oleaceae**
	Dianella caerulea var. caerulea	**Phormiaceae**
Hairy Pittosporum	*Pittosporum revolutum*	**Pittosporaceae**
Threeawn Speargrass	*Aristida vagans*	**Poaceae**
Wallaby Grass	*Austrodanthonia fulva*	**Poaceae**
	Cymbopogon refractus	**Poaceae**

	Dichelachne sieberiana	**Poaceae**
Hedgehog Grass	*Echinopogon ovatus*	**Poaceae**
Wiry Panic	*Entolasia stricta*	**Poaceae**
	Joycea pallida	**Poaceae**
	Panicum simile	**Poaceae**
	Paspalidium distans	**Poaceae**
Kangaroo Grass	*Themeda australis*	**Poaceae**
Narrow-leaved Geebung	*Persoonia linearis*	**Proteaceae**
	Galium gaudichaudii	**Rubiaceae**
	Pomax umbellata	**Rubiaceae**
	Macrozamia reducta	**Zamiaceae**

Western MU15

Common Name	**Scientific Name**	**Family Name**
Blue Trumpet	*Brunoniella australis*	**Acanthaceae**
Pastel Flower	*Pseuderanthemum variabile*	**Acanthaceae**
Maiden Hair Fern	*Adiantum aethiopicum*	**Adiantaceae**
Mulga Fern	*Cheilanthes sieberi*	**Adiantaceae**
Pale Grass-lily	*Caesia parviflora var. parviflora*	**Anthericaceae**
	Tricoryne elatior	**Anthericaceae**
	Hydrocotyle peduncularis	**Apiaceae**
Elderberry Ash	*Polyscias sambucifolia*	**Araliaceae**
	Lagenifera stipitata	**Asteraceae**
Fuzzweed	*Vittadinia cuneata*	**Asteraceae**
Wonga Vine	*Pandorea pandorana subsp. pandorana*	**Bignoniaceae**
	Wahlenbergia communis	**Campanulaceae**
Forest Oak	*Allocasuarina torulosa*	**Casuarinaceae**
Orange Bark	*Maytenus silvestris*	**Celastraceae**
	Polymeria calycina	**Convolvulaceae**
	Lepidosperma concavum	**Cyperaceae**
	Hibbertia empetrifolia subsp. empetrifolia	**Dilleniaceae**
	Hibbertia obtusifolia	**Dilleniaceae**
Twining Guinea Flower	*Hibbertia scandens*	**Dilleniaceae**
	Leucopogon juniperinus	**Epacridaceae**
Coffee Bush	*Breynia oblongifolia*	**Euphorbiaceae**
	Poranthera microphylla	**Euphorbiaceae**
Gorse Bitter Pea	*Daviesia ulicifolia*	**Fabaceae (Faboideae)**
	Desmodium rhytidophyllum	**Fabaceae (Faboideae)**
	Glycine clandestina	**Fabaceae (Faboideae)**
	Glycine microphylla	**Fabaceae (Faboideae)**
False Sarsaparilla	*Hardenbergia violacea*	**Fabaceae (Faboideae)**
	Gonocarpus teucrioides	**Haloragaceae**
Whiteroot	*Pratia purpurascens*	**Lobeliaceae**
Wombat Berry	*Eustrephus latifolius*	**Luzuriagaceae**
Scrambling Lily	*Geitonoplesium cymosum*	**Luzuriagaceae**
Red Bloodwood	*Corymbia gummifera*	**Myrtaceae**
Spotted Gum	*Corymbia maculata*	**Myrtaceae**
	Eucalyptus globoidea	**Myrtaceae**

	Eucalyptus punctata	**Myrtaceae**
	Eucalyptus siderophloia	**Myrtaceae**
White Mahogany	*Eucalyptus umbra*	**Myrtaceae**
	Melaleuca styphelioides	**Myrtaceae**
Turpentine	*Syncarpia glomulifera subsp. glomulifera*	**Myrtaceae**
Native Olive	*Notelaea longifolia*	**Oleaceae**
	Notelaea venosa	**Oleaceae**
	Oxalis exilis	**Oxalidaceae**
	Dianella caerulea var. caerulea	**Phormiaceae**
	Dianella tasmanica	**Phormiaceae**
Apple Dumplings	*Billardiera scandens var. scandens*	**Pittosporaceae**
	Bursaria spinosa var. spinosa	**Pittosporaceae**
Trailing Speedwell	*Veronica plebeia*	**Plantagenaceae**
Threeawn Speargrass	*Aristida vagans*	**Poaceae**
Wallaby Grass	*Austrodanthonia fulva*	**Poaceae**
	Cymbopogon refractus	**Poaceae**
	Digitaria ramularis	**Poaceae**
Hedgehog Grass	*Echinopogon caespitosus var. caespitosus*	**Poaceae**
Hedgehog Grass	*Echinopogon ovatus*	**Poaceae**
Wiry Panic	*Entolasia stricta*	**Poaceae**
	Eragrostis brownii	**Poaceae**
Bladey Grass	*Imperata cylindrica var. major*	**Poaceae**
	Microlaena stipoides var. stipoides	**Poaceae**
	Panicum simile	**Poaceae**
Kangaroo Grass	*Themeda australis*	**Poaceae**
Narrow-leaved Geebung	*Persoonia linearis*	**Proteaceae**
Woody Pear	*Xylomelum pyriforme*	**Proteaceae**
Headache Vine	*Clematis glycinoides*	**Ranunculaceae**
	Pomax umbellata	**Rubiaceae**
	Boronia polygalifolia	**Rutaceae**
	Dodonaea triquetra	**Sapindaceae**
	Solanum prinophyllum	**Solanaceae**
	Stackhousia viminea	**Stackhousiaceae**
	Hybanthus stellaroides	**Violaceae**
	Macrozamia flexuosa	**Zamiaceae**

Floristic plot data

Plot 1

Common Name	Scientific Name	Family Name	CA
Blue Trumpet	*Brunoniella australis*	**Acanthaceae**	2
Pastel Flower	*Pseuderanthemum variabile*	**Acanthaceae**	2
Maiden Hair Fern	*Adiantum aethiopicum*	**Adiantaceae**	2
Mulga Fern	*Cheilanthes sieberi subsp. sieberi*	**Adiantaceae**	2
Pale Grass-lily	*Caesia parviflora var. parviflora*	**Anthericaceae**	1
	Tricoryne elatior	**Anthericaceae**	1
	Hydrocotyle peduncularis	**Apiaceae**	3
Elderberry Ash	*Polyscias sambucifolia*	**Araliaceae**	2
	Lagenifera stipitata	**Asteraceae**	2
Fuzzweed	*Vittadinia cuneata*	**Asteraceae**	2
Wonga Vine	*Pandorea pandorana subsp. pandorana*	**Bignoniaceae**	1
Forest Oak	*Allocasuarina torulosa*	**Casuarinaceae**	2
Orange Bark	*Maytenus silvestris*	**Celastraceae**	1
	Polymeria calycina	**Convolvulaceae**	2
	Lepidosperma concavum	**Cyperaceae**	2
	Lepidosperma laterale	**Cyperaceae**	1
	Hibbertia empetrifolia subsp. empetrifolia	**Dilleniaceae**	1
	Hibbertia obtusifolia	**Dilleniaceae**	1
	Leucopogon juniperinus	**Epacridaceae**	1
Coffee Bush	*Breynia oblongifolia*	**Euphorbiaceae**	3
	Glycine clandestina	**Fabaceae (Faboideae)**	2
	Glycine microphylla	**Fabaceae (Faboideae)**	2
False Sarsaparilla	*Hardenbergia violacea*	**Fabaceae (Faboideae)**	2
Whiteroot	*Pratia purpurascens*	**Lobeliaceae**	2
Wombat Berry	*Eustrephus latifolius*	**Luzuriagaceae**	2
Red Bloodwood	*Corymbia gummifera*	**Myrtaceae**	2
Spotted Gum	*Corymbia maculata*	**Myrtaceae**	2
	Eucalyptus globoidea	**Myrtaceae**	1
	Eucalyptus siderophloia	**Myrtaceae**	2
White Mahogany	*Eucalyptus umbra*	**Myrtaceae**	4
Turpentine	*Syncarpia glomulifera subsp. glomulifera*	**Myrtaceae**	2
Native Olive	*Notelaea longifolia*	**Oleaceae**	2
	Oxalis exilis	**Oxalidaceae**	1
	Dianella caerulea var. caerulea	**Phormiaceae**	1
	Dianella tasmanica	**Phormiaceae**	2
	Bursaria spinosa subsp. spinosa	**Pittosporaceae**	3
Threeawn Speargrass	*Aristida vagans*	**Poaceae**	3
	Cymbopogon refractus	**Poaceae**	2
Hedgehog Grass	*Echinopogon caespitosus var. caespitosus*	**Poaceae**	2
Hedgehog Grass	*Echinopogon ovatus*	**Poaceae**	2
Wiry Panic	*Entolasia stricta*	**Poaceae**	2
Bladey Grass	*Imperata cylindrica var. major*	**Poaceae**	2
	Microlaena stipoides var. stipoides	**Poaceae**	2
	Panicum simile	**Poaceae**	2
Kangaroo Grass	*Themeda australis*	**Poaceae**	5

Narrow-leaved Geebung	*Persoonia linearis*	**Proteaceae**	2
Headache Vine	*Clematis glycinoides var. glycinoides*	**Ranunculaceae**	2
	Hybanthus stellaroides	**Violaceae**	1

Plot 2

Common Name	**Scientific Name**	**Family Name**	**CA**
Blue Trumpet	*Brunoniella australis*	**Acanthaceae**	1
Pastel Flower	*Pseuderanthemum variabile*	**Acanthaceae**	1
Mulga Fern	*Cheilanthes sieberi subsp. sieberi*	**Adiantaceae**	2
	Alternanthera denticulata	**Ameranthaceae**	1
Pale Grass-lily	*Caesia parviflora var. parviflora*	**Anthericaceae**	1
Wonga Vine	*Pandorea pandorana subsp. pandorana*	**Bignoniaceae**	2
Orange Bark	*Maytenus silvestris*	**Celastraceae**	1
	Lepidosperma laterale	**Cyperaceae**	2
	Leucopogon juniperinus	**Epacridaceae**	1
Coffee Bush	*Breynia oblongifolia*	**Euphorbiaceae**	1
	Phyllanthus hirtellus	**Euphorbiaceae**	1
Gorse Bitter Pea	*Daviesia ulicifolia*	**Fabaceae (Faboideae)**	2
	Desmodium rhytidophyllum	**Fabaceae (Faboideae)**	2
	Glycine microphylla	**Fabaceae (Faboideae)**	2
	Pultenaea retusa	**Fabaceae (Faboideae)**	1
	Acacia elongata	**Fabaceae (Mimosoideae)**	1
	Acacia falcata	**Fabaceae (Mimosoideae)**	1
	Acacia parvipinnula	**Fabaceae (Mimosoideae)**	1
	Goodenia rotundifolia	**Goodeniaceae**	1
Whiteroot	*Pratia purpurascens*	**Lobeliaceae**	2
	Lomandra filiformis subsp. coriacea	**Lomandraceae**	3
	Lomandra multiflora subsp. multiflora	**Lomandraceae**	2
Scrambling Lily	*Geitonoplesium cymosum*	**Luzuriagaceae**	2
Red Bloodwood	*Corymbia gummifera*	**Myrtaceae**	1
Spotted Gum	*Corymbia maculata*	**Myrtaceae**	3
Red Ironbark	*Eucalyptus fibrosa*	**Myrtaceae**	3
White Mahogany	*Eucalyptus umbra*	**Myrtaceae**	4
	Notelaea venosa	**Oleaceae**	1
Apple Dumplings	*Billardiera scandens*	**Pittosporaceae**	2
	Bursaria spinosa subsp. spinosa	**Pittosporaceae**	2
Threeawn Speargrass	*Aristida vagans*	**Poaceae**	2
Wallaby Grass	*Austrodanthonia fulva*	**Poaceae**	2
	Cymbopogon refractus	**Poaceae**	1
	Dichelachne sieberiana	**Poaceae**	1
Hedgehog Grass	*Echinopogon ovatus*	**Poaceae**	2
Wiry Panic	*Entolasia stricta*	**Poaceae**	2
	Joycea pallida	**Poaceae**	2
	Panicum simile	**Poaceae**	1
	Paspalidium distans	**Poaceae**	1
Kangaroo Grass	*Themeda australis*	**Poaceae**	5
Narrow-leaved	*Persoonia linearis*	**Proteaceae**	2

Geebung			
	Pomax umbellata	**Rubiaceae**	1
	Boronia polygalifolia	**Rutaceae**	1
	Macrozamia reducta	**Zamiaceae**	1

Plot 3

Common Name	**Scientific Name**	**Family Name**	**CA**
Pastel Flower	*Pseuderanthemum variabile*	**Acanthaceae**	1
Mulga Fern	*Cheilanthes sieberi subsp. sieberi*	**Adiantaceae**	2
	Tricoryne elatior	**Anthericaceae**	2
	Astrotricha obovata	**Araliaceae**	1
Wonga Vine	*Pandorea pandorana subsp. pandorana*	**Bignoniaceae**	2
Forest Oak	*Allocasuarina torulosa*	**Casuarinaceae**	3
Orange Bark	*Maytenus silvestris*	**Celastraceae**	2
	Lepidosperma concavum	**Cyperaceae**	2
	Lepidosperma laterale	**Cyperaceae**	2
	Hibbertia empetrifolia subsp. empetrifolia	**Dilleniaceae**	1
	Phyllanthus hirtellus	**Euphorbiaceae**	1
Gorse Bitter Pea	*Daviesia ulicifolia*	**Fabaceae (Faboideae)**	3
	Dillwynia retorta	**Fabaceae (Faboideae)**	2
	Glycine clandestina	**Fabaceae (Faboideae)**	1
Whiteroot	*Pratia purpurascens*	**Lobeliaceae**	2
	Lomandra filiformis subsp. coriacea	**Lomandraceae**	2
Smooth-barked Apple	*Angophora costata*	**Myrtaceae**	3
Spotted Gum	*Corymbia maculata*	**Myrtaceae**	2
Red Ironbark	*Eucalyptus fibrosa*	**Myrtaceae**	2
	Eucalyptus punctata	**Myrtaceae**	2
White Mahogany	*Eucalyptus umbra*	**Myrtaceae**	4
	Leptospermum trinervium	**Myrtaceae**	2
	Dianella caerulea var. caerulea	**Phormiaceae**	2
Apple Dumplings	*Billardiera scandens*	**Pittosporaceae**	3
	Anisopogon avenaceus	**Poaceae**	1
Threeawn Speargrass	*Aristida vagans*	**Poaceae**	2
Wiry Panic	*Entolasia stricta*	**Poaceae**	2
Narrow-leaved Geebung	*Persoonia linearis*	**Proteaceae**	2
	Pomax umbellata	**Rubiaceae**	1
	Macrozamia reducta	**Zamiaceae**	1

Plot 4

Common Name	Scientific Name	Family Name	CA
Pastel Flower	*Pseuderanthemum variabile*	**Acanthaceae**	1
Mulga Fern	*Cheilanthes sieberi subsp. sieberi*	**Adiantaceae**	2
	Tricoryne elatior	**Anthericaceae**	2
	Chrysocephalum semipapposum	**Asteraceae**	1
	Lagenifera stipitata	**Asteraceae**	2
	Ozothamnus diosmifolius	**Asteraceae**	1
Fuzzweed	*Vittadinia cuneata*	**Asteraceae**	1
Wonga Vine	*Pandorea pandorana subsp. pandorana*	**Bignoniaceae**	1
Forest Oak	*Allocasuarina torulosa*	**Casuarinaceae**	1
	Lepidosperma laterale	**Cyperaceae**	2
	Hibbertia empetrifolia subsp. empetrifolia	**Dilleniaceae**	1
	Leucopogon juniperinus	**Epacridaceae**	2
	Phyllanthus hirtellus	**Euphorbiaceae**	1
Gorse Bitter Pea	*Daviesia ulicifolia*	**Fabaceae (Faboideae)**	3
	Dillwynia retorta	**Fabaceae (Faboideae)**	2
	Glycine microphylla	**Fabaceae (Faboideae)**	2
	Acacia elongata	**Fabaceae (Mimosoideae)**	2
	Acacia falcata	**Fabaceae (Mimosoideae)**	2
Whiteroot	*Pratia purpurascens*	**Lobeliaceae**	2
	Lomandra filiformis subsp. coriacea	**Lomandraceae**	1
Spotted Gum	*Corymbia maculata*	**Myrtaceae**	3
Red Ironbark	*Eucalyptus fibrosa*	**Myrtaceae**	4
White Mahogany	*Eucalyptus umbra*	**Myrtaceae**	3
	Dianella longifolia var. longifolia	**Phormiaceae**	1
Apple Dumplings	*Billardiera scandens*	**Pittosporaceae**	2
	Bursaria spinosa subsp. spinosa	**Pittosporaceae**	2
	Anisopogon avenaceus	**Poaceae**	2
Threeawn Speargrass	*Aristida vagans*	**Poaceae**	3
	Aristida warburgii	**Poaceae**	1
Wallaby Grass	*Austrodanthonia fulva*	**Poaceae**	1
	Dichelachne sieberiana	**Poaceae**	1
	Digitaria ramularis	**Poaceae**	1
Wiry Panic	*Entolasia stricta*	**Poaceae**	3
	Eragrostis brownii	**Poaceae**	1
	Microlaena stipoides var. stipoides	**Poaceae**	1
	Paspalidium distans	**Poaceae**	1
Kangaroo Grass	*Themeda australis*	**Poaceae**	3
Narrow-leaved Geebung	*Persoonia linearis*	**Proteaceae**	1
	Dodonaea triquetra	**Sapindaceae**	1
	Macrozamia reducta	**Zamiaceae**	1

Appendix 2 - Fauna species recorded on the subject site

Scientific Name	Common Name	Method	Habitat	Site
Amphibians				
Pseudophryne coriacea	Red-back Toadlet	Heard, sighted	Gully/Drainage line	Eastern Site
Litoria latopalmata	Broad-palmed Frog	Heard, sighted	Gully/ Dam	Western & Eastern Site
Reptiles				
Amphibolurus muricatus	Jacky Lizard	Funnel trap	Open Forest	Eastern Site
Oedura lesueurii	Lesueur's Velvet Gecko	Habitat Search	Open Forest	Eastern Site
Ramphotyphlops nigrescens	Blackish Blind Snake	Habitat Search	Open Forest	Eastern Site
Furina diadema	Red-naped Snake	Habitat Search	Open Forest	Eastern Site
Carlia tetradactyla	Southern Rainbow Skink	Funnel trap	Open Forest	Western & Eastern Site
Saiphos equalis	Three-toed Skink	Habitat Search	Open Forest	Eastern Site
Diplodactylus vittatus	Eastern Stone Gecko	Habitat Search	Open Forest	Eastern Site
Arboreal mammals				
Trichosurus vulpecula	Brushtail Possum	Hair Tube	Open Forest	Western & Eastern Site
Terrestrial mammals				
Macropus giganteus	Eastern Grey Kangaroo	Sighting	Open Forest	Western Site
Perameles nasuta	Long-nosed Bandicoot	Elliot B	Open Forest	Eastern Site
Antechinus stuartii	Brown Antechinus	Elliot A	Open Forest	Western Site
*Oryctolagus cuniculus**	Rabbit	Sighting	Open Forest	Eastern Site
Bats				
Vespadelus vulturnus	Little Forest Bat	Anabat, Harp trap	Open forest	Western & Eastern Site
Nyctophilus geoffroyi	Lesser Long-eared Bat	Harp trap	Open forest	Western & Eastern Site
Saccolaimus flaviventris#	Yellow-bellied Sheathtail Bat	Anabat	Open forest	Western site
Mormopterus norfolkensis#	East Coast Freetail Bat	Anabat	Open forest	Western & Eastern Site
Miniopterus australis#	Little Bent-wing Bat	Anabat	Open forest	Eastern Site
Miniopterus schreibersii#	Large Bent-wing Bat	Anabat	Open forest	Western & Eastern Site
Scoteanax rueppellii#	Greater Broad-nosed Bat	Anabat	Open forest	Western & Eastern Site

Tadarida australis	White-striped Mastiff Bat	Anabat	Open forest	Western & Eastern Site
Mormopterus planiceps	Southern Freetail Bat	Anabat	Open forest	Western Site
Rhinolopus megaphyllus	Eastern Horseshoe Bat	Anabat	Open forest	Eastern Site
Chalinolobus morio	Chocolate Wattled Bat	Anabat, Harp trap	Open forest	Western Site
Scotorepens balstoni	Inland Broad-nose Bat	Anabat	Open forest	Western Site
Scotorepens orion	Eastern Broad-nose Bat	Anabat	Open forest	Western & Eastern Site
Chalinolobus gouldii	Gould’s Wattled Bat	Anabat, Harp trap	Open forest	Western & Eastern Site
Birds				
Gymnorhina tibicen	Australian Magpie	Western Site	Open forest	Heard
Corvus coronoides	Australian Raven	Western & Eastern Site	Open forest	Heard, sighted
Geopelia humeralis	Bar-shouldered Dove	Eastern Site	Open forest	Heard
Coracina novaehollandiae	Black-faced Cuckoo-shrike	Western & Eastern Site	Open forest	Heard, sighted
Coracina tenuirostris	Cicadabird	Western Site	Open forest	Heard
Taeniopygia bichenovii	Double-barred Finch	Western Site	Open forest	Sighted
Platycercus eximius	Eastern Rosella	Eastern Site	Open forest	Sighted
Acanthorhynchus tenuirostris	Eastern Spinebill	Western & Eastern Site	Open forest	Heard
Eopsaltria australis	Eastern Yellow Robin	Western & Eastern Site	Open forest	Heard, sighted
Cacomantis flabelliformis	Fan-tailed Cuckoo	Western Site	Open forest	Heard
Rhipidura fuliginosa	Grey Fantail	Western Site	Open forest	Heard
Colluricincla harmonica	Grey Shrike-thrush	Western Site	Open forest	Heard
Chrysococcyx basalis	Horsfield's Bronze-Cuckoo	Eastern Site	Open forest	Heard
Dacelo novaeguineae	Laughing Kookaburra	Western Site	Open forest	Heard
Cracticus nigrogularis	Pied Butcherbird	Western Site	Open forest	Heard, sighted
Strepera graculina	Pied Currawong	Western Site	Open forest	Heard
Neochmia temporalis	Red-browed Finch	Western Site	Open forest	Sighted
Myiagra rubecula	Leaden Flycatcher	Western Site	Open forest	Sighted
Pachycephala rufiventris	Rufous Whistler	Western & Eastern Site	Open forest	Heard, sighted
Todiramphus sanctus	Sacred Kingfisher	Eastern Site	Open forest	Sighted
Chrysococcyx lucidus	Shining Bronze-Cuckoo	Western Site	Open forest	Heard
Zosterops lateralis	Silvereye	Western Site	Open forest	Sighted
Pardalotus punctatus	Spotted Pardalote	Western & Eastern Site	Open forest	Heard, sighted
Pardalotus striatus	Striated Pardalote	Western Site	Open forest	Heard
Acanthiza lineata	Striated Thornbill	Eastern Site	Open forest	Heard, sighted
Cacatua galerita	Sulphur-crested Cockatoo	Eastern Site	Open forest	Heard
Malurus cyaneus	Superb Fairy-wren	Western &	Open forest	Heard

		Eastern Site		
Malurus lamberti	Variegated Fairy-wren	Eastern Site	Open forest	Heard
Hirundo neoxena	Welcome Swallow	Eastern Site	Open forest	Sighted
Sericornis frontalis	White-browed Scrubwren	Western & Eastern Site	Open forest	Heard
Gerygone olivacea	White-throated Gerygone	Western & Eastern Site	Open forest	Heard
Cormobates leucophaeus	White-throated Treecreeper	Western & Eastern Site	Open forest	Heard, sighted
Acanthiza nana	Yellow Thornbill	Eastern Site	Open forest	Sighted
Lichenostomus chrysops	Yellow-faced Honeyeater	Western & Eastern Site	Open forest	Heard, sighted
Lichenostomus melanops	Yellow-tufted Honeyeater	Eastern Site	Open forest	Sighted
Opportunistic sightings of bird species on the subject site				
Alisterus scapularis	Australian King-Parrot	Sighted	Open forest	Sighted
Coturnix ypsilophora	Brown Quail	Sighted	Open forest	Sighted
Scythrops novaehollandiae	Channel-billed Cuckoo	Heard, sighted	Open forest	Heard, sighted
Ocyphaps lophotes	Crested Pigeon	Sighted	Open forest	Sighted
Platycercus elegans	Crimson Rosella	Sighted	Open forest	Sighted
Nycticorax caledonicus	Nankeen Night Heron	Sighted	Gully/ Dam	Sighted
Philemon corniculatus	Noisy Friarbird	Heard, sighted	Open forest	Heard, sighted
Oriolus sagittatus	Olive-backed Oriole	Sighted	Open forest	Heard, sighted
Podargus strigoides	Tawny Frogmouth	Sighted	Open forest	Sighted
Calyptorhynchus funereus	Yellow-tailed Black-Cockatoo	Heard	Open forest	Heard

* - Introduced species

- Listed as threatened (vulnerable) under the TSC Act

Appendix 3 – Qualifications of staff involved in sampling and preparation of report

Name	Title	Qualifications	Licences / permits	Contribution
Colin Driscoll	Senior Environmental Scientist	B. Sc.	NPWS Scientific Licence S10565	Vegetation community assessment, GIS, report writing
Adam Blundell	Environmental Scientist	B. Env. Sc. (Hons)	NPWS Scientific Licence S10565	Trapping design, hair sample analysis, spotlighting, mammal trap checking, owl call playback, report writing
Kristy Peters	Environmental Scientist (Ornithologist)	B. Park Mgt.	NPWS Scientific Licence S10565	Bird surveys, habitat hollow survey, report writing
Simon Clulow	Ecologist (Herpetologist)	B. Sc. B. Teach.	NPWS Scientific Licence S10565	Herpetofauna survey, report writing
Julie-Anne Harty	Ecologist (Herpetologist)	B. App. Sc. (Hons) PhD (SRM)	NPWS Scientific Licence S10565	Habitat hollow survey

Appendix 4 Field sheets

BLOOMFIELDS EIA - FIELDWORK (16 - 20 OCT 2006) **Transect 2 - 17/10/06**

TRAP NUMBERS	TYPE	COMMENT	TRAP INTERVALS
1	EA		10m
2	EBG-1		10m
3	EA		10m
4	EBT-1		10m
5	EA		10m
6	CAGE-1		10m
7	EA		10m
8	EBT-2		10m
9	EA		10m
10	EBG-2		10m
11	EA		10m
12	HT-1		10m
13	EA		10m
14	EBT-3		10m
15	EA		10m
16	HARP	Lesser Long-eared Bats (2 x pregant F, 1 x M)	10m
17	EA		10m
18	HT-2		10m
19	EA		10m
20	CAGE-2		10m
21	EA		10m
22	EBT-4		10m
23	EA		10m
24	HT-3		10m
25	EA		10m
26	EBT-5		10m
27	EA		10m
28	EBG-3		10m
29	EA		10m
30	HT-4		10m
31	EA		10m
32	EBT-6		10m
33	EA		10m
34	CAGE-3		10m
35	EA		10m
36	EBT-7		10m
37	EA		10m
38	HT-5		10m
39	EA		10m
40	HERP		
			390 m in total

BLOOMFIELDS EIA - FIELDWORK (16 - 20 OCT 2006) **Transect 1 - 18/10/06**

TRAP NUMBERS	TYPE	COMMENT	TRAP INTERVALS
1	EA		10m
2	EBG-1		10m
3	EA		10m
4	EBT-1		10m
5	EA		10m
6	CAGE-1		10m
7	EA		10m
8	EBT-2		10m
9	EA		10m
10	EBG-2		10m
11	EA		10m
12	HT-1		10m
13	EA		10m
14	EBT-3		10m
15	EA		10m
16	HT-2		10m
17	EA		10m
18	CAGE-2		10m
19	EA		10m
20	HT-3		10m
21	EA		10m
22	EBT-4		10m
23	EA		10m
24	HARP	Lesser Long-eared Bat Little Forest Bat x 2	10m
25	EA		10m
26	EBT-5		10m
27	EA		10m
28	EBG-3		10m
29	EA		10m
30	HT-4		10m
31	EA		10m
32	EBT-6		10m
33	EA		10m
34	CAGE-3		10m
35	EA		10m
36	EBT-7		10m
37	EA		10m
38	HT-5		10m
39	EA		10m
40	HERP		
			390 m in total

BLOOMFIELDS EIA - FIELDWORK (16 - 20 OCT 2006) **Transect 2 - 18/10/06**

TRAP NUMBERS	TYPE	COMMENT	TRAP INTERVALS
1	EA		10m
2	EBG-1		10m
3	EA		10m
4	EBT-1		10m
5	EA		10m
6	CAGE-1	Brushtail Possum	10m
7	EA		10m
8	EBT-2		10m
9	EA		10m
10	EBG-2	Long-nosed Bandicoot	10m
11	EA		10m
12	HT-1		10m
13	EA		10m
14	EBT-3		10m
15	EA		10m
16	HARP	Lesser Long-eared Bat	10m
17	EA		10m
18	HT-2		10m
19	EA		10m
20	CAGE-2		10m
21	EA		10m
22	EBT-4		10m
23	EA		10m
24	HT-3		10m
25	EA		10m
26	EBT-5		10m
27	EA		10m
28	EBG-3		10m
29	EA		10m
30	HT-4		10m
31	EA		10m
32	EBT-6		10m
33	EA		10m
34	CAGE-3		10m
35	EA		10m
36	EBT-7		10m
37	EA		10m
38	HT-5		10m
39	EA		10m
40	HERP		
			390 m in total

BLOOMFIELDS EIA - FIELDWORK (16 - 20 OCT 2006) **Transect 1 - 19/10/06**

TRAP NUMBERS	TYPE	COMMENT	TRAP INTERVALS
1	EA		10m
2	EBG-1		10m
3	EA	A. stuartii (F) with young	10m
4	EBT-1		10m
5	EA		10m
6	CAGE-1		10m
7	EA		10m
8	EBT-2		10m
9	EA		10m
10	EBG-2		10m
11	EA		10m
12	HT-1		10m
13	EA		10m
14	EBT-3		10m
15	EA		10m
16	HT-2		10m
17	EA		10m
18	CAGE-2		10m
19	EA		10m
20	HT-3		10m
21	EA		10m
22	EBT-4		10m
23	EA		10m
24	HARP	Lesser Long-eared Bat (F) x 2	10m
25	EA		10m
26	EBT-5		10m
27	EA		10m
28	EBG-3		10m
29	EA		10m
30	HT-4		10m
31	EA		10m
32	EBT-6		10m
33	EA		10m
34	CAGE-3		10m
35	EA		10m
36	EBT-7		10m
37	EA		10m
38	HT-5		10m
39	EA		10m
40	HERP		
			390 m in total

BLOOMFIELDS EIA - FIELDWORK (16 - 20 OCT 2006) **Transect 2 - 19/10/06**

TRAP NUMBERS	TYPE	COMMENT	TRAP INTERVALS
1	EA		10m
2	EBG-1		10m
3	EA		10m
4	EBT-1		10m
5	EA		10m
6	CAGE-1		10m
7	EA		10m
8	EBT-2		10m
9	EA		10m
10	EBG-2		10m
11	EA		10m
12	HT-1		10m
13	EA		10m
14	EBT-3		10m
15	EA		10m
16	HARP		10m
17	EA		10m
18	HT-2		10m
19	EA		10m
20	CAGE-2		10m
21	EA		10m
22	EBT-4		10m
23	EA		10m
24	HT-3		10m
25	EA		10m
26	EBT-5		10m
27	EA		10m
28	EBG-3		10m
29	EA		10m
30	HT-4		10m
31	EA		10m
32	EBT-6		10m
33	EA		10m
34	CAGE-3		10m
35	EA		10m
36	EBT-7		10m
37	EA		10m
38	HT-5		10m
39	EA		10m
40	HERP		
			390 m in total

BLOOMFIELDS EIA - FIELDWORK (16 - 20 OCT 2006) **Transect 1 - 20/10/06**

TRAP NUMBERS	TYPE	COMMENT	TRAP INTERVALS
1	EA		10m
2	EBG-1		10m
3	EA		10m
4	EBT-1		10m
5	EA		10m
6	CAGE-1		10m
7	EA		10m
8	EBT-2		10m
9	EA		10m
10	EBG-2		10m
11	EA		10m
12	HT-1		10m
13	EA		10m
14	EBT-3		10m
15	EA		10m
16	HT-2		10m
17	EA		10m
18	CAGE-2		10m
19	EA		10m
20	HT-3		10m
21	EA		10m
22	EBT-4		10m
23	EA		10m
24	HARP	Gould's Wattled Bat, Chocolate Wattled Bat, Little Forest Bat x 7	10m
25	EA		10m
26	EBT-5		10m
27	EA		10m
28	EBG-3		10m
29	EA		10m
30	HT-4		10m
31	EA		10m
32	EBT-6		10m
33	EA		10m
34	CAGE-3		10m
35	EA		10m
36	EBT-7		10m
37	EA		10m
38	HT-5		10m
39	EA		10m
40	HERP	C. tetradactyla (1 x M, 1 x F)	
			390 m in total

BLOOMFIELDS EIA - FIELDWORK (16 - 20 OCT 2006) **Transect 2 - 20/10/06**

TRAP NUMBERS	TYPE	COMMENT	TRAP INTERVALS
1	EA		10m
2	EBG-1		10m
3	EA		10m
4	EBT-1		10m
5	EA		10m
6	CAGE-1		10m
7	EA		10m
8	EBT-2		10m
9	EA		10m
10	EBG-2		10m
11	EA		10m
12	HT-1		10m
13	EA		10m
14	EBT-3		10m
15	EA		10m
16	HARP	Little Forest Bat x 1	10m
17	EA		10m
18	HT-2		10m
19	EA		10m
20	CAGE-2		10m
21	EA		10m
22	EBT-4		10m
23	EA		10m
24	HT-3		10m
25	EA		10m
26	EBT-5		10m
27	EA		10m
28	EBG-3		10m
29	EA		10m
30	HT-4		10m
31	EA		10m
32	EBT-6		10m
33	EA		10m
34	CAGE-3		10m
35	EA		10m
36	EBT-7		10m
37	EA		10m
38	HT-5		10m
39	EA		10m
40	HERP	Jacky Lizard	
			390 m in total

147/331 Bloomfield Coal Mine
Avifauna Record Sheet

Date: 24.10.06 Time Start: 0730 Time Finish: 0800

Rain: **0** 1 2 3 4 Cloud: **0** 1 2 3 4 Wind: **0** 1 2 3 4 Direction: ____________

Temp: 21° Site/Transect: East (1)

No.	Species	H, S	Time	No.	Br.	Remarks
1.	Yellow-faced Honeyeater	S				
2.	Spotted Pardalote	H				
3.	Bar-shouldered Dove	H				
4.	Welcome Swallow	S				
5.	White-throated Treecreeper	S				
6.	White-browed Scrubwren	H				
7.	Superb Fairy-wren	H				
8.	Australian Raven	S				
9.	Horsefield's Bronze-cuckoo	H				
10.	Yellow-tufted Honeyeater	S				
11.	Black-faced Cuckoo-shrike	H				
12.						
13.						
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147/331 Bloomfield Coal Mine
Avifauna Record Sheet

Date: 24.10.06 Time Start: 0700 Time Finish: 0730

Rain: **0** 1 2 3 4 Cloud: **0** 1 2 3 4 Wind: **0** 1 2 3 4 Direction: ____________

Temp: 20° Site/Transect: East (2)

No.	Species	H, S	Time	No.	Br.	Remarks
31.	Yellow-faced Honeyeater	H				
32.	Sacred Kingfisher	S				
33.	Spotted Pardalote	H				
34.	Bar-shouldered Dove	H				
35.	Sulphur-crested Cockatoo	H				
36.	Eastern Rosella	S				
37.	Welcome Swallow	S				
38.	White-throated Treecreeper	H				
39.	White-browed Scrubwren	H				
40.	Superb Fairy-wren	H				
41.	Rufous Whistler	S				
42.	Striated Thornbill	H, S				
43.	Yellow Thornbill	S				
44.	Australian Raven	H				
45.	Horsefield's Bronze-cuckoo	H				
46.	Variegated Fairy-wren	H				
47.	White-throated Gerygone	H				
48.	Eastern Spinebill	H				
49.						
50.						
51.						
52.						
53.						
54.						
55.						
56.						
57.						
58.						
59.						
60.						

147/331 Bloomfield Coal Mine
Avifauna Record Sheet

Date: 24.10.06 Time Start: 0800 Time Finish: 0830

Rain: **0** 1 2 3 4 Cloud: **0** 1 2 3 4 Wind: **0** 1 2 3 4 Direction: ____________

Temp: 21° Site/Transect: West (3)

No.	Species	H, S	Time	No.	Br.	Remarks
61.	Yellow-faced Honeyeater	S				
62.	Spotted Pardalote	S				
63.	White-throated Treecreeper	H				
64.	White-browed Scrubwren	H				
65.	Superb Fairy-wren	H				
66.	Australian Raven	H				
67.	Black-faced Cuckoo-shrike	S				
68.	Pied Butcherbird	H				
69.	Leaden Flycatcher	H,S				
70.	White-throated Gerygone	H				
71.	Red-browed Finch	S				
72.	Australian Magpie	H				
73.	Fan-tailed Cuckoo	H				
74.	Rufous Whistler	H				
75.	Grey Shrike-thrush	H				
76.	Shining Bronze-cuckoo	H				
77.	Grey Fantail	H				
78.	Striated Pardalote	H				
79.	Cicadabird	H				
80.	Eastern Yellow Robin	H				
81.						
82.						
83.						
84.						
85.						
86.						
87.						
88.						
89.						
90.						

147/331 Bloomfield Coal Mine
Avifauna Record Sheet

Date: 24.10.06 Time Start: 0830 Time Finish: 0900

Rain: **0** 1 2 3 4 Cloud: **0** 1 2 3 4 Wind: 0 **1** 2 3 4 Direction: ____________

Temp: 23° Site/Transect: West (4)

No.	Species	H, S	Time	No.	Br.	Remarks
91.	Yellow-faced Honeyeater	H				
92.	Spotted Pardalote	H				
93.	Superb Fairy-wren	H				
94.	Black-faced Cuckoo-shrike	S				
95.	Pied Butcherbird	H				
96.	White-throated Gerygone	H				
97.	Australian Magpie	H				
98.	Silvereye	S				
99.	Eastern Spinebill	H				
100.	Double-barred Finch	S				
101.	Laughing Kookaburra	H				
102.	Pied Currawong	S				
103.						
104.						
105.						
106.						
107.						
108.						
109.						
110.						
111.						
112.						
113.						
114.						
115.						
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118.						
119.						
120.						

147/331 Bloomfield Coal Mine
Oct - Nov 2006

Opportunistic Sightings

No.	Species	Site	Date
1.	Eastern Grey Kangaroo	Western	17/10/06
2.	*P. coriacea*	Western	17/10/06
3.	*P. coriacea*	Eastern	17/10/06
4.	*Litoria latopalmata*	Eastern	17/10/06
5.	Rabbit	Eastern	19/10/06
6.	Australian King-Parrot	Eastern	26/10/06
7.	Brown Quail	Eastern	26/10/06
8.	Channel-billed Cuckoo	Western	26/10/06
9.	Crested Pigeon	Eastern	26/10/06
10.	Crimson Rosella	Western	26/10/06
11.	Nankeen Night Heron	Eastern	26/10/06
12.	Noisy Friarbird	Western	26/10/06
13.	Olive-backed Oriole	Eastern	26/10/06
14.	Tawny Frogmouth	Eastern	26/10/06
15.	Yellow-tailed Black-Cockatoo	Eastern	26/10/06
16.			
17.			
18.			
19.			
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147/331 Bloomfield Coal Mine Fauna Survey – October 2006

Spotlighting Record Sheet

Site: Transect 1 **Date**: 18.10.06

Cloud Cover: **0** 1 2 3 4 Rain: **0** 1 2 3 4 Wind: **0** 1 2 3 4

Wind Direction: ____________ Time Start: 1900

Species	Remarks
Oedura lesueurii	
Ramphotyphlops nigrescens	
Furina diadema	
Carlia tetradactyla	
Saiphos equalis	
Diplodactylus vittatus	
Litoria latopalmata	
Time Finish: 2030	

Site: Transect 2 **Date**: 18.10.06

Cloud Cover: **0** 1 2 3 4 Rain: **0** 1 2 3 4 Wind: **0** 1 2 3 4

Wind Direction: ____________ Time Start: 2030

Species	Remarks
Pseudophryne coriacea	
Litoria latopalmata	
Time Finish: 2200	

TREE SURVEY DATA SHEET

CLIENT: Bloomfields (147/331)

LOCATION: Beresfield

DATE: 13 November 2006

GPS: 1 (Kristy Peters)

WP	Tree	Species	Small (<8cm)	Medium (8-20 cm)	Large (>20cm)
1	1	E. globoidea	2	1	
2	2	Dead stag		1	
3	3	Dead stag		1	
4	4	E. acmenoides	2		
5	5	E. crebra	2		
6	6	Dead stag	2		
7	7	E. acmenoides	2		
8	8	E. acmenoides	2	2	
9	9	E. crebra	3	2	
10	10	Dead stag	2	1	
11	11	E. acmenoides	4	2	
12	12	E. crebra		1	
13	13	Dead stag	2		
14	14	E. crebra	2	1	
15	15	Dead stag	2	1	
16	16	E. acmenoides	3		
17	17	Dead stag	1		
18	18	E. acmenoides	2	1	
	19				
	20				
	21				
	22				
	23				
	24				
	25				

TREE SURVEY DATA SHEET

CLIENT: Bloomfields (147/331)

LOCATION: Beresfield

DATE: 26 October 2006

GPS: 2 (Julie-Anne Harty)

WP	Tree	Species	Small (<8cm)	Medium (8-20 cm)	Large (>20cm)
1	1	E. crebra			1
2	2	Box sp.	4	1	
3	3	E. paniculata	4		
4	4	Dead stag	1	1	
5	5	E. acmenoides		1	
6	6	E. acmenoides	1		
7	7	C. maculata	1		
8	8	A. costata	3	3	
9	9	A. costata	2	1	
10	10	E. paniculata	3		
11	11	A. costata	1		
12	12	Dead stag	4	2	
13	13	Dead stag		1	
14	14	Dead stag	1		
15	15	Box sp.	1	1	
16	16	Dead stag		1	
17	17	E. glomullifera	2	1	
18	18	C. gummifera		1	
19	19	Dead stag	2		
20	20	Dead stag		1	
21	21	Dead stag		1	
22	22	Dead stag	1		
23	23	Box sp.	9	1	
	24				
	25				

TREE SURVEY DATA SHEET

CLIENT: Bloomfields (147/331)

LOCATION: Beresfield

DATE: 26 October 2006

GPS: 1 (Kristy Peters)

WP	Tree	Species	Small (<8cm)	Medium (8-20 cm)	Large (>20cm)
1	1	E. acmenoides		1	
2	2	C. maculata	2	1	
3	3	E. acmenoides	2		
4	4	A. costata	2		
5	5	Dead stag	3		
6	6	Dead stag	1		
7	7	A. costata	3		
8	8	Dead stag		1	
9	9	Dead stag	3		
10	10	A. costata	2	1	
11	11	Dead stag	2		
12	12	Dead stag		1	
13	13	E. acmenoides	3	1	
14	14	Dead stag		1	
	15				
	16				
	17				
	18				
	19				
	20				
	21				
	22				
	23				
	24				
	25				

Appendix F

Noise & Blasting Impact Assessment

Bloomfield Colliery Completion of Mining and Rehabilitation

Part 3A Environmental Assessment

November 2008

HEGGIES

REPORT 30-1573R1

Revision 1

Noise and Blasting Impact Assessment
Bloomfield Project

PREPARED FOR

Bloomfield Collieries Pty Ltd
Four Mile Creek Road
Ashtonfield NSW 2323

1 SEPTEMBER 2008

HEGGIES PTY LTD
ABN 29 001 584 612

Incorporating New Environment Graeme E. Harding & Associates Eric Taylor Acoustics

NOISE AND BLASTING IMPACT ASSESSMENT

BLOOMFIELD PROJECT

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Reference	Status	Date	Prepared	Checked	Authorised
30-1573R1	Revision 1	1 September 2008	John Cotterill	Daniel Weston	John Cotterill
30-1573R1	Revision 0	5 June 2008	John Cotterill	Daniel Weston	John Cotterill

EXECUTIVE SUMMARY

Heggies Pty Ltd (Heggies) has been engaged by Bloomfield Collieries Pty Ltd (Bloomfield) to undertake an assessment of noise and blasting impacts associated with the proposed Bloomfield completion and rehabilitation project (Bloomfield Project) near Beresfield, NSW.

Operational Noise Predictions

A computer model was used to predict noise emissions from the proposed Bloomfield Project. The Environmental Noise Model (ENM) has been produced in conjunction with the Department of Environment and Climate Change (DECC). Noise levels were predicted for the general operational scenarios summarised in **Section 7** with the inclusion of the noise mitigation and management procedures detailed in **Section 5**.

Operational noise levels from the proposed Bloomfield Project are predicted to meet the project specific noise criteria at all receiver locations under calm and prevailing weather conditions with the exception of:

- **Location G** where an exceedance of 1 dBA is predicted during a prevailing south east wind during the evening period in Years 1, 5 and Year 10 and during the night-time period in Years 1 and 10; and
- **Location M** where an exceedance of 1 dBA is predicted during a prevailing north west wind during the night-time period in Year 1.

These minor exceedance of up to 1 dBA are unlikely to be noticeable by most people. Since the operational scenario modelled is likely to represent an acoustically worst-case scenario, actual operational noise levels from the proposed Bloomfield Project are likely to be less than those predicted.

Sleep Disturbance Assessment

The predicted L_{Amax} noise levels from the proposed Bloomfield Project will meet the sleep disturbance criteria at all locations surrounding the development during calm and prevailing weather conditions with the exception of:

- **Location G** where a 1 dBA exceedance during the morning shoulder period is predicted during a south east wind in Year 10.

This 1 dBA exceedance is unlikely to cause sleep disturbance at this location.

Blasting Assessment

The blast prediction results presented in **Section 8** demonstrate that predicted airblast and ground vibration levels will meet the DECC guidelines for blasting at all residences surrounding the development during all operational stages of the Bloomfield Project.

Cumulative Impact Assessment

The cumulative impact of mining in the area surrounding the Bloomfield Project including existing Donaldson Coal Mine, approved Abel Coal Mine and existing Tasman Coal Mine is predicted to comply with the relevant amenity criteria set in accordance with the INP.

TABLE OF CONTENTS

1 INTRODUCTION

Heggies Pty Ltd (Heggies) has been engaged by Bloomfield Collieries Pty Ltd (Bloomfield) to undertake an assessment of noise and blasting impacts associated with the proposed Bloomfield completion and rehabilitation project (Bloomfield Project) near Beresfield, NSW.

Broadly, the objective of the assessment was to identify the potential impacts of noise and blasting from the proposed development. The proposed Bloomfield Project will utilise the existing rail loop/loading and washery facilities already assessed as part of the approved Abel coal mine project. Therefore, the noise impact from these facilities will only be considered as part of a cumulative assessment. It is envisaged that no construction activities will occur as a result of this project, accordingly, construction noise will not be considered in this assessment. Advice with regard to effective mitigation strategies will be provided where necessary.

The noise assessment has been prepared with reference to Australian Standard AS 1055:1997 *Description and Measurement of Environmental Noise* Parts 1, 2 and 3 and in accordance with the Department of Environment and Climate Control (DECC) NSW Industrial Noise Policy (INP). Where issues relating to noise are not addressed in the INP, such as sleep disturbance, reference has been made to the NSW Environmental Noise Control Manual (ENCM).

2 NOISE MANAGEMENT

Selecting an appropriate noise management strategy for the proposed Bloomfield Project involves the following steps:

- Determining the noise reduction required to achieve the project-specific noise levels.
- Identifying the specific characteristics of the industry and the site that would indicate a preference for specified measures.
- Examining the mitigation strategies chosen by similar industries on similar sites with similar requirements for noise reduction; and considering that strategy's appropriateness for the subject development.
- Considering the range of noise-control measures available.
- Considering community preferences for particular strategies. This is especially important when the community has particular sensitivities to noise.

The preference ranking (from most preferred to least preferred) for noise mitigation strategies is as follows:

- **Land-use controls** - a long-term strategy preferable to other measures when such strategic decisions are possible in planning land use, as it separates noise-producing industries from sensitive areas and avoids more expensive short-term measures.
- **Control at the source** - Best Management Practice (BMP) and Best Available Technology Economically Achievable (BATEA). These strategies serve to reduce the noise output of the source so that the surrounding environment is protected against noise.
- **Control in transmission** - the next best strategy to controlling noise at the source—it serves to reduce the noise level at the receiver but not necessarily the environment surrounding the source.
- **Receiver controls** - the least-preferred option, as it protects only the internal environment of the receiver and not the external noise environment.

The proponent will take into account the cost-effectiveness of strategies in determining how much noise reduction is affordable. A proponent's choice of a particular strategy is likely to have unique features due to the economics of the industry and site specific technical considerations.

The above steps and the range of measures described in this chapter can be used as a guide in assessing the strength of the proponent's mitigation proposals. Where a proposed mitigation strategy will not achieve the desired noise reduction and leaves a remaining noise impact, the problem needs to be solved by negotiation between the land owner and regulatory authority.

3 IMPACT ASSESSMENT PROCEDURES

3.1 General Objectives

Responsibility for the control of noise emission in New South Wales is vested in Local Government and the DECC. The INP was released in January 2000 and provides a framework and process for deriving noise criteria for consents and licences that will enable the DECC to regulate premises that are scheduled under the Protection of the Environment Operations Act, 1997.

The specific policy objectives are:

- To establish noise criteria that would protect the community from excessive intrusive noise and preserve amenity for specific land uses.
- To use the criteria as the basis for deriving project specific noise levels.
- To promote uniform methods to estimate and measure noise impacts, including a procedure for evaluating meteorological effects.
- To outline a range of mitigation measures that could be used to minimise noise impacts.
- To provide a formal process to guide the determination of feasible and reasonable noise limits for consents or licences that reconcile noise impacts with the economic, social and environmental considerations of industrial development.
- To carry out functions relating to the prevention, minimisation and control of noise from premises scheduled under the Act.

3.2 Assessing Intrusiveness

For assessing intrusiveness, the background noise level must be measured. The intrusiveness criterion essentially means that the equivalent continuous noise level (L_{Aeq}) of the source should not be more than five decibels above the measured background level (L_{A90}).

3.3 Assessing Amenity

The amenity assessment is based on noise criteria specific to land use and associated activities. The criteria relate only to industrial-type noise and do not include road, rail or community noise. The existing noise level from industry is measured. If it approaches the criterion value, then noise levels from new industries need to be designed so that the cumulative effect does not produce noise levels that would significantly exceed the criterion. For high-traffic areas there is a separate amenity criterion.

An extract from the INP that relates to the amenity criteria is given in **Table 1** and **Table 2**.

Table 1 Amenity Criteria - Recommended LAeq Noise Levels from Industrial Noise Sources

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended LAeq(Period) Noise Level (dBA)	
			Acceptable	Recommended Maximum
Residence	Rural	Day	50	55
		Evening	45	50
		Night	40	45
	Suburban	Day	55	60
		Evening	45	50
		Night	40	45
	Urban	Day	60	65
		Evening	50	55
		Night	45	50
School classrooms - internal	All	Noisiest 1 hour period when in use	35	40
Hospital wards	All	Noisiest 1 hour period		
- internal			35	40
- external			50	55
Place of worship - internal	All	When in use	40	45
Area specifically reserved for passive recreation (eg National Park)	All	When in use	50	55
Active recreation area (eg school playground, golf course)	All	When in use	55	60
Commercial premises	All	When in use	65	70
Industrial premises	All	When in use	70	75

Note: Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am, On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.
The LAeq index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period.

Table 2 Modification to Acceptable Noise Level (ANL)* to Account for Existing Levels of Industrial Noise

Total Existing L_{Aeq} noise level from Industrial Noise Sources	Maximum L_{Aeq} Noise Level for Noise from New Sources Alone, dBA
≥ Acceptable noise level plus 2 dBA	If existing noise level is *likely to decrease* in future acceptable noise level minus 10 dBA If existing noise level is *unlikely to decrease* in future existing noise level minus 10 dBA
Acceptable noise level plus 1 dBA	Acceptable noise level minus 8 dBA
Acceptable noise level	Acceptable noise level minus 8 dBA
Acceptable noise level minus 1 dBA	Acceptable noise level minus 6 dBA
Acceptable noise level minus 2 dBA	Acceptable noise level minus 4 dBA
Acceptable noise level minus 3 dBA	Acceptable noise level minus 3 dBA
Acceptable noise level minus 4 dBA	Acceptable noise level minus 2 dBA
Acceptable noise level minus 5 dBA	Acceptable noise level minus 2 dBA
Acceptable noise level minus 6 dBA	Acceptable noise level minus 1 dBA
< Acceptable noise level minus 6 dBA	Acceptable noise level

* ANL = recommended acceptable L_{Aeq} noise level for the specific receiver, area and time of day from **Table 1**

3.4 Assessing Sleep Disturbance

The DECC has acknowledged that the relationship between maximum noise levels and sleep disturbance is not currently well defined. Criteria for assessing sleep disturbance has not been identified under the INP and hence, sleep arousal has been assessed using the guidelines set out in the ENCM Chapter 19-3.

To avoid the likelihood of sleep disturbance the ENCM recommends that the $L_{A1(1minute)}$ noise level of the source under consideration should not exceed the background noise level (L_{A90}) by more than 15 dBA when measured outside the bedroom window of the receiver during the night-time hours (10.00 pm to 7.00 am).

4 EXISTING ACOUSTICAL AND METEOROLOGICAL ENVIRONMENT

4.1 Ambient Background Noise Monitoring

Ambient noise surveys were conducted to characterise and quantify the acoustical environment in the area surrounding the Bloomfield Project, proposed (and approved) Abel Coal Mine and existing Donaldson Coal Mine. Noise surveys were conducted by Heggies in October 2000 prior to the commencement of the Donaldson Mine operation. Additional ambient monitoring was conducted in 2006 at new residential premises to the north of the Bloomfield Coal Handling and Preparation Plant (CHPP) at Ashtonfield during the Abel Coal Mine environmental assessment and in 2007 at Lings Road as a part of this assessment. A plan of the monitoring and assessment locations is contained in **Appendix A**.

The use of the ambient noise data prior to the commencement of Donaldson Mine is seen as a conservative measure, as quarterly monitoring data collected as part of the noise management of the Donaldson site, suggests that the ambient levels in the general area from traffic and industrial sources (other than mining) have risen since 2000.

The influence of the operation of Bloomfield (CHPP) on background noise measurements conducted at Location L (Ashtonfield) was insignificant. No correlation between Bloomfield CHPP operating times and noise levels could be established. This was confirmed during operator attended noise surveys conducted at Location L where contribution from the Bloomfield CHPP was noted as inaudible.

The background noise level at Location N (Lings Road) was dominated by traffic on John Renshaw Drive. Noise contributions from the existing Bloomfield operation were not measurable during attended surveys at the site.

A morning shoulder period between 6.00 am and 7.00 am was defined for the area surrounding the mine. During this period the rating background noise levels (RBL's) were typically higher than those during the day. This is due to the significant influence of peak traffic flows in the surrounding area on John Renshaw Drive, Weakleys Drive, the F3 freeway and New England Highway.

The morning shoulder period RBL levels have been calculated using actual measurements undertaken during the morning shoulder period. The DECC current preferred method to determine a morning shoulder RBL is to take the midpoint between the daytime and night-time period as it is claimed that the 10th percentile method does not give a statistically valid assessment background level (ABL). For the Bloomfield Project, the current DECC approach significantly under estimates the actual ambient noise level during this period. A conservative approach has been adopted in this report where the minimum L_{A90} level recorded in the morning shoulder period has been used as the ABL level instead of the 10th percentile levels. An RBL using the modified ABL levels was then calculated.

A summary of the noise levels recorded at the monitoring locations is contained within **Table 3.** The details of the recent noise monitoring results at Lings Road are given in **Appendix C.**

Table 3 Background Noise Levels in area surrounding Bloomfield Project

Location	Description	Background LA90 Noise Level Rating Background Level	Estimated Existing Industrial LAeq Contribution
A Weakleys Drive Beresfield	Daytime	45 dBA	< 54 dBA
	Evening	48 dBA	< 44 dBA
	Night	39 dBA	< 39 dBA
	Shoulder	52 dBA	< 44 dBA
B Yarrum Road Beresfield	Daytime	50 dBA	< 54 dBA
	Evening	43 dBA	< 44 dBA
	Night	36 dBA	< 39 dBA
	Shoulder	52 dBA	< 44 dBA
C Phoenix Road Black Hill (Ebenezer Park)	Daytime	38 dBA	< 49 dBA
	Evening	39 dBA	< 39 dBA
	Night	35 dBA	36 dBA
	Shoulder	45 dBA	< 44 dBA
D Black Hill School	Daytime	39 dBA	< 49 dBA
	Evening	36 dBA	< 39 dBA
	Night	32 dBA	< 34dBA
	Shoulder	41 dBA	< 44 dBA
E Browns Road Black Hill	Daytime	36 dBA	43 dBA
	Evening	37 dBA	< 39 dBA
	Night	31 dBA	34 dBA
	Shoulder	39 dBA	< 44 dBA
F Black Hill Road Black Hill	Daytime	39 dBA	< 49 dBA
	Evening	35 dBA	< 39 dBA
	Night	31 dBA	< 34 dBA
	Shoulder	44 dbA	< 44 dBA
G Buchanan Road Buchanan	Daytime	39 dBA	41 dBA
	Evening	37 dBA	< 39 dBA
	Night	34 dBA	< 34 dBA
	Shoulder	40 dBA	41 dBA
H Mt Vincent Rd Louth Park	Daytime	38 dBA	40 dBA
	Evening	36 dBA	< 39 dBA
	Night	31 dBA	33 dBA
	Shoulder	37 dBA	40 dBA
I Lord Howe Dr. Ashtonfield	Daytime	39 dBA	44 dBA
	Evening	41 dBA	< 39 dBA
	Night	33 dBA	< 34 dBA
	Shoulder	43 dBA	44 dBA
J Kilarney Street Avalon Estate (Thornton)	Daytime	44 dBA	< 54 dBA
	Evening	42 dBA	< 44 dBA
	Night	35 dBA	< 39 dBA
	Shoulder	48 dBA	<44 dBA
K1,K2,K3 (existing residences) Catholic Diocese (Former Bartter)	Daytime	41 dBA	< 49 dBA
	Evening	40 dBA	< 39 dBA
	Night	35 dBA	< 34 dBA
	Shoulder	47 dBA	<44 dBA
L Kilshanny Avenue Ashtonfield	Daytime	41 dBA	< 49 dBA
	Evening	41 dBA	< 39 dBA
	Night	38 dBA	< 34 dBA
	Shoulder	46 dBA	<44 dBA
M John Renshaw Drive Buttai N Lings Road Buttai	Daytime	40 dBA	< 49 dBA
	Evening	38 dBA	< 39 dBA
	Night	31 dBA	< 34 dBA
	Shoulder	48 dBA	<44 dBA

4.2 Effects of Meteorology on Noise Levels

Wind

Wind has the potential to increase noise at a receiver when it is light and stable and blows from the direction of the source of the noise. As the strength of the wind increases the noise produced by the wind will obscure noise from most industrial and transport sources.

Wind effects need to be considered when wind is a feature of the area under consideration. Where wind blows from the source to the receiver at speeds up to 3 m/s for more than 30% of the time in any season, then wind is considered to be a feature of the area and noise level predictions must be made under these conditions.

Weather data was obtained, for a period of 12 months, from a DECC weather station located at Francis Greenway High School near to Beresfield. This location is approximately 7 km north east of the subject site. The data from the Beresfield site was used in favour of that collected at the Donaldson mine site as the station at Donaldson is shielded by trees which means that lower than normal wind speeds are recorded at this location. The Beresfield data was analysed to determine the frequency of occurrence of winds up to speeds of 3 m/s for daytime, evening and night in each season. A summary of the most frequently occurring winds is contained within **Table 4**, **Table 5** and **Table 6**. The percentage occurrence figures provided in bold are those that exceed the 30% threshold.

Table 4 Seasonal Frequency of Occurrence of Wind Speed Intervals - Daytime

Period	Calm	Wind Direction	0.5 - 2 m/s	2 - 3 m/s	0.5 - 3 m/s
Summer	1.8%	SE±45°	5.5%	13.9%	19.4%
Autumn	1.5%	SSE±45°	9.4%	14.0%	23.4%
Winter	1.9%	NW±45°	7.0%	12.4%	19.3%
Spring	55.6%	ESE±45°	3.1%	5.7%	8.8%

Table 5 Seasonal Frequency of Occurrence of Wind Speed Intervals - Evening

Period	Calm	Wind Direction	0.5 - 2 m/s	2 - 3 m/s	0.5 - 3 m/s
Summer	1.5%	SE±45°	26.4%	26.1%	**52.5%**
Autumn	7.3%	S±45°	26.5%	9.2%	**35.7%**
Winter	9.3%	NW±45°	20.3%	6.0%	26.3%
Spring	56.6%	SE±45°	12.9%	6.9%	19.8%

Table 6 Seasonal Frequency of Occurrence of Wind Speed Intervals - Night

Period	Calm	Wind Direction	0.5 - 2 m/s	2 - 3 m/s	0.5 - 3 m/s
Summer	7.0%	SSE±45°	**31.6%**	10.5%	**42.1%**
Autumn	5.9%	WNW±45°	24.9%	12.7%	**37.6%**
Winter	6.3%	NW±45°	24.4%	19.7%	**44.1%**
Spring	58.3%	S±45°	15.2%	1.9%	17.2%

Seasonal wind records indicate that certain winds, typically from the southern sector in the evening and night and north western sector at night, are a feature of the area.

4.3 Temperature Inversion

Temperature inversions, when they occur, have the ability to increase noise levels by focusing sound waves. Temperature inversions occur predominantly at night during the winter months. For a temperature inversion to be a significant characteristic of the area it needs to occur for approximately 30% of the total night-time during winter, or about two nights per week.

Meteorological data, obtained from the DECC weather station at Beresfield was analysed by Holmes Air Sciences to determine the percentage occurrences of temperature inversions during winter nights. The analysis indicates that stabilities of F class[1] and above occur for 27.6% of the time during winter. This means that temperature inversions are not a feature of the area as the occurrence of inversion does not exceed the 30% threshold. Hence, the occurrence of temperature inversion during the night-time period has not been considered as part of this noise assessment.

[1] An atmospheric condition in which temperature increases by 3 °C, per 100m above ground.

5 NOISE CONTROLS

The following noise controls are recommended for the Bloomfield Project. Noise mitigation and management procedures that have been incorporated into the noise model with the aim of achieving project specific noise criteria include the following:

Year 1

- The excavator or face shovel and dump site would be situated in a shielded location during night-time operation;
- No dozer operation at the drill location would occur during night and morning shoulder periods (i.e. between 10.00 pm and 7.00 am); and
- A front end loader would replace the dozer at the dump site during the night-time period unless 4 dBA of noise suppression is achieved[2].

Year 5

- The excavator or face shovel and dump site would be situated in a shielded location during night-time operation;
- No dozer operation at the drill location would occur during night and morning shoulder periods (i.e. between 10.00 pm and 7.00 am); and
- A front end loader would replace the dozer at the dump site during the night-time period unless 4 dBA of noise suppression is achieved.

Year 10

- The excavator or face shovel and dump site would be situated in a shielded location during night-time operation; and
- No dozer operation at the drill location would occur during night and morning shoulder periods (i.e. between 10.00 pm and 7.00 am).

[2] The dozer (CAT D11N) sound power level measured at Bloomfield's on 18 July 2007 was approximately 118 dBA

6 PROJECT SPECIFIC NOISE CRITERIA

6.1 Operational Noise Design Criteria

The noise emission design criteria for the proposed Bloomfield Project have been established with reference to the INP as outlined in **Section 3** of this report.

The amenity criteria have been set from **Table 1**, with adjustments to account for existing industrial noise contributions, from **Table 2** as necessary.

The acoustical environment typifies that of urban, suburban and commercial environments. The residences in the general area have been assessed under the relevant receiver type as shown in **Table 7.**

The intrusive and amenity noise assessment criteria based on the INP for the assessment localities are presented in **Table 7.**

Table 7 Bloomfield Project Specific Noise Criteria

Location	Locality (Noise Amenity Area)	Period	Intrusiveness Criteria $L_{Aeq(15minute)}$	Amenity Criteria $L_{Aeq(Period)}$
A	Beresfield (Urban)	Day	50 dBA	60 dBA
		Evening	48 dBA	50 dBA
B		Night	41 dBA	45 dBA
		Shoulder	57 dBA	53 dBA
C	Ebenezer Park, (Suburban)	Day	43 dBA	55 dBA
		Evening	44 dBA	45 dBA
		Night	40 dBA	38 dBA
		Shoulder	50 dBA	47 dBA
D	Black Hill (Suburban)	Day	41 dBA	55 dBA
		Evening	40 dBA	45 dBA
E		Night	36 dBA	39 dBA
F		Shoulder	44 dBA	47 dBA
G	Buchanan & Louth Park (Suburban)	Day	43 dBA	55 dBA
		Evening	41 dBA	45 dBA
H		Night	36 dBA	40 dBA
		Shoulder	45 dBA	48 dBA
I	Ashtonfield (Suburban)	Day	44 dBA	55 dBA
		Evening	46 dBA	45 dBA
		Night	38 dBA	40 dBA
		Shoulder	48 dBA	47 dBA
J	Avalon Estate Thornton (Urban)	Day	49 dBA	60 dBA
		Evening	47 dBA	50 dBA
		Night	40 dBA	45 dBA
		Shoulder	53 dBA	53 dBA
K K1,K2,K3	Catholic Diocese [Former Bartter]	Day	41[1] dBA	55 dBA
		Evening	40[1] dBA	45 dBA
		Night	36[1] dBA	39 dBA
		Shoulder	52[1] dBA	47 dBA
L	Ashtonfield (Suburban)	Day	46 dBA	55 dBA
		Evening	46 dBA	45 dBA
		Night	43 dBA	40 dBA
		Shoulder	51 dBA	48 dBA
M	Buttai (Suburban)	Day	45 dBA	55 dBA
		Evening	43 dBA	45 dBA
N		Night	36 dBA	40 dBA
		Shoulder	53 dBA	48 dBA

For Monday to Saturday, Daytime 7.00 am - 6.00pm; Evening 6.00pm - 10.00pm; Night-time 10.00pm - 7.00am. Morning Shoulder 6.00 am to 7.00 am
On Sundays and Public Holidays, Daytime 8.00am - 6.00pm; Evening 6.00pm - 10.0 pm; Night-time 10.0 pm - 8.00am. Morning Shoulder 6.00 am to 8.00 am
1. The RBL's calculated for the Black Hill area were adopted as representative of the background levels at the occupied residential receivers on the Catholic Diocese Land (K1, K2 and K3).

It should be noted that RBL's calculated for the Black Hill area were adopted as representative of the background levels at the occupied residential receivers on the Catholic Diocese Land (K1, K2 and K3). The RBL's chosen are more restrictive than those at Location K where noise levels are influenced more by traffic noise along John Renshaw Drive.

The criteria stated for the intrusive criteria for the morning shoulder period is based on measured results during the 6.00 am to 7.00 am period as described in **Section 4**.

The INP states that these criteria have been selected to protect at least 90% of the population, living in the vicinity of industrial noise sources, from the adverse effects of noise for at least 90% of the time. Provided the criteria in the INP are achieved, it is unlikely that most people would consider the resultant noise levels excessive.

6.2 Sleep Disturbance Noise Goals

The relevant sleep disturbance noise goals for each residential area are provided in **Table 8**. To minimise the potential for sleep disturbance in the morning shoulder period between 6.00 am and 7.00 am night-time RBL's have been used to set criteria instead of those recorded during the morning shoulder period

Table 8 Sleep Disturbance Noise Goals

Location	Locality (Noise Amenity Area)	Period	Sleep Disturbance Criteria $L_{A1(1minute)}$
A B	Beresfield (Urban)	Night and Morning Shoulder	51 dBA
C	Ebenezer Park (Suburban)	Night and Morning Shoulder	50 dBA
D E F	Black Hill (Suburban)	Night and Morning Shoulder	46 dBA
G H	Buchanan & Louth Park (Suburban)	Night and Morning Shoulder	46 dBA
I	Ashtonfield (Suburban)	Night and Morning Shoulder	48 dBA
J	Avalon Estate, Thornton (Urban)	Night and Morning Shoulder	50 dBA
K K1,K2,K3	Catholic Diocese [Former Bartter]	Night and Morning Shoulder	46 dBA
L	Ashtonfield (Suburban)	Night and Morning Shoulder	53 dBA
M N	Buttai (Suburban)	Night and Morning Shoulder	46 dBA

7 OPERATIONAL NOISE MODELLING

7.1 Operational Noise Modelling Parameters

A computer model was used to predict noise emissions from operation of the proposed Bloomfield Project. The Environmental Noise Model (ENM) used has been produced in conjunction with the DECC. A three-dimensional digital terrain map giving all relevant topographic information was used in the modelling process. The model used this map, together with noise source data, ground cover, shielding by barriers and/or adjacent buildings and atmospheric information to predict noise levels at the nearest potentially affected receivers.

Topographic contours and operational mine plans were supplied by Bloomfield for the purpose of modelling noise from the proposed development.

Prediction of noise sources were carried out, under calm and prevailing atmospheric conditions (prevailing winds), for three operational scenarios namely;

- Year 1
- Year 5
- Year 10

Atmospheric parameters under which noise predictions were made are given in **Table 9**.

Table 9 Meteorological Parameters for Noise Predictions

	Temperature	Humidity	Wind Speed	Wind Direction (degrees from north)	Temperature Gradient
Calm (All periods)	20°C	65%	N/A	N/A	N/A
South Easterly Wind (Evening and night)	10°C	65%	3 m/s	135°	N/A
North West Wind (Night)	10°C	65%	3 m/s	315°	N/A

Other assumptions made relating to the mine operation in the modelling process include:

- All acoustically significant plant and equipment operates simultaneously.
- Mobile noise sources, such as haul trucks, were modelled at typical locations and assumed to operate in repetitive cycles.
- All noise control measures described in **Section 5** are implemented.

7.2 Operational Scenario - Noise Model Summary

The operational scenario modelled during each period is summarised in **Table 10**. A tick (✓) indicates that the equipment is in operation during the relevant period. Where there is a number in brackets following a tick, this represents the number of pieces of the equipment that has been considered in the noise model during the relevant period. Sound power levels of relevant equipment are contained within **Appendix D**. It should be noted that the operational scenario modelled is likely to represent an acoustically worst-case scenario.

Table 10 Operational Scenario Considered in Noise Model

Plant and Equipment	Day	Evening	Night	Morning Shoulder
Hitachi Excavator 5500 or P&H 9020 Face Shovel	✓	✓	✓	✓
Caterpillar Rear Dump Trucks 789 (or similar)	✓(3)	✓(3)	✓(3)	✓(3)
Caterpillar Rear Dump Trucks 777(or similar)	✓	✓		✓
Caterpillar Front End Loader 992 – Coal (or similar)	✓	✓		✓
Caterpillar Front End Loader 992 - Overburden (or similar)	✓	✓	✓(2)	✓
Caterpillar Dozer D11 (or similar)	✓(3)	✓(3)		✓(3)
Caterpillar Dozer D10 – Rehabilitation (or similar)	✓			✓
Caterpillar Grader 16G (or similar)	✓	✓		✓
Coal Trucks	✓ (6)	✓ (6)		✓ (6)
Drillteck D40K (or similar)	✓	✓	✓(*)	✓
Caterpillar Watercart 777 (or similar)	✓	✓	✓	✓
Pump	✓	✓		✓

Note: * The drill will only operate at night when the overburden fleet is not operating

7.3 Operational Noise Modelling Results and Discussion

Noise emission levels were predicted from the proposed operation for the typical operational scenario described in **Table 10** including the noise control and management procedures described in **Section 5**. Noise from all sources that contribute to the total noise from the site have been examined to identify characteristics that may cause greater annoyance (for example tonality, impulsiveness etc). The appropriate modifying factors, as outlined in the INP, have been applied where these characteristics are considered to be present. A summary of the predicted operational noise levels from the proposed Bloomfield Project for Years 1, 5 and 10 for worst case receiver locations are contained within **Table 11** to **Table 13**. A summary of predicted noise levels for all receiver locations can be found in **Appendix B**.

Table 11 Predicted Bloomfield Project Noise Levels Year 1

Location	Period	Predicted Noise Level LAeq(15minute) (dBA)			Project Specific Noise Criteria (LAeq)
		Calm	NW Wind	SE Wind	
E Browns Road Black Hill	Day	<30	N/A	N/A	41 dBA
	Evening	<30	N/A	<30	40 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	40	<30	44 dBA
F Black Hill Road Black Hill	Day	<30	N/A	N/A	41 dBA
	Evening	<30	N/A	<30	40 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	41	<30	47 dBA
G Buchanan Road Buchanan	Day	37	N/A	N/A	43 dBA
	Evening	37	N/A	**42**	41 dBA
	Night	<30	<30	**37**	36 dBA
	Morning Shoulder	37	30	40	45 dBA
H Mt Vincent Rd Louth Park	Day	<30	N/A	N/A	43 dBA
	Evening	<30	N/A	32	41 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	<30	32	42 dBA
I Lord Howe Dr. Ashtonfield	Day	<30	N/A	N/A	44 dBA
	Evening	<30	N/A	<30	45 dBA
	Night	<30	<30	<30	38 dBA
	Morning Shoulder	<30	<30	<30	47 dBA
J Kilarney Street Avalon Estate (Thornton)	Day	<30	N/A	N/A	49 dBA
	Evening	<30	N/A	<30	47 dBA
	Night	<30	<30	<30	40 dBA
	Morning Shoulder	<30	<30	<30	53 dBA
K Catholic Diocese (Former Bartter) K1,K2,K3	Day	<30	N/A	N/A	41 dBA
	Evening	<30	N/A	<30	40 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	32	<30	47 dBA
L Kilshanny Avenue Ashtonfield	Day	<30	N/A	N/A	46 dBA
	Evening	<30	N/A	34	46 dBA
	Night	<30	<30	<30	40 dBA
	Morning Shoulder	<30	<30	34	48 dBA
M John Renshaw Drive Buttai	Daytime	39	N/A	N/A	45 dBA
	Evening	39	N/A	36	43 dBA
	Night	<30	**37**	<30	36 dBA
	Morning Shoulder	39	47	36	48 dBA
N Lings Road Buttai	Daytime	42	N/A	N/A	45 dBA
	Evening	42	N/A	42	43 dBA
	Night	34	34	33	36 dBA
	Morning Shoulder	42	42	43	48 dBA

Table 12 Predicted Bloomfield Project Noise Levels Year 5

Location	Period	Predicted Noise Level LAeq(15minute) (dBA)			Project Specific Noise Criteria (LAeq)
		Calm	NW Wind	SE Wind	
E Browns Road Black Hill	Day	<30	N/A	N/A	41 dBA
	Evening	<30	N/A	<30	40 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	39	<30	44 dBA
F Black Hill Road Black Hill	Day	<30	N/A	N/A	41 dBA
	Evening	<30	N/A	<30	40 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	41	<30	47 dBA
G Buchanan Road Buchanan	Day	37	N/A	N/A	43 dBA
	Evening	31	N/A	**42**	41 dBA
	Night	<30	<30	36	36 dBA
	Morning Shoulder	38	33	43	45 dBA
H Mt Vincent Rd Louth Park	Day	<30	N/A	N/A	43 dBA
	Evening	<30	N/A	32	41 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	<30	33	42 dBA
I Lord Howe Dr. Ashtonfield	Day	<30	N/A	N/A	44 dBA
	Evening	<30	N/A	<30	45 dBA
	Night	<30	<30	<30	38 dBA
	Morning Shoulder	<30	<30	<30	47 dBA
J Kilarney Street Avalon Estate (Thornton)	Day	<30	N/A	N/A	49 dBA
	Evening	<30	N/A	<30	47 dBA
	Night	<30	<30	<30	40 dBA
	Morning Shoulder	<30	<30	<30	53 dBA
K Catholic Diocese (Former Bartter) K1,K2,K3	Day	<30	N/A	N/A	41 dBA
	Evening	<30	N/A	<30	40 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	31	<30	47 dBA
L Kilshanny Avenue Ashtonfield	Day	<30	N/A	N/A	46 dBA
	Evening	<30	N/A	33	46 dBA
	Night	<30	<30	<30	40 dBA
	Morning Shoulder	<30	<30	34	48 dBA
M John Renshaw Drive Buttai	Daytime	38	N/A	N/A	45 dBA
	Evening	38	N/A	35	43 dBA
	Night	<30	36	<30	36 dBA
	Morning Shoulder	38	48	36	48 dBA
N Lings Road Buttai	Daytime	34	N/A	N/A	45 dBA
	Evening	31	N/A	34	43 dBA
	Night	<30	32	<30	36 dBA
	Morning Shoulder	35	42	36	48 dBA

Table 13 Predicted Bloomfield Project Noise Levels Year 10

Location	Period	Predicted Noise Level LAeq(15minute) (dBA)			Project Specific Noise Criteria (LAeq)
		Calm	NW Wind	SE Wind	
E Browns Road Black Hill	Day	32	N/A	N/A	41 dBA
	Evening	31	N/A	<30	40 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	31	40	<30	44 dBA
F Black Hill Road Black Hill	Day	30	N/A	N/A	41 dBA
	Evening	<30	N/A	<30	40 dBA
	Night	<30	32	<30	36 dBA
	Morning Shoulder	<30	42	<30	47 dBA
G Buchanan Road Buchanan	Day	39	N/A	N/A	43 dBA
	Evening	34	N/A	**42**	41 dBA
	Night	<30	<30	**37**	36 dBA
	Morning Shoulder	34	33	43	45 dBA
H Mt Vincent Rd Louth Park	Day	<30	N/A	N/A	43 dBA
	Evening	<30	N/A	34	41 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	<30	33	42 dBA
I Lord Howe Dr. Ashtonfield	Day	<30	N/A	N/A	44 dBA
	Evening	<30	N/A	<30	45 dBA
	Night	<30	<30	<30	38 dBA
	Morning Shoulder	<30	<30	<30	47 dBA
J Kilarney Street Avalon Estate (Thornton)	Day	<30	N/A	N/A	49 dBA
	Evening	<30	N/A	<30	47 dBA
	Night	<30	<30	<30	40 dBA
	Morning Shoulder	<30	<30	<30	53 dBA
K Catholic Diocese (Former Bartter) K1,K2,K3	Day	<30	N/A	N/A	41 dBA
	Evening	<30	N/A	<30	40 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	32	<30	47 dBA
L Kilshanny Avenue Ashtonfield	Day	<30	N/A	N/A	46 dBA
	Evening	<30	N/A	35	46 dBA
	Night	<30	<30	<30	40 dBA
	Morning Shoulder	<30	<30	35	48 dBA
M John Renshaw Drive Buttai	Daytime	39	N/A	N/A	45 dBA
	Evening	39	N/A	36	43 dBA
	Night	<30	36	<30	36 dBA
	Morning Shoulder	39	46	35	48 dBA
N Lings Road Buttai	Daytime	31	N/A	N/A	45 dBA
	Evening	<30	N/A	<30	43 dBA
	Night	<30	33	<30	36 dBA
	Morning Shoulder	<30	37	<30	48 dBA

Operational noise levels from the proposed Bloomfield Project are predicted to meet the project specific noise criteria at all receiver locations under calm and prevailing weather conditions with the exception of:

- **Location G** where an exceedance of 1 dBA is predicted during a prevailing south east wind during the evening period in Years 1, 5 and 10 and during the night-time period in Years 1 and 10; and
- **Location M** where an exceedance of 1 dBA is predicted during a prevailing north west wind during the night-time period in Year 1.

These minor exceedance of up to 1 dBA are unlikely to be noticeable by most people. Since the operational scenario modelled is likely to represent an acoustically worst-case scenario, actual operational noise levels from the proposed Bloomfield Project are likely to be less than those predicted.

7.4 Sleep Disturbance Analysis

In assessing sleep disturbance, typical L_{Amax} noise levels of plant and equipment to be used at the subject site during the night was used as input to the ENM acoustic model and predictions were made at the nearest residential areas under adverse weather conditions at night. The use of the L_{Amax} noise level provides a worst-case prediction since the $L_{A1(1minute)}$ noise level of a noise event is likely to be less than the L_{Amax}.

A summary of the predicted maximum noise levels at the most affected locations are contained within **Table 14 to Table 16**.

Table 14 Predicted Maximum Noise Levels at Night during Adverse Weather Year 1

Location	Period	Predicted Noise Level L_{Amax} (dBA)		Sleep Disturbance Criteria (L_{Aeq})
		NW Wind	SE Wind	
E Browns Road Black Hill	Night	34	<30	46 dBA
	Morning Shoulder	34	<30	46 dBA
F Black Hill Road Black Hill	Night	38	32	46 dBA
	Morning Shoulder	39	32	46 dBA
G Buchanan Road Buchanan	Night	<30	39	46 dBA
	Morning Shoulder	<30	39	46 dBA
H Mt Vincent Rd Louth Park	Night	<30	31	46 dBA
	Morning Shoulder	<30	31	46 dBA
I Lord Howe Dr. Ashtonfield	Night	<30	<30	48 dBA
	Morning Shoulder	<30	<30	48 dBA
J Kilarney Street Avalon Estate (Thornton)	Night	<30	<30	50 dBA
	Morning Shoulder	<30	<30	50 dBA
K Catholic Diocese (Former Bartter) K1,K2,K3	Night	42	<30	46 dBA
	Morning Shoulder	42	<30	46 dBA
L Kilshanny Avenue Ashtonfield	Night	<30	<30	53 dBA
	Morning Shoulder	<30	<30	53 dBA
M John Renshaw Drive Buttai	Night	41	31	46 dBA
	Morning Shoulder	46	31	46 dBA
N Lings Road Buttai	Night	41	36	46 dBA
	Morning Shoulder	41	36	46 dBA

Table 15 Predicted Maximum Noise Levels at Night during Adverse Weather Year 5

Location	Period	Predicted Noise Level L_{Amax} (dBA)		Sleep Disturbance Criteria (L_{Aeq})
		NW Wind	SE Wind	
E Browns Road Black Hill	Night	<30	<30	46 dBA
	Morning Shoulder	32	<30	46 dBA
F Black Hill Road Black Hill	Night	36	<30	46 dBA
	Morning Shoulder	36	<30	46 dBA
G Buchanan Road Buchanan	Night	31	43	46 dBA
	Morning Shoulder	32	43	46 dBA
H Mt Vincent Rd Louth Park	Night	<30	<30	46 dBA
	Morning Shoulder	<30	33	46 dBA
I Lord Howe Dr. Ashtonfield	Night	<30	<30	48 dBA
	Morning Shoulder	<30	<30	48 dBA
J Kilarney Street Avalon Estate (Thornton)	Night	<30	<30	50 dBA
	Morning Shoulder	<30	<30	50 dBA
K Catholic Diocese (Former Bartter) K1,K2,K3	Night	<30	<30	46 dBA
	Morning Shoulder	<30	<30	46 dBA
L Kilshanny Avenue Ashtonfield	Night	<30	<30	53 dBA
	Morning Shoulder	<30	34	53 dBA
M John Renshaw Drive Buttai	Night	45	<30	46 dBA
	Morning Shoulder	45	36	46 dBA
N Lings Road Buttai	Night	38	30	46 dBA
	Morning Shoulder	38	36	46 dBA

Table 16 Predicted Maximum Noise Levels at Night during Adverse Weather Year 10

Location	Period	Predicted Noise Level LAmax (dBA)		Sleep Disturbance Criteria (LAeq)
		NW Wind	SE Wind	
E Browns Road Black Hill	Night	36	<30	46 dBA
	Morning Shoulder	40	<30	46 dBA
F Black Hill Road Black Hill	Night	42	<30	46 dBA
	Morning Shoulder	42	<30	46 dBA
G Buchanan Road Buchanan	Night	35	45	46 dBA
	Morning Shoulder	40	**47**	46 dBA
H Mt Vincent Rd Louth Park	Night	<30	32	46 dBA
	Morning Shoulder	<30	31	46 dBA
I Lord Howe Dr. Ashtonfield	Night	<30	<30	48 dBA
	Morning Shoulder	<30	<30	48 dBA
J Kilarney Street Avalon Estate (Thornton)	Night	<30	<30	50 dBA
	Morning Shoulder	<30	<30	50 dBA
K Catholic Diocese (Former Bartter) K1,K2,K3	Night	<30	<30	46 dBA
	Morning Shoulder	32	<30	46 dBA
L Kilshanny Avenue Ashtonfield	Night	<30	<30	53 dBA
	Morning Shoulder	<30	<30	53 dBA
M John Renshaw Drive Buttai	Night	46	30	46 dBA
	Morning Shoulder	46	32	46 dBA
N Lings Road Buttai	Night	40	30	46 dBA
	Morning Shoulder	43	31	46 dBA

The predicted LAmax noise levels from the proposed Bloomfield Project will meet the sleep disturbance criteria at all locations for all operational scenarios considered with the exception of Location G where a 1 dBA exceedance during the morning shoulder period is predicted during a south east wind in Year 10. This 1 dBA exceedance is unlikely to cause sleep disturbance at this location.

7.5 Cumulative Noise Assessment

Existing and proposed mining in the vicinity of the proposed Bloomfield Project includes the existing Bloomfield CHPP (assessed as part of the Abel Coal Mine), existing Donaldson Coal Mine, approved Abel Coal Mine and approved Tasman Coal Mine. Due to its remote location the noise impact of the proposed Tasman Coal Mine will be negligible and therefore has not been considered as part of this assessment.

The potential for the simultaneous operation of the proposed Bloomfield Project, Abel Coal Mine and Donaldson Coal Mine to exceed the acceptable and maximum noise amenity criteria can be assessed on a worst case scenario basis by adding the predicted noise levels from the existing and proposed operations together. The cumulative intrusive level is then adjusted (by -3 dBA) to the equivalent amenity level for comparison with the relevant amenity criteria for each location. The cumulative mine noise amenity levels during calm and adverse weather conditions, for areas with greatest potential for cumulative impact are presented in **Table 17**.

Table 17 Predicted Cumulative Impact Bloomfield Project

Location	Period	Intrusive Predicted Noise Level LAeq(15minute) (dBA)			Cumulative Amenity Level LAeq(period)	Amenity Criteria (LAeq)
		Project Abel	Donaldson Coal	Bloomfield Project		
		Adverse	Adverse	Adverse	Adverse	
D Black Hill School	Day	<30 dBA (calm)	42 dBA	<30 dBA (calm)	39 dBA	55 dBA
	Evening	< 30 dBA	40 dBA	< 30 dBA	38 dBA	45 dBA
	Night	30 dBA	36 dBA	<30 dBA	35 dBA	40 dBA
E Browns Road Black Hill	Day	< 30 dBA (calm)	43 dBA	<30 dBA (calm)	40 dBA	55 dBA
	Evening	< 30 dBA	< 40 dBA	< 30 dBA	38 dBA	45 dBA
	Night	30 dBA	< 36 dBA	<30 dBA	35 dBA	40 dBA
F Black Hill Road Black Hill	Day	< 30 dBA (calm)	43 dBA	<30 dBA (calm)	40 dBA	55 dBA
	Evening	< 30 dBA	< 40 dBA	< 30 dBA	38 dBA	45 dBA
	Night	33 dBA	< 36 dBA	<30 dBA	36 dBA	40 dBA
G Buchanan Road Buchanan	Day	< 30 dBA (calm)	< 30 dBA	37 dBA (calm)	36 dBA	55 dBA
	Evening	< 30 dBA	< 30 dBA	42 dBA	39 dBA	45 dBA
	Night	< 30 dBA	< 30 dBA	37 dBA	36 dBA	40 dBA
H Mt Vincent Rd Louth Park	Day	< 30 dBA (calm)	< 30 dBA	<30 dBA (calm)	32 dBA	55 dBA
	Evening	< 30 dBA	< 30 dBA	32 dBA	32 dBA	45 dBA
	Night	< 30 dBA	< 30 dBA	<30 dBA	32 dBA	40 dBA
I Lord Howe Dr. Ashtonfield	Day	< 30 dBA (calm)	< 31 dBA	<30 dBA (calm)	32 dBA	55 dBA
	Evening	36 dBA	< 31 dBA	< 30 dBA	35 dBA	45 dBA
	Night	36 dBA	< 31 dBA	<30 dBA	35 dBA	40 dBA
K Catholic Diocese Land K1,K2,K3	Day	< 30 dBA (calm)	44 dBA	<30 dBA (calm)	41 dBA	55 dBA
	Evening	< 30 dBA	43 dBA	< 30 dBA	40 dBA	45 dBA
	Night	37 dBA	38 dBA	<30 dBA	38 dBA	40 dBA
L Kilshanny Avenue Ashtonfield	Day	33 dBA (calm)	< 31 dBA	<30 dBA (calm)	33 dBA	55 dBA
	Evening	40 dBA	< 31 dBA	34 dBA	38 dBA	45 dBA
	Night	40 dBA	< 38 dBA	<30 dBA	39 dBA	40 dBA
M John Renshaw Drive Buttai	Day	< 30 dBA (calm)	43 dBA	39 dBA (calm)	41 dBA	55 dBA
	Evening	< 30 dBA	< 40 dBA	39 dBA	40 dBA	45 dBA
	Night	33 dBA	< 36 dBA	37 dBA	38 dBA	40 dBA
N Lings Road Buttai	Day	< 30 dBA (calm)	43 dBA	42 dBA (calm)	43 dBA	55 dBA
	Evening	< 30 dBA	< 40 dBA	42 dBA	41 dBA	45 dBA
	Night	33 dBA	< 36 dBA	34 dBA	36 dBA	40 dBA

n/a: the meteorological condition is not relevant during this period

The results contained in **Table 17** show that the cumulative impact of mining in the area surrounding the Bloomfield Project will comply with the relevant amenity criteria set in accordance with the INP.

8 USE OF EXPLOSIVES

8.1 Blasting Practice

Existing blast designs at Bloomfield Mine vary depending on the location of the blast in relation to sensitive residences. A typical blast design is presented in **Table 18**.

Table 18 Typical Blast Design

Blast Design Parameter	Typical Dimension
Number of holes	195 average
Hole diameter	229 mm
Spacing	5 m
Burden	5.5 m
Maximum Instantaneous Charge (MIC)	115 kg average

8.2 Blasting Emissions Criteria

The DECC has set down guidelines for blasting based on human comfort levels. The guidelines have been adapted from the ANZECC Guidelines "*Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration"* and are as follows:

Airblast

The recommended maximum level for airblast is 115 dB Linear Peak.

The level of 115 dB may be exceeded on up to 5% of the total number of blasts over a period of 12 months. However, the level should not exceed 120 dB Linear Peak at any time.

Ground Vibration

The recommended maximum level for ground vibration is 5 mm/s (peak particle velocity [ppv]). It is recommended that a level of 2 mm/s be considered as a long term regulatory goal.

The ppv level of 5 mm/s may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 10 mm/s at any time.

Times and Frequency of Blasting

Blasting should only generally be permitted during the hours of 9.00 am to 5.00 pm Monday to Saturday. Blasting should not take place on Sundays or Public Holidays.

Blasting should generally take place no more than once per day.

8.3 Assessment of Blasting Impacts

In order to predict the levels of blast emissions (ground vibration and airblast) at the surrounding receivers from the proposed Bloomfield Project, the measured ground vibration and airblast levels from recent blasting operations conducted in 2006 and 2007 were used to develop blast emissions site laws.

8.4 Blast Emissions Site Laws

For each site law, using statistical analysis of the measured data and assuming a log-normal distribution of data, a 95% confidence line and 50% confidence levels were determined. The ground vibration and airblast criteria advocated by the DECC and ANZECC (refer to **Section 8.1**), cater for the inherent variation in emission levels from a given blast design by allowing a five percent exceedance of a general criterion up to a (never to be exceeded) maximum. Correspondingly, the "5% exceedance" (95% confidence) levels have been used in the blast emission site laws.

The 5% site laws for ground vibration and airblast are:

Ground Vibration

$$PVS\ (5\%) = 3743\ (SD_1)^{-1.6}$$

Airblast

$$SPL(5\%) = 170 - 25 \log (SD_2)$$

where PVS (5%) and SPL (5%) are the levels of ground vibration (Peak Vector Sum - mm/s) and airblast (dB Linear) respectively, above which 5% of the total population (of data points) will lie, assuming that the population has the same statistical distribution as the underlying measured sample.

SD_1 and SD_2 are the ground vibration and airblast scaled distances, where:

$$SD1 = \frac{\text{Distance}}{\sqrt{MIC}} \quad (m.kg^{-0.5})$$

and,

$$SD2 = \frac{\text{Distance}}{3\sqrt{MIC}} \quad (m.kg^{-0.33})$$

where MIC is maximum instantaneous explosive charge in kg.

Predicted Levels of Blast Emission

The levels of airblast and ground vibration have been predicted using the developed site laws for the mine for each of the three stages of mine development considered, assuming current blasting practice. The maximum instantaneous charge (MIC) will vary, and be limited, depending on the location of the area being mined and its relation to the nearest affected receiver. Site laws are currently used to design the MIC for each individual blast based on the limit at the nearest affected receiver. This will continue to be the practice for future mine development. Currently, MIC levels near the southern boundary of the development vary up to 200 kg depending on the orientation and depth of face being fired.

A summary of the results for the closest affected receivers is contained within **Table 19** to **Table 21**. The results contained within these tables reflect the levels that would be experienced when blasting at the nearest point to residential receivers during each stage of development.

Table 19 Blasting Prediction Year 1

Residential Location		Predicted Mine Blasting Level*	
		Airblast dB Linear	Ground Vibration mm/s
A	Weakleys Drive Beresfield	89.9	0.1
B	Yarrum Road Beresfield	85.5	0.1
C	Phoenix Road Black Hill (Ebenezer Park)	86.8	0.1
D	Black Hill School	95.9	0.3
E	Browns Road Black Hill	98.9	0.5
F	Black Hill Road Black Hill	97.8	0.5
G	Buchanan Road Buchanan	99.1	0.6
H	Mt Vincent Rd Louth Park	94.9	0.3
I	Lord Howe Dr. Ashtonfield	88.5	0.1
J	Kilarney Street Avalon Estate (Thornton)	88.0	0.1
K	Catholic Diocese	90.2	0.2
L	Kilshanny Avenue Ashtonfield	91.5	0.2
M	John Renshaw Drive Buttai	104.3	1.2
N	Lings Road Buttai	113.7	4.8

Note: * Predicted level based on MIC of approximately 90 kg

Table 20 Blasting Prediction Year 5

Residential Location		Predicted Mine Blasting Level*	
		Airblast dB Linear	Ground Vibration mm/s
A	Weakleys Drive Beresfield	90.8	0.1
B	Yarrum Road Beresfield	86.4	0.1
C	Phoenix Road Black Hill (Ebenezer Park)	87.6	0.1
D	Black Hill School	97.2	0.5
E	Browns Road Black Hill	98.9	0.6
F	Black Hill Road Black Hill	97.9	0.5
G	Buchanan Road Buchanan	102.1	1.0
H	Mt Vincent Rd Louth Park	96.5	0.4
I	Lord Howe Dr. Ashtonfield	89.4	0.1
J	Kilarney Street Avalon Estate (Thornton)	88.9	0.1
K	Catholic Diocese	90.9	0.2
L	Kilshanny Avenue Ashtonfield	92.6	0.2
M	John Renshaw Drive Buttai	103.5	1.2
N	Lings Road Buttai	113.0	4.8

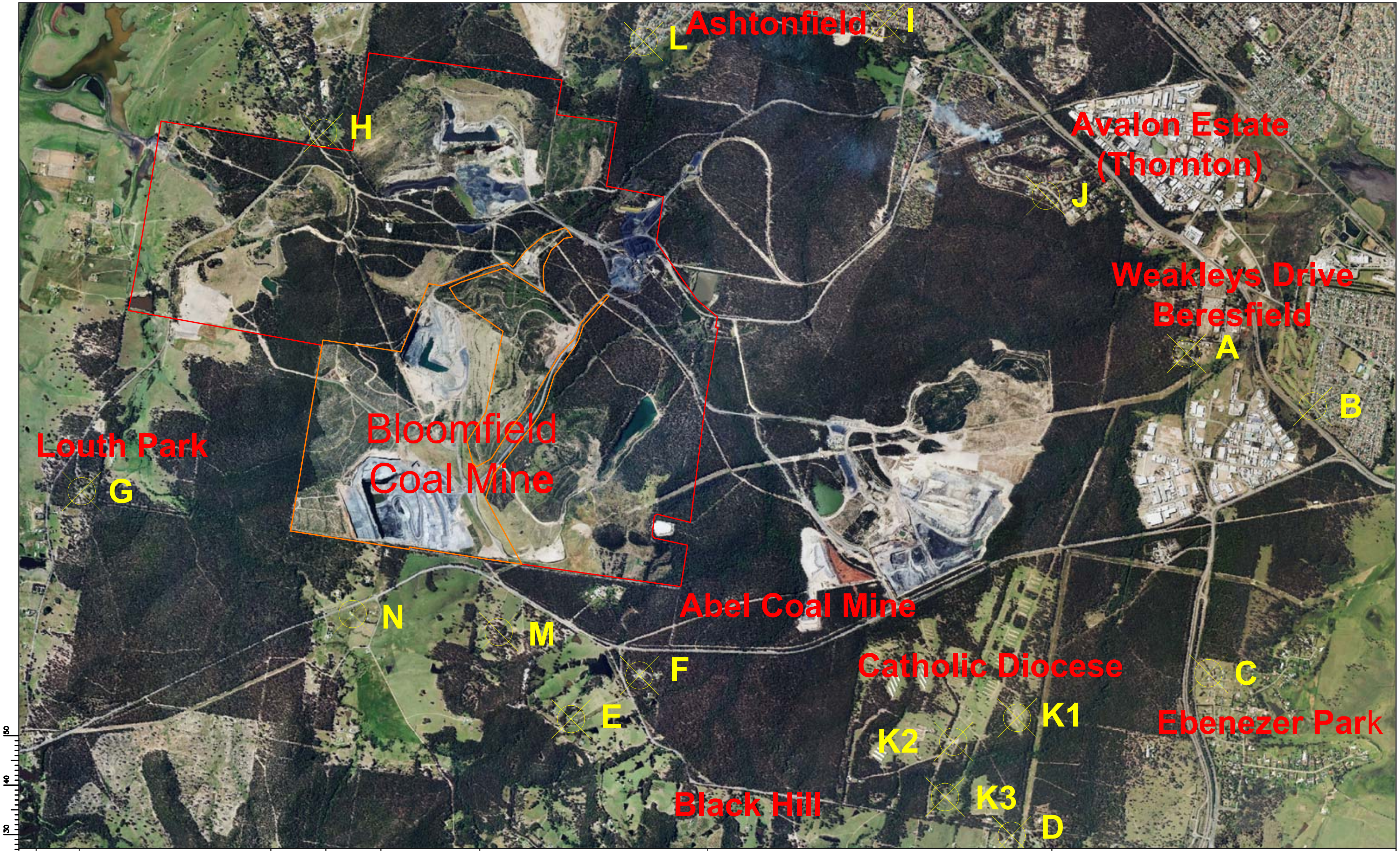
Note: * Predicted level based on MIC of approximately 130 kg

Table 21 Blasting Prediction Year 10

Residential Location		Predicted Mine Blasting Level*	
		Airblast dB Linear	Ground Vibration mm/s
A	Weakleys Drive Beresfield	92.3	0.2
B	Yarrum Road Beresfield	87.9	0.1
C	Phoenix Road Black Hill (Ebenezer Park)	88.8	0.2
D	Black Hill School	96.8	0.5
E	Browns Road Black Hill	98.7	0.7
F	Black Hill Road Black Hill	98.1	0.6
G	Buchanan Road Buchanan	104.4	1.5
H	Mt Vincent Rd Louth Park	100.2	0.8
I	Lord Howe Dr. Ashtonfield	91.5	0.2
J	Kilarney Street Avalon Estate (Thornton)	90.7	0.2
K	Catholic Diocese	91.8	0.2
L	Kilshanny Avenue Ashtonfield	95.1	0.4
M	John Renshaw Drive Buttai	102.6	1.2
N	Lings Road Buttai	107.9	2.6

Note: * Predicted level based on MIC of approximately 200 kg

The blast prediction results presented in **Table 19** to **Table 21** demonstrate that predicted airblast and ground vibration levels will meet the DECC guidelines for blasting at all residences surrounding the development during all operational stages of the Bloomfield Project.



N Assessed Receiver Location

Project Application Area

CCL 761

Heggies Pty Ltd
Level 1, 14 Watt Street
PO Box 1768
Newcastle NSW 2300
Email address newcastle@heggies.com.au
Telephone 02 4908 4500 Facsimilie 02 4908 4501

Appendix A
Bloomfields Noise & Blasting
Impact Assessment
Location Map

REV	DATE	AMENDMENT / ISSUE DESCRIPTION	PREPARED	CHECKED
0	6/5/07	v01r0	DW	JC

FILE NAME:	DRAWING No.	REVISION
30-1573 Appendix A.dwg	001	0

Predicted Bloomfield Project Noise Levels Year 1

Location	Period	Predicted Noise Level LAeq(15minute) (dBA)			Project Specific Noise Criteria (LAeq)
		Calm	NW Wind	SE Wind	
A Weakleys Drive Beresfield	Day	<30	N/A	N/A	50 dBA
	Evening	<30	N/A	<30	48 dBA
	Night	<30	<30	<30	41 dBA
	Morning Shoulder	<30	<30	<30	53 dBA
B Yarrum Road Beresfield	Day	<30	N/A	N/A	50 dBA
	Evening	<30	N/A	<30	48 dBA
	Night	<30	<30	<30	41 dBA
	Morning Shoulder	<30	<30	<30	53 dBA
C Phoenix Road Black Hill (Ebenezer Park)	Day	<30	N/A	N/A	43 dBA
	Evening	<30	N/A	<30	44 dBA
	Night	<30	<30	<30	38 dBA
	Morning Shoulder	<30	<30	<30	47 dBA
D Black Hill School	Day	<30	N/A	N/A	41 dBA
	Evening	<30	N/A	<30	40 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	30	<30	46 dBA
E Browns Road Black Hill	Day	<30	N/A	N/A	41 dBA
	Evening	<30	N/A	<30	40 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	40	<30	44 dBA
F Black Hill Road Black Hill	Day	<30	N/A	N/A	41 dBA
	Evening	<30	N/A	<30	40 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	41	<30	47 dBA
G Buchanan Road Buchanan	Day	37	N/A	N/A	43 dBA
	Evening	37	N/A	**42**	41 dBA
	Night	<30	<30	**37**	36 dBA
	Morning Shoulder	37	30	40	45 dBA
H Mt Vincent Rd Louth Park	Day	<30	N/A	N/A	43 dBA
	Evening	<30	N/A	32	41 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	<30	32	42 dBA
I Lord Howe Dr. Ashtonfield	Day	<30	N/A	N/A	44 dBA
	Evening	<30	N/A	<30	45 dBA
	Night	<30	<30	<30	38 dBA
	Morning Shoulder	<30	<30	<30	47 dBA
J Kilarney Street Avalon Estate (Thornton)	Day	<30	N/A	N/A	49 dBA
	Evening	<30	N/A	<30	47 dBA
	Night	<30	<30	<30	40 dBA
	Morning Shoulder	<30	<30	<30	53 dBA
K Catholic Diocese (Former Bartter) K1,K2,K3	Day	<30	N/A	N/A	41 dBA
	Evening	<30	N/A	<30	40 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	32	<30	47 dBA
L Kilshanny Avenue Ashtonfield	Day	<30	N/A	N/A	46 dBA
	Evening	<30	N/A	34	46 dBA
	Night	<30	<30	<30	40 dBA
	Morning Shoulder	<30	<30	34	48 dBA
M John Renshaw Drive Buttai	Daytime	39	N/A	N/A	45 dBA
	Evening	39	N/A	36	43 dBA
	Night	<30	**37**	<30	36 dBA
	Morning Shoulder	39	47	36	48 dBA
N Lings Road Buttai	Daytime	42	N/A	N/A	45 dBA
	Evening	42	N/A	42	43 dBA
	Night	34	34	33	36 dBA
	Morning Shoulder	42	42	43	48 dBA

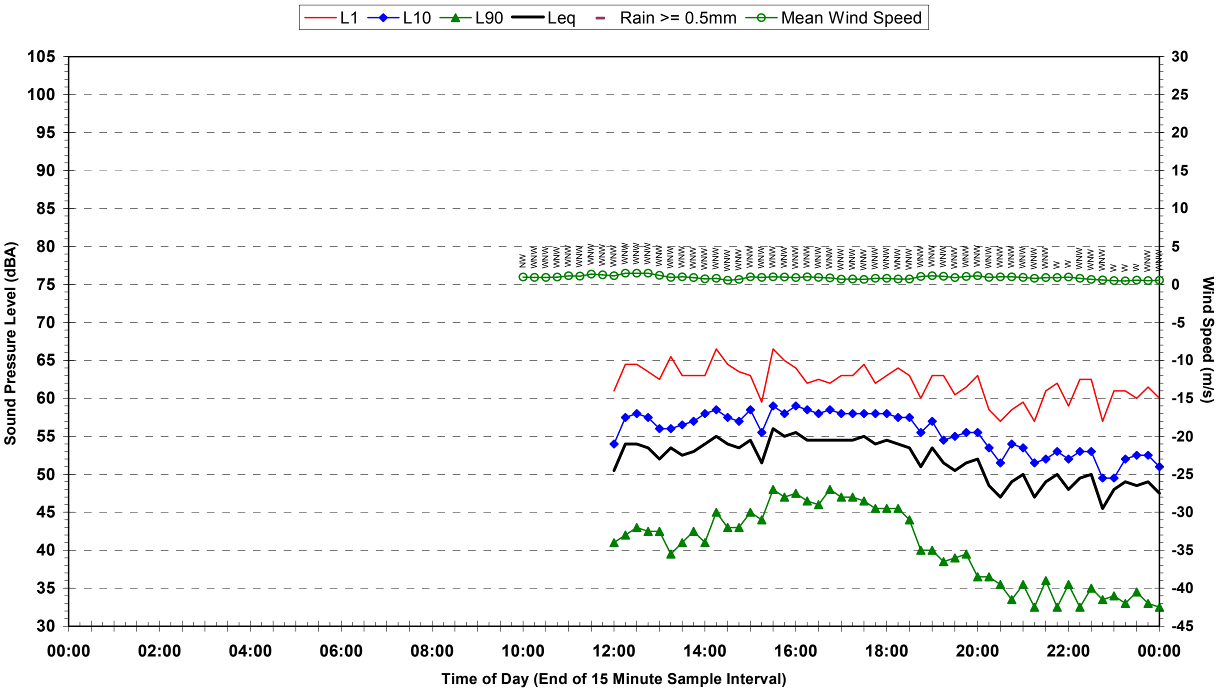
Predicted Bloomfield Project Noise Levels Year 5

Location	Period	Predicted Noise Level LAeq(15minute) (dBA)			Project Specific Noise Criteria (LAeq)
		Calm	NW Wind	SE Wind	
A Weakleys Drive Beresfield	Day	<30	N/A	N/A	50 dBA
	Evening	<30	N/A	<30	48 dBA
	Night	<30	<30	<30	41 dBA
	Morning Shoulder	<30	<30	<30	53 dBA
B Yarrum Road Beresfield	Day	<30	N/A	N/A	50 dBA
	Evening	<30	N/A	<30	48 dBA
	Night	<30	<30	<30	41 dBA
	Morning Shoulder	<30	<30	<30	53 dBA
C Phoenix Road Black Hill (Ebenezer Park)	Day	<30	N/A	N/A	43 dBA
	Evening	<30	N/A	<30	44 dBA
	Night	<30	<30	<30	38 dBA
	Morning Shoulder	<30	<30	<30	47 dBA
D Black Hill School	Day	<30	N/A	N/A	41 dBA
	Evening	<30	N/A	<30	40 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	<30	<30	46 dBA
E Browns Road Black Hill	Day	<30	N/A	N/A	41 dBA
	Evening	<30	N/A	<30	40 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	39	<30	44 dBA
F Black Hill Road Black Hill	Day	<30	N/A	N/A	41 dBA
	Evening	<30	N/A	<30	40 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	41	<30	47 dBA
G Buchanan Road Buchanan	Day	37	N/A	N/A	43 dBA
	Evening	31	N/A	**42**	41 dBA
	Night	<30	<30	36	36 dBA
	Morning Shoulder	38	33	43	45 dBA
H Mt Vincent Rd Louth Park	Day	<30	N/A	N/A	43 dBA
	Evening	<30	N/A	32	41 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	<30	33	42 dBA
I Lord Howe Dr. Ashtonfield	Day	<30	N/A	N/A	44 dBA
	Evening	<30	N/A	<30	45 dBA
	Night	<30	<30	<30	38 dBA
	Morning Shoulder	<30	<30	<30	47 dBA
J Kilarney Street Avalon Estate (Thornton)	Day	<30	N/A	N/A	49 dBA
	Evening	<30	N/A	<30	47 dBA
	Night	<30	<30	<30	40 dBA
	Morning Shoulder	<30	<30	<30	53 dBA
K Catholic Diocese (Former Bartter) K1,K2,K3	Day	<30	N/A	N/A	41 dBA
	Evening	<30	N/A	<30	40 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	31	<30	47 dBA
L Kilshanny Avenue Ashtonfield	Day	<30	N/A	N/A	46 dBA
	Evening	<30	N/A	33	46 dBA
	Night	<30	<30	<30	40 dBA
	Morning Shoulder	<30	<30	34	48 dBA
M John Renshaw Drive Buttai	Daytime	38	N/A	N/A	45 dBA
	Evening	38	N/A	35	43 dBA
	Night	<30	36	<30	36 dBA
	Morning Shoulder	38	48	36	48 dBA
N Lings Road Buttai	Daytime	34	N/A	N/A	45 dBA
	Evening	31	N/A	34	43 dBA
	Night	<30	32	<30	36 dBA
	Morning Shoulder	35	42	36	48 dBA

Predicted Bloomfield Project Noise Levels Year 10

Location	Period	Predicted Noise Level LAeq(15minute) (dBA)			Project Specific Noise Criteria (LAeq)
		Calm	NW Wind	SE Wind	
A Weakleys Drive Beresfield	Day	<30	N/A	N/A	50 dBA
	Evening	<30	N/A	<30	48 dBA
	Night	<30	<30	<30	41 dBA
	Morning Shoulder	<30	<30	<30	53 dBA
B Yarrum Road Beresfield	Day	<30	N/A	N/A	50 dBA
	Evening	<30	N/A	<30	48 dBA
	Night	<30	<30	<30	41 dBA
	Morning Shoulder	<30	<30	<30	53 dBA
C Phoenix Road Black Hill (Ebenezer Park)	Day	<30	N/A	N/A	43 dBA
	Evening	<30	N/A	<30	44 dBA
	Night	<30	<30	<30	38 dBA
	Morning Shoulder	<30	<30	<30	47 dBA
D Black Hill School	Day	<30	N/A	N/A	41 dBA
	Evening	<30	N/A	<30	40 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	<30	<30	46 dBA
E Browns Road Black Hill	Day	32	N/A	N/A	41 dBA
	Evening	31	N/A	<30	40 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	31	40	<30	44 dBA
F Black Hill Road Black Hill	Day	30	N/A	N/A	41 dBA
	Evening	<30	N/A	<30	40 dBA
	Night	<30	32	<30	36 dBA
	Morning Shoulder	<30	42	<30	47 dBA
G Buchanan Road Buchanan	Day	39	N/A	N/A	43 dBA
	Evening	34	N/A	**42**	41 dBA
	Night	<30	<30	**37**	36 dBA
	Morning Shoulder	34	33	43	45 dBA
H Mt Vincent Rd Louth Park	Day	<30	N/A	N/A	43 dBA
	Evening	<30	N/A	34	41 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	<30	33	42 dBA
I Lord Howe Dr. Ashtonfield	Day	<30	N/A	N/A	44 dBA
	Evening	<30	N/A	<30	45 dBA
	Night	<30	<30	<30	38 dBA
	Morning Shoulder	<30	<30	<30	47 dBA
J Kilarney Street Avalon Estate (Thornton)	Day	<30	N/A	N/A	49 dBA
	Evening	<30	N/A	<30	47 dBA
	Night	<30	<30	<30	40 dBA
	Morning Shoulder	<30	<30	<30	53 dBA
K Catholic Diocese (Former Bartter) K1,K2,K3	Day	<30	N/A	N/A	41 dBA
	Evening	<30	N/A	<30	40 dBA
	Night	<30	<30	<30	36 dBA
	Morning Shoulder	<30	32	<30	47 dBA
L Kilshanny Avenue Ashtonfield	Day	<30	N/A	N/A	46 dBA
	Evening	<30	N/A	35	46 dBA
	Night	<30	<30	<30	40 dBA
	Morning Shoulder	<30	<30	35	48 dBA
M John Renshaw Drive Buttai	Daytime	39	N/A	N/A	45 dBA
	Evening	39	N/A	36	43 dBA
	Night	<30	36	<30	36 dBA
	Morning Shoulder	39	46	35	48 dBA
N Lings Road Buttai	Daytime	31	N/A	N/A	45 dBA
	Evening	<30	N/A	<30	43 dBA
	Night	<30	33	<30	36 dBA
	Morning Shoulder	<30	37	<30	48 dBA

Statistical Ambient Noise Levels
30-1573 Lings Road, Buttai - Thursday 31 May 2007



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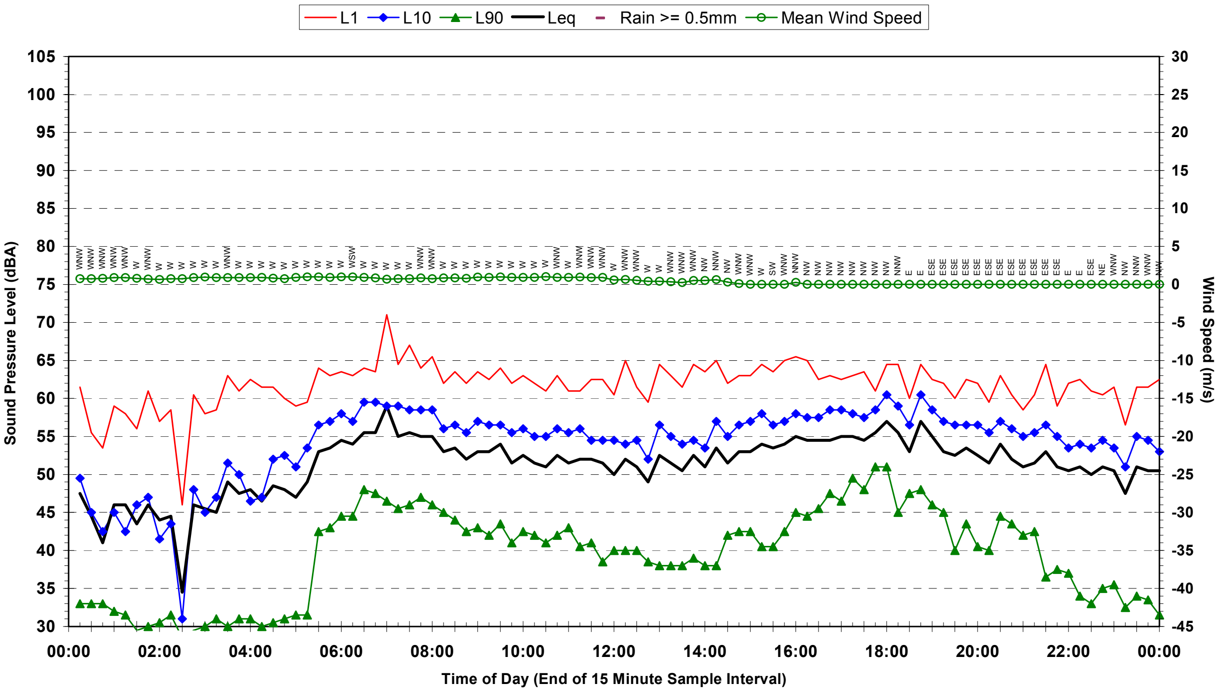

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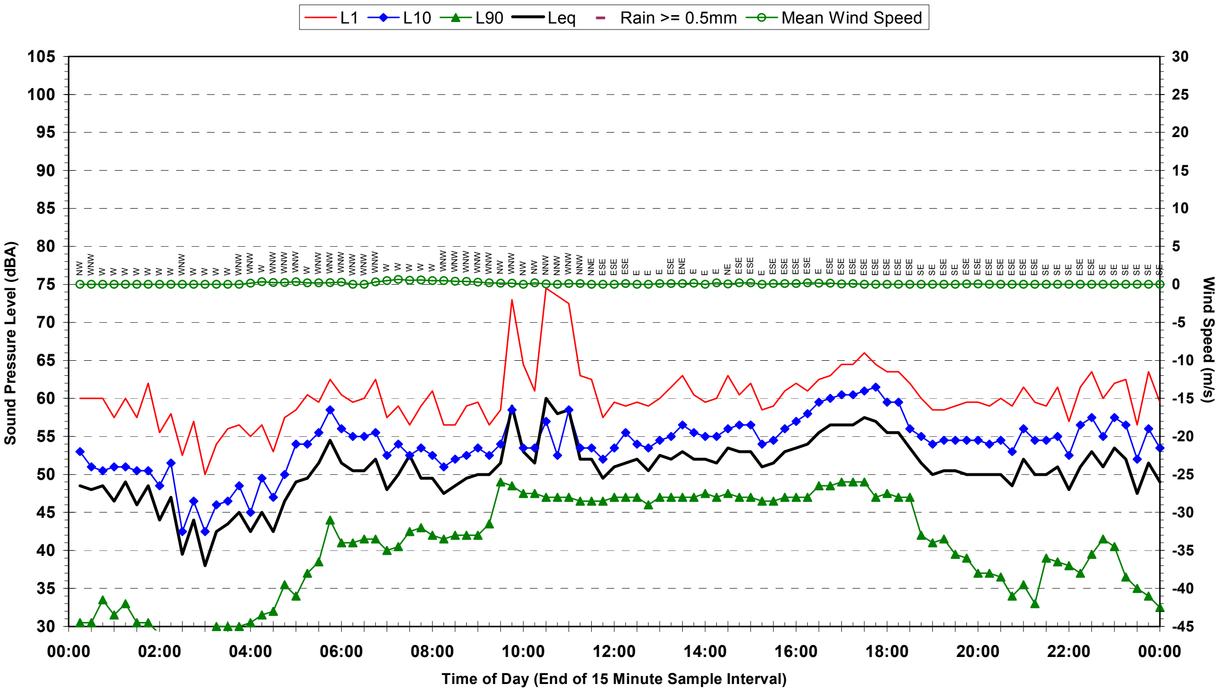

Statistical Ambient Noise Levels
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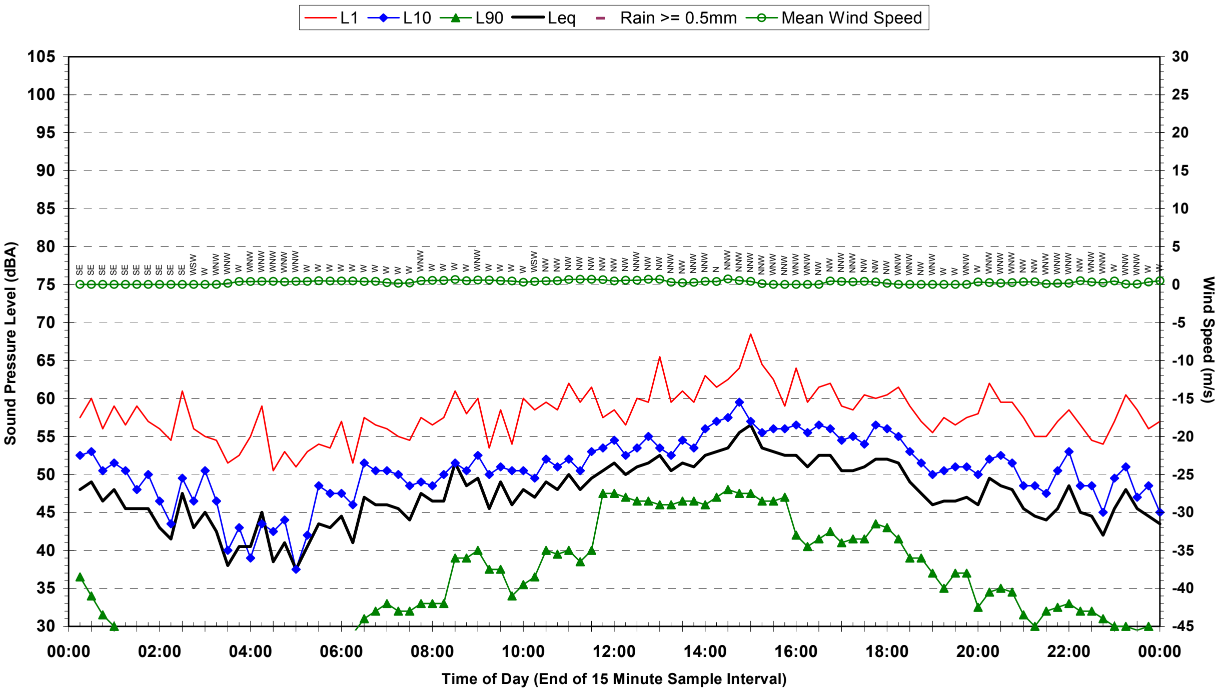
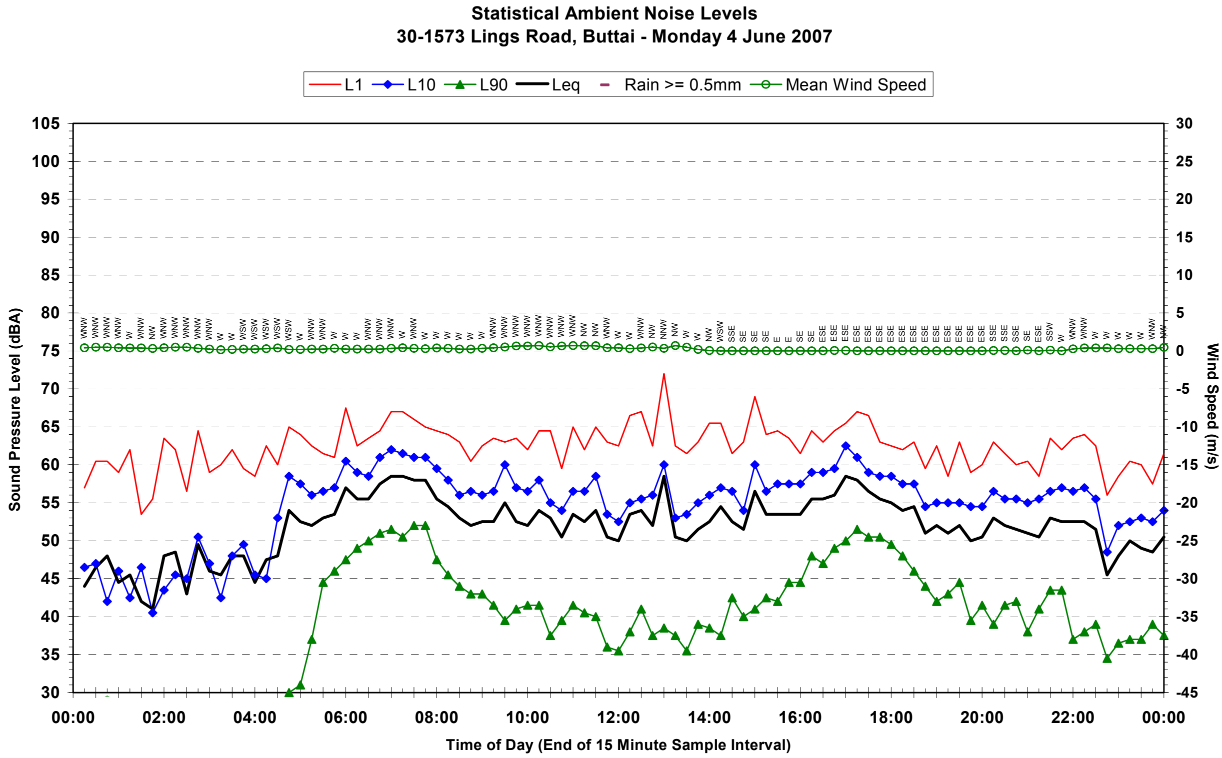
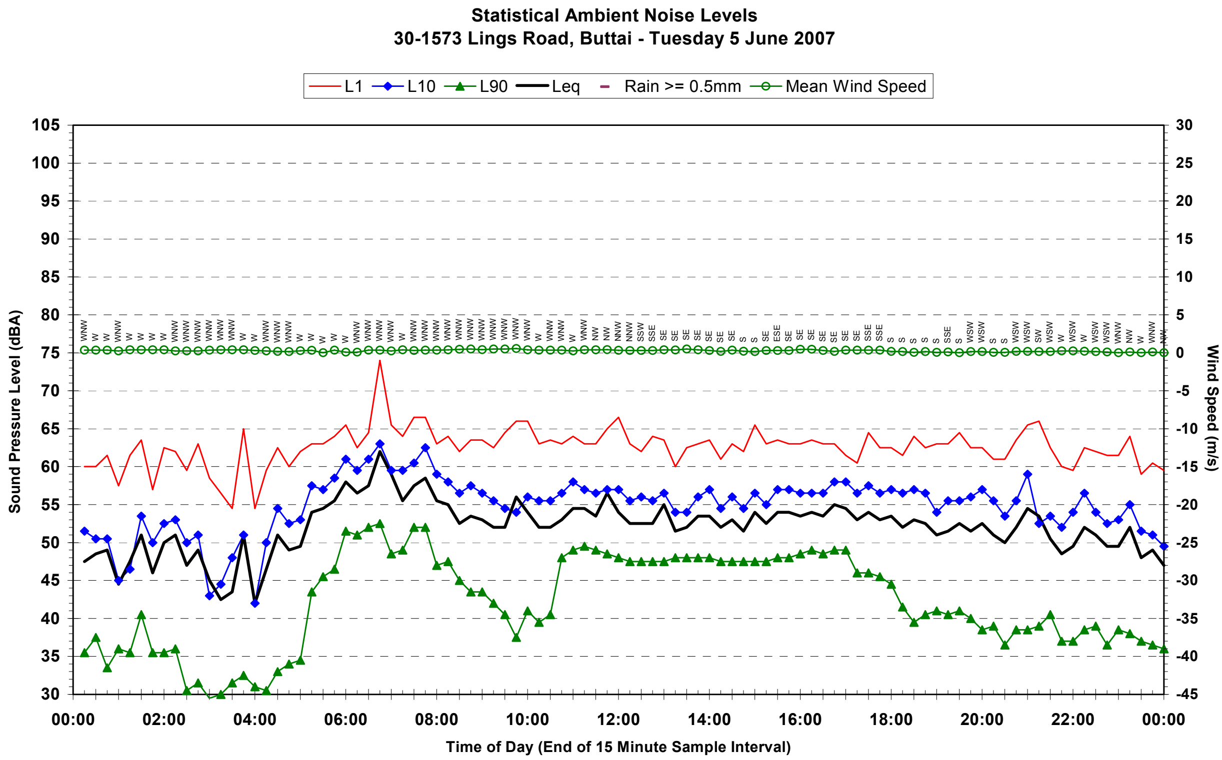
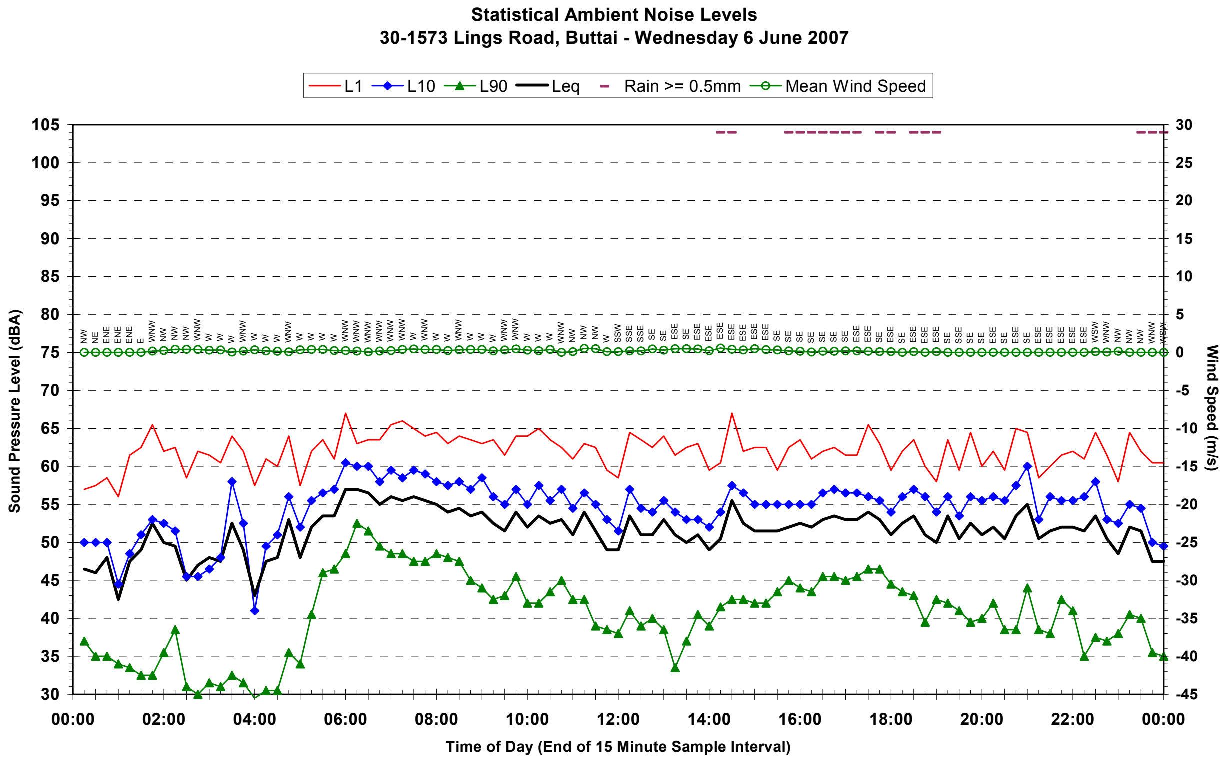
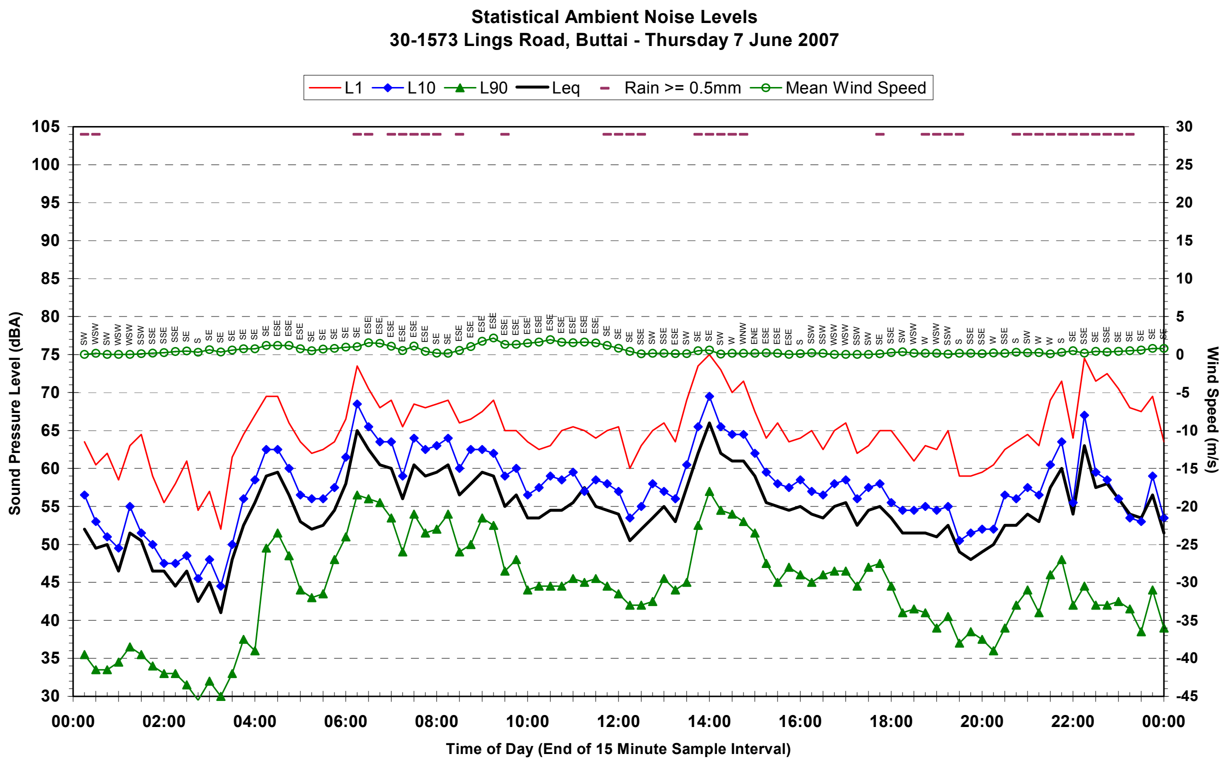



Statistical Ambient Noise Levels
30-1573 Lings Road, Buttai - Monday 4 June 2007
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sample Interval)

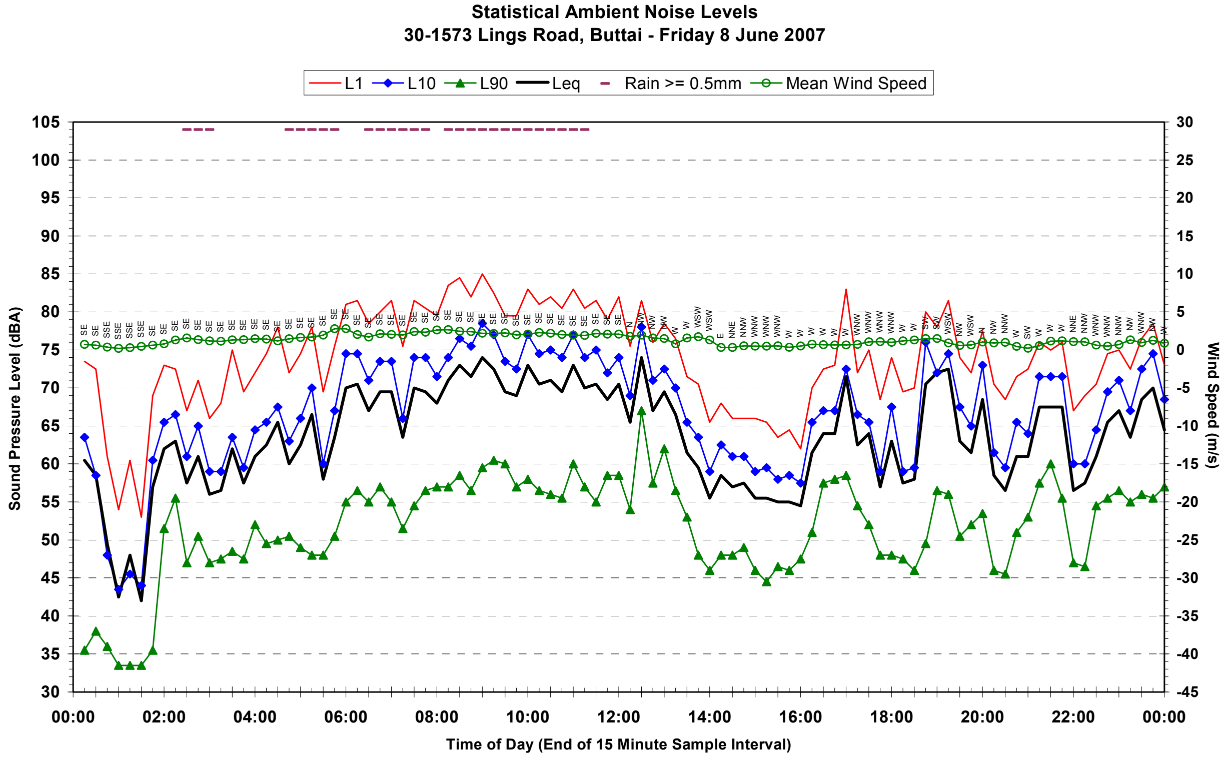

Statistical Ambient Noise Levels
30-1573 Lings Road, Buttai - Tuesday 5 June 2007
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sample Interval)

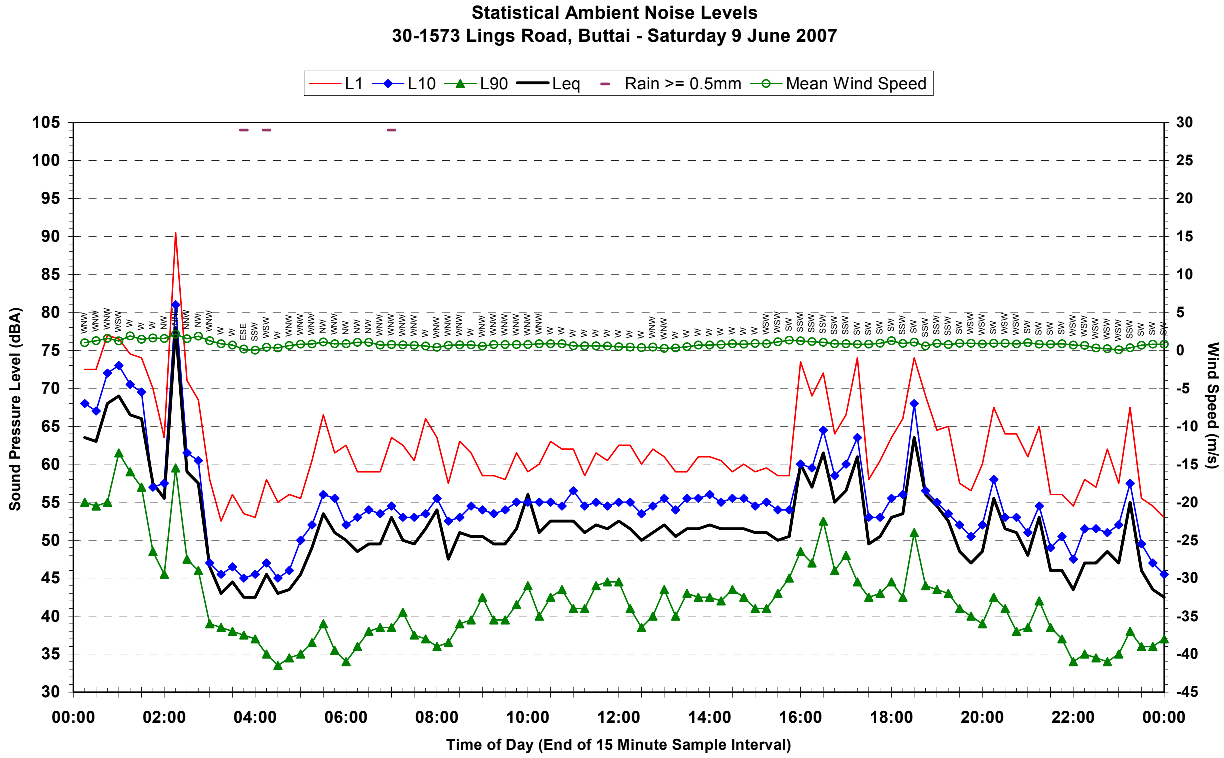


Statistical Ambient Noise Levels
30-1573 Lings Road, Buttai - Wednesday 6 June 2007
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sample Interval)

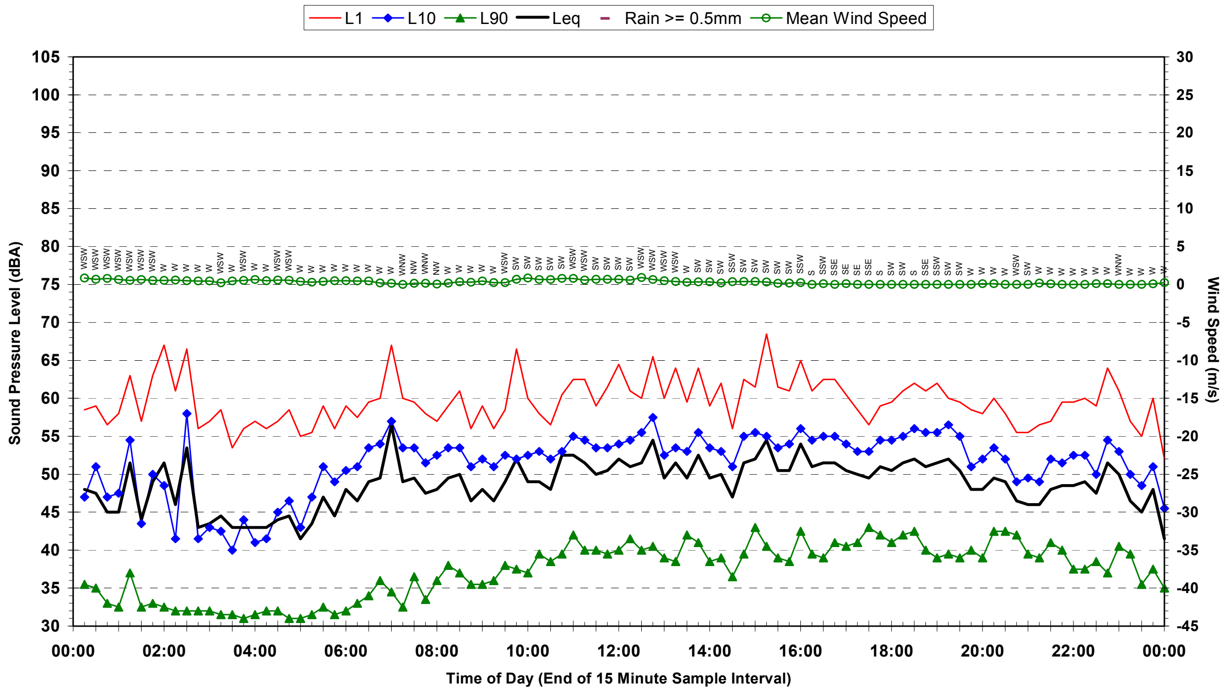


Statistical Ambient Noise Levels
30-1573 Lings Road, Buttai - Thursday 7 June 2007
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sample Interval)

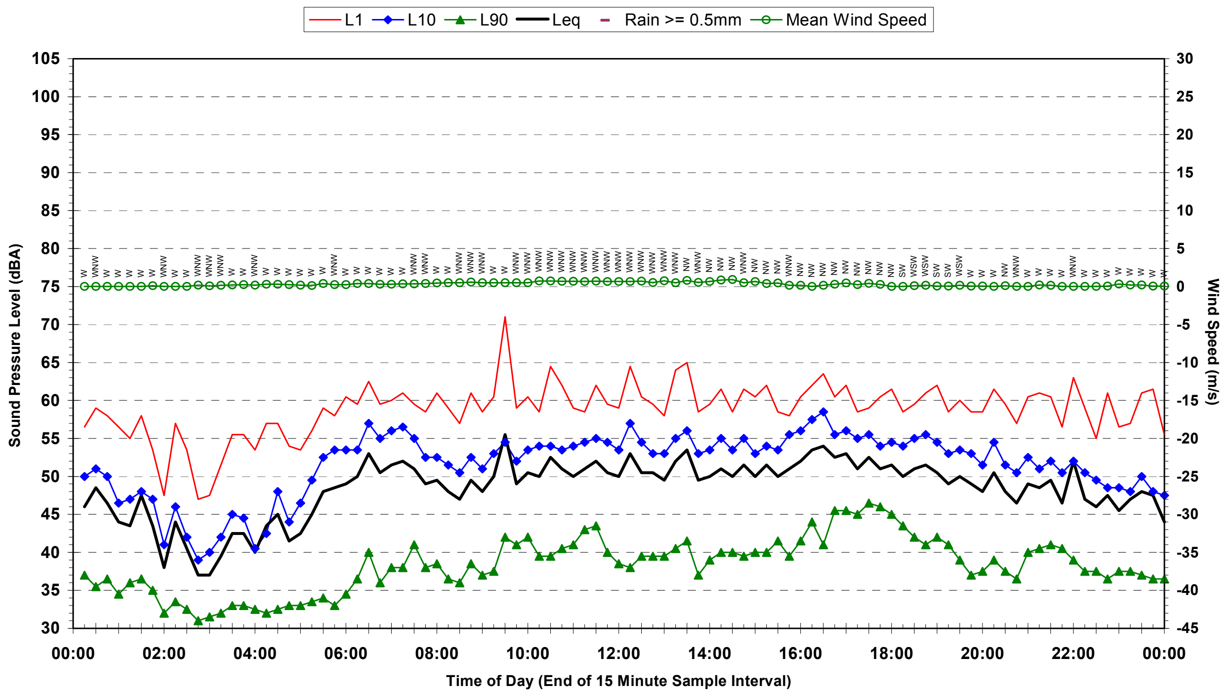

Statistical Ambient Noise Levels
30-1573 Lings Road, Buttai - Friday 8 June 2007
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
30-1573 Lings Road, Buttai - Saturday 9 June 2007
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sample Interval)

Statistical Ambient Noise Levels
30-1573 Lings Road, Buttai - Sunday 10 June 2007



Statistical Ambient Noise Levels
30-1573 Lings Road, Buttai - Monday 11 June 2007



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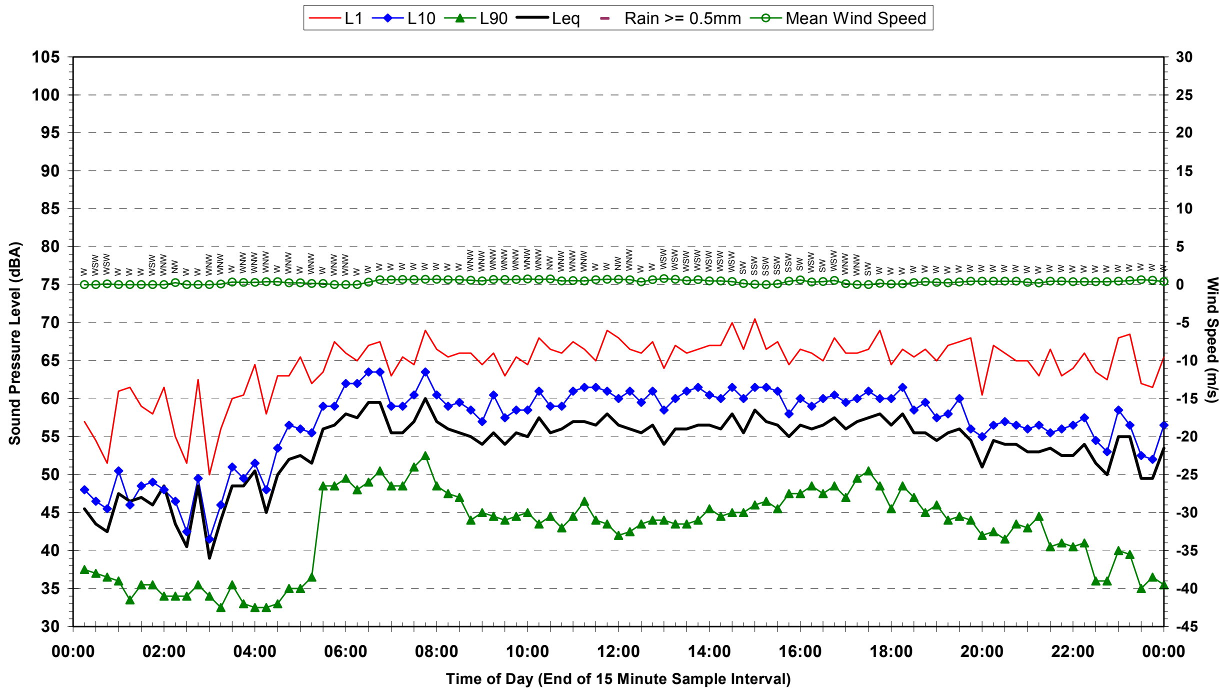

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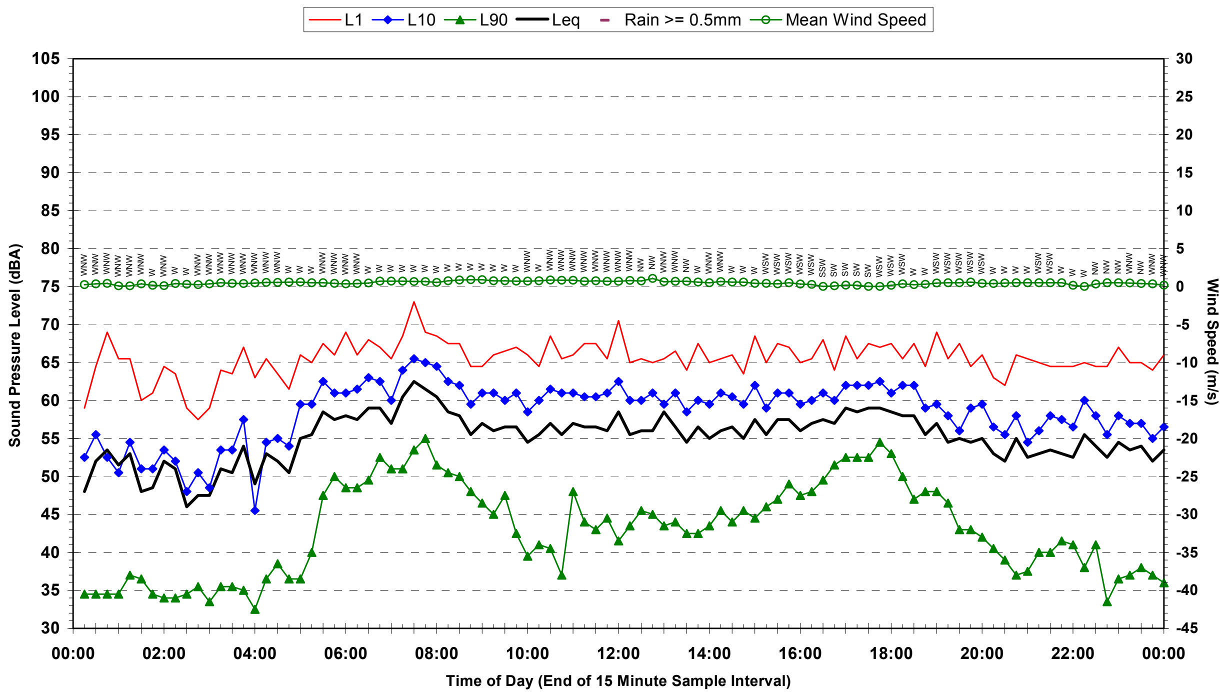
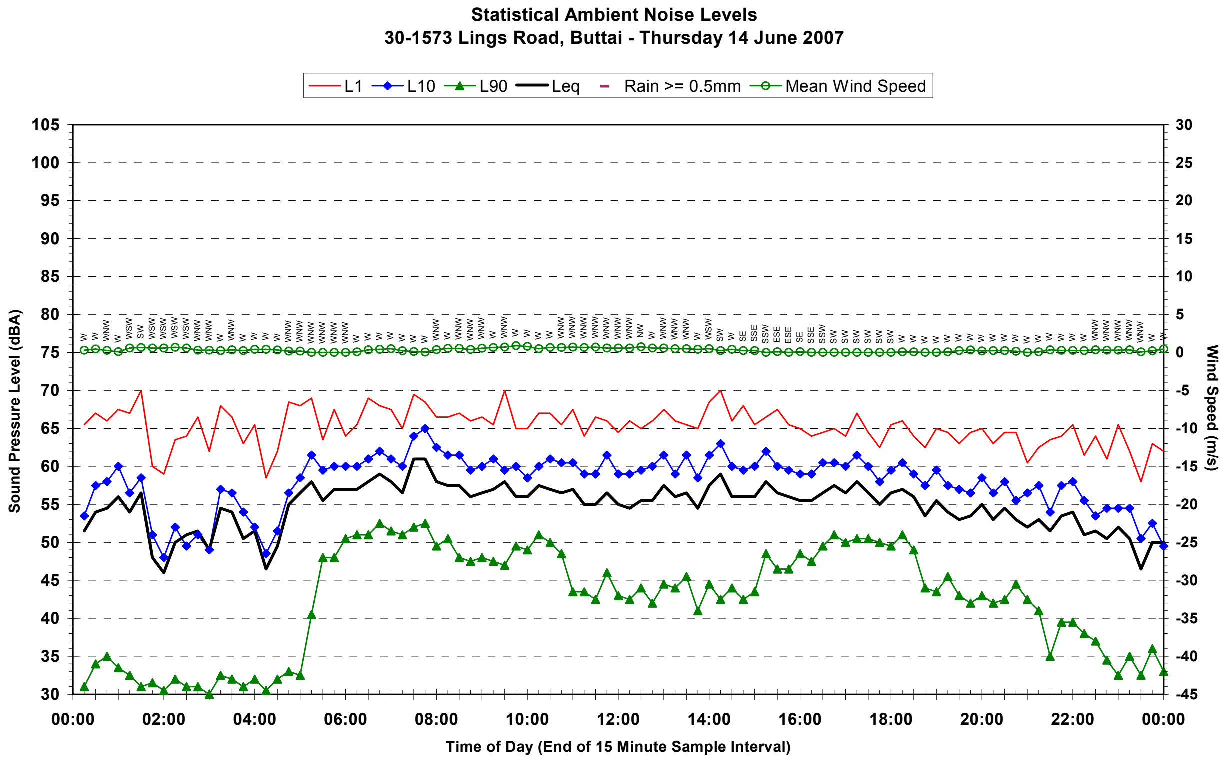
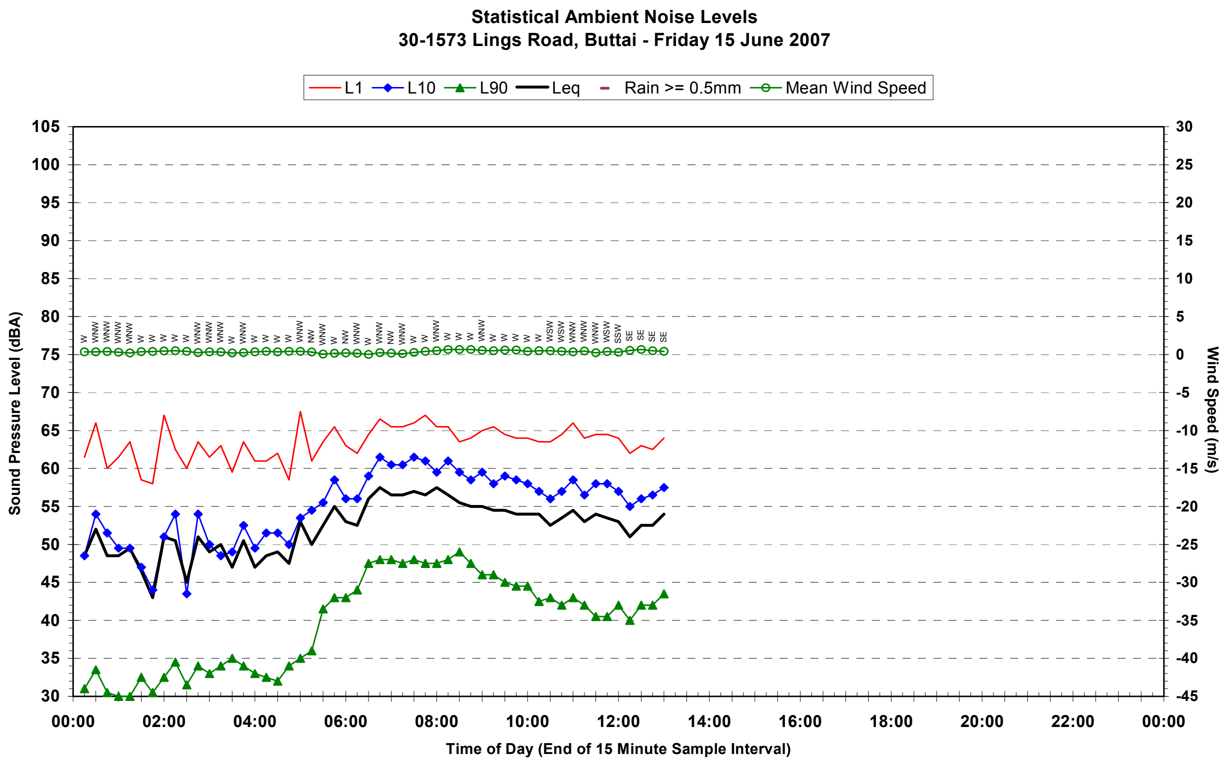




Statistical Ambient Noise Levels
30-1573 Lings Road, Buttai - Thursday 14 June 2007
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sample Interval)



Statistical Ambient Noise Levels
30-1573 Lings Road, Buttai - Friday 15 June 2007
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sample Interval)

Equipment Description	Sound Power Level (SWL) Octave Band Centre Frequency (Hz) - dBL re 1pW										dBA Overall SWL
	31.5	63	125	250	500	1k	2k	4k	8k	16k	
Hitachi Excavator 5500	54	78	96	103	103	109	110	108	102	90	115
P&H 9020 Face Shovel	62	84	93	103	103	111	114	110	104	90	117
Caterpillar Rear Dump Trucks 789	67	82	93	103	106	106	105	104	96	81	112
Caterpillar Rear Dump Trucks 777[1]	67	82	93	103	106	106	105	104	96	81	112
Caterpillar Front End Loader 992	77	90	99	103	103	106	107	110	104	91	114
Caterpillar Dozer D11	67	84	97	104	113	113	109	110	103	90	118
Caterpillar Dozer D10[2]	67	84	97	104	113	113	109	110	103	90	118
Caterpillar Grader 16G	53	70	81	98	103	104	105	105	99	90	111
Coal Truck (road-going)	41	56	74	80	88	90	92	93	89	84	98
Reedrill D40K	110	110	110	110	107	104	104	96	88	88	110
Caterpillar Watercart 777	39	54	67	76	80	84	85	84	78	72	90
Pump	57	73	96	106	104	110	113	111	105	96	117

Notes: [1] SWL of a Caterpillar Rear Dump Truck 789 has been used to represent a worst case scenario.
[2] SWL of a Caterpillar Dozer D11 has been used to represent a worst case scenario.

Appendix G

Air Quality Assessment

Bloomfield Colliery Completion of Mining and Rehabilitation

Part 3A Environmental Assessment

November 2008

Draft

AIR QUALITY ASSESSMENT: BLOOMFIELD MINE

8 September 2008

Prepared for
Bloomfield Collieries Pty Ltd

by

Holmes Air Sciences
Suite 2B, 14 Glen Street
Eastwood NSW
ACN 003 741 035
ABN 79 003 741 035

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Fax (02) 9874 8904
Email Nigel.Holmes@holmair.com.au
ACN: 003-741-035

CONTENTS

LIST OF TABLES

LIST OF FIGURES (all figures are at the end of the report)

1 INTRODUCTION

This report has been prepared by Holmes Air Sciences on behalf of Bloomfield Collieries Pty Ltd (Bloomfield). It provides an air quality assessment for the continuation of mining at the Bloomfield Open Cut Coal Mine, located near Maitland in the lower Hunter Valley. Bloomfield proposes to extend mining operations to the west and north of the current open cut mine operations.

The overall approach to the assessment follows the "*Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*" (**DECC, 2005**) using a level 2 assessment. The approach uses the ISCMOD dispersion model (see later) with estimated emissions (taking account of control measures) and local meteorological data to predict dust concentration and deposition levels arising from the proposal for selected stages in the life of the mine. After making appropriate allowances for existing levels of dust the predicted values have been compared with the assessment criteria published by the NSW Department of Environment and Climate Change (DECC).

In summary, the report provides information on:

- the local setting
- the way in which the proposal will be operated
- existing air quality
- assessment criteria that are used to assess the acceptability or otherwise of the predicted dust concentration and deposition levels
- dispersion conditions in the area
- the approach used in the modelling
- the estimated emissions from the project for four representative stages
- the results of the modelling and an assessment of impacts
- greenhouse gas emissions

2 IDENTIFICATION OF ISSUES

The continuation of existing mining operations will result in the liberation of a number of classes of particulate matter (PM) namely total suspended particulate matter (TSP)[1], particulate matter with equivalent aerodynamic diameters of 10 μm or less (PM_{10})[2] and particles with equivalent aerodynamic diameters of 2.5 μm and less ($PM_{2.5}$). These emissions would occur primarily as fugitive dust from open cut mining operations.

There will also be exhaust emissions from diesel-powered haul trucks and other open cut mining equipment. These emissions will include carbon monoxide (CO), minor quantities of sulfur dioxide (SO_2), nitrogen dioxide (NO_2) and PM_{10}. (Greenhouse gases (including CO_2) are assessed separately). In practice, the gaseous emissions will be minor and the sources too widely dispersed across the mine site to cause ambient concentrations that could give rise to environmental impacts. Emissions of particulate matter from the exhausts of diesel-powered mining equipment will automatically be taken into account in the assessment of dust emissions. This is because they are included in the

[1] TSP is particulate matter suspended in the air and measured using a high volume sampler operated according to AS2724.3-1984. The size range of particles is indeterminate and depends on the measurement conditions. TSP is usually taken to comprise particles in the size range up to 0 to 50 μm. Particles larger than 50 μm are generally too large to remain suspended in the air for long enough to be considered as air pollutants.

[2] A particle is said to have an equivalent aerodynamic diameter of x μm if its dynamical behavior in the atmosphere is the same as a sphere of diameter x and with density 1 g/cm^3.

estimates of emissions when the emission-factor equations used for estimating fugitive emissions are applied.

Because of the low concentrations of gaseous emissions compared with the assessment criteria, the focus of the assessment will be on potential impacts due to emissions of PM.

3 LOCAL SETTING

Figure 1 shows the location of Bloomfield Collieries and the surrounding urban areas of Beresfield and Maitland. **Figure 2** shows a more detailed view of the project, showing the location of the mine, the lease boundary, the project area[3] and infrastructure including stockpiles, the coal handling and preparation plant (CHPP), rail loop, internal roads and current mine operations.

Figure 3 shows a pseudo 3-dimensional representation of the terrain in the area of the mine and surrounds. The elevation of the terrain shown in **Figure 3** (excluding the open cut pits) ranges from close to sea-level up to 214 m above sea-level. Much of the higher ground and steeper slopes retain moderately dense woodland cover. Land within the lease area that has not been disturbed by mining, or for mining infrastructure, also retains a moderately dense woodland cover. The surrounding non-mining land is either bushland or has been cleared and is used for farming and residential use.

Two other mining operations exist in the area to the east of Bloomfield. These are the Donaldson Open Cut and the Abel Underground Mines. Bloomfield, Donaldson and Abel make use of a common CHPP and also operate stockpiles in the same area. They also share the same rail loop. These activities were approved as part of the Abel Underground Mine Project (Donaldson Coal 2006).

4 PROJECT DESCRIPTION

The proposal deals with the continuation of mining and the rehabilitation of affected areas over five stages (four mining stages and one rehabilitation stage), which will occur during a ten year period. Average production rates during each stage will be the same as current rates, being an average of 880,000 tpa ROM coal and 500,000 tpa product coal extracted. Maximum future ROM coal production rates may be as high as 1.3 Mtpa and the assessment is based on the maximum levels.

Table 1. Overburden, ROM coal and product coal production levels

Phase	Overburden (bcm)	ROM coal (t)	Activity[4] North	Activity South
Stage 1	4618950	880,000	58%	42%
Stage 2	8,125,000	1,300,000		
Stage 2	8,125,000	1,300,000		
Stage 2	8,125,000	1,300,000		
Stage 2	8,125,000	1,300,000		
Stage 3	8,125,000	1,300,000	48%	52%
Stage 3	8,125,000	1,300,000		
Stage 4	8,125,000	1,300,000	19%	81%
Stage 4	8,125,000	1,300,000		
Stage 4	8,125,000	1,300,000		

[3] The area to be mined

[4] Activity refers to the approximately quantity of coal and overburden that is expected to be handled in each of the two main mining areas – North and South

Stage 4	8,125,000	1,300,000	0%	100%

The air quality effects of the mine will change with time as the mining and waste emplacement areas vary over the life of the mine. To assess the range of air quality effects the project has been assessed over the four stages, being:

- Current (Year 1)
- Year 1 to 5
- Year 5 to 7
- Year 7 to 10

Some rehabilitation will occur in Years 10 to 12 but the emissions from this would be less than that from mining in Years 7 to 10.

The model simulations for Year 1 allow the model predictions to be compared with historical monitoring data, which assists in establishing background levels for particulate matter.

The new area to be disturbed by mining occupies approximately 200 hectares at the southern half of the lease boundary.

The assessment envisages working within a ROM coal production average of up to 1.3 Mtpa of ROM coal with 8.125 bcm of overburden removed. The overburden will be transported to the emplacement areas using rear dump trucks. This would include soil being stripped and stockpiled for later use in the rehabilitation work, which will involve the establishment of a growth media layer for revegetation of the final rehabilitated landform. Overburden will need to be drilled and blasted.

Figure 2 shows the overburden and active mining zone. The following stages will move generally in a northward and westerly direction towards the Creek Cut area. For these years the total amount of ROM coal removed from the mine will be split between the Creek Cut and S Cut zones (see **Figure 2**) in the ratio indicated in **Table 1**. For modelling purposes these ratios have been applied to overburden and coal production activities to determine the intensity of the activity in the north or south. **Figures 3** and **4** show clearly where dust sources are assumed to be located for each scenario assessed.

It is estimated that an average of 500,000 tpa of product coal will be produced and transported from the CHPP to customers via the rail loop (see **Figure 2**) however the assessment is based on a future ROM coal production level of 1.3 Mtpa, which corresponds to a product coal production of approximately 812,000 tpa. The ROM coal and product coal will be transported using 40 t semi trailer or similar from the active mining zone to the Bloomfield CHPP. It is estimated that 275,000 tpa of reject materials will be produced and transported back to the disturbed area.

Figures 4 and **5** show the source locations used in the modelling for each of the four stages simulated in the modelling. These figures can be used to precisely identify the locations of the mining areas and the haul routes assumed for each of the model runs. Each numbered point on the plans show the location of a dust emission source used in the model and the number can be used to identify exactly which dust source have been allocated to a particular area. To do this in detail requires access to the computer emissions files used in the modelling. These will be provided on request. However the figures allows readers familiar with the operation of an open cut mine to identify the pits, overburden dumps, coal processing areas and haul roads without access to the computer emission files.

As noted earlier, ROM coal from the neighbouring Abel and Donaldson coal mines will also be processed at the Bloomfield CHPP. The emissions from these mines and from the ROM coal processed at the Bloomfield CHPP have been included in the cumulative modelling.

5 AIR QUALITY ASSESSMENT CRITERIA

5.1 Particulate matter

Table 2 and **Table 3** summarise the assessment criteria that will be used to assess the significance of predicted deposition and concentration levels that arise from the project. The PM_{10} criteria in **Table 2** are used to relate predicted concentrations to potential health effects. These assessment criteria relate to the total PM burden in the air and not just that from the project. This means that it will be necessary to consider the effects of PM emissions from other mining operations and other sources of PM, as well as emissions from Bloomfield.

Table 2. Air quality assessment criteria for particulate matter concentrations (Source: DECC, 2005)

POLLUTANT	STANDARD / GOAL	AVERAGING PERIOD	AGENCY
Total suspended particulate matter (TSP)	90 $\mu g/m^3$	Annual mean	National Health and Medical Research Council (NSW DECC, 2005)
Particulate matter < 10 μm (PM_{10})	50 $\mu g/m^3$	24-hour maximum	NSW DECC (2005)
	30 $\mu g/m^3$	Annual mean	NSW DECC (2005) (long-term reporting goal)
	50 $\mu g/m^3$	(24-hour average, 5 exceedances permitted per year)	National Environment Protection Measure (NEPC, 1998)

$\mu g/m^3$ – micrograms per cubic metre
μm - micrometre

5.2 Dust deposition

In addition to health impacts, airborne dust also has the potential to cause nuisance impacts by depositing on surfaces, for example washing, motor cars, verandas, outdoor furniture and on vegetation/crops. **Table 3** shows the maximum acceptable increase in dust deposition over the existing dust levels from an amenity perspective. It also shows the maximum acceptable level. The criteria for dust fallout levels are set to protect against nuisance impacts (**DECC, 2005**).

Table 3. DECC criteria for dust (insoluble solids) fallout

Pollutant	**Averaging period**	**Maximum increase in deposited dust level**	**Maximum total deposited dust level**
Deposited dust	Annual	2 g/m^2/month	4 g/m^2/month

6 EXISTING AIR QUALITY

6.1 Dust (insoluble solids) deposition

Bloomfield has operated a network of dust deposition gauges for a considerable period. The locations of the gauges are shown in **Figure 1** and the results showing the annual average dust (insoluble solids) deposition rates since 1998 are summarised in **Table 4**. Note five of the ten gauges are within the lease boundary.

Table 4. Insoluble solids deposition rate - $g/m^2/month$

Gauge → Year ↓	1	2	3	4	5	6	7	8	9	10
Ann. 1998	1.2	2.3	1.8	1.7	2.0	2.6	1.7	1.1		
Ann. 1999	1.5	2.4	1.8	1.1	1.9	1.7	1.8	1.3		
Ann. 2000	1.4	2.0	1.3	0.8	1.2	3.4	1.9	1.1		
Ann. 2001	1.3	1.7	1.4	5.9	1.4	2.3	2.1	1.2	1.5	1.9
Ann. 2002	1.5	1.8	1.2	4.6	1.7	2.2	2.1	1.7	1.3	2.2
Ann. 2004	1.4	1.5	1.0	5.8	1.1	2.0	1.5	1.5	0.9	1.0
Ann. 2005	3.4	1.9	1.1	2.9	1.0	1.6	1.4	1.4	0.9	1.4
Ann. 2006	2.6	2.0	1.5	3.8	2.7	1.5	1.7	1.4	1.4	1.9
Ann. 2007	2.7	3.0	2.5	4.9	2.4	2.5	2.3	3.3	2.0	2.5

Note the data for 2007: is not a complete year. It relates to the period January to April inclusive.

Since 1998 all dust gauges except for D4, have recorded annual average deposition levels lower than the DECC's annual average assessment criterion of 4 $g/m^2/month$ for insoluble solids. The exception D4, is situated within the existing mining lease and well removed from residential areas. **Appendix A** shows the data in a more complete form and illustrates the monthly variations as well as the annual averages.

Note these observations include the effects of existing operations at Bloomfield and Donaldson as well as all other sources of PM that are active e.g. traffic, and emission from industrial and domestic activities in Newcastle and the surrounding urban and industrial areas.

6.2 Dust concentration data

No TSP or PM_{10} concentration data are collected as part of the Bloomfield Mine's air quality monitoring. However, continuous data on PM_{10} concentrations are available from the DECC's monitoring station at Beresfield (see **Figure 1**) and TSP and PM_{10} concentrations (one-day-in-six-basis) are available from the Donaldson Mine's monitors at Blackhill (see HV2 on **Figure 1**). Data from December 1999 to October 2007 (see **Figure 6**) show that there have been 31 occasions when the 24-hour average PM_{10} concentration at Beresfield has exceeded the DECC's criteria of 50 $\mu g/m^3$, there has been only one such occasion in the past 12 months (October 2007). Similarly, since December 1999 there have been nine occasions when 24-hour average PM_{10} concentration (measured every sixth day) has exceeded 50 $\mu g/m^3$ at the Blackhill monitor. None of these has occurred in the last 12 months.

Note these observations include the effects of existing operations at Bloomfield, Donaldson and Abel as well as the other industrial, domestic and other sources referred to in **Section 6.1**.

The annual average PM_{10} concentration (running mean) at Beresfield exceeded the DECC 30 $\mu g/m^3$ criterion for a period running from late 2002 to the end of 2003, but has been below the criterion since that time. The annual average PM_{10} concentration at Blackhill has not exceeded the criterion since monitoring commenced in December 1999. The annual average TSP concentration at Blackhill has also been lower than the DECC 90 $\mu g/m^3$ criterion since monitoring commenced.

Although emissions from mining at Donaldson and Bloomfield will theoretically contribute to concentrations of PM_{10} and TSP at the Beresfield and Blackhill sites, modelling of emissions presented in the Donaldson EIS indicates that the contributions are likely to be small and are unlikely to have caused, or contributed significantly to the measured exceedances. The higher concentrations at both the Beresfield and Blackhill sites occur on the same days (see **Figure 6**). Therefore the highest concentrations measured are most likely to be due to regional air pollution from bushfires or other, non-mining, events that cause elevated levels over wide areas.

7 METEOROLOGICAL CONDITIONS

7.1 Wind speed and wind direction

A meteorological station has been operated since 1999 as part of the Donaldson Project environmental monitoring program. The weather station is located on the mine site but is unavoidably affected by the trees. Therefore, the weather station's exposure does not comply with Australian Standard 2923-1987, which specifies the requirements for the exposure of weather stations used to collect wind speed and wind direction data for modelling. For this reason, the modelling work has been undertaken using data from the nearby DECC meteorological station at Beresfield (see **Figure 1**). It is nevertheless interesting to compare the meteorological conditions recorded onsite with the conditions recorded at the DECC monitoring site.

Wind roses prepared from the DECC's weather station for the period 1 August 2004 to 31 July 2005 at Beresfield are shown in **Figure 7**. Seasonal and annual wind roses for the Donaldson Mine's meteorological station for 2004 are presented in **Figure 8**. The two sites show a similar distribution of winds, but the Donaldson site shows a much higher frequency of light winds. This is not unexpected given the shielding effect of the vegetation on the mine site. The winds at Beresfield also appear to be rotated slightly, approximately 20 degrees or so clockwise, relative to the mine site data. The reason for this slight deflection of the winds is not immediately obvious, but may be due to local topographical effects.

The wind roses show that over the year the most common winds are from the west, west-northwest and east-southeast and southeast. Westerlies are most common in the winter and the south-easterlies in the summer. Autumn and spring show an intermediate pattern between that which applies in the summer and the winter.

Since the DECC's meteorological station is in a better exposed position it has been used for the modelling. If in practice the Donaldson meteorological data was more representative of the conditions at Bloomfield, the use of the DECC's data would tend to show dust being transported further to the south (in winter) and the north (in summer) than might actually be the case (i.e. tend to indicate higher concentration and deposition levels for locations to the south and north than would be the case in reality). Since the closest residences are to the south of the proposed extended Bloomfield open cut mining area, the use of the DECC data will be conservative.

7.2 Temperature and rainfall

Bureau of Meteorology data from the East Maitland Bowling Club provide a longer record of temperature, humidity and rainfall data than is available from either the Donaldson or DECC weather stations, and the Bureau of Meteorology's data set is useful for identifying the range of values that might be expected for these parameters. The Bureau of Meteorology's data are shown in **Table 5**.

January is the warmest month with a mean daily maximum temperature of 30.7 ^{o}C and July is the coolest with a mean daily minimum temperature of 5.8 ^{o}C.

Rainfall data, in particular the number of rain days that can be expected per year, is of particular importance in estimating dust emissions from wind erosion. Over approximately 82 years of records, there have been approximately 84.7 rain days per year.

Table 5. Bureau of Meteorology data from East Maitland Bowling Club

Climate averages for Station: 061034 EAST MAITLAND BOWLING CLUB Commenced: 1902; Last record: 1994; Latitude (deg S): -32.7483; Longitude (deg E): 151.5833; State: NSW														
Element	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	No. of years	Percen tage
Mean daily maximum temperature - deg C	30.7	29.6	27.7	24.3	20.1	17.1	16.5	18.6	21.9	25.3	28.3	30.1	24.2	91.3	83
Mean no. of days where Max Temp >= 40.0 deg C	1.3	0.5	0.3	0	0	0	0	0	0	0	0	0.5	2.5	3.3	91
Mean no. of days where Max Temp >= 35.0 deg C	5.8	6.5	2.3	0	0	0	0	0	0.3	0.7	3.7	2.5	21.7	3.3	91
Mean no. of days where Max Temp >= 30.0 deg C	11.8	12.8	10.8	2.7	0	0	0	0	1.7	4.3	9.3	9.5	62.8	3.3	91
Highest daily Max Temp - deg C	41.1	42.8	40	33.3	29.4	23.9	22.8	28.3	35.6	38.3	39.4	40	42.8	3.3	93
Mean daily minimum temperature - deg C	17.6	17.6	15.7	12.3	8.9	7	5.8	6.8	8.9	11.8	14.3	16.4	11.9	91.3	83
Mean no. of days where Min Temp <= 2.0 deg C	0	0	1	0	3.7	7.3	8.3	2.7	0.7	0	0	0	23.6	3.3	91
Mean no. of days where Min Temp <= 0.0 deg C	0	0	0.3	0	0.3	3.7	3	0.7	0	0	0	0	7.9	3.3	91
Lowest daily Min Temp - deg C	7.2	11.1	-6.7	3.9	0	-2.8	-2.9	0	0.6	4.4	5	7.8	-6.7	3.3	88
Mean 9am wind speed - km/h	6.9	8.5	6.3	5.8	4.7	6.7	13	6.9	7.8	7.2	9.7	5.7	7.5	2.1	60
Mean monthly rainfall - mm	89	94.1	96.5	87.4	70.3	84.2	58.1	52.2	54.8	65.5	61.6	81.3	894.9	85.4	93
Median (5th decile) monthly rainfall - mm	70.4	74.6	82.8	60.8	42.9	47.1	38.9	38.1	42.7	52.2	49.8	64.3	886.3	79	
9th decile of monthly rainfall - mm	169.5	202.2	209.7	182.8	189.3	189.6	137.4	111.3	127.8	153.6	127.5	171.5	1197.6	79	
1st decile of monthly rainfall - mm	18.2	10.8	19.8	18	8.5	13.1	7.3	7.5	6.4	7.7	8.5	11.6	564.6	79	
Mean no. of raindays	7.9	7.8	7.7	7.7	6.7	7.5	6.6	6.2	6.2	7.4	6.5	6.4	84.7	80.8	88
Highest monthly rainfall - mm	430.2	455.8	263.6	454.7	328.5	554.2	237.2	440.1	217.3	279.4	201.8	300		85.4	93
Lowest monthly rainfall - mm	0	0	0	0	0.8	1.5	0	0.3	0	1.1	0	0		85.4	93
Highest recorded daily rainfall - mm	103.4	171.2	119	190.5	115	287.5	129.5	124.5	102.4	168	88	142.7	287.5	84.4	92

8 APPROACH TO ASSESSMENT

The assessment has followed the DECC's "*Approved Methods of the Modelling and Assessment of Air Pollutants in New South Wales*"(Approved Methods) (**DECC, 2005**). The approved methods specify how assessments based on the use of air dispersion models should be undertaken. They include guidelines for the preparation of meteorological data to be used in dispersion models and the relevant air quality criteria for assessing the significance of predicted concentration and deposition rates from the proposal. The approach taken in this assessment follows as closely as possible the approaches suggested by the guidelines. The only deviation relates to the use of the ISCMOD model instead of the AUSPLUME, CALPUFF and TAPM models which are named models in the approved methods. ISCMOD has been specially developed from the US EPA's ISCST3 model to give improved performance in the prediction of short-term PM_{10} concentrations. It has been accepted for use in NSW by the DECC for a number of recently completed mining and quarry assessments, where the modifications are particularly relevant.

The remainder of this section is provided so that technical reviewers can appreciate how the modelling of different particle size categories was carried out.

ISCMOD has been derived from the ISCST3[5] model by applying changes to the horizontal and vertical dispersion curves following recommendations made by the American Meteorological Society (AMS) Expert Panel on Dispersion Curves (**Hanna et al., 1977**) (see **Holmes Air Sciences, 2007**). ISCST3 is fully described in the user manual and the accompanying technical description (**US EPA, 1995**). The modelling has been based on the use of three particle-size categories (0 to 2.5 μm - referred to as $PM_{2.5}$, 2.5 to 10 μm - referred to as CM (coarse matter) and 10 to 30 μm - referred to as the Rest). Emission rates of TSP have been calculated using emission factors derived from **US EPA (1985)** and **NERDDC (1988)** work (see **Appendix B**).

The distribution of particles has been derived from measurements in the **SPCC (1986)** study. The distribution of particles in each particle size range is as follows:

- $PM_{2.5}$ (FP) is 4.68% of the TSP;
- $PM_{2.5-10}$ (CM) is 34.4% of TSP; and
- PM_{10-30} (Rest) is 60.9% of TSP.

Modelling was done using three ISC source groups. Each group corresponded to a particle size category. Each source in the group was assumed to emit at the full TSP emission rate and to deposit from the plume in accordance with the deposition rate appropriate for particles with an aerodynamic diameter equal to the geometric mean of the limits of the particle size range, except for the $PM_{2.5}$ group, which was assumed to have a particle size of 1 μm. The predicted concentration in the three plot output files for each group were then combined according to the weightings in the dot points above to determine the concentration of PM_{10} and TSP.

The ISC models also have the capacity to take into account dust emissions that vary in time, or with meteorological conditions. This has proved particularly useful for simulating emissions on mining or quarry operations where wind speed is an important factor in determining the rate at which dust is generated.

[5] In subsequent text, when referring to the operation of the ISCMOD or ISCST3 model, where the structure of the models is identical, the acronym ISC will be used.

For the current study, the operations were represented by a series of volume sources located according to the location of activities for the modelled scenario (see **Figure 4** and **5)**. Estimates of emissions for each source were developed on an hourly time step taking into account the activities that would take place at that location. Thus, for each source, for each hour, an emission rate was determined which depended upon the level of activity and the wind speed. It is important to do this in the ISC models to ensure that long-term average emission rates are not combined with worst-case dispersion conditions, which are associated with light winds. Light winds at a mine site would correspond with periods of low dust generation (because wind erosion and other wind-dependent emissions rates will be low) and also correspond with periods of poor dispersion. If these measures are not taken then the model has the potential to significantly overstate impacts.

Dust concentrations and deposition rates have been predicted over the areas shown in **Figures 9** to **16.** Local terrain has been included in the modelling although no allowance has been made for retention of dust from deep within the pit. This means that model results will be conservative. Typically 5% of PM_{10} and 50% of TSP emissions might be retained in the pit.

The modelling has been performed using the DECC's meteorological data from Beresfield (as discussed in **Section 7.1**) and the dust emission estimates from **Section 9**.

Model predictions have been made at 432 discrete receptors, including residential locations, located in the study area. The location of these receptors has been chosen to provide finer resolution closer to the dust sources and nearby receptors compared with the sparser spacing further from the sources or critical receptors. This reduces the computer run times for the modelling compared with the time required for a receptor grid using regular spacing regardless of the need for resolution.

The ISCMOD model input files will be provided in electronic form on request.

9 ESTIMATING EMISSIONS

This section provides a detailed discussion of the emissions for each stage of the mine that has been modelled. A summary table is provided at the end of the section The assessment is based on 880,000 tpa ROM coal for Stage 1, and a maximum of 1.3 Mtpa ROM coal for Stages 2-4.

When estimating the emissions of greenhouse gases (see **Section 11**) the calculations have been based on the average ROM production level of 800,000 tpa and 1.3 Mtpa.

9.1 Stage 1 (Current)

Project description

The proposal will remove 4,618,950 bcm of overburden from the site during Stage 1. The total amount of ROM coal removed from the mine will be split between the Creek Cut and S Cut zones (see **Figure 2**) in the ratio of 58 % and 42 % respectively. This is transported to the designated emplacement in the pit behind the coal extraction area using rear dump trucks. Drilling and blasting is used to fragment the overburden prior to its removal. It is estimated that the 2007 ROM coal production was 880,000 t per year. The ROM coal is transported via 40 t trucks to the ROM coal stockpile where it is either be fed directly to the CHPP or be stored in the ROM coal stockpile. Product coal from the CHPP is transported by conveyor to the rail load out bin and then to trains that access the site via the rail loop also shown in **Figure 2**. Emissions due to activities at the CHPP have not been included in this assessment.

The remainder of this section provides estimates of TSP emissions due to the main dust generating activities onsite.

Removing topsoil
The emission factor for this activity has been taken from the estimate of 14 kg/h provided by the State Pollution Control Commission (SPCC) (now DECC) (**SPCC, 1983**). It has been assumed that topsoil stripping will on average be undertaken over 40 hours per year.

The total estimated TSP emission is 560 kg/year [40 h/y x 14 kg/h].

Drilling of overburden
The emission factor for drilling has been taken from the estimate of 0.59 kg/hole provided by the US EPA (**US EPA, 1985 and updates**). The number of holes drilled has been estimated to be 123 per blast at a maximum of 3 times per week assuming 52 weeks of operation.

The total estimated TSP emission is therefore 11,320 kg/year [123 holes x 156 blasts/year x 0.59 kg/hole].

Blasting of overburden
The TSP emission factor for blasting (E_{TSP}) has been calculated from the **US EPA (1985 and updates**) emission factor equation which is reproduced as **Equation 1** below.

Equation 1

$$\mathrm{E_{TSP}} = 0.00022 \times A^{1.5} \qquad \text{kg/blast}$$

where,

$$\mathrm{A} = \text{area blasted in m}^2$$

the number of holes drilled each for each blast is 153 and hole spacing set to 6m x 5m. This results in an area of approximately 4,590 m^2 for each of the S Cut and Creek Cut project areas. This then gives an emission factor of 68 kg/blast. There are approximately 126 blasts/year and these result in an annual emission of approximately 8,605 kg.

Loading overburden for transport to emplacement area
Approximately 10,240,080 t [4,266,700 bcm/year x 2.4 t/m^3] of overburden will be loaded to Caterpillar rear dump trucks (190 t payload) for transport to the emplacement area in Stage 1. Each tonne of overburden loaded will generate a quantity of TSP that will depend on the wind speed and the moisture content. **Equation 2** shows the relationship between these variables.

Equation 2

$$E_{TSP} = k \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \right) \qquad \text{kg/t}$$

where,

$k = 0.74$

$U = \text{wind speed (m/s)}$

$M = \text{moisture content (\%)}$

$[\text{where } 0.25 \le M \le 4.8]$

For the hourly data from the Beresfield meteorological station in 2004/2005 the average value of $(U/2.2)^{1.3}$ is 1.3937.

Assuming moisture content of 1% for the overburden, the emission factor is: 0.00435 kg/t.

The annual TSP emission associated with loading overburden to the emplacement area is estimated to be 44,544 kg/year [4,266,700 bcm/year x 2.4 t/m^3 x 0.00435 kg/t].

Hauling overburden

It is assumed that 10,240,080 tonnes of overburden [4,266,700bcm x 2.4 t/m^3] will be transported to the emplacement area in 2007 using 190 t loads. This will involve a haulage route of approximately 2.0 kilometres return for both the S Cut and Creek Cut sites. Based on an emission factor of 1.0 kg/VKT[6] (**SPCC, 1983**) for controlled unsealed roads the TSP emission is estimated to be 107,790 kg /year [10,240,080 t/year / 190 t/load x 2.0 km/trip x 1.0 kg/VKT].

Unloading overburden in the emplacement area

It is assumed that the TSP emissions from the unloading of the trucks will be the same as the loading of the overburden to the truck and will therefore have the same TSP emission of 44,544 kg/year although of course in a different place.

Dozers on overburden

Emissions from dozers on overburden have been calculated using the relevant US EPA emission factor equation **US EPA (1985 and updates available from the web)**. The equation is as follows:

Equation 3

$$E_{TSP} = 2.6 \times \left(\frac{s^{1.2}}{M^{1.3}} \right) \qquad \text{kg/h}$$

where,

$s = \text{silt content in \%}$

$M = \text{moisture content \%}$

Assuming that the silt content (sub-75 micron size range) of the overburden is 10% and that the moisture level is 1%, the estimated TSP emission factor will be 41.2 kg/h. Assuming that the dozers

[6] VKT vehicle kilometres travelled

will operate 4,791 h/year the estimated TSP emission will be 197,389 kg/year [4,791 h x 41.2 kg/h]. The estimate of 4,791 h/year is based on the 2006/2007 hours of use for the two dozers working with the overburden on both the emplacement area and one dozer working on rehabilitation sites for each of the Creek Cut and S Cut sites.

Bulldozers working on coal

Emissions from dozers on coal have been calculated using the US EPA emission factor equation (**US EPA (1985 and updates available from the web)**). The equation is as follows:

Equation 4

$$E_{TSP} = 35.6 \times \left(\frac{s^{1.2}}{M^{1.4}} \right) \qquad \text{kg/h}$$

where,

s = silt content in %

M = moisture content %

Assuming that the silt content (sub-75 micron size range) of the coal is 5% and that the moisture level is 4%, the estimated TSP emission factor will be 35.3 kg/h. Assuming that the dozers will operate 1,969 h/year the estimated TSP emission will be 69,506 kg/year [1,969 h x 35.3 kg/h]. The estimate of 1,969 h/year is based on 2006/2007 rates for dozers working on coal.

Loading coal to trucks

Approximately 880,000 t of raw coal will be loaded to CAT 992 trucks (40 t payload) for transport to the ROM coal stockpile. (The emission will of course be split between the two areas where mining is taking place). The TSP emission can be estimated using the **US EPA (1985 and updates available from the web)** emission factor equation shown as **Equation 5**.

Equation 5

$$E_{TSP} = \left(\frac{0.580}{M^{1.2}} \right) \qquad \text{kg/t}$$

where,

M = moisture content (%)

For 5% moisture the emission factor is 0.08407 kg/t. Based on loading 880,000 t/year the TSP emission would be 73,986 kg.

Hauling coal

It is assumed that 880,000 tpa of coal will be transported to the coal stockpile via 40 t loads. This will involve a haulage route of approximately 7.2 kilometres return for S Cut and 5.9 kilometres return for Creek Cut. Based on controlled emission factor of 1.0 kg/VKT (**SPCC, 1983**) for unsealed roads the TSP emission for the Creek Cut route is estimated to be 146,388 kg [(880,000 t/year /40 t/load x 58% x 7.2 km/trip x 1.0 kg/VKT)+(880,000 t/year / 40 t/load x 42% x 5.9 km/trip x 1.0 kg/VKT)].

Wind erosion – Overburden spoil area

The emission factor for wind erosion is given in **Equation 6** below.

Equation 6.

$$E_{TSP} = 1.9 \times \left(\frac{s}{1.5}\right) \times \left(\frac{365 - p}{235}\right) \times \left(\frac{f}{15}\right) \qquad \text{kg/ha/day}$$

where,

E_{TSP} = *TSP emissions*
s = silt content (%)
p = number of raindays per year, and
f = percentage of the time that wind speed is above 5.4 m/s

Assuming a silt content of 10% and number of rain days at 84 (see data from the Bureau of Meteorology's station at East Maitland) (**Table 5**) and the percentage of winds above 5.4 m/s is 9.6% (from the DECC data for Beresfield 2006), the emission factor is 3,538 kg/ha/year. Assuming that area of the site that is susceptible to wind erosion is 35 ha at the S Cut overburden spoil area then the TSP emissions are estimated to be 123,830 kg/year [35 x 3,538 kg/ha/day].

Wind erosion – Open cut
Wind erosion at the open cut will also be produced. The area for the Creek Cut open pit is 4 ha and will produce 14,152 kg/year of TSP emissions. The area for the S Cut open pit is 25 ha and will produce 88,453 kg/year of TSP emissions (**Equation 6**).

Grading roads
The grading of roads at the project site is estimated to accumulate to 2745 hours per year. Graders typically have an average speed of 8 km/h the kilometres travelled will be 21,960 km, combined with an emission factor of 0.62 kg/VKT the TSP emissions will be 13,615 kg/yr.

Contributions from surrounding mines
The Donaldson and Abel coal mines are located approximately 2 km to the southwest of the proposed mine extension. These mines will therefore contribute to the annual TSP concentrations experienced in the surrounding area. At the mine sites for Donaldson and Abel the annual TSP contributions account for 1,123,655 kg/year.

The ROM coal from the Donaldson, Abel and Bloomfield mines is processed at the Bloomfield CHPP. This will generate TSP emissions in the amount of 531,364 kg/yr.

9.2 Stage 2 (Current Stage +5)

Project description
The proposal involves the removal of up to 8,125,000 bcm per year of overburden from the site during Stage 2. This overburden will be transported to the designated emplacement using rear dump trucks. Both drilling and blasting methods will be used. It is estimated a maximum of 1.3 Mt of ROM coal per year will be removed from the approved mine lease boundary. Over the course of Stage 2 the total amount of ROM coal removed from the mine will be split between the Creek Cut and S Cut zones (see **Figure 2**) in the ratio of 52 % and 48 % respectively. For modelling purposes these ratios have been applied to all overburden and relevant coal handling activities. The ROM coal will then be transported via 40 t trucks to the ROM coal stockpile where it will undergo processing and storage in the product stockpile. From here the product coal will be transported to an offsite location via the rail loop also shown in **Figure 2**.

The remainder of this section provides estimates of TSP emissions due to the main dust generating activities onsite.

Removing topsoil

The emission factor for this activity has been taken from the estimate of 14 kg/h provided by the State Pollution Control Commission (SPCC) (now DECC) (**SPCC, 1983**). It has been assumed that topsoil stripping will be undertaken over 40 hours per year.

The total estimated TSP emission is 560 kg/year [40 h/y x 14 kg/h].

Drilling of overburden

The emission factor for drilling has been taken from the estimate of 0.59 kg/hole provided by the US EPA (**US EPA, 1985 and updates**). The number of holes drilled has been estimated to be 33,854 holes/year.

The total estimated TSP emission is therefore 19,974 kg/year [33,854 holes/year x 0.59 kg/hole].

Blasting of overburden

The TSP emission factor for blasting (E_{TSP}) has been calculated using **Equation 1**.
As the number of holes drilled each for each blast is 136 and hole-spacing is 6.0 m x 5.0 m resulting in an area of approximately 4,590 m^2 for each of the Creek Cut and S Cut sites. This then gives an emission factor of 68 kg/blast. Up to 221 blasts will be required per year and this will liberated an annual emission of TSP of 15,138 kg.

Loading overburden for transport to emplacement area

Up to 19,500,000 t [8,125,000 bcm/year x 2.4 t/m^3] of overburden will be loaded to Caterpillar rear dump trucks (190 t payload) for transport to the emplacement area in Stage 2. Each tonne of overburden loaded will generate a quantity of TSP that will depend on the wind speed and the moisture content and calculated using **Equation 2**.

Assuming moisture content of 1% for the overburden, the emission factor is: 0.00435 kg/t

The annual TSP emission associated with loading overburden to the emplacement area is estimated to be 84,918 kg/year [81250,000 bcm/year x 2.4 t/m^3 x 0.00435 kg/t].

Hauling overburden

It is assumed that 19,500,000 tonnes of overburden [8,125,000 bcm x 2.4 t/m^3] will be transported to the emplacement area for Stage 2 via 190 t loads. This will involve a haulage route of approximately 2.0 kilometres return for both the S Cut and Creek Cut sites. Based on a controlled emission factor of 1.0 kg/VKT (**SPCC, 1983**) for unsealed roads the TSP emission is estimated to be 205,263,683 kg [19,500,000 t/year / 190 t/load x 2.0 km/trip x 1.0 kg/VKT].

Unloading overburden in the emplacement area

It is assumed that the TSP emissions from the unloading of the trucks will be the same as the loading of the overburden to the truck and will therefore have the same TSP emission of 84,918 kg/year.

Dozers on overburden

Emissions from dozers on overburden have been calculated using **Equation 2**.

Assuming that the silt content (sub-75 micron size range) of the overburden is 10% and that the moisture level is 1%, the estimated TSP emission factor will be 41.2 kg/h. Assuming that the dozers will operate 4,791 h/year, the estimated TSP emission will be 197,389 kg/year [4,791 hours/y x 41.2 kg/h]. The estimate of 4,791 h/year is based on the 2006/2007 hours of use for the two dozers working with the overburden on the emplacement area and on dozer working on the rehabilitation sites for the S Cut and Creek Cut areas.

Bulldozers working on coal
Emissions from dozers on coal have been calculated using **Equation 4**.

Assuming that the silt content (sub-75 micron size range) of the coal is 5% and that the moisture level is 4%, the estimated TSP emission factor will be 35.3 kg/h. Assuming that the dozers will operate 1,969 h/year, the estimated TSP emission will be 69,506 kg/year [1,969 hours x 35.3 kg/h]. The estimate of 1,969 h/year is based on 2006/2007 rates for dozers working at the open pit.

Loading coal to trucks
Approximately 1.3 Mt of ROM coal will be loaded to CAT 992 trucks (40 t payload) for transport to the ROM coal stockpiles. The TSP emission can be estimated using the emission factor **Equation 5**.

For 5% moisture the emission factor is 0.08407 kg/t. Based on loading 1.3 Mtpa the TSP emission would be 109,297 t.

Hauling coal
It is assumed that 1.3 Mtpa tpa of ROM coal over the course of Stage 2 will be transported to the coal stockpile area via 40 t loads. This will involve a haulage route of approximately 7.1 kilometres return to the Creek Cut location accounting for approximately 52% of the ROM coal removal. The haulage route from the S Cut location will be 7.6 kilometres return and accounts for approximately 48%of the ROM coal removed. Based on controlled emission factor of 1.0 kg/VKT (**SPCC, 1983**) for unsealed roads the TSP emission for the Creek Cut route is estimated to be 119,990 kg [676,000 t/year / 40 t/load x 7.4 km/trip x 1.0 kg/VKT]. Under the same conditions the S Cut TSP emissions will produce 118,560 kg/year [624,000 t/year / 40 t/load x 7.6 km/trip x 1.0 kg/VKT].

Annual TSP for the Creek Cut and S Cut mining area will be 238,550 kg.

Wind erosion – Overburden spoil area
The emission factor for wind erosion is given in **Equation 5**. Assuming a silt content of 10% and number of rain days at 84 (see data from the Bureau of Meteorology's station at East Maitland) (**Table 5**) and the percentage of winds above 5.4 m/s is 9.6% (from the EPA data for Beresfield 2006), the emission factor is 3,538 kg/ha/year. Assuming that area of the site that is susceptible to wind erosion is 5 ha at the Creek Cut site and 24 ha at the S Cut site then the TSP emissions are estimated to be 178,569 kg/year [(5 + 46) x 3,538 kg/ha/day].

Wind erosion – Open cut
Wind erosion at the open cut will also be produced. The area for the Creek Cut open pit is 11 ha and will produce 38,212 kg/year of TSP emissions. The S Cut site open pit site is made up of 27 ha and will produce 95,176 kg/year TSP emissions (**Equation 6**).

Grading roads
The grading of roads at the project site is estimated to accumulate to 2745 hours per year. Graders typically have an average speed of 8km/h the kilometres travelled will be 21,960 km, combined with an emission factor of 0.62 kg/VKT the TSP emissions will be 13,615 kg.

Contributions from surrounding mines
For Stage 2, only Abel coal mine is in operation and is located approximately 2 km to the southwest of the proposed mine extension and will therefore contribute to the annual TSP concentrations experienced in the surrounding area. At the mines sites the annual TSP contributions account for 84,444 kg/year. The ROM coal from the Abel mine is processed at the Bloomfield CHPP, inturn this generating annual TSP emissions in the amount of 280,390kg/yr.

9.3 Stage 3 (Current Stage +7)

Project description
The proposal involves the removal of up to 8,125,000 bcm per year of overburden from the site during Stage 3 and will be transported to the designated emplacement using 190 t trucks. Both drilling and blasting methods will be used. It is estimated a maximum of 1.3 Mtpa of ROM coal per year will be removed from the approved mine lease boundary. For Stage 3, the total amount of ROM coal removed from the mine will be split between the Creek Cut and S Cut zones (see **Figure 2**) in the ratio of 81 % and 19 % respectively. For modelling purposes these ratios have been applied to all overburden and relevant coal handling activities. The ROM coal will then be transported via 40 t trucks to the ROM coal stockpile where it will undergo processing and storage in the product stockpile. From here the product coal will be transported to an offsite location via the rail loop also shown in **Figure 2**.

The remainder of this section provides estimates of TSP emissions due to the main dust generating activities onsite.

Removing topsoil
The emission factor for this activity has been taken from the estimate of 14 kg/h provided by the State Pollution Control Commission (SPCC) (now DECC) (**SPCC, 1983**). It has been assumed that topsoil stripping will be undertaken over 40 hours per year.

The total estimated TSP emission is 560 kg/year [40 h x 14 kg/h].

Drilling of overburden
The emission factor for drilling has been taken from the estimate of 0.59 kg/hole provided by the US EPA (**US EPA, 1985 and updates**). The number of holes drilled has been estimated to be 33,854 holes/year.

The total estimated TSP emission is therefore 19,974 kg/year [33,854 holes/year x 0.59 kg/hole].

Blasting of overburden
The TSP emission factor for blasting (E_{TSP}) has been calculated using **Equation 1**.
As the number of holes drilled each for each blast is 136 and hole-spacing is 6.0 m x 5.0 m resulting in an area of approximately 4,590 m^2 for each of the Creek Cut and S Cut sites. This then gives an emission factor of 68 kg/blast. Up to 221 blasts will be required per year and this will liberated an annual emission of TSP of 15,138 kg.

Loading overburden for transport to emplacement area
Up to 19,500,000 t [8,125,000 bcm/year x 2.4 t/m^3] of overburden will be loaded to Caterpillar rear dump trucks (190 t payload) for transport to the emplacement area in Stage 2. Each tonne of overburden loaded will generate a quantity of TSP that will depend on the wind speed and the moisture content and calculated using **Equation 2**.

Assuming moisture content of 1% for the overburden, the emission factor is: 0.00435 kg/t

The annual TSP emission associated with loading overburden to the emplacement area is estimated to be 84,918 kg/year [8,125,000 bcm/year x 2.4 t/m^3 x 0.00435 kg/t].

Hauling overburden
It is assumed that 19,500,000 tonnes of overburden [8,125,000 bcm x 2.4 t/m^3] will be transported to the emplacement area during Stage 3 via 190 t loads. This will involve a haulage route of approximately 2.0 kilometres return for each of the Creek Cut and S Cut sites. Based on an emission factor of 1.0 kg/VKT (**SPCC, 1983**) for controlled unsealed roads the TSP emission is estimated to be 205,263 kg [19,500,000 t/year / 190 t/load x 2.0 km/trip x 1.0 kg/VKT].

Unloading overburden in the emplacement area
It is assumed that the TSP emissions from the unloading of the trucks will be the same as the loading of the overburden to the truck and will therefore have the same TSP emission of 84,918 kg/year.

Dozers on overburden
Emissions from dozers on overburden have been calculated using **Equation 2**.

Assuming that the silt content (sub-75 micron size range) of the overburden is 10% and that the moisture level is 1%, the estimated TSP emission factor will be 41.2 kg/h. Assuming that the dozers will operate 4,791 h/year the estimated TSP emission will be 197,389 kg/year [4,791 hours x 41.2 kg/h]. The estimate of 4,791h/year is based on the 2006/2007 hours of use for the two dozers working with the overburden on the emplacement area and one dozer working on the rehabilitation sites for the Creek Cut and S Cut sites.

Bulldozers working on coal
Emissions from dozers on coal have been calculated using **Equation 4**.

Assuming that the silt content (sub-75 micron size range) of the coal is 5% and that the moisture level is 4%, the estimated TSP emission factor will be 35.3 kg/h. Assuming that the dozers will operate 1,969 h/year the estimated TSP emission will be 69,506 kg/year [1,969 hours x 35.3 kg/h]. The estimate of 1,969 h/year is based on 2006/2007 rates for dozers working at the open pit.

Loading coal to trucks
Approximately 1.3 Mtpa of ROM coal will be loaded to CAT 992 trucks (40 t payload) for transport to the ROM coal stockpiles. The TSP emission can be estimated using the emission factor **Equation 5**.

For 5% moisture the emission factor is 0.08407 kg/t. Based on loading 1.3 Mtpa, the TSP emission would be 109,297 t.

Hauling coal
It is assumed that 1.3 Mtpa tpa of coal will be transported to the coal stockpile area during Stage 3 via 40 t loads. This will involve a haulage route of approximately 7.2 kilometres return to the Creek Cut location accounting for approximately 81% of the ROM coal removal. The haulage route from the S Cut location will be 7.7 km return and accounts for approximately 19% of the ROM coal removed. Based on controlled emission factor of 1.0 kg/VKT (**SPCC, 1983**) for unsealed roads the TSP emission for the Creek Cut route is estimated to be 189,540 kg [1,053,000 t/year / 40 t/load x 7.2 km/trip x 1.0 kg/VKT]. Under the same conditions the S Cut TSP emissions will produce 47,548 kg/year [247,000 t/year / 40 t/load x 7.7 km/trip x 1.0 kg/VKT].

Annual TSP for the Creek Cut and S Cut mining area will be 237,088 kg.

Wind erosion – Overburden spoil area
The emission factor for wind erosion calculated using **Equation 6**.

Assuming a silt content of 10% and number of rain days at 88 (see data from the Bureau of Meteorology's station at East Maitland) (**Table 5**) and the percentage of winds above 5.4 m/s is 9.6% (from the EPA data for Beresfield 2006), the emission factor is 3488 kg/ha/year. Assuming that area of the site that is susceptible to wind erosion is 60 ha the annual TSP emission of 209,280 kg/year [60 x 3488 kg/ha/day].

Wind erosion – Open cut
Wind erosion at the open pit will also be produced. The area for the Creek Cut open pit is 18 ha and will produce 62,784 kg/year of TSP emissions. The S Cut site open pit site is also made up of 18 ha and will produce the same amount of emissions.

Grading roads
The grading of roads at the project site is estimated to accumulate to 2,745 hours per year. Graders typically have an average speed of 8km/h the kilometres travelled will be 21,960 km, combined with an emission factor of 0.62 kg/VKT the TSP emissions will be 13,615 kg.

Contributions from surrounding mines
For Stage 3, only Abel coal mine is in operation and is located approximately 2 km to the southwest of the proposed mine extension and will therefore contribute to the annual TSP concentrations experienced in the surrounding area. At the Abel mine site, the annual TSP contributions account for 84,444 kg/year. The ROM coal from the Abel mine is processed at the Bloomfield CHPP, in turn this generating annual TSP emissions in the amount of 282,390 kg/yr.

9.4 Stage 4 (Current Stage +10)

Project description
The proposal involves the removal of up to 8,125,000 bcm of overburden from the site and will be transported to the designated emplacement using 190 t trucks. Both drilling and blasting methods will be used. It is estimated a maximum of up to 1.3 Mt of ROM coal per year will be removed from the approved mine lease boundary. The ROM coal will then be transported via 40 t trucks to the ROM coal stockpile where it will undergo processing and storage in the product stockpile. From here the product coal will be transported to an offsite location via the rail loop also shown in **Figure 2**.

The remainder of this section provides estimates of TSP emissions due to the main dust generating activities onsite.

Removing topsoil
The emission factor for this activity has been taken from the estimate of 14 kg/h provided by the State Pollution Control Commission (SPCC) (now DECC) (**SPCC, 1983**). It has been assumed that topsoil stripping will be undertaken over 40 hours per year.

The total estimated TSP emission is 560 kg/year [40 h x 14 kg/h].

Drilling of overburden
The emission factor for drilling has been taken from the estimate of 0.59 kg/hole provided by the US EPA (**US EPA, 1985 and updates**). The number of holes drilled has been estimated to be 33,854 holes/year.

The total estimated TSP emission is therefore 19,974 kg/year [33,854 holes/year x 0.59 kg/hole].

Blasting of overburden
The TSP emission factor for blasting (E_{TSP}) has been calculated using **Equation 1**.
As the number of holes drilled each for each blast is 136 and hole-spacing is 6.0 m x 5.0 m resulting in an area of approximately 4,590 m^2. This gives an emission factor of 68 kg/blast. Up to 221 blasts will be required per year and this will liberated an annual emission of TSP of 15,138 kg.

Loading overburden for transport to emplacement area
Up to 19,500,000 t [8,125,000 bcm/year x 2.4 t/m^3] of overburden will be loaded to Caterpillar rear dump trucks (190 t payload) for transport to the emplacement area in Stage 4. Each tonne of overburden loaded will generate a quantity of TSP that will depend on the wind speed and the moisture content and calculated using **Equation 2**.

Assuming moisture content of 1% for the overburden, the emission factor is: 0.00435 kg/t

The annual TSP emission associated with loading overburden to the emplacement area is estimated to be 84,918 kg/year [8,12500,000 bcm/year x 2.4 t/m^3 x 0.00435 kg/t].

Hauling overburden
It is assumed that 19,500,000 tonnes [8,125,000 bcm/year x 2.4t/m^3] of overburden will be transported to the emplacement area during Stage 4 via 190 t loads. This will involve a haulage route of approximately 2.0 kilometres return. Based on an emission factor of 1.0 kg/VKT (**SPCC, 1983**) for controlled unsealed roads the TSP emission is estimated to be 205,263 kg [8,125,000 bcm x 2.4 t/m^3 / 190 t/load x 2.0 km/trip x 1.0 kg/VKT].

Unloading overburden in the emplacement area
It is assumed that the TSP emissions from the unloading of the trucks will be the same as the loading of the overburden to the truck and will therefore have the same TSP emission of 84,918 kg/year.

Dozers on overburden
Emissions from dozers on overburden have been calculated using **Equation 2**.

Assuming that the silt content (sub-75 micron size range) of the overburden is 10 % and that the moisture level is 1 %, the estimated TSP emission factor will be 41.2 kg/h. Assuming that the dozers will operate 4,791 h/year the estimated TSP emission will be 197,389 kg/year [4,791 hours x 41.2 kg/h]. The estimate of 4,791 h/year is based on the 2006/2007 hours of use for the three dozers working with the overburden on both the emplacement area and rehabilitation sites.

Bulldozers working on coal
Emissions from dozers on coal have been calculated using **Equation 4**.

Assuming that the silt content (sub-75 micron size range) of the coal is 5% and that the moisture level is 4%, the estimated TSP emission factor will be 35.3 kg/h. Assuming that the dozers will operate 1,969 h/year the estimated TSP emission will be 69,506 kg/year [1,969 hours x 35.3 kg/h]. The estimate of 1,969 h/year is based on 2006/2007 rates for dozers working at the open pit.

Loading coal to trucks
Approximately 1.3 Mt of ROM coal will be loaded to CAT 992 trucks (40 t payload) for transport to the emplacement area. The TSP emission can be estimated using the emission factor **Equation 5**.

For 5% moisture the emission factor is 0.08407 kg/t. Based on loading 800,000 t/year the TSP emission would be 109,297t/yr.

Hauling coal
It is assumed that 1.3 Mtpa of ROM coal will be transported to the coal stockpile area during Stage 4 via 40 t loads. This will involve a haulage route of approximately 8.3 kilometres. Based on controlled emission factor of 1.0 kg/VKT (**SPCC, 1983**) for unsealed roads the TSP emission for the Creek Cut route is estimated to be 269,750 kg [1,300,000 t/year / 40 t/load x 8.3 km/trip x 1.0 kg/VKT].

The estimated annual TSP emissions for the Creek Cut mining area will be 269,750 kg.

Wind erosion – Overburden spoil area
The emission factor for wind erosion calculated using **Equation 6**.

Assuming a silt content of 10% and number of rain days at 88 (see data from the Bureau of Meteorology's station at East Maitland) (**Table 5**) and the percentage of winds above 5.4 m/s is 9.6% (from the EPA data for Beresfield 2006), the emission factor is 3488 kg/ha/year. Assuming that area of the site that is susceptible to wind erosion is 53 ha the annual TSP emission of 184,864 kg/year [53 x 3488 kg/ha/day].

Wind erosion – Open cut
Wind erosion at the open cut will also be produced. The area for the Creek Cut open cut is 26 ha and will produce 90,688kg/year of TSP emissions.

Grading roads
The grading of roads at the project site is estimates to accumulate to 2,745 hours per year. Graders typically have an average speed of 8km/h, the kilometres travelled will be 21,960 km, combined with an emission factor of 0.62kg/VKT, the TSP emissions will be 13,615 kg.

Contributions from surrounding mines
For Stage 4, only Abel coal mine is in operation and is located approximately 2 km to the southwest of the proposed mine extension and will therefore contribute to the annual TSP concentrations experienced in the surrounding area. At the mine sites, the annual TSP contributions account for 84,444 kg/year. The ROM coal from the Abel mine is processed at the Bloomfield CHPP, in turn this generates annual TSP emissions of 282,390 kg/yr.

9.5 Summary of emissions

A summary of the emissions inventory is shown in **Table 6**.

Table 6. Summary of emissions for Bloomfield (kg)

Activity	2007	2012	2014	2017
OB - Stripping topsoil - Creek cut	235	291	454	-
OB - Stripping topsoil - S cut	325	269	106	560
OB - Drilling - Creek cut	4,769	10,386	16,179	19,974
OB - Drilling - S cut	6,586	9,588	3,795	-
OB - Blasting - Creek cut	3,614	7,872	12,262	15,138
OB - Blasting - S cut	4,991	7,266	2,876	-
OB - Sh/Ex/FELs loading - Creek cut	20,275	44,157	68,783	-
OB - Sh/Ex/FELs loading - S cut	27,999	40,760	16,134	84,918
OB - Hauling to emplacement - from Creek cut	49,009	106,737	166,263	-
OB - Hauling to emplacement - from S cut	67,680	98,526	39,000	205,263
OB - Emplacing at dumps - Creek cut	20,275	44,157	68,783	-
OB - Emplacing at dumps - S cut	27,999	40,760	16,134	84,918
OB - Dozers on O/B - Creek cut	-	63,512	107,176	-
OB - Dozers on O/B - S cut	132,316	68,805	25,140	132,316
OB - Dozers on Rehabilitation - Creek cut	-	31,252	52,737	65,107
OB - Dozers on Rehabilitation - S cut	65,107	37,762	12,370	-
CL - Dozers ripping - Creek cut	29,163	36,106	56,242	69,435
CL - Dozers ripping - S cut	40,272	33,329	13,193	-
CL - Loading ROM to trucks -Creek cut	31,074	56,834	99,460	109,297
CL - Loading ROM to trucks - South Pit	42,912	52,462	20,766	-
CL - Hauling ROM coal to dump hopper - Creek cut	54,516	119,990	189,540	269,750
CL - Hauling ROM coal to dump hopper - S cut	91,872	118,560	47,548	-
CL - unloading ROM coal at stockpile/hopper Creek cut	Emissions from approved activities at CHPP are taken into account in the cumulative assessment-			
CL - unloading ROM coal at stockpile/hopper S cut				
CL - Rehandle ROM coal at stock pile/hopper				
CL - Handling coal at CHPP				
CL - Dozers at CHPP				
CL - Loading rejects (too wet)				
CL - Loading product coal stockpile				
CL - Loading coal to trains				
WE - OB spoil area - Creek cut	-	16,983	-	-
WE - OB spoil area - S cut	123,835	161,586	212,288	187,521
WE - Open pit - Creek cut	14,153	38,212	63,686	91,991
WE - Open pit - S cut	88,453	95,176	63,686	-
WE - ROM stockpiles	Emissions from approved activities at CHPP are taken into account in the cumulative assessment-			
WE - Product stockpiles				
Grading roads	13,516	13,516	13,516	13,516
Total (kg)	**960,946**	**1,354,854**	**1,388,118**	**1,349,703**
ROM coal production (t)	**880,000**	**1,300,000**	**1,300,000**	**1,300,000**
TSP emission per tonne of ROM coal produced (kg/t)	**1.09**	**1.04**	**1.07**	**1.04**

OB – refers to activities involving overburden handling
CL – refers to activities involving coal handling
WE – refers to activities involving wind erosion.

Table 7. Summary of emissions for nearby mines (kg)

Surrounding mines contribution	1,123,655	84,444	84,444	84,444
Donaldson (only in 2007), Abel and Bloomfield emissions from Bloomfield CHPP	531,364	282,390	282,390	282,390

10 ASESSMENT OF MODEL PREDICTIONS

The modified version of the ISC model (ISCMOD) has been used, with estimated emissions for Current and Stages +5, +7 and +10 and meteorological data for 2005, to model the dispersion and deposition of emissions for these years.

The area covered by the model predictions is shown in **Figures 9** and **16**. The results show the estimated:

- maximum 24-hour PM_{10} concentrations;
- annual average PM_{10} concentrations;
- annual average TSP concentrations; and
- annual average dust (insoluble solids) deposition rates.

Nine receptors were considered representative of the most exposed receptors surrounding the mine. All these receptors are private residential properties and are labelled E, F, G, H, I, K, L, M and N on **Figures 9** to **16**.

The stages selected for presentation are intended to illustrate the air quality effects of the mine over its lifetime.

The significance of the predicted levels has been assessed by comparing the values with the DECC's assessment criteria. For each of the years or scenarios simulated, the results are presented showing (1) the effects of Bloomfield's emissions in isolation and (2) the effects when Bloomfield's emissions considered in conjunction with emission from other nearby mines, and other sources of particulate matter.

In the case of the maximum 24-hour average concentrations, only the case of Bloomfield in isolation is considered and the predicted levels have been compared with the DECC's 50 $\mu g/m^3$ 24-hour PM_{10} assessment criterion. This approach follows the conventions developed for other mining approvals.

The DECC's annual average increment of 2 g/m^2/month for dust (insoluble solids) deposition is the limit that applies to the affect of the project by itself. In these two cases the assessment examines the effects of the mine by itself. For all the other assessment criteria, the predicted values due to the project have been combined with the estimated ambient concentrations due to all other sources of dust including other mines and other non-mining sources. For sources not explicitly included in the model, the annual average background PM_{10} concentrations have been taken to be 9.6 $\mu g/m^3$. For annual average TSP concentrations, the value has been taken to be 24.5 $\mu g/m^3$ and for annual average deposition (insoluble solids) the value has been taken to be 0.5 g/m^2/month.

The value of annual average background PM_{10} (of 9.6 $\mu g/m^3$) has been determined by comparing the predicted cumulative annual average PM_{10} concentration for the Current Stage with the measured annual average PM_{10} concentration at HV2. The difference between these two values (9.6 $\mu g/m^3$) has been assumed to be the annual average PM_{10} concentration due to all sources that are not explicitly in the model. If the model has a tendency to over predict the effects of the mine then the figure of 9.6 µg/m^3 will of course underestimate the effects of the non-modelled source (and vice versa), but the result will nevertheless represent the correct value to add to the model predictions to ensure that the cumulative model will provide reasonable estimates of the actual annual average PM_{10} concentrations in the neighbourhood of the mine. For other mining projects assessed in the past Holmes Air Sciences has used a value of 5 µg/m^3 for the contribution made to annual average PM_{10} levels by non-mining contribution. The higher value adopted here is possibly attributable to the proximity of the mine to Newcastle, Maitland and other large developed urban and the coastal emissions, which have not been explicitly included in the model.

The remainder of this section discusses the predictions for each case. The final section summarises the results for all cases in **Table 7**.

10.1 Results for Current Stage

Figure 9 shows the predicted:

- maximum 24-hour average PM_{10} concentrations,
- annual average PM_{10} concentrations,
- annual average TSP concentrations, and
- annual average (insoluble solids) deposition levels.

Figure 10 shows:

- annual average PM_{10} concentrations with other sources,
- annual average TSP concentrations with other sources, and
- annual average (insoluble solids) deposition levels.

The maximum 24-hour average PM_{10} concentrations are not shown in the cumulative case because the relevant background level cannot be determined with any level of reliability. For example, bushfire smoke can result in 24-hour average concentrations of hundreds on micrograms per cubic metre. It is more useful to assess impact using the maximum predicted concentrations caused by the project considered in isolation.

Examination of the predicted concentration and deposition levels in **Figures 9** and **10** shows that all the assessment criteria will be met.

10.2 Results for Stage 2 (Current Stage +5 years)

As for the previous discussion, **Figure 11** shows the Stage 2 predicted:

- maximum 24-hour average PM_{10} concentrations,
- annual average PM_{10} concentrations,
- annual average TSP concentrations, and
- annual average (insoluble solids) deposition levels.

Figure 12 shows:

- annual average PM_{10} concentrations with other sources,
- annual average TSP concentrations with other sources, and
- annual average (insoluble solids) deposition levels.

As before, the maximum 24-hour average PM_{10} concentrations are not shown in the cumulative case because the relevant background level cannot be determined with any level of reliability.

Examination of the predicted concentration and deposition levels in **Figures 11** and **12** shows that all the assessment criteria are predicted to be met.

10.3 Results for Stage 3 (Current Stage +7 years)

As for the previous cases, **Figure 13** shows the predicted:

- maximum 24-hour average PM_{10} concentrations,
- annual average PM_{10} concentrations,
- annual average TSP concentrations, and
- annual average (insoluble solids) deposition levels.

Figure 14 shows:

- annual average PM_{10} concentrations with other sources,
- annual average TSP concentrations with other sources, and
- annual average (insoluble solids) deposition levels.

Examination of the predicted concentration and deposition levels in **Figures 13** and **14** shows that all the assessment criteria are predicted to be met.

10.4 Results for Stage 4 (Current Stage +10 years)

As for the previous years, **Figure 14** shows the predicted:

- maximum 24-hour average PM_{10} concentrations,
- annual average PM_{10} concentrations,
- annual average TSP concentrations, and
- annual average (insoluble solids) deposition levels.

Figure 16 shows:

- annual average PM_{10} concentrations with other sources,
- annual average TSP concentrations with other sources, and
- annual average (insoluble solids) deposition levels.

Examination of the predicted concentration and deposition levels in **Figures 15** and **16** shows that all the assessment criteria are predicted to be met.

10.5 Summary for all years

The preceding discussion and the information provided in **Figure 9 to 16** shows the effects of the mine and other sources of particulate matter graphically. However, in many cases, it is more convenient to review the data in tabular form and this is done in **Table 8**. The table shows that no residences are predicted to experience either dust deposition or PM concentrations above the DECC's assessment criteria.

Table 8. Summary of model predictions

Summary of predicted PM levels at residential locations for the proposal in isolation and cumulatively											
Stage	**Easting (m) MGA Coordinates**	**Northing (m) MGA Coordinates**	**Resident ID**	**Project in isolation**				**Project combined with other sources and background**			
				24hr PM_{10}	**Annual Average PM_{10}**	**Annual Average TSP**	**Annual Average Dust Deposition**	**24hr PM_{10}**	**Annual Average PM_{10}**	**Annual Average TSP**	**Annual Average Dust Deposition**
				µg/m³	**µg/m³**	**µg/m³**	**g/m²/month**	**µg/m³**	**µg/m³**	**µg/m³**	**g/m²/month**
	DECC goal			**50**	**30**	**90**	**4**	**-**	**30**	**90**	**4**
Current	366938	6366795	E	22.4	2.7	3.3	0.5	NA	15.3	31.3	1.0
	367471	6367197	F	16.4	3.2	4.1	0.8	NA	20.3	37.6	1.3
	362820	6368716	G	8.5	1.2	1.4	0.1	NA	11.5	26.7	0.6
	364843	6371713	H	14.5	2.2	2.3	0.1	NA	13.6	28.9	0.6
	369556	6372623	I	5.8	0.3	0.4	0.0	NA	11.9	27.0	0.5
	370119	6366617	K	5.7	1.0	1.1	1.1	NA	18.9	36.5	1.6
	367414	6372389	L	9.7	1.0	1.1	0.1	NA	14.9	30.2	0.6
	366319	6367539	M	45.5	6.4	8.4	1.2	NA	19.2	36.7	1.7
	365080	6367704	N	28.2	2.9	3.8	0.2	NA	13.8	29.7	0.7
+5 years	366938	6366795	E	20.4	2.8	3.4	0.4	NA	12.9	28.5	0.9
	367471	6367197	F	20.0	3.4	4.2	0.5	NA	14.1	30.1	1.0
	362820	6368716	G	9.7	1.5	1.8	0.1	NA	11.3	26.4	0.6
	364843	6371713	H	23.1	4.1	4.5	0.1	NA	14.2	29.6	0.7
	369556	6372623	I	9.5	0.5	0.6	0.0	NA	10.7	25.6	0.5
	370119	6366617	K	7.3	1.3	1.5	0.1	NA	12.4	27.9	0.8
	367414	6372389	L	16.9	1.5	1.6	0.0	NA	12.3	27.4	0.6
	366319	6367539	M	32.7	5.6	7.3	0.9	NA	15.7	32.3	1.4
	365080	6367704	N	28.5	3.5	4.4	0.3	NA	13.3	29.2	0.8
+7 years	366938	6366795	E	22.6	2.9	3.5	0.4	NA	13.6	29.3	0.9
	367471	6367197	F	20.3	3.5	4.3	0.5	NA	16.2	32.8	1.2
	362820	6368716	G	13.4	1.7	2.0	0.1	NA	11.6	26.7	0.6

Summary of predicted PM levels at residential locations for the proposal in isolation and cumulatively											
Stage	**Easting (m) MGA Coordinates**	**Northing (m) MGA Coordinates**	**Resident ID**	**Project in isolation**				**Project combined with other sources and background**			
				24hr PM_{10}	**Annual Average PM_{10}**	**Annual Average TSP**	**Annual Average Dust Deposition**	**24hr PM_{10}**	**Annual Average PM_{10}**	**Annual Average TSP**	**Annual Average Dust Deposition**
				µg/m³	**µg/m³**	**µg/m³**	**g/m²/month**	**µg/m³**	**µg/m³**	**µg/m³**	**g/m²/month**
	364843	6371713	H	21.4	3.4	3.7	0.1	NA	13.7	29.0	0.6
	369556	6372623	I	9.4	0.5	0.5	0.0	NA	10.8	25.8	0.5
	370119	6366617	K	8.2	1.3	1.6	0.1	NA	13.6	29.5	0.9
	367414	6372389	L	14.8	1.4	1.5	0.0	NA	12.7	27.9	0.6
	366319	6367539	M	35.6	5.7	7.3	0.9	NA	16.3	33.0	1.4
	365080	6367704	N	28.7	3.8	4.9	0.4	NA	13.9	29.9	0.9
+10 years	366938	6366795	E	18.2	2.6	3.2	0.3	NA	12.7	28.2	0.7
	367471	6367197	F	25.1	3.5	4.3	0.4	NA	14.3	30.3	0.9
	362820	6368716	G	12.1	1.5	1.8	0.1	NA	11.3	26.5	0.6
	364843	6371713	H	19.2	3.5	3.9	0.1	NA	13.6	28.9	0.6
	369556	6372623	I	9.0	0.5	0.6	0.0	NA	10.7	25.6	0.5
	370119	6366617	K	9.5	1.4	1.7	0.1	NA	12.6	28.1	0.7
	367414	6372389	L	14.4	1.6	1.7	0.0	NA	12.6	27.7	0.6
	366319	6367539	M	33.0	4.6	5.8	0.6	NA	14.7	30.9	1.0
	365080	6367704	N	22.1	2.8	3.6	0.3	NA	12.6	28.4	0.8

11 GREENHOUSE GAS ISSUES

Greenhouse gas inventories are calculated according to a number of different methods. The procedures specified under the Kyoto Protocol United Nations Framework Convention on Climate Change are the most common.

The protocol identifies greenhouse gases as follows:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulphur hexafluoride (SF_6).

Carbon dioxide and N_2O are formed and released during the combustion of gaseous, liquid and solid fuels. The most significant gases for the current proposal are CO_2 and N_2O, which will be liberated when fuels are burnt in diesel power equipment and in the generation of the electrical energy that will be used by the project.

The project will liberate greenhouse gases as a result of the combustion of diesel and petrol to power mining and other equipment, the use of explosives and the use of electrical energy.

Inventories of greenhouse gas emissions can be calculated using published emission factors. Different gases have different greenhouse warming effects (potentials) and emission factors take into account the global warming potentials of the gases created during combustion.

The global warming potentials assumed in the Australian Greenhouse Office (AGO) (**2006**) emission factors are as follows:

- CO_2 – 1
- CH_4 – 21
- N_2O – 310
- NO_2 – not included.

When the global warming potentials are applied to the estimated emissions then the resulting estimate is referred to in terms of CO_2-equivalent emissions.

The emission factors published by the Australian Greenhouse Office (AGO) (**2006**) have been used to convert fuel usage and electricity consumption into CO_2equivalent emissions. The relevant emission factors are:

1. 3.0 kg CO_2-equivalent/litre for diesel usage – based on full fuel cycle analysis (see Table 3 of **AGO (2006)**) – made up of 2.7 kg CO_2-equivalent for Scope 1 emissions and 0.3 kg CO_2-equivalent for Scope 3 emissions
2. 2.6 kg CO_2-equivalent/litre for petrol usage – based on full fuel cycle analysis (see Table 3 of **AGO (2006)**) – made up of 2.4 kg CO_2-equivalent for Scope 1 emissions and 0.3 kg CO_2-equivalent for Scope 3 emissions

3. 1.068 kg CO_2-equivalent/kWh of electrical energy used in NSW (estimated factor for NSW 2005 see Table 25 of **AGO (2006)**) – made up of 0.893 kg CO_2-equivalent for Scope 2 emissions and 0.176 kg CO_2-equivalent for Scope 3 emissions
4. 45.5 kg CO_2-equivalent/t of ROM coal mined due to liberation of methane (estimated factors for NSW open cut mines see Table 6 of **AGO (2006)**.
5. 0.167 t/t of ANFO (explosive) used (see Table 12 of **AGO (2006)**)

To estimate the future consumption of these energy sources, information on their usage for 2006 was reviewed. Changes to the equipment planned for to be used in the future development of the mine were then taken into account to estimate usages for 2007. The most significant change was the replacement of a 5700 electrically-powered shovel with an Hitachi 5500 diesel-powered excavator. This reduced electricity usage but increased diesel usage. ROM coal production for 2007 was then taken to be the base case and estimates for future electricity, liquid fuel and explosive usage was estimated assuming that these changed in direct proportion to ROM coal production. Clearly this would only be strictly true if the overburden to coal ratio remained constant for the life of the mine, but the uncertainty introduced by using this approach is probably not significant compared with other uncertainties as to future ROM coal production.

It should be noted that the estimated greenhouse gas emissions have been presented for two operating scenarios: (1) assuming that the future ROM production is 800,000 tpa and (2) assuming that the production is 1.3 Mtpa, which is the maximum ROM production level assumed for the dust modelling work. For estimating emissions of greenhouse gases it is more appropriate to base the estimation on the expected average ROM coal production rate over the life of the mine, which would be expected to between these two figures and closer to 800,000 tpa than 1.3 Mtpa.

The estimated annual emissions of CO_2-equivalent (including Scope 3 emissions) are in the range 1,936,385 for the current year to 1,755,154 t/y for all remaining years. The total estimated emission over the life of the mine is 19,460.688 t, or an average of 1,769,153 t/y. This can be compared with the estimated annual emission of 559 Mt of CO_2-equivalent for Australia in 2005 using the Kyoto accounting procedures (see http://www.ageis.greenhouse.gov.au). This includes the Scope 3 emission from burning the coal by the ultimate customer (assuming the customer is a power station). NSW is estimated to be responsible for approximately 28% of Australia's emissions (157 Mtpa) (http://www.environment.nsw.gov.au/climatechange/emissionsoverview.htm). It is important to note that the Scope 3 emissions from the project would not be included in the NSW inventory as these would be accounted for in the inventory for the country in which the end user is located.

Table 9. Estimated emissions of greenhouse gases for 800,000 tpa ROM production for Year 2 onward

Year	ROM (t)	Diesel	Petrol	Electricity	ANFO	CO_2-e due to methane released during mining	Scope 1	Scope 2	Scope 3	Scope 3 from burning coal	Total excluding burning coal	Total including burning coal
		kl	kl	MWh	t	t	t	t	t	t	t	t
1	880,000	7,258	102	15,917	9,104	40,040	28,489	14,214	5,009	1,888,674	47,711	1,936,385
2	800,000	5,669	80	12,432	7,111	36,400	23,164	11,102	3,913	1,716,976	38,178	1,755,154
3	800,000	5,669	80	12,432	7,111	36,400	23,164	11,102	3,913	1,716,976	38,178	1,755,154
4	800,000	5,669	80	12,432	7,111	36,400	23,164	11,102	3,913	1,716,976	38,178	1,755,154
5	800,000	5,669	80	12,432	7,111	36,400	23,164	11,102	3,913	1,716,976	38,178	1,755,154
6	800,000	5,669	80	12,432	7,111	36,400	23,164	11,102	3,913	1,716,976	38,178	1,755,154
7	800,000	5,669	80	12,432	7,111	36,400	23,164	11,102	3,913	1,716,976	38,178	1,755,154
8	800,000	5,669	80	12,432	7,111	36,400	23,164	11,102	3,913	1,716,976	38,178	1,755,154
9	800,000	5,669	80	12,432	7,111	36,400	23,164	11,102	3,913	1,716,976	38,178	1,755,154
10	800,000	5,669	80	12,432	7,111	36,400	23,164	11,102	3,913	1,716,976	38,178	1,755,154
11	800,000	5,669	80	12,432	7,111	36,400	23,164	11,102	3,913	1,716,976	38,178	1,755,154
All years	8,880,000	59,076	829	129,553	74,104	404,040	245,790	115,691	40,773	19,058,434	402,254	19,460,688

Table 10. Estimated emissions of greenhouse gases for 1.3 Mpta for Year 2 onward

Year	ROM (t)	Diesel	Petrol	Electricity	ANFO	CO_2-e due to methane released during mining	Scope 1	Scope 2	Scope 3	Scope 3 from burning coal	Total excluding burning coal	Total including burning coal
		kl	kl	MWh	t	t	t	t	t	t	t	t
1	880,000	7,258	102	15,917	9,104	40,040	28,489	14,214	5,009	1,888,674	47,711	1,936,385
2	1,300,000	8,420	118	18,466	10,563	59,150	35,312	16,490	5,812	2,790,086	57,613	2,847,699
3	1,300,000	8,420	118	18,466	10,563	59,150	35,312	16,490	5,812	2,790,086	57,613	2,847,699
4	1,300,000	8,420	118	18,466	10,563	59,150	35,312	16,490	5,812	2,790,086	57,613	2,847,699
5	1,300,000	8,420	118	18,466	10,563	59,150	35,312	16,490	5,812	2,790,086	57,613	2,847,699
6	1,300,000	8,420	118	18,466	10,563	59,150	35,312	16,490	5,812	2,790,086	57,613	2,847,699
7	1,300,000	8,420	118	18,466	10,563	59,150	35,312	16,490	5,812	2,790,086	57,613	2,847,699
8	1,300,000	8,420	118	18,466	10,563	59,150	35,312	16,490	5,812	2,790,086	57,613	2,847,699
9	1,300,000	8,420	118	18,466	10,563	59,150	35,312	16,490	5,812	2,790,086	57,613	2,847,699
10	1,300,000	8,420	118	18,466	10,563	59,150	35,312	16,490	5,812	2,790,086	57,613	2,847,699
11	1,300,000	8,420	118	18,466	10,563	59,150	35,312	16,490	5,812	2,790,086	57,613	2,847,699
All years	13,880,000	91,463	1,284	200,576	114,729	631,540	381,604	179,114	63,125	29,789,534	623,843	30,413,377

12 SUMMARY AND CONCLUSIONS

This report has assessed the air quality impacts associated with the completion of mining at Bloomfield. Modelling simulations of the dispersion of dust emissions for the four representative stages in the life of the mine have been undertaken: Current, +5, +7 and +10.

The model predictions show the effects of the mine in isolation and when the mine is considered with other sources of dust. No exceedences of any long-term assessment criteria are predicted.

The assessment also provides estimates of the greenhouse gas emissions from the operation. Based on an average future ROM coal production rate of 800,000 tpa, the Project is expected to liberate approximately 19.5 Mt of CO_2-equivalent at the rate of approximately 1.769 Mtpa including Scope 3 emissions from the burning of product coal. If the mine were to be operated at its maximum ROM production level of 1.3 Mtpa the equivalent figures are 30.413 Mtpa and 2.848 Mtpa.

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APPENDIX A
ALL DUST DEPOSITION DATA
FROM 1998 TO 2007 (APRIL) (INCLUSIVE)

Dust (insoluble solids) deposition (g/m^2/month)

Gauge → Month ↓	1	2	3	4	5	6	7	8	9	10
Jan	1.8	3.1	2.1	1.1	4.3	2.7	2.1	1.2		
Feb	1.2	2.0	1.4	1.1	1.5	3.3	1.9	1.8		
Mar	1.7	3.1	1.9	2.5	1.8	2.1	1.9	2.0		
Apr	0.3	3.9	1.0	1.2	0.9	3.4	1.9	2.0		
May	0.8	1.5	0.8	1.0	0.5	3.7	1.0	0.5		
Jun	0.4	1.4	1.5	4.4	0.5	2.8	1.2	0.6		
Jul	0.6	2.1	3.7	1.4	1.4	2.0	2.9	0.9		
Aug	nr	1.5	0.9	1.2	0.9	1.2	1.2	0.4		
Sep	1.3	1.4	2.3	1.1	1.3	1.3	1.8	1.7		
Oct	2.1	2.0	2.0	1.0	2.1	2.1	1.5	1.0		
Nov	1.2	2.7	1.4	2.6	1.9	2.9	1.8	0.4		
Dec	2.0	3.4	2.5	1.4	6.4	3.9	1.7	1.1		
Ann. 1998	**1.2**	**2.3**	**1.8**	**1.7**	**2.0**	**2.6**	**1.7**	**1.1**		
Jan	1.1	3.3	1.9	1.4	1.8	2.6	1.8	1.4		
Feb	2.1	1.7	2.1	0.6	1.4	1.0	1.6	1.3		
Mar	1.4	2.1	1.2	1.0	1.3	1.3	0.8	1.3		
Apr	0.9	3.1	2.0	0.8	0.3	1.7	N/A	0.4		
May	2.3	3.6	2.6	2.1	1.9	2.0	2.1	1.6		
Jun	1.6	3.2	1.4	0.6	1.2	2.3	2.4	2.1		
Jul	N/A	1.2	1.5	0.6	1.9	0.6	0.9	0.3		
Aug	N/A	2.3	2.4	0.9	1.4	1.1	1.4	1.7		
Sep	0.8	1.1	0.6	0.9	3.5	1.7	1.5	1.5		
Oct	1.4	1.8	1.1	0.8	3.8	1.7	1.9	1.5		
Nov	1.5	1.9	2.5	1.5	1.3	2.6	2.6	1.4		
Dec	1.9	3.2	2.5	1.5	2.4	2.0	2.6	1.6		
Ann. 1999	**1.5**	**2.4**	**1.8**	**1.1**	**1.9**	**1.7**	**1.8**	**1.3**		
Jan	2.2	2.5	2.1	1.1	1.5	3.7	2.5	1.3		
Feb	3.9	4.0	1.7	1.2	1.8	4.3	2.3	1.3		
Mar	1.2	2.9	0.6	1.0	1.3	NR	1.6	1.0		
Apr	0.7	1.8	1.0	1.0	1.1	**C**	2.0	0.9		
May	1.4	**c**	0.6	0.6	**c**	2.9	1.6	0.6		
Jun	1.0	1.8	0.8	0.7	0.6	3.8	1.8	1.2		
Jul	0.8	1.0	1.1	1.2	1.0	**C**	1.0	0.8		
Aug	1.4	**c**	0.8	0.6	**c**	4.6	1.9	0.7		
Sep	0.8	1.4	0.9	0.6	0.7	**C**	0.9	1.2		
Oct	1.6	1.0	0.6	0.5	**c**	2.9	2.0	1.2		
Nov	0.9	1.3	2.2	0.6	1.8	2.9	2.8	1.6		
Dec	1.3	2.4	2.9	0.6	1.3	1.7	2.6	1.4		

Ann. 2000	**1.4**	**2.0**	**1.3**	**0.8**	**1.2**	**3.4**	**1.9**	**1.1**		
Jan	0.7	2.0	1.2	NR	1.9	2.2	1.2	1.5		
Feb	1.1	**c**	1.4	3.2	**c**	4.3	1.7	0.8		
Mar	2.1	1.0	1.6	6.3	0.9	1.1	1.6	1.5		
Apr	0.8	1.8	1.1	8.5	1.0	4.2	1.4	0.9		
May	0.8	1.5	0.9	5.7	1.2	3.6	3.0	1.1		
Jun	0.7	1.0	0.9	8.3	1.1	1.8	1.9	0.7		
Jul	1.2	1.0	0.9	**c**	1.2	1.5	3.8	0.8		
Aug	2.8	1.3	0.9	**c**	1.3	2.0	1.8	0.8		
Sep	1.9	2.8	2.2	4.1	0.8	1.9	2.0	1.4	0.9	1.0
Oct	1.2	1.8	0.8	**c**	2.2	2.5	2.5			
Nov	0.9	**c**	4.0	**c**	2.1	1.2	**c**	1.8	1.9	3.1
Dec	1.4	2.7	0.7	5.4	1.8	1.4	**c**	1.8	1.7	1.7
Ann. 2001	**1.3**	**1.7**	**1.4**	**5.9**	**1.4**	**2.3**	**2.1**	**1.2**	**1.5**	**1.9**
Jan	1.3	2.3	2.0	4.2	0.8	2.3	2.9	2.2	2.1	1.7
Feb	1.0	2.2	1.3	**c**	1.1	1.7	2.4	1.6	1.1	1.1
Mar	0.6	1.3	1.0	7.5	0.6	1.7	2.5	0.7	0.7	1.9
Apr	0.7	1.6	1.0	2.8	0.5	1.2	1.4	0.8	0.9	2.2
May	1.8	1.2	0.7	**4.6**	1.1	0.9	1.2	1.0	1.6	1.1
Jun	1.8	1.2	0.5	**4.7**	0.8	3.7	1.0	0.8	0.5	2.7
Jul	1.1	1.9	0.6	**5.4**	1.4	2.4	3.3	1.6	0.7	3.8
Aug	1.5	1.5	1.2	**5.0**	1.6	2.9	2.3	2.1	1.2	1.2
Sep	1.3	3.0	1.2	4.7	1.4	2.8	2.2	1.6	1.2	3.3
Oct	3.1	1.0	2.1	**0.9**	3.9	2.1	1.6	3.4	0.8	1.7
Nov	1.3	**6.7 c**	1.6	**4.9**	2.7	**7.7 c**	**1.8**	1.9	2.4	3.3
Dec	2.4	3.1	1.7	5.4	4.7	2.5	2.6	2.2	2.1	2.3
Ann. 2002	**1.5**	**1.8**	**1.2**	**4.6**	**1.7**	**2.2**	**2.1**	**1.7**	**1.3**	**2.2**
Jan	2.7	2.6	1.8	3.5	1.7	2.2	1.8	2.1	2.2	1.2
Feb	1.3	3.0	1.4	**4.6**	**15.6 c**	1.9	2.3	2.4	2.9	2.1
Mar	1.1	1.6	1.1	5.0	1.0	2.5	1.1	1.5	0.7	1.4
Apr	0.8	1.6	0.6	5.8	0.6	0.7	1.2	0.8		1.2
May	**c**	0.8	0.4	1.2	0.7	**C**	1.3	0.7	0.3	0.8
Jun	**11.8**	0.8	0.5	2.5	1.3	1.1	0.7	0.7	0.5	0.8
Jul	4.1	0.7	0.2	3.4	**c**	2.5	0.7	1.1	0.3	0.9
Aug	2.0	2.1	0.4	**4.3**	1.4	2.0	1.2	1.2	0.6	1.5
Sep	1.2	1.1	0.7	**16.5**	1.3	1.2	1.0	1.3	0.7	0.8
Oct	1.2	2.8	1.5	**5.5**	1.7	1.8	1.5	0.2	ns	1.0
Nov	0.9	1.3	1.2	**6.8**	1.3	2.9	2.2	1.9	3.9	1.2
Dec	1.2	1.2	0.7	3.4	1.6	1.1	1.3	1.6	0.8	0.9
Ann. 2003	**2.6**	**1.6**	**0.9**	**5.2**	**1.3**	**1.8**	**1.4**	**1.3**	**1.3**	**1.2**
Jan	0.6	2.1	1.1	**6.0**	0.9	1.0	1.5	1.4	0.7	0.6

Feb	1.1	2.2	1.1	**5.7**	**1.3**	1.3	2.0	3.2	1.1	0.9
Mar	1.2	1.9	1.1	**16.5**	1.5	1.4	1.9	1.0	1.0	0.9
Apr	0.8	0.8	1.2	4.2	1.1	1.1	1.4	1.2	0.7	0.8
May	1.2	0.5	0.5	1.9	0.6	1.3	1.1	1.1	0.5	0.8
Jun	0.8	1.6	0.7	**5.1**	0.7	1.0	1.4	1.8	0.7	1.4
Jul	3.4	1.6	1.5	3.1	0.7	1.8	1.2	1.2	Ns	0.9
Aug	2.0	0.9	0.5	2.2	0.9	3.7	1.1	0.6	1.2	0.8
Sep	0.9	1.3	0.8	2.8	0.6	1.6	1.8	0.8	0.7	0.9
Oct	1.0	1.9	0.8	**3.6**	1.6	3.8	1.8	1.8	0.7	0.7
Nov	1.0	0.8	0.9	**13.8**	0.8	2.1	1.8	1.2	0.6	1.2
Dec	3.0	2.1	1.8	4.8	2.7	3.8	1.1	2.6	1.8	2.1
Ann. 2004	**1.4**	**1.5**	**1.0**	**5.8**	**1.1**	**2.0**	**1.5**	**1.5**	**0.9**	**1.0**
Jan	1.3	3.1	1.7	3.5	2.0	3.5	1.3	1.4	0.6	1.9
Feb	2.2	1.3	1.4	2.6	0.7	1.8	1.5	1.8	1.4	0.3
Mar	1.1	1.6	1.4	**2.4**	1.3	1.4	1.0	1.0	0.6	0.9
Apr	0.4	NR	0.5	3.6	0.3	0.7	1.4	0.7	0.5	0.7
May	0.5	0.4	0.2	0.3	0.2	0.3	0.4	0.4	0.2	0.2
Jun	**25.9**	2.7	0.7	**4.4**	1.9	2.9	1.6	1.6	1.0	2.1
Jul	3.3	1.3	0.8	3.8	1.0	1.3	1.4	1.1	0.8	0.9
Aug	1.3	2.5	0.8	3.6	1.0	1.2	0.9	2.3	1.1	1.3
Sep	0.6	1.6	0.7	2.4	0.7	0.5	1.1	1.5	0.8	1.1
Oct	0.5	1.7	0.9	2.2	0.6	1.3	3.2	1.9	0.8	0.7
Nov	0.9	1.3	1.2	**2.5**	1.0	1.5	0.7	1.2	0.7	0.9
Dec	3.3	3.1	2.6	3.9	1.5	2.4	2.1	NR	2.2	6.0
Ann. 2005	**3.4**	**1.9**	**1.1**	**2.9**	**1.0**	**1.6**	**1.4**	**1.4**	**0.9**	**1.4**
Jan	1.6	2.4	1.8	4.0	1.4	1.9	3.2	2.3	1.8	3.9
Feb	0.9	1.7	3.5	2.0	0.7	1.1	0.8	0.8	3.1	1.8
Mar	1.0	2.1	1.0	**5.0**	1.4	1.5	1.0	1.2	1.5	3.1
Apr	1.0	1.8	1.1	3.6	1.0	0.9	1.7	0.7	1.0	1.3
May	1.3	1.8	0.8	3.8	0.9	2.2	1.3	0.8	1.0	0.5
Jun	0.9	1.7	0.7	**4.3**	2.6	1.8	1.4	0.7	0.5	2.8
Jul	3.4	1.3	0.5	2.0	0.9	0.5	0.9	0.9	0.5	1.1
Aug	**13.4**	1.6	1.0	**6.1**	1.9	1.3	1.7	1.5	0.6	1.3
Sep	1.5	3.4	1.4	0.7	**6.7**	1.6	2.0	1.2	ns	2.1
Oct	2.0	1.5	1.0	3.0	**4.4c**	1.2	1.6	1.1	1.1	0.7
Nov	0.8	1.9	1.6	**5.0**	3.9	1.0	2.1	2.0	1	2.0
Dec	3.0	2.9	3.5	**6.4**	**8.7**	2.5	2.9	3.6	2.7	2.0
Ann. 2006	**2.57**	**2.01**	**1.49**	**3.83**	**2.74**	**1.46**	**1.72**	**1.40**	**1.35**	**1.88**
Jan	2.6	2.0	1.9	2.8	2.3	3.1	1.5	**5.1c**	1.9	1.9
Feb	1.9	3.4	2.8	**5.0**	2.4	2.0	2.0	3.0	1.5	1.9
Mar	1.8	3.2	2.1	3.8	1.9	2.3	2.3	3.1	ns	3.7
Apr	4.3	3.2	3.0	7.9	2.9	2.7	3.5	3.7	2.5	2.4

Ann. 2007	**2.7**	**3.0**	**2.5**	**4.9**	**2.4**	**2.5**	**2.3**	**3.3**	**2.0**	**2.5**

APPENDIX B
STATISTICAL SUMMARY OF METEOROLOGICAL DATA

STATISTICS FOR FILE: C:\Jobs\Abel\Met\BER0405.isc
MONTHS: All
HOURS : All
OPTION: Frequency

ALL PASQUILL STABILITY CLASSES

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.006677	0.006677	0.001607	0.000989	0.000124	0.000000	0.000000	0.000000	0.016073
NE	0.008531	0.007047	0.001978	0.000618	0.000000	0.000000	0.000000	0.000000	0.018175
ENE	0.006058	0.014713	0.008160	0.002596	0.000247	0.000000	0.000000	0.000000	0.031775
E	0.007295	0.018917	0.011746	0.004946	0.000865	0.000247	0.000000	0.000000	0.044016
ESE	0.009644	0.028190	0.022626	0.006306	0.000247	0.000000	0.000000	0.000000	0.067013
SE	0.017681	0.036597	0.030539	0.001360	0.000124	0.000000	0.000000	0.000000	0.086301
SSE	0.024233	0.030663	0.022750	0.006553	0.000865	0.000000	0.000247	0.000000	0.085312
S	0.026583	0.034743	0.011993	0.002102	0.000618	0.000000	0.000000	0.000000	0.076039
SSW	0.017557	0.023863	0.005811	0.001484	0.000000	0.000000	0.000000	0.000000	0.048714
SW	0.008778	0.019659	0.008408	0.002102	0.000124	0.000124	0.000000	0.000000	0.039194
WSW	0.009891	0.006182	0.001484	0.001113	0.000495	0.000124	0.000000	0.000000	0.019288
W	0.011622	0.011375	0.004204	0.002844	0.000247	0.000124	0.000000	0.000000	0.030415
WNW	0.023244	0.038081	0.038205	0.023615	0.011993	0.013477	0.004822	0.004204	0.157641
NW	0.023368	0.056009	0.031775	0.017062	0.014095	0.008160	0.002473	0.002596	0.155539
NNW	0.018422	0.023986	0.009149	0.004946	0.003586	0.001360	0.000989	0.000618	0.063056
N	0.010880	0.010015	0.001607	0.000247	0.000000	0.000000	0.000000	0.000000	0.022750
CALM									0.038699
TOTAL	0.230465	0.366716	0.212043	0.078882	0.033630	0.023615	0.008531	0.007418	1.000000

MEAN WIND SPEED (m/s) = 2.84
NUMBER OF OBSERVATIONS = 8088

PASQUILL STABILITY CLASS 'A'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.002720	0.003091	0.000124	0.000000	0.000000	0.000000	0.000000	0.000000	0.005935
NE	0.002720	0.001484	0.000247	0.000000	0.000000	0.000000	0.000000	0.000000	0.004451
ENE	0.002226	0.002102	0.000124	0.000000	0.000000	0.000000	0.000000	0.000000	0.004451
E	0.002349	0.002967	0.000124	0.000000	0.000000	0.000000	0.000000	0.000000	0.005440
ESE	0.001855	0.002473	0.000247	0.000000	0.000000	0.000000	0.000000	0.000000	0.004575
SE	0.002473	0.003215	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005687
SSE	0.001978	0.003338	0.000495	0.000000	0.000000	0.000000	0.000000	0.000000	0.005811
S	0.002967	0.008655	0.003462	0.000000	0.000000	0.000000	0.000000	0.000000	0.015084
SSW	0.002720	0.007047	0.002596	0.000495	0.000000	0.000000	0.000000	0.000000	0.012859
SW	0.000989	0.002967	0.000495	0.000247	0.000000	0.000000	0.000000	0.000000	0.004698
WSW	0.001484	0.000989	0.000371	0.000000	0.000000	0.000000	0.000000	0.000000	0.002844
W	0.001113	0.001484	0.000247	0.000000	0.000000	0.000000	0.000000	0.000000	0.002844
WNW	0.002102	0.001731	0.000247	0.000000	0.000000	0.000000	0.000000	0.000000	0.004080
NW	0.003709	0.002226	0.000371	0.000000	0.000000	0.000000	0.000000	0.000000	0.006306
NNW	0.003091	0.001731	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004822
N	0.001855	0.002226	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004080
CALM									0.007542
TOTAL	0.036350	0.047725	0.009149	0.000742	0.000000	0.000000	0.000000	0.000000	0.101508

MEAN WIND SPEED (m/s) = 1.74
NUMBER OF OBSERVATIONS = 821

PASQUILL STABILITY CLASS 'B'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000371	0.000742	0.000124	0.000000	0.000000	0.000000	0.000000	0.000000	0.001236
NE	0.000000	0.000495	0.000495	0.000000	0.000000	0.000000	0.000000	0.000000	0.000989
ENE	0.000247	0.000989	0.000618	0.000000	0.000000	0.000000	0.000000	0.000000	0.001855
E	0.000000	0.001607	0.000371	0.000000	0.000000	0.000000	0.000000	0.000000	0.001978
ESE	0.000371	0.002226	0.000495	0.000000	0.000000	0.000000	0.000000	0.000000	0.003091
SE	0.000371	0.007789	0.006182	0.000000	0.000000	0.000000	0.000000	0.000000	0.014342
SSE	0.001113	0.003586	0.006058	0.000989	0.000000	0.000000	0.000000	0.000000	0.011746
S	0.000865	0.004080	0.002596	0.000247	0.000000	0.000000	0.000000	0.000000	0.007789
SSW	0.000618	0.002844	0.002473	0.000742	0.000000	0.000000	0.000000	0.000000	0.006677
SW	0.000618	0.002844	0.001855	0.000124	0.000000	0.000000	0.000000	0.000000	0.005440
WSW	0.000247	0.000495	0.000000	0.000371	0.000000	0.000000	0.000000	0.000000	0.001113
W	0.000495	0.000742	0.000495	0.000247	0.000000	0.000000	0.000000	0.000000	0.001978
WNW	0.000989	0.001236	0.000865	0.000124	0.000000	0.000000	0.000000	0.000000	0.003215
NW	0.001484	0.002720	0.001731	0.000124	0.000000	0.000000	0.000000	0.000000	0.006058
NNW	0.000247	0.001731	0.000371	0.000000	0.000000	0.000000	0.000000	0.000000	0.002349
N	0.000618	0.001484	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002102
CALM									0.000000
TOTAL	0.008655	0.035608	0.024728	0.002967	0.000000	0.000000	0.000000	0.000000	0.071958

MEAN WIND SPEED (m/s) = 2.70
NUMBER OF OBSERVATIONS = 582

PASQUILL STABILITY CLASS 'C'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000000	0.000495	0.000495	0.000495	0.000000	0.000000	0.000000	0.000000	0.001484
NE	0.000371	0.000618	0.000742	0.000495	0.000000	0.000000	0.000000	0.000000	0.002226
ENE	0.000000	0.000989	0.001607	0.000371	0.000000	0.000000	0.000000	0.000000	0.002967
E	0.000495	0.001236	0.003215	0.000742	0.000000	0.000000	0.000000	0.000000	0.005687
ESE	0.000000	0.002844	0.008408	0.001360	0.000000	0.000000	0.000000	0.000000	0.012611
SE	0.000495	0.007047	0.016197	0.000865	0.000000	0.000000	0.000000	0.000000	0.024604
SSE	0.000618	0.001360	0.004451	0.003462	0.000000	0.000000	0.000000	0.000000	0.009891
S	0.000371	0.000495	0.000618	0.000000	0.000000	0.000000	0.000000	0.000000	0.001484
SSW	0.000000	0.000371	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000371
SW	0.000124	0.001113	0.000989	0.000247	0.000000	0.000000	0.000000	0.000000	0.002473
WSW	0.000495	0.000742	0.000124	0.000124	0.000000	0.000000	0.000000	0.000000	0.001484
W	0.000371	0.000865	0.000371	0.000618	0.000000	0.000000	0.000000	0.000000	0.002226
WNW	0.000371	0.001236	0.003709	0.002967	0.000000	0.000000	0.000000	0.000000	0.008284
NW	0.001360	0.005687	0.004204	0.002967	0.000000	0.000000	0.000000	0.000000	0.014219
NNW	0.000865	0.002473	0.001360	0.000371	0.000000	0.000000	0.000000	0.000000	0.005069
N	0.000371	0.000618	0.000618	0.000000	0.000000	0.000000	0.000000	0.000000	0.001607
CALM									0.000000
TOTAL	0.006306	0.028190	0.047107	0.015084	0.000000	0.000000	0.000000	0.000000	0.096686

MEAN WIND SPEED (m/s) = 3.36
NUMBER OF OBSERVATIONS = 782

PASQUILL STABILITY CLASS 'D'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000495	0.001607	0.000865	0.000495	0.000124	0.000000	0.000000	0.000000	0.003586
NE	0.000124	0.003091	0.000495	0.000124	0.000000	0.000000	0.000000	0.000000	0.003833
ENE	0.000247	0.008408	0.005687	0.002226	0.000247	0.000000	0.000000	0.000000	0.016815
E	0.000495	0.008531	0.007913	0.004204	0.000865	0.000247	0.000000	0.000000	0.022255
ESE	0.002844	0.016444	0.013477	0.004946	0.000247	0.000000	0.000000	0.000000	0.037957
SE	0.003338	0.007047	0.008160	0.000495	0.000124	0.000000	0.000000	0.000000	0.019164
SSE	0.003462	0.005687	0.011746	0.002102	0.000865	0.000000	0.000247	0.000000	0.024110
S	0.000618	0.001113	0.004698	0.001855	0.000618	0.000000	0.000000	0.000000	0.008902
SSW	0.000124	0.000371	0.000124	0.000247	0.000000	0.000000	0.000000	0.000000	0.000865
SW	0.000124	0.002720	0.004946	0.001484	0.000124	0.000124	0.000000	0.000000	0.009520
WSW	0.000371	0.001607	0.000989	0.000618	0.000495	0.000124	0.000000	0.000000	0.004204
W	0.002596	0.005564	0.003091	0.001978	0.000247	0.000124	0.000000	0.000000	0.013600
WNW	0.005935	0.018793	0.021761	0.018299	0.011993	0.013477	0.004822	0.004204	0.099283
NW	0.005317	0.029550	0.019288	0.012735	0.014095	0.008160	0.002473	0.002596	0.094214
NNW	0.003586	0.011128	0.004451	0.004575	0.003586	0.001360	0.000989	0.000618	0.030292
N	0.001484	0.004080	0.000742	0.000247	0.000000	0.000000	0.000000	0.000000	0.006553
CALM									0.002226
TOTAL	0.031157	0.125742	0.108432	0.056627	0.033630	0.023615	0.008531	0.007418	0.397379

MEAN WIND SPEED (m/s) = 4.05
NUMBER OF OBSERVATIONS = 3214

PASQUILL STABILITY CLASS 'E'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000618	0.000495	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001113
NE	0.001484	0.001236	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002720
ENE	0.000618	0.001855	0.000124	0.000000	0.000000	0.000000	0.000000	0.000000	0.002596
E	0.001360	0.003462	0.000124	0.000000	0.000000	0.000000	0.000000	0.000000	0.004946
ESE	0.002473	0.003338	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005811
SE	0.004327	0.009397	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.013724
SSE	0.005687	0.011004	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.016691
S	0.004822	0.006429	0.000618	0.000000	0.000000	0.000000	0.000000	0.000000	0.011869
SSW	0.001855	0.001978	0.000618	0.000000	0.000000	0.000000	0.000000	0.000000	0.004451
SW	0.000742	0.004822	0.000124	0.000000	0.000000	0.000000	0.000000	0.000000	0.005687
WSW	0.001236	0.001236	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002473
W	0.002102	0.001978	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004080
WNW	0.005440	0.013229	0.011622	0.002226	0.000000	0.000000	0.000000	0.000000	0.032517
NW	0.004080	0.014590	0.006182	0.001236	0.000000	0.000000	0.000000	0.000000	0.026088
NNW	0.003833	0.006058	0.002967	0.000000	0.000000	0.000000	0.000000	0.000000	0.012859
N	0.002349	0.000989	0.000247	0.000000	0.000000	0.000000	0.000000	0.000000	0.003586
CALM									0.000618
TOTAL	0.043027	0.082097	0.022626	0.003462	0.000000	0.000000	0.000000	0.000000	0.151830

MEAN WIND SPEED (m/s) = 2.17
NUMBER OF OBSERVATIONS = 1228

PASQUILL STABILITY CLASS 'F'

Wind Speed Class (m/s)

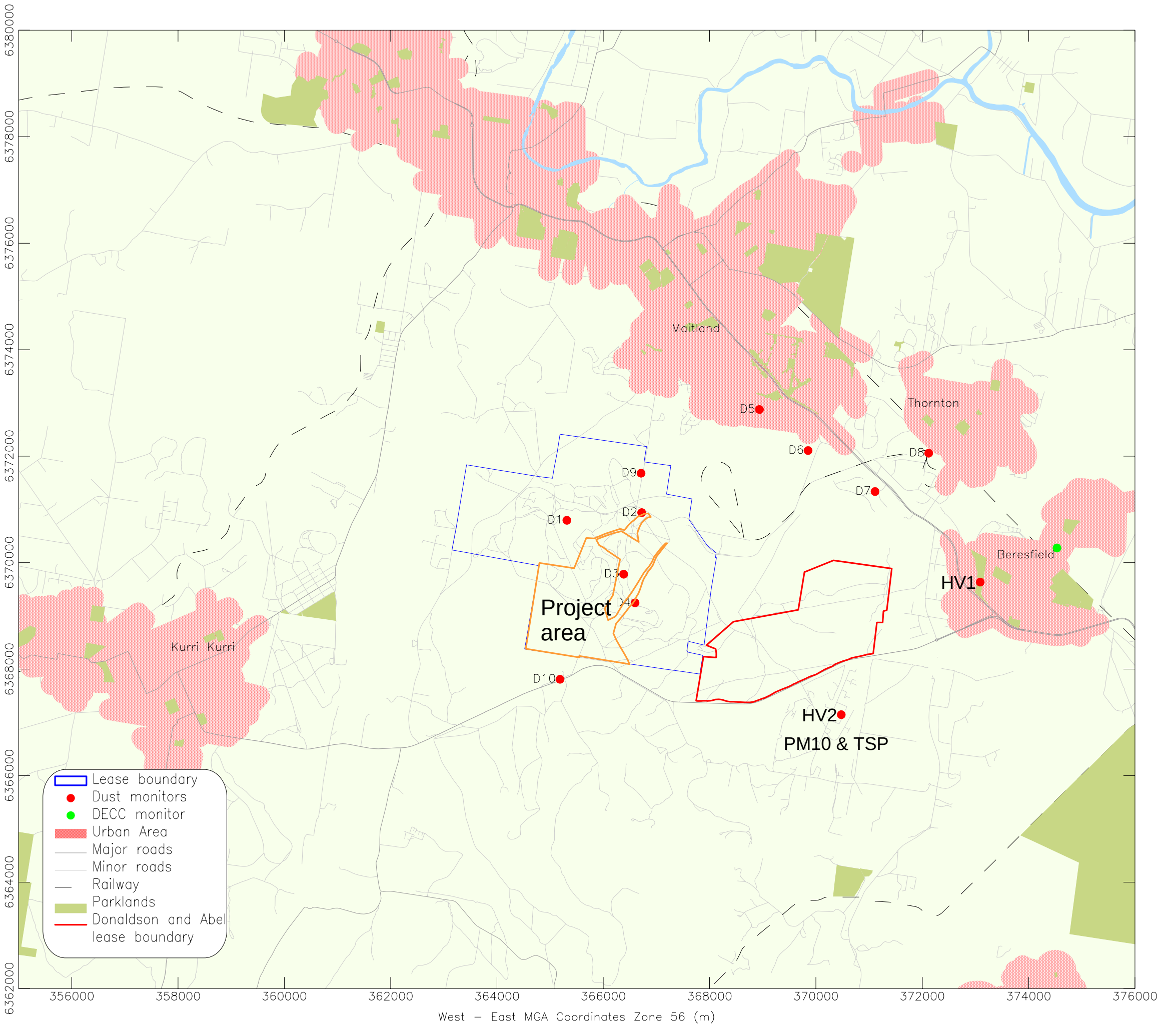
WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.002473	0.000247	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002720
NE	0.003833	0.000124	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003956
ENE	0.002720	0.000371	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003091
E	0.002596	0.001113	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003709
ESE	0.002102	0.000865	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002967
SE	0.006677	0.002102	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.008778
SSE	0.011375	0.005687	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.017062
S	0.016939	0.013971	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.030910
SSW	0.012240	0.011251	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.023492
SW	0.006182	0.005193	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.011375
WSW	0.006058	0.001113	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.007171
W	0.004946	0.000742	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005687
WNW	0.008408	0.001855	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.010262
NW	0.007418	0.001236	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.008655
NNW	0.006800	0.000865	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.007666
N	0.004204	0.000618	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004822
CALM									0.028314
TOTAL	0.104970	0.047354	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.180638

MEAN WIND SPEED (m/s) = 1.15
NUMBER OF OBSERVATIONS = 1461

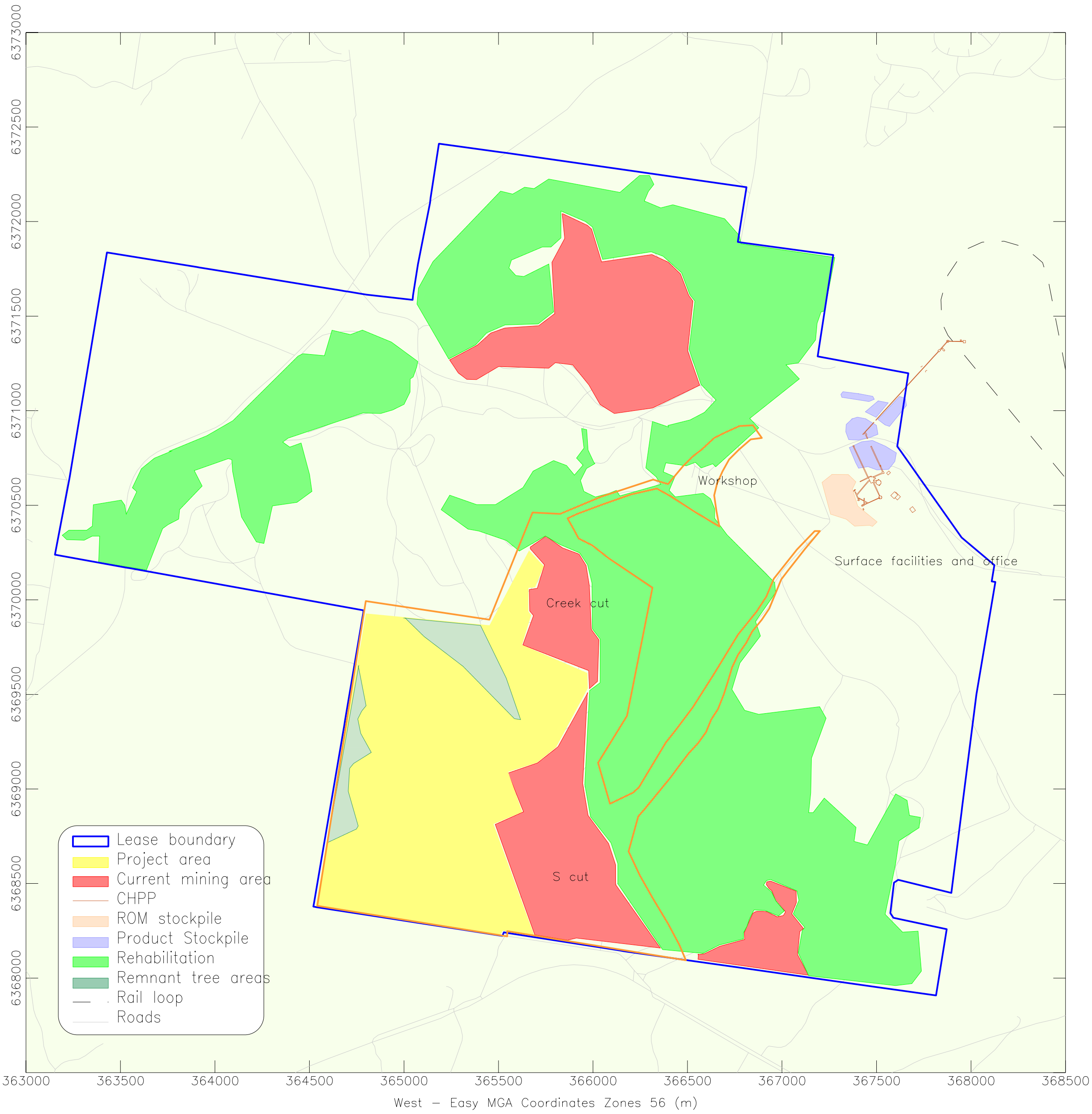
```
-------------------------------------------
FREQUENCY OF OCCURENCE OF STABILITY CLASSES
-------------------------------------------
  A : 10.2%
  B : 7.2%
  C : 9.7%
  D : 39.7%
  E : 15.2%
  F : 18.1%


------------------------------
STABILITY CLASS BY HOUR OF DAY
------------------------------
Hour   A    B    C    D    E    F
  01 0000 0000 0000 0112 0095 0130
  02 0000 0000 0000 0108 0100 0129
  03 0000 0000 0000 0099 0119 0119
  04 0000 0000 0000 0116 0108 0113
  05 0000 0000 0000 0112 0115 0110
  06 0013 0011 0010 0122 0100 0081
  07 0039 0032 0038 0139 0051 0038
  08 0060 0036 0053 0173 0011 0004
  09 0055 0046 0051 0185 0000 0000
  10 0078 0047 0056 0156 0000 0000
  11 0093 0061 0050 0133 0000 0000
  12 0119 0051 0063 0104 0000 0000
  13 0120 0054 0069 0094 0000 0000
  14 0098 0074 0087 0078 0000 0000
  15 0083 0078 0094 0082 0000 0000
  16 0052 0067 0113 0086 0003 0016
  17 0010 0023 0086 0152 0026 0040
  18 0001 0002 0012 0244 0038 0040
  19 0000 0000 0000 0217 0063 0057
  20 0000 0000 0000 0182 0073 0082
  21 0000 0000 0000 0148 0073 0116
  22 0000 0000 0000 0135 0074 0128
  23 0000 0000 0000 0123 0080 0134
  24 0000 0000 0000 0114 0099 0124

--------------------------------
STABILITY CLASS BY MIXING HEIGHT
--------------------------------
Mixing height    A    B    C    D    E    F
    <=500 m    0096 0065 0086 0796 1195 1409
   <=1000 m    0305 0198 0220 1350 0009 0019
   <=1500 m    0420 0319 0476 0786 0024 0033
   <=2000 m    0000 0000 0000 0156 0000 0000
   <=3000 m    0000 0000 0000 0117 0000 0000
    >3000 m    0000 0000 0000 0009 0000 0000

----------------------------
MIXING HEIGHT BY HOUR OF DAY
----------------------------
       0000  0100  0200  0400  0800  1600  Greater
        to    to    to    to    to    to   than
Hour   0100  0200  0400  0800  1600  3200  3200
  01   0139  0084  0019  0046  0035  0014  0000
  02   0138  0088  0011  0050  0032  0018  0000
  03   0131  0101  0014  0041  0033  0016  0001
  04   0121  0097  0015  0045  0044  0014  0001
  05   0144  0090  0012  0039  0035  0016  0001
  06   0091  0121  0070  0024  0018  0013  0000
  07   0093  0062  0110  0063  0006  0003  0000
  08   0000  0060  0120  0157  0000  0000  0000
  09   0000  0000  0086  0182  0069  0000  0000
  10   0000  0000  0000  0217  0120  0000  0000
  11   0000  0000  0000  0134  0203  0000  0000
  12   0000  0000  0000  0086  0251  0000  0000
  13   0000  0000  0000  0000  0337  0000  0000
  14   0000  0000  0000  0000  0337  0000  0000
  15   0000  0000  0000  0000  0337  0000  0000
  16   0000  0000  0000  0000  0337  0000  0000
  17   0012  0007  0000  0006  0299  0013  0000
```

18	0031	0031	0000	0031	0219	0024	0001
19	0057	0060	0006	0040	0147	0027	0000
20	0086	0069	0008	0058	0097	0018	0001
21	0124	0064	0011	0060	0063	0015	0000
22	0137	0062	0015	0056	0055	0012	0000
23	0143	0070	0015	0051	0045	0013	0000
24	0141	0077	0022	0047	0038	0012	0000

FIGURES

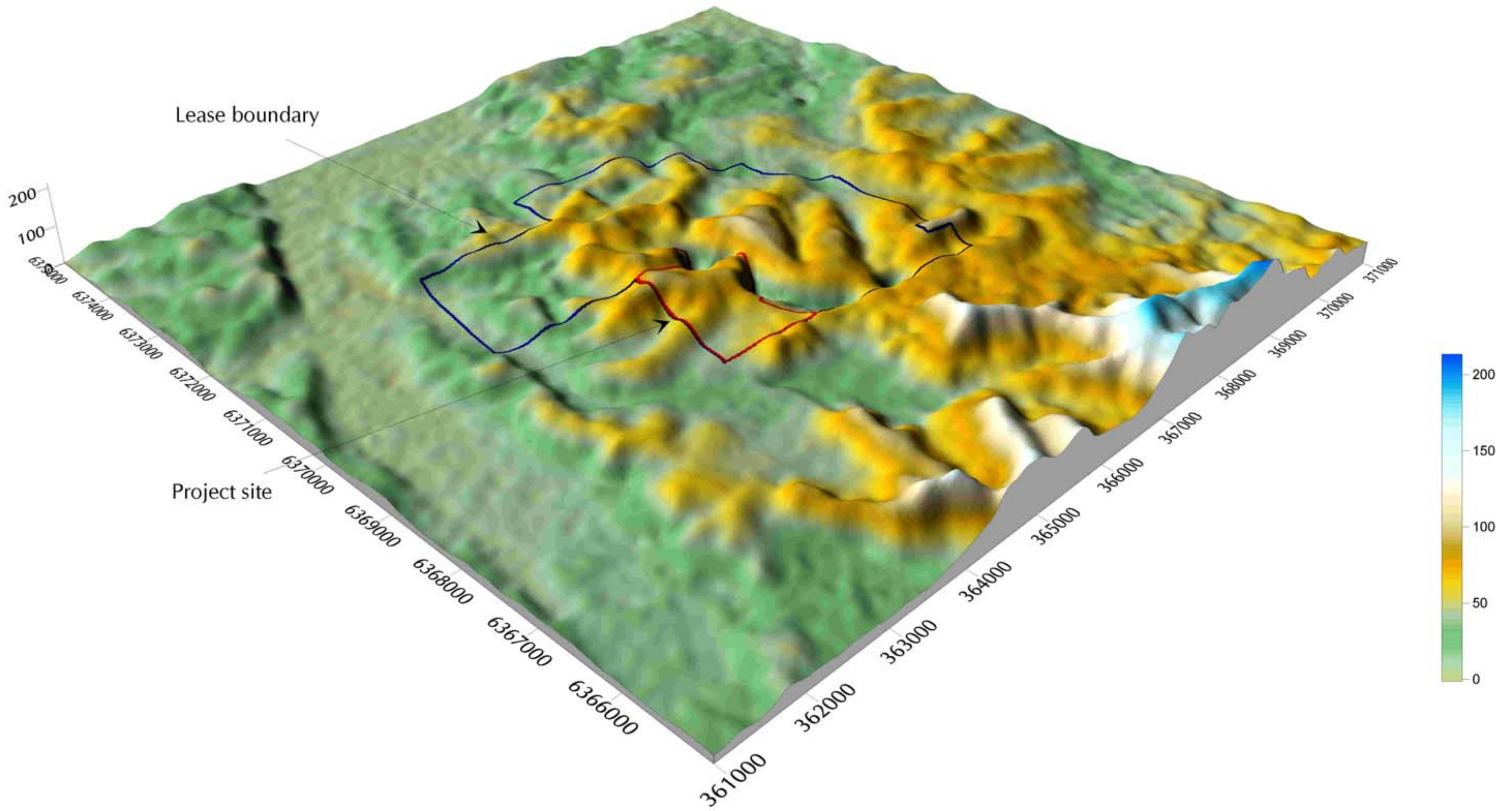


Location of Bloomfield Collieries and monitoring sites

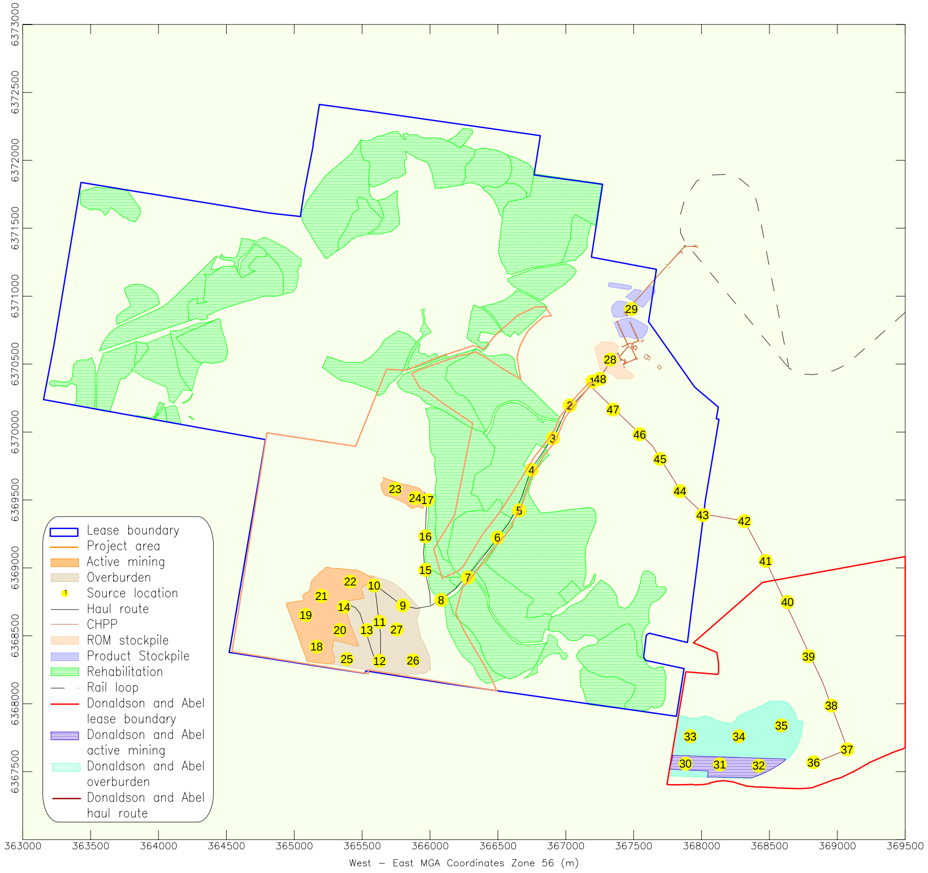


6373000
6372500
6372000
6371500
6371000
6370500
6370000
6369500
6369000
6368500
6368000
Workshop
Surface facilities and office
Creek cut
S cut
Lease boundary
Project area
Current mining area
CHPP
ROM stockpile
Product Stockpile
Rehabilitation
Remnant tree areas
Rail loop
Roads
363000
363500
364000
364500
365000
365500
366000
366500
367000
367500
368000
368500
West – Easy MGA Coordinates Zones 56 (m)

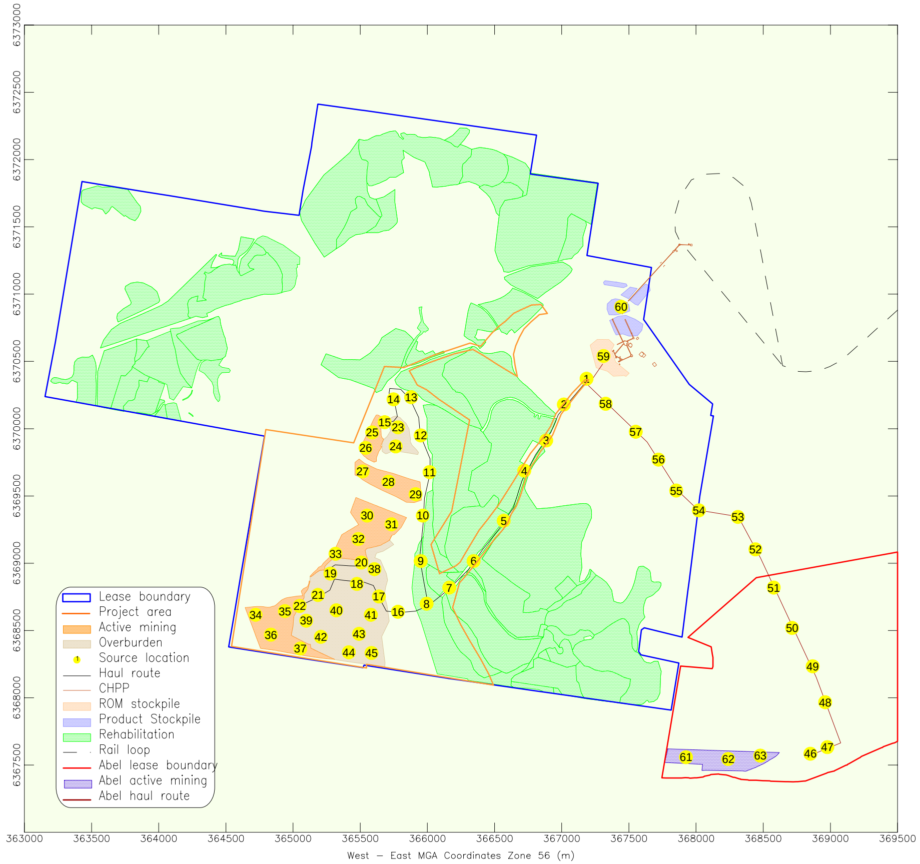
Site layout


Lease boundary
Project site
200
100
6374000
6373000
6372000
6371000
6370000
6369000
6368000
6367000
6366000
361000
362000
363000
364000
365000
366000
367000
368000
369000
370000
371000
0
50
100
150
200

Topography

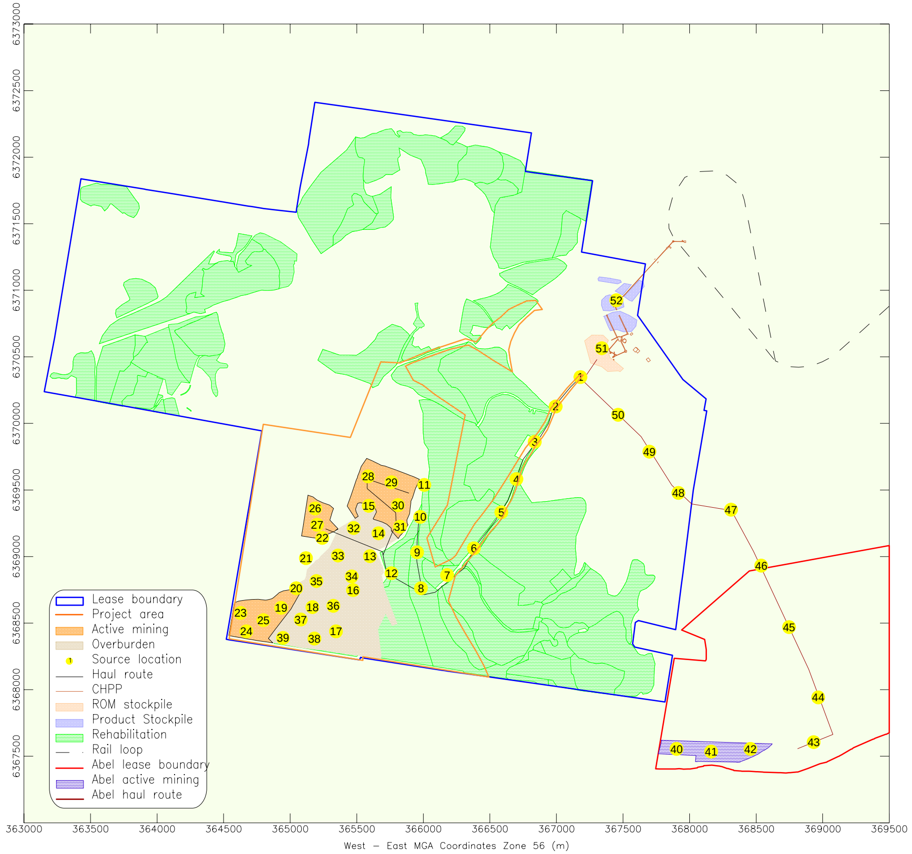


Source locations - Stage 1

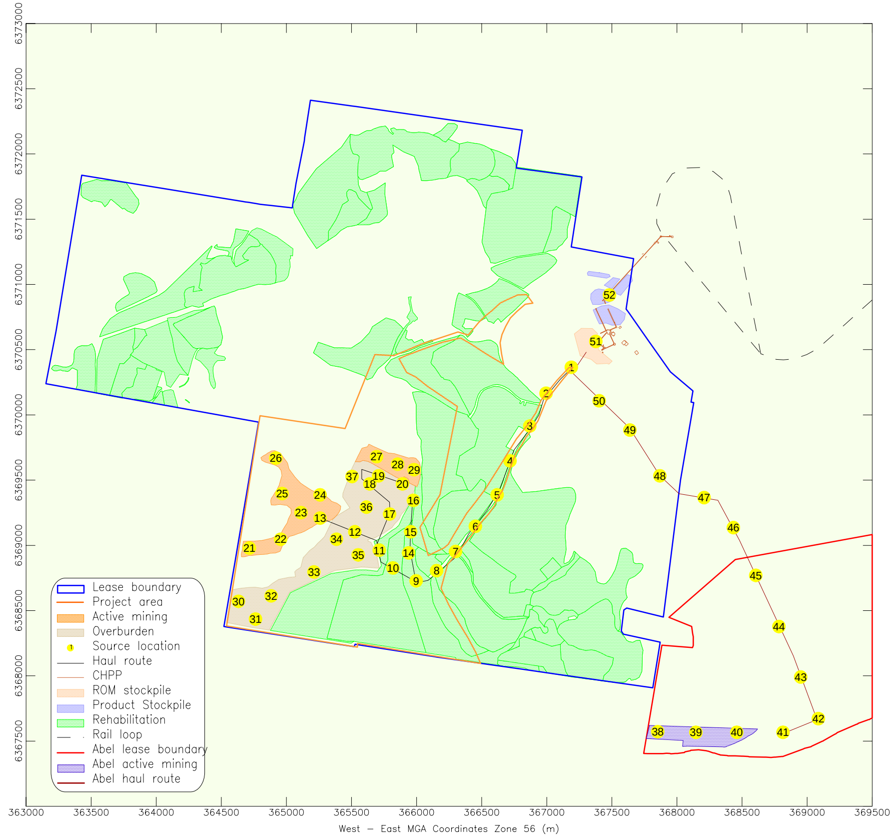


Source locations - Stage 2

Location of sources – Stages 1 and 2



Source locations – Stage 3



Source locations – Stage 4

Location of sources – Stages 3 and 4

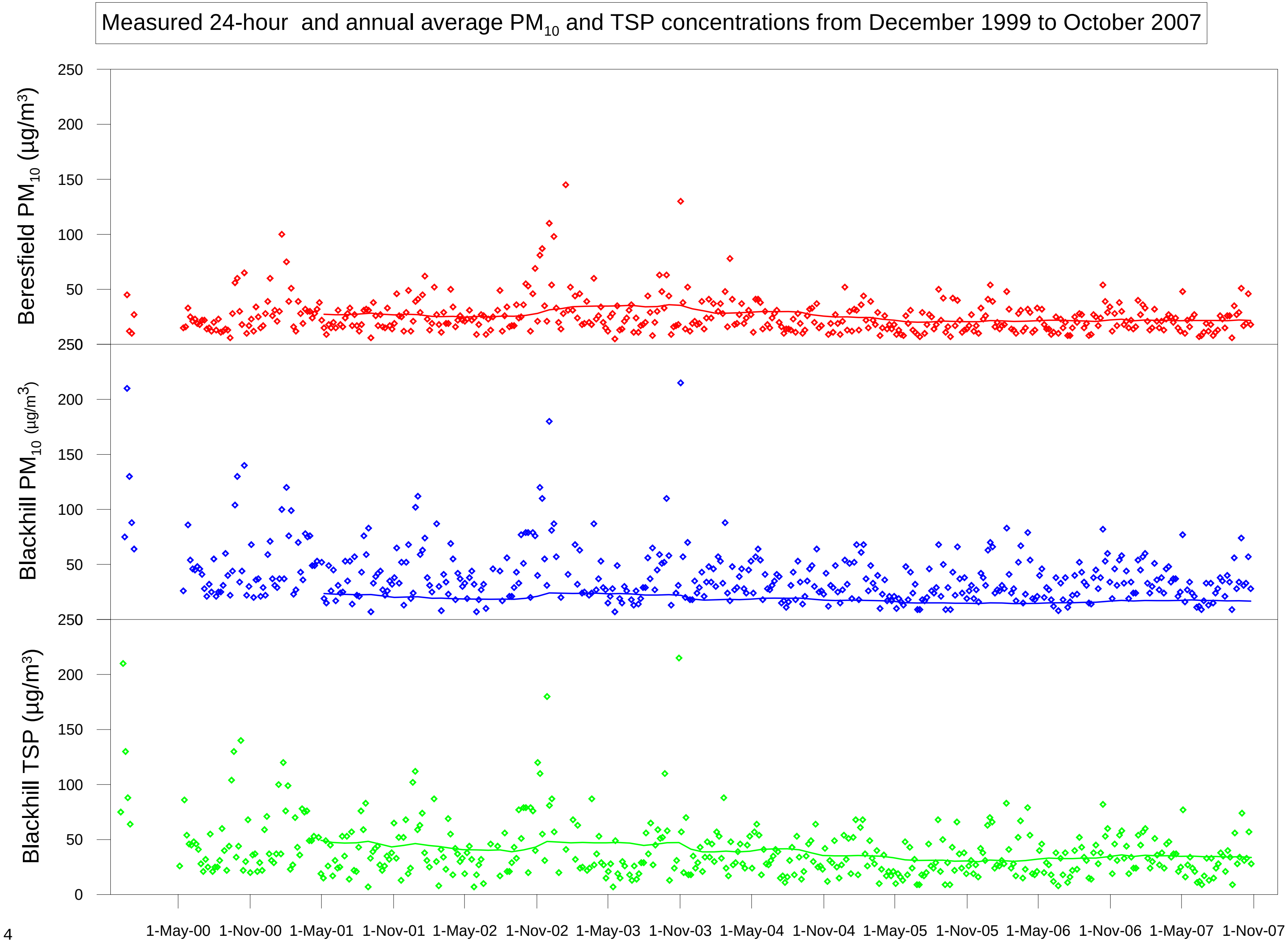
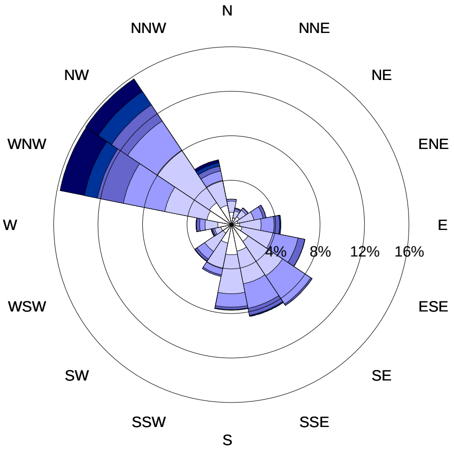
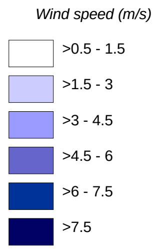

Measured 24-hour and annual average PM10 and TSP concentrations from December 1999 to October 2007
Beresfield PM10 (µg/m3)
Blackhill PM10 (µg/m3)
Blackhill TSP (µg/m3)
250
200
150
100
50
0
1-May-00 1-Nov-00 1-May-01 1-Nov-01 1-May-02 1-Nov-02 1-May-03 1-Nov-03 1-May-04 1-Nov-04 1-May-05 1-Nov-05 1-May-06 1-Nov-06 1-May-07 1-Nov-07

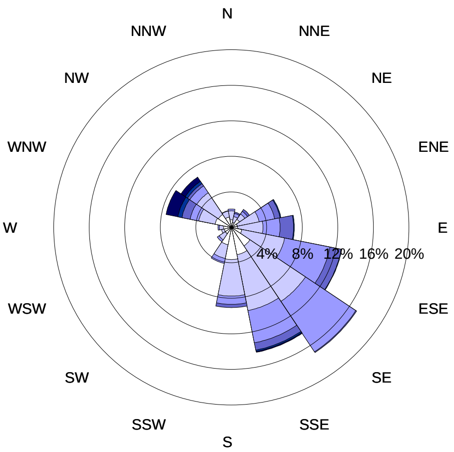
FIGURE 6

Annual and seasonal windroses prepared from data collected at DEC monitoring station at Beresfield (1 August 2004 to 31 July 2005)

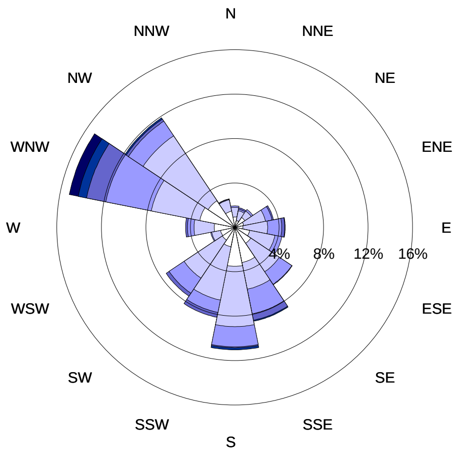


Annual
Calms = 3.9%

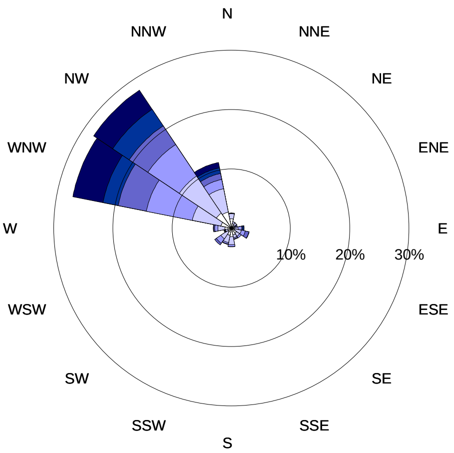




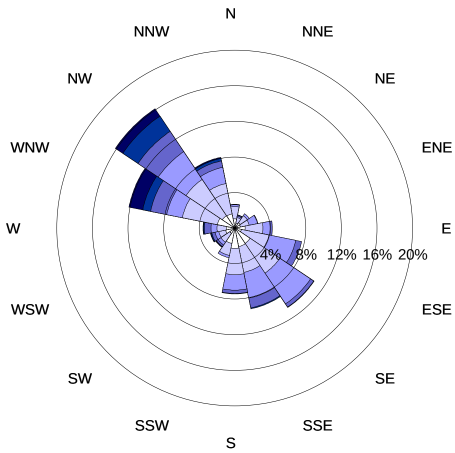
Summer
Calms = 3.1%



Autumn
Calms = 4.1%

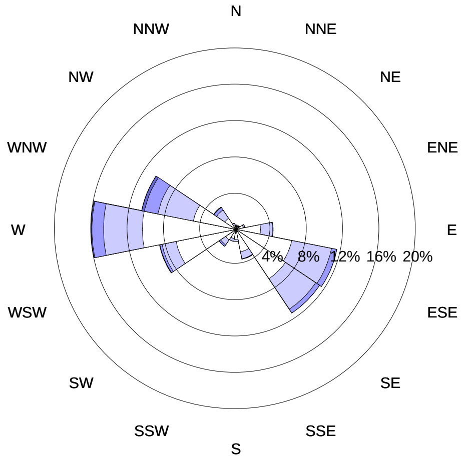


Winter
Calms = 4.8%

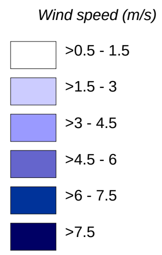


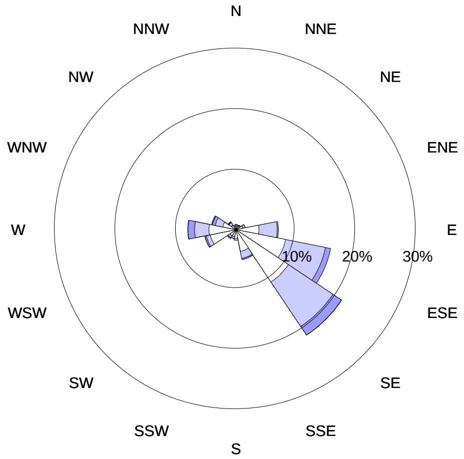
Spring
Calms = 3.3%

Annual and seasonal windroses for Donaldson Meteorological Station (2004)

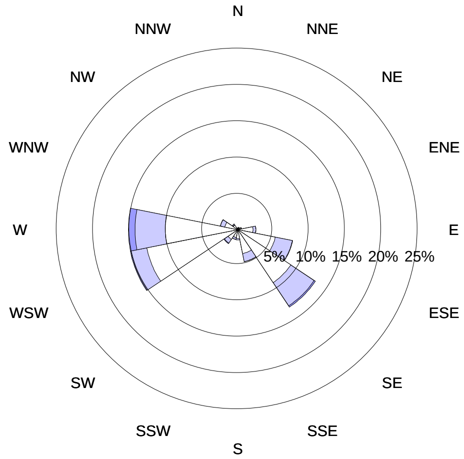


Annual
Calms = 24.1%

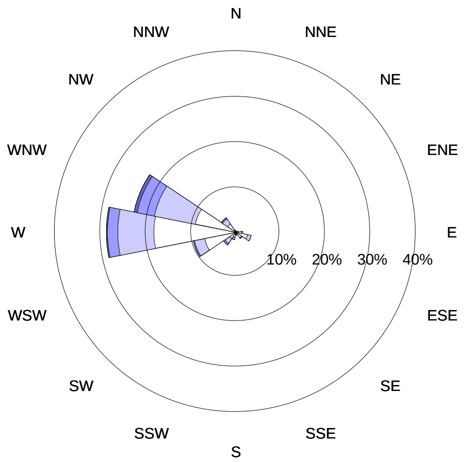




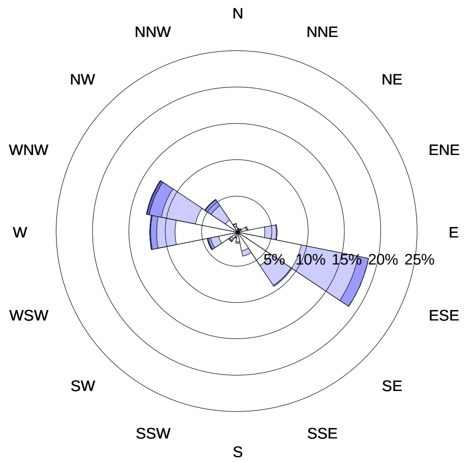
Summer
Calms = 22.3%



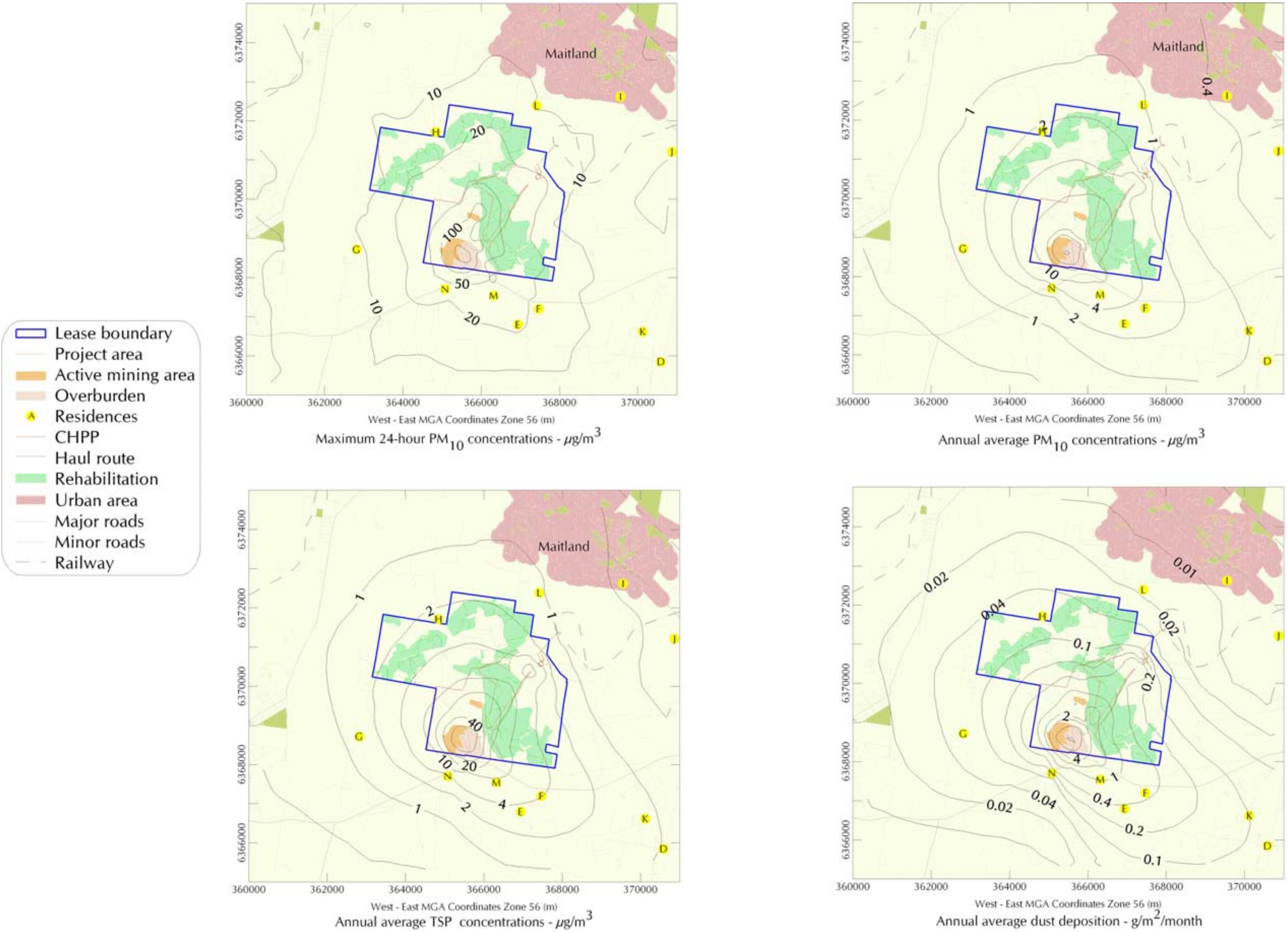
Autumn
Calms = 32.2%



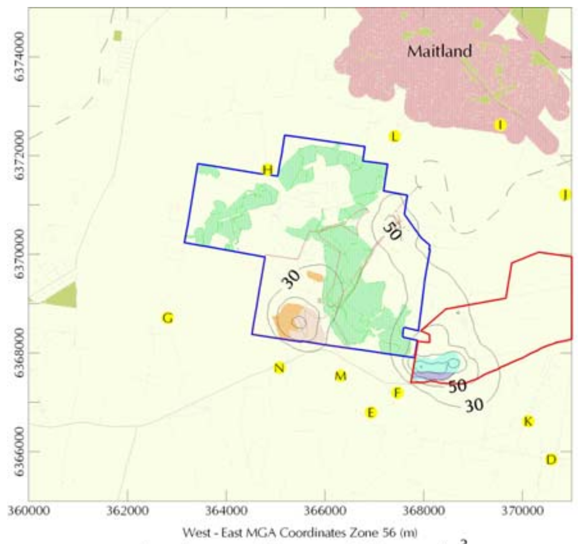
Winter
Calms = 20.7%



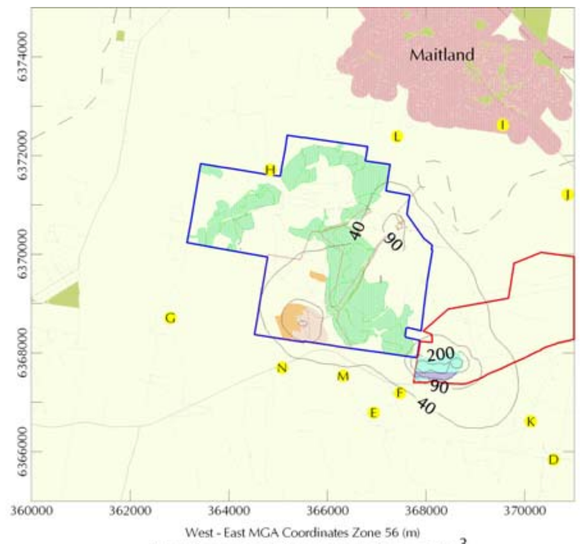
Spring
Calms = 21.1%



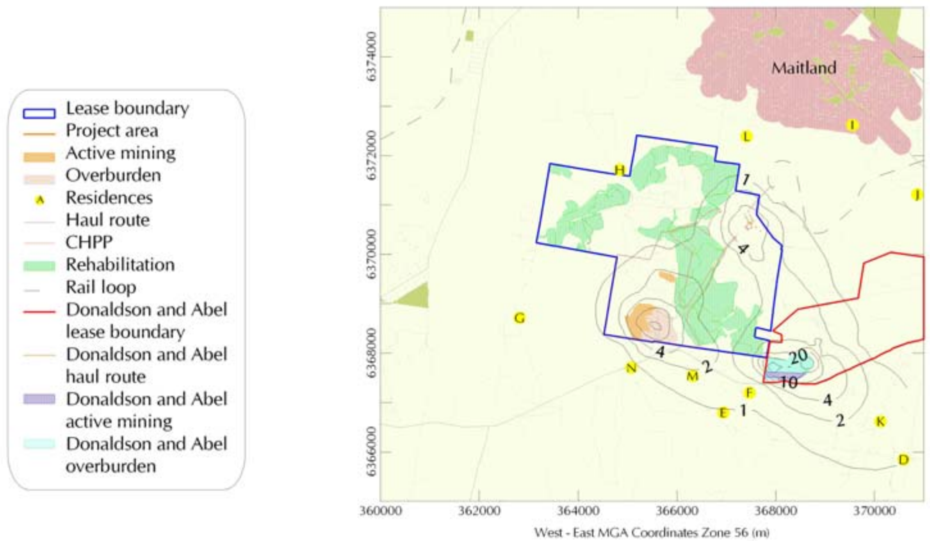
Predicted particulate matter concentration and deposition levels for Bloomfield - Stage 1



Annual average PM_{10} concentrations - $\mu g/m^3$

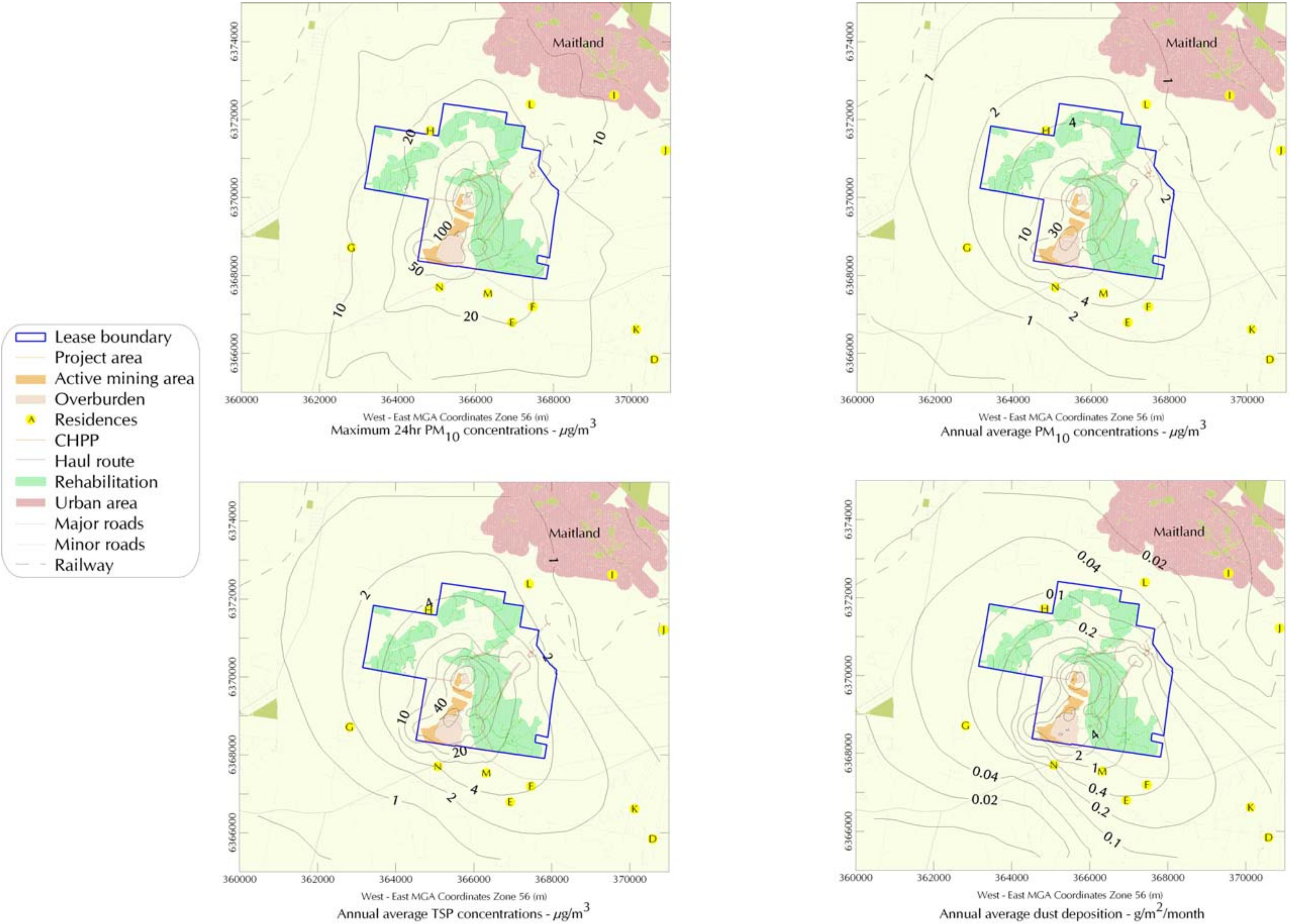


Annual average TSP concentrations - $\mu g/m^3$

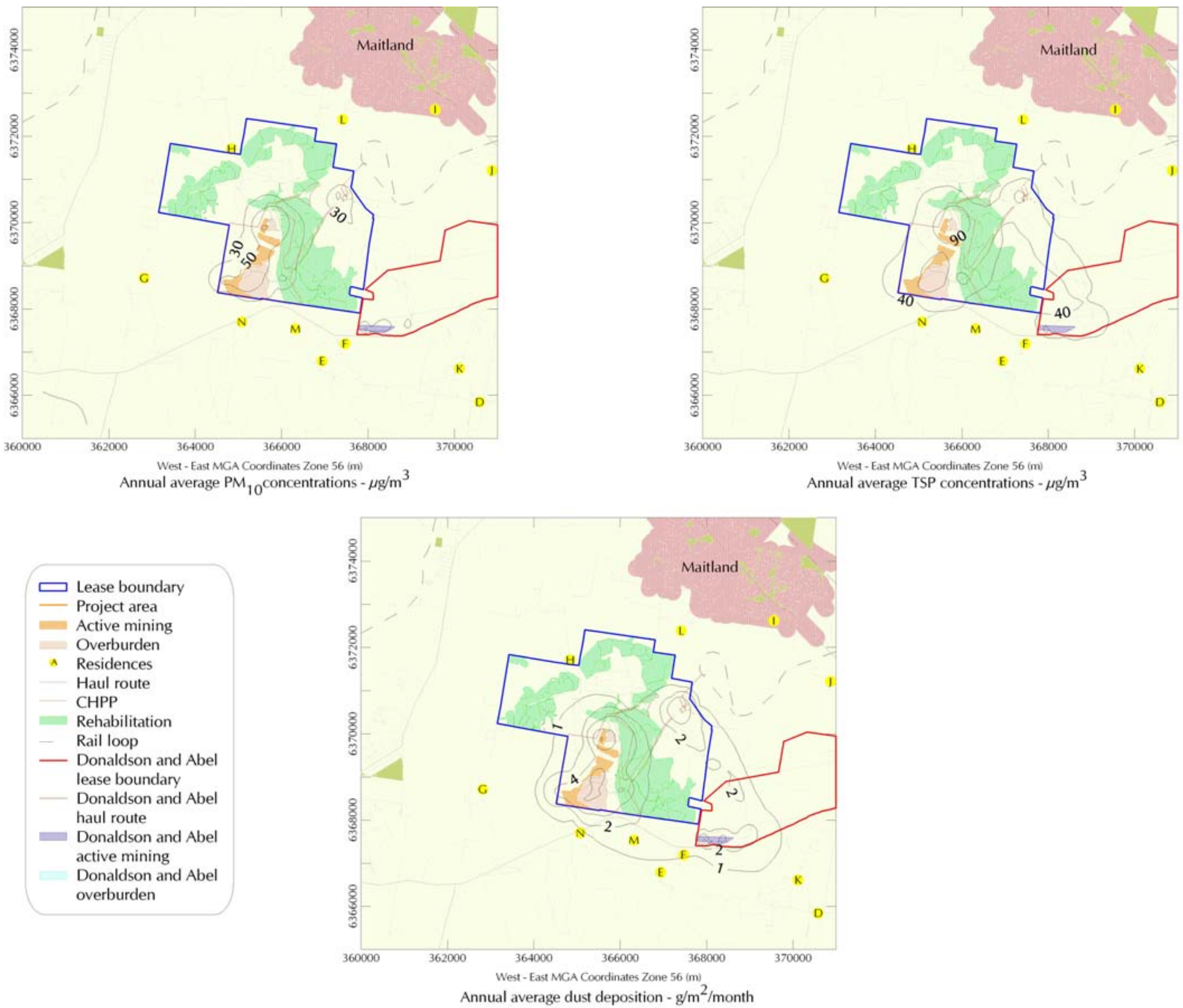


Annual average dust deposition - g/m^2/month

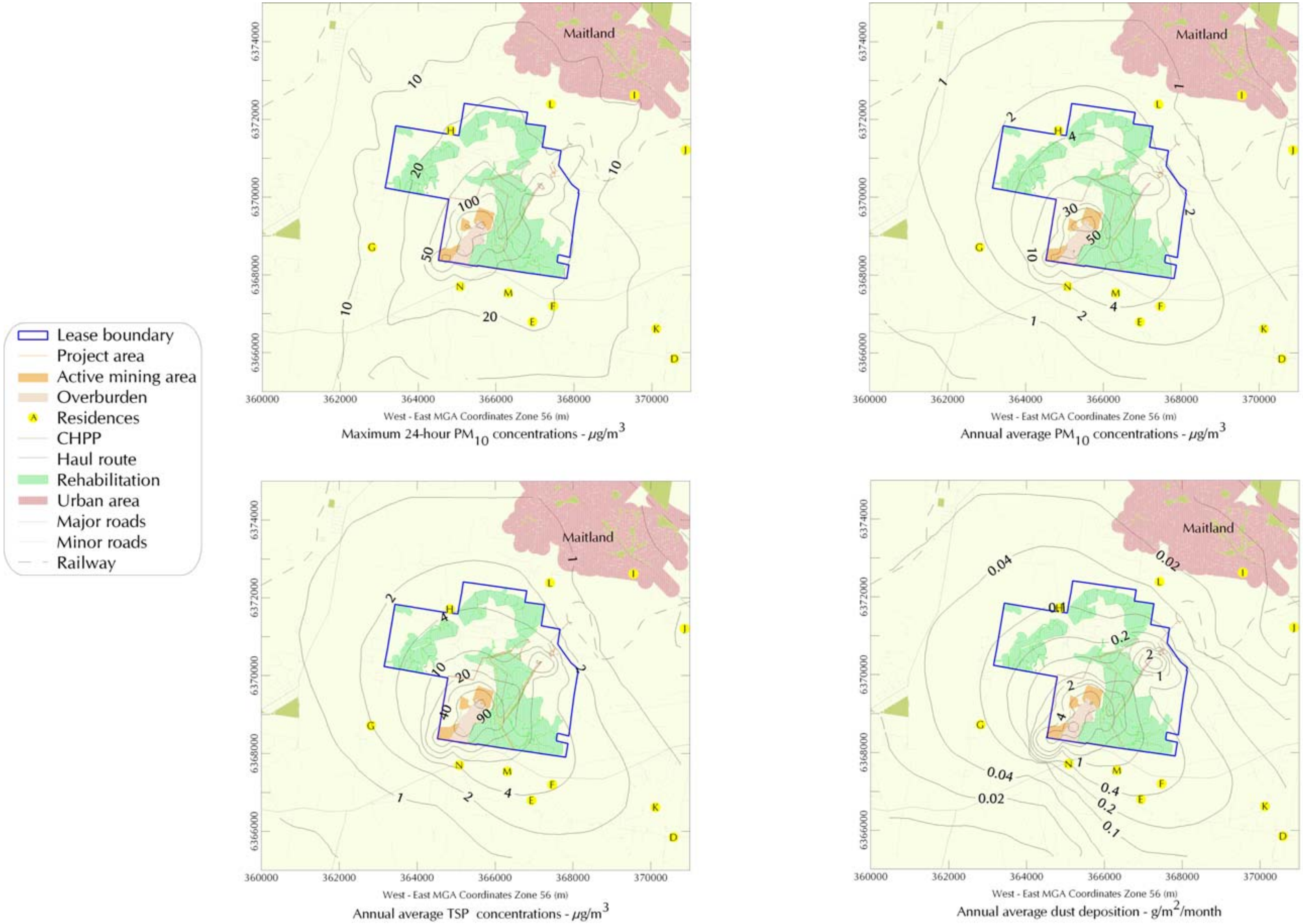
Predicted particulate matter concentration and deposition levels
for Bloomfield, Donaldson and Abel mines and other sources - Stage 1



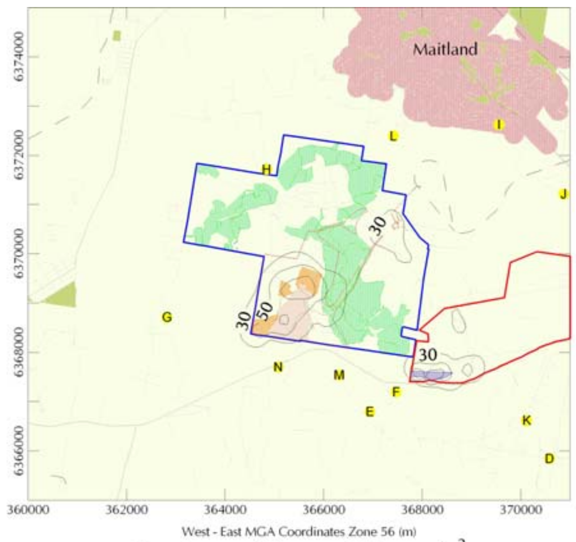
Predicted particulate matter concentration and deposition levels for Bloomfield - Stage 2



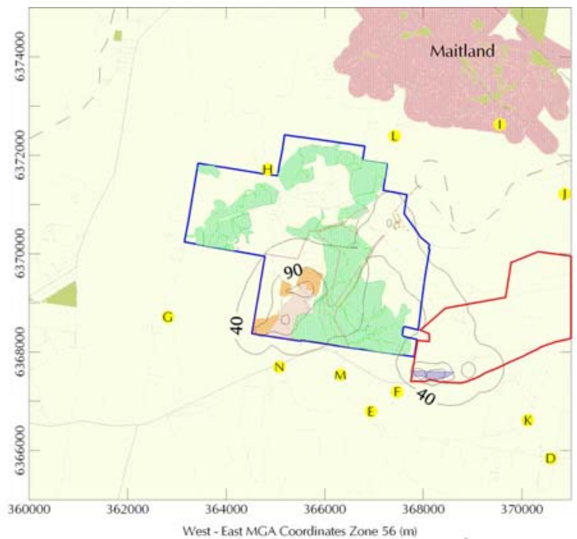
Predicted particulate matter concentration and deposition levels
for Bloomfield, Donaldson and Abel mines and other sources - Stage 2



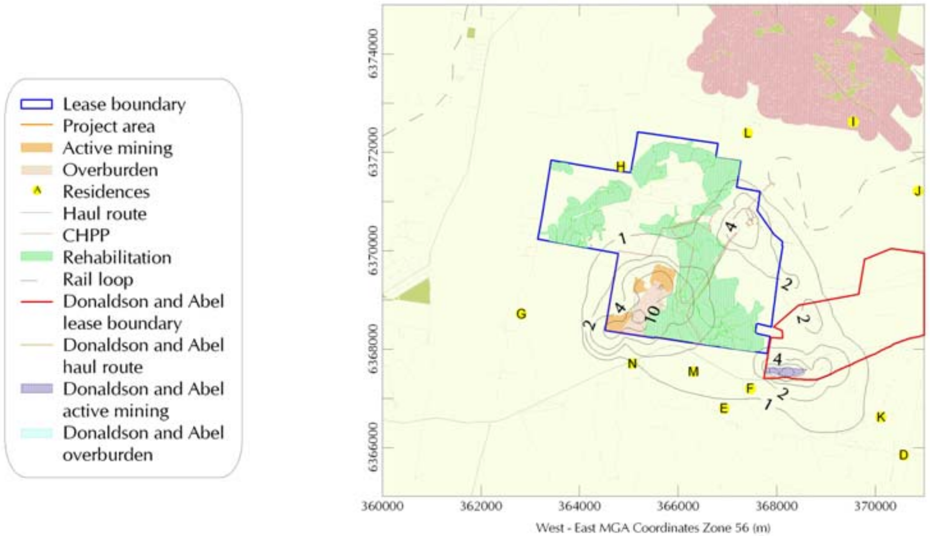
Predicted particulate matter concentration and deposition levels for Bloomfield - Stage 3



Annual average PM_{10} concentrations - $\mu g/m^3$

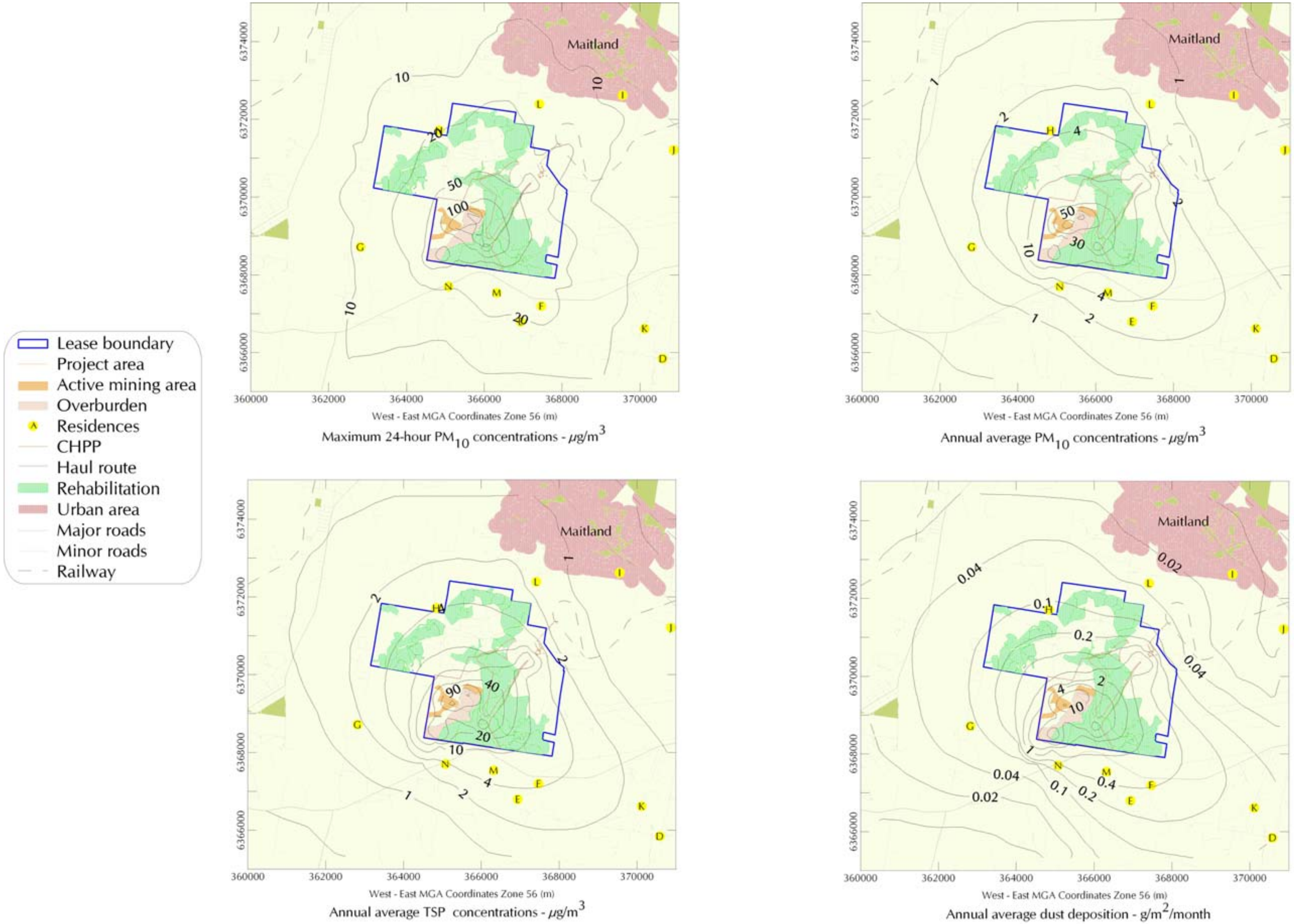


Annual average TSP concentrations - $\mu g/m^3$

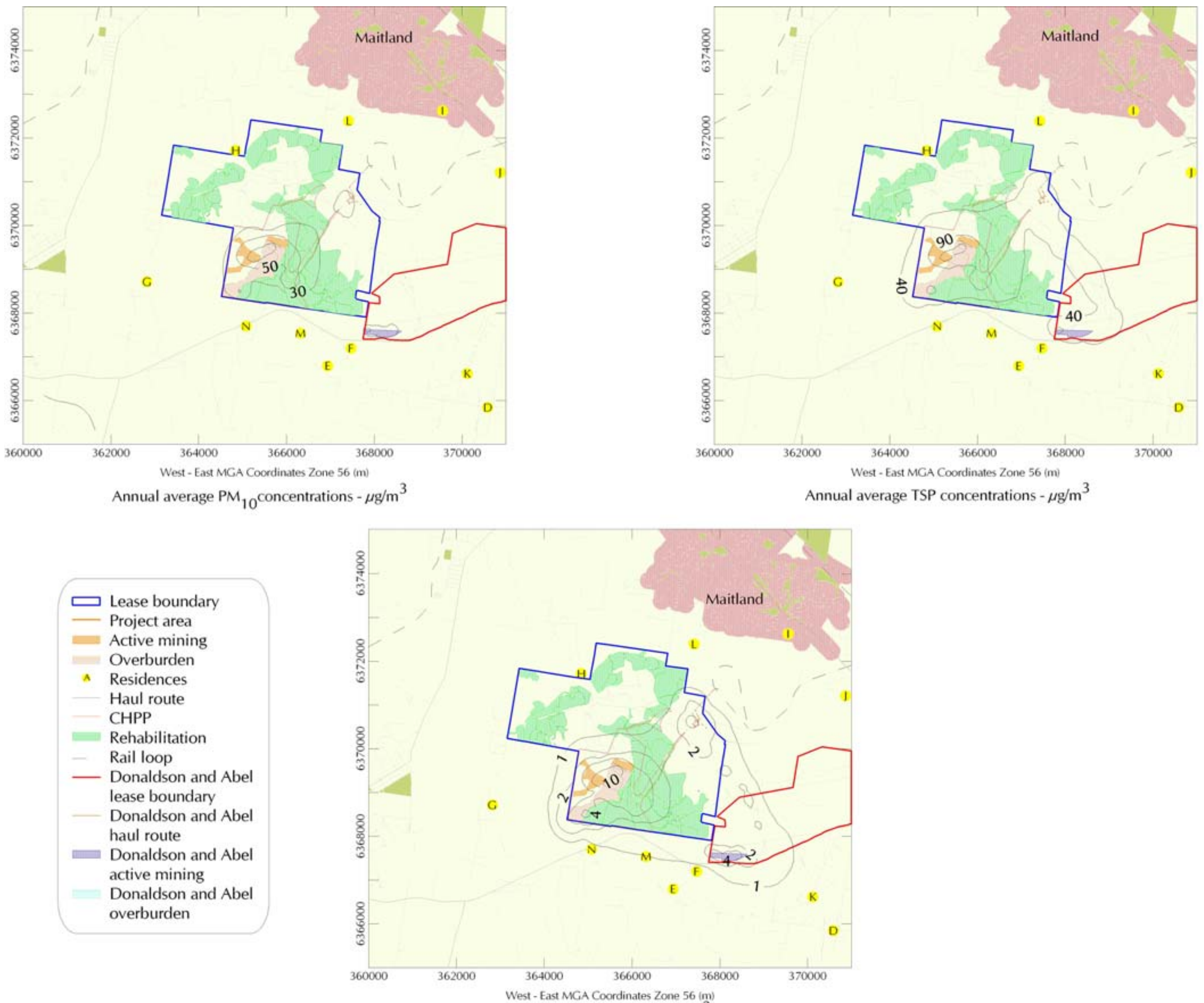


Annual average dust deposition - g/m^2/month

Predicted particulate matter concentration and deposition levels
for Bloomfield, Donaldson and Abel mines and other sources - Stage 3



Predicted particulate matter concentration and deposition levels for Bloomfield - Stage 4



Annual average PM_{10} concentrations - $\mu g/m^3$

Annual average TSP concentrations - $\mu g/m^3$

Annual average dust deposition - g/m^2/month

Predicted particulate matter concentration and deposition levels for Bloomfield, Donaldson and Abel mines and other sources - Stage 4

Appendix H

Surface Water Assessment

Bloomfield Colliery Completion of Mining and Rehabilitation

Part 3A Environmental Assessment

November 2008

Bloomfield Collieries Pty Ltd

Completion of Mining and Rehabilitation Project

Surface Water Assessment

Date: 9 September 2008

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EXECUTIVE SUMMARY

Bloomfield Colliery proposes to complete its current open cut mining and rehabilitation program on its Consolidated Coal Lease 761 (CCL 761). Surface water management required as part of this completion and rehabilitation program will utilise the existing water management facilities within CCL 761. These facilities include infrastructure to manage and divert clean water away from areas of disturbance, drain in-pit water, convey water to various areas of the site, including several dams and the Coal Handling and Preparation Plant (CHPP), and the management of tailings from the CHPP. Erosion and sedimentation control forms an integral part of all these activities.

The majority of the above activities form part of the integrated water management system that has been developed for CCL761 and the nearby Donaldson and Abel Mines that utilise the majority of this system and the CHPP for their operations. This integrated water management system was included in the 3A Approval for the Abel Project, provided to Donaldson Coal by the Department of Planning as Approval No. 05_0136 in June 2007. A detailed Water Management Plan describing this integrated water management system has been prepared by Donaldson Coal in consultation with Bloomfield Collieries and was approved by the Department of Planning in May, 2008.

Although there are some water management aspects of this proposal that apply directly to the completion of open cut mining and rehabilitation within CL761, it is not possible to address these matters in isolation from the integrated water management that is used to manage water across the neighbouring operations, who share water resources and infrastructure such as dams, tailings management systems and a licenced discharge point to Four Mile Creek.

This Surface Water Assessment therefore addresses those matters that are specific to this proposal, such as management of in-pit flows, control of runoff in the vicinity of the Bloomfield workshop and erosion and sedimentation controls around disturbed areas and haul roads, but generally focuses on how this proposal relates to the approved integrated water management system and overall site water balance. This Assessment therefore refers to aspects of the integrated system, such as dams, CHPP operation, stockpiles and tailings management, that have been previously approved by the Abel Project.

Analysis of potential impact of this proposal to complete open cut mining and rehabilitation on CCL761 on the integrated water management system and water balance indicates that the available water storage and conveyance systems within the approved system are adequate to deal with any anticipated changes to water inflows to the Bloomfield pits, while maintaining supply to the CHPP and minimising discharge to Four Mile Creek. Accordingly, the proposed activities that are the subject of this application can be undertaken without the need to alter the existing approved water management facilities or water management regime.

1 INTRODUCTION

1.1 Background

This report provides an assessment of the surface water issues related to the proposed completion of open cut mining and rehabilitation by Bloomfield Colliery within Consolidated Coal Lease 761 (the lease area). The assessment has been prepared as part of a Part 3A Environmental Assessment, required under Section 75F of the *Environmental Planning and Assessment Act 1979*. The Project Application area is outlined in orange on **Figure 1.1**. The area outlined in red on **Figure 1.1** is the lease area.

The report addresses the relevant issues identified by the Director-General of the Department of Planning's (DoP) letter dated 8/10/2007 as requiring assessment, as well as the requirements of Department of Environment and Climate Change (DECC), Department of Water and Energy (DWE), Department of Primary Industries (DPI) and Maitland City Council (MCC).

The surface water management system required to support the ongoing operation of mining and rehabilitation at the Bloomfield Colliery is an integral part of the water management system for the Abel Project that was the subject of Approval No. 05_0136 issued by the Department of Planning in June 2007. The integrated water management system that was approved for the Abel Project is shown schematically on **Figure 1.2** and involves the management of all surface runoff and groundwater sources associated with the Abel, Bloomfield and Donaldson mines in a manner that ensures continuity of supply to the Bloomfield Coal Handling and Preparation Plant (CHPP) while minimising discharge of water to Four Mile Creek from the operating areas. (Note that the lettering on each of the catchment areas identified on **Figure 1.2** represents the designation used for water balance analysis - see **Annexure C**).

For consistency, the relevant elements of the integrated water management system for the Abel Project that are located within the Bloomfield Colliery lease area will be referred to in this report, even though they have been approved as part of the approval for the Abel Project. The approved facilities located within the lease area include:

- the existing surface water storages and sediment control dams (Lake Kennerson, Lake Foster, Possums Puddle and the Stockpile Dam) and the various pipelines and channels that allow water to be directed into or past these storages;
- pumps for the supply of water from Lake Foster to the Bloomfield Coal Handling and Preparation Plan (CHPP);
- pumps for supply of groundwater extracted from old underground workings to supplement water supply to the CHPP when required;
- the CHPP associated stockpile areas and the Stockpile Dam;
- disposal of wastes from the CHPP (coarse rejects and fine tailings) to previously mined areas including U Cut, S Cut and Creek Cut; and the rehabilitation of these areas following completion of waste disposal;
- water quality and discharge monitoring as required by the existing EPA Licence.

1.2 Part 3A Requirements

An application for the project, including a Preliminary Assessment Report, was lodged with the Department of Planning (DOP) in July 2007. The key issues, which are the focus of this Surface Water Assessment, as identified by the Department of Planning and other relevant government agencies are outlined below and summarised in **Table 1.1**.

1.2.1 General Requirements

The EA must include:

- an assessment of the potential surface water impacts of the project, including cumulative impacts, that might arise from the combined operation of the project with the other existing and approved mines in the area;
- a description of the measures that would be implemented to avoid, minimise, mitigate, offset, manage and/or monitor the impacts of the project.

1.2.2 Key Issues that relate to Water Management

Surface Water: Detailed modelling of potential surface water impacts; a site water balance; a salinity balance and a detailed description of final void management.

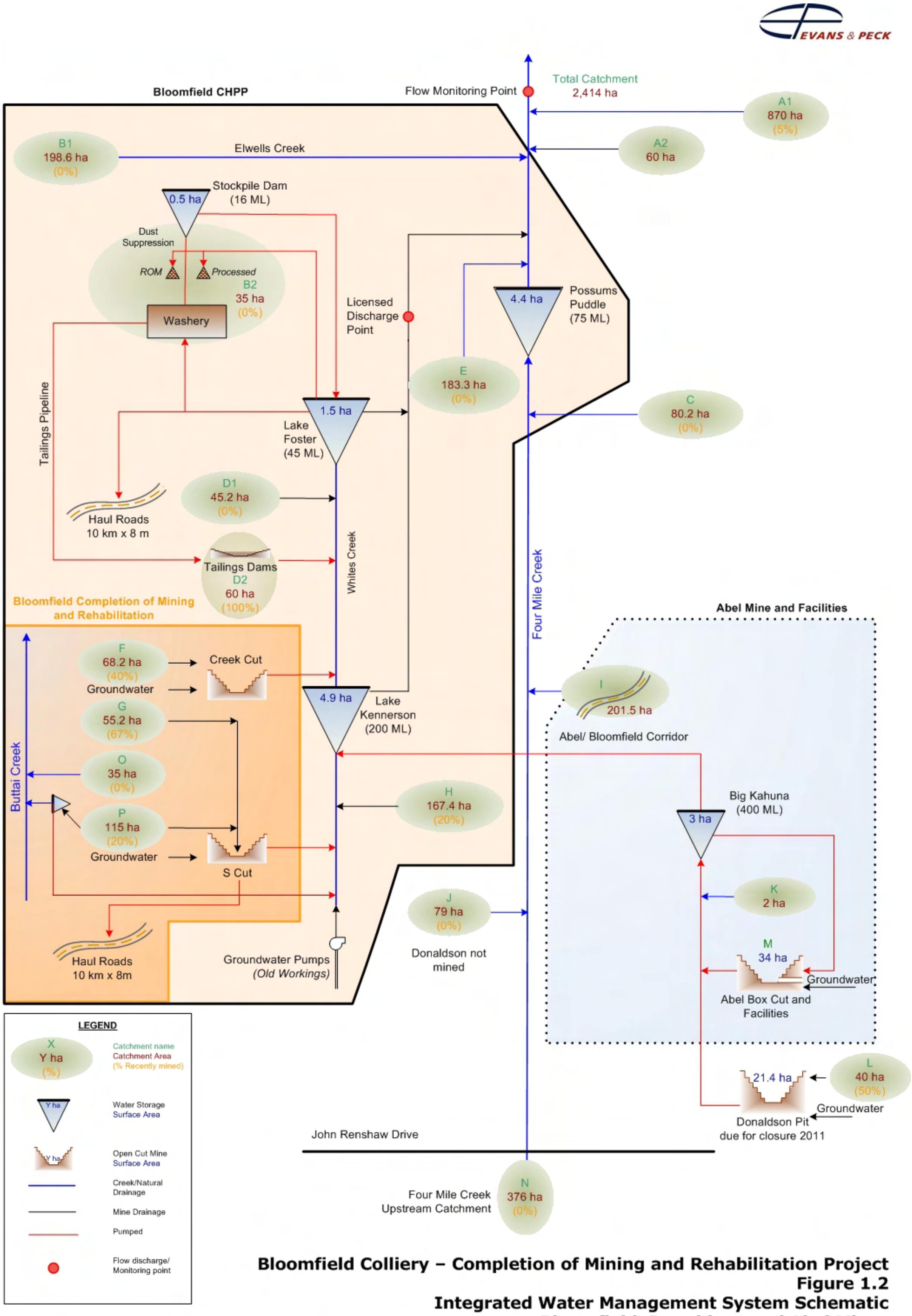
Integrated Management: Proposal for surface water monitoring and management to be integrated with neighbouring mining operations in particular the Abel and Donaldson Coal Mines.

Table 1.1: Summary of Agency Requirements

Issue	Agency	Section in this report
Surface Water		
Identify potential cumulative surface water impacts	DoP/DWE	6
Carry out site water balance (include revised figures from the Abel, Tasman, Donaldson and Bloomfield integrated water management system)	DoP/ DECC/ DWE	5
Carry out salinity balance	DoP	6.2
Operate development in compliance with *POEO Act 1997*	DECC	4, 7
Address principles, objects and targets of *Water Act 1912* and *Water Management Act 2000 (*WMA)	DWE	4, 5, 7
Identify sources of water to the development, including licensing of extraction of surface water to the existing and proposed project	DWE	3, 5
Water Management Plan		
Water Management Plan to include:	DECC	7
• Measures to avoid/minimise impacts, including on water users in zone of affectation	DoP/DWE	7
• Measures to mitigate/manage impacts	DoP/DWE	7
• Measures to monitor impacts	DoP/DWE	7

Table 1.1: Summary of Agency Requirements

Issue	Agency	Section in this report
• Triggers for mitigation plans	DWE	7
• Maximum on-site reuse of wastewater	DECC	5
• Avoid discharge of pollutants from the premises	DECC/MCC	4, 7
• Methodology, data and assumptions used to design pollution control works	DECC/MCC	4, Ann B
• Segregation of contaminated water from non-contaminated water	DECC	4, 5
• Spillage control and bunding	DECC	2.6
• Maintenance of sediment & erosion control structures	DECC	7
• Identify fuel and chemical storage	DECC	2.7
• Protect Wallis Creek and Four Mile Creek from pollution or degradation of the in-stream or riparian zones.	MCC	7
• Consider impacts of accumulated surface water which may increase groundwater levels.	MCC	N/A



Bloomfield Colliery – Completion of Mining and Rehabilitation Project
Figure 1.2
Integrated Water Management System Schematic
Bloomfield, Donaldson and Abel Mines

2 EXISTING OPERATIONS AND WATER MANAGEMENT

This application relates to the completion of open cut mining within the area shaded orange on **Figure 1.1** including the workshop area used for servicing of machinery used in the open cut and the haul roads linking the open cut to the workshop area and the ROM stockpile. All the supporting facilities used for water management, coal preparation and handling and the disposal of coarse reject material and fine tailings have been approved as part of the Abel Project.

2.1 Mining

Mining currently occurs in the S Cut pit located to the west of Lake Kennerson (refer **Figure 2.1**). All surface runoff and groundwater that drains to the pit is transferred to Lake Kennerson. From Lake Kennerson it is either transferred to Lake Foster for use in the CHPP or, in the event of there being excess water held in Lake Kennerson, is discharged to Four Mile Creek in accordance with an existing EPA licence (see **Section 3.2** for further details).

In recent years the Bloomfield Open Cut Mine has delivered run-of-mine (ROM) coal at a rate of approximately 0.8 to 1.3 million tonnes per annum to the Bloomfield CHPP and will continue to operate at this rate for the completion of mining activities covered by this application.

2.2 CHPP and Stockpile Area

The Bloomfield CHPP currently receives approximately 3.3 million tonnes of ROM coal per annum from the Bloomfield, Donaldson and Tasman mines, of which about 2.3 million tonnes are product and 1 million tonnes are reject material. This reject material consists of approximately 580,000 tonnes of coarse tailings and 420,000 tonnes of fine tailings. Coarse and fine reject material is disposed of within the Bloomfield mine area. Surface runoff from the stockpile areas is directed to the Stockpile Dam from where it is transferred to Lake Foster.

Water requirements for operation of the CHPP are currently about 2,100 ML per year. This water is primarily drawn from old underground workings under the Bloomfield lease area via Lake Kennerson and Lake Foster which also store surface runoff from the surrounding catchments.

The approval for the Abel Project included approval for expansion of the CHPP and associated stockpile area to accept up to 5.5 million tonnes per annum of ROM coal.

2.3 Water Supply to the CHPP

The current water supply to the CHPP involves a series of storages and interconnecting pipelines that are shown schematically in **Figure 1.2** and in plan in **Figure 2.1**. All these facilities have been approved under the Abel Project.

- Lake Foster (45 ML capacity) receives water from various sources and acts as the supply dam for the CHPP.
- Lake Kennerson (200 ML capacity) receives surface runoff from its contributing catchment (290 ha of rehabilitated mine overburden dumps) as well as water collected

in the active mine pit. Approximately 123 ha of land currently drains to these mine pits and is then pumped to Lake Kennerson. Water from Lake Kennerson is released to supply Lake Foster.

- Possums Puddle (75 ML capacity) is located on Four Mile Creek and provides emergency backup supply for Lake Foster in the rare event that insufficient water is available for CHPP operations from other sources. No water has been drawn from Possum's Puddle during the last decade, even during the 2005-07 drought.
- Runoff collected in the Stockpile Dam near the CHPP is transferred to Lake Foster for use in the CHPP.
- Surface runoff as well as supernatant water from the tailings emplacement in the U Cut which is pumped to Lake Foster.
- A pipeline that connects the "Big Kahuna" dam to Lake Kennerson. (The "Big Kahuna" currently serves the existing Donaldson Mine and is also the focal point for water management for the Abel Underground Mine). Excess water that is not required for operational purposes in the Donaldson and Abel Mines is transferred to Lake Foster for use in the CHPP.
- Pumps that extract water from the base of the Creek Cut and two bores that intersect old underground mine workings below the Bloomfield open cut workings. This source is only used to make up any shortfall in the water supply for the CHPP after taking account of all other sources. Historically, up to 2,000 ML per year have been pumped from these sources.

2.4 Overburden Dump Drainage

All drainage from active overburden dumps currently drains either to the active pits (S Cut and Creek Cut) or to Lake Kennerson (200 ML). Surface runoff draining to the pits, as well as groundwater inflow to the pits, is pumped to Lake Kennerson which serves as a sediment control dam as well as a key part of the Bloomfield water management system. Routine monitoring of water quality since 1996 shows an average total suspended solids (TSS) concentration of 9.5 mg/L and a 90^{th} percentile concentration of 19 mg/L. The monitoring data show that Lake Kennerson achieves a high level of sediment capture.

2.5 Haul Roads

The existing haul roads connect the S Cut to the workshop area and the ROM stockpile area. Runoff from the haul roads drains into the existing water management systems located within the Bloomfield Mine lease area.

2.6 Workshop Area

The layout of the existing workshop area is shown on **Figure 2.2** which also shows the boundary of the catchment that drains to the workshop sediment dam. The main access road between Creek Cut and the ROM coal stockpile forms the southern boundary of the workshop area. This road is drained, via a table drain, to a low (vegetated) detention basin on the southern side of road. This detention basin acts as a sediment control pond. Once the basin is sufficiently full, water overflows through a culvert under the access road and discharges into the drainage line that flows along the western side of the workshop area as shown on **Figure 2.2.** This drainage line eventually becomes Elwells Creek.

The facilities and the stormwater drainage arrangements within the workshop area catchment comprise:

- A covered workshop in which all machinery maintenance and repair is undertaken. Roof runoff from the workshop is directed to the ground adjacent to the building.
- Roads and machinery parking area to the immediate south and south-east of the workshop building drain via a slightly depressed drainage path around the eastern side of the workshop building towards the main sediment dam. A small localised catchment drains to a small sediment control basin (marked as "Collection Area" on the **Figure 2.2**). If filled to capacity, this collection area overflows into the drain that diverts water around the eastern side of the workshop.
- Surface runoff from the roads and car park areas to the north and east of the workshop drain to a culvert under the sealed access road, before draining into a sediment dam. This sediment dam overflows into the Elwells Creek drainage line.
- The entrance to the workshop is ramped up, to divert surface runoff around the workshop entrance. All internal drainage from within the covered workshop drains through an internal grease trap and sediment control sump, then through a triple baffle oily water separator. Retained oily water is diverted to a storage tank and emptied periodically by a licenced contractor. The storage tank has a flashing beacon to indicate when near capacity and requiring evacuation. A licenced contractor pumps out the tank.
- A tank farm, located immediately west of the workshop, has a series of fuel tanks that store bulk diesel and oil (total capacity of 128,000 L). The tank farm is contained within a bunded area which was designed in accordance with Section 5.8 of AS1940. The bunded area has a locked valve overflow line. Surface runoff from the bunded area drains to a sump. The sump pump operates automatically, pumping to a triple chamber oil/water separator. Separated oily water flows to a holding tank (with flashing warning beacon). Fuel decanting is carried out in a dished pad. Underflow from the dished pad flows to an automatically draining holding tank and into the triple chamber oil/water separator. Separated oily water flows to the holding tank (with flashing warning beacon).
- Minor volumes of oils and greases are stored on a raised storage platform located at the north-eastern corner of the workshop building. A catch tray that drains to the triple baffle oily water separator surrounds the storage platform.
- A bin for the storage of prill (pelletised ammonium nitrate used in the mine blasting) is located approximately 100 m north-east of the open cut workshop. The prill is transported to the site in covered semi-trailers (up to 24 tonne load capacity). The trucks reverse onto an elevated platform and the trailer is emptied via a chute into a hopper. An enclosed system then conveys the prill to an elevated bin. The prill loading chute and hopper has been engineered to minimise the potential for spillage during loading. As the prill is pelletised, if it is spilt the majority can be recovered manually by shovel and re-used, or disposed of in covered bins located permanently at the prill bin pad.

  Trucks operated by the explosives contractor collect up to 10 tonnes of prill for transport to a blasting site. The site trucks stop under the prill bin and the driver manually opens the gate valve on the bin chute. The driver controls the input to the site truck to avoid discharge by observing the filling process and shutting off the gate valve when the compartment is full. The gate valve is locked closed when not in use.

The prill bin and pad is surrounded by 150 mm concrete guttering, which directs surface runoff via a sediment retention sump into a below-ground concrete holding tank. The tank is equipped with a float switch that triggers a red flashing beacon when requiring evacuation. The tank is evacuated by a licensed contractor.

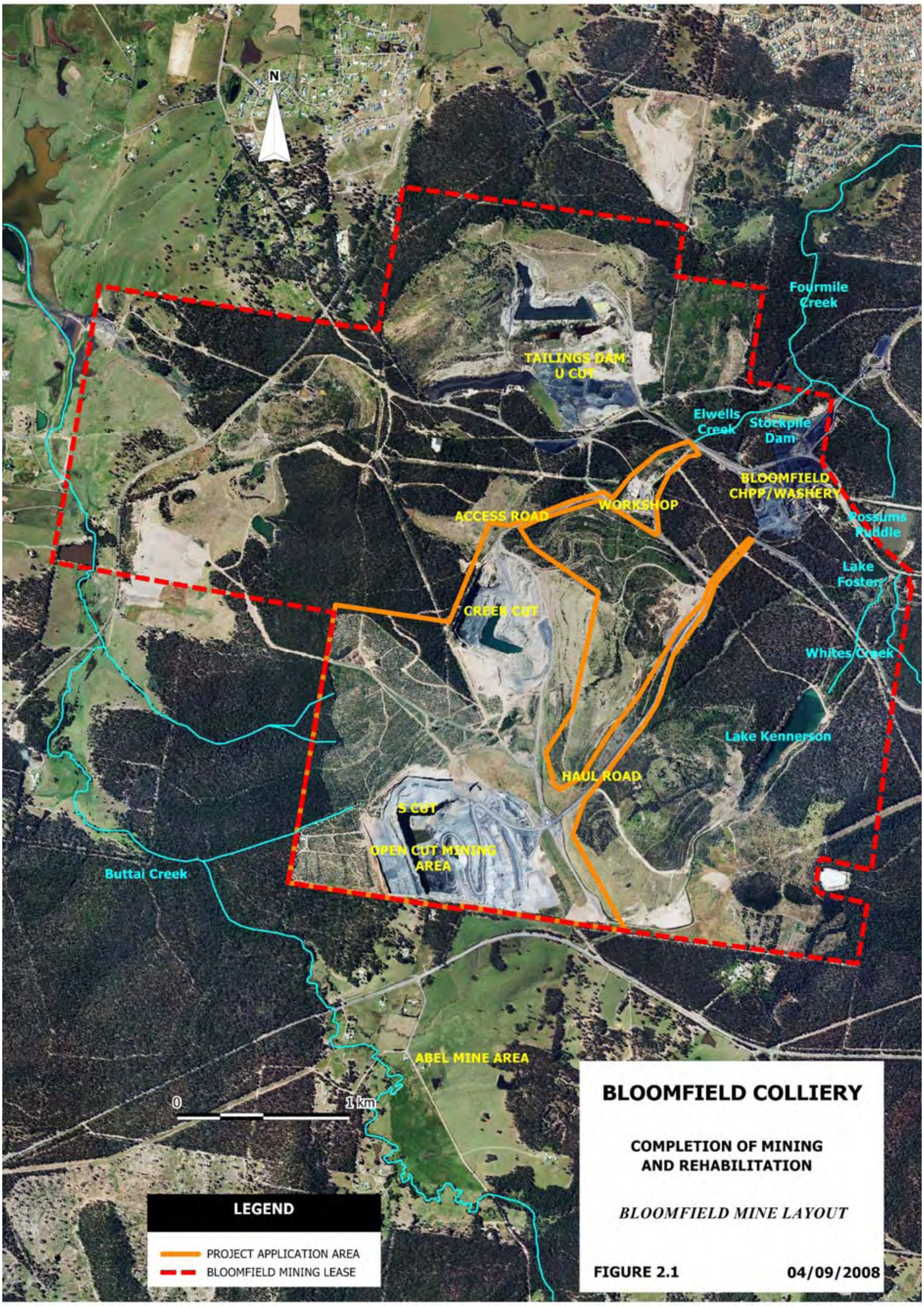
The local catchment surrounding the prill bin drains, via a small sediment pond, into Elwells Creek. This sediment pond is inspected and cleaned out periodically. The local catchment is largely undisturbed bushland and overflow of surface runoff from the prill pad would only occur in very high rainfall events, when the pad would not be operating.

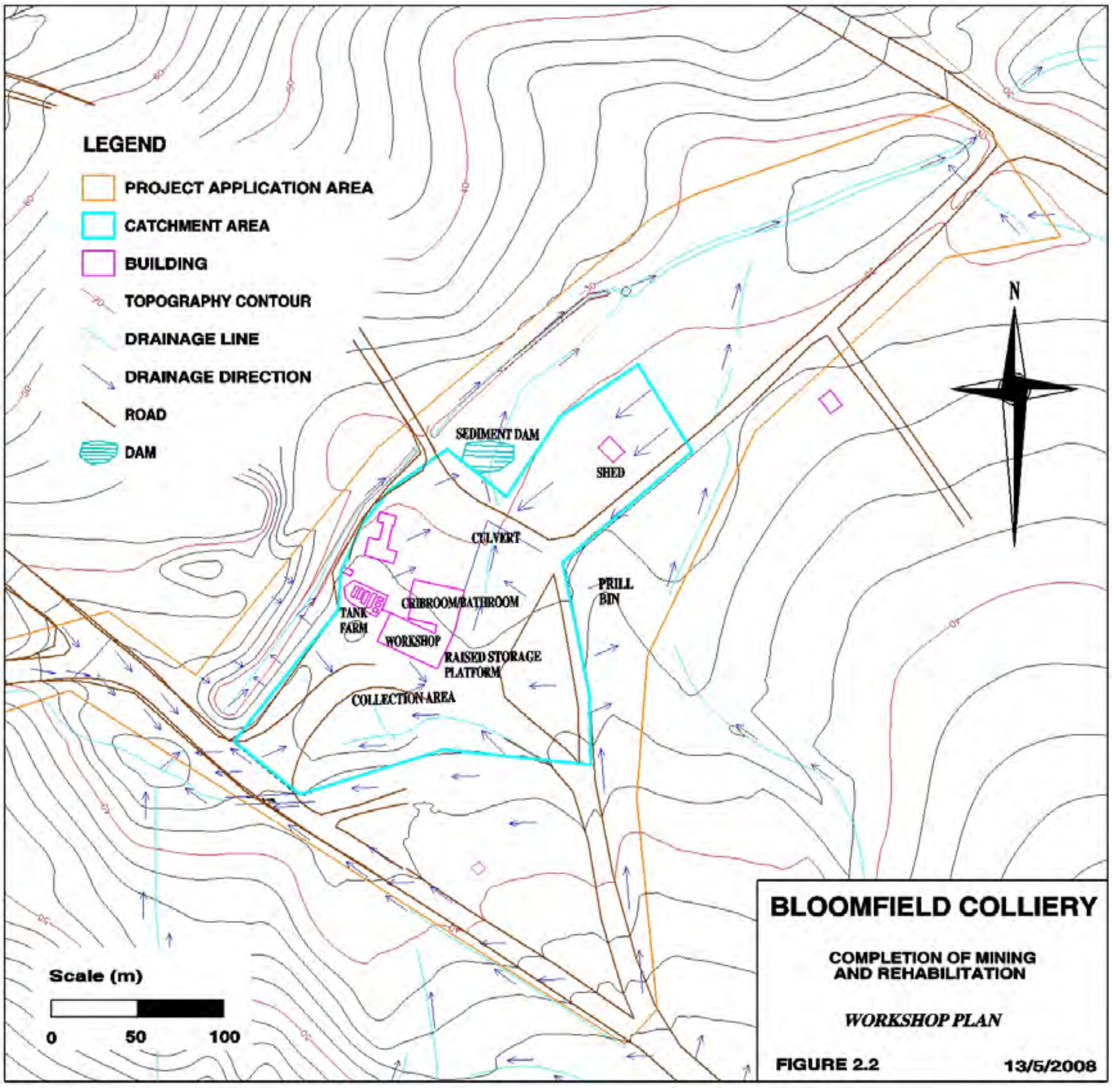
Management actions to ensure appropriate operation of the pollution control systems in the vicinity of the workshop area include:

- All water storage tanks (for oily water runoff from the tank farm and the oil storage platform, and runoff from the prill pad area) are emptied by a licenced contractor on a routine basis. The contractor is on call to undertake additional pump-out if a flashing warning light indicates that pump-out is required.
- All hydrocarbon management infrastructure is subject to quarterly documented maintenance inspections.
- The sediment dam is inspected quarterly and cleaned out as necessary to maintain sediment capture capacity.
- A water quality monitoring point is located on Elwells Creek about 350 m downstream of the sediment dam to which the workshop area drains. This monitoring point also receives runoff that drains via sediment traps from the haul road located immediately adjacent to the monitoring point. Monthly sampling since 1996 indicates that TSS concentrations average 43 mg/L.

2.7 Tailings Dams and Coarse Rejects Emplacement

Arrangements for disposal of coarse rejects and fine tailings from the CHPP to U Cut, S Cut and the Creek Cut have been approved as part of the Abel Project.


N
Fourmile Creek
TAILINGS DAM U CUT
Elwells Creek
Stockpile Dam
BLOOMFIELD CHPP/WASHERY
WORKSHOP
ACCESS ROAD
Possums Puddle
Lake Foster
CREEK CUT
Whites Creek
Lake Kennerson
HAUL ROAD
S CUT
OPEN CUT MINING AREA
Buttai Creek
ABEL MINE AREA
0
1 km
LEGEND
PROJECT APPLICATION AREA
BLOOMFIELD MINING LEASE
BLOOMFIELD COLLIERY
COMPLETION OF MINING AND REHABILITATION
BLOOMFIELD MINE LAYOUT
FIGURE 2.1
04/09/2008


LEGEND
PROJECT APPLICATION AREA
CATCHMENT AREA
BUILDING
TOPOGRAPHY CONTOUR
DRAINAGE LINE
DRAINAGE DIRECTION
ROAD
DAM
SEDIMENT DAM
SHED
CULVERT
PRILL BIN
CRIBROOM/BATHROOM
TANK FARM
WORKSHOP
RAISED STORAGE PLATFORM
COLLECTION AREA
N
Scale (m)
0
50
100
BLOOMFIELD COLLIERY
COMPLETION OF MINING AND REHABILITATION
WORKSHOP PLAN
FIGURE 2.2
13/5/2008

3 EXISTING SURFACE WATER CONDITIONS

3.1 Existing Surface Water System

Current mining operations and water management facilities on the Bloomfield Mine lease area lie within the catchments of Four Mile Creek and Buttai Creek (a tributary of Wallis Creek).

3.1.1 Pits and Water Management Facilities

The characteristics of the existing pits and main water facilities located within the lease area are summarised in **Table 3.1** below.

Table 3.1: Pits and Water Management Facilities

Name	Type	Capacity (ML)	Area (ha)	Discharges to
S Cut & contributing catchment	Open cut	na	60[1]	Lake Kennerson via Whites Ck
Lake Kennerson	Storage	200	4.9	Lake Foster or bypass channel
Creek Cut & contributing catchment	Open cut	na	68[1]	Lake Kennerson
Lake Foster	Storage	45	1.5	
Possums Puddle	Storage	75	4.4	Four Mile Creek
Stockpile Dam	Sediment Dam	15	35	Lake Foster

Note 1: contributing catchment areas are variable depending on the stage of mining.

3.1.2 System Operation

The water management system within the Bloomfield Mine lease area is used to manage water that drains into the mine pits (surface and groundwater) as well as runoff from haul roads and stockpile areas. Water from the various storages is used for dust suppression as well as to provide water supply for the Bloomfield CHPP. Any excess water, as a result of rainfall or groundwater inflow to the active pit, is discharged via a licensed discharge point.

Within the Bloomfield Mine lease area, both groundwater and surface water drain into the S Cut and are pumped to Whites Creek, which in turns drains to Lake Kennerson. When required to maintain supply to the CHPP, Lake Kennerson also receives water pumped from the old underground mine workings (Big Ben seam) that underlie much of the Bloomfield lease area. There are three separate discharge/bypass systems associated with Lake Kennerson:

- A bypass channel that conveys clean catchment runoff around the western side of Lake Kennerson and Lake Foster to Four Mile Creek. During licensed discharge, this western channel is also used to convey licensed discharge water from Lake Kennerson to the licensed discharge point immediately downstream of Lake Foster, without mixing with water from Lake Foster.
- A second bypass channel that runs around the eastern side of Lake Kennerson and Lake Foster. This channel collects clean runoff from a catchment area of about 57 ha, which is conveyed into Four Mile Creek and then flows into Possums Puddle.
- A central channel that is used to convey discharge from Lake Kennerson to Lake Foster in order to maintain water supply for the CHPP.

Lake Kennerson also receives any excess water accumulated in the Big Kahuna dam as a result of operation of the Donaldson and Abel Mines.

Lake Foster also receives runoff from adjoining catchment areas totalling about 45 ha as well as pumped discharge from the Stockpile Dam. Water from Lake Foster is pumped to the Bloomfield CHPP for coal processing. Lake Foster has no natural discharge point of its own. In extremely wet conditions it is possible for the water level in Lake Foster to reach the level of the western bypass channel and mix with water discharged from Lake Kennerson. However, this is a rare event and normally any discharge from the site only comprises water from Lake Kennerson conveyed to the licensed discharge point via the western bypass channel.

3.2 EPA Licence Conditions

The EPA Licence Conditions for the Bloomfield Mine are summarised in **Table 3.2** and **Table 3.3** below. **Table 3.2** contains the location, type and description of the monitoring and discharge points, while **Table 3.3** contains the EPA Limit Conditions in terms of pollutant concentration and volume limits.

Table 3.2: Location of EPA Monitoring and Discharge Points

ID	Type of Monitoring Point	Type of Discharge Point	Description of Location
1	• Discharge to waters under wet weather conditions* • Volume monitoring • Discharge quality monitoring	• Discharge to waters under wet weather conditions* • Volume monitoring • Discharge quality monitoring	Lake Foster pipe outlet labelled as Discharge Point W001 on Bloomfield Colliery Water Management Plan dated 31/03/1999
2	• Ambient water quality monitoring		Four Mile Creek located 500 m upstream of the current NE Hwy culvert

*Discharge limits for wet weather conditions are defined as:

- Discharge for one day following rainfall of at least 10 mm in 24 hours;
- Discharge for two days following rainfall of at least 15 mm in 24 hours;
- Discharge for three days following rainfall of at least 20 mm in 24 hours.

Table 3.3: EPA Limit Conditions

100th Percentile Concentration Limits				Volume
Conductivity (µS/cm)	**pH**	**TSS (mg/L)**	**Filterable Iron (mg/L)**	**Limit (ML/day)**
6,000	6.5 - 8.5	30	1	40

3.3 Flow Monitoring and Discharge

Statistics for the annual site discharge for the period 1999 to 2007 at the EPA discharge monitoring point are summarised in **Table 3.4**. The annual rainfall reported in the table is based on the daily rainfall measured at the Bloomfield Mine.

Table 3.4: Annual Discharge from Lake Kennerson

Year	No. of Discharge Events	Daily Discharge (ML)			Annual Discharge (ML)	Annual Salt Load (t)	Annual Rainfall (mm)
		Min	Max	Average			
1999	42	1.7	40	22	915	3,108	997
2000	60	0.6	40	36	2,201	7,176	912
2001	30	15	40	36	1,126	3,439	941
2002	17	40	40	40	680	1,824	856
2003	6	40	40	40	240	1,014	701
2004	20	5	40	34	670	2,572	769
2005	6	35	40	38	319	1,367	775
2006	0	0	0	0	0	0	663
2007	26	10	40	38	955	3,030	1,149

In the early years of the record, particularly 2000, large volumes of discharge occurred because the base of the mine pit was below the groundwater table and dewatering was required to control groundwater inflow to the pit. The groundwater pumped for dewatering purposes was directed to Lake Kennerson and subsequently discharged from the site. Similarly, a high level of discharge also occurred during 2004 because of increased pumping to Lake Kennerson for groundwater level control purposes. As a result, throughout 2004 Lake Kennerson was very full (approximately 85%) and discharge was necessary to control water levels. In 2006, as a result of drought conditions, zero discharged occurred.

3.4 Existing Water Quality

Routine (monthly) ambient water quality monitoring has been carried out at 12 locations (sites WM1 to WM12 on **Figure 3.1**) within and around the Bloomfield Mine lease area. Water samples are tested for conductivity, pH, and TSS, as required by the EPA licence conditions. In addition, water samples have also been collected in Four Mile Creek by Donaldson Mine since 2000. (Note that the historic monitoring regime has now been modified by the recently approved Water Management Plan for the Abel Project which involves:

- Monthly field testing for Temperature, pH, EC, DO and Turbidity;
- Monthly grab samples for laboratory analysis of TSS, TDS, pH and EC;
- Quarterly grab samples for laboratory analysis of Chlorides, Sulfates, Alkalinity, Calcium, Magnesium, Sodium and Potassium).

Table 3.5 summarises the water quality data collected at the various monitoring locations along Four Mile Creek during the period 1996 – 2007 by both Donaldson Mine and Bloomfield Colliery. The data has been arranged from upstream to downstream starting at John Renshaw Drive. Further details of the water quality data are contained Annexure A.

Table 3.5: Summary of Water Quality Data in Four Mile Creek

Location	Four Mile Creek Upstream Donaldson	Four Mile Creek@ John Renshaw Dr	Four Mile Creek D/S Donaldson	Four Mile CreekU/S Lake Foster	Possums Puddle	Possums Puddle Outflow	Elwells Ck / Four Mile Creek	Shamrock Creek / Four Mile Creek @ Highway	Shamrock Ck / Four Mile Creek	Four Mile Creek @ Highway	Four Mile Creek @ Highway
Designation >	EM1	WM10	EM2	WM6	WM7	WM4	WM3	WM2	WM12		WM11
Source[1] >	D	B	D	B	B	B	B	B	B	D	B
pH											
Mean	6.57	6.8	6.87	6.8	7.2	7.5	7.1	5.9	7.2	6.97	7.2
Minimum		6.0		5.5	5.9	5.9	4.2	3.9	4.1		5.7
10% Percentile	6.01	6.4	6.14	6.4	6.6	6.9	6.7	4.5	6.8	6.4	6.7
90% Percentile	6.99	7.2	7.33	7.2	7.9	8.1	7.6	7.0	7.6	7.4	7.7
Maximum		8.1		8.5	9.3	15.5	8.1	7.6	8.1		8.7
EC (µS/cm)											
Mean	328	426	167	242	503	1,332	1,405	1,189	1,494	782	2,051
Minimum		50		121	9	150	230	211	26		12
10% Percentile	118	191	125	162	200	220	370	454	478	400	577
90% Percentile	617	695	260	330	1,200	3,396	2,737	2,302	2,820	1,478	4,668
Maximum		1,080		2,100	3,320	7,360	6,080	2,750	5,750		13,331
TDS (mg/L)											
Mean	216	305	108	151	570	577	736	763	913	518	1,381
Minimum		130		50	190	8	120	46	126		97
10% Percentile	78	177	75	73	190	98	189	424	288	265	310
90% Percentile	390	445	143	240	968	1,490	1,083	1,388	1,566	965	3,376
Maximum		560		410	1,040	5,660	5,070	1,440	4,830		5,130
TSS (mg/L)											
Mean	71.8	39	265.1	29	62	28	19	43	45	10.5	92
Minimum		2.0		1.0	1.0	1.0	1.0	14.0	1.0		1.0
10% Percentile	6	8.0	1.6	1.6	2.0	1.0	2.0	15.4	2.0	2	2.8
90% Percentile	220.8	89	867.2	67	218	51	39	66	100	19.5	75
Maximum		180		370	250	627	140	202	426		5,470

Note 1: D = Donaldson Mine (2000 – 2007) B = Bloomfield Colliery (1996 – 2007)

In addition to data collected within Four Mile Creek itself, data has also been collected at a number of other sites within, and adjacent to, the Bloomfield Mine lease area. The data collected from these sites is summarised in **Table 3.6.**

Table 3.6: Summary of Water Quality Data from Other Sites

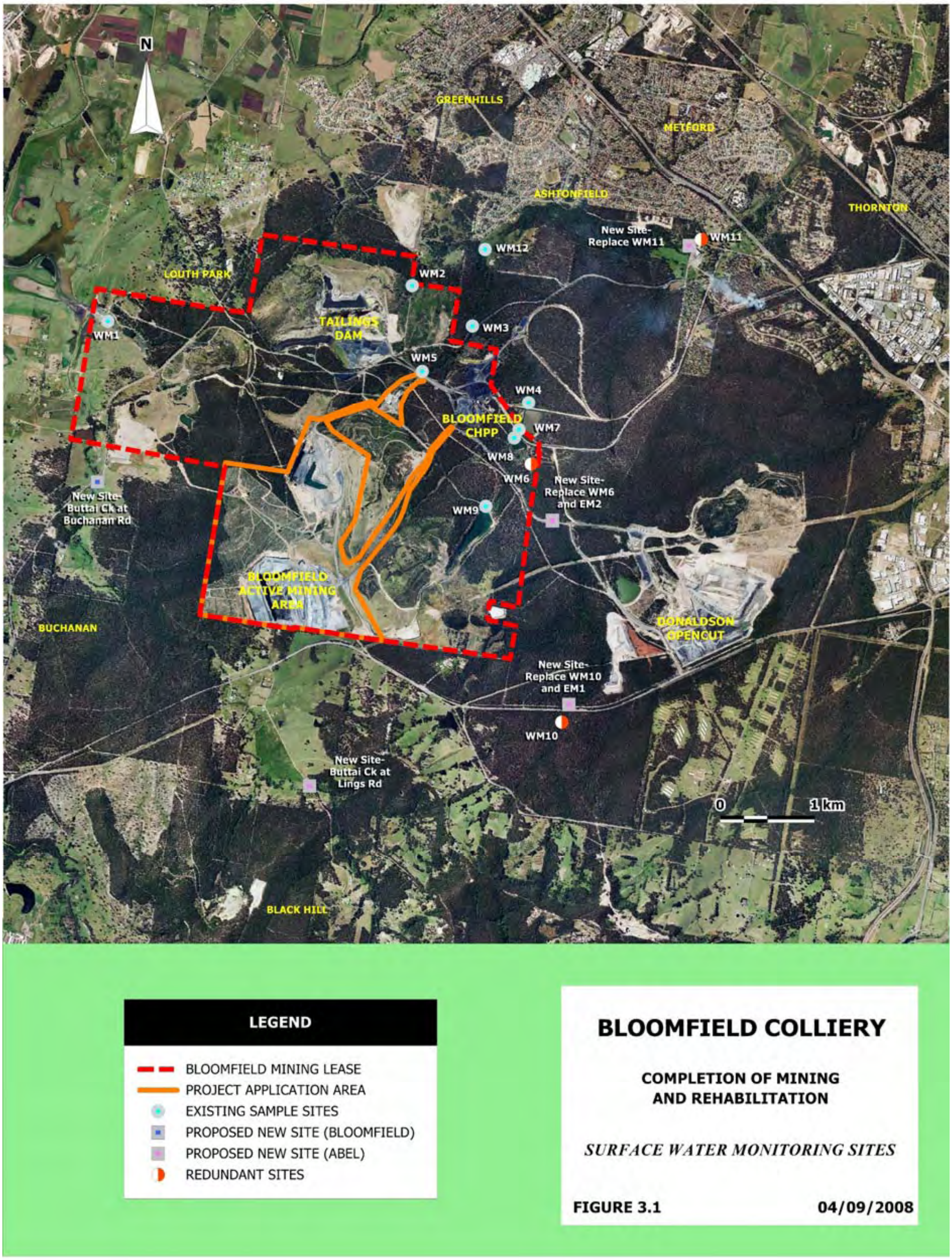
Location	Adj Rathluba	Lake Kennerson	Lake Kennerson Discharge	Elwells Creek Adj Haul Road
Designation	WM1	WM9	WM8	WM5
pH				
Mean	3.7	8.1	7.9	6.7
Minimum	2.7	5.6	6.7	3.4
10% Percentile	2.8	7.9	7.5	5.2
90% Percentile	4.7	8.4	8.2	7.8
Maximum	8.0	9.3	8.9	8.4
EC (µS/cm)				
Mean	3,338	5,042	4,936	1,938
Minimum	145	300	12	9
10% Percentile	1,117	3,140	3,210	434
90% Percentile	7,884	6,350	6,030	3,968
Maximum	14,400	8,880	8,770	6,620
TDS (mg/L)				
Mean	1,862	3,226	3,347	1,040
Minimum	164	450	600	100
10% Percentile	280	1,730	1,940	230
90% Percentile	5,668	4,270	4,420	2,160
Maximum	5,825	5,080	5,270	6,110
TSS (mg/L)				
Mean	107	10	77	43
Minimum	1.0	1.0	1.0	1.0
10% Percentile	1.0	1.0	1.0	4.0
90% Percentile	127	20	19	80
Maximum	1,272	50	4,220	470

Since the conditions of the EPA discharge licence were amended in July 1999, a representative grab sample has been taken from any wet weather discharge from Lake Kennerson and analysed for pH, EC, TSS and filterable iron, as required by the EPA licence conditions. On any day that wet weather discharge occurs from Lake Kennerson, a representative grab sample has also been taken within Four Mile Creek at the flow monitoring station (Four Mile workshops) and tested for pH, EC and TSS. Water quality statistics for these two sites for all days on which discharge occurred are summarised in **Table 3.7**.

Table 3.7: Summary of Water Quality for Lake Kennerson Discharge

	Lake Kennerson Discharge				Four Mile Creek @ W'shop		
	pH	TSS (mg/L)	Conductivity (uS/cm)	Iron (mg/L)	pH	TSS (mg/L)	Conductivity (uS/cm)
Mean	7.9	12.1	4,779	0.11	7.4	48.6	2,764
Minimum	6.7	1.0	860	0.01	6.0	1.0	320
10%	7.4	2.0	3,235	0.02	6.8	7.9	691
90.0%	8.2	20	5,805	0.18	7.8	130	5,182
Maximum	8.9	150	6,850	0.88	8.1	360	5,930

The water management system is designed and operated such that uncontrolled discharges should not occur. Should any uncontrolled discharge occur, a grab sample is taken and analysed for the same suite of pollutants as designated for the controlled discharge events.


N
GREENHILLS
METFORD
ASHTONFIELD
THORNTON
New Site-
Replace WM11
WM11
WM12
WM2
LOUTH PARK
TAILINGS DAM
WM1
WM3
WM5
WM4
BLOOMFIELD CHPP
WM7
WM8
WM6
New Site-
Replace WM6
and EM2
New Site-
Buttai Ck at
Buchanan Rd
WM9
BLOOMFIELD ACTIVE MINING AREA
BUCHANAN
DONALDSON OPENCUT
New Site-
Replace WM10
and EM1
WM10
New Site-
Buttai Ck at
Lings Rd
0
1 km
BLACK HILL
LEGEND
BLOOMFIELD MINING LEASE
PROJECT APPLICATION AREA
EXISTING SAMPLE SITES
PROPOSED NEW SITE (BLOOMFIELD)
PROPOSED NEW SITE (ABEL)
REDUNDANT SITES
BLOOMFIELD COLLIERY
COMPLETION OF MINING
AND REHABILITATION
SURFACE WATER MONITORING SITES
FIGURE 3.1
04/09/2008

4 PROJECT DESCRIPTION

From a water management perspective, the completion of the mining and rehabilitation project will involve only minor alterations to the existing operations.

4.1 Proposed Mining Operations

The area that is proposed to be mined within the project application area is generally located in the south western section of the lease area and covers an area to the west and north of S Cut extending as far north as the Creek Cut. Proposed mining will occur concurrently westward from the existing S Cut and northward to link with the existing Creek Cut.

Mining operations will be carried out in such a way as to facilitate the labour requirements for the contract coal preparation and handling operations at the Bloomfield CHPP. The mine plan provides for a continuation of the current rate of approximately 0.8 to 1.3 million tonnes per annum of ROM coal.

The existing S Cut encroaches by about 51 ha into the headwaters of Buttai Creek. As mining progresses approximately 118 ha of the Buttai Creek Catchment will be affected by mining. At the completion of mining all areas draining to Buttai Creek will be rehabilitated.

4.2 Spoil Emplacement

Backfilling of the S Cut void will occur progressively commencing at the eastern side of the existing S Cut pit. The material placed in the void will primarily comprise overburden material derived from extension of the S Cut. Some wastes from the CHPP will also be placed in the void.

Emplacement methods will continue unchanged from the current sequence. Material from the pre-stripping and main excavation operations will be transported to the spoil emplacement areas. Active spoil dumps will be constructed in lifts 10 m to 15 m in height and a minimum width for the size of the trucks operating in the area.

4.3 Rehabilitation

Rehabilitation of the backfilled areas will occur progressively as backfilling is completed. Overburden dumps will be reshaped to produce slopes, topography and drainage patterns, which blend visually with the surrounding topography.

4.4 Runoff and Sediment Control

Overburden placement and rehabilitation will follow the mining sequence. Until about Year 7 of the project runoff from all active overburden dumps and rehabilitated areas will drain to active pit areas from where it will be pumped to Lake Kennerson. After about Year 7 a series of diversion drains and a sediment dam (as shown on **Figure 4.1**) will be constructed on the overburden dumps in the following sequence:

- A diversion drain to serve Area A will be constructed to direct all runoff into the northern extraction area;

- At about the same time a diversion drain will be progressively constructed along the northern edge of Area B to direct runoff into the western extraction area;
- As overburden placement nears completion in the north-western corner of Area B, a small area of the mine pit will be left to serve as a sediment dam (see below for further details);
- As overburden placement commences in Area C a diversion drain will be constructed along the southern boundary of the extraction area to direct runoff from Area C into the drain which will run along the northern boundary of Area B;
- Once backfilling commences in the vicinity of Area D, a diversion drain will be constructed to collect runoff from this area and direct it into the northern mine pit.

Note that the areas to the west of areas “A” to “D” on **Figure 4.1** will not be mined and will be protected from runoff from the overburden areas until rehabilitation is complete. Once final rehabilitation has been completed on each area, the relevant diversion drain will be filled-in and rehabilitated except for the drain along the northern boundary of Area B which will be retained to direct runoff into the sediment dam which will be retained as a water storage dam.

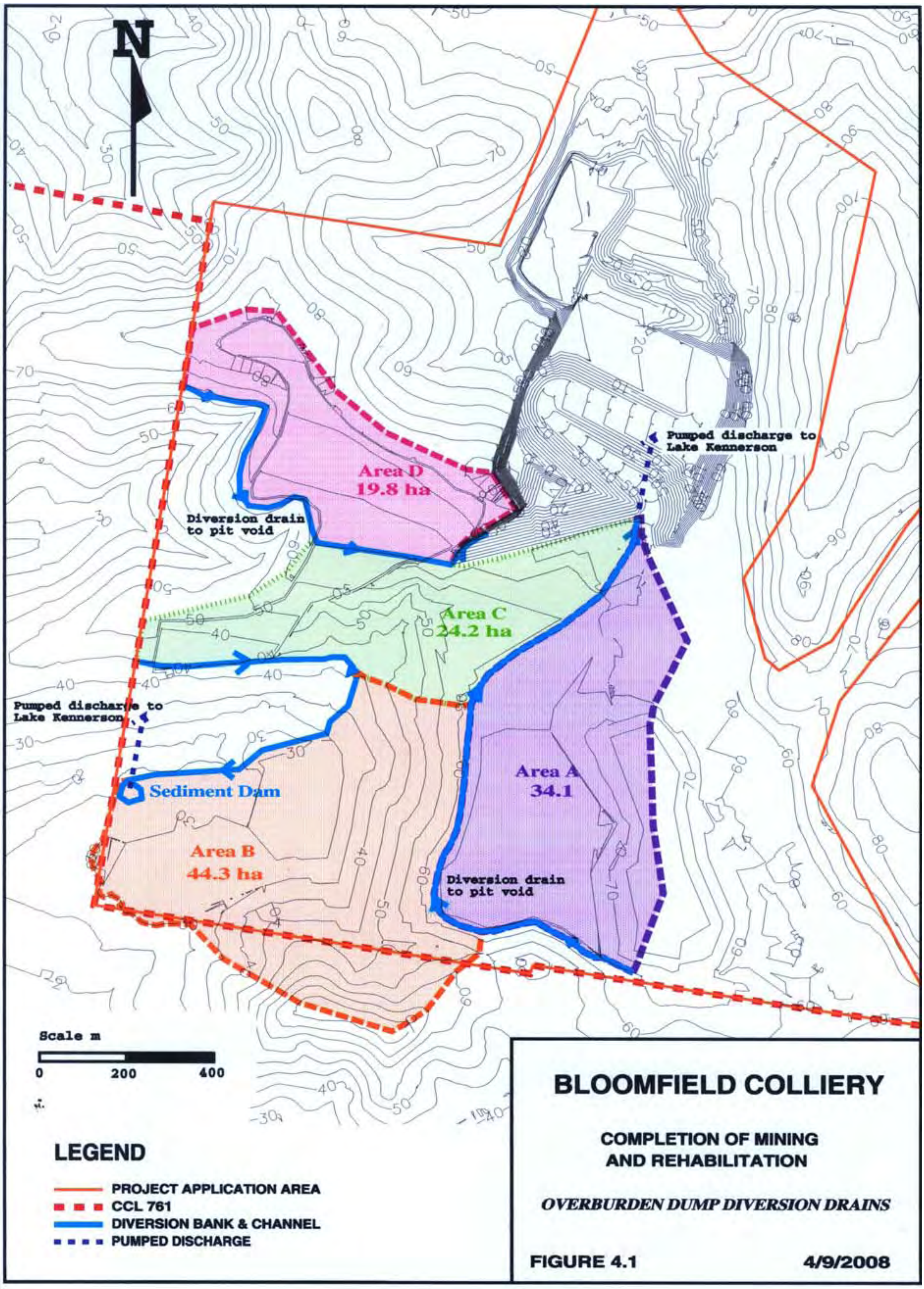
Based on the proposed rate of overburden placement and typical time required for vegetation establishment, each diversion drain will have an operating life of about 5 years. Accordingly, in order to provide a factor of safety, the design of each drain has been based on a 10 year average recurrence interval (ARI) storm for the relevant time of concentration for each of the catchments. Details of the design calculations are provided in **Annexure B.** The design calculations show that the design storm runoff from the various sub-catchments could be safely conveyed by diversion drains with a bed width of 2 m, side slopes of 1:2 (V:H) and flow depths in the range of 0.32 m to 0.46 m. Assuming a reasonable grass cover in the drains, the drains would remain stable at the expected peak flow velocities of 1.4 – 1.6 m/s.

The sediment dam in the north-west corner of Area B, which will have a settlement zone capacity of 18.5 ML, has been designed to satisfy the requirements for capture of stormwater from 95th percentile rainfall events of 2, 5 and 10 days duration in accordance with the requirements set out in *Managing Urban Stormwater: Soils & Construction* (Landcom, 2004). All water captured in the basin will be pumped to Lake Kennerson in the same manner as all water that reports to either of the pits. The basin has been sized on the conservative assumption that pumping from the basin to Lake Kennerson will start no later than two days after rainfall commences. In addition to the settlement zone, the basin will have a sediment storage zone of 9 ML. The emergency spillway for the sediment dam which will only operate in storms that exceed the 95th percentile 10 day rainfall (1-2 times per year on average) will be designed to safely convey the peak runoff from the 20 year ARI storm. Details of the design calculations for sizing the sediment dam and spillway are provided in **Annexure B**.

Until rehabilitation is complete, all runoff from the overburden dumps that is directed to mine pits or to the sediment dam will be pumped to Lake Kennerson, as is done for current operations.

4.5 Workshop Area

The stormwater pollution control arrangements and management regime in the vicinity of the workshop and prill bin have been reviewed and are considered to be in line with current standards. No modifications are proposed.



BLOOMFIELD COLLIERY

COMPLETION OF MINING AND REHABILITATION

OVERBURDEN DUMP DIVERSION DRAINS

FIGURE 4.1 **4/9/2008**

5 SURFACE WATER MANAGEMENT

As noted in Chapter 1, the completion of open cut mining at Bloomfield Colliery will make use of existing water management facilities within the Bloomfield Mine lease area for which approval has previously been given for the Abel underground mine and the expansion of the Bloomfield Coal Handling and Processing Plant (CHPP) and associated facilities.

An outline of the features and operation of the system is provided in this report in order to provide the background on which the assessment of surface water impacts as a result of this application has been undertaken.

The water management system within the Bloomfield Mine lease area forms part of the integrated water management system for the Abel, Bloomfield and Donaldson mines. In addition to any excess surface runoff or groundwater from the Donaldson and Abel mines, the existing water management system is designed to accept all runoff and groundwater seepage that reports to the S Cut and Creek Cut pits that are the subject of this application.

In support of this application a water balance analysis has been undertaken for the entire Abel/Bloomfield/Donaldson water management system including the areas of pits and catchments reporting to the pits that are the subject of this application. The analysis, which is summarised below and provided in detail in **Annexure C**, examines the effect of the completion of the Bloomfield mining operations in the context of the expected tonnages of ROM delivered from the Donaldson, Abel and Tasman mines, the continuation of deliveries from Bloomfield and any associated water transfers in to or out of the Bloomfield water management system.

The main changes to previous estimates of the overall water balance in the Abel/Donaldson/Bloomfield water management system that result from the proposed completion of mining at Bloomfield occur because of:

- Updated estimates of ROM tonnage delivered to the Bloomfield CHPP which are reflected in changes in the water requirements for the CHPP process;
- Ongoing groundwater inflow into the active mine pits; and,
- Surface runoff that enters the pits during active mining.

Some additional water will also be directed into the Bloomfield water management system from the sediment dam that will be constructed in the Buttai Creek catchment near the south-west corner of the lease area.

5.1 Mine Water Management System

A complex water management system has developed over the years within the lease area to meet the needs for supply of water for the CHPP, removal of water from the active pits and to provide appropriate systems control of stormwater pollution from the overburden dumps, waste disposal areas utilised by the CHPP, stockpile areas and the workshop area. The complexity of the system is illustrated in the schematic diagram in **Figure 1.2.** The main features of the system are:

- All water for the CHPP is sourced from Lake Foster;
- Lake Foster is supplied by a number of sources in the following priority order:

  - Runoff from the contributing catchment;
  - Water transferred from the Stockpile Dam;
  - Water transferred from the Tailings Dams;
  - Controlled release of water from Lake Kennerson;
- Lake Kennerson is supplied by:
  - Runoff from the contributing catchment;
  - Runoff and groundwater collected in the active mine pits;
  - Excess water transferred from the Big Kahuna Dam which serves as the main water storage fro the Abel and Donaldson mines;
  - Water pumped from the base of the Creek Cut and old underground mine workings that underlie the open-cut mining workings on Bloomfield.

Pumping of water from the base of the Creek Cut and the old underground mine workings only occurs when necessary to supplement water from the other sources listed above.

Water is only transferred from Possums Puddle as a last resort in the unlikely event that water is not available from any other sources. This has not occurred during the last decade, even during the 2005/7 drought.

The characteristics of the four key water storages in the Bloomfield water management system are set out in **Table 5.1**.

Table 5.1: Key Water Storages in the Bloomfield Water Management System

Water Dam/Storages	Surface Area (ha)	Depth (m)	Capacity (ML)
Possums Puddle	4.4	5.0	75
Lake Foster	1.5	10.0	45
Lake Kennerson	4.9		200
Stockpile Dam	0.5	3.5	16

5.2 Water Requirements

Water requirements for mine operations comprise water use for dust suppression on haul roads, work areas and stockpiles and the water required for the CHPP. Of these, by far the largest is the water required for the CHPP. Most of this water is used to convey the fine tailings to the tailings dam while a small volume is lost in the coal transported off-site by rail. **Table 5.2** summarises the projected deliveries of ROM coal from the various mines to the Bloomfield CHPP during the completion of mining for Bloomfield and the associated requirement for water supply to the CHPP. The data in **Table 5.2** is based on ROM production from Bloomfield of 1.3 million tonnes per annum, which represents a 'worst case' in terms of water requirements for the CHPP.

Table 5.2: Projected Annual Coal Production, Tailings Disposal and Water Requirements

Year	ROM Coal Production (t x 1,000)			Coarse Rejects (t x 1,000)	Fine Tailings (t x 1,000)	Cumulative Tailings & Rejects (m^3 x 1,000)	Annual CHPP Water Req'd (ML)
	Bloomfield O/C	Total Other	Total				
1	880	3,400	4,280	795	568	3,047	2,712
2	1,300	3,975	5,275	953	680	4,433	3,252
3	1,300	3,425	4,725	792	566	5,586	2,713
4	1,300	3,175	4,475	654	467	6,537	2,254
5	1,300	4,175	5,475	774	553	7,663	2,673
6	1,300	5,175	6,475	894	639	8,964	3,091
7	1,300	5,175	6,475	894	639	10,265	3,091
8	1,300	5,100	6,400	885	632	11,553	3,059
9	1,300	4,960	6,260	868	620	12,816	3,001
10	1,300	4,800	6,100	849	606	14,051	2,934

5.3 Water Balance Model Overview

A model for assessment of water balance for the Bloomfield completion of mining project has been developed that encompasses the whole of the integrated water management system for the Bloomfield, Abel and Donaldson mines as illustrated in **Figure 1.2**. The model, which is described in detail in Annexure C, accounts for:

- surface runoff from the contributing catchments into the various storages;
- groundwater inflow to open cut pits and underground workings;
- rainfall onto, and evaporation from, the surface of the various storages;
- extraction and recycling of water for use in the Bloomfield CHPP;
- extraction of water for dust suppression purposes (on haul roads and stockpiles);
- pumped discharge or controlled gravity flow between storages;
- water losses as a result of disposal of tailings; and
- controlled discharge from Lake Kennerson in the event that the maximum target water level is exceeded and conditions permit discharge in accordance with the requirements of the EPA licence.

The model uses daily historic climate data (rainfall and evaporation), keeps account of all daily inputs and outputs and provides annual summaries of the volume and frequency of pumped discharges and overflows.

To demonstrate the capacity of the water management system to cater for anticipated future conditions, the model has been operated for a range of climatic scenarios for each year of the Bloomfield completion of mining project, representing different stages of mine production, the associated groundwater inflow to the workings, changes in catchment areas draining to the pits and the requirements for water in the CHPP.

The model takes account of groundwater inflows to open cut pits and active underground workings quoted in **Table 5.3** below which are derived from a variety of sources including mine records and computer modelling, including analysis for the Bloomfield completion of mining project by Peter Dundon & Associates (2008).

Table 5.3: Estimated Groundwater Inflow into Pits & Underground Workings

Mine Year	Estimated Annual Inflow (ML/year)		
	Abel	Donaldson	Bloomfield
1	4	100	627
2	7	105	620
3	21	110	615
4	49	-	610
5	95	-	747
6	158	-	720
7	231	-	260
8	313	-	325
9	394	-	351
10	472	-	144

Note: Donaldson Open Cut due for closure in 2011

5.4 Buttai Creek Catchments

At the completion of mining the proposed landform will allow about 128 ha within the Bloomfield Mine lease area to drain to the headwaters of Buttai Creek and thereby approximately restore the pre-mining catchment conditions. The mine plans show that the encroachment into the Buttai Creek catchment will increase as shown in **Table 5.4**, with approximately 32 ha unaffected by mining.

Table 5.4: Buttai Creek Areas Draining to Mine Water System

Mine Year	Area Draining to the Pits (ha)
1	48
5	77
7	118
10	118

5.5 Water Balance Model Operation

The water balance model accounts for the different runoff characteristics of different surfaces such as active dumps, mine pits and rehabilitated areas. Details of the runoff modelling employed in the water balance analysis are provided in Annexure C. In order to analyse the water balance during the life of the mine, the water balance model was configured to represent the mining conditions in each year. The main factors that changed for each year were:

- The status of open cut pits in terms of active pit area, contributing catchment and time since initial rehabilitation occurred;
- The coal produced from the different mines, principally to account for the different characteristics of open cut and underground coal, the tonnage from each source and the resulting water requirements for the CHPP as set out in **Table 5.2**;
- Changes in groundwater inflows to open cut pits and underground workings (as set out in **Table 5.3** above) to reflect the status of each mine at that time.
- For most of the time that mining occurs in the Buttai Creek catchment, all runoff will drain into an active pit and subsequently be transferred to Lake Kennerson. Once the post-mining landform no longer drains to an active pit, it will drain to a sediment dam from which water will also be transferred to Lake Kennerson.

Table 5.5 summarises the adopted operational rules for the storages within the mine water management system. As further operating experience is gained, it is anticipated that there will be regular reviews of the water management plan and further refinement of the operating rules.

Table 5.5: Proposed Operating Conditions for Storages and Water Sources

Storage/Source	Target Operating Level (% of full capacity)	Transfer Rate (ML/day)	Transfer To	Transfer From
Big Kahuna	75%	5	L Kennerson	Abel Mine
Stockpile Dam	25%	3.5	L Foster	na
Lake Kennerson	80%	9	na	Groundwater
Lake Foster	50%	9	na	L Kennerson

For each year of the mine completion project, the water balance model was run for the 1974-89 climate sequence from which statistics were extracted for representative years as set out in **Table 5.6**.

Table 5.6: Climatic Scenarios Used in Water Balance Analysis

Rainfall Statistic	Annual Rainfall (mm)
Median rainfall year	892
10 percentile (dry) year	673
90 percentile (wet) year	1,198

5.6 Water Balance Model Results

Tables C4.3 to C4.6 in Annexure C provide details of the main elements of the water balance of the entire Bloomfield/Abel/Donaldson water management system for each year of the Bloomfield completion of mining project under median, dry and wet rainfall conditions. The key aspects of those tables that relate specifically to the facilities within the lease area, including the operations that are the subject of this application are set out in the tables below. Note that the following sign convention is used:

- Positive numbers indicate inflow;
- Negative numbers indicate outflow or losses.

Table 5.7: Estimated Water Balance - Median Rainfall Year (892 mm)

Year	Bloomfield Area - Lake Kennerson						Bloomfield Area - Lake Foster							
	Inflow			Uses & Losses			Inflow				Uses & Losses			
	Pit Inflow (ML)	Surface Runoff (ML)	Transfer from Big Kahuna (ML)	Net Evap and Seepage (ML)	Transfer to L Foster (ML)	Controlled Discharge (ML)	Transfer from Stockpile Net Evap and Seepage (ML)	Pumping from Creek Cut and Old Underground Workings (ML)	Surface Runoff (ML)	Import from L Kennerson (ML)	Net Evap and Seepage (ML)	Dust Suppression Uses (ML)	CHPP and Lost in Product (ML)	Overflow (ML)
1	627	638	350	-46	-1,466	-103	408	1,038	68	1,466	-14	-255	-2,712	0
2	620	652	343	-46	-1,471	-98	408	1,573	68	1,471	-14	-255	-3,252	0
3	615	665	345	-46	-1,489	-91	408	1,017	68	1,489	-14	-255	-2,713	0
4	610	668	16	-46	-1,172	-77	408	875	68	1,172	-14	-255	-2,254	0
5	747	681	37	-46	-1,345	-75	408	1,121	68	1,345	-14	-255	-2,673	0
6	720	695	75	-46	-1,368	-76	408	1,515	68	1,368	-14	-255	-3,091	0
7	260	709	148	-46	-988	-83	408	1,896	68	988	-14	-255	-3,091	0
8	325	716	231	-46	-1,134	-92	408	1,717	68	1,134	-14	-255	-3,059	0
9	351	723	311	-46	-1,243	-97	408	1,551	68	1,243	-14	-255	-3,001	0
10	144	723	389	-46	-1,106	-105	408	1,621	68	1,106	-14	-255	-2,934	0

Table 5.8: Estimated Water Balance - 1 in 10 Dry Year (673 mm)

Year	Bloomfield Area - Lake Kennerson						Bloomfield Area - Lake Foster							
	Inflow			Uses & Losses			Inflow				Uses & Losses			
	Pit Inflow (ML)	Surface Runoff (ML)	Transfer from Big Kahuna (ML)	Net Evap and Seepage (ML)	Transfer to L Foster (ML)	Controlled Discharge (ML)	Transfer from Stockpile Net Evap and Seepage (ML)	Pumping from Creek Cut and Old Underground Workings (ML)	Surface Runoff (ML)	Import from L Kennerson (ML)	Net Evap and Seepage (ML)	Dust Suppression Uses (ML)	CHPP and Lost in Product (ML)	Overflow (ML)
1	627	523	310	-65	-1,310	-85	345	1,279	63	1,310	-20	-264	-2,712	0
2	620	534	303	-65	-1,309	-84	345	1,820	63	1,309	-20	-264	-3,252	0
3	615	545	304	-65	-1,316	-84	345	1,274	63	1,316	-20	-264	-2,713	0
4	610	548	-19	-65	-1,016	-58	345	1,114	63	1,016	-20	-264	-2,254	0
5	747	559	2	-65	-1,193	-50	345	1,356	63	1,193	-20	-264	-2,673	0
6	720	570	40	-65	-1,210	-55	345	1,757	63	1,210	-20	-264	-3,091	0
7	260	581	113	-65	-822	-67	345	2,145	63	822	-20	-264	-3,091	0
8	325	587	197	-65	-970	-75	345	1,967	63	970	-20	-264	-3,059	0
9	351	593	276	-65	-1,074	-81	345	1,803	63	1,074	-20	-264	-3,001	0
10	144	593	354	-65	-939	-87	345	1,871	63	939	-20	-264	-2,934	0

Table 5.9: Estimated Water Balance - 1 in 10 Wet Year (1,198 mm)

Year	Bloomfield Area - Lake Kennerson						Bloomfield Area - Lake Foster							
	Inflow			Uses & Losses			Inflow				Uses & Losses			
	Pit Inflow (ML)	Surface Runoff (ML)	Transfer from Big Kahuna (ML)	Net Evap and Seepage (ML)	Transfer to L Foster (ML)	Controlled Discharge (ML)	Transfer from Stockpile Net Evap and Seepage (ML)	Pumping from Creek Cut and Old Underground Workings (ML)	Surface Runoff (ML)	Import from L Kennerson (ML)	Net Evap and Seepage (ML)	Dust Suppression Uses (ML)	CHPP and Lost in Product (ML)	Overflow (ML)
1	627	897	413	-27	-1,809	-101	429	644	88	1,809	-8	-249	-2,712	0
2	620	916	406	-27	-1,816	-99	429	1,176	88	1,816	-8	-249	-3,252	0
3	615	936	408	-27	-1,833	-98	429	621	88	1,833	-8	-249	-2,713	0
4	610	940	71	-27	-1,511	-82	429	483	88	1,511	-8	-249	-2,254	0
5	747	958	92	-27	-1,696	-73	429	717	88	1,696	-8	-249	-2,673	0
6	720	977	130	-27	-1,716	-84	429	1,116	88	1,716	-8	-249	-3,091	0
7	260	996	203	-27	-1,343	-89	429	1,488	88	1,343	-8	-249	-3,091	0
8	325	1,007	286	-27	-1,489	-101	429	1,310	88	1,489	-8	-249	-3,059	0
9	351	1,017	366	-27	-1,606	-101	429	1,136	88	1,606	-8	-249	-3,001	0
10	144	1,017	444	-27	-1,476	-102	429	1,199	88	1,476	-8	-249	-2,934	0

The water balance estimates set out in the tables above show the following features:

- Water supply for all mine purposes can be provided by the water management system without extracting water from the base of the Creek Cut and the old Bloomfield underground workings at a greater rate than has been extracted historically (up to 2,000 ML/year).
- Some discharge from Lake Kennerson is likely to continue under most climate conditions. However the volume that requires discharge (listed as "Controlled Discharge") for Lake Kennerson is estimated to be significantly less than historical rates of discharge as set out in **Table 3.4** (average about 790 ML/year).
- The detailed model results indicate that the Stockpile Dam would not overflow in any of the three representative climate years.

6 SURFACE WATER ASSESSMENT AND IMPACTS

6.1 Water Balance Analysis

As set out in Chapter 5 above and described in further detail in Annexure C, a detailed water balance analysis has been undertaken that takes account of all surface and groundwater sources that would enter the water management systems on the Bloomfield, Donaldson and Abel Mine sites.

The water balance model results presented above indicate that by adopting the proposed target operating water levels in the various storages and transfer pumping rates, the existing water management facilities within the Bloomfield and Donaldson mine areas can be operated in a manner that would achieve the following objectives:

- Maintain water supply for the CHPP and dust suppression at all times;
- Minimise discharge from the Stockpile Dam; and
- Minimise discharge from Lake Kennerson.

The water balance model has been used to develop a feasible set of operating rules that demonstrate the adequacy of the water management facilities to achieve these objectives. It is anticipated that the operating rules will be regularly reviewed and refined in the light of operating experience.

6.2 Salinity

Salt discharges from the Bloomfield mine are mainly associated with controlled discharges from Lake Kennerson. **Table 3.4** shows that since 1999 when the discharge licence was amended, discharge has varied from 2,201 ML in 2000 to zero in 2006 with an average of 789 ML. Average salinity TDS in the controlled discharge from Lake Kennerson was 3,313 mg/L corresponding to a conductivity of 4,780 µS/cm. The estimated salt loads corresponding to the controlled discharge from Lake Kennerson are also shown in **Table 3.4** and range from 7,176 tonnes in 2000 to zero in 2006 with an average of 2,614.

Assuming that salinity levels in Lake Kennerson remain similar to historic levels, the estimated discharge volumes set out in **Table 5.7**,

Table 5.8 and **Table 5.9** would lead to salt load discharge loads from Lake Kennerson that are significantly lower than those observed historically. The average estimates for various rainfall conditions are:

- Average rainfall 300 tonnes;
- Dry year 240 tonnes;
- Wet year 310 tonnes.

6.3 Impacts on Flow Regime

Given all the other influences of mine activities, the increase in the catchment area that will drain into the Four Mile Creek catchment as a result of encroachment into the Buttai Creek catchment (maximum of 118 ha out of a total of 2,467 ha) is not expected to lead to any perceptible increase in flow in Four Mile Creek.

The existing high wall of the S Cut encroaches about 50 ha into the Buttai Creek catchment. As the S Cut progressively extends to the west it will further encroach into two small tributary catchments of the Buttai Creek catchment (36 ha and 114 ha respectively within the Lease area).

The area draining into the pits will alter as mining and backfilling of the S Cut progresses, as summarised in **Table 5.4**. The data in **Table 5.4** shows that the maximum area affected by mining within the Buttai Creek catchment will be about 118 ha by the end of Year 7. Approximately 32 ha of these catchments within the lease boundary will not be affected by mining.

Once rehabilitation has been completed satisfactorily to meet the criteria for final rehabilitation clearance from DPI-Minerals (expected within 2 years of completion of mining), the 118 ha of catchment that has been progressively excluded from the Buttai Creek catchment will be restored to the catchment.

Based on the *Farm Dams Assessment Guide* (DLWC, 1999), the average runoff lost from the upper Buttai Creek catchment as a result of mining would be 0.9 ML/ha. On this basis the anticipated reduction of flow into the Buttai Creek catchment at Buchannan Road would be as set out in **Table 6.1**. The table shows that the effect of mining would be to reduce the average annual flow in Buttai Creek at Buchanan Road by 3% in Year 1, rising to 7% by Year 7 and remaining at that level until rehabilitation is complete.

Table 6.1: Estimated Reduction of Average Annual Runoff in Buttai Creek

Year	Mine Area (ha)	Reduction	
		Flow (ML/y)	Percent (%)
1	48	43	3%
2	55	50	3%
3	62	56	4%
4	69	62	4%
5	77	69	4%
6	95	86	6%
7	118	106	7%
8	118	106	7%
9	118	106	7%
10	118	106	7%
11	118	106	7%
12	118	106	7%
13	0	0	0%

6.4 Impacts on Surface Water Quality

The proposed continuation of mining at Bloomfield is expected to have the following impacts on water quality compared to existing conditions:

- Reduced salt load discharged to Four Mile Creek on account of the anticipated deduction on discharge volume from Lake Kennerson;
- Continuation of the existing low level of discharge of sediment to Four Mile Creek on account of the fact that all sediment laden water from the rehabilitation areas will be collected in the pits or sediment dam and transferred to Lake Kennerson

which has demonstrated capacity to provide low levels of TSS in any discharge (average 12 mg/L);

- No discharge of sediment to Buttai Creek on account of the fact that all runoff collected in the pits and the sediment dam will be transferred to Lake Kennerson.

6.5 Impacts on Existing Surface Water Users

Table 6.1 shows that the measures to protect Buttai Creek against sediment discharge will have the effect of reducing the estimated average annual flow at Buchanan Road by about 3% in Year 1 and increasing to 7% between Years 7 and 12. This reduction in flow will be of relatively short duration and is expected to return to original flow conditions once rehabilitation is complete by Year 13.

This reduction in flow is not expected to have any effect on any downstream water users.

7 DRAFT SURFACE WATER MANAGEMENT PLAN

7.1 Introduction

With the exception of a small sediment dam on the headwaters of Buttai Creek, the water management systems that support the existing and proposed completion of mining at Bloomfield are part of the Integrated Water Management System for the Bloomfield, Abel and Donaldson mines that has been approved under the Abel Project approval. This draft Surface Water Management Plan is consistent with the Water Management Plan that was approved for the Abel Project in May 2008.

New pits and sediment dams proposed as part of the Bloomfield completion of mining project will be operated in the same way as the S Cut pit is currently operated and will not require any new facilities other than a small sediment dam constructed near the western boundary of the lease area in about Year 7.

7.2 Objectives

The proposed objectives for the management of an integrated surface water management system for the Bloomfield, Donaldson and Abel mines are to:

- Maintain water supply for the CHPP and dust suppression at all times;
- Minimise discharge from the Stockpile Dam; and
- Minimise discharge from Lake Kennerson.

7.3 Water Management Facilities and Operations

Based on the water balance modelling, the existing water management facilities within the Bloomfield Mine lease area, as approved for the Abel Project, will not require any modification in terms of size or operating regime to cater for the proposed completion of mining at Bloomfield.

The target operating levels of various storages, as approved for the Abel Project, are set out in **Table 7.1.**

Table 7.1: Indicative Target Operating Levels and Pumping / Discharge Rates

Storage / Source	Capacity	Target Operating Level	Controlled Discharge Rate	Pumping Rate	Pumping / Discharge To
	(ML)	(ML)	(ML / day)	(ML / day)	
Big Kahuna	400	340	-	5	Lake Kennerson
Stockpile Dam	16	6	-	5	Lake Foster
Lake Kennerson	200	160	Up to 40	-	Four Mile Creek
Lake Foster	45	22	0	0	No discharge

Additional significant pumps that form part of the water management system are set out in **Table 7.2.**

Table 7.2: Indicative Pumping Rates from Sources and Target Water Levels

Storage/Source	Transfer (ML/day)	Discharge To	Constraint
Old Underground Workings	9	Pumped to L Kennerson	L Kennerson level <50%
Old Underground Workings	7	Pumped to L Kennerson	L Kennerson level <40%
S Cut	2	Pumped to L Kennerson	L Kennerson level <80%
Lake Kennerson	Up to 16	Gravity flow to L Foster	L Foster < 50%
Tailings Dams (U Cut)	2	Pumped to L Foster	L Foster <50%
Creek Cut	2	Pumped to L Foster	L Foster <50%
S Cut	2	Pumped to L Foster	L Foster <50%

Management actions to ensure appropriate operation of the pollution control systems in the vicinity of the workshop area include:

- All water storage tanks (for oily water runoff from the tank farm and the oil storage platform, and runoff from the prill pad area) are emptied by a licenced contractor on a routine basis. The contractor is on standby to carry out additional pump-out in the event that the flashing warning light indicates that pump-out is required.
- All hydrocarbon management infrastructure is subject to quarterly documented maintenance inspections.
- The sediment dam is cleaned out as necessary to maintain sediment capture capacity.

7.4 Proposed Surface Water Monitoring

The overall surface water monitoring program approved for the Abel Project includes the following sites that are relevant to this project:

- Four Mile Creek at John Renshaw Drive;
- Four Mile Creek upstream of the Bloomfield lease area;
- Four Mile Creek at the New England Highway;
- Buttai Creek at Lings Road.

For this project, it is proposed to supplement this list with a monitoring site on Buttai Creek immediately upstream of Buchanan Road. The existing and proposed locations for surface water monitoring in the Bloomfield/Donaldson areas are shown on **Figure 3.1.**

The following monitoring regime is proposed:

- Monthly field testing for Temperature, pH, EC, DO and Turbidity;
- Monthly grab samples for laboratory analysis of TSS, TDS, pH and EC;
- Quarterly grab samples for laboratory analysis of Chlorides, Sulfates, Alkalinity, Calcium, Magnesium, Sodium and Potassium).
- Daily water grab samples collected from the discharge point on any occasion when there is controlled discharge from Lake Kennerson. A grab sample will also be collected at the flow gauging station behind the Four Mile Workshops. These samples will be analysed for EC, pH, TSS and Filterable iron in accordance with the EPA licence; and

- Daily water grab samples will be collected from any overflow from the Stockpile Dam. These samples will be analysed for TSS, TDS, pH and EC.

7.5 Proposed Surface Water Response Plan

The procedure to be followed in the event of unforeseen surface or groundwater impacts being detected during the project is as follows:

1. The nature of the suspected impact and all relevant monitoring data will be immediately referred to an independent qualified hydrologist or hydrogeologist as appropriate for assessment.
2. An assessment will be made of the potential magnitude of the impact and the level of risk.
3. Alternative response and mitigation measures will be detailed for discussion with DWE, DECC and/or DPI-Minerals as appropriate.
4. A response/mitigation plan will be implemented to the satisfaction of DWE, DECC and/or DPI-Minerals.

7.6 Erosion and Sediment Control

An Erosion and Sediment Control Plan (ESCP) will be implemented to ensure that no undue pollution of receiving waters occurs during the completion of mining and rehabilitation at Bloomfield. The ESCP will be prepared in accordance with guidelines contained in *"Managing Urban Stormwater: Soils and Construction" (4th Edition)* (Landcom, 2004).

8 REFERENCES

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Pty Ltd

Completion of Mining and Rehabilitation Project

Surface Water Assessment

Annexure A
Surface Water Quality Data

Date: 20 May 2008

SUMMARY OF WATER QUALITY AT BLOOMFIELD												
Location	WM1	WM2	WM3	WM4	WM5	WM6	WM7	WM8	WM9	WM10	WM11	WM12
Data period												
Start Date	17/6/96	12/6/96	12/6/96	12/6/96	12/6/96	12/6/96	12/6/96	12/6/96	12/6/96	12/6/96	12/6/96	12/6/96
End Date	8/11/07	8/11/07	8/11/07	8/11/07	8/11/07	8/11/07	8/11/07	8/11/07	8/11/07	8/11/07	8/11/07	8/11/07
Length of record (days)	4,161	4,166	4,166	4,166	4,166	4,166	4,166	4,166	4,166	4,166	4,166	4,166
Length of record (years)	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4
No# of observations	191	156	245	258	207	245	246	449	249	229	454	348
Ave frequency of obs (days)	21.8	26.7	17.0	16.1	20.1	17.0	16.9	9.3	16.7	18.2	9.2	12.0
pH												
No# of Samples	106	79	242	258	183	241	240	446	242	202	437	157
Maximum Value	8.0	7.6	8.1	15.5	8.4	8.5	9.3	8.9	9.3	8.1	8.7	8.1
Mean	3.7	5.9	7.1	7.5	6.7	6.8	7.2	7.9	8.1	6.8	7.2	7.2
Standard deviation	1.1	0.9	0.5	0.5	1.0	0.4	0.6	0.3	0.4	0.3	0.4	0.5
Minimum Value	2.7	3.9	4.2	5.9	3.4	5.5	5.9	6.7	5.6	6.0	5.7	4.1
10% Percentile	2.8	4.5	6.7	6.9	5.2	6.4	6.6	7.5	7.9	6.4	6.7	6.8
90% Percentile	4.7	7.0	7.6	8.1	7.8	7.2	7.9	8.2	8.4	7.2	7.7	7.6
Electrical Conductivity (µS/cm)												
No# of Samples	108	79	244	258	183	241	241	446	241	202	414	157
Maximum Value	14,400	2,750	6,080	7,360	6,620	2,100	3,320	8,770	8,880	1,080	13,331	5,750
Mean	3,338	1,189	1,405	1,332	1,938	242	503	4,936	5,042	426	2,051	1,494
Standard deviation	2,838	687	1,125	1,560	1,395	232	555	1,224	1,450	200	1,611	1,020
Minimum Value	145	211	230	150	9	121	9	12	300	50	12	26
10% Percentile	1,117	454	370	220	434	162	200	3,210	3,140	191	577	478
90% Percentile	7,884	2,302	2,737	3,396	3,968	330	1,200	6,030	6,350	695	4,668	2,820
Total Suspended Solids (mg/L)												
No# of Samples	16	15	129	139	78	47	13	123	21	28	229	61
Maximum Value	1,272	202	140	627	470	370	250	4,220	50	180	5,470	426
Mean	107	43	19	28	43	29	62	77	10	39	92	45
Standard deviation	313	47	26	44	87	57	88	531	13	42	566	70
Minimum Value	1.0	14.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.0	1.0	1.0
10% Percentile	1.0	15.4	2.0	1.0	4.0	1.6	2.0	1.0	1.0	8.0	2.8	2.0
90% Percentile	127	66	39	51	80	67	218	19	20	89	75	100
Total Dissolved Solids (mg/L)												
No# of Samples	12	15	130	140	76	44	9	221	21	28	200	78
Maximum Value	5,825	1,440	5,070	5,660	6,110	410	1,040	5,270	5,080	560	5,130	4,830
Mean	1,862	763	736	577	1,040	151	570	3,347	3,226	305	1,381	913
Standard deviation	2,212	417	960	875	1,204	83	339	955	1,239	111	1,296	853
Minimum Value	164	46	120	8	100	50	190	600	450	130	97	126
10% Percentile	280	424	189	98	230	73	190	1,940	1,730	177	310	288
90% Percentile	5,668	1,388	1,083	1,490	2,160	240	968	4,420	4,270	445	3,376	1,566
Non-filterable Residue (mg/L)												
No# of Samples								183			156	17
Maximum Value								150			360	180
Mean								11.4			48	68
Standard deviation								16.4			62	53
Minimum Value								0.1			1.0	8.0
10% Percentile								2.0			7.0	18.4
90% Percentile								19.8			125	154
Iron (mg/L)												
No# of Samples								183				
Maximum Value								0.88				
Mean								0.08				
Standard deviation								0.09				
Minimum Value								0.05				
10% Percentile								0.05				
90% Percentile								0.10				

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Completion of Mining and Rehabilitation Project

Surface Water Assessment

Appendix B
Water Storage & Conveyance Structures

Date: 20 May 2008

Buttai Creek Catchments and Diversion Drains
See Figure 4.1 for catchment definition and areas

Design Storm ARI (years) 10

Catchment >	**A**	**B**	**C**	**D**
Area (ha)	34.1	44.3	24.2	19.8
Overland Flow				
Max Length (m)	500	625	350	250
Elevation at Top	78	65	58	68
Elevation at Bottom (m)	65	30	40	58
Overland Flow Slope	2.6%	5.6%	5.1%	4.0%
Channel				
Total Length (m)	1375	720	550	1120
Length from Overland Flow Point	875	420	300	520
Elevation at Top	55	40	45	70
Elevation at Bottom (m)	46	36	42	65
Channel Slope (%)	1.0%	1.0%	1.0%	1.0%

Overland Flow Time (Kinematic Wave)

$T = 6.94 \times (L \times n^*)^{0.6} / (I^{0.4} \times S^{0.3})$

n* 0.2

Time	**Rainfall Intensity**	**Tc (min) for Corresponding Rainfall Intensity**			
(min)	**(mm/h)**	**A**	**B**	**C**	**D**
10	113	48	43	31	28
15	94	51	47	34	30
20	82	54	49	36	32
25	73	57	52	37	33
30	66	59	54	39	34
35	61	61	56	40	35
40	56	63	58	42	37
45	53	65	59	43	38
50	50	66	60	44	38
55	47	68	62	45	39
60	45	69	63	45	40
75	39.3	73	66	48	42
90	35.3	76	69	50	44
105	32.2	79	72	52	46
120	29.7	82	74	54	47
180	23.3	90	82	59	52
Channel Flow Time					
Assume 1.4 m/s		10	5	4	6
Total Tc (min)		**90**	**60**	**50**	**45**

Peak Discharge

C10	0.4	0.4	0.4	0.4
Peak Discharge (m3/s)	**1.3**	**2.2**	**1.3**	**1.1**

Channel Flow Depths : Trapezoidal Channel

Catchment >	**A**	**B**	**C**	**D**
Bed Width (m)	2.0	2.0	2.0	2.0
Mannings n (grass)	0.035	0.035	0.035	0.035
Side Slopes (1:x)	2.0	2.0	2.0	2.0
Flow Depth (m)	0.33	0.46	0.34	0.32
Top Width (m)	3.3	3.8	3.4	3.3
Area (m^2)	0.9	1.3	0.9	0.8
Wetted Perimeter (m)	2.5	3.1	2.6	2.5
Hydraulic Radius (m)	0.34	0.44	0.35	0.34
Flow Velocity (m/s)	1.4	1.6	1.4	1.4
Discharge (m^3/s)	1.3	2.2	1.3	1.1

BLOOMFIELD SEDIMENT DAM

Runoff Capture

Soil Class	Borderline between Class D and Class F.
Design Objective	Retention and appropriate treatment of 95th percentile rainfall up to 10 days duration
Management	All retained runoff pumped to Lake Kennerson
Pump Rate (ML/day)	5

	Duration (days)		
	2	5	10
95th percentile rainfall *(average of Newcastle & Cessnock)*	46.6	69.9	100.5
Runoff Coefficient *(Blue Book Table F2)*	0.58	0.7	0.7
Maximum Catchment Area (ha) *(from Figure 4.1)*	68.5	68.5	68.5
Required Runoff Capture Volume (ML)	18.5	33.5	48.2
Cumulative Capture Volume (ML) (assuming pump starts 1 day after rainfall starts)	14.2	29.2	54.2
Cumulative Capture Volume (ML) (assuming pump starts 2 day after rainfall starts)	18.5	33.5	58.5

System with 18.5 ML storage and pump rate of 5 ML/day starting 2 days rainfall commences meets requirements for capture of runoff for 2, 5 and 10 day 95th percentile rainfll events

Sediment Basin Spillway

See Figure 4.1 for catchment definition and areas

Design Storm ARI (years) 20

Contributing Catchments >	**B**	**C**
Area (ha)	44.3	24.2
Overland Flow		
Max Length (m)	625	350
Elevation at Top	65	58
Elevation at Bottom (m)	30	40
Overland Flow Slope	5.6%	5.1%
Channel		
Total Length (m)	720	550
Length from Overland Flow Point	420	300
Elevation at Top	40	45
Elevation at Bottom (m)	36	42
Channel Slope (%)	1.0%	1.0%

Overland Flow Time (Kinematic Wave)

$T = 6.94 \times (L \times n^*)^{0.6} / (I^{0.4} \times S^{0.3)}$

n* 0.2

Time	**Rainfall Intensity (10 y ARI)**	**Flow Time (min)**	
(min)	**(mm/h)**	**B**	**C**
10	130	41	30
15	108	44	32
20	94	47	34
25	84	49	35
30	76	51	37
35	70	53	38
40	65	54	39
45	61	56	40
50	57	57	41
55	55	58	42
60	52	59	43
120	34.4	70	51
180	27	77	56
Channel Flow Time			
Assume 1.4 m/s		5	4
Total Tc (min)		**65**	**44**

Peak Discharge for Critical Duration Storm

C10	0.4
FF20	1.12
Peak Discharge (m3/s)	**4.4**

Spillway Width

Assume broad crested weir	
Assume flow depth (m)	0.3
Required width (m)	18.0

Bloomfield Collieries Pty Ltd

Completion of Mining and Rehabilitation Project

Surface Water Assessment

Annexure C Water Balance Modelling

Saved: 9 September 2008

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C1. BACKGROUND

A detailed surface water management model has been developed to assess the overall performance of the water management systems associated with the Bloomfield, Donaldson and Abel mines and the operation of the Bloomfield CHPP. The model has been developed to represent the runoff, flow, water storage and pumped transfer systems within the Four Mile Creek catchment as shown in **Figure C1**.

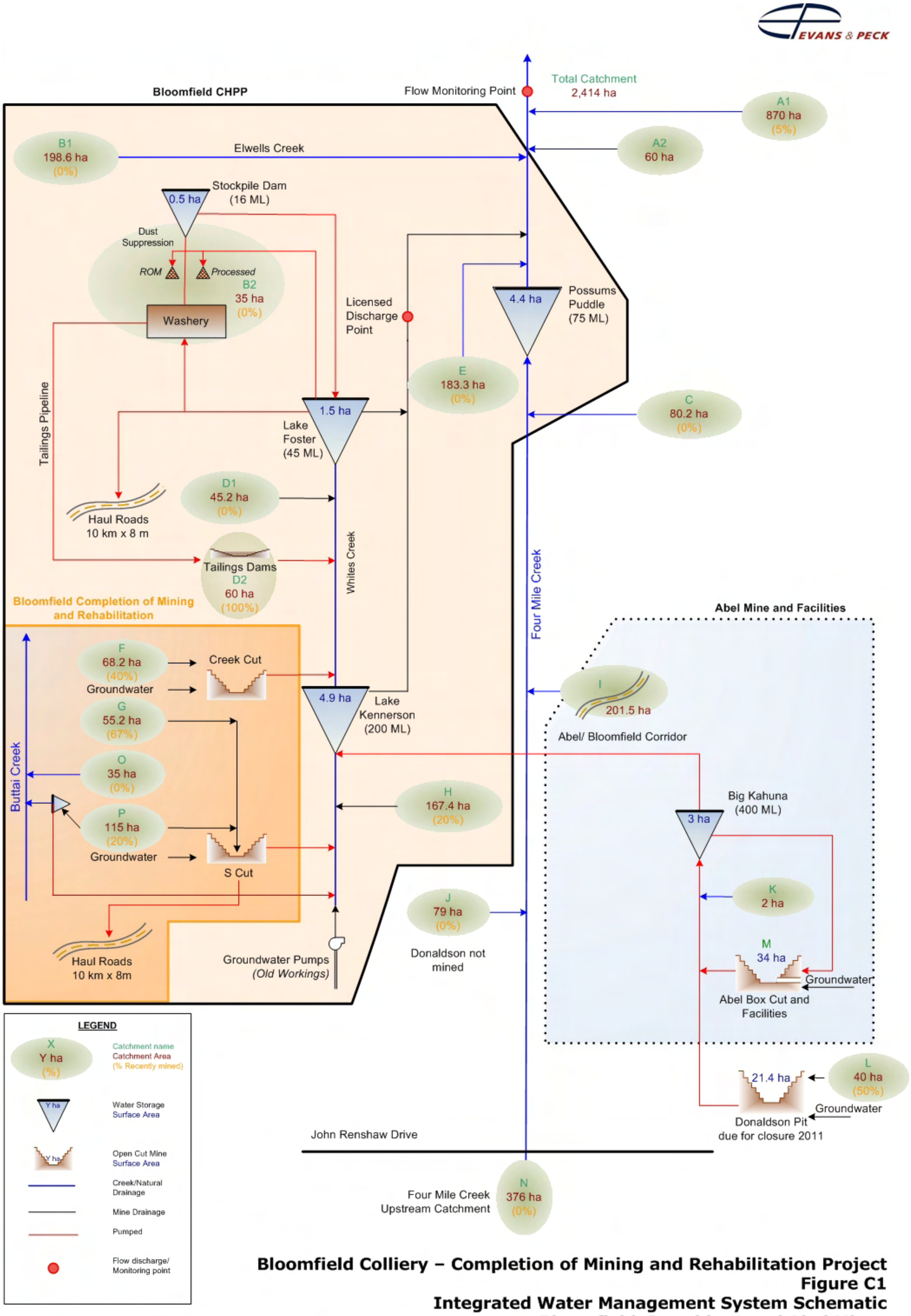
The Bloomfield CHPP receives ROM coal from the Tasman mine as well as the three mines located within the catchment of Four Mile Creek (Bloomfield, Donaldson and Abel). The interactions between Tasman and the operations depicted in **Figure C1** will comprise the haulage of ROM to the Bloomfield CHPP and, if necessary (although highly unlikely), the transfer of water between sites by truck to cater for shortfall or excess of water at Tasman.

The model for assessment of water balance for the Bloomfield completion of mining project includes:

- surface runoff from the contributing catchments into the various storages;
- groundwater inflow to open cut pits and underground workings;
- rainfall onto, and evaporation from, the surface of the various storages;
- extraction and recycling of water for use in the Bloomfield CHPP;
- extraction of water for dust suppression purposes (on haul roads and stockpiles);
- pumped discharge or controlled gravity flow between storages;
- water losses as a result of disposal of tailings;
- controlled discharge from Lake Kennerson in the event that the maximum target water level is exceeded and conditions permit discharge in accordance with the requirements of the EPA licence.

The model uses daily historic climate data (rainfall and evaporation), keeps account of all daily inputs and outputs and provides annual summaries of the volume and frequency of pumped discharges and overflows. Further details of the main elements of the model are set out below.

To demonstrate the capacity of the water management system to cater for anticipated future conditions, the model has been operated for a range of climatic scenarios for each year of the project, representing different stages of mine production, the associated groundwater inflow to the workings and the requirements for water in the CHPP.



Bloomfield Colliery – Completion of Mining and Rehabilitation Project
Figure C1
Integrated Water Management System Schematic
Bloomfield, Donaldson and Abel Mines

C2. SURFACE RUNOFF MODELLING

A variety of different land surfaces contribute to flow in Four Mile Creek including “natural” bushland areas, areas cleared for grazing, mine overburden dumps and various mine stockpile areas and haul roads. The hydrologic response of these land surfaces to rainfall and evapotranspiration has been represented in the water balance model for the Four Mile Creek catchment using the AWBM model. AWBM is a catchment water balance model, developed for Australian conditions, that uses rainfall and evaporation data to generate catchment daily runoff. The model represents a catchment as three surface moisture stores with different storage and runoff characteristics. Each of the three surface stores is assigned a surface storage capacity value as well as partial area which are adjusted as part of the calibration process. Runoff from each store is calculated independently of the other two stores.

At each time step (daily in this case), rainfall is added to each of the three surface moisture stores and evapotranspiration and deep drainage is subtracted from the stores. Runoff occurs when there is excess moisture in any of the stores. The model also calculates baseflow as a function of baseflow storage and a baseflow recession constant.

Lyall & Macoun Consulting Engineers (LMCE) (1998) utilised the AWBM model as the basis for a catchment management study of the Morpeth-Tenambit, Woodberry and Millers Forest catchments on behalf of the Maitland Landcare Group. The catchments studied by LMCE adjoin the Four Mile Creek catchment and contain a similar range of land uses. For the LMCE study, the AWBM model was calibrated using 11 years of flow records from Pokolbin Creek. For modelling of the Morpeth-Tenambit, Woodberry and Millers Forest catchments, the AWBM model was run using rainfall data from East Maitland and evaporation data from Williamtown. Using the model parameters derived for Pokolbin Creek as a starting point, model parameters (principally percentage impervious area) were adjusted to reflect a range of land use types, including those listed in **Table C2.1.**

Table C2.1: Land Use and Runoff Data from the AWBM Model Prepared by LMCE (1998)

Land Use Type	Impervious	Average Runoff
	(%)	(% of rainfall)
1. Bushland	0	12
2. Grazing	5	15
3. Rural Industry	10	21
4. Urban Residential	35	29
5. Urban Industrial	90	58

Table C2.1 also indicates the average annual runoff expressed as a percentage of average annual rainfall. The model results for urban and industrial land uses with a high proportion of impervious surfaces were validated against runoff data collected by Sydney Water for a variety of urban catchments in the Sydney area.

C3. WATER BALANCE MODEL

C3.1 CLIMATE DATA

For the Four Mile Creek water balance model depicted in **Figure C1**, the daily rainfall and climatic data utilised in the LMCE (1998) study were adopted, namely:

- daily rainfall data for East Maitland (1902 – 1995); and
- daily evaporation data for Williamtown (1974 – 1989).

C3.2 CATCHMENT RUNOFF

Results from the AWBM model (expressed as depth of runoff (mm) for different land uses) were used to estimate the runoff from the various contributing sub-catchment areas within the Four Mile Creek catchment. The contributing sub-catchments contain a wide range of land use components for which appropriate runoff characteristics were selected in the water balance model:

- semi-natural bushland areas located to the south of John Renshaw Drive;
- recently rehabilitated overburden dump area;
- previously rehabilitated overburden dump areas;
- low permeability open cut pits, haul roads and work areas; and
- highly impermeable areas such as sealed roads and urban residential areas.

Table C3.1 summarises the catchment areas and characteristics used in the Four Mile Creek water balance model.

Table C3.1: Catchment Areas

Catchments	Designation[1]	Not Mined (ha)	Previously Mined (ha)	Recently Mined (ha)	Total (ha)
Four Mile Creek Catchment					
Possums Puddle To Highway	A1	724	84		809
Possums Puddle To Highway (urban)	A2				60
Elwells Creek	B1	114	65	0	179
Washery Stockpile area	B2	35	0	0	35
Possums Puddle	C	59	28	0	87
Lake Foster	D1	30	15	0	45
Tailings Dams	D2	0	0	65	65
Clean Water Diversion Past Possums Puddle	E	75	109	0	183
Creek Cut Void	F	40	28		68
S Cut Void	G	5	14	37	55
Lake Kennerson catchment	H	0	132	36	167
Four Mile Catchment north of John Renshaw Drive outside Bloomfield & Donaldson Leases	I	202	0	0	202
Donaldson not mined	J	79	0	0	79

Catchments	Designation[1]	Not Mined (ha)	Previously Mined (ha)	Recently Mined (ha)	Total (ha)
Catchment to Big Kahuna Dam	K	2	0	0	2
Donaldson mined and remnant void	L	0	21	11	32
Abel Surface Workings	M	0	0	34	34
South of John Renshaw Drive	N	376	0	0	376
Total Four Mile Creek Catchment					2,467
Buttai Creek Catchment					
Bloomfield not mined	O	35	0	0	35
Bloomfield mined	P	0	20	95	115
Total Buttai Creek Catchment					150

Note [1]: Designation refers to the catchment lettering shown on Figure C1

In addition to the catchment areas draining to Four Mile Creek identified in **Figure C1**, the mining will eventually encroach onto an area of about 118 ha in the headwaters of Buttai Creek. By about Year 5 approximately 70 ha of the Buttai Creek catchment will have been mined. Although about 50 ha of this will have been back-filled with overburden, the overburden dump will continue to drain into the active pit areas from where runoff will be pumped to Lake Kennerson. By Year 7 an additional active pit area of about 20 ha will be located in the Buttai Creek catchment. At this stage, the 70 ha in the catchment that was mined up to Year 5 will be back filled and partially rehabilitated and will drain into a sedimentation basin that will be pumped to Lake Kennerson. At completion of mining all 118 ha of mined land will drain back to Buttai Creek.

C3.3 WATER STORAGES

The model includes five key water storages that form part of the Bloomfield, Donaldson and Abel water management systems. For modelling purposes, a number of small storages that feed the key storages have been ignored. The characteristics of the key storages have been derived from data provided by each mine and are summarised in **Table C3.2**.

Table C3.2: Water Storages Represented in the Four Mile Creek Water Balance Model

Water Dam / Storages	Surface Area (ha)	Depth (m)	Capacity (ML)
Possums Puddle	4.4	5.0	75
Lake Foster	1.5	10.0	45
Lake Kennerson	4.9		200
Stockpile Dam	0.5	3.5	16
Big Kahuna	3.0		400

As noted above, the Four Mile Creek water balance model also allows for:

- rainfall onto the surface of the storages;
- evaporation from the surface of the storages; and

- seepage loss from the storages.

C3.4 WATER USE

Water requirements for mine operations principally comprise water use for dust suppression on haul roads, work areas and stockpiles and the water required for coal processing.

Estimates of water use for dust suppression on haul roads and work areas have been derived from records kept by the individual mines. For modelling purposes this requirement was factored proportionally to allow for changes in the area of active haul road at the particular state of mine development represented in the model. In the model, the assessed water demand for dust suppression is only taken into account on days on which there is less than 10 mm of rainfall.

Error! Not a valid bookmark self-reference. below summarises the annual ROM coal production, coarse and fine tailings production and water requirements for the CHPP for the expected production from the completion of the Bloomfield Mine and the other mines feeding the Bloomfield CHPP (Donaldson, Abel and Tasman). In the case of Bloomfield, production will be to a maximum of 1.3 million tonnes per annum.

Table C3.3: Projected Annual Coal Production, Tailings Disposal and Water Requirements

Year	ROM Coal Production (t x 1,000)			Coarse Rejects (t x 1,000)	Fine Tailings (t x 1,000)	Cumulative Tailings & Rejects (m³ x 1,000)	Annual Water Req'd (ML)
	Bloomfield O/C	Total Other	Total				
1	880	3,400	4,280	795	568	3,047	2,712
2	1,300	3,975	5,275	953	680	4,433	3,252
3	1,300	3,425	4,725	792	566	5,586	2,713
4	1,300	3,175	4,475	654	467	6,537	2,254
5	1,300	4,175	5,475	774	553	7,663	2,673
6	1,300	5,175	6,475	894	639	8,964	3,091
7	1,300	5,175	6,475	894	639	10,265	3,091
8	1,300	5,100	6,400	885	632	11,553	3,059
9	1,300	4,960	6,260	868	620	12,816	3,001
10	1,300	4,800	6,100	849	606	14,051	2,934

The estimated water requirements for the CHPP are based on the following assumptions (derived from operating experience and records at the CHPP):

- Open cut ROM — 21% coarse rejects, 14% fine tailings
- Underground coal — 12% coarse rejects, 8% fine tailings
- Water required for fine tailings disposal — 4.85 m^3/t
- Water increase from ROM to product — 2%
- Water increase from ROM to coarse reject — 12%

C3.5 GROUNDWATER INFLOWS

C3.5.1 Inflow to Pits and Active Underground Workings

Groundwater inflows to open cut pits and active underground workings quoted in **Table C3.4** below have been derived from a variety of sources including mine records and computer modelling as set out below:

- Bloomfield Peter Dundon & Associates, 2008;
- Donaldson Peter Dundon & Associates, 2003;
- Abel Aquaterra Simulations, 2006.

Table C3.4: Estimated Groundwater Inflow into Pits and Underground Workings

Calendar Year	Estimated Annual Inflow (ML/year)		
	Abel	Donaldson[1]	Bloomfield
1	4	100	627
2	7	105	620
3	21	110	615
4	49	-	610
5	95	-	747
6	158	-	720
7	231	-	260
8	313	-	325
9	394	-	351
10	472	-	144

Note 1: Donaldson Open Cut due for closure in 2011

C3.5.2 Backup Supply

In addition to inflows to the active pits and underground workings, the model takes account of pumping from the base of the Creek Cut and the two existing pumps that extract water from old underground workings within the Bloomfield Mine area. These pumps have the capacity to pump 11, 9 and 7 ML/day respectively. Pumping from these sources is undertaken under two circumstances:

- when pumping is required to control groundwater levels and thereby reduce groundwater inflow to the active Bloomfield mine pit.
- when sufficient water is not available from surface runoff sources or pit inflow to meet the requirements for CHPP operations.

As shown in **Table C3.4**, it is predicted that groundwater inflow to the Abel underground workings will progressively increase from 4 ML/year in Year 1 to 472 ML/year in Year 10. It is proposed that once all requirements for operation of the Abel Mine have been satisfied (dust suppression and water for the mining process) any excess water will be transferred to Bloomfield. This water will be substituted for water that has, in the past, been drawn from the old underground workings on Bloomfield. The water balance model assumes that pit inflows on Bloomfield and excess water from the Abel project are given priority for supply of the CHPP. Water will only be taken from the old Bloomfield underground workings to make up for any shortfall in the available water from other sources.

C3.6 SYSTEM OPERATION

The water balance model has been configured to allow the water storages to operate to achieve the following objectives:

- Maintain water supply for the CHPP and dust suppression at all times;
- Minimise discharge from Big Kahuna;
- Minimise discharge from the Bloomfield Stockpile Dam;
- Minimise discharge from Lake Kennerson.

To achieve these objectives, the model allows the storage operation to be adjusted for:

- The target operating water level that provides capacity to capture and retain runoff from the contributing catchment;
- The transfer rate to/from the designated storage once the required target storage level is reached.

C3.7 MODEL VALIDATION

For validation purposes, the water balance model was adjusted to reflect mining conditions as they existed within the Four Mile Creek catchment in 2004-5. The model was then run using rainfall for those years and the model results checked against:

- total discharge from the catchment as measured at the rear of the Four Mile Workshops (about 500 m upstream of the New England Highway); and
- manual records of controlled discharge from Lake Kennerson into the bypass channel around Possums Puddle which discharges into Four Mile Creek.

For modelling of the Morpeth-Tenambit, Woodberry and Millers Forest catchments, the AWBM model was run using rainfall data from East Maitland and evaporation data from Williamtown. The study period (1974-1989) was restricted by the availability of concurrent and consistent rainfall and evaporation data. Using the model parameters derived for Pokolbin Creek as a starting point, model parameters (principally percentage impervious area) were adjusted to reflect a range of land use types, including those listed in **Table C3.5**.

Table C3.5: Land Use and Runoff Data from the AWBM Model

Land Use Type	Impervious (%)	Average Runoff (% of rainfall)
1	0	12
2	5	15
3	10	21
4	35	29
5	90	58

Table C3.5 also indicates the average annual runoff expressed as a percentage of average annual rainfall. The model results for urban and industrial land uses with a high proportion of impervious surfaces were validated against runoff data collected by Sydney Water for a variety of urban catchments in the Sydney area.

C4. MODEL SCENARIOS AND RESULTS

C4.1 CLIMATE SCENARIOS

To assess the overall performance of the water management systems in the Four Mile Creek catchment and the effect of the proposed completion of mining, the water balance model has been run to represent mining and operating conditions (as summarised in **Error!** Not a valid bookmark self-reference. below summarises the annual ROM coal production, coarse and fine tailings production and water requirements for the CHPP for the expected production from the completion of the Bloomfield Mine and the other mines feeding the Bloomfield CHPP (Donaldson, Abel and Tasman). In the case of Bloomfield, production will be to a maximum of 1.3 million tonnes per annum.

Table C3.3) for each year of the proposed completion of mining.

For each year the model was run for the 1974-89 climate sequence from which statistics were extracted for representative years as set out in **Table C4.1**.

Table C4.1: Climatic Scenarios Used in Water Balance Analysis

Rainfall Statistic	Average Annual Rainfall (mm)
Median rainfall year	892
10 percentile (dry) year	673
90 percentile (wet) year	1,198

C4.2 MODEL SETUP

Having adopted runoff characteristics for the various catchments based on catchment land use characteristics, the water balance model was configured to represent the mining conditions in each milestone year. The main factors that changed for each year were:

- The status of open cut pits in terms of active pit area, contributing catchment and time since initial rehabilitation occurred;
- The coal produced from the different mines, principally to account for the different characteristics of open cut and underground coal, the tonnage from each source and the resulting water requirements for the CHPP as set out in **Error!** Not a valid bookmark self-reference. below summarises the annual ROM coal production, coarse and fine tailings production and water requirements for the CHPP for the expected production from the completion of the Bloomfield Mine and the other mines feeding the Bloomfield CHPP (Donaldson, Abel and Tasman). In the case of Bloomfield, production will be to a maximum of 1.3 million tonnes per annum.
- Table C3.3;
- Changes in groundwater inflows to open cut pits and underground workings (as set out in **Table C3.4** above) to reflect the status of the mines at that time.
- For most of the time that mining occurs in the Buttai Creek catchment, all runoff will drain into an active pit. Once the post-mining landform no longer drains to an active pit, it will drain to a sediment dam from water will be transferred to Lake Kennerson.

For each year the operational parameters of the water balance model (target operating water levels and pumping rates) were adjusted to explore the response of the system to these factors and to identify a set of operating parameters that would, for a wide range of climatic conditions, achieve the objectives set out in **Section C3.6**.

The operating parameters in the model (target water levels in storages and pumping rates) were adjusted until the system achieved satisfactory performance against the criteria listed above. **Table C4.2** summarises the adopted operational rules. As further operating experience is gained, it is anticipated that there will be regular reviews of the water management plan and further refinement of the operating rules.

Table C4.2: Proposed Operating Conditions for Storages and Water Sources

Storage/Source	Target Operating Level (% of full capacity)	Transfer Rate (ML/day)	Transfer To	Transfer From
Big Kahuna	75%	5	L Kennerson	Abel Mine
Stockpile Dam	25%	7	L Foster	na
Lake Kennerson	80%	9	na	Groundwater
Lake Foster	50%	9	na	L Kennerson

A target maximum operating level 75% of the capacity of Big Kahuna Dam has been adopted for the model. Above this level water would be transferred to Lake Foster and serve as the "first call" source of water for maintaining water level in Lake Foster provided Lake Foster was not above its target operating level (50% capacity). Pumping rate from Big Kahuna to Lake Foster 5 ML/day (55 L/s) when the water level criteria are satisfied. (Note that the pipeline has a design capacity of 10 ML/day to allow for additional pumping if necessary to avoid discharge from Big Kahuna).

The operating rules adopted for the Stockpile Dam are:

- target maximum operating level 25% of capacity above which water would be transferred to Lake Foster;
- pumping rate to Lake Foster of 7 ML/day (80 L/s), which is twice the rate required to satisfy the criteria for operating stormwater pollution control dams as set out in *Managing Urban Stormwater: Soils and Construction* (Landcom 2004).

The detailed model results for specific years were consolidated into a summary for the major storages in the system (Big Kahuna, Lake Kennerson and Lake Foster) and the overall water balance for each of these storages was calculated for each year of the project life based on the surface runoff and dust suppression volumes derived from the detailed model and the predicted groundwater inflows (**Section C3.5** above) and CHPP water requirements as set out in **Error!** Not a valid bookmark self-reference. below summarises the annual ROM coal production, coarse and fine tailings production and water requirements for the CHPP for the expected production from the completion of the Bloomfield Mine and the other mines feeding the Bloomfield CHPP (Donaldson, Abel and Tasman). In the case of Bloomfield, production will be to a maximum of 1.3 million tonnes per annum.

Table C3.3. Any shortfall in water to meet all operational requirements (including the CHPP) was assumed to be sourced from the Bloomfield groundwater pumps that extract water from old underground workings within the Bloomfield mine lease area.

C4.3 MODEL RESULTS

Table C4.4 to

Table C4.6 below provide consolidated summaries of the estimated inflows, water uses and losses for the Big Kahuna Dam, Lake Kennerson and Lake Foster for each year of the Abel project for the three reference climatic years:

- Median rainfall year (892 mm) **Table C4.3**
- 1 in 10 dry year (673 mm) **Table C4.4**
- 1 in 10 wet year (1,198 mm) **Table C4.5**

Table C4.6 summarises the overall water balance for the whole of the Abel/Donaldson/Bloomfield combined water management system for each of the three climate years represented in **Table C4.3**, **Table C4.4** and **Table C4.5**. The column "Balance Check" provides a check that the total inputs (surface runoff and groundwater) equal the uses and losses.

Table C4.3: Estimated Water Balance - Median Rainfall Year (892 mm)

			Abel/Donaldson Area - Big Kahuna								Bloomfield Area - Lake Kennerson						Bloomfield Area - Lake Foster							
			Inflow				Losses				Inflow			Losses			Inflow				Losses			
Year	Total ROM Production (t x 1000)	CHPP Water Demand (ML)	Pit Inflow (ML)	Underground Inflow (ML)	Surface Runoff (ML)	Import from L Foster (ML)	Net Evaporation and Seepage (ML)	Total Water Use (ML)	Transfer to L Kennerson (ML)	Overflow (ML)	Pit Inflow (ML)	Surface Runoff (ML)	Transfer from Big Kahuna (ML)	Net Evaporation and Seepage (ML)	Transfer to L Foster (ML)	Controlled Discharge (ML)	Transfer from Stockpile Area and Tailings (ML)	Pumping from Creek Cut and Old Underground Workings (ML)	Surface Runoff (ML)	Import from L Kennerson (ML)	Net Evaporation and Seepage (ML)	Dust Suppression Uses (ML)	CHPP and lost in Product (ML)	Overflow (ML)
1	4,280	-2,712	299	4	127	0	-28	-52	-350	0	627	638	350	-46	-1,466	-103	408	1,038	68	1,466	-14	-255	-2,712	0
2	5,275	-3,252	299	7	127	0	-28	-62	-343	0	620	652	343	-46	-1,471	-98	408	1,573	68	1,471	-14	-255	-3,252	0
3	4,725	2,713	299	21	127	0	-28	-74	-345	0	615	665	345	-46	-1,488	-91	408	1,017	68	1,488	-14	-255	2,713	0
4	4,475	-2,254	0	49	88	0	-28	-93	-16	0	610	668	16	-46	-1,172	-77	408	875	68	1,172	-14	-255	-2,254	0
5	5,475	-2,673	0	95	88	0	-28	-118	-37	0	747	681	37	-46	-1,345	-75	408	1,121	68	1,345	-14	-255	-2,673	0
6	6,475	-3,091	0	158	88	0	-28	-143	-75	0	720	695	75	-46	-1,368	-76	408	1,515	68	1,368	-14	-255	-3,091	0
7	6,475	-3,091	0	231	88	0	-28	-143	-148	0	260	709	148	-46	-988	-83	408	1,896	68	988	-14	-255	-3,091	0
8	6,400	-3,059	0	314	88	0	-28	-143	-231	0	325	716	231	-46	-1,134	-92	408	1,717	68	1,134	-14	-255	-3,059	0
9	6,260	-3,001	0	394	88	0	-28	-143	-311	0	351	723	311	-46	-1,243	-97	408	1,551	68	1,243	-14	-255	-3,001	0
10	6,100	-2,934	0	472	88	0	-28	-143	-389	0	144	723	389	-46	-1,106	-105	408	1,621	68	1,106	-14	-255	-2,934	0

Table C4.4: Estimated Water Balance - 1 in 10 Dry Year (673 mm)

			Abel/Donaldson Area - Big Kahuna								Bloomfield Area - Lake Kennerson						Bloomfield Area - Lake Foster							
			Inflow				Losses				Inflow			Losses			Inflow				Losses			
Year	Total ROM Production (t x 1000)	CHPP Water Demand (ML)	Pit Inflow (ML)	Underground Inflow (ML)	Surface Runoff (ML)	Import from L Foster (ML)	Net Evaporation and Seepage (ML)	Total Water Use (ML)	Transfer to L Kennerson (ML)	Overflow (ML)	Pit Inflow (ML)	Surface Runoff (ML)	Transfer from Big Kahuna (ML)	Net Evaporation and Seepage (ML)	Transfer to L Foster (ML)	Controlled Discharge (ML)	Transfer from Stockpile Area and Tailings (ML)	Pumping from Creek Cut and Old Underground Workings (ML)	Surface Runoff (ML)	Import from L Kennerson (ML)	Net Evaporation and Seepage (ML)	Dust Suppression Uses (ML)	CHPP and lost in Product (ML)	Overflow (ML)
1	4,280	-2,712	299	4	105	0	-40	-59	-310	0	627	523	310	-65	-1,310	-85	345	1,279	63	1,310	-20	-264	-2,712	0
2	5,275	-3,252	299	7	105	0	-40	-69	-303	0	620	534	303	-65	-1,308	-84	345	1,820	63	1,308	-20	-264	-3,252	0
3	4,725	2,713	299	21	105	0	-40	-81	-304	0	615	545	304	-65	-1,316	-84	345	1,274	63	1,316	-20	-264	2,713	0
4	4,475	-2,254	0	49	72	0	-40	-100	19	0	610	548	-19	-65	-1,017	-58	345	1,114	63	1,017	-20	-264	-2,254	0
5	5,475	-2,673	0	95	72	0	-40	-125	-2	0	747	559	2	-65	-1,193	-50	345	1,356	63	1,193	-20	-264	-2,673	0
6	6,475	-3,091	0	158	72	0	-40	-150	-40	0	720	570	40	-65	-1,211	-55	345	1,757	63	1,211	-20	-264	-3,091	0
7	6,475	-3,091	0	231	72	0	-40	-150	-113	0	260	581	113	-65	-823	-67	345	2,145	63	823	-20	-264	-3,091	0
8	6,400	-3,059	0	314	72	0	-40	-150	-197	0	325	587	197	-65	-969	-75	345	1,967	63	969	-20	-264	-3,059	0
9	6,260	-3,001	0	394	72	0	-40	-150	-276	0	351	593	276	-65	-1,075	-81	345	1,803	63	1,075	-20	-264	-3,001	0
10	6,100	-2,934	0	472	72	0	-40	-150	-354	0	144	593	354	-65	-940	-87	345	1,871	63	940	-20	-264	-2,934	0

Table C4.5: Estimated Water Balance - 1 in 10 Wet Year (1,198 mm)

			Abel/Donaldson Area - Big Kahuna								Bloomfield Area - Lake Kennerson						Bloomfield Area - Lake Foster							
			Inflow				Losses				Inflow			Losses			Inflow				Losses			
Year	Total ROM Production (t x 1000)	CHPP Water Demand (ML)	Pit Inflow (ML)	Underground Inflow (ML)	Surface Runoff (ML)	Import from L Foster (ML)	Net Evaporation and Seepage (ML)	Total Water Use (ML)	Transfer to L Kennerson (ML)	Overflow (ML)	Pit Inflow (ML)	Surface Runoff (ML)	Transfer from Big Kahuna (ML)	Net Evaporation and Seepage (ML)	Transfer to L Foster (ML)	Controlled Discharge (ML)	Transfer from Stockpile Area and Tailings (ML)	Pumping from Creek Cut and Old Underground Workings (ML)	Surface Runoff (ML)	Import from L Kennerson (ML)	Net Evaporation and Seepage (ML)	Dust Suppression Uses (ML)	CHPP and lost in Product (ML)	Overflow (ML)
1	4,280	-2,712	299	4	173	0	-17	-46	-413	0	627	897	413	-27	-1,809	-101	429	644	88	1,809	-8	-249	-2,712	0
2	5,275	-3,252	299	7	173	0	-17	-56	-406	0	620	916	406	-27	-1,816	-99	429	1,176	88	1,816	-8	-249	-3,252	0
3	4,725	2,713	299	21	173	0	-17	-68	-408	0	615	936	408	-27	-1,833	-98	429	621	88	1,833	-8	-249	2,713	0
4	4,475	-2,254	0	49	126	0	-17	-87	-71	0	610	940	71	-27	-1,512	-82	429	483	88	1,512	-8	-249	-2,254	0
5	5,475	-2,673	0	95	126	0	-17	-112	-92	0	747	958	92	-27	-1,697	-73	429	717	88	1,697	-8	-249	-2,673	0
6	6,475	-3,091	0	158	126	0	-17	-137	-130	0	720	977	130	-27	-1,716	-84	429	1,116	88	1,716	-8	-249	-3,091	0
7	6,475	-3,091	0	231	126	0	-17	-137	-203	0	260	996	203	-27	-1,343	-89	429	1,488	88	1,343	-8	-249	-3,091	0
8	6,400	-3,059	0	314	126	0	-17	-137	-286	0	325	1,007	286	-27	-1,490	-101	429	1,310	88	1,490	-8	-249	-3,059	0
9	6,260	-3,001	0	394	126	0	-17	-137	-366	0	351	1,017	366	-27	-1,606	-101	429	1,136	88	1,606	-8	-249	-3,001	0
10	6,100	-2,934	0	472	126	0	-17	-137	-444	0	144	1,017	444	-27	-1,476	-102	429	1,199	88	1,476	-8	-249	-2,934	0

Table C4.6: Overall System Water Balance – Median, 1 in 10 Dry & 1 in 10 Wet Years

			Median Rainfall Year						1 in 10 Dry Year						1 in 10 Wet Year					
			Inflows		Losses				Inflows		Losses				Inflows		Losses			
Year	Total ROM Production (t x 1000)	CHPP Water Demand (ML)	Groundwater Inflows & Punping (ML)	Surface Runoff (ML)	Net Evaporation and Seepage (ML)	Total all Uses (ML)	Total Discharge and Overflow (ML)	Water Balance Check (ML)	Groundwater Inflows & Punping (ML)	Surface Runoff (ML)	Net Evaporation and Seepage (ML)	Total all Uses (ML)	Total Discharge and Overflow (ML)	Water Balance Check (ML)	Groundwater Inflows & Punping (ML)	Surface Runoff (ML)	Net Evaporation and Seepage (ML)	Total all Uses (ML)	Total Discharge and Overflow (ML)	Water Balance Check (ML)
1	4,280	-2,712	1,038	1,241	-88	-3,019	-103	0	1,279	1,036	-124	-3,035	-85	0	644	1,587	-53	-3,007	-101	0
2	5,275	-3,252	1,573	1,255	-88	-3,569	-98	0	1,820	1,047	-124	-3,585	-84	0	1,176	1,606	-53	-3,557	-99	0
3	4,725	2,713	1,017	1,269	-88	2,384	-91	0	1,274	1,058	-124	2,368	-84	0	621	1,626	-53	2,396	-98	0
4	4,475	-2,254	875	1,233	-88	-2,602	-77	0	1,114	1,028	-124	-2,618	-58	0	483	1,583	-53	-2,590	-82	0
5	5,475	-2,673	1,121	1,246	-88	-3,046	-75	0	1,356	1,038	-124	-3,062	-50	0	717	1,601	-53	-3,034	-73	0
6	6,475	-3,091	1,515	1,259	-88	-3,489	-76	0	1,757	1,049	-124	-3,505	-55	0	1,116	1,620	-53	-3,477	-84	0
7	6,475	-3,091	1,896	1,273	-88	-3,489	-83	0	2,145	1,061	-124	-3,505	-67	0	1,488	1,640	-53	-3,477	-89	0
8	6,400	-3,059	1,717	1,281	-88	-3,457	-92	0	1,967	1,067	-124	-3,473	-75	0	1,310	1,650	-53	-3,445	-101	0
9	6,260	-3,001	1,551	1,288	-88	-3,399	-97	0	1,803	1,073	-124	-3,415	-81	0	1,136	1,660	-53	-3,387	-101	0
10	6,100	-2,934	1,621	1,288	-88	-3,332	-105	0	1,871	1,073	-124	-3,348	-87	0	1,199	1,660	-53	-3,320	-102	0

The water balance estimates in **Table C4.3**, **Table C4.4**, **Table C4.5** and

Table C4.6 show the following features:

- Water supply for all mine purposes can be provided by the water management system without extracting water from the base of the Creek Cut and the old Bloomfield underground workings at a greater rate than has been extracted historically (up to 2,000 ML/year).
- Some discharge from Lake Kennerson is likely to continue under most climate conditions, reflecting the modelling assumption that all excess water held in "Big Kahuna" would be transferred to Bloomfield (rather than held in storage in the Abel underground workings).
- The detailed model results (not identified separately in **Table C4.3**, **Table C4.4** and **Table C4.5**) indicate that the Stockpile Dam would not overflow in any of the three representative climate years.

C5. CONCLUSIONS

The water balance model results presented above indicate that by adopting the proposed target operating water levels in the various storages and transfer pumping rates, the existing water management facilities within the Bloomfield and Donaldson mine areas can be operated in a manner that would achieve the following objectives:

- Maintain water supply for the CHPP and dust suppression at all times;
- Minimise discharge from the Stockpile Dam; and
- Minimise discharge from Lake Kennerson.

The water balance model has been used to develop a feasible set of operating rules that demonstrate the adequacy of the water management facilities to achieve these objectives. It is anticipated that the operating rules will be regularly reviewed and refined in the light of operating experience.

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Appendix I

Groundwater Impact Assessment

Bloomfield Colliery Completion of Mining and Rehabilitation

Part 3A Environmental Assessment

November 2008

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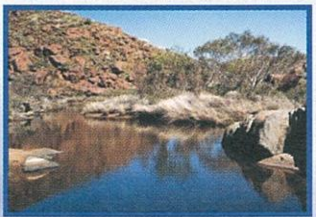

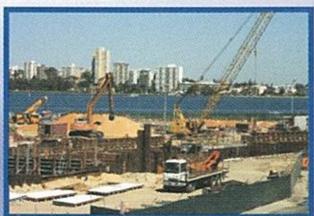

BLOOMFIELD COLLIERY COMPLETION OF MINING AND REHABILITATION GROUNDWATER IMPACT ASSESSMENT

Prepared for: Bloomfield Collieries Pty Limited

Ref: S05/R02g

September 2008

BLOOMFIELD COLLIERY

COMPLETION OF MINING AND REHABILITATION

GROUNDWATER IMPACT ASSESSMENT

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A	10 April 2008	Preliminary draft
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D	1 May 2008	Final draft for client review
G	10 November 2008	Final

	Name	Position	Signature	Date
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SECTION 1 - INTRODUCTION

1.1 PROJECT OVERVIEW

Bloomfield Colliery is located approximately 20 kilometres north-west of Newcastle (Figure 1). Coal has been mined on the site for approximately 170 years. Underground mining ceased on the site in 1992 and the current operation consists of open cut mining, a Coal Handling and Preparation Plant (CHPP) and a rail loading facility that transports processed coal to the Port of Newcastle.

This project is for the completion and rehabilitation of open cut mining. The continued use of the coal washery and rail loading facility (including the management of water associated with the washery, coarse reject and tailings disposal, and coal handling) was approved in June 2007 as part of the Abel Underground Mine project (Donaldson Coal, 2006).

Bloomfield is currently in the final stages of its planned open cut mining program and is actively rehabilitating former mining areas on the site. The current average production rate is 0.8 million tonnes per annum (Mtpa) of run of mine (ROM) coal. It is proposed to continue mining at this average production rate in order to complete the mining and rehabilitation of the site, but actual rate may reach a maximum of 0.9 Mtpa in Stage 1, and 1.3 Mtpa in Stages 2 to 4. There is estimated to be approximately 14 million tonnes (Mt) of viable run-of-mine (ROM) coal remaining on the site, and mining is expected to be completed in 10 to 12 years.

Mining operations at the Colliery have previously been carried out pursuant to existing use rights. The introduction of Part 3A of the *Environmental Planning and Assessment Act, 1979* (EP&A Act) and *State Environmental Planning Policy (Major Projects) 2005* required Bloomfield to obtain approval under Part 3A to continue the mining of areas subject to this application and undertake rehabilitation.

A Preliminary Assessment report prepared in June 2007 identified key issues requiring further investigation to determine any potential environmental impact.

The proposed completion of open cut mining activities at Bloomfield Colliery has been designed to cater for the ongoing operation of the washery and the reject management system as outlined in detail in the Abel Underground Mine Environmental Assessment (Donaldson Coal Pty Ltd, 2006).

1.2 INTERACTION WITH NEIGHBOURING MINES

Coal from the Bloomfield Colliery, together with coal from the Donaldson open cut mine and the Tasman underground mine is processed through the Bloomfield CHPP. Coal from the Abel Underground Mine will also be processed at the Bloomfield CHPP when production commences.

The tailings from the CHPP are disposed of on the Bloomfield site. Until mid-2007, tailings were deposited predominantly underground in former workings, but are now deposited in abandoned open cuts on the Bloomfield site. Water is recovered from the tailings and recycled through the CHPP.

1.3 OBJECTIVES OF GROUNDWATER STUDY

The broad objectives of the study were:

- To assess and describe the existing groundwater environment in the vicinity of the Bloomfield Colliery operations that are the subject of the Part 3A Application (“the Proposal”);

- To identify key potential risks to the environment from the proposal;
- To evaluate the potential impacts of the proposal on the regional and local groundwater resources, incorporating any necessary management and mitigation strategies; and
- To assess the residual post-project impacts and any ongoing management requirements.

The study has been undertaken with reference to the following relevant policies:

- NSW State Rivers and Estuaries Policy;
- NSW Wetlands Management Policy;
- NSW Groundwater Policy Framework Document – General;
- NSW Groundwater Quantity Management Policy;
- NSW Groundwater Quality Protection Policy; and
- NSW Groundwater Dependent Ecosystem Policy,

And the following relevant best practice guidelines:

- Groundwater Flow Modelling Guideline (MDBC, 2001);
- Independent Inquiry into the Hunter River System (Healthy Rivers Commission, 2002);
- Guidelines for Management of Stream/Aquifer Systems in Coal Mining Developments – Hunter Region (DNR, 2005); and
- Groundwater Monitoring Guidelines for Mine Sites within the Hunter Region (DIPNR, 2003).

The Draft Water Sharing Plan for Hunter unregulated and alluvial aquifer sources released in March 2008 has been considered. Although it is unlikely to be adopted prior to the lodgement of the Bloomfield Part 3A Application, Bloomfield proposes to conduct the mining operations in accordance with the Draft WSP.

2.1 SUMMARY

Piezometers were installed at eight sites around the Bloomfield mine area, to enable separate sampling, testing and monitoring of the main coal seams involved in past or proposed mining, as well as the shallow alluvium and/or regolith zone.

Each piezometer was designed to monitor a specific depth interval. Both open standpipe piezometers and vibrating wire piezometers were used. Standpipes were mainly used for shallow piezometers, with the casing/screen annulus sealed above and below, to enable the specific screened zone to be separately sampled and tested. Deeper piezometers consisted of vibrating wire piezometers encased in fully-grouted holes.

A limited amount of historical information was also available from several old piezometers on the site, however, in most cases the construction details were uncertain. Regional information was obtained where possible from piezometers on adjacent mining projects.

A hydraulic testing program was carried out on the standpipe piezometers, comprising short duration pumping tests or slug tests, to determine aquifer permeabilities. Water samples were collected for detailed chemical and physico-chemical analysis at a NATA-accredited laboratory.

Follow-up water quality sampling was carried out six months after the initial testing, as part of the ongoing baseline monitoring program. The baseline program also involves monthly measurement of water levels in all the Bloomfield piezometers.

A numerical computer model of the groundwater flow system was set up to predict potential impacts of the proposal on the groundwater, and surface water baseflow impacts. The model was initially calibrated against the available monitoring data. Steady state calibration was achieved against long-term average groundwater conditions. Transient calibration was achieved against observed impacts from past mining on the Bloomfield site and the adjacent Donaldson project.

The predictive modelling addressed cumulative impacts from the proposed mining at Bloomfield, as well as the neighbouring Donaldson and Abel projects. Predicted impacts were generated by the model for the period up to the projected completion of mining, and then for a post-mining period of 100 years.

The hydrogeological investigations (including modelling) have been undertaken with reference to the *Guidelines for Management of Stream/Aquifer Systems in Coal Mining Developments – Hunter Region* (DNR, 2005). The groundwater modelling has been carried out in accordance with the best practice guidelines on groundwater flow modelling (MDBC, 2001).

2.2 CENSUS OF EXISTING GROUNDWATER USAGE

A search of the Department of Water and Energy (DWE) groundwater bore database has been made to identify existing registered bores within approximately 5km of the project. Summary details of the 13 registered bores within 5km of the project are presented in Appendix A. Locations are shown on Figure 2.

Nine of the registered bores within 5 km of Bloomfield are monitoring bores around the Bloomfield and Donaldson open cuts. Two are water supply bores, viz:

- GW51353, a domestic/stock bore approximately 3km south of Bloomfield; and
- GW51647, a stock bore approximately 4km north-west of Bloomfield (Figure 2).

GW51353 is reported to be 50m deep, with a water level at 15m, yielded 0.2 L/s and has a salinity in the range 3000-7000 ppm. GW51647 is shallow (12m deep), but no other details are recorded. Both bores were drilled in 1980. Neither bore is expected to be impacted adversely by the continuation of mining at Bloomfield.

The remaining two registered bores are GW53411 and GW53412, located more than 4km southwest of Bloomfield within the Wallis Creek floodplain. They are beyond the range of potential impact from the completion of mining at Bloomfield.

2.3 PIEZOMETERS

Eight previously existing bores or old mine shafts had been identified (denoted as BL01 to BL08 on Figure 3), but there was little information available about their construction details or the aquifers open to them. Accordingly, twenty-four (24) new piezometers were installed in March-April 2007, at eight (8) sites around the Bloomfield project area (denoted as Site 01 to Site 08 on Figure 3).

Completion details of the new piezometers are listed in Table 1. The piezometers were drilled at 100 or 125mm diameter, and completed either as open standpipe bores (single level piezometers), or with up to three multi-level vibrating wires piezometers placed adjacent to the main coal seams, in fully-grouted boreholes (multi-level piezometers).

Standpipe piezometers were constructed by installation of 50mm diameter PVC casing, with PVC screens set adjacent to the desired monitoring interval in the bore, then placing a gravel pack around the screen and a bentonite seal in the annulus above the screened zone. The rest of the annulus above the bentonite seal was then backfilled with cement grout using a tremie pipe from the surface.

Vibrating wire piezometers were installed by securing them to the cementing tremie pipe at the desired depth level and the hole then fully grouted back to the surface.

All piezometers have been completed at the surface with a concrete block to prevent ingress of surface runoff or contamination, and secured within a padlocked steel monument.

Summary bore logs for each of the eight new piezometer sites are presented in Appendix B.

The piezometers were located and designed to provide a geographic spread of monitoring locations across the project area, and also to allow separate monitoring of aquifers in the Whites Creek, Donaldson, Big Ben and Rathluba coal seams, and in the shallow surficial aquifer which comprises alluvium (where present) and the weathered Permian (regolith).

Table 1
Groundwater Piezometers and Other Monitoring Bores

Site	Piezometer	MGA Coordinates		Surface RL (mAHD)	Depth (m)	Screen / Vibrating Wire Piezometer (m)	Water Level			Aquifer Formation	Status
		E	N				Date	m BGL	m AHD		
Site 1	VW1-35	363632	6370167	17.4	171	35	25/02/08	24.0	– 7.0	Donaldson Seam (33.0 – 35.4 m)	Active
	VW1-46					46	25/02/08	24.0	– 7.0	Big Ben Seam (44.3 – 47.2 m)	Active
	VW1-171					171	25/02/08	42.9	– 25.9	Rathluba Seam (170 – 171 m)	Active
Site 2	SP2-1	365112	6371264	65.2	65	50 – 53, 62 – 65	25/02/08	54.2	11.0	Donaldson Seam (55.2 – 61.4 m)	Active
	SP2-2			65.2	85	82 – 85	25/02/08	61.5	3.7	Big Ben Seam (79 – 94 m)	Active
	VW2-189			65.2	189	189	25/02/08	81.5	– 16.5	Rathluba Seam (187.8 – 191.3 m)	Active
Site 3	SP3-1	366732	6371893	38.8	14	11 – 14	25/02/08	5.7	33.1	Alluvium/weathered Permian	Active
	VW3-131			38.8	131	131	25/02/08	22.4	16.4	Rathluba Seam (129.7 – 131.5 m)	Active
Site 4	SP4-1	367612	6370989	27.8	78.4	75.4 – 78.4	25/02/08	22.5	5.3	Rathluba Seam (75.4 – 77.4 m)	Active
	SP4-2			27.8	9.4	6.4 – 9.4	25/02/08	3.1	24.7	Alluvium/weathered Permian	Active
Site 5	VW5-62	366700	6368083	55.7	90	62	25/02/08	46.7	9.0	White Ck Seam (62.3 – 63.1 m)	Active
	VW5-71					71	25/02/08	53.8	1.9	Donaldson Seam (70.5 – 71.9 m)	Active
	VW5-90					90	25/02/08	50.9	4.8	Big Ben Seam (89.3 – 89.7 m)	Active
Site 6	VW6-96	365337	6368293	52.5	130	96	25/02/08	85.7	– 33.4	White Ck Seam (95.1 – 96.7 m)	Active
	VW6-114					114	25/02/08	97.1	– 44.6	Donaldson Seam (113.2 – 114.7 m)	Active
	VW6-128					128	25/02/08	98.9	– 46.4	Big Ben Seam (128.0 – 129.3 m)	Active
Site 7	SP7-1	364619	6368701	24.9	11.2	9.2 – 12.2	25/02/08	Dry	Dry	Alluvium/weathered Permian	Dry
	VW7-70			24.9	110	70	25/02/08	32.5	– 7.6	White Ck Seam (67.9 – 69.8 m)	Active
	VW7-95					95	25/02/08	34.1	– 9.2	Donaldson Seam (90.0 – 91.8 m)	Active
	VW7-107					107	25/02/08	34.8	– 9.9	Big Ben Seam (104.7 – 107.7 m)	Active
Site 8	SP8-1			22.5	9.9	6.9 – 9.9	25/02/08	Dry	Dry	Alluvium/weathered Permian	Dry
	VW8-83			22.5	238	83	25/02/08	29.5	– 7.0	Donaldson Seam (80.4 – 84.0 m)	Active
	VW8-97					97	25/02/08	29.1	– 6.6	Big Ben Seam (91.5 – 98.5 m)	Active
	VW8-238					238	25/02/08	36.9	– 14.4	Rathluba Seam (237.2 – 240.2 m)	Active
BL01	Old fan shaft	363789	6371466	16.1		?				?	

Site	Piezometer	MGA Coordinates		Surface RL (mAHD)	Depth (m)	Screen / Vibrating Wire Piezometer (m)	Water Level			Aquifer Formation	Status
		E	N				Date	m BGL	m AHD		
BL02	BL02	365994	6372249	26.7		?		Dry	Dry	?	Blocked by tree roots
BL03	BL03A	366422	6368077	63.6	72	?	14/04/06	69.0	– 4.5	?	
	BL03B				53	?	14/04/06	50.2	14.3	?	
BL04	BL04	366519	6368076	61.5	52	?	14/04/06	43.7	18.6	?	
BL05	BL05	367385	6367957	75.4	46	?	14/04/06	? 45	31	?	
BL07	BL07	367211	6368485	57.6	26	?	13/04/06	24.6	33.7	?	Partially blocked at 15m
BL08	BL08	367029	6368431	52.3	49	?	13/04/06	27.0	26.0	?	
Abel Project	CO78A	367140	6367054	77	101	99-96, 90-87	26/04/06	48.6	28.4	Whites Creek Seam *(Abel's Donaldson Seam)*	Active
	CO78B				24	24-18	28/03/06	9.5	67.5	Alluvium/weathered Permian	Active
	C087	367187	6367079	74	18.3	18.3-12.3	26/04/06	10.5	63.5	Alluvium/weathered Permian	Active
Donaldson Project	REGDPZ1	371142	6371207		33	27-33				No information	Active – regional bore
	FMC1									No information	Active
	FMC2									No information	Active
	DPZ3	368774	6368609	49.1	30	6.8-18.8	17/08/05	12.4	36.7	Undifferentiated coal measures below Whites Creek Seam *(Abel's Lower Donaldson Seam)*	Active
	DPZ6			57.7	43	26.7-42.5	14/08/02	13.64	31.02	Whites Creek Seam *(Abel's U and L Donaldson Seams)*	Not read - unreliable
	DPZ7A	368848	6367641	55.4	18	12.9-16.9	11/07/01	16.9	38.5	Overburden above Whites Creek Seam *(Abel's Upper Donaldson)*	Not read since 2001
	DPZ7B			55.4	41	22.9-34.9	17/08/05	23.5	31.9	Whites Creek Seam *(Abel's L Donaldson Seam)*	Active
	DPZ8	369375	6368074	51.8	33	22.2-32.2	17/08/05	25.3	26.5	Whites Ck and Donaldson Seams *(Abel's L Donaldson and Big Ben)*	Active – responds to Donaldson mine dewatering

The Bloomfield piezometer network is supplemented by a number of piezometers previously installed for the Donaldson project adjacent to the southern or eastern boundaries of the Bloomfield lease. Locations of nearby Donaldson piezometers are shown on Figure 3.

2.4 GROUNDWATER LEVELS

Groundwater level hydrographs are shown in Figures 4 to 11.

Groundwater levels are monitored monthly in all Bloomfield piezometers. There is one year of records from the piezometers installed in early 2007, together with one-off water level measurements from the original eight bores/shafts in 2006.

More than 10 years of relevant groundwater level monitoring records are available from the nearby Donaldson bores, extending from July 1997 to the present time. The earliest records were collected during the pre-project investigations for the Donaldson mine in 1997. Routine monthly monitoring at Donaldson commenced in June 2000, prior to the commencement of mining in the Donaldson open cut in January 2001.

Longer-term hydrographs are available from some of the bores in the Donaldson monitoring network. In particular, bore REGDPZ1, which is located approximately 5 km east of Bloomfield (Figure 2) and stratigraphically deeper than the strata being mined at both Donaldson and Bloomfield, was included in the Donaldson network to show only climatic and/or seasonal trends, so that mining impacts could be distinguished from natural fluctuations. The REGDPZ1 hydrograph (Figure 4) shows a strong downward trend between around 2001 and late 2004, believed to be due to the generally below average rainfall during that period. Between early 2005 and the present time, there was a pronounced flattening of the downward trend, in response to a return to more normal rainfall conditions. There has not been any significant recovery of the groundwater level decline that occurred over the period from 2001 to 2004.

Bores FMC2 (Figure 4) and DPZ7 (Figure 5) which are also distant from the early years of Donaldson mining, show a similar pattern. Other Donaldson bores show strong effects of pit dewatering.

The Bloomfield piezometer hydrographs (Figures 6 to 9) display generally downward or flat trends over most of their period of monitoring (April 2007 to March 2008). Some of the shallower piezometers show a temporary water level rise between March and July 2007, believed to be reflecting recharge from the major rainfall event in early June 2007. However, most piezometers showed a continuing downward trend through the June rainfall event, indicating that they were not readily responding to recharge.

Dewatering of the Bloomfield mine is achieved by allowing free drainage of groundwater to sumps at the low points in the active mining areas, and pumping from the sumps into the water management system. Additional inflows occur by seepage into waste backfill from behind and collection as toe seepage at the base of the fill areas.

The groundwater levels in the Bloomfield mining area show the accumulated effects of long-term mining activity both at Bloomfield and at former open cut and underground mines to the west (eg Buchanan). Although there is no evidence to suggest what pre-mining groundwater levels might have been, as mining commenced at Bloomfield over 170 years ago, the influence of mining on water levels is apparent from the marked differences in groundwater level between shallow (alluvium/regolith) and deeper coal measures groundwater levels.

This is illustrated in particular on Figures 6 to 9. At Sites 1, 6, 7 and 8, the coal measures groundwater levels are below 0 mAHD and well below the groundwater levels in the alluvium and near-surface weathered Permian. At Sites 2, 3 and 4 the Rathluba Seam groundwater level is more than 20m lower than in the shallower Whites Creek, Donaldson and Big Ben Seams, and in the case of Site 2, it is also below 0 mAHD. The Rathluba and Big Ben Seams were previously mined underground on the Bloomfield lease, and the low groundwater levels in these seams may be partly a residual effect from former mining. The groundwater levels are also kept lowered by virtue of pumping to recover recycled water from tailings which were previously deposited underground in the old Big Ben Seam workings.

Water level records from the old bores and shafts (BL01 to BL07) and the Big Ben Shaft tailings water recovery borehole are shown on Figure 10. Hydrographs from nearby Abel piezometers are shown on Figure 11.

Contours groundwater levels representative of the seams being mined at Bloomfield are shown on Figure 12. These are based on recent water levels measured in January-February 2008 in the Bloomfield bores and nearby Donaldson bores, and from early 2007 in the more distant Donaldson and Abel bores, which are the most recent data available. In some cases, water levels from either the Big Ben or Whites Creek seams are used, in others the Donaldson Seam levels are used. Although there are small differences between the seams, the differences are small relative to regional water level differences, and combining data from these seams does not alter the overall picture of regional groundwater flow patterns within the coal measures.

The contours on Figure 12 show prominent cones of depression coinciding with the centres of pumping on the Bloomfield and Donaldson sites. There is also a moderate mound on the northern part of the Bloomfield site, centred around the washery tailings disposal area. Tailings were previously discharged via a bore to former underground workings (Figure 12), and are now surface discharged into the U North open cut.

2.5 HYDRAULIC TESTING

A hydraulic testing program was carried out on the new standpipe piezometers, comprising either slug tests or short duration pumping tests using low capacity sampling pumps, to determine aquifer permeabilities. The pumping tests were all of relatively short duration, generally 120 minutes or less, due to the low bore yields and low capacity pumps used. Analysis of the constant rate pumping tests was undertaken using the Jacob method (Cooper and Jacob, 1946). The slug tests were analysed by the Hvorselv method (Hvorslev, 1951).

Pumping tests or slug tests were also carried out on four old bores on the Bloomfield site in 2006. These are of only limited value, as the construction details and stratigraphic intervals open in each case are not known accurately.

Details of the hydraulic testing program carried out are summarised in Table 2. The results of previous testing carried out on Donaldson and Abel piezometers located close to the southern and eastern lease boundaries are also included in the table. The results of testing for the Bloomfield bores are presented graphically in Figures 13 to 17.

Table 2
Hydraulic Testing Program – Piezometers and Monitoring Bores

Piezometer / Test Bore	Test Interval	Aquifer / Lithology	Date of Test	Type of Test	Pumping Rate kL/d	Duration min	Transmissivity m^2/d	Average Hydraulic Conductivity		Comments
								m/d	m/s	
Bloomfield Monitoring Bores:										
SP2-01	50-53m and 62-65m	Donaldson Seam	25 May 2007	Constant Rate	4.1	40	0.24	0.08	9×10^{-7}	
SP2-02	82-85m	Big Ben Seam	27 May 2007	Slug Test	-	-	-	0.03	3×10^{-7}	
SP3-01	11-14m	Donaldson Seam	26 May 2007	Constant Rate	15	47	6.4	2	2×10^{-5}	
SP4-01	75-78m	Donaldson Seam	27 May 2007	Constant Rate	12	19	<0.07	<0.02	$<3 \times 10^{-7}$	
SP4-02	6.4-9.4m	Alluvium/ Weathered Permian	27 May 2007	Constant Rate	13	6	1.9	0.6	7×10^{-6}	
SP7-01	8-11m	Alluvium/ Weathered Permian	26 May 2007	Slug Test	-	-	-	0.001	1.1×10^{-8}	
BL03A	?	?	14 April 2006	Slug test	-	-	-	1.3	1.6×10^{-5}	
BLO4	?	?	14 April 2006	Slug Test	-	-	-	0.02	3×10^{-7}	
BL05	?	?	14 April 2006	Slug Test	-	-	-	0.04	5×10^{-7}	
BL07	?	?	13 April 2006	Slug Test	-	-	-	2.3	3×10^{-5}	
Abel Piezometers:										
C062A	118-124m	Whites Creek Seam *(Abel's Donaldson)*	27 May 2006	Constant Rate	7.5	15	-	-	-	Reached pump inlet in 15 minutes
			30 May 2006	Slug Test	-	-	-			
C062B	81-87m	Overburden	27 May 2006	Constant Rate	2	5	0.7	0.1	1×10^{-6}	Interrupted test
			30 May 2006	Constant Rate	10	120	0.4	0.06	7×10^{-7}	Early data
							0.08	0.01	1.5×10^{-7}	Late data
C072B	42-45m	Alluvium / weathered Permian	20 March 2006	Constant Rate	13	30	1.2	0.4	5×10^{-6}	
C078A	87-90m and 96-99m	Whites Creek Seam *(Abel's Donaldson)*	2 June 2006	Constant Rate	2	120	0.4	0.07	8×10^{-7}	
C078B	18-24m	Alluvium / weathered Permian	30 May 2006	Constant Rate	11	60	0.2	0.07	8×10^{-7}	

Piezometer / Test Bore	Test Interval	Aquifer / Lithology	Date of Test	Type of Test	Pumping Rate kL/d	Duration min	Transmissivity m^2/d	Average Hydraulic Conductivity		Comments
								m/d	m/s	
C081B	14-20m	Alluvium / weathered Permian	22 March 2006	Constant Rate	13	75	2.4	0.4	4×10^{-6}	
C082	14-20m	Alluvium / weathered Permian	22 March 2006	Constant Rate	13	160	0.3	0.05	6×10^{-7}	
C087	12-18m	Alluvium / weathered Permian								No test – pumped dry in 4 minutes
Donaldson Piezometers:										
DPZ1	16.5-26.9m	Whites Creek Seam *(Abel's L Donaldson)* and Donaldson Seam *(Abel's Big Ben)*	31 July 1997	Slug Test	-	-	-	0.08	9.6×10^{-7}	-
	17.4-17.6m	Mudstone	4 Sept 1997	Lab K Test	-	-	-	0.0003	3×10^{-9}	Kh
								0.0001	1×10^{-9}	Kv
	18.5-18.6m	Mudstone	4 Sept 1997	Lab K Test	-	-	-	0.0037	4×10^{-8}	Kh
								0.0008	9×10^{-9}	Kv
DPZ4	12.8-13.0m	Interbedded sandstone / mudstone	4 Sept 1997	Lab K Test	-	-	-	0.0015	2×10^{-8}	Kh
								0.0005	5×10^{-9}	Kv
	20.0-20.2m	Mudstone	4 Sept 1997	Lab K Test	-	-	-	0.0015	2×10^{-8}	Kh
								0.0002	2×10^{-9}	Kv
	35.7-35.9m	Interbedded sandstone / mudstone	4 Sept 1997	Lab K Test	-	-	-	0.0014	1.6×10^{-8}	Kh
								0.0001	1×10^{-9}	Kv
	37.0-37.2m	Sandstone (very coarse)	4 Sept 1997	Lab K Test	-	-	-	1.3	1.5×10^{-5}	Kh
								0.19	2.2×10^{-6}	Kv
DPZ7	22.9-34.9m	Whites Creek Seam *(Abel's L Donaldson)*	30 June 1997	Slug Test	-	-	-	0.002	1.4×10^{-8}	
	18.4-18.6m	Sandstone	4 Sept 1997	Lab K Test	-	-	-	0.0015	1.7×10^{-8}	Kh
								0.0009	1×10^{-8}	Kv
DPZ8	22-32m	Whites Creek Seam *(Abel's L Donaldson)* and Donaldson Seam	30 June 1997	Slug Test	-	-	-	0.17	1.9×10^{-6}	

Piezometer / Test Bore	Test Interval	Aquifer / Lithology	Date of Test	Type of Test	Pumping Rate kL/d	Duration min	Transmissivity m^2/d	Average Hydraulic Conductivity		Comments
								m/d	m/s	
		(Abel's Big Ben)								
DPZ9	12.5-36.5m	Whites Creek Seam *(Abel's U/L Donaldson)* and Donaldson Seam *(Abel's Big Ben)*	30 June 1997	Slug Test	-	-	-	0.02	2.3×10^{-7}	
DPZ14	24-32m	Big Ben Seam *(Abel's Buchanan and Ashtonfield)*	26 July 2001	Slug Test	-	-	-	0.7	8×10^{-6}	Early data (Gravel pack?)
								0.02	2.5×10^{-7}	Late data (formation?)
DPZ15	41-47m	Big Ben Seam *(Abel's Buchanan and Ashtonfield)*	26 July 2001	Slug Test	-	-	-	0.3	3×10^{-6}	Early data (Gravel pack?)
								0.009	1×10^{-7}	Late data (formation?)
DPZ16	21-24m	Big Ben Seam *(Abel's Ashtonfield)*	26 July 2001	Slug Test	-	-	-	0.4	4×10^{-6}	Early data (Gravel pack?)
								0.04	3×10^{-7}	Late data (formation?)

2.6 WATER SAMPLING AND ANALYSIS

Water samples were collected in winter and summer (May and December 2007) from the Bloomfield standpipe piezometers, and submitted to NATA-accredited laboratory ALS Environmental for detailed chemical analysis. Electrical conductivity (EC) and pH were measured in the field at the time of sampling.

The laboratory analysis results are presented in Table 3. Water analysis results from previous sampling of nearby Donaldson and Abel bores are included in Table 3.

The main water quality characteristics of groundwater from within the Bloomfield lease area are as follows:

2.6.1 Salinity

Salinity is variable, ranging from less than 1000 to over 13000 mg/L total dissolved solids (TDS). The December 2007 sample from SP2-1 (TDS of 230 mg/l) appears to be anomalous, as the earlier sample from this bore collected in May 2007 had a TDS of 5820 mg/L, as do other samples collected from the Donaldson Seam. The very low TDS is most likely due to rainfall contamination.

The highest salinities are reported from the surficial groundwater, ie the colluvium / weathered Permian (13,000 mg/L TDS in C078B and over 11,000 mg/L in SP4-2). The lowest reported salinity of 1000 mg/L (apart from the anomalous result from SP2-1) was from the Whites Creek and Donaldson Seams at Donaldson bores DPZ7 and DPZ8

2.6.2 pH

pH is close to neutral in all samples, discounting the anomalous value from C087, which reported a pH of 11.9. This elevated value is considered to have been due to residual effects of cement grout during bore construction.

2.6.3 Dissolved Metals

Sampling of dissolved metals revealed generally low concentrations relative to ANZECC (2000) freshwater ecosystem protection guidelines, with the exception of copper and zinc. The concentrations of copper exceed the ANZECC guideline value of 0.0014 mg/L in all samples. The zinc guideline value of 0.008 mg/L is exceeded in all but 2 samples.

Exceedence of the cadmium guideline value of 0.0002 mg/L was reported from the two samples from SP4-2. Both samples from SP3-1 reported elevated manganese concentrations above the ANZECC guideline. The nickel guideline value was also exceeded in several samples. Finally, one exceedence for aluminium was reported (the December sample from SP3-1).

Dissolved iron concentrations are relatively high in some samples, although no ANZECC guideline value is set.

2.6.4 Nutrients

Limited sampling for nutrients revealed concentrations of all parameters to be generally within the ANZECC guidelines, with a very slight exceedence for ammonia only in the first sample from SP2-1.

2.7 SURFACE WATER QUALITY

Surface water samples are collected regularly (at 2 to 4 weekly intervals) from 12 sites on and around the Bloomfield lease area, and are subjected to laboratory analysis for pH, EC, TSS and TDS. WM1 is located in the Buttai Creek catchment. The other 11 sites are in the Four Mile Creek catchment.

The sampling results are summarised in Table 4. Full details of the sampling results and interpretations are presented in Evans and Peck (2008).

The data in Table 4 show generally high salinities at all sites, except WM6, WM7 and WM10, all on Four Mile Creek upstream of Kennerson Dam. Mean EC values range from 242 µS/cm at WM6 to 5042 µS/cm at WM9.

The higher salinities are believed to be due to groundwater discharge, During periods of low rainfall runoff, baseflow in most streams is maintained by natural groundwater discharges. Hence, the surface water quality typically displays significant variability, particularly in salinity, over the climatic cycle. At all sites, the minimum recorded salinity values (as EC) are less than 300 µS/cm, and the maximums at all sites are greater than 1000 µS/cm.

Table 4
Summary Surface Water Monitoring Data

Location		WM1	WM2	WM3	WM4	WM5	WM6	WM7	WM8	WM9	WM10	WM11	WM12
pH	no samples	106	79	242	258	183	241	240	446	242	202	437	157
	max	8.0	7.6	8.1	15.5	8.4	8.5	9.3	8.9	9.3	8.1	8.7	8.1
	mean	3.7	5.9	7.1	7.5	6.7	6.8	7.2	7.9	8.1	6.8	7.2	7.2
	min	2.7	3.9	4.2	5.9	3.4	5.5	5.9	6.7	5.6	6.0	5.7	4.1
EC (µS/cm)	no samples	108	79	244	258	183	241	241	446	241	202	414	157
	max	14,400	2,750	6,080	7,360	6,620	2,100	3,320	8,770	8,880	1,080	13,331	5,750
	mean	3,338	1,289	1,405	1,332	1,938	242	503	4,936	5,042	426	2,051	1,494
	min	145	211	230	150	9	121	9	12	300	50	12	26
TSS (mg/L)	no samples	16	15	129	139	78	47	13	123	21	28	229	61
	max	1,272	202	140	627	470	370	250	4,220	50	180	5,470	426
	mean	107	43	19	28	43	29	62	77	10	39	92	45
	min	1	14	1	1	1	1	1	1	1	2	1	1
TDS (mg/L)	no samples	12	15	130	140	76	44	9	221	21	28	200	78
	max	5,825	1,440	5,070	5,660	6,110	410	1,040	5,270	5,080	560	5,130	4,830
	mean	1,862	763	736	577	1,040	151	570	3,347	3,226	305	1,381	913
	min	164	46	120	8	100	50	190	600	450	130	97	126
NFR (mg/L)	no samples								183				
	max								150				
	mean								11.4				
	min								0.1				
Fe (mg/L)	no samples								183				
	max								0.88				
	mean								0.08				
	min								0.05				

3.1 CLIMATE

3.1.1 Rainfall

The nearest long-term Bureau of Meteorology rain gauging stations to the Bloomfield operation are listed in Table 5.

Table 5
Bureau of Meteorology Stations

Station No.	Location	Latitude	Longitude
61008	Campbells Hill	32.7000 S	151.5000 E
61009	Cessnock Post Office	32.8272 S	151.3661 E
61034	East Maitland Bowling Club	32.7483 S	151.5833 E
61223	Maryville	32.9131 S	151.7500 E
61242	Cessnock – Nulkaba	32.8093 S	151.3490 E

Analysis of the daily rainfall data since 1902 from the nearest meteorological station at East Maitland, approximately 5 km north of Bloomfield, provides the following key characteristics shown in Table 6.

Table 6
Long Term Rainfall Data for East Maitland Station 61034

Rainfall	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Mean (mm)	89	94	96	87	70	84	58	52	55	65	62	81	895
Mean No of Raindays	7.9	7.8	7.7	7.7	6.7	7.5	6.6	6.2	6.2	7.4	6.5	6.4	85

The annual rainfall at the East Maitland site exhibits a moderate seasonal pattern with the highest mean rainfall occurring during the December to June period and lower rainfall between July and November. No evaporation data is available from the East Maitland meteorological station.

3.1.2 Evapotranspiration

Average annual potential evapotranspiration for the Project area is around 1470 mm.

Table 7
Average Monthly Potential Evapotranspiration Rates for the Project Area (mm)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
mm	182	143	127	96	68	57	67	93	120	149	167	200	1470

Average of Cessnock and Paterson Stations - Source: Bureau of Meteorology (2001)

A comparison between monthly average rainfall and monthly average potential evapotranspiration over the year, indicates that on average the area has an excess evaporative capacity over rainfall in all months. There is variability in monthly rainfall and there would be periods when rainfall could exceed evapotranspiration during the winter months.

3.2 GEOLOGY

The Bloomfield project area is underlain by Permian Tomago Coal Measures (Figure 18). The target coal seams for the completion of mining at Bloomfield are the Big Ben, Donaldson, Elwells Creek, Whites Creek and Upper and Lower Buttai Seams of the Tomago Coal Measures. Sediments above, below and between these coal seams comprise predominantly interbedded mudstone, siltstone and sandstone.

Previously the Big Ben Seam and the deeper Rathluba Seam were mined underground at Bloomfield, but all underground mining ceased in 1992.

The Tomago Coal Measures are overlain downdip to the south by the Newcastle Coal Measures, but the latter are not present on the Bloomfield site (Figure 18).

Bloomfield is located on the western limb of the Four Mile Creek Anticline (the Donaldson project is on the east limb). On the Bloomfield site, the strata dip generally towards the south and south-west. Minor faulting and dykes are present.

Because of the south/southeasterly dip, the shallowest Upper Buttai Seam is at a depth of more than 60m below surface along the southern boundary of the Bloomfield lease, but is absent (eroded) at the northern lease boundary. Natural surface topography generally ranges from around 15 to 90 mAHD in the Bloomfield mining lease area.

To the west of Bloomfield, the Permian bedrock is overlain by Quaternary alluvial sediments along the Wallis Creek drainage, which occupies a wetland system of disconnected ponds and swampy areas (Figure 18). Several kilometres to the east of Bloomfield, alluvial deposits including gravel, sand, silt and clay, overlie the Permian in Hexham Swamp and the floodplain of the Hunter River. Minor alluvial development also extends into the lower reaches of Buttai Creek, Four Mile Creek, and other larger tributary streams. Elsewhere, minor intermittent occurrences of localised alluvium can be found in association with creek-lines of the smaller tributaries.

The upper part of the Permian sequence is moderately to highly weathered to depths of up to 20-30 m.

3.3 HYDROGEOLOGY

Overall, the coal measures are poorly permeable, but permeability is relatively higher in the coal seams. The interbedded sandstones and siltstones are less permeable (generally by one to two orders of magnitude lower than the coal seams) and possess very limited intergranular porosity and little secondary permeability and storage in joints.

Groundwater also occurs in the main alluvial deposits, which comprise mainly swamp, floodplain and estuarine sediments in Wallis Creek and the Hunter floodplain. Minor localised alluvial groundwater also occurs in places in the tributary drainages, but is not regionally extensive or continuous. There is believed to be very limited hydraulic connectivity between the alluvium and the coal measures.

The colluvium / weathered bedrock zone constitutes a minor aquifer up to about 10-20 m thick which blankets most of the area. Groundwater occurs locally within this zone and represents a discontinuous unconfined aquifer, that may be hydraulic connected locally with the surface stream system, but is hydraulically isolated from deeper groundwater within the Permian coal measures sequence.

A summary of representative aquifer properties of the hydrogeological units in the study area is given in Table 8. These are based on hydraulic testing on the Bloomfield, Donaldson and Abel projects, and experience in other parts of the Hunter Valley coalfields.

Table 8
Representative Hydraulic Parameters of Hydrogeological Units

Units	Horizontal Hydraulic Conductivity (m/d)	Confined Storativity	Unconfined Specific Yield
Coal Seams	0.01 to 0.1	0.0001	0.01
Interburden (undisturbed)	0.001	0.00001	0.005
Interburden (disturbed through subsidence by underground mining)	1 to 10	0.0001	0.01 to 0.05
Colluvium / weathered coal measures sediments	0.1 to 0.5	-	0.05
Alluvium	0.1 to 5	-	0.1

Horizontal hydraulic conductivity is at least 10-100 times higher than vertical hydraulic conductivity. This is generally supported by the results of laboratory testing on samples collected at the Donaldson site in 1997 (Table 3) which showed horizontal/vertical ratios of between 1.7 and 14 in solid rock samples. Much higher ratios are expected for bulk rock mass hydraulic conductivity, when fractures and bedding plane partings are included.

Groundwater flow within the coal measures is overall controlled by the recharge-discharge process, with recharge occurring to coal seams and other permeable zones where they outcrop in areas of elevated terrain, and then slow movement down-dip or along strike to areas of lower topography, with ultimate discharge probably to the ocean. There is believed to be only a very small component of vertical downward flow across the bedding within the coal measures.

Groundwater level contours for the Permian aquifer system show an overall pattern of flow to the west, south and east from a central ridge which coincides approximately with the axis of the Four Mile Creek Anticline, and the flow pattern is largely independent of the local topography (Figure 12). The contours also show the influence of dewatering in the Bloomfield and Donaldson mine areas with prominent cones of depression centred on the low points of current active open cuts on the two projects. There is no evidence as yet for any drawdown influence associated with the Abel project, which has not yet proceeded to underground development.

There is also a small mound on the northern part of the Bloomfield site, centred around the disposal area for washery tailings (previously discharged via a bore to former underground workings and now by surface discharge into the U North open cut).

There is a consistent pattern of lower pressure heads with depth in the coal measures, suggesting either a potential downward gradient in the Permian, or a greater propensity for recharge to occur to the near-surface strata due to proximity to outcrop.

Groundwater levels in the near surface material, which includes alluvium, colluvium and weathered bedrock, show a much closer relationship to the local topography. Near surface groundwater levels in the shallow piezometers on and near the Bloomfield site, SP4-2, SP7-1, SP8-1, CO78A and CO87, are at least 20m higher than groundwater levels in the Permian at the same sites (see Table 1 and Figures 4 to 11). In areas of low topography (eg Long Gully and Blue Gum Creek to the southeast of Bloomfield), the near surface groundwater levels are typically lower than the Permian groundwater levels.

The groundwater levels in the deeper coal measures are not influenced by local topography, but rather by the topographic elevations of the recharge zones (ie in updip areas where they outcrop). By contrast, the surficial groundwater levels are locally influenced, as they are recharged by infiltration of local rainfall and downward percolation to the water table.

Flow within the deeper coal measures is therefore believed to be more regionally controlled, whereas flow within the near-surface material is subject to local topographic influences.

3.4 RECHARGE AND DISCHARGE

Rainfall recharge occurs to both the coal seams where they outcrop, and to the alluvial aquifers. The alluvial aquifers are likely to be in hydraulic continuity with Wallis Creek to the west and the Hunter River floodplain to the east and north. The shallow aquifer system normally discharges to the streams, although during periods of high stream flow, streamflow may contribute some recharge to these alluvial aquifers for short periods while stream water levels are temporarily higher than the adjacent alluvium groundwater levels. Stream flows from runoff are generally short-lived after rainfall events.

The coal seams, where covered by overburden, are recharged mainly by flow along the bedding from elevated areas where the beds are exposed in outcrop, with minimal downward percolation through the overburden. After reaching the water table, flow is predominantly down-gradient along the more permeable horizons, but possibly also with a smaller component of continuing downward flow to recharge underlying coal seam aquifers.

Rainfall recharge rates within the hard rock outcrop area are believed to be relatively low (below 10mm/yr). However, where alluvial deposits occur, recharge rates may be as high as 100mm/yr. No direct measurements of recharge rate are available, and these values are estimated based on experience and professional judgement, supported by the results of model calibration (see Section 4.3).

Natural groundwater discharge occurs through evaporation, seepage and baseflow contributions to the main creeks, rivers and some of the smaller tributaries, where aquifer horizons outcrop in low lying areas. However, most natural discharge is believed to occur by slow downdip flow within the coal measures strata to the south and east, with ultimate discharge to the ocean.

3.5 EXISTING GROUNDWATER USAGE

Due to the generally high groundwater salinities and low bore yields, there is very limited existing groundwater abstraction in the study area other than for coal mine dewatering. Occasional small stock water supplies are drawn from near surface groundwater, such as the DWE registered bore GW51353 discussed in Section 2.2.

Incidental use of groundwater from the coal measures is believed to occur. A landholder south of John Renshaw Drive reported that groundwater inflow was observed to occur from a shallow coal seam (believed to be the Sandgate Seam, stratigraphically above the Bloomfield seams) intersected during excavation of a dam. The salinity is reported to be too high for beneficial use, unless it is blended with low salinity surface runoff in the dam.

3.6 GROUNDWATER QUALITY

The quality of groundwater sampled from within the Bloomfield lease is variable, with total dissolved solids (TDS) ranging from less than 1000 mg/L to 13,000 mg/L. The highest salinities are reported from the surficial groundwater, ie the colluvium / weathered Permian (eg 11000+ mg/L at SP4-2, and 13,000 mg/L TDS in Abel's C078B, just south of the Bloomfield lease boundary).

The lowest salinities were from the upper parts of the coal measures on the adjacent Donaldson mine area on the eastern limb of the Four Mile Creek Anticline (Whites Creek and Donaldson Seams and overburden sediments), with TDS generally in the range 1000 to 2500 mg/L. Groundwater in these seams is markedly more saline on the Bloomfield lease, ie west of the Four Mile Creek Anticline (eg SP2-1, see Table 3).

pH is close to neutral, with reported values in the range 6.00 to 7.44. The sample from Abel bore C087 reporting a pH values of 11.9 is believed to be anomalous, and reflects the residual effects of cement grout during bore construction.

3.6.1 Piper Diagram

The groundwater samples have been plotted on a Piper Trilinear diagram (Figure 19), which allows each sample to be plotted at a unique point on the basis of the relative concentrations of the major ions in solution – the cations calcium, magnesium, sodium and potassium, and the anions carbonate/bicarbonate, sulphate and chloride. This plot allows an assessment of the recharge-discharge processes, and also allows a comparison of water samples derived from different environments within the hydrological cycle. It can also be used to assess the possible mixing of waters from different sources.

Recently-recharged water tends to plot closer to the left-hand apex of the diamond field in the Piper diagram, and waters further from the source of recharge plot closer to the right-hand side.

The Piper trilinear diagram presented in Figure 19 shows that the dominant ions in all samples are sodium and chloride, which would suggest that there is limited recharge occurring.

All but one sample plot on the right hand side of the diamond field, indicating considerable distance or time from recharge. The December 2007 sample at SP2-1 stands out on the Piper diagram due to its relatively low chloride concentration. As discussed previously this is most likely due to rainfall contamination.

3.7 GROUNDWATER-SURFACE WATER INTERACTION

Groundwater in the alluvium associated with Wallis Creek and the Hunter floodplain is believed to be in direct hydraulic connection with the surface water in these wetland areas, based on close correlation between the surface water and groundwater levels. Similar conditions are expected to occur in the lower reaches of the major tributary streams. There is believed to be relatively free interchange of water between the alluvium and the surface water bodies, with the groundwater discharging to the surface water at most times, and possibly flowing in the reverse direction for short periods following periods of heavy rainfall.

The limited occurrences of localised surficial groundwater in the colluvium / weathered bedrock are believed to be in reasonable hydraulic connection with the high level streams, and there is expected to be some interchange of water between the creek-beds and the shallow weathered bedrock beneath. These localised occurrences of surficial groundwater do not represent a significant or regionally extensive aquifer system, and should really be considered to be part of the surface water flow system.

On the other hand, there is believed to be minimal interaction between the surface drainage system (including the alluvial and other surficial groundwater), and the deeper groundwater within the coal measures. Likewise, there is believed to be limited interaction between groundwater in the alluvium and deeper groundwater in the coal measures.

SECTION 4 - ASSESSMENT OF POTENTIAL IMPACTS OF THE PROPOSAL ON THE GROUNDWATER SYSTEM

4.1 THE PROPOSAL

Bloomfield is currently in the final stages of its planned open cut mining program and is actively rehabilitating former mining areas on the site. The operations previously included underground as well as open cut mining, but all underground mining ceased in 1992.

It is proposed to continue mining by open cut means at the current average production rate (0.8 Mtpa) in order to complete the mining and rehabilitation of the site. Actual mining rate may reach a maximum of 0.9 Mtpa in Stage 1, and 1.3 Mtpa in Stages 2 to 4. There is estimated to be approximately 14 million tonnes of viable run-of-mine (ROM) coal remaining on the site. Mining of the remaining coal reserves is expected to be completed in 10-12 years.

The mining proposal is illustrated by staged layout plans on Figures 20a to 20e. There are two current active pits, which will be progressively extended generally downdip in a westwards direction, until completion of mining. Concurrent with mining, waste rock will be progressively backfilled into mined out sections of the open cuts.

Tailings and coarse rejects from the CHPP will continue to be deposited in the former open cuts near the northern part of the lease (Figures 20a to 20e).

The final landform remaining at the completion of mining is shown on Figure 20e. It shows final pit voids at Creek Cut and S Cut, in the central part of the lease area. Other pits would have been substantially backfilled with mine waste rock and/or tailings by the completion of mining.

The Creek Cut and S Cut voids have been assumed to remain as permanent open voids in the groundwater modelling, so that the impact of the Bloomfield proposal can be assessed (as far as possible) separately from the impacts of neighbouring mining projects, one of which (Abel) is approved to continue for several years after completion of mining at Bloomfield. However, with ongoing processing of coal at the Bloomfield CHPP, the final voids will be progressively backfilled by deposition of CHPP rejects.

4.2 GROUNDWATER FLOW MODEL

A numerical groundwater flow model based on the MODFLOW package, used in conjunction with the SURFACT module, has been used to assess the potential impacts of the proposed mining operation. A detailed account of the modelling carried out for the Abel project is presented in Appendix C.

The model area of about 200 km^2 is shown in Figure 18. It includes the nearby Abel and Donaldson mining areas as well as Bloomfield, and extends to the north and west as far as the outcrop line of the Big Ben seam, which is represented in the model using a no-flow boundary. The southern model boundary has been set at Northing 6 360 000, about 10 km south of Bloomfield, considered to be sufficiently far from Bloomfield to avoid any interference with the mining activities to be simulated in the Bloomfield, Donaldson and Abel mining areas.

At the southern model boundary, the coal seam “aquifers” are overlain by considerable thickness of overburden, such that only limited flow occurs across it. This boundary has been represented numerically using a head-dependent flux (using MODFLOW’s General Head Boundary “GHB” package), with water level set to observed or estimated heads.

A variable cell size has been used in the model, ranging from 25m x 25m in the mine area to 100m x 100m at the outer margins of the model.

Eight layers were incorporated in the model, with each main coal seam and the respective interburden intervals represented as separate layers with different properties. The geological sequence is represented by the following layers:

- Layer 1 - Alluvium and weathered Permian (unconfined layer);
- Layer 2 - Permian overburden above Whites Creek Seam;
- Layer 3 - Whites Creek Seam;
- Layer 4 - Interburden;
- Layer 5 - Donaldson Seam;
- Layer 6 - Interburden;
- Layer 7 - Big Ben Seam; and
- Layer 8 - Combination of deeper coal measures and basement.

Hydraulic properties were assigned to each cell in the model, based on the results of hydraulic testing, and experience from other mining projects in the lower Hunter and Newcastle coal fields.

A full account of the model set-up and the assumed hydraulic parameters are presented in Appendix C.

The model was first run in steady state mode to calibrate it against the observed distribution of groundwater levels across the model area, and the best available estimates of recharge-discharge and boundary conditions. Steady state modelling assumes that the current distribution of groundwater levels represents long-term equilibrium (pre-mining) conditions. However, it is recognised that the present conditions are influenced by the present and past mining on the Bloomfield and Donaldson projects, and other former mines in the vicinity, and do not represent equilibrium conditions. However, in the absence of any information concerning the actual pre-mining conditions, and with only a limited set of data in response to recent mining at Bloomfield and Donaldson, it is the best case approach to an assumed “pre-mining” condition for the Bloomfield proposal.

After the model was satisfactorily calibrated against the present groundwater conditions, it was run in transient mode to predict the potential groundwater impacts of the Bloomfield proposal. The progressive further development of the open cuts, and the associated backfilling of the open cuts with waste rock, were simulated in the model, to assess the potential impacts on groundwater levels and surface water baseflows. Mining was simulated by assigning “drain” cells to each model cell coinciding with the active pit area at each time stage through the mine life, and by altering the hydraulic parameters of cells within the pit areas firstly from in-situ properties to properties representing voids, then to properties representing waste backfill material, in accordance with the staged mining and backfilling schedule of the mining and rehabilitation plan.

Subsequently, a sensitivity analysis and prediction uncertainty analysis were undertaken to determine the sensitivity of the model to possible errors in the assumed hydraulic properties.

Finally, the model was run in transient mode for a period of 100 years after completion of mining to predict the nature and rate of groundwater level and baseflow recovery after completion of mining and rehabilitation.

4.3 MODEL CALIBRATION

The steady state model calibration was achieved with sequential model runs with manual adjustment of horizontal and vertical hydraulic conductivity values, and other hydraulic parameters, until the best fit was obtained between observed and simulated groundwater levels. All available bores on the Bloomfield site and other nearby project areas were used in the calibration process.

A satisfactory calibration was achieved in accordance with the Australian modelling guideline (MDBC, 2001), with good correlation between simulated and observed groundwater levels (scaled RMS error of less than 9%). Baseflows derived from the calibration model were 920 kL/d to Wallis Creek, 14.5 kL/d to Buttai Creek and 2 kL/d to Blue Gum Creek. Baseflows in all other creeks, including Four Mile Creek, were negligible.

Table 9
Bloomfield Model Parameters after Calibration

Layer		Kh [m/d]	Kv [m/d]	Confined S_c*	Unconfined S_y*
1	Alluvium	1	0.1	0.005	0.1
	Weathered regolith	0.1	0.01	0.001	0.08
2	Permian overburden above Whites Creek Seam	0.002	0.001	0.00002	0.002
3	Whites Creek Seam	0.1	0.01	0.0003	0.03
4	Interburden	0.002	0.001	0.0001	0.01
5	Donaldson Seam	0.05	0.005	0.0003	0.03
6	Interburden	0.002	0.001	0.00005	0.005
7	Big Ben Seam	0.08	0.008	0.0003	0.03
8	Underlying coal measures and basement	0.05	0.005	0.0001	0.01

* only applicable for the transient model runs

Recharge was applied at rates of 15 mm/yr generally, except for the alluvium areas, which received 100mm/yr. Evapotranspiration is active in low lying areas such as around creeks and the swamp area to the east, and operates at maximum rates of 250 mm/yr.

The impact of past mining at Bloomfield and Donaldson has been simulated in a simplistic way, using drain cells set to the elevations of observed water levels in the respective mining areas.

The water balance derived from the steady-state model calibration is summarised in Table 10.

Table 10
Steady State Water Balance – Groundwater Inflows and Outflows (ML/d)

	Recharge	Evapo-transpiration	Mine Dewatering		River/Stream Flows			Tailings Disposal	Flows across boundaries
			Bloomfield	Donaldson	Wallis Creek	Hexham Swamp	Tributaries		
Inflows	10.4	0	0	0	0.08	1.3	0	0.03	8.1
Outflows	0	7.5	1.7	0.4	1.0	0.9	0.02	0	8.5

4.4 SENSITIVITY ANALYSIS

Sensitivity analysis was carried out to assess the sensitivity of the model calibration to potential errors in the assumed input parameters and boundary conditions. This was done by decreasing or increasing each input parameter or boundary condition in turn, and evaluating the impact of each change on the calibration statistics. The results are detailed in Appendix C, however in summary it was found that generally the model was insensitive to changes in the hydraulic conductivity values, apart from:

- Layer 2 – overburden above Whites Creek Seam (low sensitivity to higher vertical conductivity);
- Layer 3 – Whites Creek Seam (low sensitivity to both higher and lower horizontal conductivity);
- Layer 4 – interburden between Whites Creek Seam and Donaldson Seam (low sensitivity to reduced vertical conductivity); and
- Layer 8 – coal measures beneath Big Ben Seam (slightly sensitive to a reduced horizontal conductivity).

Sensitivity analysis also showed that the adopted recharge rates are optimal, and the model is insensitive to the adopted values for river and drain conductance values.

4.5 PREDICTIVE MODELLING

The potential impacts of the proposed future mining and rehabilitation at Bloomfield were assessed by running the calibrated model in transient mode. The model was configured with annual changes in the area and base level(s) of mining, by altering the hydraulic parameter values of model cells within mined and/or backfilled areas, and with drain cells activated in all active open cut areas. To accommodate parameter changes using MODFLOW, the modelling was conducted as a series of sequential model runs, with parameter changes between successive runs in accordance with the mining schedule.

It is expected that mining will be completed in 10 to 12 years, but for the purposes of modelling, a remaining life of 11 years has been assumed. The mine plan was modelled using nine consecutive time-slice models representing the remaining 11 years of mining (annual increments, except for Years 8-10 which comprise a single time-slice). The final groundwater head distribution from each time-slice was used as the starting heads for the succeeding time-slice, and the parameters of cells affected by mining altered between time-slices in accordance with the mine plan and schedule. The model cells within the pit areas commence with hydraulic properties of the insitu rock, and the properties are altered in turn firstly to values appropriate for voids and then to values appropriate for waste rock backfill, as mining progresses. Higher hydraulic conductivity values (Kh = 1 m/d and Kv = 0.1 m/d) were used for the waste backfill compared with the insitu rock properties, with a specific yield Sy value of 0.05.

Because of the proximity of nearby Donaldson and Abel projects, these operations were also simulated in the model. The Donaldson project has been in operation since 2001 and is due for completion in another 3-4 years, and the Abel project is currently under development. Abel is projected to continue for 10 years after completion of mining at Bloomfield.

The predicted mine dewatering rate (ie the rate of groundwater inflow to the pits) from the prediction modelling ranged between 0.4 and 2.1 ML/d, with the maximum occurring in Year 6 and minimum in Year 11. Predicted average rate over the 11 years was 1.4 ML/d. These rates are of similar magnitude to current and recent dewatering rates.

A detailed account of the predictive modelling results is presented in Appendix C.

4.6 RECOVERY MODELLING – POST-MINING IMPACTS

The post-mining recovery of groundwater levels was modelled by a transient model run for 100 years after completion of mining in Project Year 11. Aquifer parameter values for the mined out and backfilled open cut areas were modified to values appropriate for either waste backfill or voids.

Although the pit voids will continue to be backfilled by deposition of washery rejects from the CHPP, this ongoing activity is outside the scope of this study. Therefore, for the post-mining recovery, it was assumed that the final voids would remain intact through the 100 year recovery period. The residual pit voids were represented in the model by high permeability values (Kh = Kv = 1000 m/d) and a high storage value (unconfined Sy = 0.99). Evaporation from the pit void lakes was assumed to be 50% of the pan evaporation rate, and recharge assumed to occur at 100% of the average annual rainfall rate.

The recovery model run showed that groundwater levels in all model layers are predicted to recover to levels higher than current (2007-2008) levels. This result is due to the fact that after completion of mining at Abel (some years after completion of Bloomfield) the groundwater levels will recover not just from the impacts of mining during the period modelled in this study (2007 to 2017), but also from the significant effects of past mining as well.

The recovery modelling shows that virtual full recovery of groundwater levels over the entire model area will occur within 60 years of completion of mining at Bloomfield, but on the Bloomfield lease area itself, recovery will be substantially completed within just 20-30 years, and to groundwater levels higher than at present. Post-mining groundwater levels are predicted to stabilise at around 18-35 mAHD within the Bloomfield mine area, compared with maximum 2006 levels around 25 mAHD predicted by the steady-state calibration model.

4.7 POTENTIAL IMPACTS ON SURFICIAL GROUNDWATER

Plots of drawdown at the completion of Bloomfield mining are presented in Appendix D of the modelling report (Appendix C). These plots present the decline in groundwater levels after completion of Mining Year 11, relative to the model-predicted levels at 2006.

The plot for the surficial aquifer Layer 1 (alluvium and regolith layer) shows a very limited area of drawdown at the location of the final S Cut pit void, and a more extensive area of groundwater recovery or draw-up (compared with 2006 levels) near the southwestern corner of the Bloomfield lease, and extending beyond the lease boundary for a maximum distance of approximately 500m. Groundwater levels were already depressed in the vicinity of the S Cut pit in 2007, due to many years of dewatering pumping from the S Cut sump area (shown on Figure 3). A much larger area of drawdown impact is predicted for the Abel project area to the south-east of Bloomfield.

Drawdowns from the Bloomfield mining were predicted to reach a maximum at Year 7, at which time mining from the southern end of S Cut is scheduled to cease, and groundwater levels would start to recover. Drawdown contours for Layer 1 at the end of Year 7 are shown on Figure 21. It is seen that drawdown of 1m or more is predicted to extend approximately 1km to the west to the edge of alluvium associated with Buttai Creek. The potential for impacts on groundwater storage in the alluvium will be monitored at shallow piezometers at Sites 1 and 8 (Figure 21).

Predicted drawdowns in Layer 1 further south from Site 8 (Figure 21) are influenced more by the Abel project than Bloomfield.

Hydrographs for the Bloomfield monitoring bores show that within a year or two of completion of mining, groundwater levels in the surficial aquifer will recover to above the model-predicted 2006 levels. The recovery model run shows that ultimately groundwater levels will stabilise at levels well above the 2006 levels.

The predicted drawdown impacts on the surficial aquifer are not expected to have any adverse impact on groundwater dependent ecosystems, firstly because the groundwater levels are already well below ground surface, and secondly because the groundwater in the surficial aquifer is saline (as discussed in Section 3.6).

4.8 POTENTIAL IMPACTS ON WALLIS CREEK AND BUTTAI CREEK

The combined effects of Bloomfield, Donaldson and Abel are predicted to have small impacts on stream baseflows. The regional drawdown impacts from the three projects are predicted to mutually interact, and it is therefore not possible to totally isolate the effects of Bloomfield from the combined impact in all cases. However, due to proximity, the Wallis Creek and Buttai Creek baseflows will be more sensitive to Bloomfield than either Donaldson or Abel.

The model results show that there will be only minimal reduction in baseflows to Wallis Creek and Buttai Creek as a result of completion of mining at Bloomfield. The maximum baseflow reduction in Wallis Creek is predicted to be 19 kL/d (0.2 L/s), which equates to only 2% of the current modelled baseflow of 923 kL/d (Table 10). A much smaller baseflow reduction is predicted for Buttai Creek, reaching a maximum of just 5.1 kL/d (0.06 L/s) in Year 8, or 35% of the current model-predicted baseflow. Nil baseflow impact is predicted for all the smaller tributary streams.

Monitoring of baseflow impacts at Buttai Creek is considered impractical, firstly due to the buffering effect of the wetlands on flow measurement, and secondly because a reduction of 5 kL/d would be too small to detect. It is recommended that baseflow impacts in Buttai Creek and Wallis Creek are assessed by reference to the groundwater model predictions, in conjunction with groundwater level monitoring at Sites 1 and 8. Drawdown impacts significantly greater than those predicted by the groundwater modelling (Figure 21) should trigger an investigation by an approved hydrogeologist, and if necessary a re-run of the groundwater model to determine possible baseflow impact.

Like groundwater levels, the recovery modelling also predicted that baseflows in Wallis Creek and Buttai Creek would recover to higher than current levels. Rapid recovery is predicted to occur in both streams in the first 20 years post-mining, and baseflows would be fully stabilised at above 2006 levels within 60 years after completion of mining at Bloomfield.

4.9 POTENTIAL IMPACTS ON GROUNDWATER QUALITY

The groundwater in the project vicinity is saline (Section 3.6), and of negligible beneficial use value. No adverse impacts on groundwater quality are expected as a result of the completion of mining and rehabilitation at Bloomfield.

Longer-term, it is possible that some local improvement in groundwater quality may occur due to increased rates of recharge into former pit areas that have been backfilled with waste. If evaporation from any water bodies that form in the residual pit voids exceeds recharge from direct rainfall, the voids could become groundwater sinks. The balance between recharge and evaporation will depend on the relative sizes of the water surfaces (evaporation) and the void catchment areas (recharge). This balance will be dependent on the rate of ongoing deposition of washery rejects after completion of the Bloomfield project, which is outside the scope of this study.

4.10 POTENTIAL IMPACTS OF TAILINGS AND COARSE REJECTS DISPOSAL

It is proposed that washery tailings and coarse rejects from the CHPP will continue to be deposited into abandoned open cuts on the Bloomfield project site. This will in time include the final pit voids remaining at the completion of Bloomfield mining and rehabilitation.

Water draining from the tailings deposited into the open cuts is currently making its way through old voids and directly through the coal seams into the former underground workings in the Big Ben Seam, from where it is recovered by pumping from the “Big Ben Borehole” (Figure 12) and transferred into the water supply circuit for re-use in the washery. The tailings disposal has caused the development of a slight mound near the northern part of the Bloomfield lease (Figure 12) and recovery from the Big Ben Bore has, in conjunction with pit dewatering, led to the formation of a pronounced cone of depression near the central southern part of the lease (Figure 12). This pattern is expected to continue until completion of mining at Bloomfield.

After mining has ceased at Bloomfield, the CHPP will continue to operate, and tailings/rejects disposal to the former open cuts will continue, and water will continue to be recycled from the tailings by recovery from the Big Ben Bore or by other means. Consequently, it is expected that the current pattern of a small groundwater mound or mounds (in disposal areas) and small depression (around water recovery areas) will continue. The depth of the cone of depression is expected to diminish over time, due to the cessation of dewatering pumping from the open cuts, other than for recycling of washery tailings water.

The rate of operation of the CHPP, and therefore the rate of backfilling of final voids, tailings and rejects disposal and water recovery, is outside the scope of this study. However, the pattern of behaviour described above is considered likely to apply.

SECTION 5 - MONITORING AND MANAGEMENT RECOMMENDATIONS

It is recommended that the monitoring program currently operating at the Bloomfield mine be continued. It should also be integrated with the surface water monitoring program.

The groundwater monitoring program would include:

- Three-monthly measurement of water levels in all piezometers;
- Six-monthly sampling of all standpipe piezometers, for laboratory analysis of electrical conductivity (EC), total dissolved solids (TDS) and pH;
- Annual collection of water samples from all standpipe piezometers for laboratory analysis of a broader suite of parameters:
    - Physical properties (EC, TDS and pH);
    - Major cations and anions;
    - Nutrients; and
    - Dissolved metals,
- Monthly measurement of the volume of mine water pumped from the open cuts, and from the former underground workings. Separate inflow rates should be monitored if two or more separate mining areas are active at any time; and
- Monthly measurement on site of the EC and pH of the mine water pumped from the open cuts.

It is also recommended that the following response plan be implemented in the event of significant unforeseen variances from the predicted inflow rates and/or groundwater level impacts:

- Additional sampling and/or water level measurements to confirm the variance from expected behaviour; and
- Immediate referral to a qualified hydrogeologist for assessment of the significance of the variance from expected behaviour. The review hydrogeologist would be requested to recommend an appropriate remedial action plan or amendment to the mining or water management approach. If appropriate, this recommended action plan would be discussed with DWE and other agencies for endorsement.

SECTION 6 - CONCLUSIONS

The groundwater investigations carried out for the Bloomfield Part 3A Proposal have led to the following principal conclusions:

- Groundwater is present in most lithologies in the area, but significant permeability is generally only present in association with cleat fracturing in the principal coal seams in the Permian coal measures. Lesser permeability may be present locally in interburden siltstones, mudstones and sandstones, and in the surficial alluvium / colluvium;
- Groundwater quality is variable, with salinity ranging from less than 1000 mg/L to more than 13000 mg/L total dissolved solids (TDS). pH is generally close to neutral;
- Groundwater levels in the Permian coal measures generally fall to the east and west from a central ridge coinciding approximately with the axis of the Four Mile Creek Anticline. Water levels range from around 35 mAHD near the central northern end of the project area to around 10-15 mAHD along the eastern boundary, and around 15-20 mAHD at the north-western corner. The groundwater levels in the Permian coal measures are unrelated to the local topography, and are frequently artesian (ie above ground level) in low-lying areas;
- Surficial groundwater levels in the alluvium / colluvium, probably including the thin upper highly weathered zone of the Permian coal measures, are strongly controlled by the local topography, and appear to be unrelated to the groundwater in the underlying less weathered Permian coal measures. Thus the surficial groundwater water levels are above the Permian groundwater levels in elevated locations and below the Permian levels in low-lying areas;
- The dewatering operations at Bloomfield and Donaldson have caused noticeable cones of drawdown in groundwater levels, ranging up to more than 30m (ie to around –15 mAHD) along the southern margin of the Bloomfield open cut. The cone of drawdown has extended only a short distance into the north-western part of the Abel lease area;
- The Bloomfield and Donaldson mine dewatering appears to have had negligible impact on groundwater levels in the alluvium/colluvium, or in the Permian coal measures lithologies that are stratigraphically above the zones that have been directly intersected by the open cut;
- Bloomfield proposes to continue mining at the current average rate (0.8 Mtpa), although mining rate may reach a maximum of 1.3 Mtpa at some stages.
- Dewatering will continue to be required as part of the proposed completion of mining at Bloomfield. The total groundwater inflow rate is predicted to average 1.4 ML/d (500 ML/yr), peaking at 2.1 ML/d (770 ML/yr) in Year 6. These inflow rates are similar to those currently occurring;
- Sensitivity modelling suggests that the maximum inflow rates could be between about 2.0 and 2.3 ML/d;
- Dewatering associated with the completion of mining at Bloomfield is predicted to impact groundwater levels in the strata above the Big Ben. Maximum drawdowns of approximately 40m are predicted in the coal measures near the southern end of the lease, but as the pit retreats to the north in later years, groundwater levels are predicted to recover to above the present (2007-8) levels even before completion of mining at Bloomfield;
- Recovery of groundwater levels after completion of mining have been assessed by 100 years of post-mining simulations. The recovery modelling has predicted that groundwater levels will recover to well

above current levels, and recovery would have stabilised over the Bloomfield lease area within 20-30 years after completion of mining;

- Small impacts on stream baseflows are predicted to occur, with a predicted 2% maximum reduction in groundwater baseflow to Wallis Creek (relative to present baseflow) and a smaller magnitude but larger percentage impact on Buttai Creek baseflows. No other surface streams are predicted to be impacted by the Bloomfield proposal;
- No adverse impacts on surface water quality are expected;
- No existing groundwater supplies are expected to be impacted; and
- No adverse impacts are expected on any groundwater dependent ecosystems (GDEs).

SECTION 7 - GLOSSARY OF TERMS

aquifer	A saturated permeable unit of rock or soil which is able to transmit significant quantities of water under ordinary hydraulic gradients.
aquitard	A saturated unit of rock or soil that is capable of transmitting water to and between aquifers, but is not sufficiently permeable to allow water to flow into a bore a rate that will allow the bore to be pumped at a useful rate.
bedrock	In this report, bedrock refers to the geological unit that underlies the geological units that are active media for the movement of groundwater.
discharge	Groundwater discharge from an aquifer is the loss of water from the aquifer, either by natural processes (such as evapotranspiration, outflow to the ocean or other water body, or to another aquifer) or by artificial means (such as pumped extraction). Under conditions of dynamic equilibrium, the average rate of natural discharge from an aquifer is usually equivalent to the average long-term rate of recharge. See "recharge".
DWE	Department of Water and Energy, formerly known as Department of Natural Resources (DNR), Department of Infrastructure, Planning and Natural Resources (DIPNR) or Department of Land and Water Conservation (DLWC).
drawdown	The lowering of the water level or the potentiometric head in an aquifer due to the removal of water from a nearby bore or excavation.
drain conductance	When the Drain Package has been used in a MODFLOW groundwater model to simulate open mine workings, the drain conductance term (units of m2/d) represents the ease with which water can leak from an aquifer into the mine opening. It is an empirical term usually determined by calibration to field data. In the modelling described in this report, the open cuts and underground longwall panels have been represented by drain cells.
ephemeral	Temporary or seasonal.
groundwater	Water that occurs beneath the water table in rock or soil that is fully saturated.
groundwater modelling	Use of mathematical functions to simulate the flow of water below the ground surface.
groundwater table	See "water table".
head	The head in an aquifer is the height above a reference datum of the surface of a column of water that can be supported by the hydraulic pressure in the aquifer against atmospheric pressure. It equates to the elevation of the water table above the datum, and is the sum of the elevation head, or the elevation of the point of measurement, and the pressure head, or the pressure of the water at that point relative to atmospheric pressure.
hydraulic conductivity (K)	A measure of the ability of a rock or soil to transmit water under a prevailing hydraulic gradient. It has the units of metres/day. In this report, the term is used synonymously with the term "permeability". Hydraulic conductivity is often anisotropic, and the horizontal hydraulic conductivity (Kh) is usually higher than the vertical hydraulic conductivity (Kv).

hydraulic testing	Testing to determine the hydraulic properties (hydraulic conductivity, storativity, etc) of aquifers. Tests used in this study included pumping tests and slug tests.
hydraulic gradient	The change in head per unit distance in a particular direction, usually the direction of maximum change, perpendicular to the groundwater contours (equipotentials).
hydrogeological unit	A unit of rock or soil which has reasonably consistent hydraulic properties of permeability and storage.
hydrograph	A linear plot of water level versus time.
infiltration	Movement of water through the surface of the ground into the saturated or unsaturated zone beneath.
lithology	A term used to describe the physical nature and characteristics of a rock or soil.
MODFLOW	A modular three-dimensional groundwater flow model which was developed by the USGS (McDonald and Harbaugh, 1988).
monitoring piezometer	Bore drilled in a location and constructed specifically to enable the sampling and ongoing measurement of groundwater levels, pressure changes and groundwater quality. It is ideally constructed so as to minimise the potential for contamination or interference from external influences, and to enable accurate and reliable sampling and hydraulic measurements from a specific aquifer or zone within an aquifer.
permeability	The permeability of a rock or soil is a measure of the ease with which fluids can flow through it, and is independent of the properties of the fluid. In this report, the term is used synonymously with the term “hydraulic conductivity”.
Permian	Last period of the Paleozoic Era, 280 – 225 million years BP.
porosity	The proportion of a volume of rock or soil that is occupied by voids, or the ratio of the total void space to the total rock or soil volume. For the movement or release of water, only the proportion of porosity that is interconnected is significant, and is referred to as the “effective” porosity, which is often very much less than the total porosity. In a saturated material, the porosity comprises two components – the proportion of porosity that will freely drain under gravity, known as the specific yield, and the proportion that will not drain under gravity, known as the specific retention.
potentiometric surface	An imaginary surface defined by the heads at all points within a particular plane in an aquifer. Where the vertical component of hydraulic gradient is much smaller than the horizontal component, the potentiometric surface can be said to apply to the aquifer as a whole.
pumping test	Test carried out to determine hydraulic properties of the aquifer (hydraulic conductivity, storativity, etc).

recharge	Groundwater recharge is the addition of water to an aquifer, either by direct infiltration at the ground surface, by percolation through an unsaturated zone, or by inflow of discharge from another aquifer.
runoff	The portion of rainfall precipitation which collects on the surface and flows to surface streams.
saturated zone	That part of a soil or rock in which all the interconnected voids are filled with water under pressure equal to or greater than atmospheric pressure. The top of the saturated zone is defined by the surface at which the water pressure is equal to atmospheric pressure. [Parts of the saturated zone may be temporarily unsaturated due to air entrapment; likewise, in parts of the "unsaturated zone" the voids may be all filled with water, but at less than atmospheric pressure.]
slug test	A type of permeability test conducted by introducing to (or removing from) a bore, a known volume of water and monitoring the progressive return of the water level in the bore back to its former level.
specific yield	The volume of water that will freely drain under gravity from a unit volume of a saturated soil or rock per unit change in head.
storage coefficient	The volume of water that will drain freely from a unit volume of saturated soil or rock per unit change in head, by means of elastic compression of the aquifer fabric and decompression of the water.
storativity	A general term for both specific yield (gravity storage term) and storage coefficient (elastic storage term).
transmissivity	The rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient. It is equal to the product of the average hydraulic conductivity and the saturated thickness of the aquifer. It is expressed in units of metres2/day.
water table	The surface within an unconfined aquifer at which the water pressure is equal to atmospheric pressure. It is defined by the level to which water would rise in a bore which just penetrates the top of the aquifer.

SECTION 8 - REFERENCES

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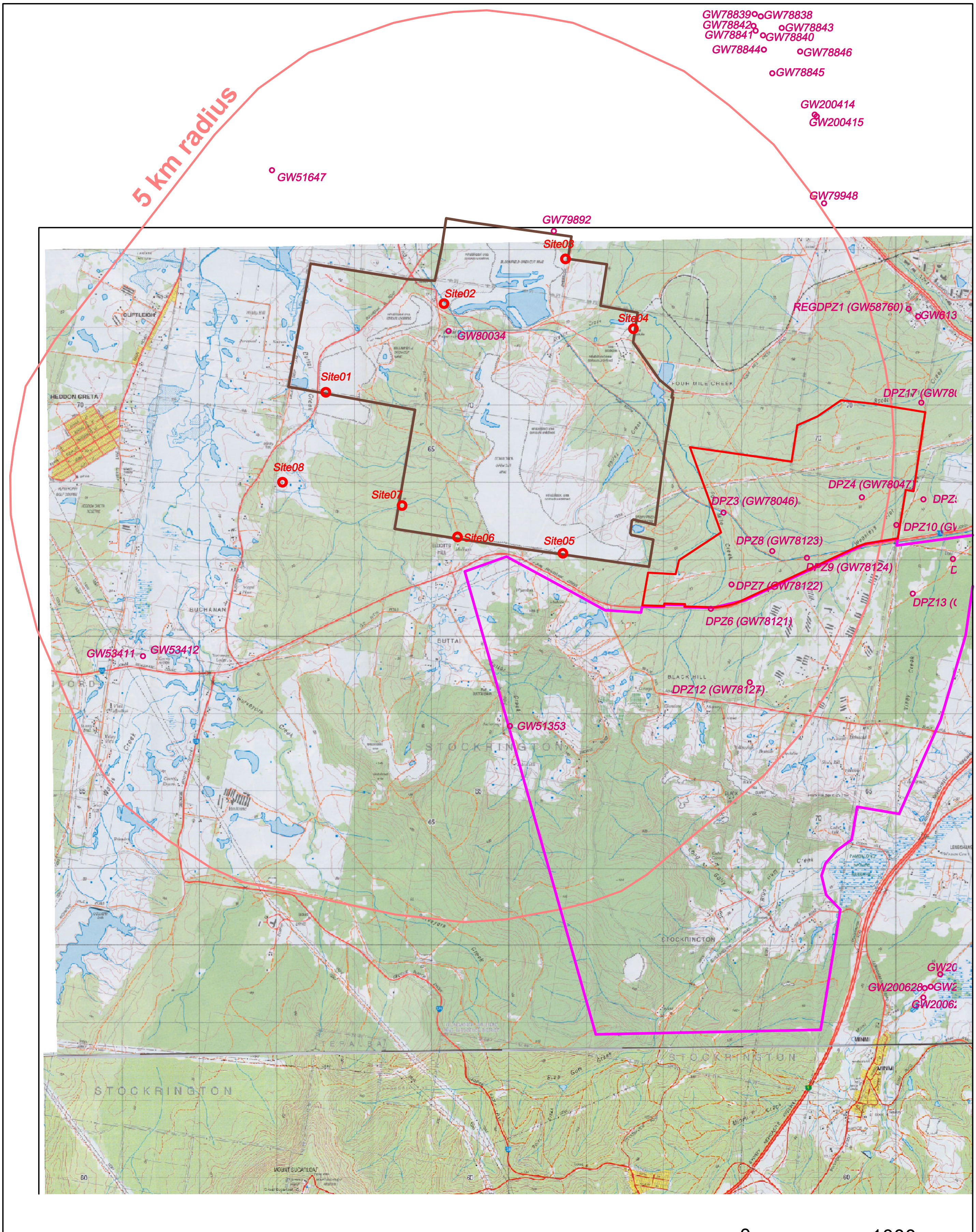
FIGURES

FIGURE 1

LOCALITY PLAN

BLOOMFIELD COLLIERY
COMPLETION OF MINING AND REHABILITATION

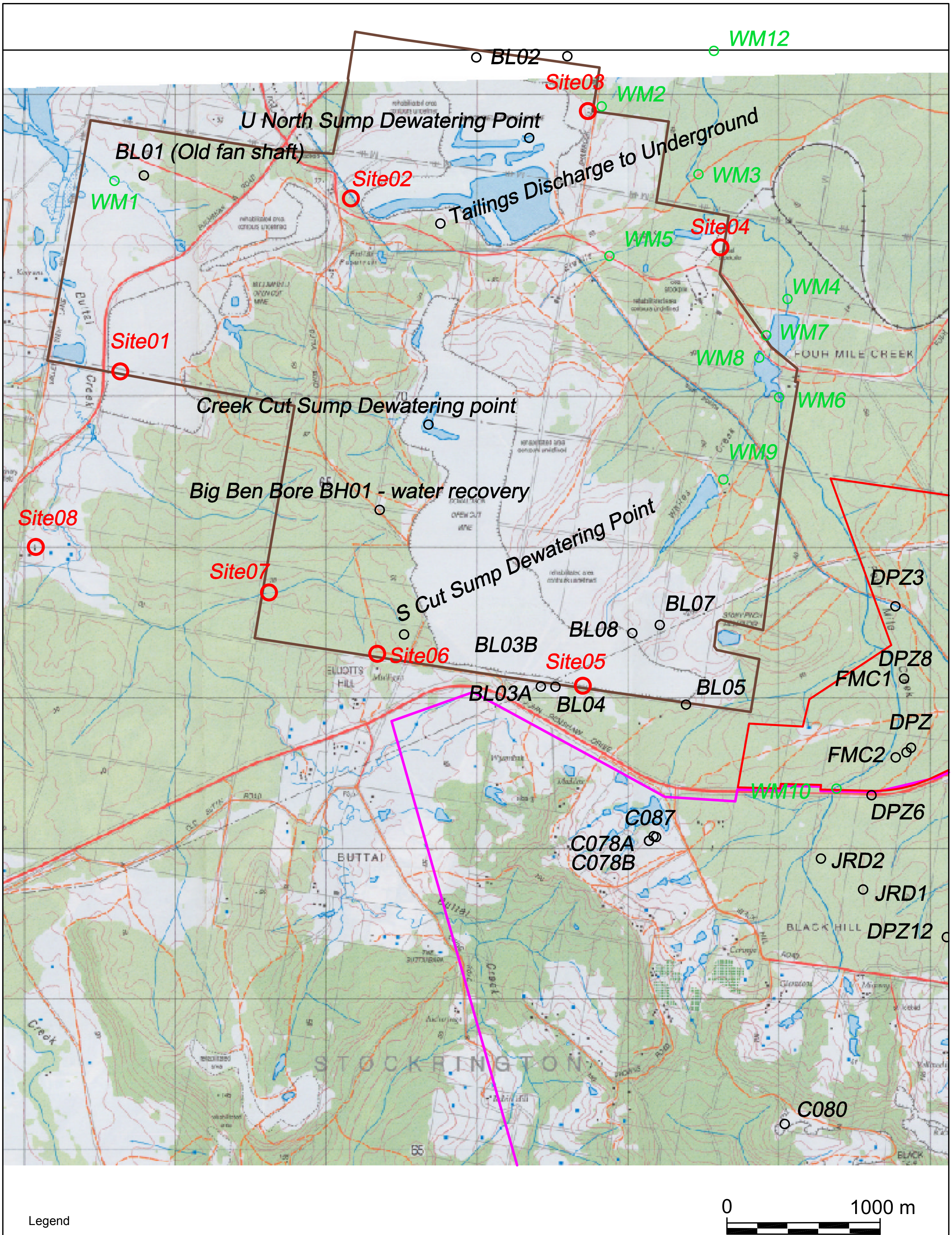
SEPTEMBER 2008



Legend

Bloomfield Project
Donaldson Project
Abel Project
GW78045 DWE Registered Bore
Site 01 Bloomfield piezometer location

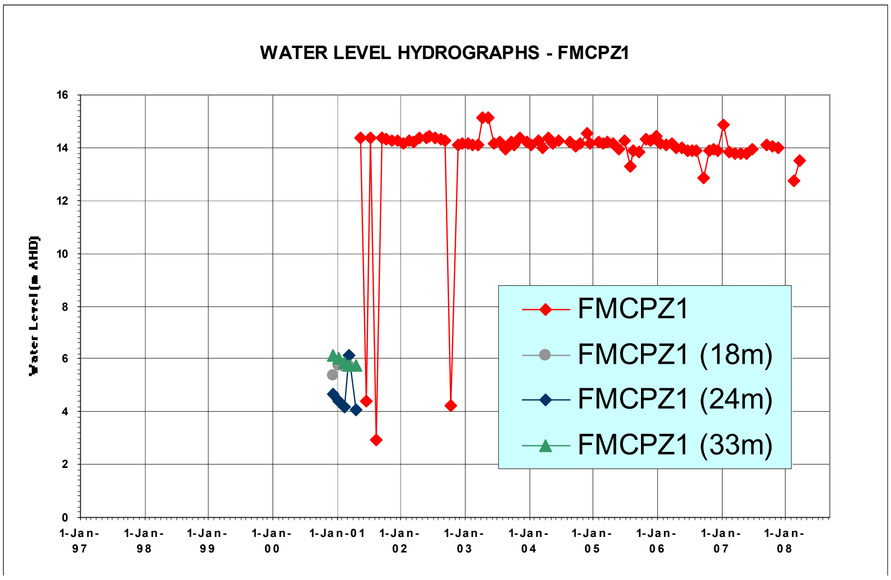
Date: 6 June 2008	Scale: as shown	**Bloomfield Collieries Pty Ltd**
Initials: PJD	Job No: S05	**COMPLETION OF MINING AND REHABILITATION DWE REGISTERED BORES**
Drawing No: S05-002	Rev: 0	
Aquaterra Consulting Pty Limited		**Figure 2**

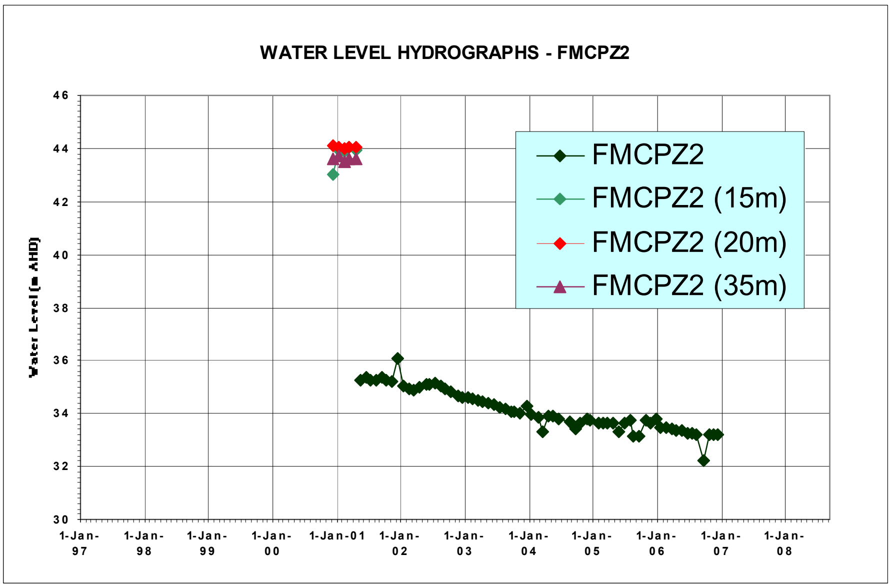


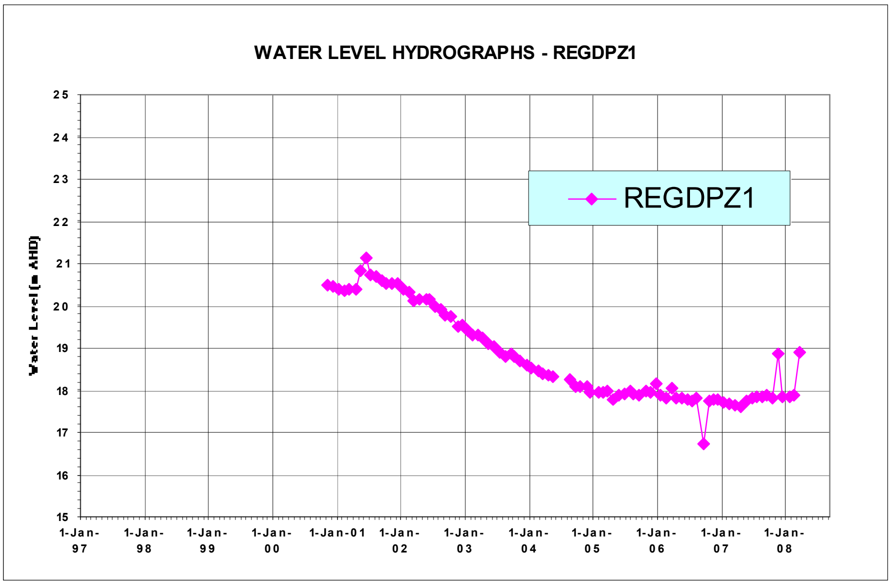
Legend

- Bloomfield Project
- Donaldson Project
- Abel Project
- WM11 Bloomfield surface water monitoring point
- BL02 Bloomfield borehole/piezometer
- DPZ13 Donaldson piezometer
- C063 Abel piezometer

Date: 6 June 2008	Scale: as shown	**Bloomfield Collieries Pty Ltd**
Initials: PJD	Job No: S05	**COMPLETION OF MINING AND REHABILITATION BORE LOCATION PLAN**
Drawing No: S05-003	Rev: 0	
Aquaterra Consulting Pty Limited		**Figure 3**

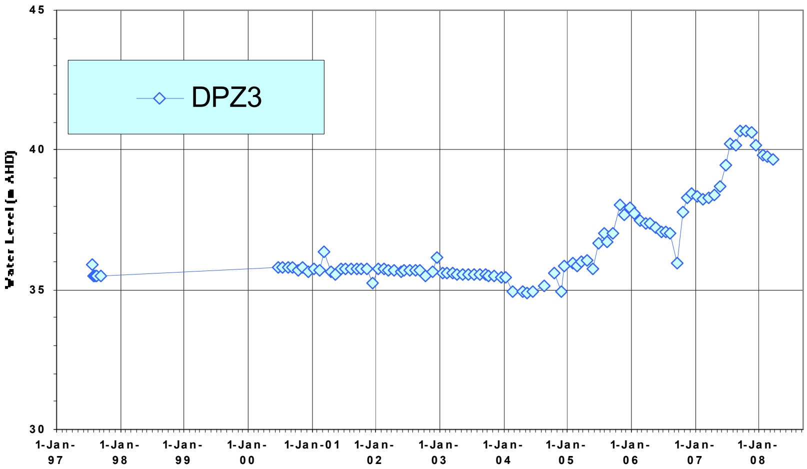




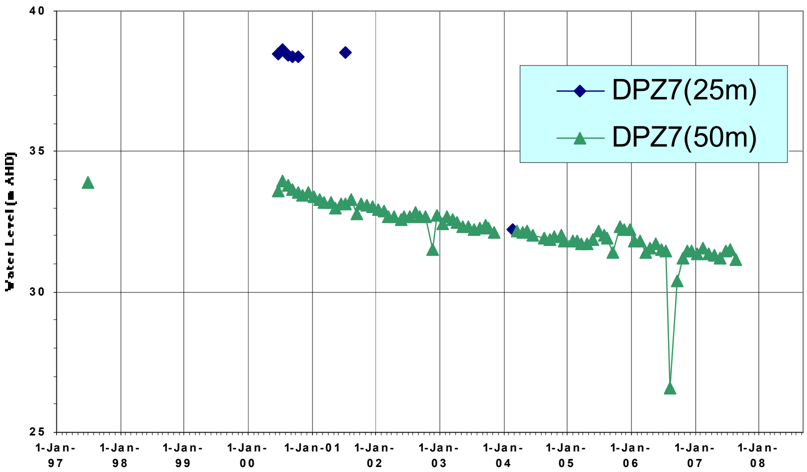


Date: 1 May 2008	Scale: as indicated	**Bloomfield Collieries Pty Ltd**
Initials: PJD	Job No: S05-B1	**COMPLETION OF MINING & REHABILITATION REGIONAL PIEZOMETER HYDROGRAPHS - DONALDSON PIEZOMETERS**
Drawing No: S05-004	Rev: 0	
Aquaterra Consulting Pty Limited		**Figure 4**

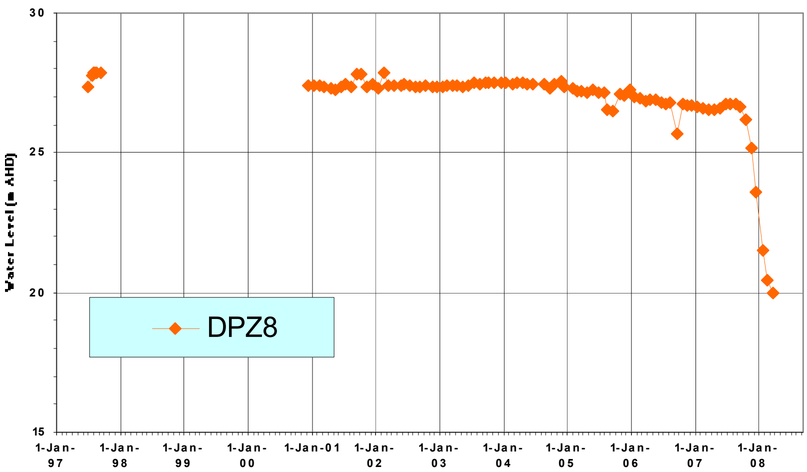
WATER LEVEL HYDROGRAPHS - DPZ3



WATER LEVEL HYDROGRAPHS - DPZ7

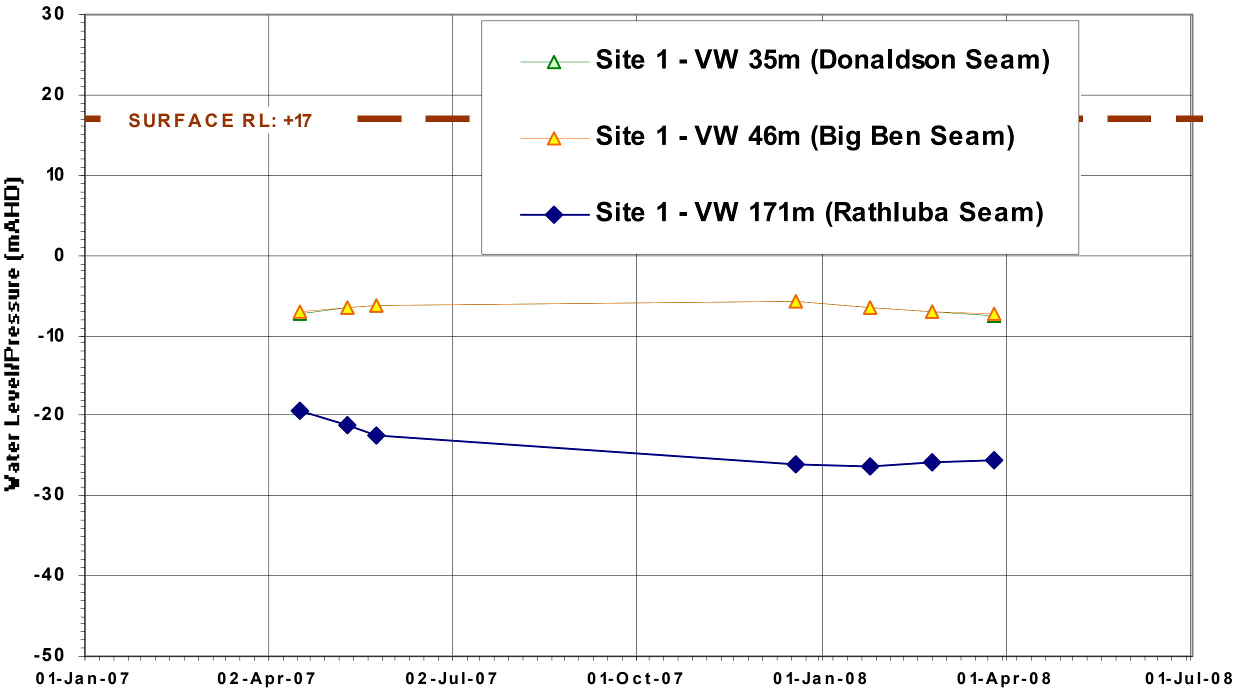


WATER LEVEL HYDROGRAPHS - DPZ8

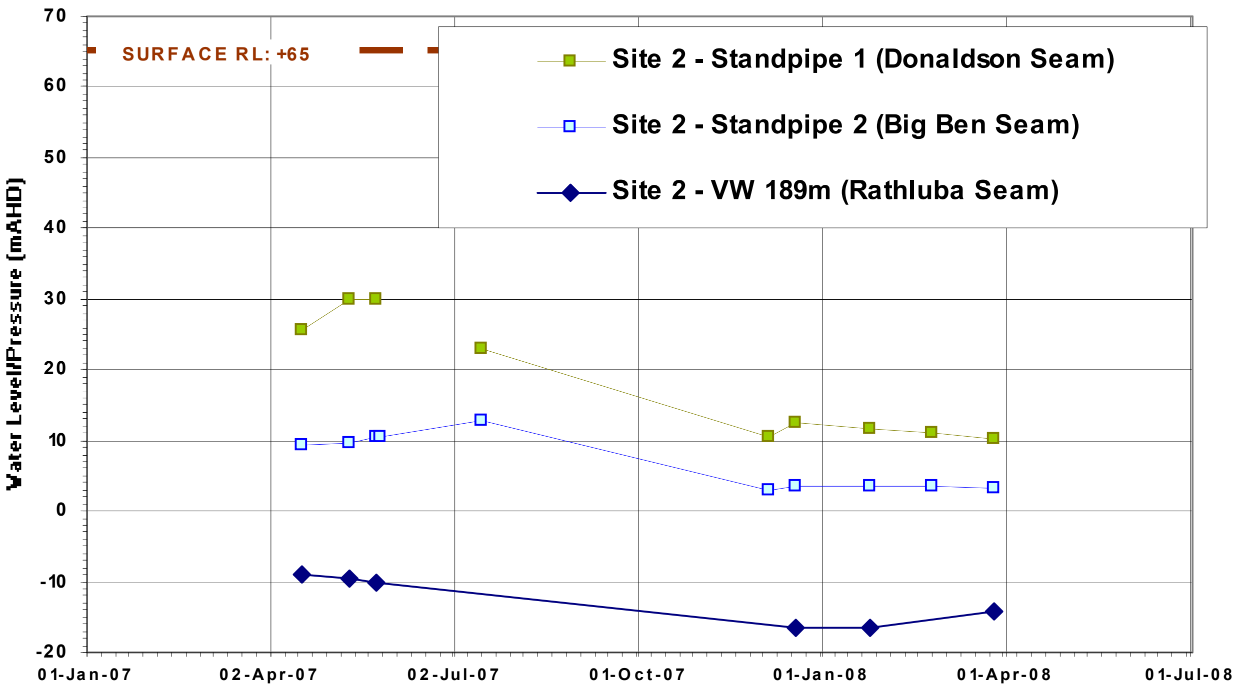


Date: 1 May 2008	Scale: as indicated	**Bloomfield Collieries Pty Ltd**
Initials: PJD	Job No: S05	**COMPLETION OF MINING & REHABILITATION REGIONAL PIEZOMETER HYDROGRAPHS - DONALDSON PIEZOMETERS**
Drawing No: S05-005	Rev: A	
Aquaterra Consulting Pty Limited		**Figure 5**

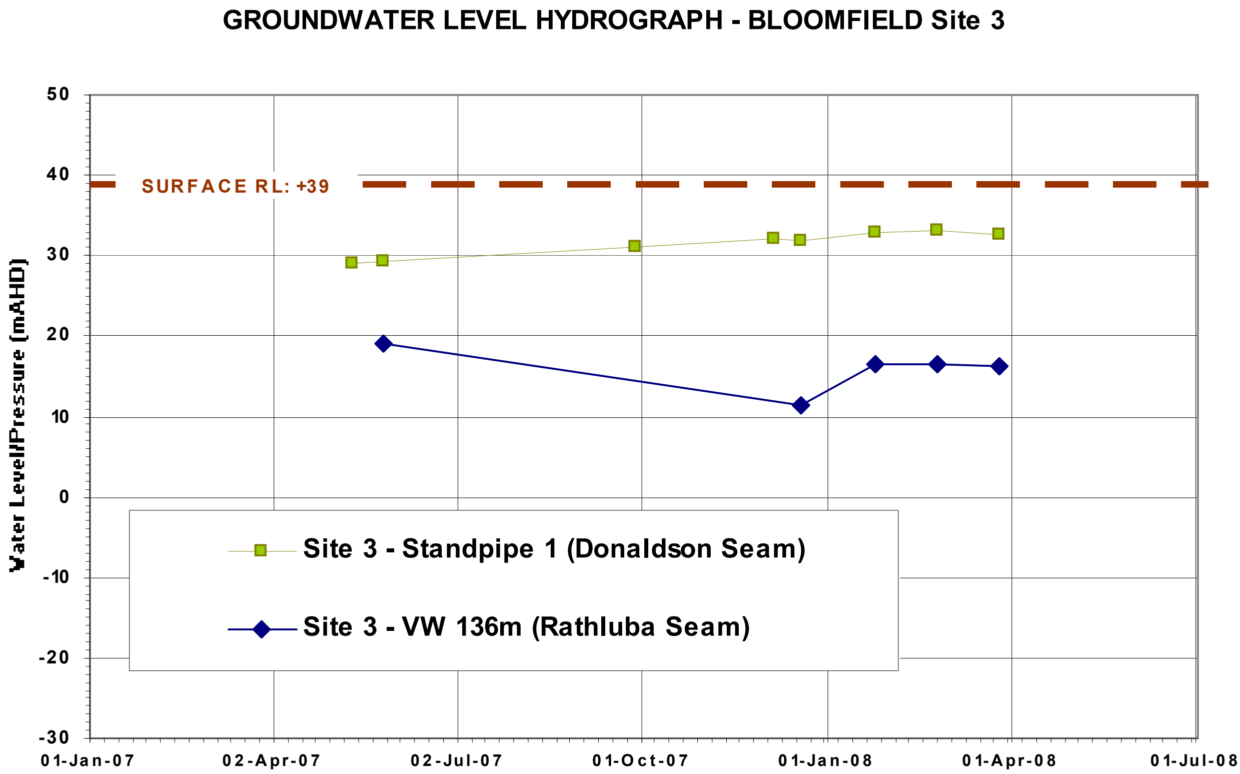
GROUNDWATER LEVEL HYDROGRAPH - BLOOMFIELD Site 1

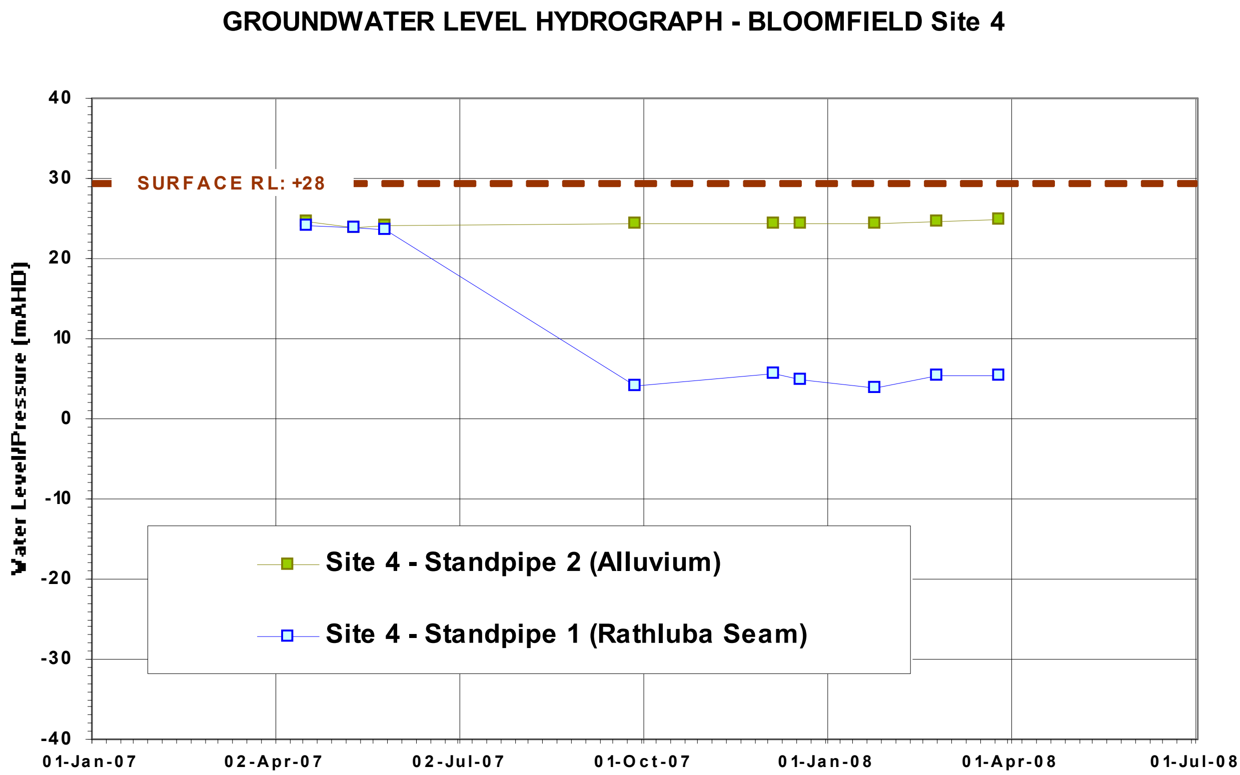


GROUNDWATER LEVEL HYDROGRAPH - BLOOMFIELD Site 2

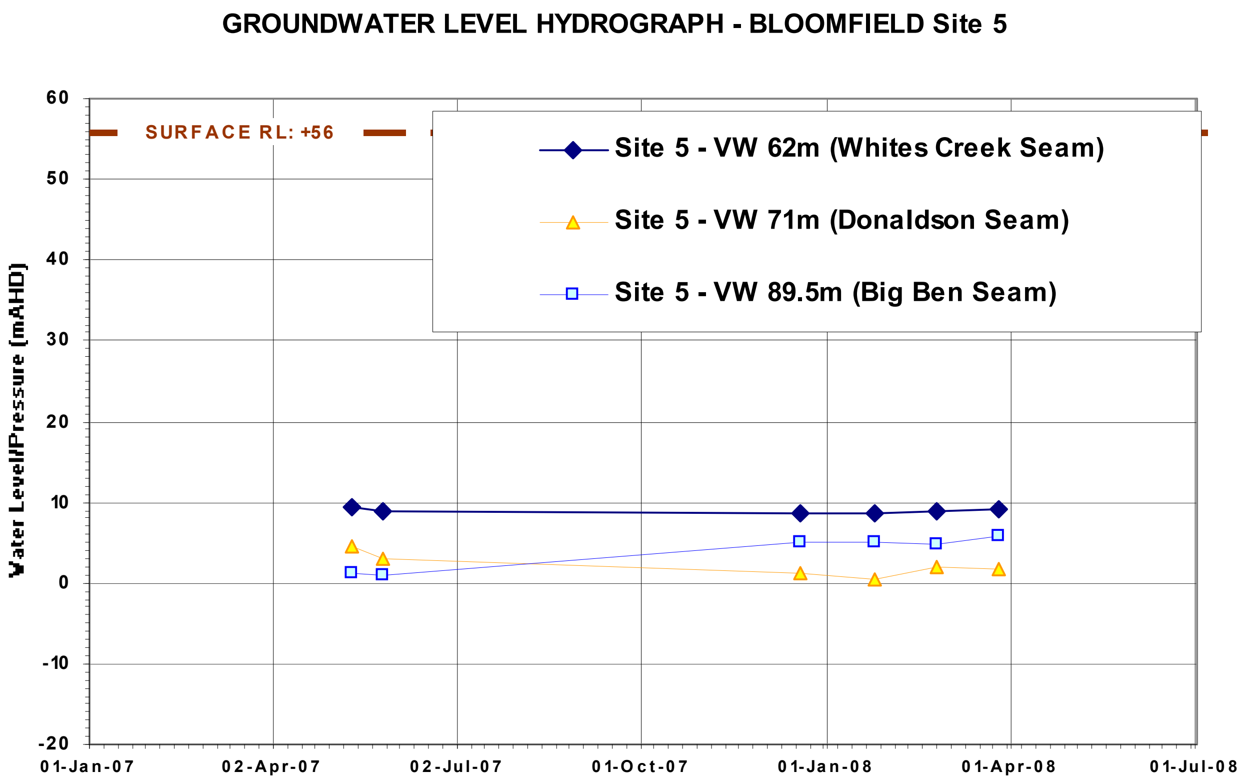


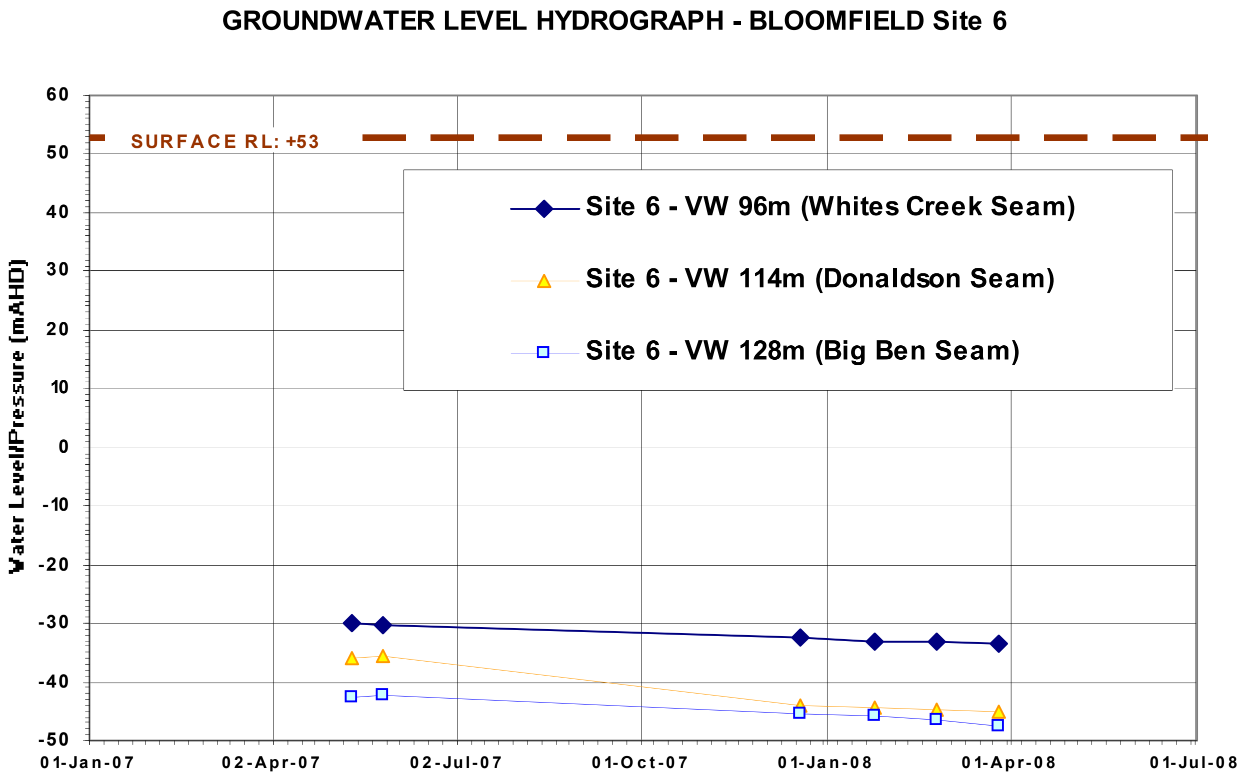
Date:	1 May 2008	Scale:	as indicated	**Bloomfield Collieries Pty Ltd**
Initials:	PJD	Job No:	S05	**COMPLETION OF MINING & REHABILITATION BLOOMFIELD PIEZOMETER HYDROGRAPHS - SITE 1 and SITE 2**
Drawing No:	S05-006	Rev:	A	
Aquaterra Consulting Pty Limited				**Figure 6**





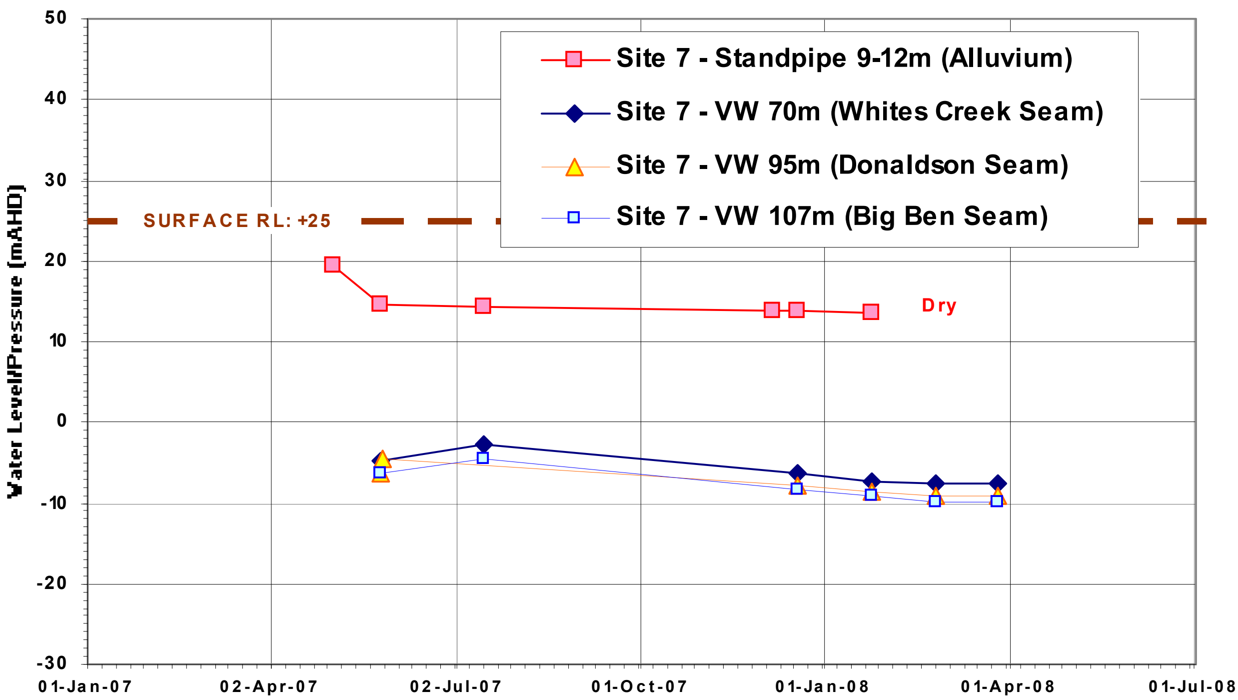
Date: 1 May 2008	Scale: as indicated	**Bloomfield Collieries Pty Ltd**
Initials: PJD	Job No: S05	**COMPLETION OF MINING & REHABILITATION BLOOMFIELD PIEZOMETER HYDROGRAPHS - SITE 3 and SITE 4**
Drawing No: S05-007	Rev: A	
Aquaterra Consulting Pty Limited		**Figure 7**



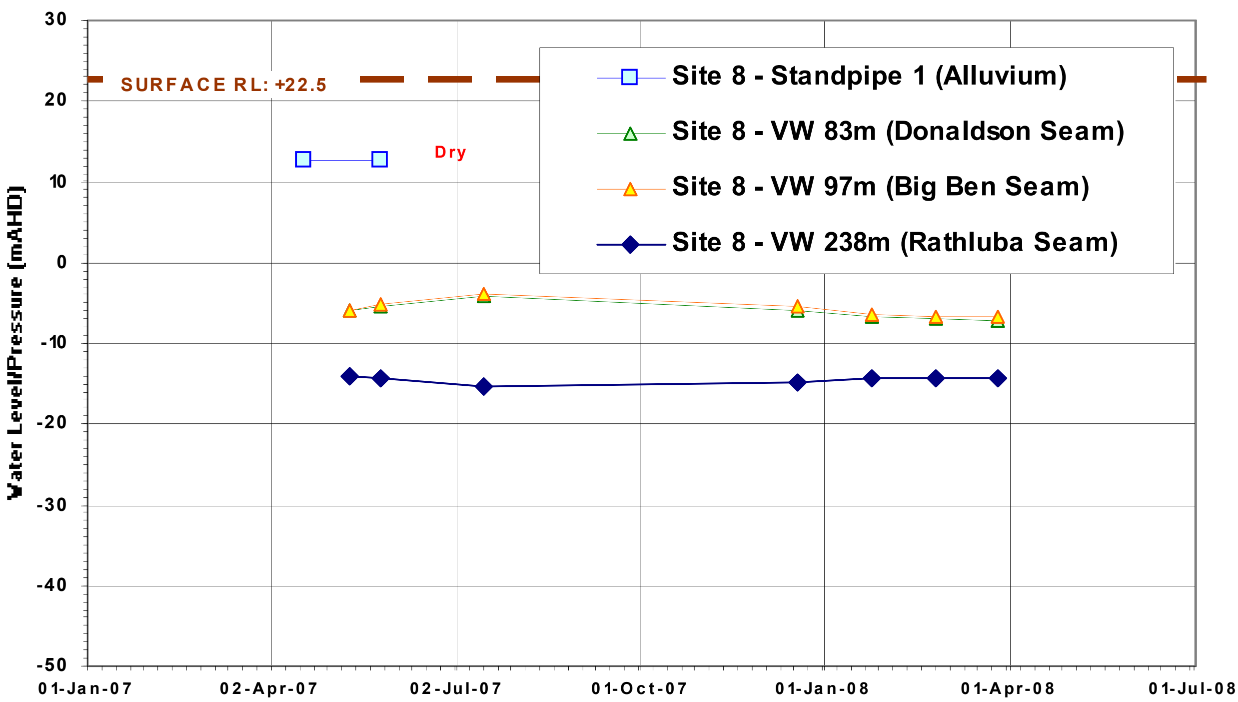


Date: 1 May 2008	Scale: as indicated	**Bloomfield Collieries Pty Ltd**
Initials: PJD	Job No: S05	**COMPLETION OF MINING & REHABILITATION BLOOMFIELD PIEZOMETER HYDROGRAPHS - SITE 5 and SITE 6**
Drawing No: S05-008	Rev: A	
Aquaterra Consulting Pty Limited		**Figure 8**

GROUNDWATER LEVEL HYDROGRAPH - BLOOMFIELD Site 7

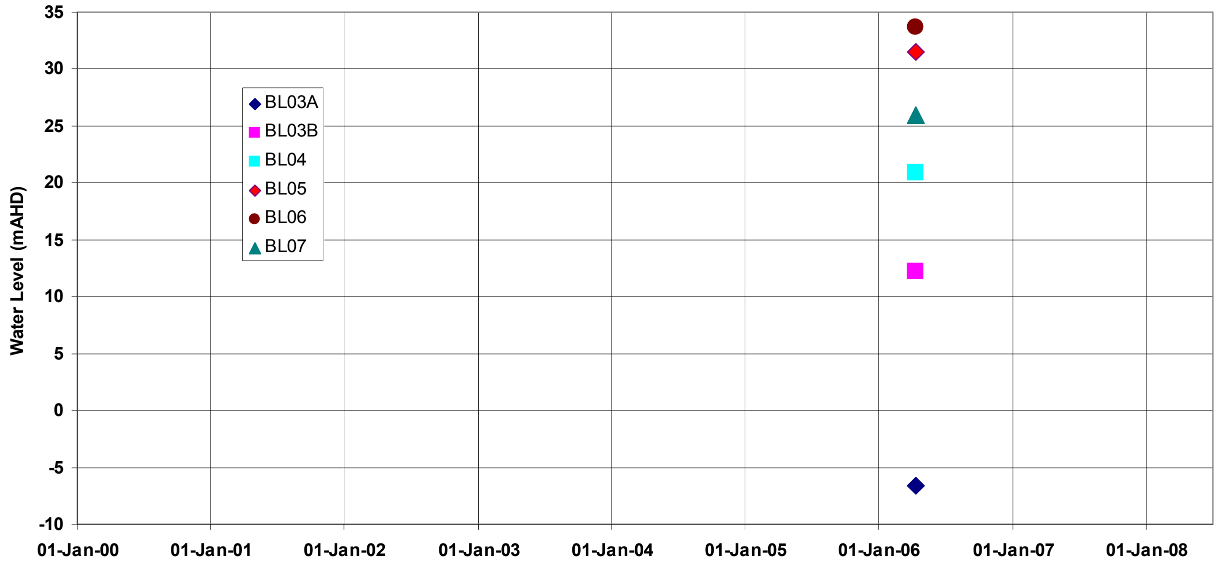


GROUNDWATER LEVEL HYDROGRAPH - BLOOMFIELD Site 8

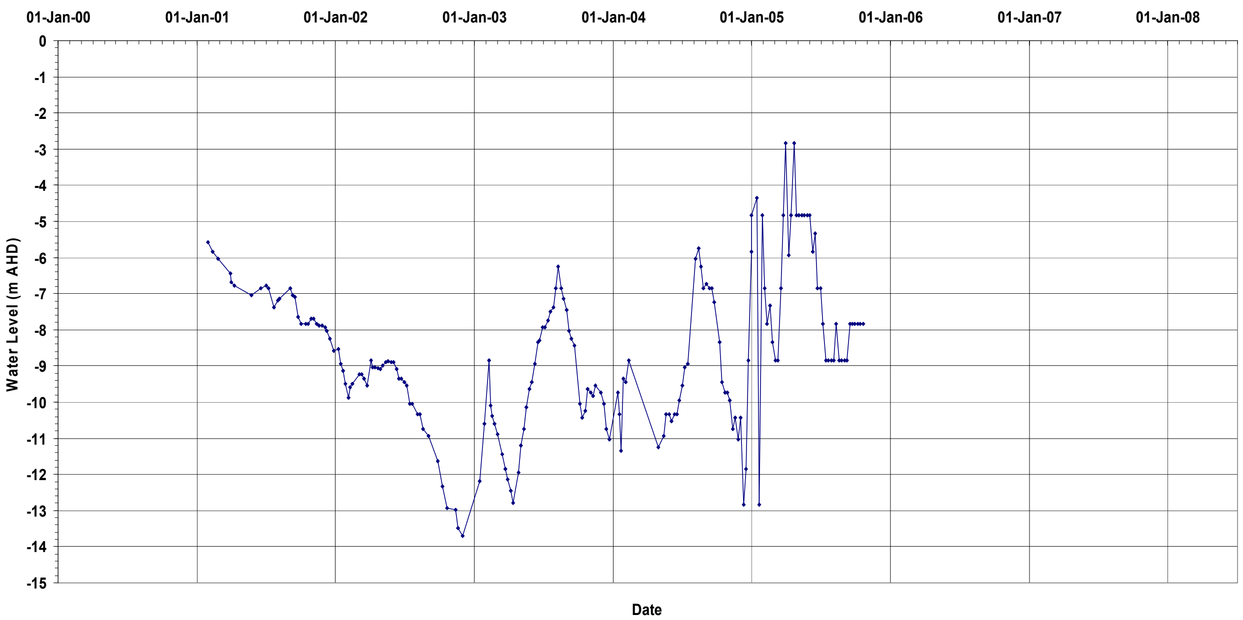


Date: 1 May 2008	Scale: as indicated	**Bloomfield Collieries Pty Ltd**	
Initials: PJD	Job No: S05	**COMPLETION OF MINING & REHABILITATION BLOOMFIELD PIEZOMETER HYDROGRAPHS - SITE 7 and SITE 8**	
Drawing No: S05-009	Rev: A		
Aquaterra Consulting Pty Limited			**Figure 9**

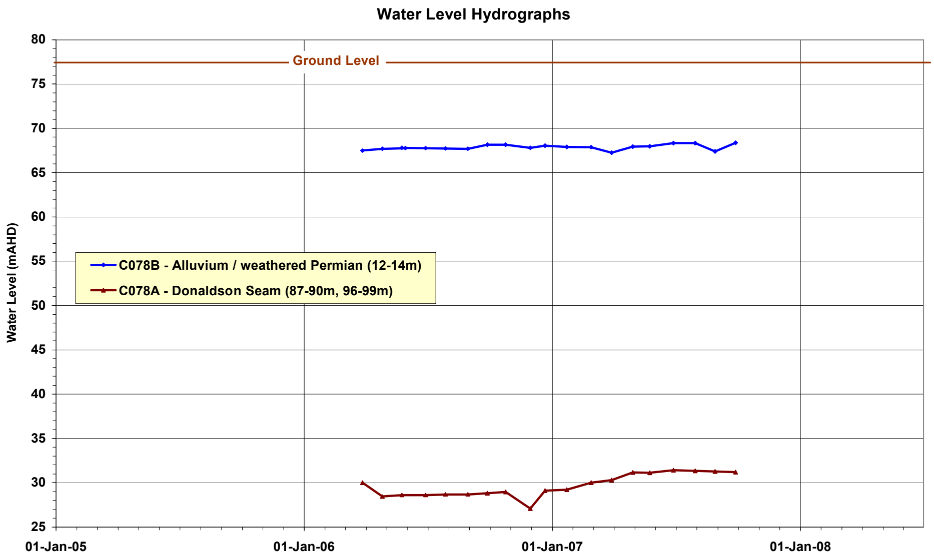
Bore Water Level (mAHD) - Old Bloomfield Bores/Shafts

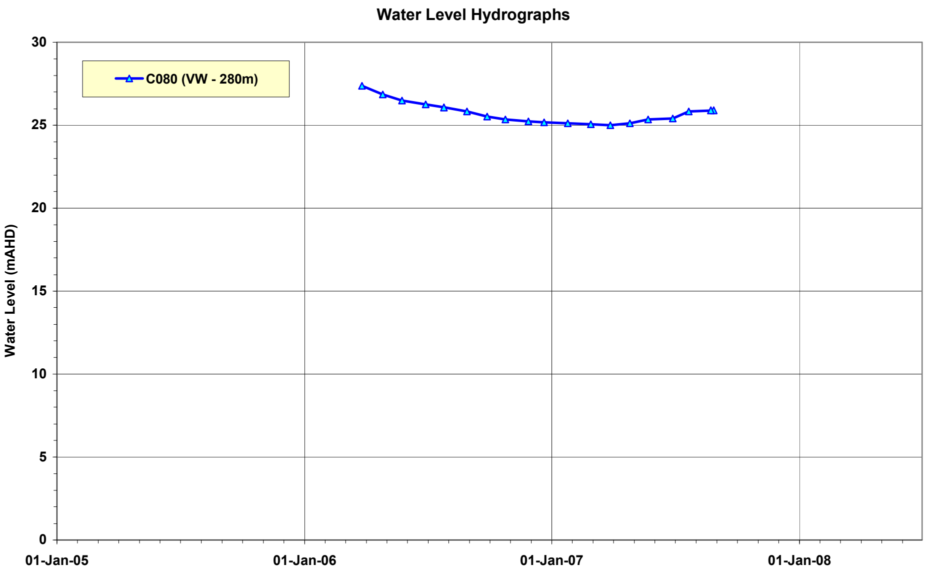


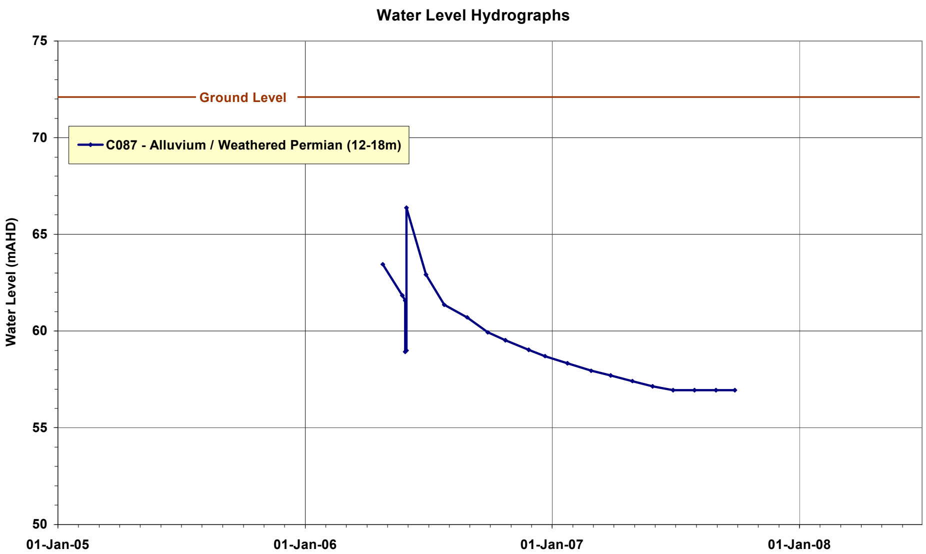
Big Ben Bore - Water Level (m AHD)



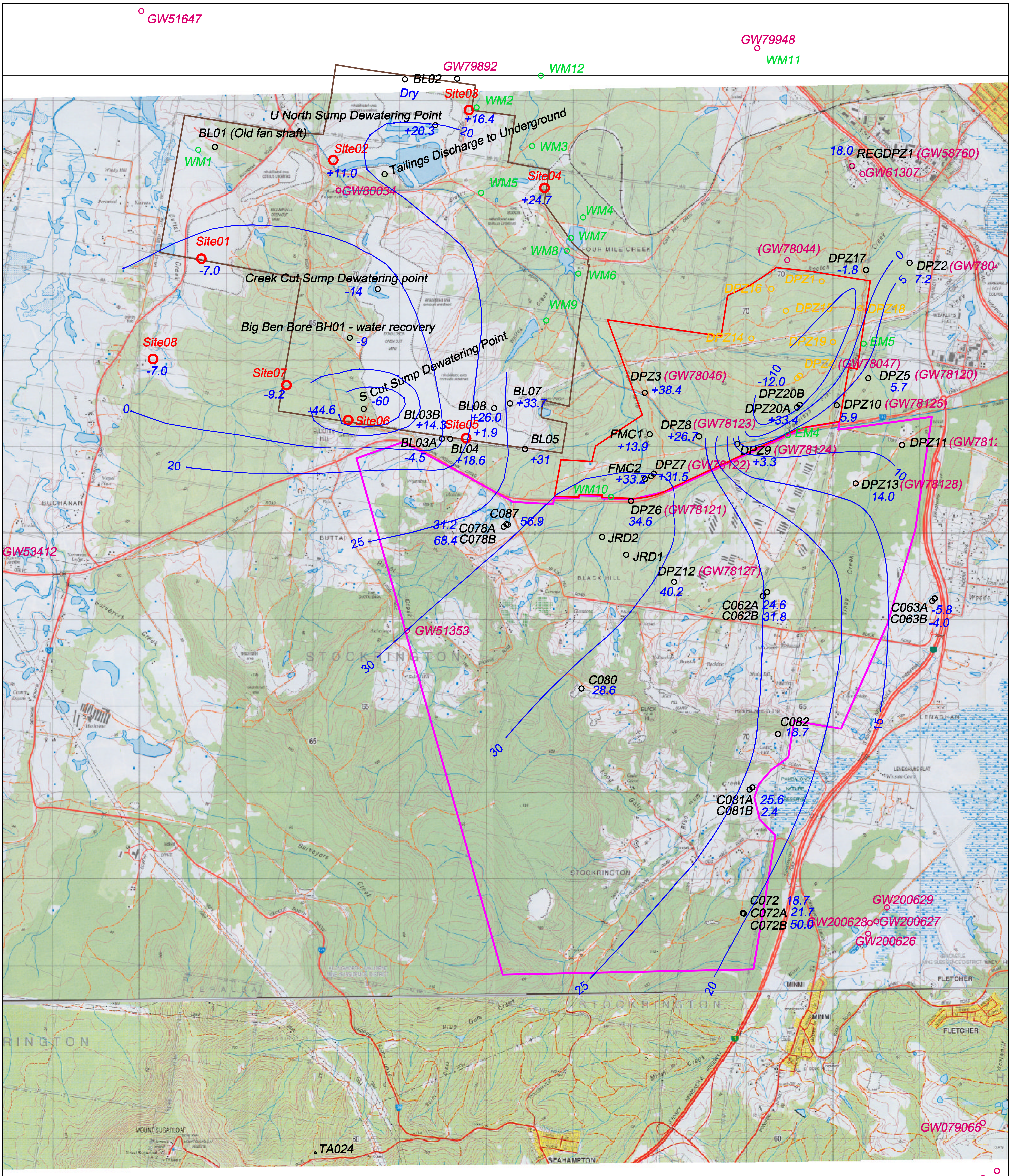
Date: 1 May 2008	Scale: as indicated	**Bloomfield Collieries Pty Ltd**
Initials: PJD	Job No: S05	**COMPLETION OF MINING & REHABILITATION PIEZOMETER HYDROGRAPHS - BL01-BL07 and BIG BEN BORE**
Drawing No: S05-010	Rev: 0	
Aquaterra Consulting Pty Limited		**Figure 10**







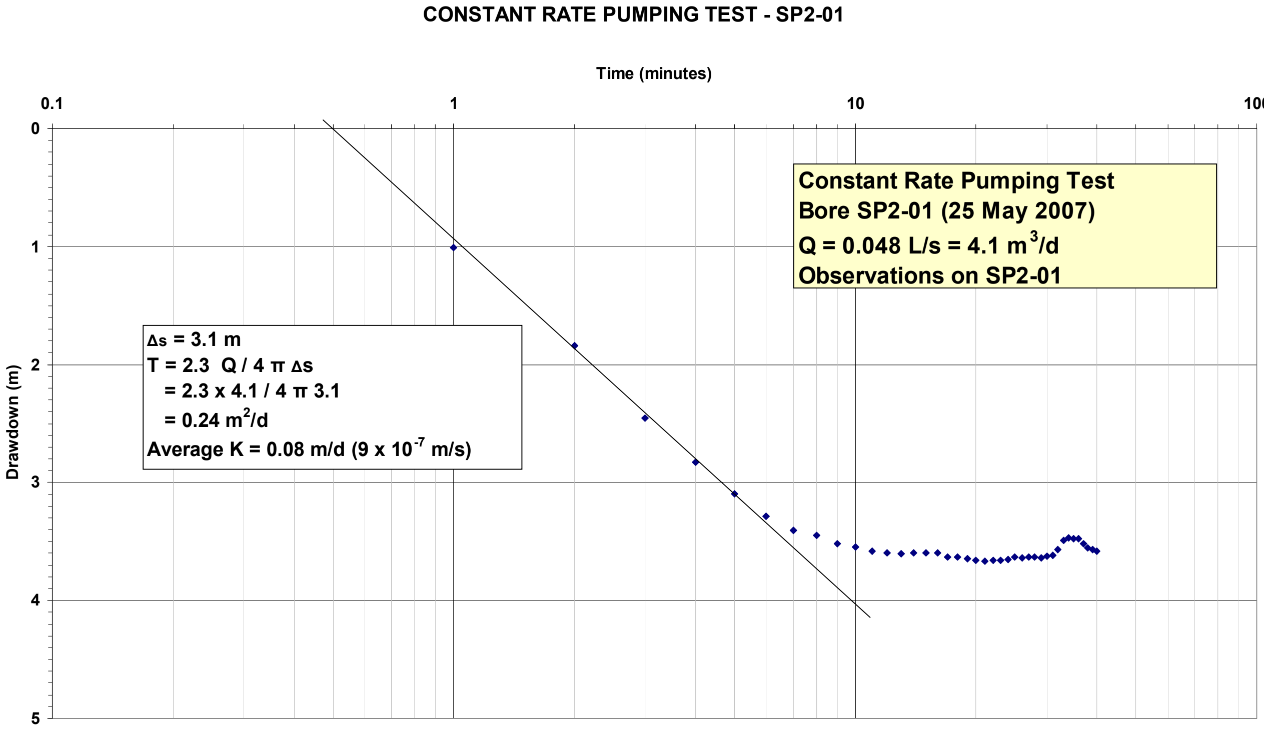
Date: 1 May 2008	Scale: as indicated	**Bloomfield Collieries Pty Ltd**
Initials: PJD	Job No: S05	**COMPLETION OF MINING & REHABILITATION REGIONAL PIEZOMETER HYDROGRAPHS - ABEL PIEZOMETERS**
Drawing No: S05-011	Rev: 0	
Aquaterra Consulting Pty Limited		**Figure 11**

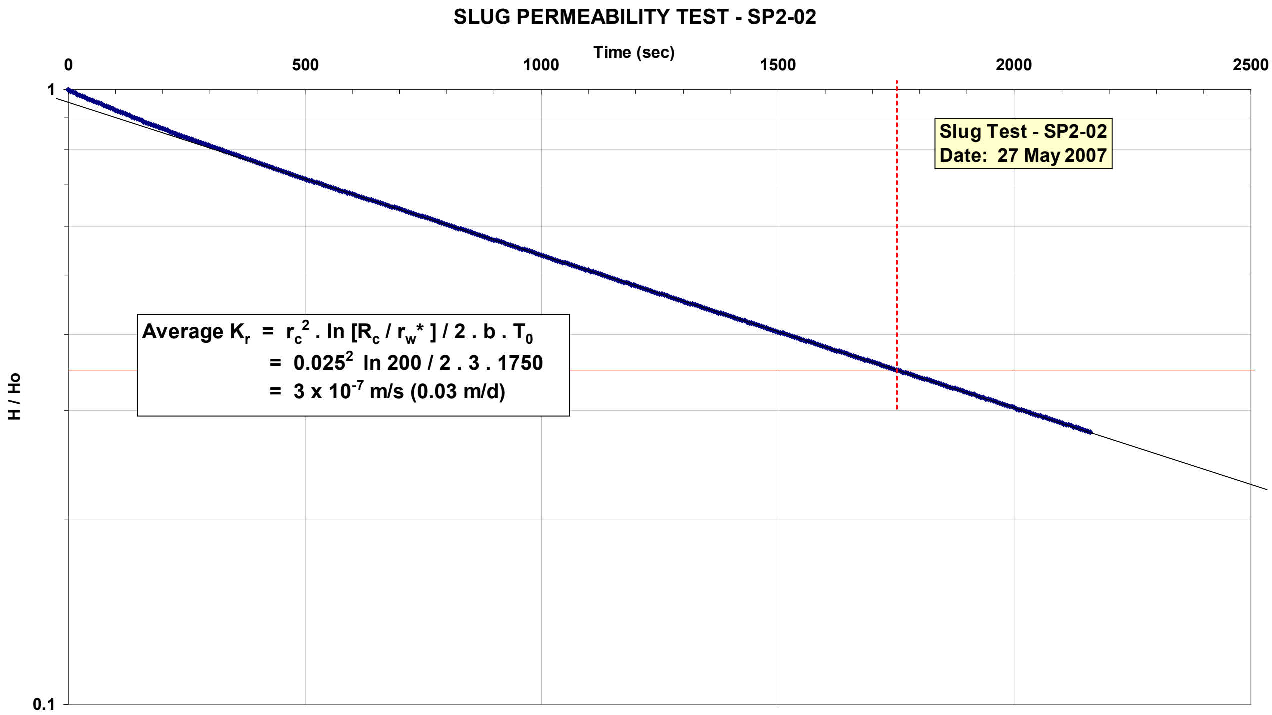


Legend

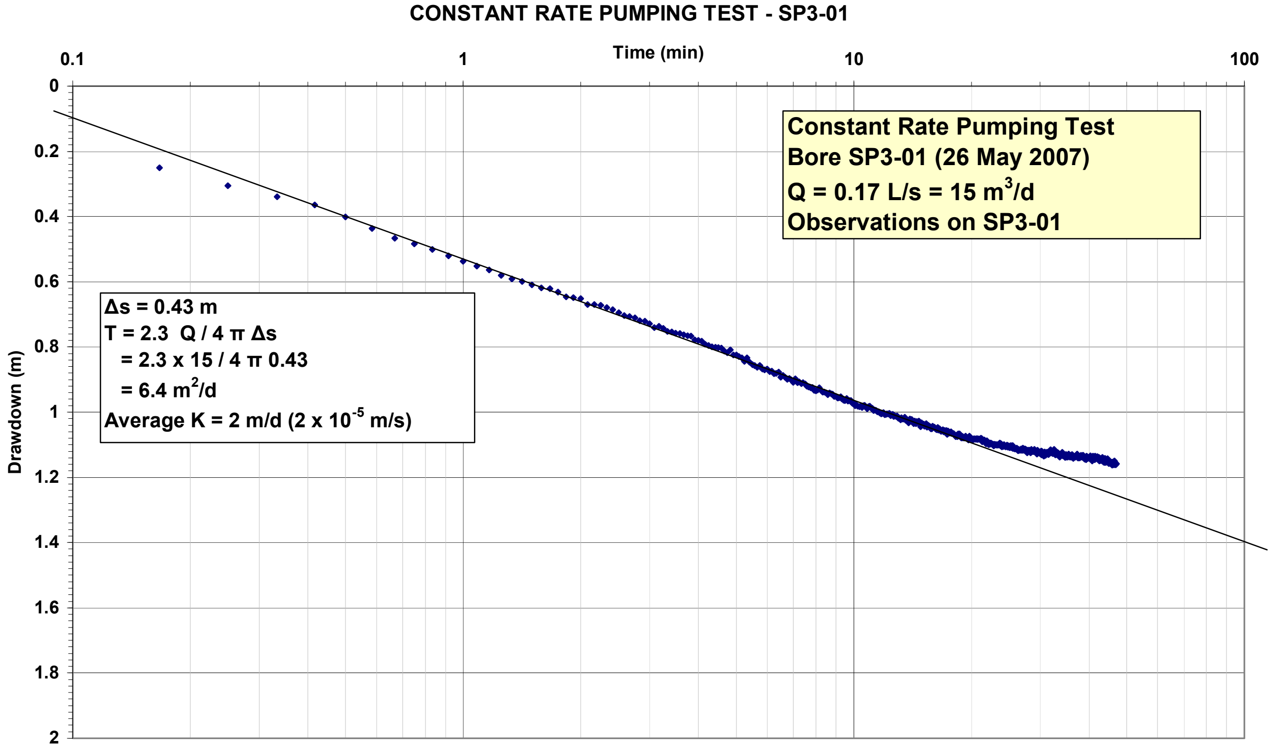
	Bloomfield Project
	Donaldson Project
	Abel Project
WM11	Bloomfield surface water monitoring point
EM5	Donaldson surface water monitoring point
Site 3	Bloomfield groundwater monitoring site
BL02	Old Bloomfield bore / mine shaft
C063	Abel piezometer
DPZ13	Donaldson piezometer
(GW78045)	DWE Licenced Bore
28.5	Groundwater Level (mAHD)
5	

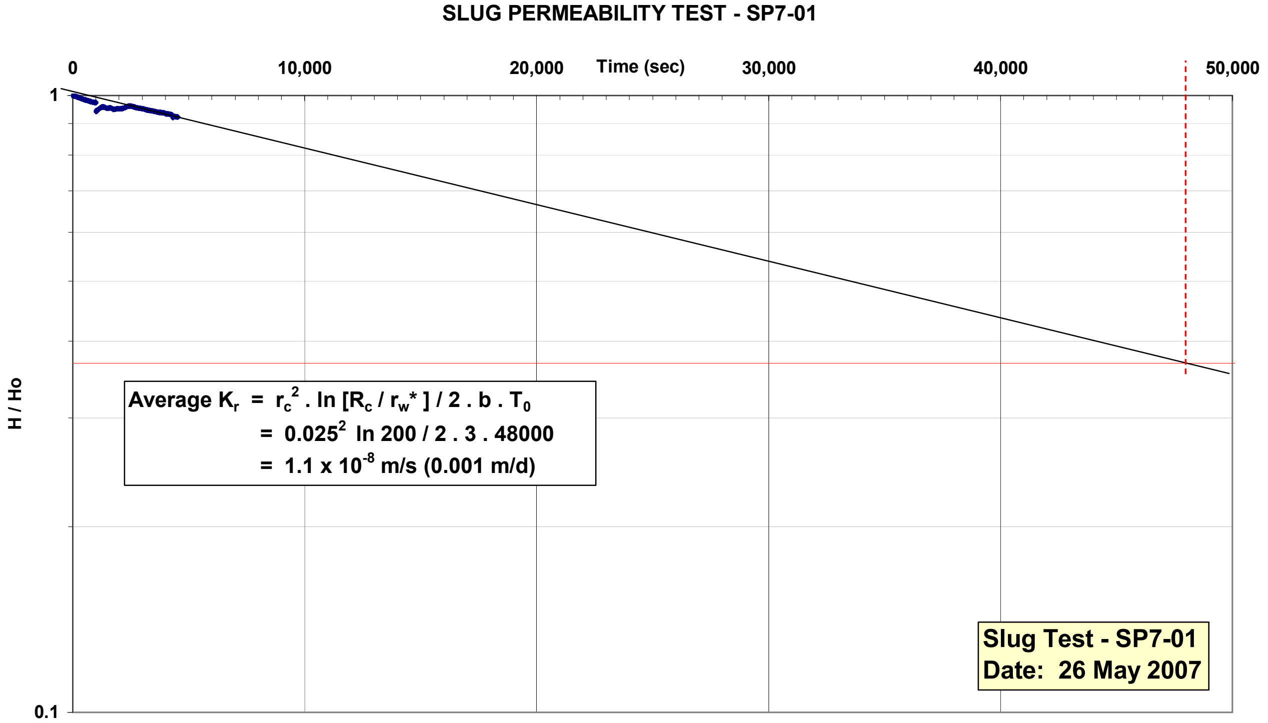
Date:	1 May 2008	Scale:	as shown	**Bloomfield Collieries Pty Ltd**
Initials:	PJD	Job No:	S05	**COMPLETION OF MINING AND REHABILITATION GROUNDWATER CONTOURS February 2008**
Drawing No:	S05-012	Rev:	0	
Aquaterra Consulting Pty Limited				**Figure 12**



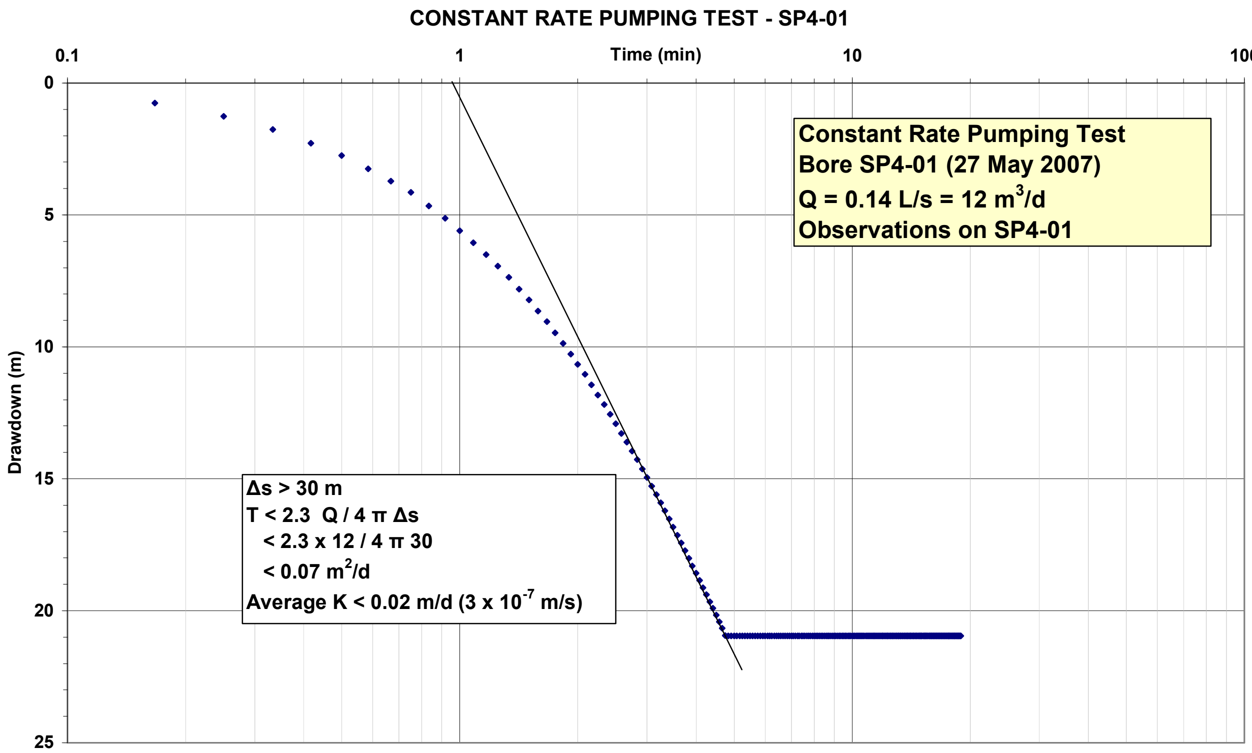


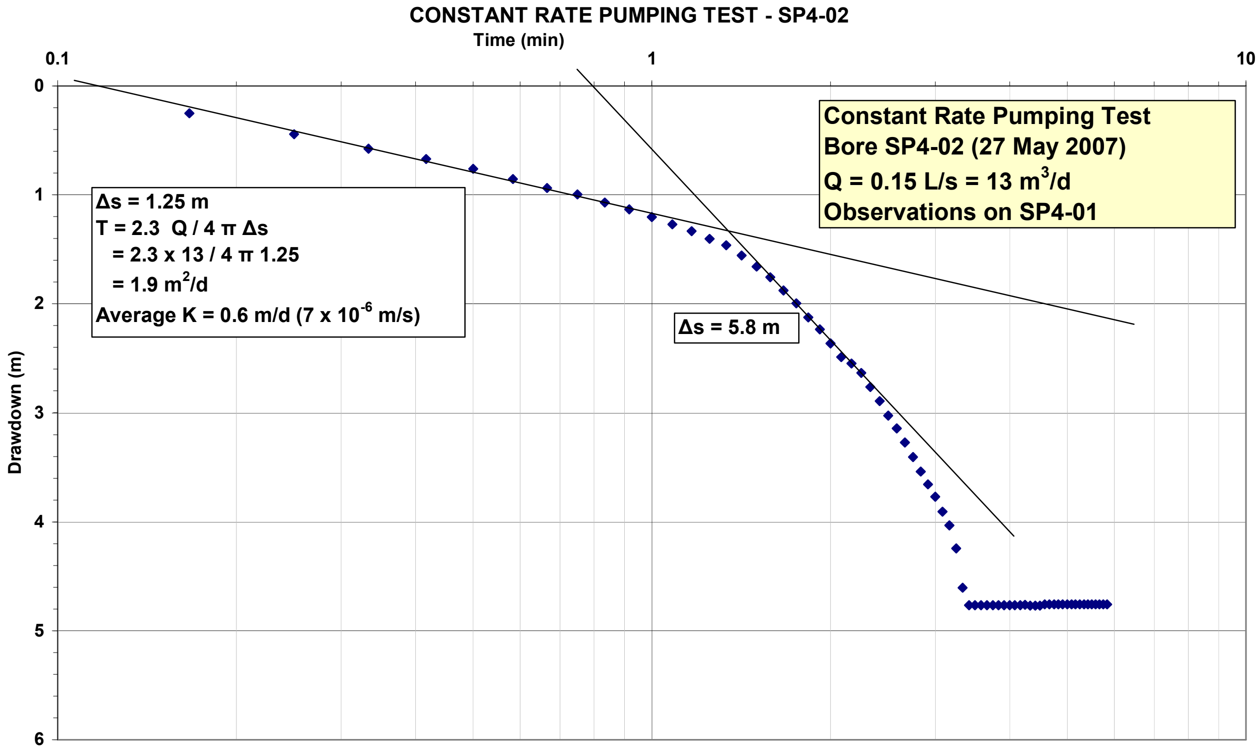
Date:	1 May 2008	Scale:	as indicated	**Bloomfield Collieries Pty Ltd**
Initials:	PJD	Job No:	S05	**COMPLETION OF MINING & REHABILITATION HYDRAULIC ANALYSIS SP2-01 and SP2-02**
Drawing No:	S05-013	Rev:	0	
Aquaterra Consulting Pty Limited				**Figure 13**



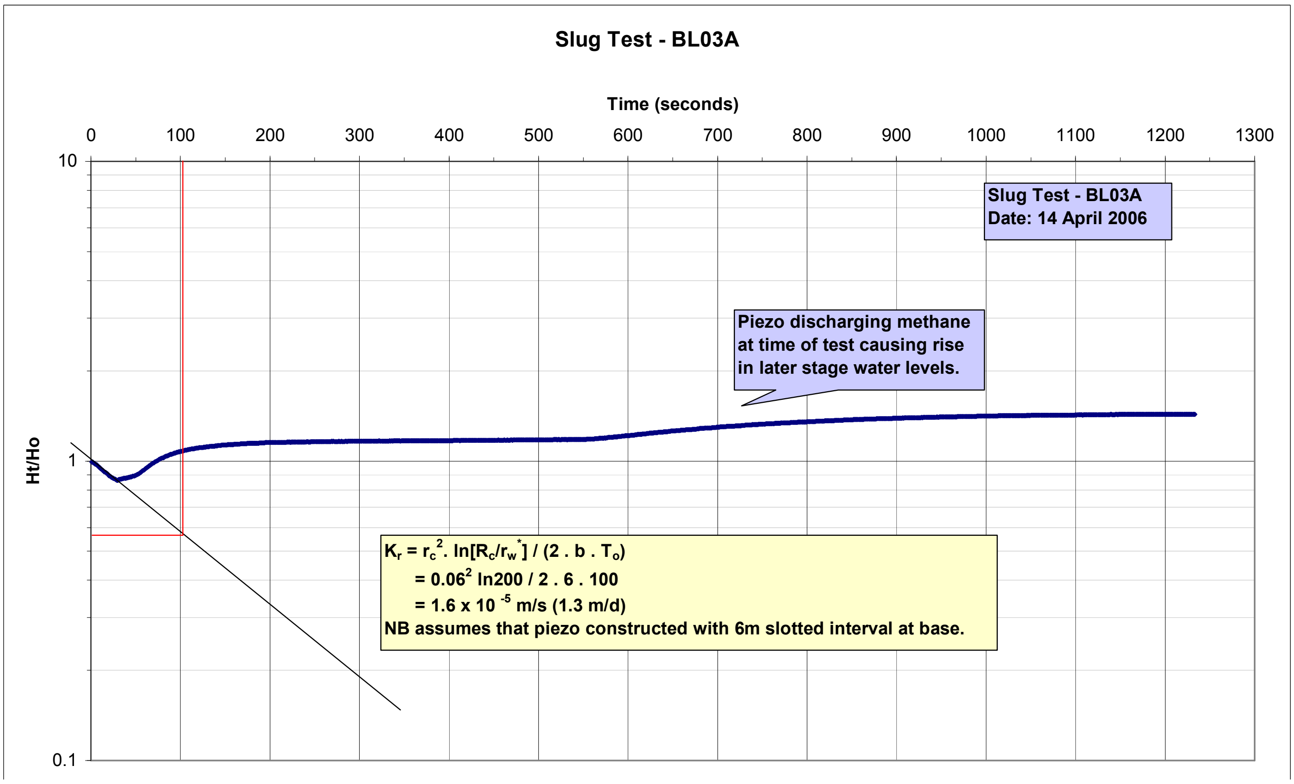


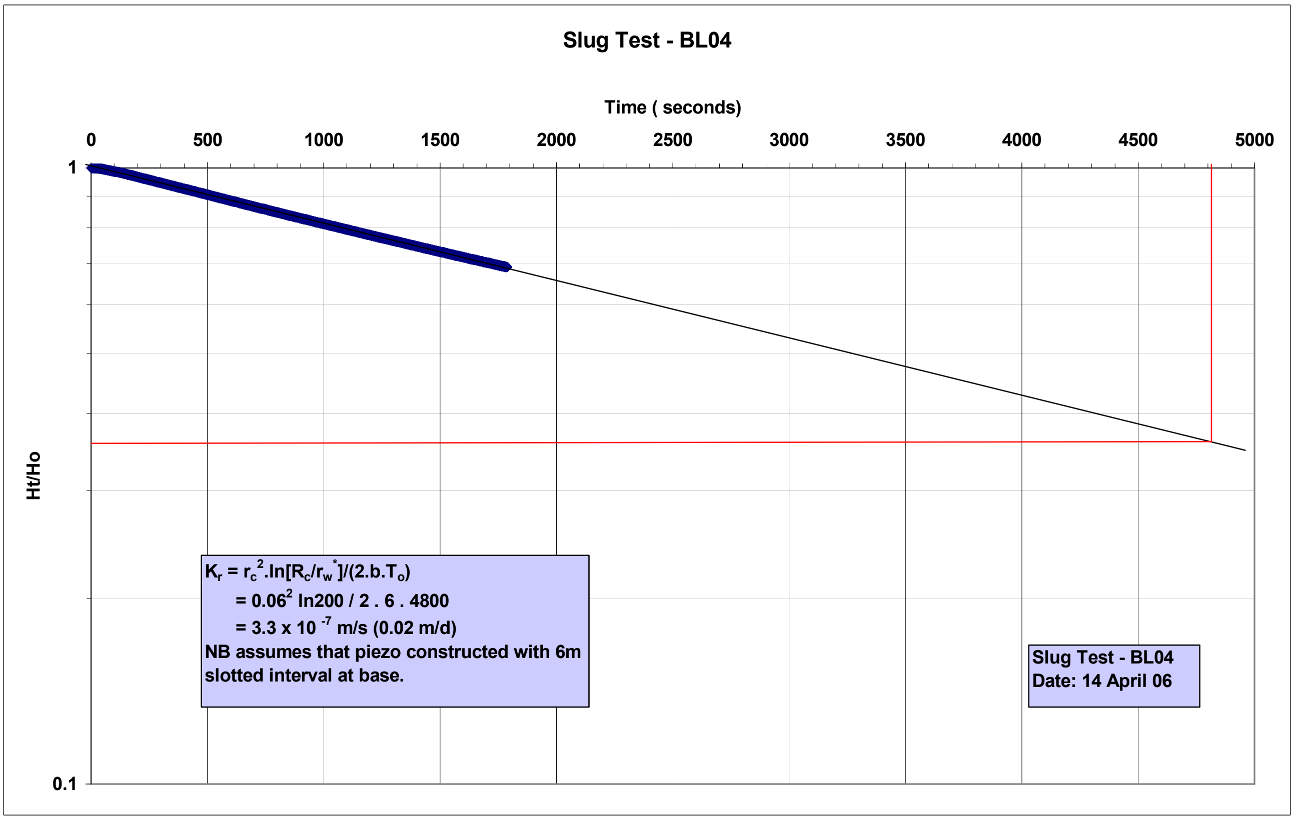
Date: 1 May 2008	Scale: as indicated	**Bloomfield Collieries Pty Ltd**	
Initials: PJD	Job No: S05	**COMPLETION OF MINING & REHABILITATION HYDRAULIC ANALYSIS SP3-01 and SP7-01**	
Drawing No: S05-014	Rev: 0		
Aquaterra Consulting Pty Limited			**Figure 14**



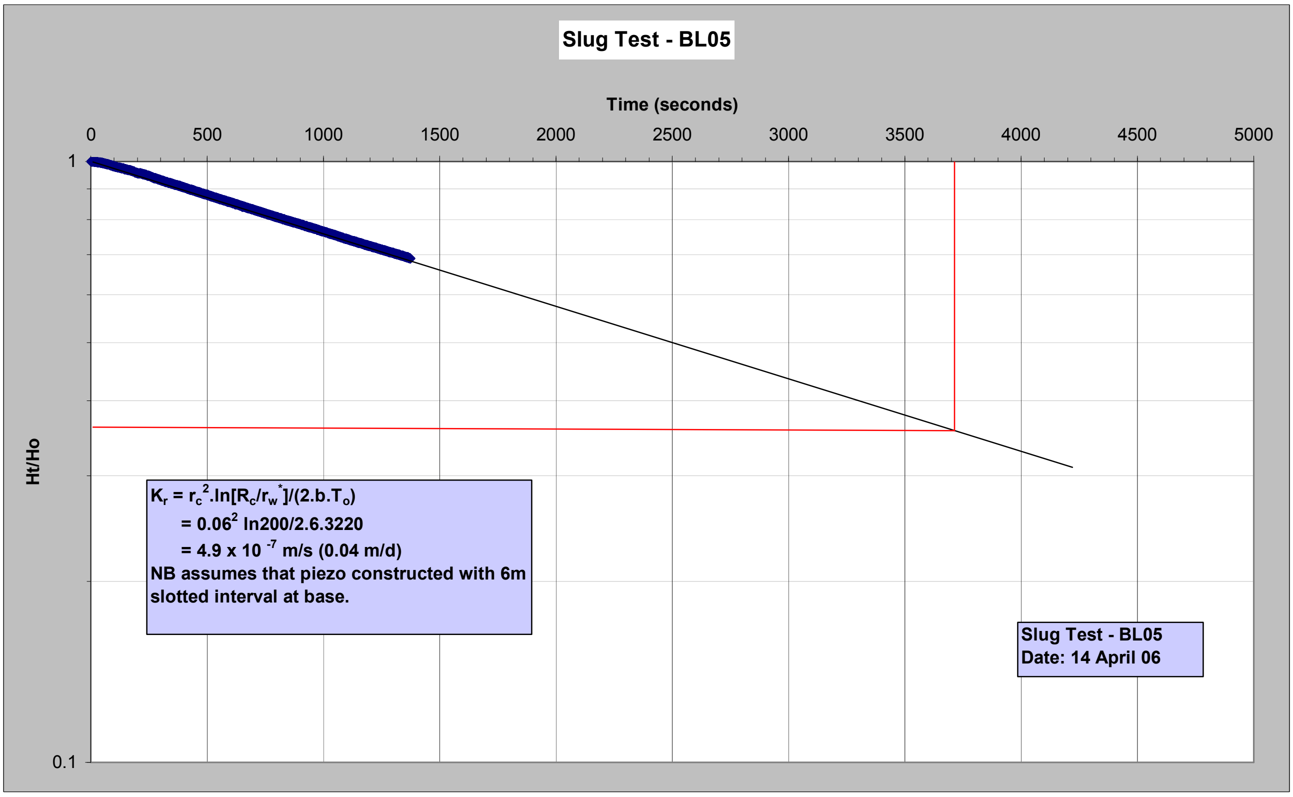


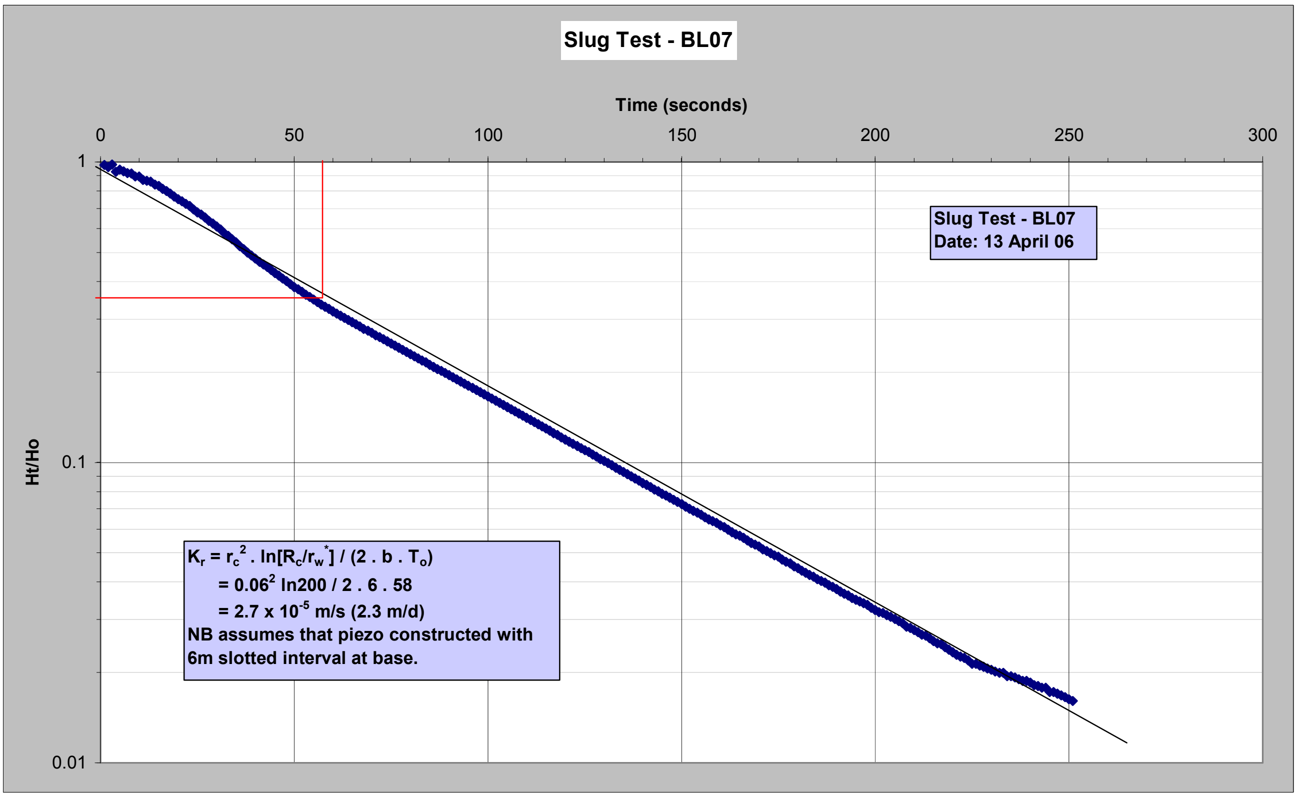
Date:	1 May 2008	Scale:	as indicated	**Bloomfield Collieries Pty Ltd**
Initials:	PJD	Job No:	S05	**COMPLETION OF MINING & REHABILITATION HYDRAULIC ANALYSIS SP4-01 and SP4-02**
Drawing No:	S05-015	Rev:	0	
Aquaterra Consulting Pty Limited				**Figure 15**



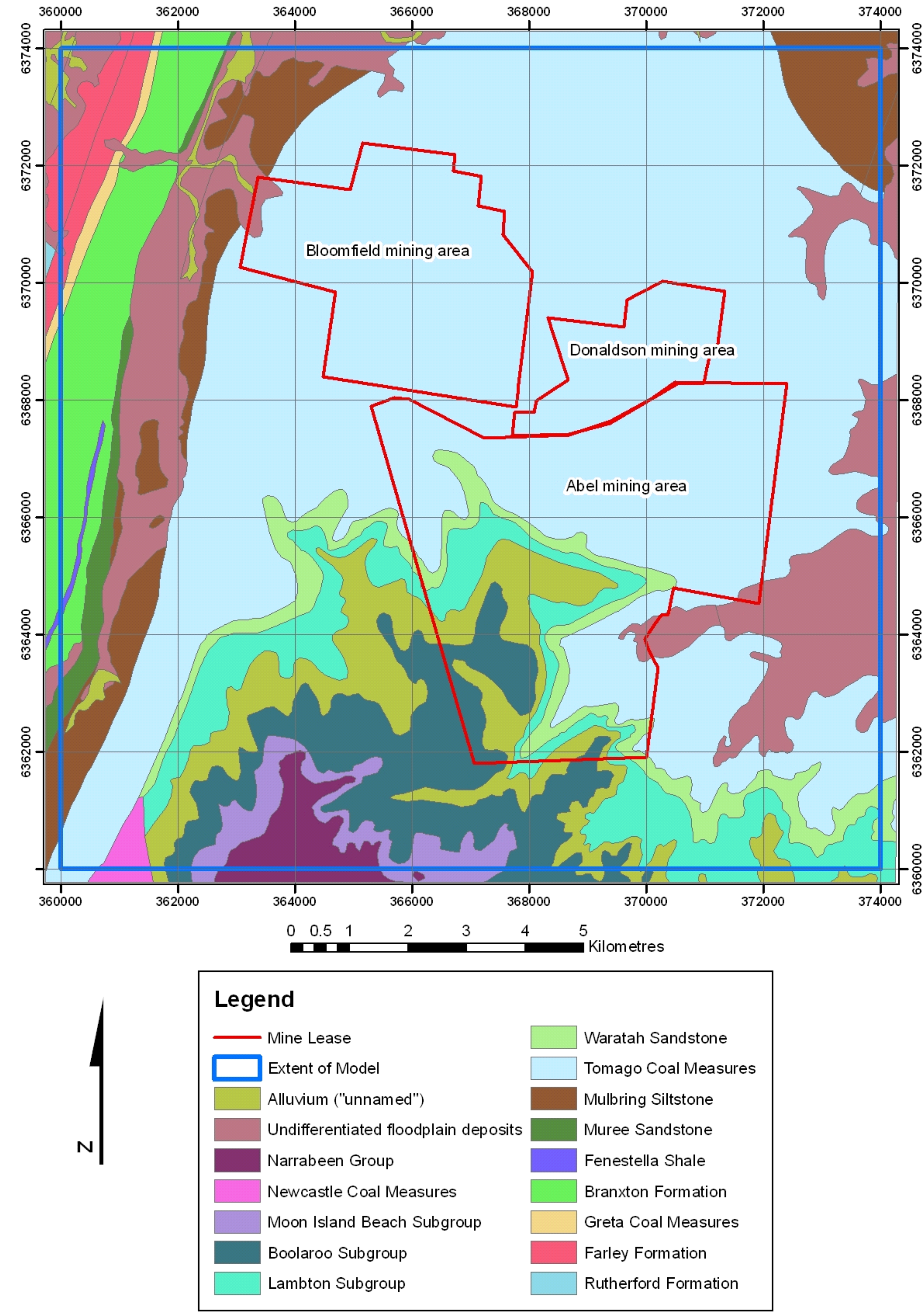


Date: 1 May 2008	Scale: as indicated	**Bloomfield Collieries Pty Ltd**
Initials: PJD	Job No: S05	**COMPLETION OF MINING & REHABILITATION HYDRAULIC ANALYSIS BL03A and BL04**
Drawing No: S05-016	Rev: 0	
Aquaterra Consulting Pty Limited		**Figure 16**

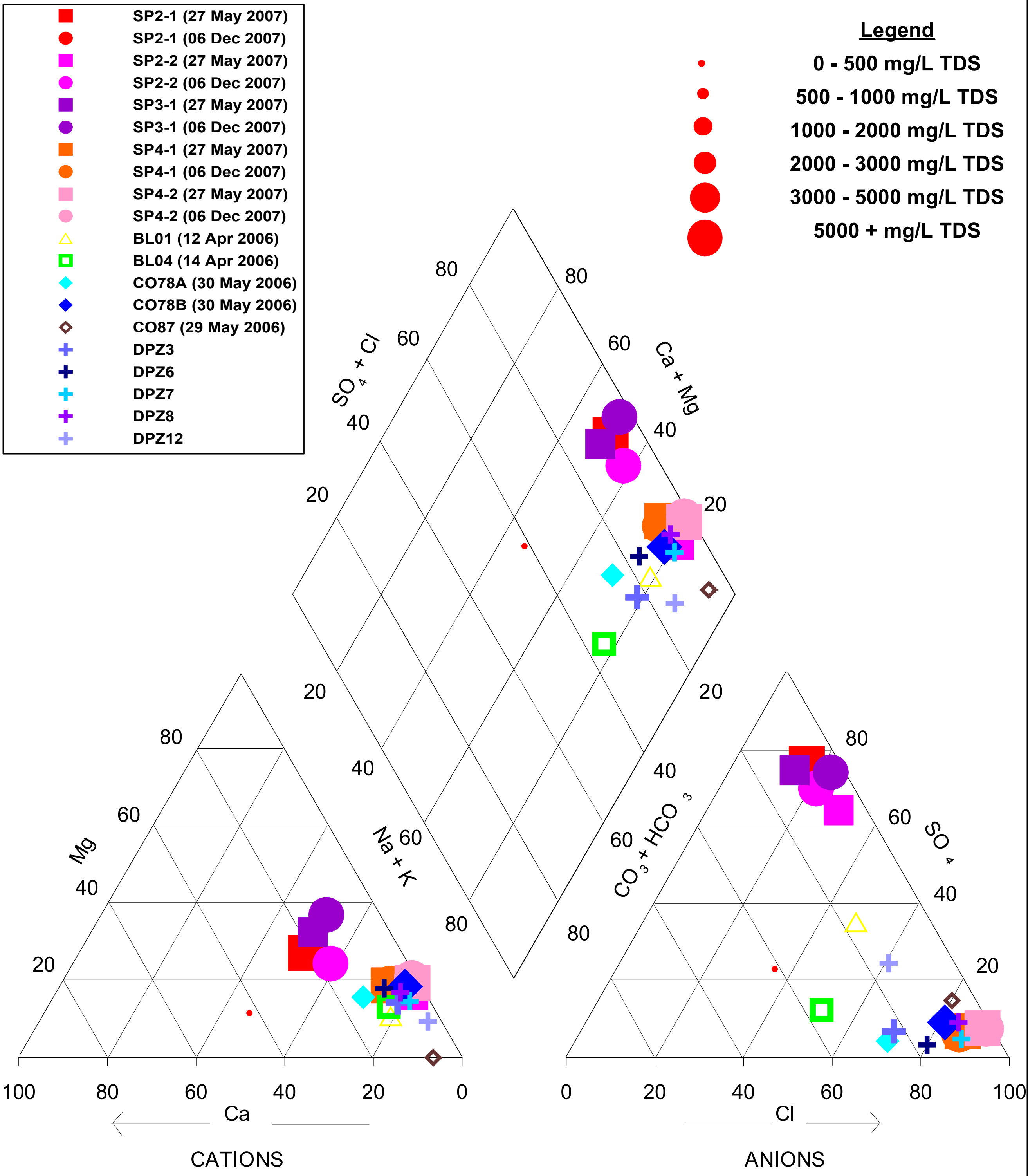




Date:	1 May 2008	Scale:	as indicated	**Bloomfield Collieries Pty Ltd**
Initials:	PJD	Job No:	S05	**COMPLETION OF MINING & REHABILITATION HYDRAULIC ANALYSIS BL05 and BL07**
Drawing No:	S05-017	Rev:	0	
Aquaterra Consulting Pty Limited				**Figure 17**

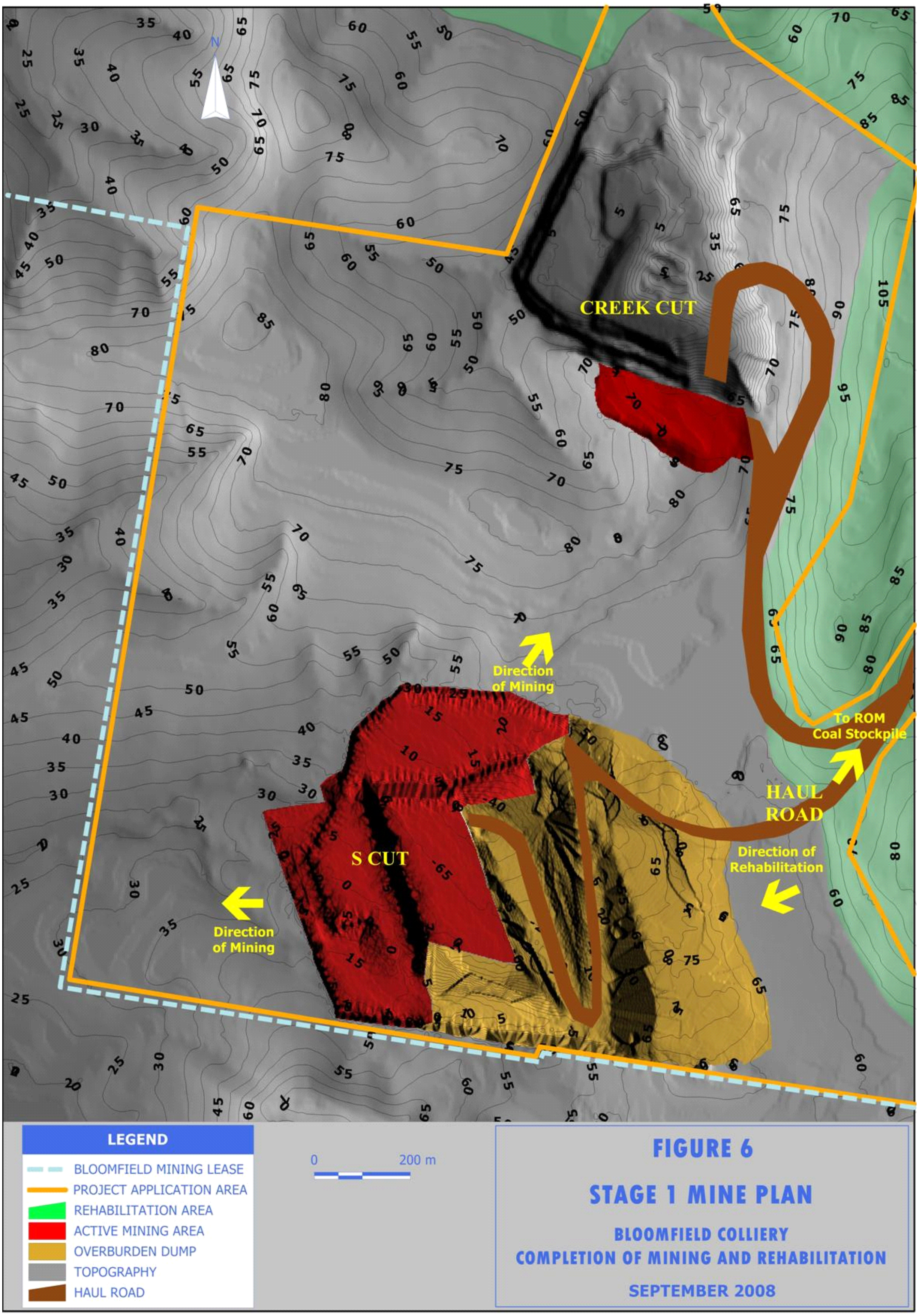


Date: 3 June 2008	Scale: as indicated	**Bloomfield Collieries Pty Ltd**
Initials: PJD	Job No: S05	**COMPLETION OF MINING & REHABILITATION REGIONAL GEOLOGY**
Drawing No: S05-018	Rev: 0	
Aquaterra Consulting Pty Limited		**Figure 18**

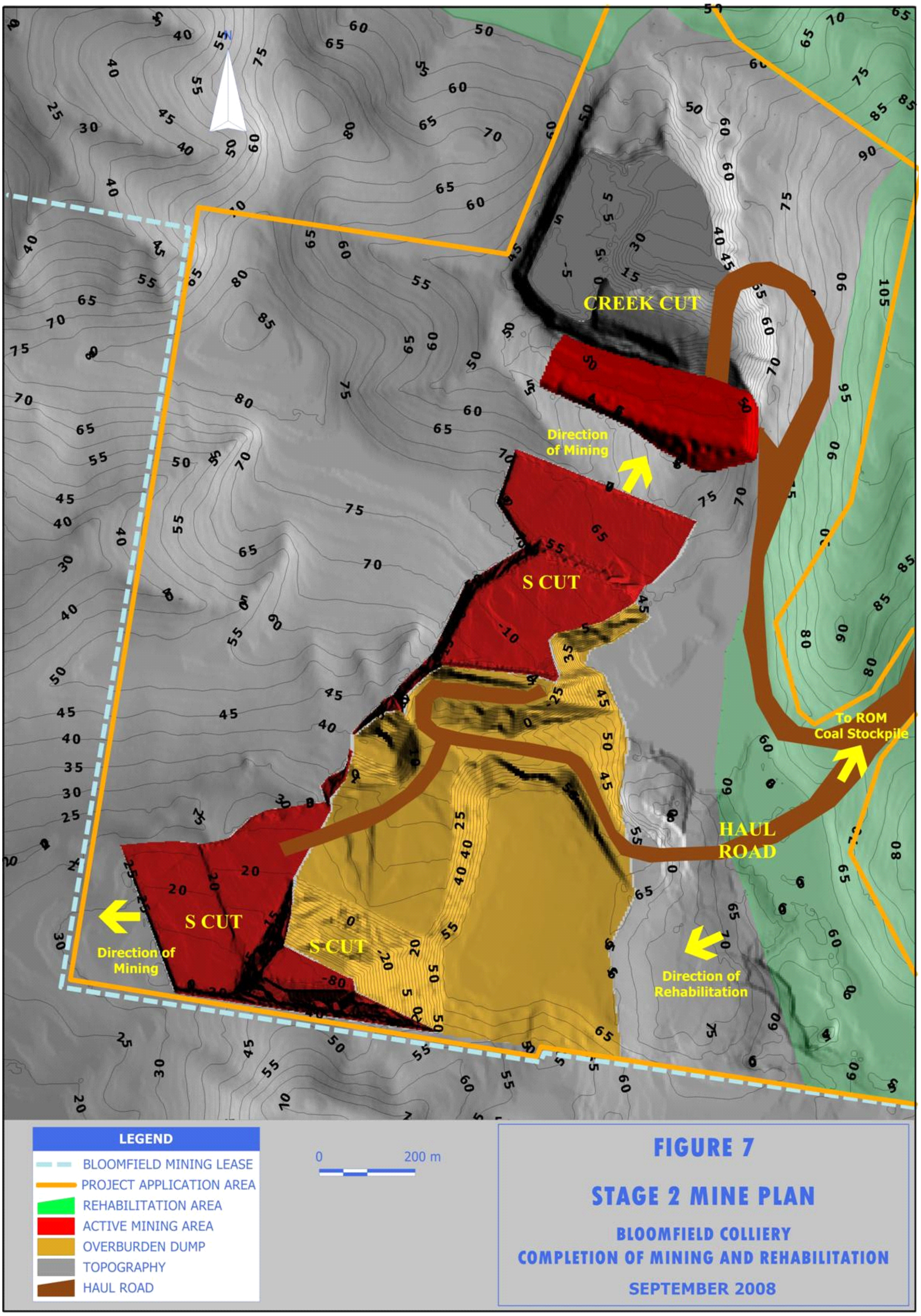


Peter Dundon and Associates Pty Ltd 12 Dakara Close Pymble NSW 2073 ph 61 2 9440 2666 fx 61 2 94493193 mb 0418 476 799 pjdundon@ozemail.com.au	CLIENT Bloomfield Collieries Pty Ltd		PROJECT BLOOMFIELD COAL PROJECT
	DRAWN PJD	DATE 5 June 2008	TITLE PIPER TRILINEAR DIAGRAM
	CHECKED	DATE	
	SCALE As Shown	Dwg S05-019 A4	PROJECT No S05 Figure 19

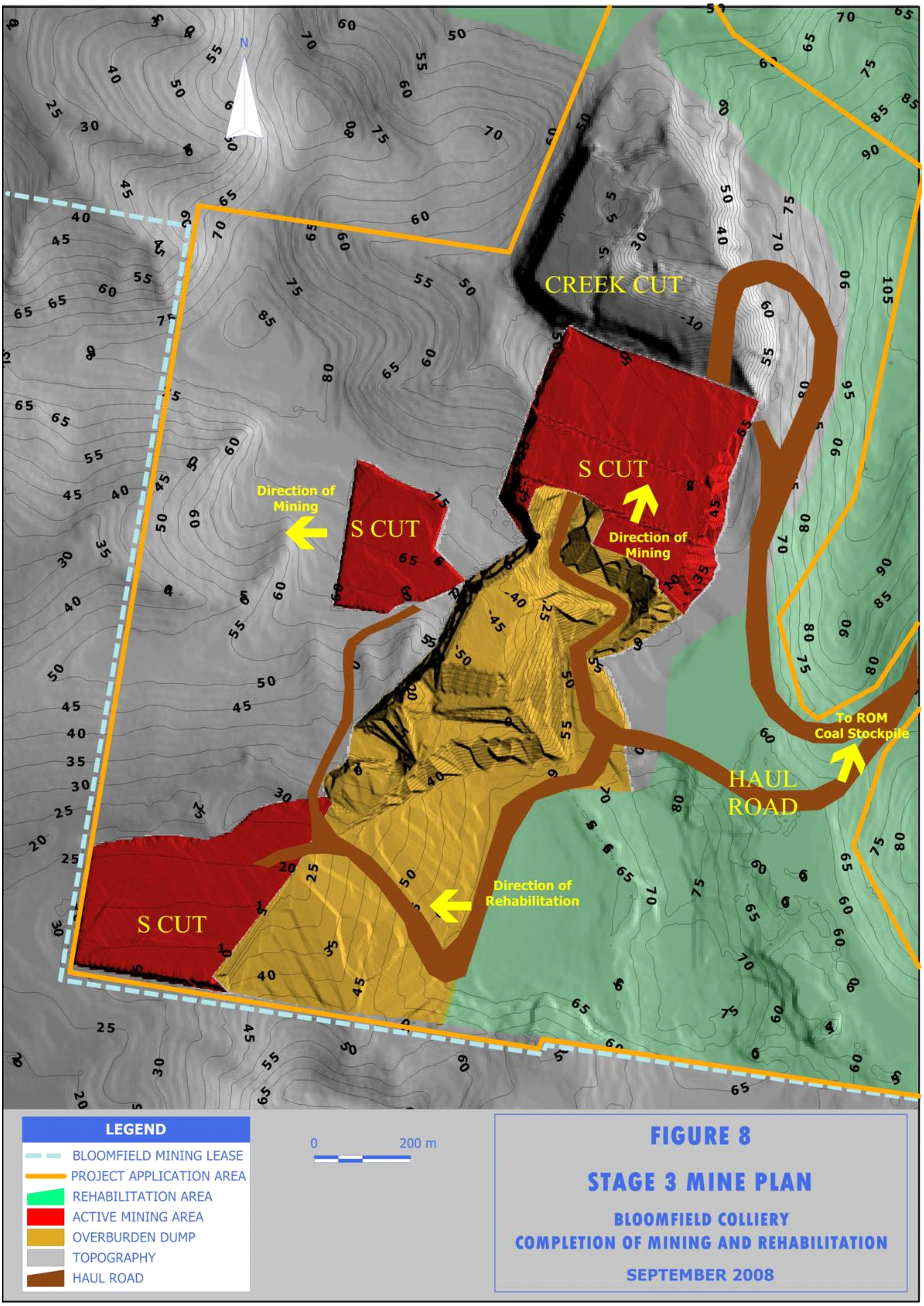
c:\...\S05\Bloomfield\piper.grt



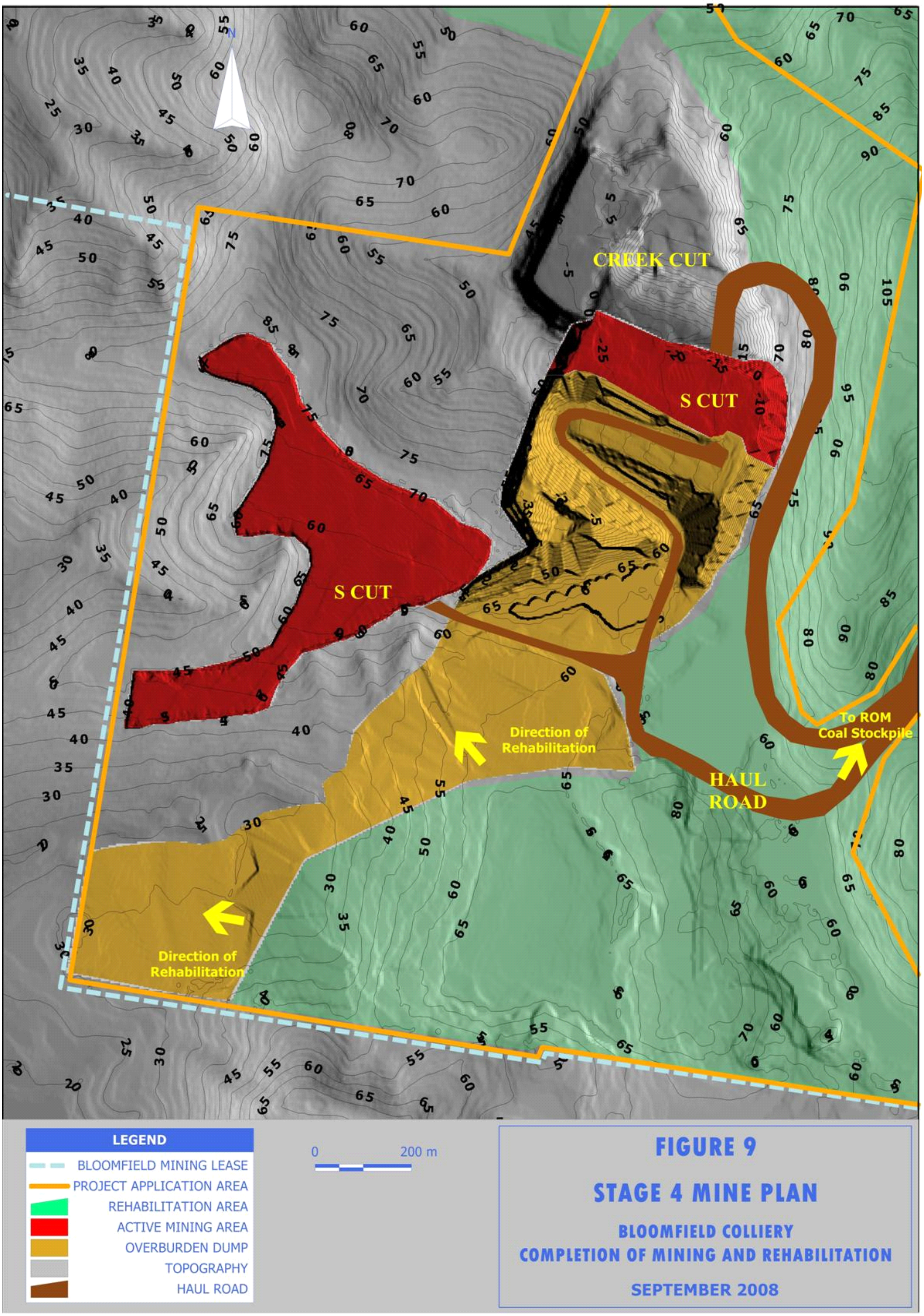
Date: 6 September 2008	Scale: as indicated	**Bloomfield Collieries Pty Ltd**
Initials: PJD	Job No: S05	**COMPLETION OF MINING & REHABILITATION CURRENT MINE LAYOUT SEPTEMBER 2008**
Drawing No: S05-020a	Rev: A	
Aquaterra Consulting Pty Limited		**Figure 20a**



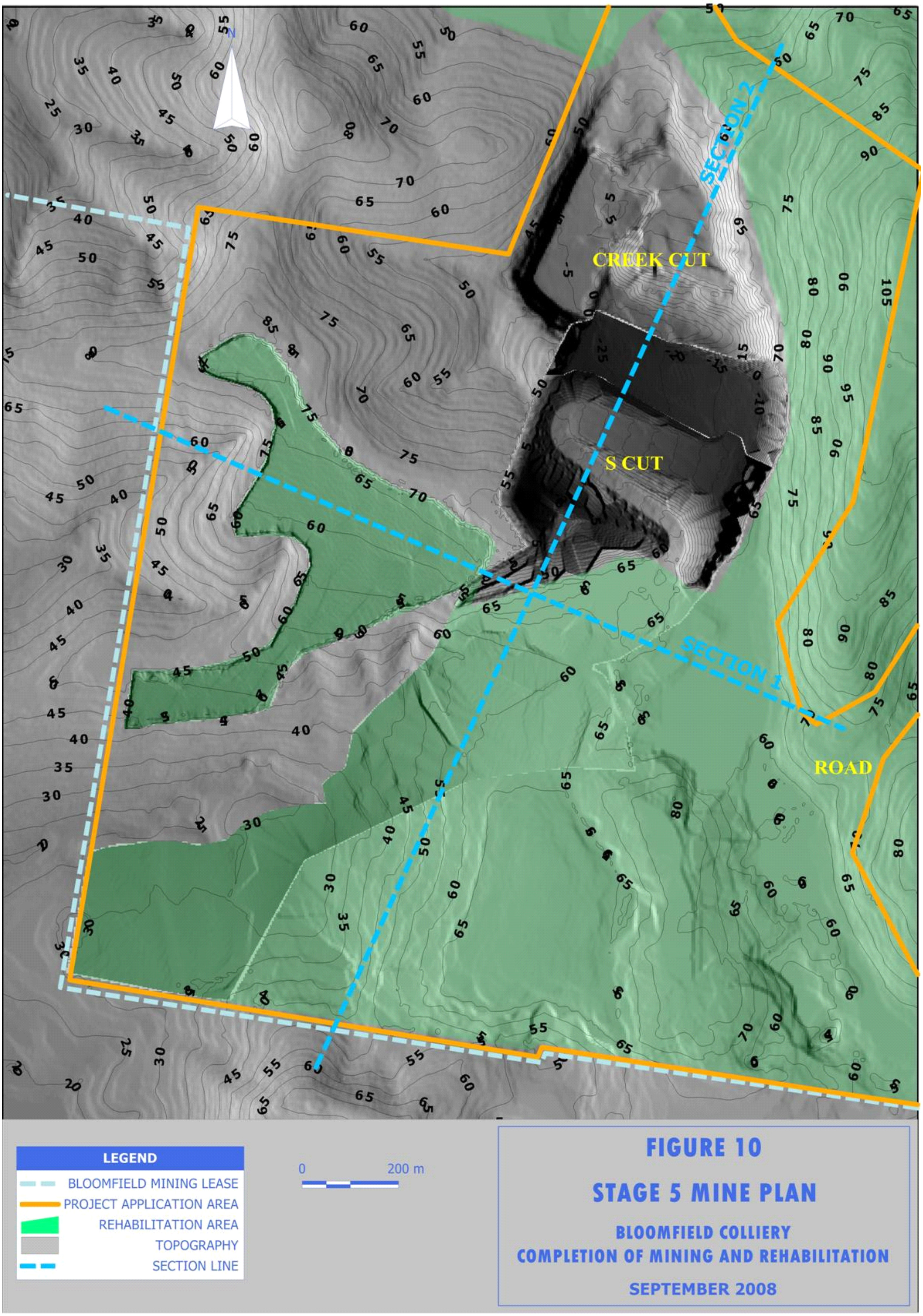
Date: 6 September 2008	Scale: as indicated	**Bloomfield Collieries Pty Ltd**
Initials: PJD	Job No: S05	**COMPLETION OF MINING & REHABILITATION STAGE 2 DRAFT MINE PLAN**
Drawing No: S05-020b	Rev: A	
Aquaterra Consulting Pty Limited		**Figure 20b**



Date: 6 September 2008	Scale: as indicated	**Bloomfield Collieries Pty Ltd**		
Initials: PJD	Job No: S05	**COMPLETION OF MINING & REHABILITATION STAGE 3 DRAFT MINE PLAN**		
Drawing No: S05-020c	Rev: A			
Aquaterra Consulting Pty Limited				**Figure 20c**



Date:	6 September 2008	Scale:	as indicated	**Bloomfield Collieries Pty Ltd**
Initials:	PJD	Job No:	S05	**COMPLETION OF MINING & REHABILITATION STAGE 4 DRAFT MINE PLAN**
Drawing No:	S05-020d	Rev:	A	
Aquaterra Consulting Pty Limited				**Figure 20d**



Date: 6 September 2008	Scale: as indicated	**Bloomfield Collieries Pty Ltd**
Initials: PJD	Job No: S05	**COMPLETION OF MINING & REHABILITATION FINAL LAYOUT AT COMPLETION OF MINING**
Drawing No: S05-020e	Rev: A	
Aquaterra Consulting Pty Limited		**Figure 20e**

Legend

- Predicted drawdown contours (m)
- Bloomfield Project
- Donaldson Project
- Abel Project
- WM11 Bloomfield surface water monitoring point
- BL02 Bloomfield borehole/piezometer
- DPZ13 Donaldson piezometer
- C063 Abel piezometer

0 1000 m

Date:	10 November 2008	Scale:	as shown	**Bloomfield Collieries Pty Ltd**
Initials:	PJD	Job No:	S05	**PREDICTED DRAWDOWNS IN LAYER 1 AT END YEAR 7**
Drawing No:	S05-021	Rev:	0	
Aquaterra Consulting Pty Limited				**Figure 21**

APPENDIX A

DWE REGISTERED BORES WITHIN 5 KM OF BLOOMFIELD PROJECT

DEPARTMENT OF WATER AND ENERGY
Work Summary

GW051353

Converted From HYDSYS

Licence : 20BL114994

Licence Status Active

	Authorised Purpose(s)	**Intended Purpose(s)**
	DOMESTIC	DOMESTIC
	STOCK	STOCK

Work Type : Bore open thru rock
Work Status : (Unknown)
Construct. Method : Rotary
Owner Type : Private

Commenced Date :
Completion Date : 01-Nov-1980

Final Depth : 49.70 m
Drilled Depth : 49.70 m

Contractor Name :
Driller :
Assistant Driller's Name :

Property : - ROBIN HILL
GWMA : -
GW Zone : -

Standing Water Level :
Salinity : 3001-7000 ppm
Yield :

Site Details

Site Chosen By

	County	Parish	Portion/Lot DP
Form A :	NORTHUMBERLAND	STOCKRINGTON	99
Licensed :	NORTHUMBERLAND	STOCKRINGTON	39

Region : 20 - HUNTER
River Basin : 210 - HUNTER RIVER
Area / District :

CMA Map : 9232-3N BERESFIELD
Grid Zone : 56/1 **Scale :** 1:25,000

Elevation :
Elevation Source : (Unknown)

Northing : 6365810
Easting : 365986

Latitude (S) : 32° 50' 15"
Longitude (E) : 151° 34' 5"

GS Map : 0053C4 **MGA Zone :** 56

Coordinate Source : GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing	P.V.C.	-0.30	1.50	114			Driven into Hole

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
22.60	23.10	0.50	Fractured	15.20		0.12			(Unknown)
24.90	25.20	0.30	Fractured	15.20		0.20			(Unknown)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.50	0.50	Soil Clay	Soil	
0.50	3.60	3.10	Sandstone Yellow	Sandstone	
3.60	3.90	0.30	Ironstone Shale	Ironstone	
3.90	10.70	6.80	Sandstone White	Sandstone	
3.90	10.70	6.80	Shale Seams	Shale	
10.70	11.90	1.20	Coal	Coal	
11.90	14.00	2.10	Sandstone Hard	Sandstone	
14.00	15.80	1.80	Shale	Shale	
15.80	22.60	6.80	Sandstone White	Sandstone	
22.60	25.60	3.00	Shale Water Supply	Shale	
25.60	49.70	24.10	Shale Black	Shale	

Remarks

***** End of GW051353 *****

DEPARTMENT OF WATER AND ENERGY
Work Summary

GW051647 *Converted From HYDSYS*

Licence : 20BL112319
Licence Status Active

Authorised Purpose(s) STOCK
Intended Purpose(s) STOCK

Work Type : Bore
Work Status : (Unknown)
Construct. Method : Rotary
Owner Type : Private

Commenced Date :
Completion Date : 01-Sep-1980
Final Depth : 12.00 m
Drilled Depth : 12.00 m

Contractor Name :
Driller : 1519 RYAN, Alan Francis
Assistant Driller's Name :

Property : - KARINYA
GWMA : -
GW Zone : -
Standing Water Level :
Salinity : (Unknown)
Yield :

Site Details

Site Chosen By

	County	Parish	Portion/Lot DP
Form A :	NORTHUMBERLAND	MAITLAND	L9 (1)
Licensed :	NORTHUMBERLAND	MAITLAND	L9 (P+ Port 1)

Region : 20 - HUNTER
River Basin : 210 - HUNTER RIVER
Area / District :
CMA Map : 9232-3N BERESFIELD
Grid Zone : 56/1
Scale : 1:25,000

Elevation :
Elevation Source : (Unknown)
Northing : 6373006
Easting : 362896
Latitude (S) : 32° 46' 20"
Longitude (E) : 151° 32' 10"

GS Map : 0053C4
MGA Zone : 56
Coordinate Source : GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details

(No Construction Details Found)

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

(No Water Bearing Zone Details Found)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.15	0.15	Topsoil	Topsoil	
0.15	3.00	2.85	Clay	Clay	
3.00	3.81	0.81	Sand Yellow	Sand	
3.81	4.57	0.76	Sand White	Sand	
4.57	6.10	1.53	Clay Sand	Clay	
6.10	12.00	5.90	Sandstone Hard	Sandstone	

Remarks

***** End of GW051647 *****

DEPARTMENT OF WATER AND ENERGY
Work Summary

GW078046

Licence : 20BL166664

Licence Status Active

Authorised Purpose(s) MONITORING BORE

Intended Purpose(s) MONITORING BORE

Work Type : Bore
Work Status : (Unknown)
Construct. Method : Backhoe
Owner Type :

Commenced Date :
Completion Date : 14-Nov-1997

Final Depth : 30.40 m
Drilled Depth : 30.40 m

Contractor Name : McDERMOTT DRILLING
Driller : DODDS
Assistant Driller's Name :

Property : - N/A
GWMA : 017 - HUNTER
GW Zone : -

Standing Water Level :
Salinity :
Yield :

Site Details

Site Chosen By		County	Parish	Portion/Lot DP
Geologist	Form A :	NORTHUMBERLAND	STOCKRINGTON	LOT 92 DP 755260
	Licensed :	NORTHUMBERLAND	STOCKRINGTON	92 755260

Region : 20 - HUNTER
River Basin :
Area / District :

CMA Map :
Grid Zone :
Scale :

Elevation :
Elevation Source :

Northing : 6368741
Easting : 368651

Latitude (S) : 32° 48' 41"
Longitude (E) : 151° 35' 49"

GS Map :
MGA Zone : 56
Coordinate Source :

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	Hole	0.00	30.40	96			Open Hole - Water
1	1	Opening	Screen	6.80	18.80				
1	1	Opening	Slots - Horizontal	6.80	18.80	55			PVC; SL: 12mm; A: 5mm
1		Annulus	Waterworn/Rounded	6.00	30.40				Ungraded; GS: 4-5mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
13.60	30.40	16.80		13.60			30.40		

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	9.20	9.20	SILTSTONE/MUDSTONE	Siltstone	
9.20	9.40	0.20	COAL	Coal	
9.40	11.20	1.80	SILTSTONE	Siltstone	
11.20	11.60	0.40	COAL	Coal	
11.60	30.40	18.80	SILTSTONE/SANDSTONE	Siltstone	

Remarks

*** End of GW078046 ***

DEPARTMENT OF WATER AND ENERGY
Work Summary

GW078047

Licence : 20BL166665

Licence Status Active

Authorised Purpose(s)	**Intended Purpose(s)**
MONITORING BORE	MONITORING BORE

Work Type : Bore
Work Status : (Unknown)
Construct. Method :
Owner Type :

Commenced Date : **Final Depth :** 54.30 m
Completion Date : 14-Nov-1997 **Drilled Depth :** 54.30 m

Contractor Name : McDERMOTT DRILLING
Driller :
Assistant Driller's Name :

Property : - N/A
GWMA : 017 - HUNTER
GW Zone : -

Standing Water Level :
Salinity :
Yield :

Site Details

Site Chosen By
Driller

	County	Parish	Portion/Lot DP
Form A :	NORTHUMBERLAND	STOCKRINGTON	PT LOT 13 DP 755260
Licensed :	NORTHUMBERLAND	STOCKRINGTON	13 755260

Region : 20 - HUNTER
River Basin :
Area / District :

CMA Map :
Grid Zone : **Scale :**

Elevation :
Elevation Source :

Northing : 6368800 **Latitude (S) :** 32° 48' 40"
Easting : 370784 **Longitude (E) :** 151° 37' 11"

GS Map : **MGA Zone :** 56 **Coordinate Source :**

Construction
Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	Hole	0.00	54.30	96			
1	1	Opening	Screen	25.20	49.20				
1	1	Opening	Slots - Horizontal	25.20	49.20	55			PVC; SL: 24mm; A: 5mm
1		Annulus	Waterworn/Rounded	24.90	49.20				Ungraded; GS: 4-5mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
22.80	54.30	31.50		22.80			54.30		

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	6.50	6.50	SILTSTONE	Siltstone	
6.50	12.00	5.50	SANDSTONE	Sandstone	
12.00	14.60	2.60	SILTSTONE/MUDSTONE	Siltstone	
14.60	15.40	0.80	COAL	Coal	
15.40	24.90	9.50	SILTSTONE	Siltstone	
24.90	27.70	2.80	COAL	Coal	
27.70	32.30	4.60	SILTSTONE/SANDSTONE	Siltstone	
32.30	33.40	1.10	COAL	Coal	
33.40	39.30	5.90	SANDSTONE	Sandstone	
39.30	39.90	0.60	COAL	Coal	
39.90	41.10	1.20	SILTSTONE/SANDSTONE	Siltstone	
41.10	43.50	2.40	COAL	Coal	
43.50	45.10	1.60	CLAYSTONE	Claystone	
45.10	49.40	4.30	COAL	Coal	
49.40	54.30	4.90	SILTSTONE	Siltstone	

Remarks

***** End of GW078047 *****

DEPARTMENT OF WATER AND ENERGY
Work Summary

GW078121

Licence : 20BL166667

Licence Status Active

Authorised Purpose(s)	**Intended Purpose(s)**
MONITORING BORE	MONITORING BORE

Work Type : Bore
Work Status : (Unknown)
Construct. Method :
Owner Type :

Commenced Date : **Final Depth :** 43.00 m
Completion Date : 14-Nov-1997 **Drilled Depth :** 43.00 m

Contractor Name : McDERMOTT DRILLING
Driller :
Assistant Driller's Name :

Property : - N/A
GWMA : 017 - HUNTER
GW Zone : -

Standing Water Level :
Salinity :
Yield :

Site Details

Site Chosen By
Geologist

	County	Parish	Portion/Lot DP
Form A :	NORTHUMBERLAND	STOCKRINGTON	LOT 10 DP 11875
Licensed :	NORTHUMBERLAND	STOCKRINGTON	10 11875

Region : 20 - HUNTER
River Basin :
Area / District :

CMA Map :
Grid Zone : **Scale :**

Elevation :
Elevation Source :

Northing : 6367262
Easting : 368619

Latitude (S) : 32° 49' 29"
Longitude (E) : 151° 35' 47"

GS Map : **MGA Zone :** 56 **Coordinate Source :**

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	Hole	0.00	43.00	96			Open Hole - Water
1	1	Opening	Screen	26.70	42.50				
1	1	Opening	Slots	26.70	42.50	55			PVC; SL: 15.8mm
1		Annulus	Waterworn/Rounded	2.00	43.00				Ungraded; GS: 4-5mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
22.30	43.00	20.70		22.30			43.00		

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	14.00	14.00	SILTSTONE/SHALE	Siltstone	
14.00	16.00	2.00	SANDSTONE	Sandstone	
16.00	20.00	4.00	SILTSTONE/SHALE	Siltstone	
20.00	22.00	2.00	SANDSTONE	Sandstone	
22.00	25.40	3.40	SILTSTONE/SHALE	Siltstone	
25.40	25.90	0.50	COAL	Coal	
25.90	32.10	6.20	SANDSTONE	Sandstone	
32.10	32.60	0.50	COAL	Coal	
32.60	33.90	1.30	SANDSTONE	Sandstone	
33.90	35.60	1.70	COAL	Coal	
35.60	36.20	0.60	SANDSTONE	Sandstone	
36.20	37.00	0.80	COAL	Coal	
37.00	38.20	1.20	SANDSTONE/SILTSTONE	Sandstone	
38.20	38.60	0.40	COAL	Coal	
38.60	43.00	4.40	SILTSTONE	Siltstone	

Remarks

***** End of GW078121 *****

DEPARTMENT OF WATER AND ENERGY
Work Summary

GW078122

Licence : 20BL166668

Licence Status Active

Authorised Purpose(s) MONITORING BORE

Intended Purpose(s) MONITORING BORE

Work Type : Bore
Work Status : (Unknown)
Construct. Method :
Owner Type :

Commenced Date :
Completion Date : 14-Nov-1997

Final Depth : 35.40 m
Drilled Depth : 35.40 m

Contractor Name : McDERMOTT DRILLING
Driller :
Assistant Driller's Name :

Property : - N/A
GWMA : 017 - HUNTER
GW Zone : -

Standing Water Level :
Salinity :
Yield :

Site Details

Site Chosen By		County	Parish	Portion/Lot DP
Geologist	Form A :	NORTHUMBERLAND	STOCKRINGTON	LOT 10 DP 11875
	Licensed :	NORTHUMBERLAND	STOCKRINGTON	10 11875

Region : 20 - HUNTER
River Basin :
Area / District :

CMA Map :
Grid Zone :
Scale :

Elevation :
Elevation Source :

Northing : 6367663
Easting : 368666

Latitude (S) : 32° 49' 16"
Longitude (E) : 151° 35' 49"

GS Map :
MGA Zone : 56
Coordinate Source :

Construction
Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	Hole	0.00	35.40	96			Open Hole - Water
1	1	Opening	Screen	19.50	35.00				
1	1	Opening	Slots - Horizontal	19.50	35.00	55			PVC; SL: 15.5mm; A: 5mm
1		Annulus	Waterworn/Rounded	19.20	35.40				Ungraded; GS: 4-5mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
23.10	51.30	28.20		23.10			35.40		

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	12.00	12.00	SANDSTONE/SILTSTONE	Sandstone	
12.00	12.40	0.40	COAL	Coal	
12.40	16.00	3.60	SILTSTONE	Siltstone	
16.00	19.50	3.50	SANDSTONE	Sandstone	
19.50	20.90	1.40	COAL	Coal	
20.90	22.00	1.10	SANDSTONE	Sandstone	
22.00	23.60	1.60	COAL	Coal	
23.60	24.40	0.80	SANDSTONE	Sandstone	
24.40	26.60	2.20	COAL	Coal	
26.60	28.00	1.40	SILTSTONE/CLAYSTONE	Siltstone	
28.00	31.70	3.70	COAL	Coal	
31.70	35.40	3.70	SANDSTONE	Sandstone	

Remarks

***** End of GW078122 *****

DEPARTMENT OF WATER AND ENERGY
Work Summary

GW078123

Licence : 20BL166669

Licence Status Active

Authorised Purpose(s) MONITORING BORE

Intended Purpose(s)

Work Type : Bore
Work Status : (Unknown)
Construct. Method :
Owner Type :

Commenced Date :
Completion Date : 14-Nov-1997

Final Depth : 33.00 m
Drilled Depth : 33.00 m

Contractor Name : McDERMOTT DRILLING
Driller :
Assistant Driller's Name :

Property : - N/A
GWMA : 017 - HUNTER
GW Zone : -

Standing Water Level :
Salinity :
Yield :

Site Details

Site Chosen By
Geologist

	County	Parish	Portion/Lot DP
Form A :	NORTHUMBERLAND	STOCKRINGTON	LOT 92 DP 755260
Licensed :	NORTHUMBERLAND	STOCKRINGTON	92 755260

Region : 20 - HUNTER
River Basin :
Area / District :

CMA Map :
Grid Zone :
Scale :

Elevation :
Elevation Source :

Northing : 6368165
Easting : 369309

Latitude (S) : 32° 49' 0"
Longitude (E) : 151° 36' 14"

GS Map :
MGA Zone : 56
Coordinate Source :

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	Hole	0.00	33.00	96			Other
1	1	Opening	Screen	20.20	32.20				
1	1	Opening	Slots - Horizontal	20.20	32.20	55			PVC; SL: 12mm; A: 5mm
1		Annulus	Waterworn/Rounded	12.50	32.20				Ungraded; GS: 4-5mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
24.40	33.00	8.60		24.40			33.00		

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	13.20	13.20	SANDSTONE/SILTSTONE	Sandstone	
13.20	15.30	2.10	COAL	Coal	
15.30	17.00	1.70	SILTSTONE	Siltstone	
17.00	17.90	0.90	COAL/SANDSTONE	Coal	
17.90	19.00	1.10	SILTSTONE	Siltstone	
19.00	19.70	0.70	COAL/SANDSTONE	Coal	
19.70	20.80	1.10	SANDSTONE	Sandstone	
20.80	23.20	2.40	COAL	Coal	
23.20	25.50	2.30	SANDSTONE/CLAYSTONE	Sandstone	
25.50	29.70	4.20	COAL	Coal	
29.70	33.00	3.30	SANDSTONE/SILTSTONE	Sandstone	

Remarks

***** End of GW078123 *****

DEPARTMENT OF WATER AND ENERGY
Work Summary

GW078124

Licence : 20BL166670

Licence Status Active

Authorised Purpose(s)	**Intended Purpose(s)**
MONITORING BORE	MONITORING BORE

Work Type : Bore
Work Status : (Unknown)
Construct. Method :
Owner Type :

Commenced Date :
Completion Date : 14-Nov-1997

Final Depth : 40.00 m
Drilled Depth : 37.00 m

Contractor Name : McDERMOTT DRILLING
Driller :
Assistant Driller's Name :

Property : - N/A
GWMA : 017 - HUNTER
GW Zone : -

Standing Water Level :
Salinity :
Yield :

Site Details

Site Chosen By
Geologist

	County	Parish	Portion/Lot DP
Form A :	NORTHUMBERLAND	STOCKRINGTON	PT LOT 13 DP755260
Licensed :	NORTHUMBERLAND	STOCKRINGTON	13 755260

Region : 20 - HUNTER
River Basin :
Area / District :

CMA Map :
Grid Zone :
Scale :

Elevation :
Elevation Source :

Northing : 6368018
Easting : 369883

Latitude (S) : 32° 49' 5"
Longitude (E) : 151° 36' 36"

GS Map :
MGA Zone : 56
Coordinate Source :

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	Hole	0.00	40.00	96			Open Hole - Water
1	1	Opening	Screen	12.50	36.50				
1	1	Opening	Slots - Horizontal	12.50	36.50	55			PVC; SL: 24mm; A: 55mm
1		Annulus	Waterworn/Rounded	11.10	40.00				Ungraded; GS: 4-5mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
18.60	40.00	21.40		18.60			40.00		

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	8.10	8.10	sandstone	Sandstone	
8.10	8.60	0.50	coal	Coal	
8.60	10.00	1.40	siltstone	Siltstone	
10.00	15.50	5.50	sandstone	Sandstone	
15.50	17.20	1.70	coal	Coal	
17.20	18.30	1.10	sandstone	Sandstone	
18.30	19.20	0.90	coal	Coal	
19.20	20.00	0.80	mudstone	Mudstone	
20.00	24.50	4.50	siltstone	Siltstone	
24.50	27.70	3.20	coal	Coal	
27.70	29.90	2.20	sandstone/claystone	Sandstone	
29.90	33.30	3.40	coal	Coal	
33.30	37.00	3.70	mudstone	Mudstone	

Remarks

***** End of GW078124 *****

DEPARTMENT OF WATER AND ENERGY
Work Summary

GW078127

Licence : 20BL166673

Licence Status Active

Authorised Purpose(s)	**Intended Purpose(s)**
MONITORING BORE	MONITORING BORE

Work Type : Bore
Work Status : (Unknown)
Construct. Method :
Owner Type :

Commenced Date :   **Final Depth :** 30.00 m
Completion Date : 14-Nov-1997   **Drilled Depth :** 30.00 m

Contractor Name : McDERMOTT DRILLING
Driller :
Assistant Driller's Name :

Property : - NOT KNOWN   **Standing Water Level :**
GWMA : 017 - HUNTER   **Salinity :**
GW Zone : -   **Yield :**

Site Details

Site Chosen By
Geologist

	County	**Parish**	**Portion/Lot DP**
Form A :	NORTHUMBERLAND	STOCKRINGTON	LOT 82 DP 627798
Licensed :	NORTHUMBERLAND	STOCKRINGTON	82 627799

Region : 20 - HUNTER   **CMA Map :**
River Basin :   **Grid Zone :**   **Scale :**
Area / District :

Elevation :   **Northing :** 6366406   **Latitude (S) :** 32° 49' 57"
Elevation Source :   **Easting :** 369073   **Longitude (E) :** 151° 36' 4"

GS Map :   **MGA Zone :** 56   **Coordinate Source :**

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	Hole	0.00	30.00	96			Open Hole - Water
1	1	Opening	Screen	14.30	26.30				
1	1	Opening	Slots - Horizontal	14.30	26.30	55			PVC; SL: 12mm; A: 5mm
1		Annulus	Waterworn/Rounded	1.00	30.00				Ungraded; GS: 4-5mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
16.60	30.00	13.40		16.60			30.00		

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	13.00	13.00	siltstone/mudstone	Siltstone	
13.00	17.00	4.00	mudstone	Mudstone	
17.00	30.00	13.00	siltstone/mudstone	Siltstone	

Remarks

***** End of GW078127 *****

DEPARTMENT OF WATER AND ENERGY
Work Summary

GW079892

Licence :

Licence Status Active

Authorised Purpose(s)

Intended Purpose(s) MONITORING BORE

Work Type : Bore
Work Status : (Unknown)
Construct. Method :
Owner Type :

Commenced Date :
Final Depth :
Completion Date :
Drilled Depth :

Contractor Name :
Driller :
Assistant Driller's Name :

Property :
Standing Water Level :
GWMA :
Salinity :
GW Zone :
Yield :

Site Details

Site Chosen By

	County	Parish	Portion/Lot DP
Form A :	GLOUCESTER	TOMAREE	
Licensed :			

Region : 20 - HUNTER
CMA Map :
River Basin :
Grid Zone :
Scale :
Area / District :

Elevation : 6.69 m (A.H.D.)
Northing : 6372257
Latitude (S) : 32° 46' 46"
Elevation Source :
Easting : 366598
Longitude (E) : 151° 34' 32"

GS Map :
MGA Zone : 56
Coordinate Source :

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details

(No Construction Details Found)

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

(No Water Bearing Zone Details Found)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments

Remarks

Form A Remarks:
RZM monitoring bore SK 6560

***** End of GW079892 *****

DEPARTMENT OF WATER AND ENERGY
Work Summary

GW080034

Licence :

Licence Status Active

Authorised Purpose(s)

Intended Purpose(s) MONITORING BORE

Work Type : Bore
Work Status : (Unknown)
Construct. Method :
Owner Type :

Commenced Date : **Final Depth :**
Completion Date : **Drilled Depth :**

Contractor Name :
Driller :
Assistant Driller's Name :

Property : **Standing Water Level :**
GWMA : **Salinity :**
GW Zone : **Yield :**

Site Details

Site Chosen By

	County	Parish	Portion/Lot DP
Form A :	GLOUCESTER	TOMAREE	
Licensed :			

Region : 20 - HUNTER **CMA Map :**
River Basin : **Grid Zone :** **Scale :**
Area / District :

Elevation : 5.94 m (A.H.D.) **Northing :** 6370959 **Latitude (S) :** 32° 47' 28"
Elevation Source : **Easting :** 365222 **Longitude (E) :** 151° 33' 38"

GS Map : **MGA Zone :** 56 **Coordinate Source :**

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details

(No Construction Details Found)

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

(No Water Bearing Zone Details Found)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments

Remarks

Form A Remarks:
RZM MONITORING BORE SK 8368

***** End of GW080034 *****

APPENDIX B

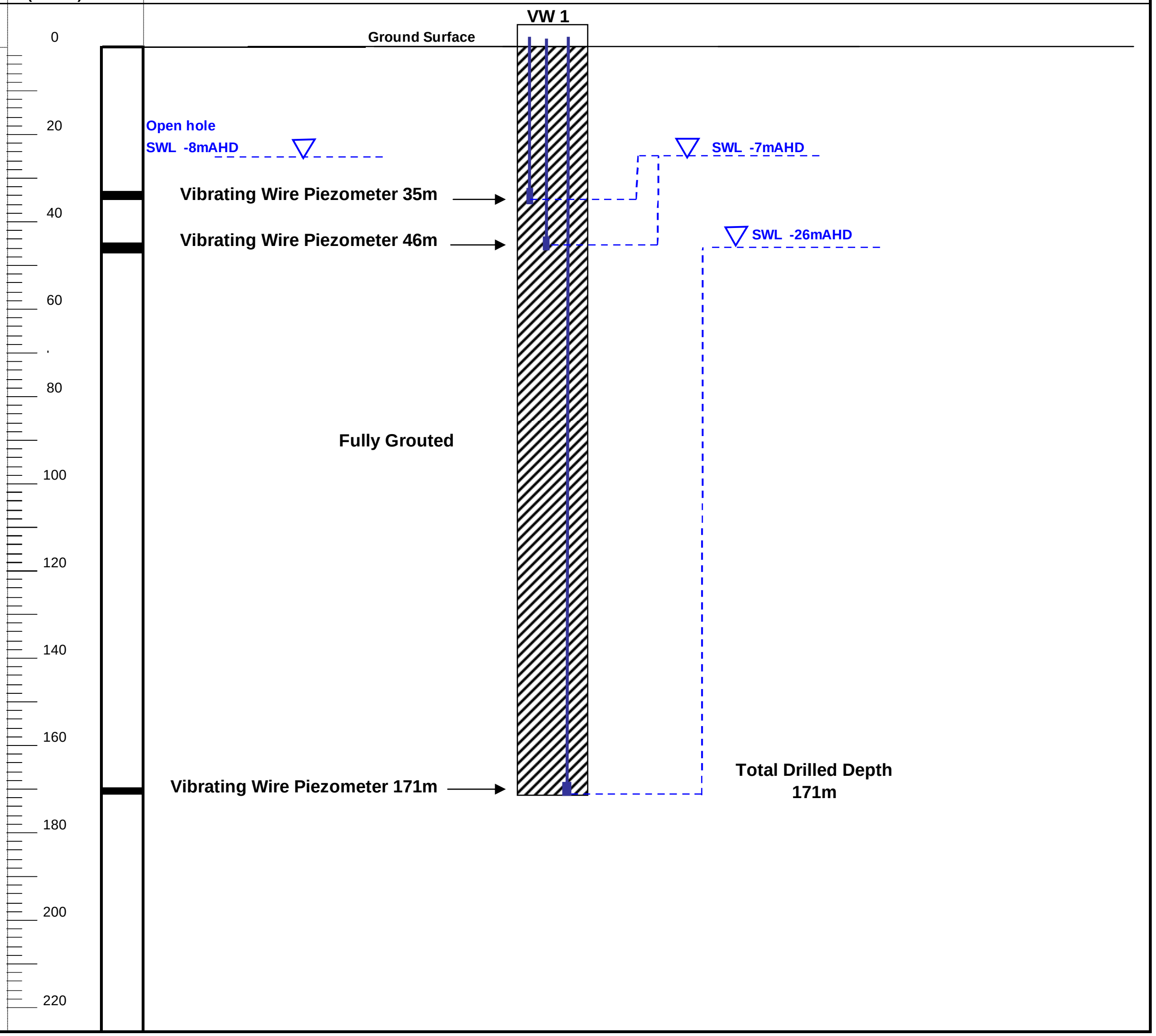
PIEZOMETER CONSTRUCTION LOGS

Aquaterra Consulting Pty Ltd
Logging Sheet

BORES: Site 1

						Project No:	S05
Client: Bloomfield Collieries Pty Ltd	Bore: VW 1	Elevation (GL): 17.4 mAHD	Elevation (TOC):	Stickup:	Drilling Contractor: Hunter Drilling Services	Date Started: 27-Mar-07	Date Finished: 12-Apr-07
Location: Bloomfield Project			Hole depths: As shown			Supervised By: R McCallum	

Description	Depth (metres)	Well Construction Details:
Donaldson Seam (33.0 to 35.4m)		
Big Ben Seam (44.3 to 47.2m)		
Rathluba Seam (170 to 171.8m)		

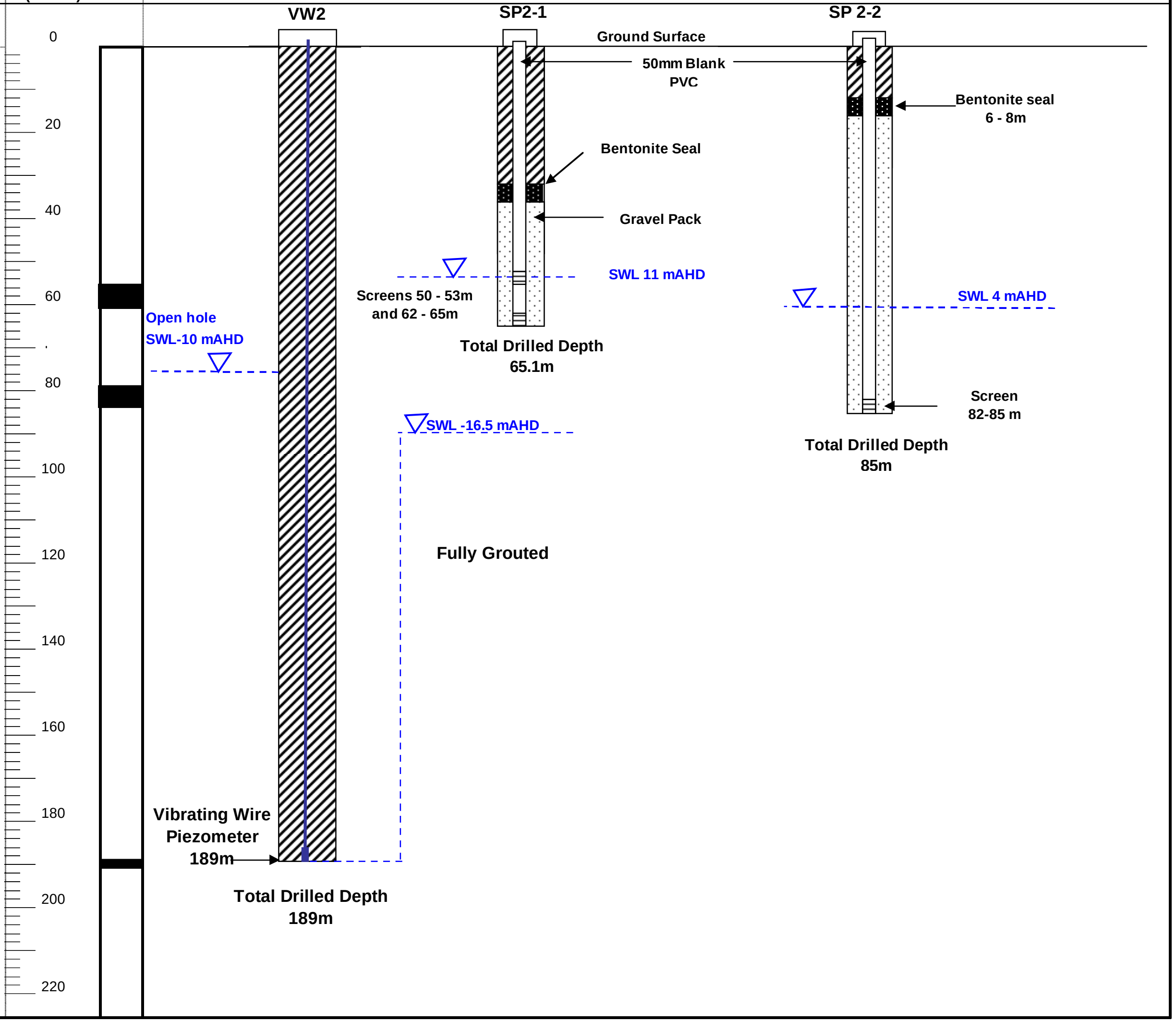


Aquaterra Consulting Pty Ltd
Logging Sheet

BORES: Site 2

						Project No:	S05
Client:	Bore:	Elevation (GL):	Elevation (TOC):	Stickup:	Drilling Contractor:	Date Started:	Date Finished:
Bloomfield Collieries Pty Ltd	VW2	65.2 mAHD			Hunter Drilling Services	20-Mar-07	27-Mar-07
Location:	SP2-1	65.2 mAHD			Hunter Drilling Services	20-Mar-07	27-Mar-07
Bloomfield Project	SP2-2	65.2 mAHD			Hunter Drilling Services	20-Mar-07	27-Mar-07
			Hole depths: As shown			Supervised By: R McCallum	

Description	Depth (metres)	Well Construction Details:
Donaldson Seam (55.2 to 61.4m)		
Big Ben Seam (79 to 84m)		
Rathluba Seam (187.8 to 191.3m)		



Appendix B-2: Bore Logs - Site 2

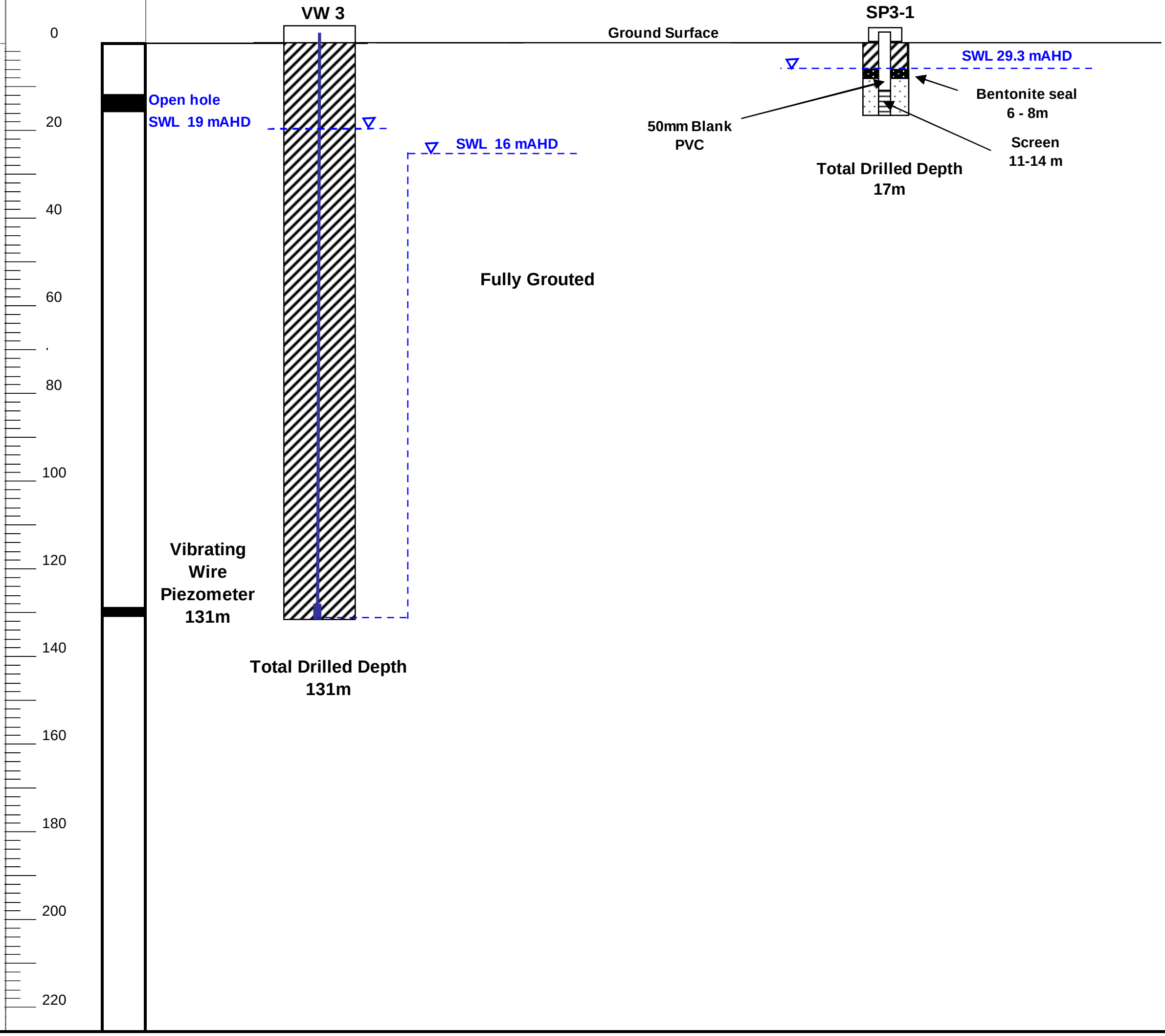
Aquaterra Consulting Pty Ltd
Logging Sheet

BORES: Site 3

Project No:	S05

Client:	Bore:	Elevation (GL):	Elevation (TOC):	Stickup:	Drilling Contractor:	Date Started:	Date Finished:
Bloomfield Collieries Pty Ltd	**VW3**	**38.8 mAHD**			**Hunter Drilling Services**	**11-May-07**	**14-May-07**
Location:	**SP3-1**	**38.8 mAHD**			**Hunter Drilling Services**	**11-May-07**	**14-May-07**
Bloomfield Project							
			Hole depths: **As shown**			Supervised By: **R McCallum**	

Description	Depth (metres)	Well Construction Details:
Donaldson Seam (12 to 15.2m)		
Rathluba Seam (129.7 to 131.5m)		

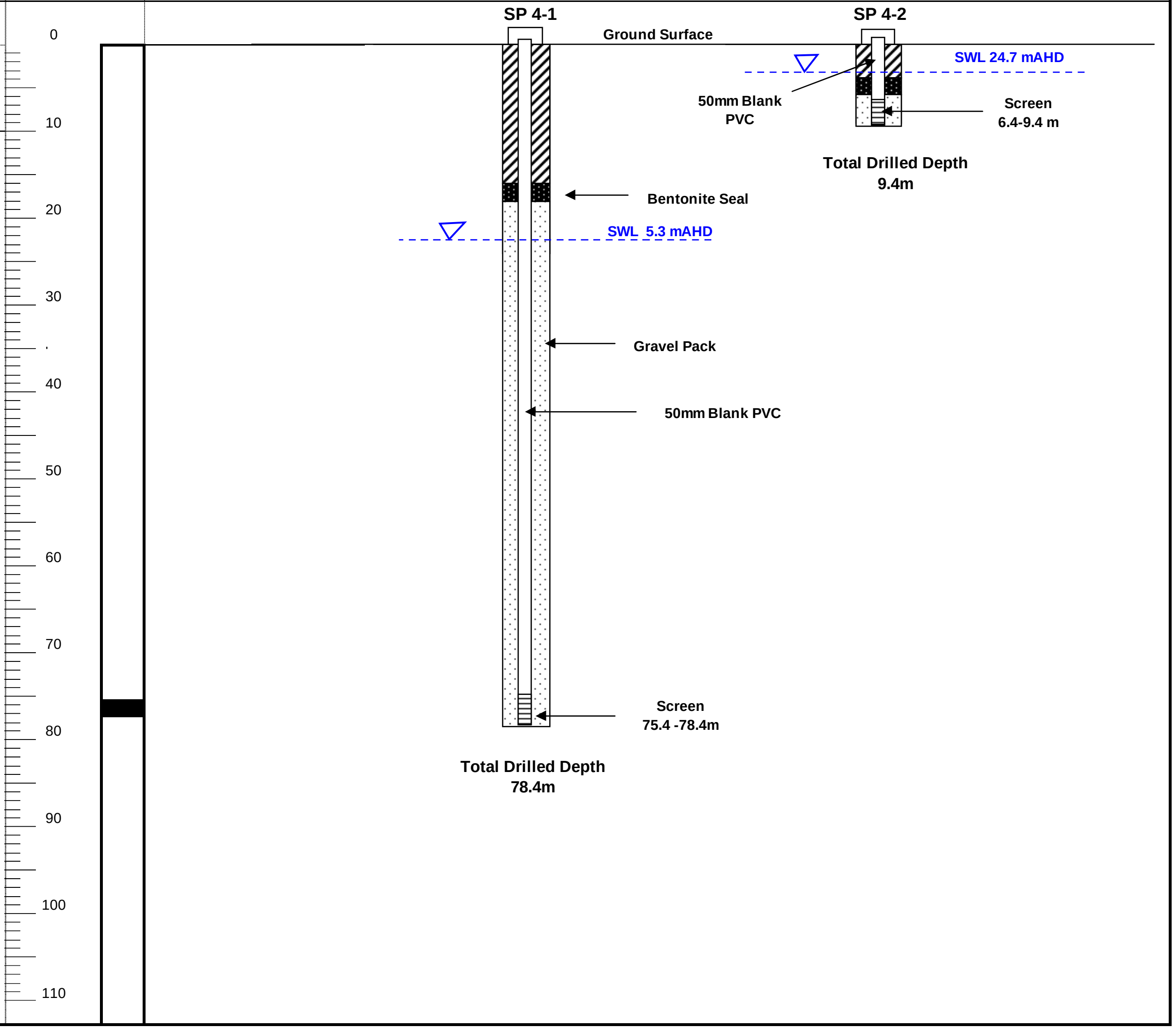


Aquaterra Consulting Pty Ltd
Logging Sheet

BORES: Site 4

						Project No:	S05
Client:	Bore:	Elevation (GL):	Elevation (TOC):	Stickup:	Drilling Contractor:	Date Started:	Date Finished:
Bloomfield Collieries Pty Ltd	**SP4-1**	**27.8 mAHD**			**Hunter Drilling Services**	**16-Mar-07**	**17-Mar-07**
Location:	**SP4-2**	**27.8 mAHD**		**0.25 m**	**Hunter Drilling Services**	**16-Mar-07**	**17-Mar-07**
Bloomfield Project							
			Hole depths: **As shown**			Supervised By: **R McCallum**	

Description	Depth (metres)	Well Construction Details:
Alluvium / weathered Permian	0–10	
Rathluba Seam (75.4 to 77.4m)		



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Logging Sheet

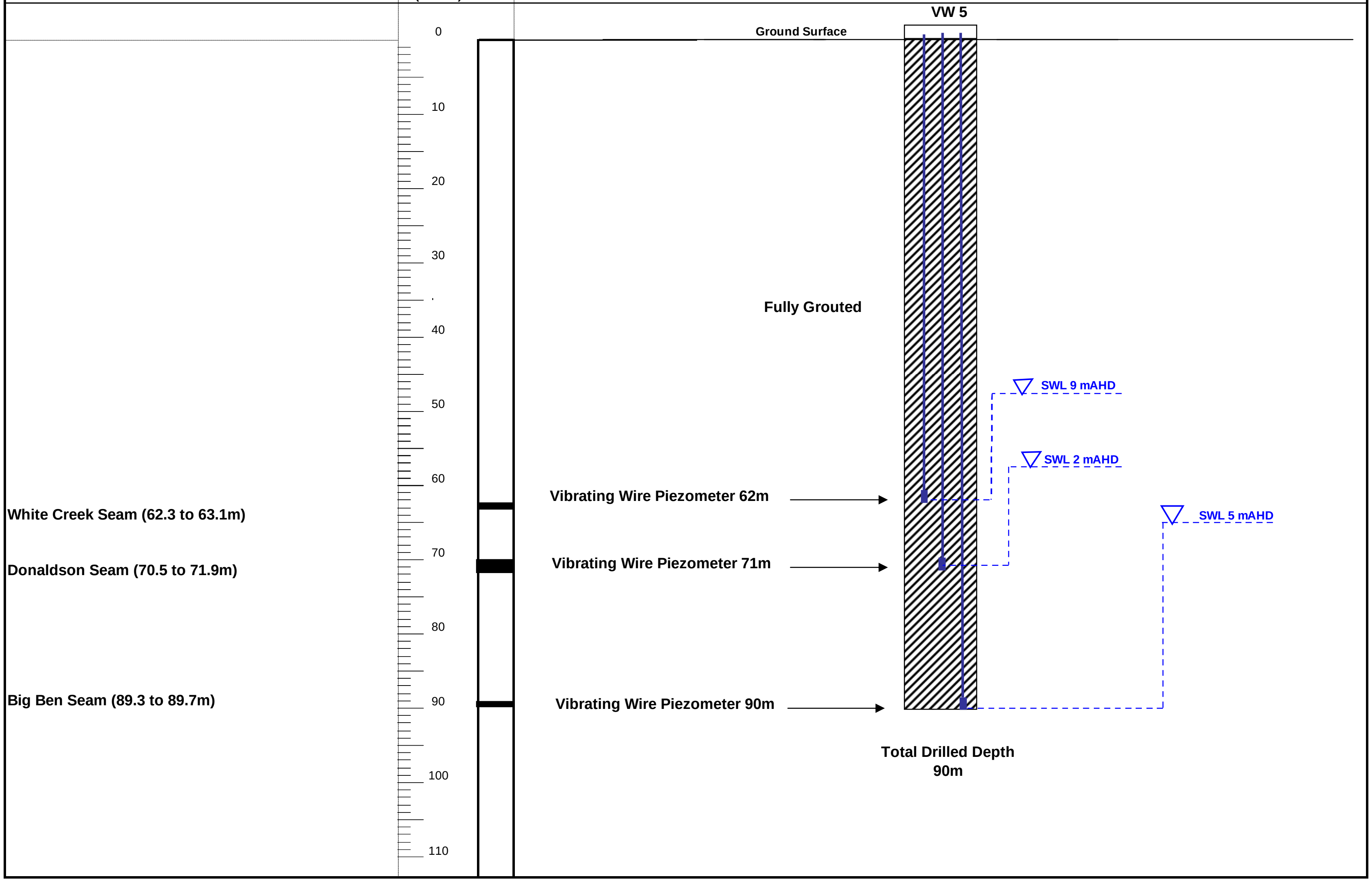
BORES: Site 5

Project No:	S05

Client:	Bore:	Elevation (GL):	Elevation (TOC):	Stickup:	Drilling Contractor:	Date Started:	Date Finished:
Bloomfield Collieries Pty Ltd	VW5	55.7 mAHD			Hunter Drilling Services	05-Apr-07	27-Apr-07

Location:		Supervised By:
Bloomfield Project	As shown	R McCallum

Description	Depth (metres)	Well Construction Details:



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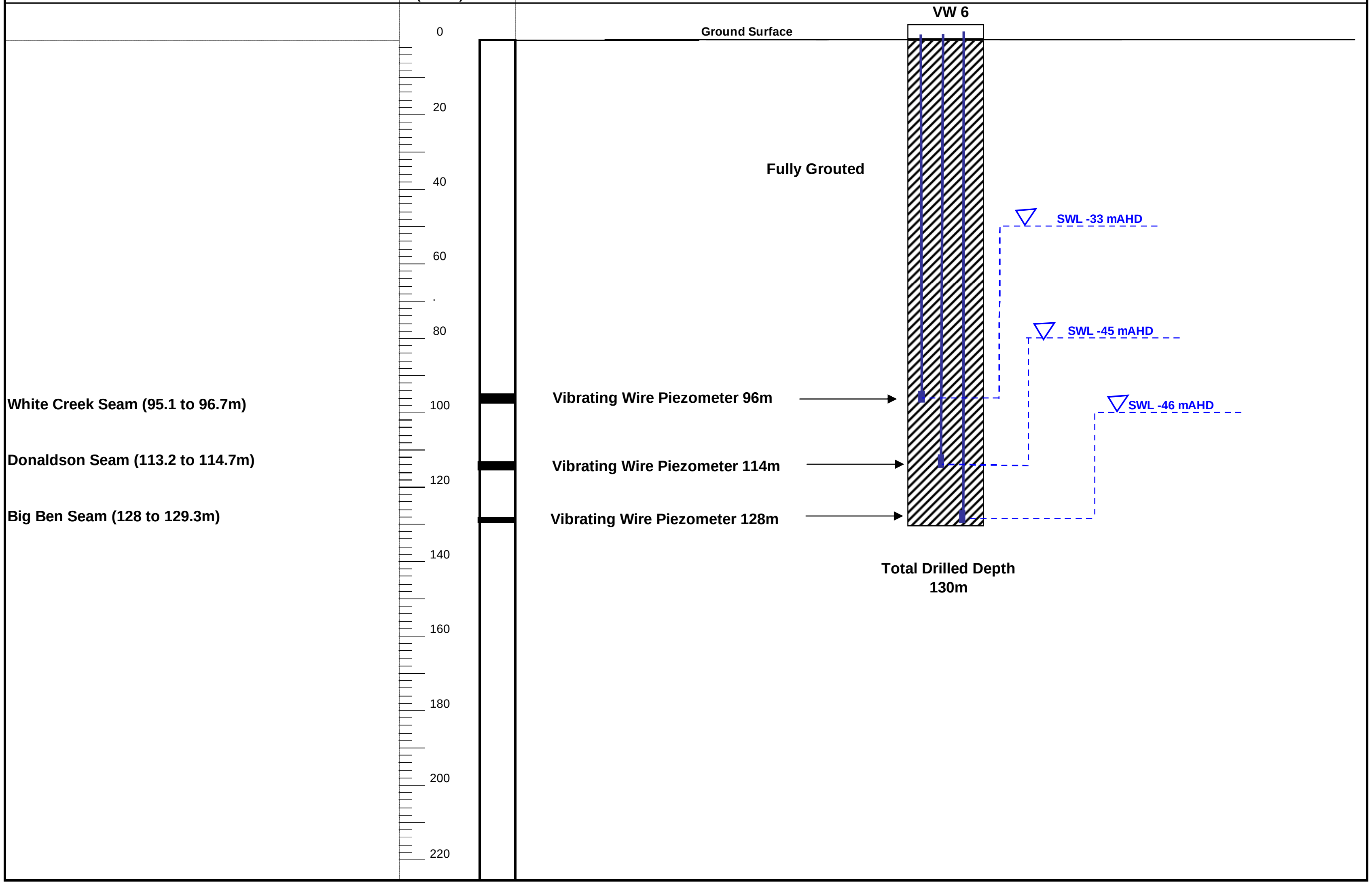
Logging Sheet

BORES: Site 6

						Project No:	S05
Client: Bloomfield Collieries Pty Ltd	Bore: VW6	Elevation (GL): 52.5 mAHD	Elevation (TOC): 52.75 mAHD	Stickup: 0.25 m	Drilling Contractor: Hunter Drilling Services	Date Started: 24-Apr-07	Date Finished: 27-Apr-07
Location: Bloomfield Project			Hole depths: As shown			Supervised By: R McCallum	

Description	Depth (metres)	Well Construction Details:



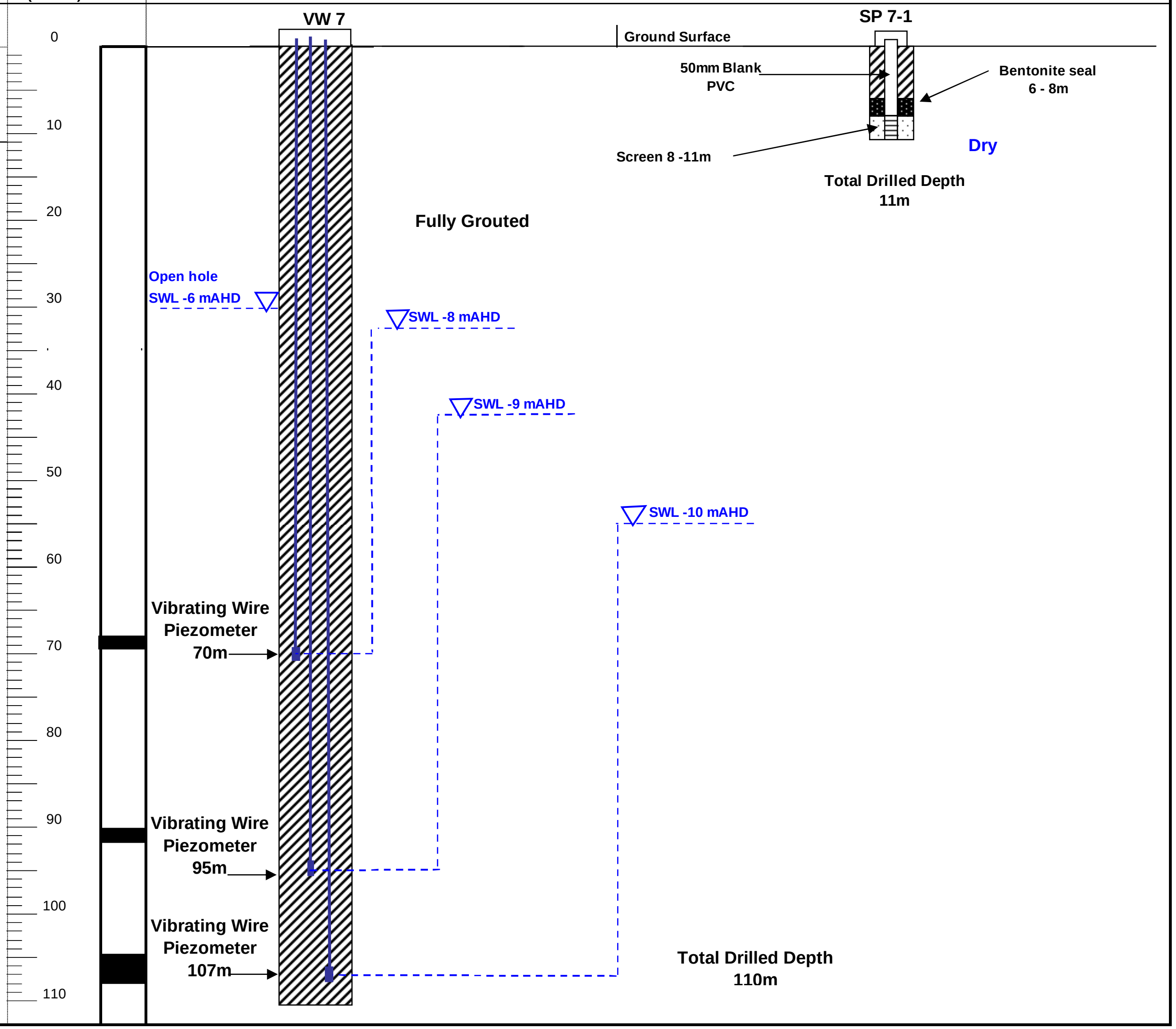
Aquaterra Consulting Pty Ltd
Logging Sheet

BORES: Site 7

Project No:	S05

Client:	Bore:	Depth:	Elevation (GL):	Elevation (TOC):	Stickup:	Drilling Contractor:	Date Started:	Date Finished:
Bloomfield Collieries Pty Ltd	VW7		24.9 mAHD			Hunter Drilling Services	18-Apr-07	24-Apr-07
Location:	SP7-1		24.9 mAHD			Hunter Drilling Services		
Bloomfield Project				As shown			Supervised By: R McCallum	

Description	Depth (metres)	Well Construction Details:
Alluvium / weathered Permian	0 – 10	
White Creek Seam (67.9 to 69.8m)	70	
Donaldson Seam (90.0 to 91.8m)	90	
Big Ben Seam (104.7 to 107.7m)	105	

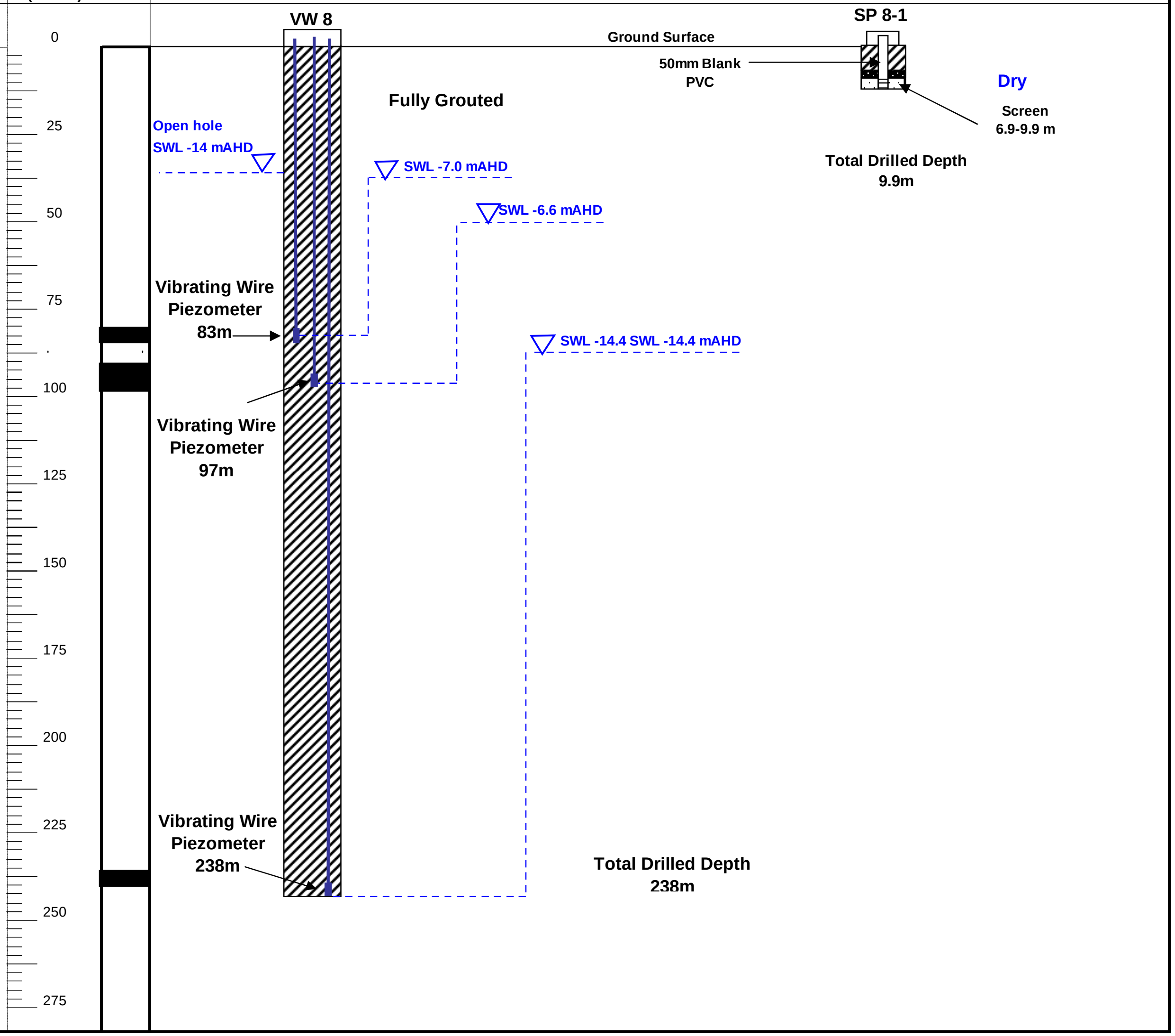


Aquaterra Consulting Pty Ltd
Logging Sheet

BORES: Site 8

						Project No:	S05
Client:	Bore:	Depth:	Elevation (GL):	Elevation (TOC):	Stickup:	Drilling Contractor:	Date Started: / Date Finished:
Bloomfield Collieries Pty Ltd	VW8		22.5 mAHD			Hunter Drilling Services	29-Mar-07 / 18-Apr-07
Location:	SP8-1		22.5 mAHD				
Bloomfield Project				As shown			Supervised By: R McCallum

Description	Depth (metres)	Well Construction Details:
Alluvium		
Donaldson Seam (80.4 to 84m)		
Big Ben Seam (91.5 to 98.5m)		
Rathluba Seam (237.2 to 240.2m)		



APPENDIX C

GROUNDWATER MODELLING REPORT

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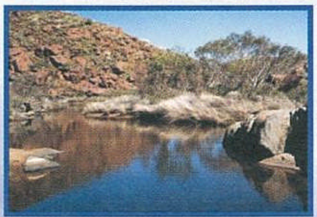
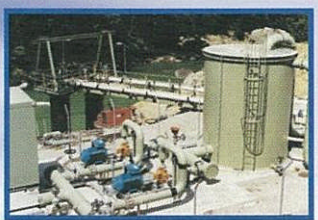
BLOOMFIELD COMPLETION OF MINING & REHABILITATION GROUNDWATER MODELLING





Prepared for: Peter Dundon & Associates Pty Ltd

Ref: A58/B1/R001e

May 2008

BLOOMFIELD COMPLETION OF MINING & REHABILITATION GROUNDWATER MODELLING

Document Status

Revision	Date	Revision Description
A	13 November, 2007	Draft for Client and Reviewer comment
B	3 March, 2008	Updated model scenarios
C	14 April, 2008	Incorporating edits from Peter Dundon
D	2 May 2008	Edits to Table 4.5 and Table 4.6
E	29 May 2008	Final draft minor edits

	Name	Position	Signature	Date
Originators:	Joel Georgiou	Groundwater Modeller	***J. Georgiou***	13 November, 2007
	Dr Mohammed Alkhatib	Groundwater Modeller	***M. Alkhatib***	28 May 2008
Reviewer:	Hugh Middlemis	Principal Water Resources Engineer	***H Middlemis***	28 May 2008

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EXECUTIVE SUMMARY

The Bloomfield Coal Mine Project is located approximately 20 kilometres north-west of Newcastle in the Hunter Valley of NSW. Coal has been mined on the site for approximately 170 years. Underground mining ceased on the site in 1992 and the current operation consists of open cut mining, a Coal Handling and Preparation Plant (CHPP) and a rail loading facility that transports processed coal to the Port of Newcastle. Bloomfield Collieries is seeking approval for the completion and rehabilitation of open cut mining. The continued use of the coal washery and rail loading facility (including the management of water associated with the washery, coarse reject and tailings disposal and coal handling) was approved in June 2007 as part of the Abel Underground Mine project (Donaldson Coal, 2006).

Bloomfield is currently in the final stages of its planned open cut mining program and is actively rehabilitating former mining areas on the site. The current average production rate is 0.8 million tonnes per annum (Mpta) of run of mine (ROM) coal. It is proposed to continue mining at this production rate in order to complete the mining and rehabilitation of the site. There is estimated to be approximately 9 million tonnes of viable run-of-mine (ROM) coal remaining on the site.

The Company engaged Peter Dundon and Associates to undertake a groundwater impact assessment study including water management relating to mine closure and post-mining. Peter Dundon and Associates in turn engaged Aquaterra to develop a numerical groundwater flow model to assist with the prediction of impacts.

This report details development of the Bloomfield Coal groundwater model, the results of the steady-state calibration, sensitivity analysis, predictive scenario modelling and prediction uncertainty assessment for mine dewatering operations and post-mining recovery. The steady-state model includes simulation of the past and present dewatering activities of Bloomfield and Donaldson open cut. Predictive modelling also includes the Abel coal project which is currently under development.

The modelling has been carried out in accordance with best practice guidelines for groundwater flow modelling (MDBC, 2001).

The main features of the Bloomfield groundwater model are:

- An **8-layered model** setup using the **MODFLOW** finite difference numerical code in conjunction with **SURFACT**. The SURFACT module allows both unsaturated and saturated flow conditions to be simulated; in this case, variably saturated flow has been simulated using SURFACT's pseudo soil function. The Groundwater Vistas interface software was employed.
- The **model domain** occupies an area of approximately 14km x 14.5km. The model boundaries to the north and west are set at the outcrop lines of the lowermost coal seam to be mined in the proposal, and have been set as no flow boundaries. In other specific areas, boundaries have been set as head-dependent flow boundaries, notably on the south-east at Hexham Swamp, and on the north-west at Wallis Creek. The southern model boundary is some distance from Bloomfield, and is also set as a head-dependent flow boundary.
- **Stream-aquifer interaction features** are incorporated into the Bloomfield model to represent the dynamic linkages between the surface water and groundwater systems along the major streams (using

MODFLOW's River and Drain packages). The model has been designed to allow for both groundwater discharge to the stream system ("baseflow"), and streambed leakage to the groundwater, for the major creeks and water bodies (Wallis Creek and Hexham Swamp). The Tailings Storage has been treated similarly. However, for the minor streams and tributaries (Buttai Creek, Surveyors Creek, Four Mile Creek, Bluegum Creek, Minmi Creek, Viney Creek, Weakleys Flat Creek and Nile Creek), the model allows for only groundwater discharge to the stream system (ie. utilising MODFLOW's DRAIN package).

- **Rainfall recharge and evapotranspiration processes** are incorporated into the model. Rainfall recharge rates in the model are varied spatially depending on topography and the location of Permian rock exposures. Evaporation processes are active wherever the water table is shallow, which is generally only in areas near the major creeks and their tributaries and also near surface water bodies like Hexham Swamp and the Tailings Storage.
- The **model grid** comprises varying cell sizes, from 25m x 25m in the central region where the Bloomfield open cut mine is located, to a maximum 100m x 100m at the outer limits of the model. This resulted in a grid mesh of 276 rows and 277 columns, with 8 model layers, giving a total of about 612,000 cells.
- The **8 model layers** represent the following designated hydrogeologic units:

    1. Weathered regolith and alluvial deposits.
    2. Represents all Permian strata above the Whites Creek seam. This layer includes the Sandgate, West Borehole and other minor coal seams.
    3. Whites Creek Seam.
    4. Interburden sediments
    5. Donaldson Coal Seam.
    6. Interburden sediments
    7. Big Ben Coal Seam.
    8. Combination of deeper coal seams, interburden and basement.

The modelling program comprised the following:

- **Steady state calibration**: to represent the current distribution of groundwater levels, for use as input to the initial conditions for the prediction scenarios.
- **Prediction modelling**: in which the calibrated model was used to predict the groundwater inflow rates to the proposed open cut mine, changes in groundwater levels, impacts on baseflow contribution to Wallis Creeks, tributaries and other water balance components.
- **Sensitivity analysis**: in which the sensitivity of the model to calibration parameter values was assessed by running the model multiple times with key parameters increased or decreased in turn.
- **Prediction uncertainty analysis**: in which the most sensitive model calibration parameters were applied to the mine dewatering prediction scenarios.
- **Post-mining recovery**: in which the model was run for 100 years after completion of mining.

The model-calculated mine dewatering inflows are very consistent with the current estimated inflows, and are predicted to average about 1400 kL/day over the 11-year mine life. Predicted dewatering impacts on groundwater levels and baseflow contributions are not significant in relation to seasonal variations, nor in terms of practical measurement resolution. The maximum reduction in baseflows is expected to be about 20 kL/d (0.2 L/sec.) in Wallis Creek by the end of Bloomfield open cut mining in year 11.

The post-mining recovery simulation indicates that groundwater levels would have substantially recovered within 20 years after completion of mining, and generally reached a post-mining equilibrium within about 40 years, and in many cases considerably earlier.

The comprehensive sensitivity and predictive uncertainty analysis indicates a small range in uncertainty in terms of the predicted mine inflow rates (generally within 10% to 20% of the adopted base case values) and in terms of the related effects of drawdown and baseflow, indicating that the calibration set of parameters is near optimal and the predictions are robust.

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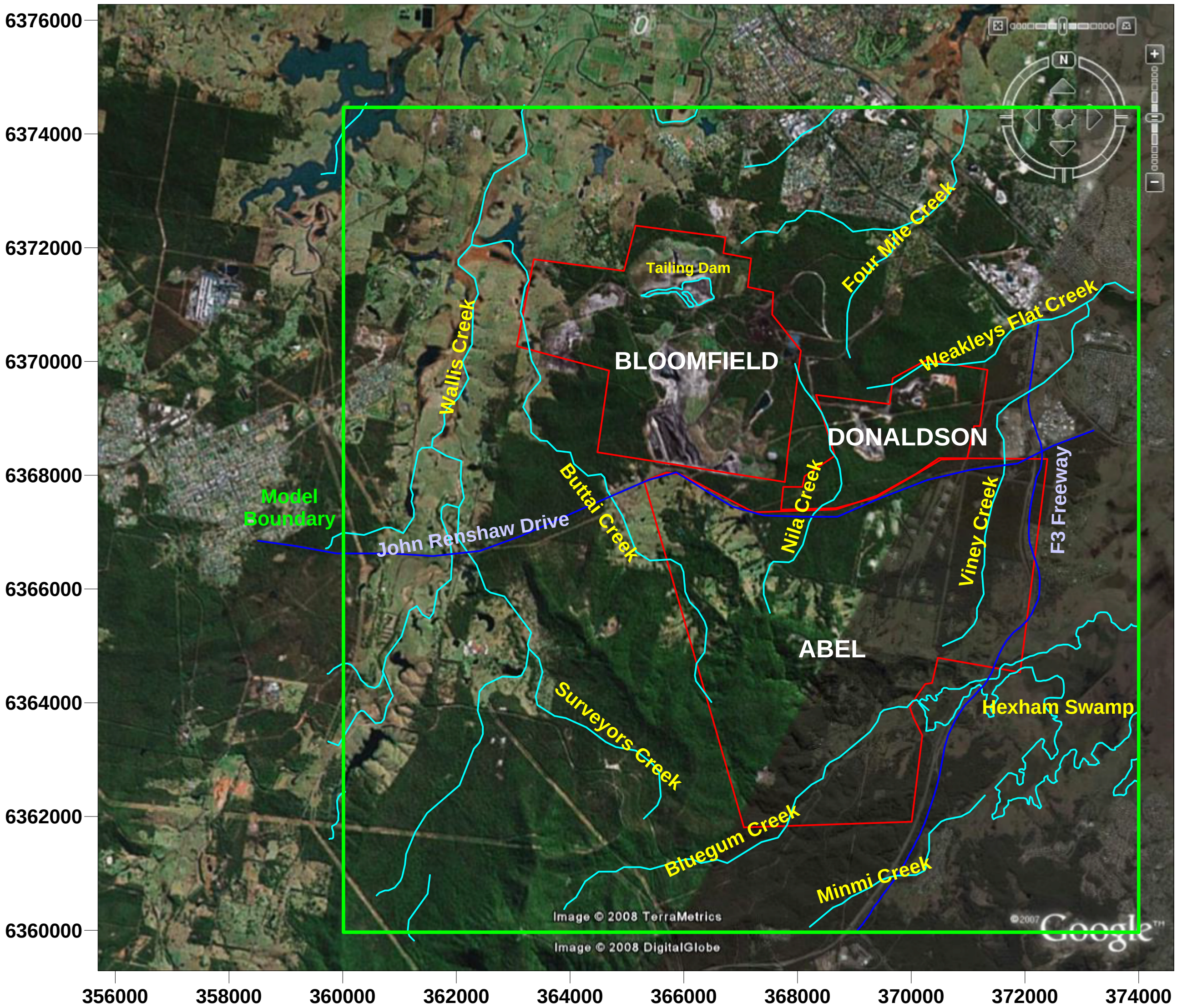
SECTION 1 - INTRODUCTION

The Bloomfield Coal Mine is an existing open cut mining operation located near Buttai in the Hunter Valley of NSW, about 25 km NW of Newcastle, and about 5km south of Maitland. The project site is located few kilometres west of the F3 Freeway and immediately North of John Renshaw Drive (Figure 1.1).

Figure 1.1
Bloomfield Coal Mine Location and Model Extent

(Green line denotes the model boundaries, mine lease areas shown in red)



Bloomfield Collieries Pty Ltd engaged Peter Dundon and Associates to undertake hydrogeological investigations to support the preparation of an EA in support of a Part 3A project application. As part of these investigations, Peter Dundon and Associates has engaged Aquaterra to develop a numerical groundwater flow model and carry out modelling studies. The main objectives of the modelling studies were to:

- investigate the dewatering requirements and potential impacts of Bloomfield open cut mining activities on aquifers, and also surface watercourses in the area, notably Wallis creek and Buttai Creek, and
- estimate potential cumulative impacts due to the influences of the nearby Abel underground mine and Donaldson open cut mine.

SECTION 2 - CONCEPTUAL HYDROGEOLOGY

The conceptual hydrogeological model for the area is based to a large degree on investigations undertaken by Peter Dundon and Associates and is summarised below.

2.1 GEOLOGY

The project area is underlain by Permian Tomago and Newcastle Coal Measures (Figure 2.1). The target seams of the remaining mining at Bloomfield are the Big Ben, Donaldson, Elwells Creek, Whites Creek and Upper and Lower Buttai Coal Seams (Figure 2.2).

Sediments above and below these coal seams comprise predominantly interbedded mudstone, siltstone and sandstone. The strata dip generally towards the south and south-west in the project area, which is situated on the western limb of the Four Mile Creek Anticline (Figure 2.2). To the west of Bloomfield along Wallis Creek, the bedrock is overlain by Quaternary alluvial deposits including gravel, sand, silt and clay. Alluvium also occurs along the floodplain of the Hunter River to the east and north-east. Further detail on geology is provided in Aquaterra (2008).

Surface topography in the Bloomfield project area ranges from less than 20 mAHD to more than 80 mAHD (Appendix A).

2.2 HYDROGEOLOGY

Overall, the coal measures are poorly permeable, but permeability is relatively higher in the coal seams. The interbedded sandstones and siltstones are of lower permeability (by at least one or two orders of magnitude) and offer very limited intergranular porosity and little secondary permeability and storage in joints.

Groundwater also occurs in the alluvium, which comprises mainly swamp, floodplain and estuarine sediments. Groundwater also occurs locally in the shallow weathered Permian, which extends to depths of 10-20 metres, and is more closely related hydrogeologically to the alluvium than to the deeper groundwater in the Permian coal measures. Groundwater levels measured in the alluvium and weathered Permian are quite variable, because the water levels are generally related to the local topographic elevations.

The potentiometric head within the coal seams is regionally-controlled, shows a consistent pattern across the project area (progressive decline with depth), and is generally unrelated to the local topographic elevation, as described in detail in Peter Dundon and Associates (2007). Deep piezometers in low-lying areas can indicate artesian coal seam conditions (piezometric water levels above ground level[1]). At more elevated sites, deeper piezometers show the groundwater levels to be up to 40 m lower than the near-surface groundwater. The large head differences between the shallow groundwater and deeper Permian groundwater levels, and the presence of artesian groundwater in the Permian in low-lying areas, are both indications of limited hydraulic connectivity between the alluvium/weathered overburden and the deeper coal measures.

[1] Water levels above ground surface in deeper piezometers generally occur only in low-lying areas, because the groundwater is confined, and is under pressure. The water level in a bore represents the groundwater pressure or head within the part of the aquifer that is screened, and the head is controlled by the elevation of the recharge zone for that horizon, usually some distance updip where that particular horizon outcrops. In the unconfined alluvium or weathered bedrock aquifers, the water level represents the level of saturation. A bore water level in the unconfined aquifer at the same elevation as the ground surface would be accompanied by seepage or boggy conditions around the bore.

Figure 2.1
Bloomfield Area Generalised Geology
(Model extent shown in blue; Bloomfield, Donaldson and Abel lease outlines shown in red)

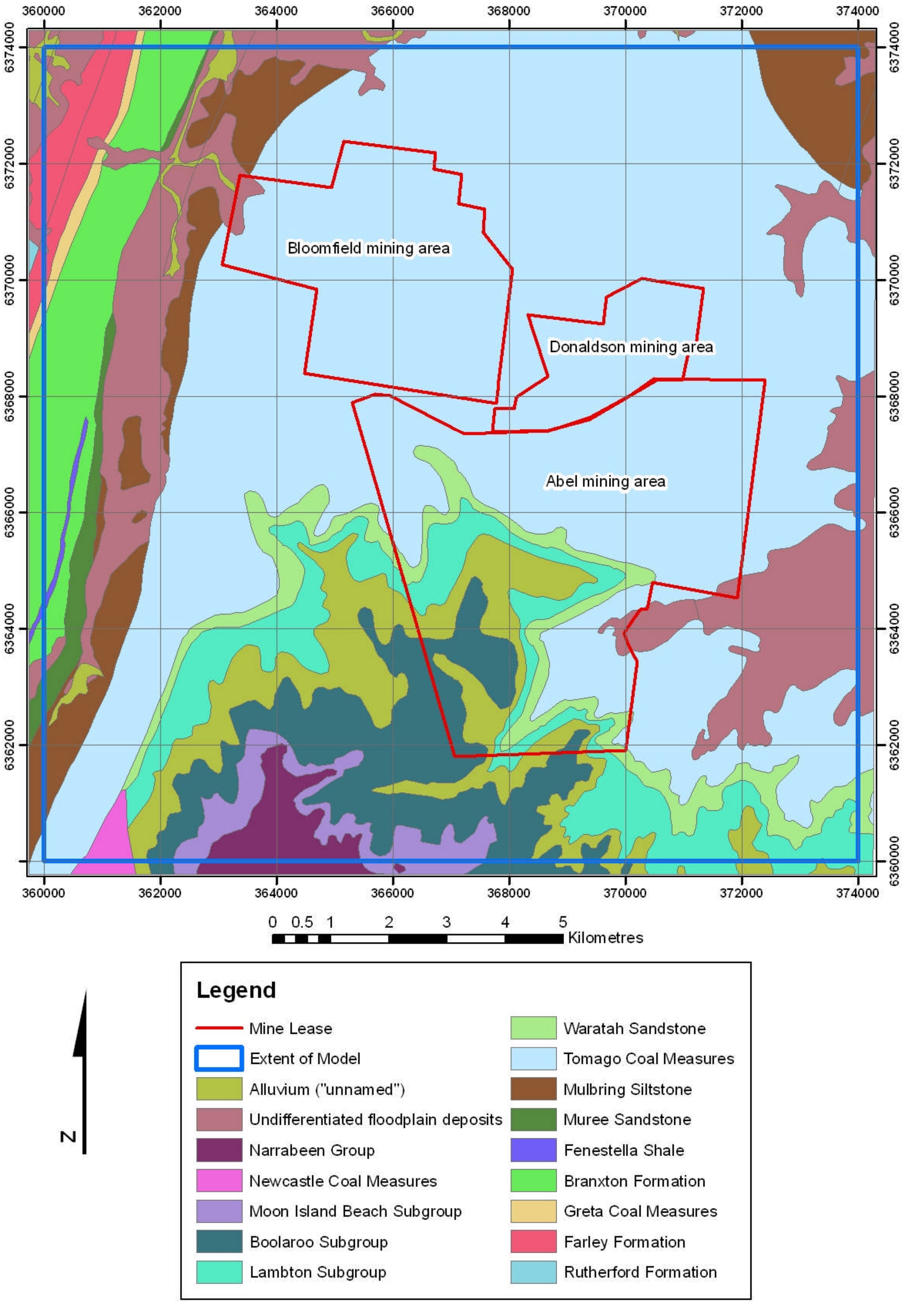
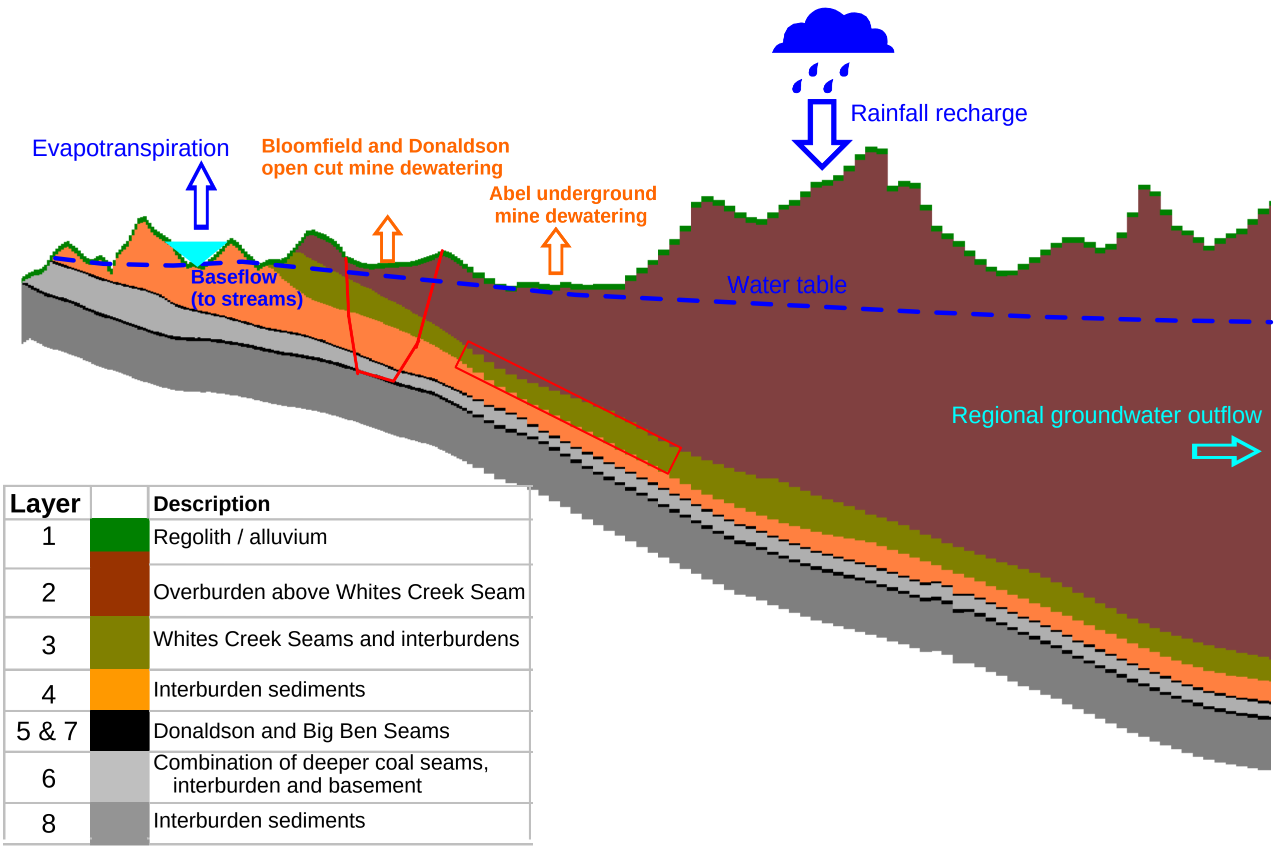


Figure 2.2
Bloomfield Area Regional Cross-Section and Conceptual Model



A summary of representative aquifer properties adopted for the main hydrogeological units in the model area is given in Table 2.1. These are based on hydraulic testing on the Bloomfield site, supplemented by previous investigations for the Abel and Donaldson projects, and experience in other parts of the Hunter Valley coalfields.

Table 2.1
Parameters of hydrogeological units

Units	Horizontal Hydraulic Conductivity (m/d)	Confined Storativity	Unconfined Specific Yield
Coal Seams	0.01 to 0.1	0.0001	0.01
Interburden (undisturbed)	0.001	0.00001	0.005
Interburden (disturbed by subsidence from underground mining)	0.1 to 10	0.0001	0.01 to 0.05
Alluvium	5 to 1 m/d	0.0001	0.1

Note: Vertical hydraulic conductivities in the coal measures are believed to be less than one tenth of the value of the horizontal hydraulic conductivities.

Groundwater within the coal measures is controlled by the recharge-discharge process, with highest groundwater levels in the northern parts of the lease area where the coal measures outcrop. Groundwater levels generally fall to the south and south-east in the direction of groundwater flow downdip to the locations of primary discharge. There is believed to be a component of lateral flow in the Coal Measures out of the model area over the southern and eastern model boundaries. The rate of flow across the model boundaries is believed to be limited due to the substantial burial of the coal seams under extensive cover of overburden material (several hundred metres thick).

Data on water levels are summarised in Section 4. The data indicates the influence of dewatering in the Bloomfield and Donaldson Mine areas, with distinct cones of depression centred on the current active open cuts.

2.3 RECHARGE

Long term records of rainfall data are available for a number of nearby stations, the closest being the East Maitland Bowling Club (32.7483S, 151.5833E; about 5 km NE of the Bloomfield mining area). Table 2.2 lists the mean monthly and annual rainfall, based on more than 90 years of daily rainfall data since 1902.

Table 2.2
Mean monthly rainfall at East Maitland Bowling Club (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Mean (mm)	89.0	94.1	96.5	87.4	70.3	84.2	58.1	52.2	54.8	65.5	61.6	81.3	895.0

Rainfall recharge occurs to both the coal seams where they outcrop, and to the surficial alluvium/weathered Permian aquifer system. The alluvial aquifers are believed to be in hydraulic continuity with Pambalong Nature Reserve and Hexham Swamp in the east, and with Wallis Creek to the west of the Bloomfield mining area. During periods of high stream flow, surface watercourses may also contribute to recharge to these alluvial aquifers. However, stream flows from rainfall runoff are reported to be short-lived after rainfall events. For most of the time, streamflows are maintained by groundwater discharge (baseflow).

The coal seams are recharged in areas of outcrop and shallow subcrop by direct infiltration of rainfall. Where covered by overburden, the coal seams are recharged primarily by lateral flow down-gradient from the outcrop areas, possibly also with a smaller component of downward percolation through the less permeable overburden.

Rainfall recharge rates within the hard rock outcrop area are believed to be relatively low (i.e. below 10 mm/yr). However, where alluvial deposits occur, recharge rates may be as high as 100 mm/yr. Rainfall recharge occurs in practice as an intermittent process, related to specific larger rainfall events. However, for the steady-state ("long term average") groundwater model, rainfall recharge has been modelled by applying constant assumed effective recharge rates to the alluvium and hard-rock areas, rather than a time-dependent recharge mechanism.

2.4 GROUNDWATER DISCHARGE

In outcrop or shallow subcrop areas, groundwater discharge from the coal measures can occur through evaporation, seepage and spring flow where the water table intersects the land surface, and through baseflow contributions to creeks, rivers and the Hexham Swamp, including discharge to the alluvium where it occurs. Away from outcrop, discharge from the coal measures occurs by slow down-dip flow along bedding or other zones of enhanced permeability to the south and south-east to areas where the groundwater heads are lower, with ultimate discharge probably to the ocean.

Groundwater discharge from the alluvium and shallow weathered bedrock can occur by evapotranspiration, seepage and discharge to creeks or to the wetlands of Pambalong Nature Reserve, Hexham Swamp and Wallis Creek.

Due to the high groundwater salinity and low bore yields, there is almost no existing groundwater abstraction within the model area other than for coal mine dewatering (Donaldson, Bloomfield, etc). A small number of stock/domestic bores are registered in the DWE bore database.

Average A Class pan evaporation data is available for Cessnock (32.8093S 151.3490E) and Paterson (32.63S, 151.59E), and provide the closest data to the Bloomfield mining area. Table 2.3 summarises mean monthly evaporation rates, based on a 34 year period.

Table 2.3
Mean daily evaporation data for Cessnock and Paterson Stations (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cessnock	5.7	5.0	4.0	3.0	2.0	1.6	1.8	2.6	3.6	4.4	5.2	5.9
Paterson	6.0	5.2	4.2	3.4	2.4	2.2	2.5	3.4	4.4	5.2	5.9	7.0

Evaporation is included in the model using the Evapotranspiration (EVT) package of MODFLOW. The EVT parameter values adopted were a constant rate of 250 mm/yr and an extinction depth of 3 m, which allows EVT to be active in areas of shallow water table, such as in areas of low topography along surface water courses such as Wallis Creek and the Hexham Swamp area.

2.5 SURFACE DRAINAGE

The land surface within the Bloomfield mining lease area is located within the lower section of the Hunter River catchment and consists of low undulating hills. There are several surface water catchments in the model area, with associated creeks being generally ephemeral or sustained by small baseflow discharges, with the possible exception of Wallis Creek to the west.

The western part of the Bloomfield mining area lies within the Buttai Creek Catchment, which drains westwards into Wallis Creek and then into Hunter River east of Maitland. Wallis Creek is characterised by alluvial deposits developed along the river bed. Such deposits are also present in the east of the model area, around Hexham Swamp, which is protected from tidal influence by floodgates, and which also receives drainage from the Long Gully/Blue Gum Creek catchment from the southern part of the model area. The numerical model incorporates river/aquifer interactions, to enable quantification of the impacts of groundwater pumping on surface water features. This is important to assess whether mining is likely to lower water levels and reduce baseflow to permanent streams, although it should be noted that the streams in the Bloomfield project area are mainly ephemeral because baseflow support is relatively short, and extensive periods of no flow occur naturally.

SECTION 3 - IMPLEMENTATION OF CONCEPTUALISATION IN MODEL

3.1 MODEL SELECTION AND COMPLEXITY

The MODFLOW numerical groundwater flow modelling package was applied to early development of this medium complexity modelling study, operating under the Processing Modflow Pro software package (IES). However, the Vistas software package (ESI) has also been used during later stages when the Bloomfield model was refined and run under the MODFLOW-SURFACT numerical package for the final series of calibration and prediction model runs.

The MODFLOW-based numerical code is suitable for this study, particularly due to its industry-leading modules for simulating surface water and groundwater interaction.

MODFLOW-SURFACT is a module with which saturated/unsaturated flow conditions can be simulated to overcome problems with unsaturated (dewatered or dry) model cells and enhance the stability of the numerical solution. The variably-saturated flow simulation is implemented with the pseudo soil function of the MODFLOW SURFACT BCF4 package in the Bloomfield model.

The degree of model complexity required to accomplish the study objectives is a key issue (MDBC, 2001). In this case, a **medium complexity model** appropriate for impact assessment purposes was required.

3.2 MODEL EXTENT, LAYERS AND GRID

The Bloomfield model area of about 200 km^2 is shown in Figure 2.1. It includes the Bloomfield, Donaldson and Abel mining areas and extends to Northing 6,374,500, which includes the outcrop line of the Big Ben seam. The southern boundary has been set at Northing 6,360,000.

The eastern model boundary is located within the Hexham Swamp at Easting 374,000, about 2 km east of the F3 Freeway. The western model boundary is located at Easting 360,000 and is represented predominantly by Wallis Creek as discussed further in Section 3.3.

The cell size throughout the model is not uniform; it varies from 25 metres square at the Bloomfield Coal Mine area, and increases gradually up to 100 metres square near the model boundaries. This gives a grid mesh of 276 rows and 277 columns, producing a total of 76,452 cells per layer, or a total number of cells for 8 model layers of 611,616 (with about 94% of model cells active). The fine grid (25 x 25 m) was selected in the mining area to provide the capability for accurate modelling results, and also has the advantage of providing better resolution of the dipping layer geometry, and the areas of potentially steep groundwater gradients close to the open cuts. The Bloomfield model is medium-sized in terms of computing requirements, and involves substantial but not excessively long run times.

Eight model layers are used (Table 3.1), with coal seams and interburden represented independently. Layer 1 is unconfined (Modflow Type 1), while layers 2 to 8 are defined as semi-confined aquifers with variable Transmissivity (Modflow Type 3).

Table 3.1
Summary of Model Layers

Layer	Description	Extent	Assumed thickness (m)
1	Weathered regolith and alluvial deposits.	Extends over the entire model domain	Constant thickness of 5 m, below surface topography from DEM.
2	Represents numerous geological units comprising all overburden above Whites Creek seam (including Sandgate, West Borehole and other coal seams)	Layers 2 to 7 are active over the entire domain of the model. However, as deeper underlying units progress towards outcrop in the north (i.e. up-dip), the parameters of that particular layer change to represent the outcropping units (see Appendix B for detailed figures for Kh & Kv).	Pinches out to the north; greater than 450 m thick down-dip.
3	Whites Creek seam including the narrow interburden		Pinches out to the north; generally between 10m and 20m thick
4	Interburden sediments		Generally around 20 to 30m thick. Reaches thicknesses around 100m in the north-west.
5	Donaldson Coal Seam		Constant thickness of 2 m.
6	Interburden		Around 12 m thick.
7	Big Ben Coal Seam		Constant thickness of 2 m.
8	Combination of deeper coal seams, interburden and basement.	Extends across entire model. Also outcrops in layer 2 to 7 to the north.	Assumed constant 50 m thickness.

A detailed DEM data set for the Bloomfield mine area was combined with the lower accuracy regional DEM data set to create the top surface of Layer 1. Layer 3 geometry was based on xyz data supplied by Bloomfield Collieries and more regional data obtained from Donaldson Coal. The layer 2 thickness is thus defined as the difference between the base of layer 1 (5m below topography) and the top of the Whites Creek seam, with refinements as discussed below.

The base elevations of Layer 5 (Donaldson seam) and Layer 7 (Big Ben seam) were supplied by Bloomfield Collieries in xyz format. The data extent was confined to Bloomfield's mine lease area. The elevations of Bloomfield's coal seams (Layers 5 and 7) were extended regionally by using the base elevation of Layer 3 (Whites Creek seam). The regional base elevations of Layers 5 and 7 were set below the base of Layer 3 by 20 m and 35 m respectively. The layer thicknesses of Bloomfield's coal seams (Layers 5 and 7) have been based on bore logs provided by Bloomfield Collieries. Detailed data on layer elevation surfaces are presented in Appendix A.

3.3 MODEL BOUNDARY CONDITIONS

3.3.1 General Head Boundaries

Head-dependent flow boundaries (or Modflow GHB cells) have been used in all layers to represent external regional flows into and out of the model domain via the coal seams and interburden. Figures in Appendix B show the boundary conditions used in each model layer along with their specified head (H), and conductance (C). Generally, the GHB heads range from 38.9 mAHD at the south-west corner of the model domain, reducing linearly to 15.0 mAHD in the south-east corner. The GHB heads range from 15 mAHD in the south-east corner, reducing linearly to 1 mAHD in the north-eastern corner of the model domain. The GHB conditions for Layers 2 to 7 are similar to Layer 1. However, to achieve calibration of the model, the Layer 8 GHB heads values needed to be set slightly higher, with heads ranging between 15 and 20 mAHD. A conductance value (C) of 1000 has been assumed for all GHB cells.

3.3.2 River Boundaries

Major surface water features are represented in the Bloomfield model using Modflow's River (RIV) package.

Wallis Creek lies on much of the western model boundary, and is represented using Modflow River cells to allow for stream-aquifer interaction due to either leakage from the creek and/or baseflow from the alluvial aquifer (refer to Appendix B). A stage height of 0.5 m and a conductance (C) of 50 d^{-1} has been implemented conservatively to represent a relatively active stream system. The water level (H) of Wallis Creek has been set to 3 m below topography due to a lack of specific surface water monitoring points, which is consistent with approaches applied to a stream-aquifer interaction study by the NSW Department of Infrastructure, Planning and Natural Resources (Braaten and Gates, 2003).

The Hexham Swamp area forms part of the eastern model boundary and has been represented using Modflow's River cells (refer to Appendix B). The use of River cells allows water to flow into or leak out of the swamp according to the difference in heads between the aquifer and specified river cells that represent the swamp. The water level of the swamp (H) has been set at the topography, with a stage depth of 0.5m above that. A conductance value (C) of 25 d^{-1} has been adopted.

Bloomfield's tailings storage has been modelled using River cells in Layer 6 (refer to Appendix B). A water level of 20.5 mAHD has been adopted based on potentiometric level contours completed by Peter Dundon and Associates. A stage height of 0.5 m and a conductance (C) of 50 has been assumed.

3.3.3 Drain Boundaries

Modflow Drain cells have been used in the Bloomfield model to represent the process of groundwater discharge (baseflow) to minor streams, and also to represent mine dewatering drainage. The representation of mining operations is discussed further in Section 3.4.

Smaller creeks and minor streams in the model domain area are generally ephemeral, where significant flow occurs only for short periods after major rainfall events, and results in minor baseflow durations/volumes. The creeks represented with Drain cells in the Bloomfield model include Buttai Creek, Surveyors Creek, Bluegum Creek, Minmi Creek, and Four Mile Creek. Drain elevations have been set to topography with a conductance value of 50 d^{-1}.

3.3.4 Evapotranspiration

Evaporation is included in the model using the Evapotranspiration (EVT) package of MODFLOW. The EVT parameter values adopted were a constant maximum rate of 250 mm/yr with an extinction depth of 3 metres below the specified topographic surface. This effectively results in EVT being active in the model in areas of shallow water table and in areas of low topography along surface watercourses such as Wallis Creek and the Hexham Swamp area.

3.3.5 Recharge

The coal seams are recharged in areas of outcrop and shallow subcrop by direct infiltration of rainfall. Where covered by overburden, the coal seams are recharged primarily by lateral flow down-gradient from the outcrop areas, possibly also with a smaller component of downward percolation through the less permeable overlying overburden sediments.

Rainfall recharge rates within the hard rock outcrop area are believed to be relatively low (i.e. below 10 mm/yr). However, where alluvial deposits occur, recharge rates may be as high as 100 mm/yr. Rainfall recharge occurs in practice as an intermittent process, related to specific larger rainfall events. However, for the steady-state ("long term average") groundwater model, rainfall recharge has been modelled by applying constant assumed effective recharge rates, rather than a time-dependent recharge mechanism.

The recharge zones were set to the highest active layer in the Bloomfield model. Figures in Appendix B show three recharge distribution rates where applied to the highest active model cell. 100 mm/yr is applied to the high permeability alluvium areas, 0 mm/yr to the northern area of low permeability hard rock outcrop, and 15 mm/yr everywhere else.

3.4 SIMULATION OF MINING OPERATIONS

The dewatering operations for the Bloomfield open cut, Donaldson open cut and Abel underground mine are modelled by progressive assignment of Modflow drain cells to active mining areas in accordance with the respective project mine plans.

The open cut mining has been represented in the Bloomfield model using Drain cells within the mined coal seams (layers 1 to 8) and assuming a relatively high conductance (C) value of 1000 d^{-1} to ensure water levels are drawn down to the specified drain levels. The modelled drain elevations for the Bloomfield open cut mining from Year 1 to Year 11 were specified at the pit floor levels that were provided by the client.

The modelled drain elevations for the Donaldson future mine plan (Year 1 to Year 4) and the Abel underground mine (Year 2 to Year 21) were specified at levels consistent with the base of the relevant layers in those areas.

The Bloomfield mine drainage cells have been assigned progressively to active mining areas in accordance with the mine plans, through a series of 11 sequential transient model runs, each representing 1 year of the 11 year mine life for Bloomfield. This period also covers the remaining 4-year mine life for Donaldson (2007-2010). The mined out drain cells were then progressively re-set to normal Modflow aquifer cells in Donaldson and Bloomfield as waste rock was placed into the pit, in accordance with the waste backfilling plan. The model was extended another 10 years to cover completion of underground mining at Abel.

During the mining and post-mining recovery model runs, aquifer properties are changed to reflect the slightly increased permeability of backfill and also to represent any residual pit voids that may be left, which are expected to form pit void lakes.

A series of sensitivity runs has been undertaken to assess the impact of uncertainties in input parameters, and to provide an indication of the upper limit of dewatering volumes and drawdown and river baseflow impacts. This was followed by a post-mining recovery model run, to assess the rate of recovery of groundwater levels.

The pit inflow can be calculated by two methods - cumulative flux and weighted average:

- The **cumulative flux** was calculated by dividing the cumulative volume reported for each stress period by the stress period time.

- The **weighted average** was calculated by multiplying the model-calculated inflow rate at the end of a time step by the duration of the time step, summing the average volume and dividing by the stress period time (ie. this is essentially a step-wise integration of the area under the inflow curve).

The advantage of the weighted average method is that the dewatering inflow can be computed for each layer, whereas the cumulative flux method quantifies the lumped flux for all layers in the model. For the weighted average method, the drain cells that represent the pit in each layer have a specified reach number within the Groundwater Vistas software, and the flux for each specific reach (layer) is extracted from the mass balance hydrograph (this feature is not available for the cumulative flux).

In this model, the pit inflow in the Bloomfield mine was calculated using the weighted average method. Therefore, the head and the flux are saved every 20 time steps for each stress period. It was not practicable to save the head and flux every time step, because of file size constraints (even with every 20 time steps, the file size is about 250MB). As the model has 200 time steps per stress period, saving every 20 steps gives 10 values of head and flux output for each stress period, but at variable times due to the variable time step size. For example, with a time step multiplier 1.07, the time step durations at time steps 10, 50, 100 and 200 are 6.243E-05 days, 9.348E-04 days, 2.754E-2 days and 23.89 days, respectively.

Hence, the weighted average pit inflow was calculated as:

$$\tilde{X} = \frac{\sum_{i=1}^{n} W_i X_i}{\sum_{i=1}^{n} W_i}$$ Where:

$\tilde{X}$: is the weighted average pit inflow (m^3/d)

W_i : is the corresponding time step size (weight) for each pit inflow

X_i : is the pit inflow at the end of each time step at which head and flux are saved (m^3/d)

n: is the total number of readings (10, in this case).

4.1 STEADY STATE CALIBRATION

The groundwater model was developed initially in steady state (“long term average”) mode. True steady state model calibration to pre-mining conditions is not possible, as Bloomfield has been mining for 170 years, and there are no hydrological records available for this period. Short term transient water level records are available for the Donaldson bores since mining began in about 2001, but such data are not available for the Bloomfield site. Therefore, transient model calibration was not run at this stage of the Bloomfield model development, but a steady state run was used to represent the effects of ongoing mining developments to date as the initial conditions for the predictive simulations.

Steady state calibration has been based on the available water level data which includes the cumulative impacts of mining at the Bloomfield and Donaldson mines. The steady state calibration was achieved with sequential model runs by manually adjusting the horizontal and vertical hydraulic conductivities until the best fit was obtained between the observed and simulated water level.

In addition to the Bloomfield monitoring bores, there are several observation boreholes available from the Donaldson and Abel Mine areas that fall within the Bloomfield groundwater model area, and cover several different model layers. As the model includes the current state of the Bloomfield and Donaldson mining operations, calibration was based on the current water levels, i.e. mining water levels. In total, the model is calibrated using 43 piezometer points where 19 head targets are located in Donaldson Mine area (Group 1), 8 head targets in Abel Mine area (Group 2) and 19 head targets in Bloomfield Mine area (Group 3).

Very good model calibration performance has been demonstrated in quantitative and qualitative terms consistent with best practice guidelines (MDBC, 2001), by:

- scatter plots of modelled versus measured head, which show a good agreement between the observed and computed target values across all model layers (Table 4.1 and Figure 4.1);
- a statistics summary for the observed and modelled head targets through the model layers (Table 4.2)
- a very small water balance residual (Table 4.3); and
- contour plans of modelled heads for each layer consistent with observed values (Appendix B).

The scaled RMS value is the RMS value divided by the range of heads across the site, and forms the main quantitative performance indicator, consistent with best practice guidelines. This approach is consistent with the Australian best practice groundwater modelling guideline (MDBC, 2001). Table 4.1 and Figure 4.1 show these performance indicators, with a scaled root mean square (RMS) value of 8.94% (within the target range of 5-10%);.

The overall groundwater balance for the steady state Bloomfield model is summarised in Table 4.3. The total inflow is about 20 ML/d comprising rainfall recharge (52%) plus leakage from the rivers and streams (Hexham swamp, Wallis creek and Tailing Storage) into the aquifer (7%) and the boundary inflow (41%). This amount represents the total inflow into the aquifer system. The total outflow of the aquifer system (20 ML/d) includes evapotranspiration (37%) plus discharge from the groundwater into the river (baseflow of 10%) plus dewatering rate from Donaldson open cut mine (2%) and Bloomfield open cut mine (8%) and the boundary outflow (43%). The discrepancy between the total inflow and outflow for the steady state simulation period was only -0.01%.

Having achieved acceptable calibration of the model, the model was applied to predictive transient modelling (Section 6) to assess the impact of progressive mining operations on the water balance in the model area. Particular interest was placed on the regional change in groundwater levels during mining and after mine closure, on changes in flows to surface water courses, including Wallis Creek, Four Mile Creek and their tributary streams, and on the predictive mine water volumes.

Table 4.1
Steady state calibration performance in the Bloomfield model

Calibration Parameters		Value	Value Units
Count	n	43	-
Sum of Residuals	R	25.71	m
Sum of Absolute Residuals	SR	240.01	m
Scaled Mean Sum of Residuals	SMSR	0.72	%
Root Mean Square	RMS	7.38	m
Scaled RMS	SRMS	8.94	%
Root Mean Fraction Square	RMFS	131.32	%
Scaled RMFS	SRMFS	17.33	%
Coefficient of Determination	CD	1.00	-

Figure 4.1
Scatter Plot for Bloomfield Steady-State Calibration

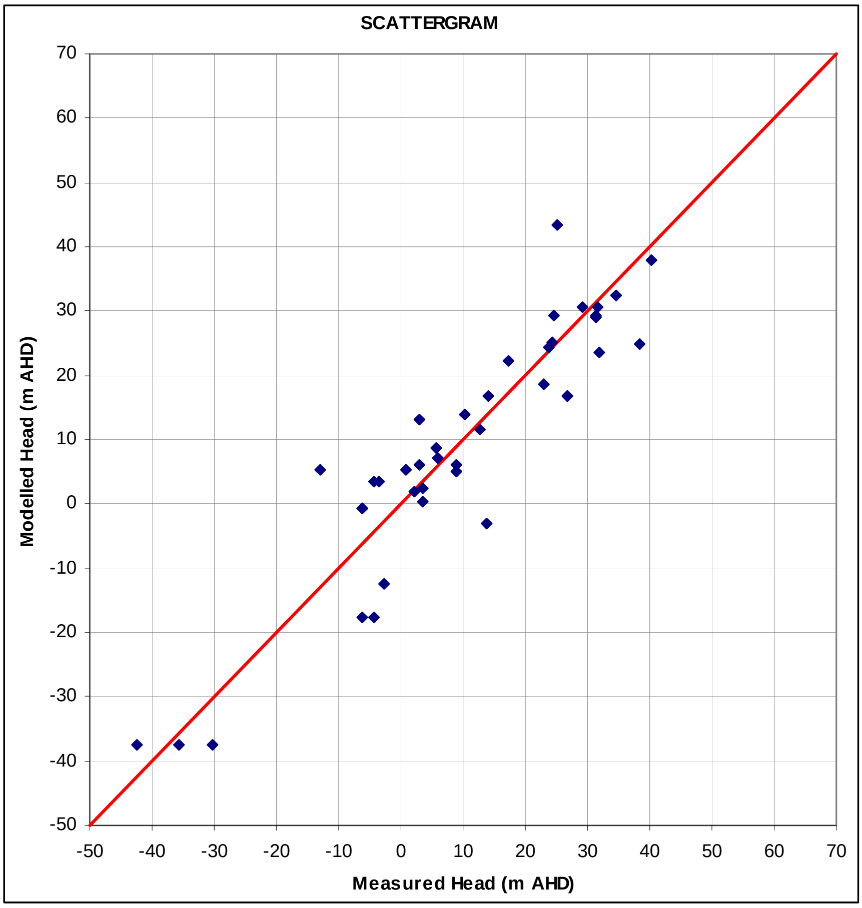


Table 4.2
Steady State calibration data set for Bloomfield Model

Bore Name	Easting (MGA)	Northing (MGA)	Observed Head (mAHD)	Simulated Head (mAHD)	Head Difference (m)	Group*	Layer
VW1-35m (Don)	363632	6370167	-6.2	-0.76	-5.44	3	5
VW1-46m (BB)	363632	6370167	-6.2	-0.76	-5.44	3	7
SP2-1 (Don)	365112	6371264	10.4	13.91	-3.51	3	5
SP2-2 (BB)	365112	6371264	3.1	13.08	-9.98	3	7
SP3-1 (Don)	366732	6371893	32	23.58	8.42	3	5
SP4-2 (All)	367612	6370989	24.4	25.03	-0.63	3	1
VW5-62m (WC)	366700	6368083	8.8	6.16	2.64	3	4
VW5-71m (Don)	366700	6368083	3	6.07	-3.07	3	5
VW5-90m (BB)	366700	6368083	0.9	5.23	-4.33	3	7
VW6-96m (WC)	365337	6368293	-30.3	-37.42	7.12	3	4
VW6-114m (Don)	365337	6368293	-35.6	-37.41	1.81	3	5
VW6-128m (BB)	365337	6368293	-42.3	-37.38	-4.92	3	7
SP7-1 (All)	364619	6368701	13.8	-2.98	16.78	3	1
VW7-70m (WC)	364619	6368701	-2.8	-12.34	9.54	3	4
VW7-95m (Don)	364619	6368701	-4.4	-17.72	13.32	3	5
VW7-107m (BB)	364619	6368701	-6.2	-17.74	11.54	3	7
SP8-1 (All)	363072	6369003	12.6	11.62	0.98	3	1
VW8-83m (Don)	363072	6369003	-4.2	3.54	-7.74	3	5
VW8-97m (BB)	363072	6369003	-3.4	3.53	-6.93	3	7
DPZ3	368774	6368610	38.44	24.91	13.53	1	7
DPZ5	371282.9	6368855	5.78	8.59	-2.81	1	2
DPZ6	368613.7	6367357	34.61	32.51	2.10	1	2
DPZ6	368613.7	6367357	34.61	32.31	2.30	1	3
DPZ7@50	368808	6367648	31.46	29.19	2.27	1	3
DPZ7@50	368808	6367648	31.46	29.14	2.32	1	4
DPZ7@50	368808	6367648	31.46	29.11	2.35	1	5
DPZ8	369332	6368059	26.72	16.80	9.92	1	3
DPZ8	369332	6368059	26.72	16.8	9.92	1	4
DPZ9	369802.9	6368000	3.46	0.47	2.99	1	3
DPZ9	369802.9	6368000	3.46	2.43	1.03	1	4
DPZ10	370918.5	6368535	5.98	7.08	-1.10	1	2
DPZ12	369114.4	6366414	40.24	37.80	2.44	1	2
DPZ13	371222.8	6367537	14.08	16.88	-2.80	1	2
DPZ20A	370540	6368439	-13.1	5.24	-18.34	1	4
DPZ20B	370540	6368439	8.9	4.91	3.99	1	2
CO72VW	369927	6362562	17.31	22.21	-4.90	2	3
CO78A	367140	6367054	29.12	30.61	-1.49	2	3
CO80	368040	6365176	25.18	43.51	-18.33	2	3
CO81A	369992	6364001	22.99	18.65	4.34	2	3
CO81B	369992	6364001	2.24	1.85	0.39	2	1
CO82	370319.4	6364647	23.71	24.44	-0.73	2	2
C062B	370143	6366248	31.5	30.68	0.82	2	2
C062A	370143	6366248	24.6	29.28	-4.68	2	3
Average			**10.89**	**10.29**			
Minimum			**-42.3**	**-37.42**			
Maximum			**40.24**	**43.51**			
Range			**82.54**	**80.93**			

***Note:** Group 3 represents Bloomfield bores, Group 2 Abel bores and Group 1 Donaldson bores.

Table 4.3
Groundwater budget for Bloomfield model Steady State calibration

Component	Groundwater Inflow (ML/d)	Groundwater Outflow (ML/d)
Recharge	10.41	0
Evapotranspiration (EVT)	0	7.47
River- Hexham Swamp	1.31	0.93
River- Wallis Creek	0.08	1.00
Tailings Storage	0.03	0.00
Drains- ephemeral creeks and streams	0	0.02
Drains- Donaldson Mine	0	0.39
Drains- Bloomfield Mine	0	1.69
Head-dependent flow (GHB)	8.12	8.46
Wells	0	0
TOTAL	**19.95**	**19.96**
Discrepancy (%)	**-0.01**	

4.2 STEADY STATE BASEFLOW

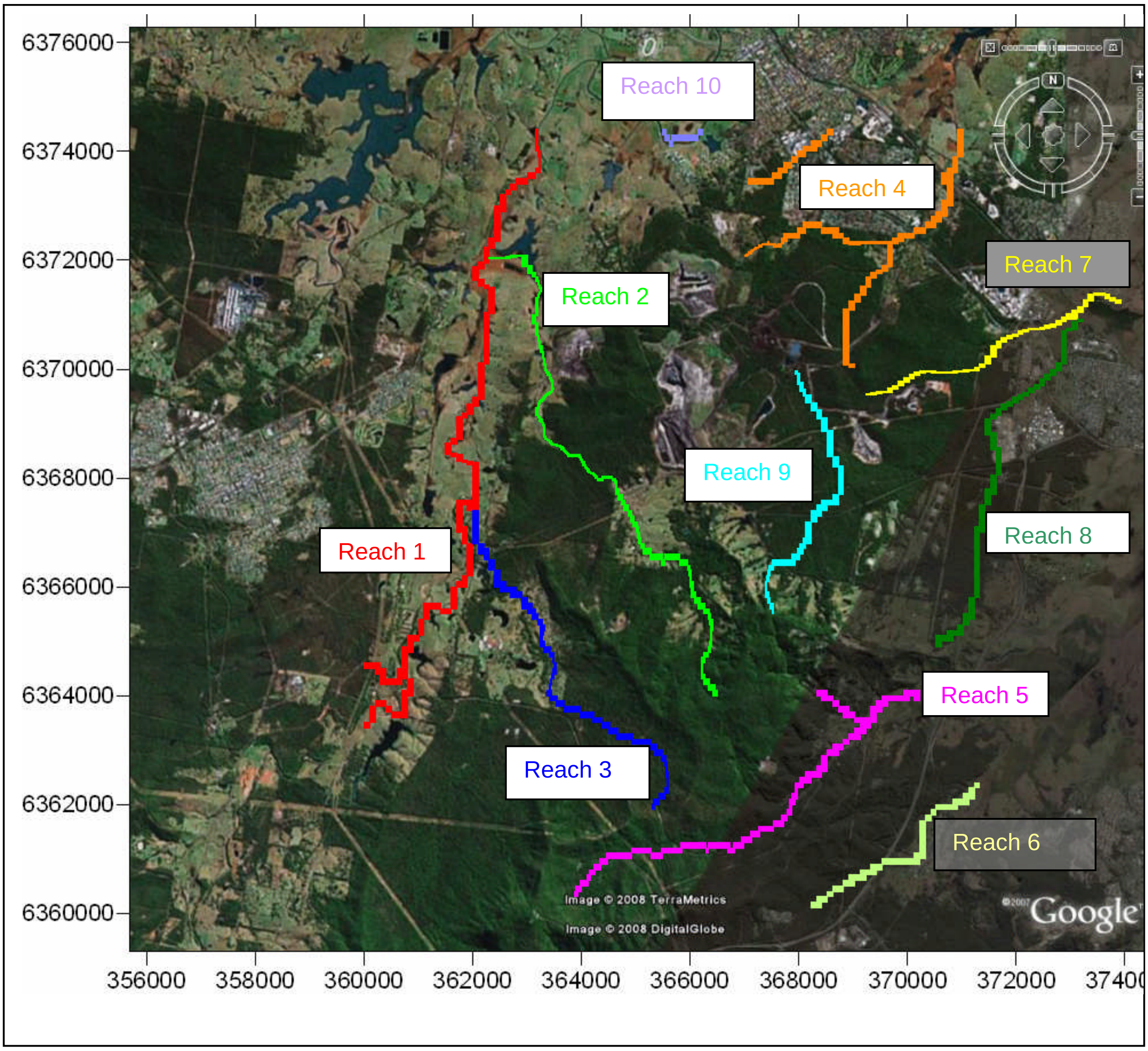
The rivers, streams and surface drainage area described in Section 2.5 were divided into nine reaches in the Bloomfield groundwater model to evaluate the groundwater discharge (baseflow) contributions.

Figure 4.2 depicts the location of these reaches and Table 4.4 describes their location in the model area and the computed baseflow values during the steady state calibration.

Table 4.4
Calculated baseflow for Bloomfield Steady State calibration model

Reach No.	Location	Layer	Baseflow (m^3/d)
1	Wallis Creek	1	923.38
2	Buttai Creek	1	14.51
3	Surveyors Creek	1	0
4	Four Mile Creek	1	0
5	Bluegum Creek	1	1.95
6	Minmi Creek	1	0
7	Weakleys Flat Creek	1	0
8	Viney Creek	1	0
9	Nila Creek	1	0

Figure 4.2
Reach Locations Map



4.3 SENSITIVITY ANALYSIS

4.3.1 Approach

Sensitivity analysis was carried out to assess the sensitivity of the model calibration to the assumed input parameters or boundary conditions, by quantifying the changes to the model response. The sensitivity analysis is carried out by decreasing and increasing each input parameter or boundary condition, and evaluating the impacts of the changes on the calibration statistics. Any parameter that results in a change to the scaled RMS statistics by a significant amount can identify a sensitive parameter in the model. The base SRMS value for these runs is 8.94%.

Table 4.5 summarises the parameters and the spatial zones that were tested during the sensitivity analysis. All hydraulic conductivity zones in the model were tested by applying multipliers to the horizontal hydraulic conductivity (Kh) of 0.5 (decrease) and 2 (increase) to the calibrated model values, whereas the vertical hydraulic conductivity (Kv) was changed by multipliers of 0.1 and 10 because models are usually not sensitive to small changes in Kv. The calibrated model aquifer hydraulic parameter values and zones are shown in Appendix C.

Two recharge zones representing the lowest and highest recharge areas were also examined in this process by changing their values by multipliers of 0.5 and 2.

River bed conductance and drain conductance for tributary streams for all reaches in the model were multiplied by 0.1 and 10. In this case, the sensitivity was evaluated in relation to aquifer head via the standard SRMS statistic, and also to predicted river baseflow.

Table 4.5
Parameters, zones and the multipliers tested in the sensitivity analysis process

Parameter	Zone	Calibrated Value	Layer	Model	Multiplier
Horizontal Hydraulic Conductivity	17	0.1 m/d	1	Steady-state	0.5, 2
	18	1 m/d	1, 2, 3, 5	Steady-state	0.5, 2
	21	1 m/d	1	Steady-state	0.5, 2
	4	0.002 m/d	2	Steady-state	0.5, 2
	6	0.002 m/d	2	Steady-state	0.5, 2
	7	0.002 m/d	4	Steady-state	0.5, 2
	12	0.002 m/d	6	Steady-state	0.5, 2
	14	0.05 m/d	5	Steady-state	0.5, 2
	15	0.1 m/d	3	Steady-state	0.5, 2
	16	0.05 m/d	8	Steady-state	0.5, 2
	20	0.08 m/d	7	Steady-state	0.5, 2
	1	0.5 m/d	4, 5, 6, 7	Steady-state	0.5, 2
	11	0.01 m/d	4	Steady-state	0.5, 2
	2	0.5 m/d	5, 6, 7	Steady-state	0.5, 2
	19	1 m/d	6	Steady-state	0.5, 2
	22	1 m/d	7	Steady-state	0.5, 2
Vertical Hydraulic Conductivity	17	0.01 m/d	1	Steady-state	0.1, 10
	18	0.1 m/d	1, 2, 3, 5	Steady-state	0.1, 10
	21	0.1 m/d	1	Steady-state	0.1, 10
	4	0.001 m/d	2	Steady-state	0.1, 10
	6	0.001 m/d	2	Steady-state	0.1, 10
	7	0.001 m/d	4	Steady-state	0.1, 10
	12	0.001 m/d	6	Steady-state	0.1, 10
	14	0.005 m/d	5	Steady-state	0.1, 10
	15	0.01 m/d	3	Steady-state	0.1, 10
	16	0.005 m/d	8	Steady-state	0.1, 10
	20	0.008 m/d	7	Steady-state	0.1, 10
	1	0.05 m/d	4, 5, 6, 7	Steady-state	0.1, 10
	11	0.001	4	Steady-state	0.1, 10
	2	0.05	5, 6, 7	Steady-state	0.1, 10
	19	0.1	6	Steady-state	0.1, 10
	22	0.1	7	Steady-state	0.1, 10
Recharge	1	2%	Applied to the Highest Active Layer	Steady-state	0.5, 2
	2	2.67%	Applied to the Highest Active Layer	Steady-state	0.5, 2
River Bed Conductance	All River Reaches in the Model			Steady-state	0.1, 10
Drain Conductance	All Drain Reaches in the Model			Steady-state	0.1, 10

4.3.2 Horizontal and Vertical Hydraulic Conductivity (Kh and Kv)

The results for the horizontal hydraulic conductivity (Kh) sensitivity analysis are summarised in Table 4.6 for 16 zones, which are defined over 8 model layers. The generally low sensitivity to hydraulic conductivity values indicates that the adopted calibration values are optimal, with the most sensitive parameters in the model (considered later for uncertainty analysis of the prediction scenarios), being:

- Layer 8, the basement layer, which includes coal measures sediments beneath the Big Ben Seam (0.05 m/d basecase value; sensitivity range of 8.3% to 11.1% change in SRMS) and
- Layer 3, which represents the Whites Creek Seam (0.1 m/d basecase value; sensitivity range of 2.9% to 4.8% change in SRMS).

Other zones showed a slight decrease in the scaled RMS when they were multiplied by 0.5, and the RMS generally increases slightly if the hydraulic conductivity values are increased by factor of 2.

Table 4.6
Sensitivity analysis of horizontal and vertical hydraulic conductivity values in the Bloomfield model

Horizontal Hydraulic Conductivity (m/d)					Vertical Hydraulic Conductivity (m/d)				
Zone	**Calibrated Value (m/d)**	**Layer**	**Multiplier**	**SRMS (%)**	**Zone**	**Calibrated Value (m/d)**	**Layer**	**Multiplier**	**SRMS (%)**
			0.5	8.95				0.1	8.94
17	0.1	1	**1**	**8.94**	17	0.01	1	**1**	**8.94**
			2	8.93				10	8.94
			0.5	8.97				0.1	8.94
18	1	1, 2, 3, 5	**1**	**8.94**	18	0.1	1, 2, 3, 5	**1**	**8.94**
			2	8.93				10	8.94
			0.5	8.95				0.1	8.94
21	1	1	**1**	**8.94**	21	0.1	1	**1**	**8.94**
			2	8.93				10	8.94
			0.5	8.98				0.1	
4	0.002	2	**1**	**8.94**	4	0.001	2	**1**	**8.94**
			2	8.90				10	8.87
			0.5	8.99				0.1	
6	0.002	2	**1**	**8.94**	6	0.001	2	**1**	**8.94**
			2	8.89				10	9.56
			0.5	8.95				0.1	9.14
7	0.002	4	**1**	**8.94**	7	0.001	4	**1**	**8.94**
			2	8.93				10	8.96
			0.5	8.94				0.1	8.85
12	0.002	6	**1**	**8.94**	12	0.001	6	**1**	**8.94**
			2	8.95				10	9.06
			0.5	8.95				0.1	8.90
14	0.05	5	**1**	**8.94**	14	0.005	5	**1**	**8.94**
			2	8.94				10	8.95
			0.5	9.37				0.1	8.90
15	0.1	3	**1**	**8.94**	15	0.01	3	**1**	**8.94**
			2	9.20				10	8.95
			0.5	9.68				0.1	
16	0.05	8	**1**	**8.94**	16	0.005	8	**1**	**8.94**
			2	9.93				10	9.04
			0.5	8.97				0.1	8.91
20	0.08	7	**1**	**8.94**	20	0.008	7	**1**	**8.94**
			2	8.92				10	8.95
			0.5	8.75				0.1	8.86
1	0.5	4, 5, 6, 7	**1**	**8.94**	1	0.05	4, 5, 6, 7	**1**	**8.94**
			2	9.88				10	9.02
			0.5	8.92				0.1	8.33
11	0.01	4	**1**	**8.94**	11	0.001	4	**1**	**8.94**
			2	8.98				10	9.90
			0.5	9.05				0.1	8.94
2	0.5	5, 6, 7	**1**	**8.94**	2	0.05	5, 6, 7	**1**	**8.94**
			2	8.85				10	8.94
			0.5	9.04				0.1	8.94
19	1	6	**1**	**8.94**	19	0.1	6	**1**	**8.94**
			2	9.24				10	8.94
			0.5	8.93				0.1	8.95
22	1	7	**1**	**8.94**	22	0.1	7	**1**	**8.94**
			2	8.98				10	8.94

Note: The basecase SRMS value is 8.94%.

Again, the generally low sensitivity to vertical hydraulic conductivity values shown in Table 4.6 indicates that the adopted calibration values are optimal, with the most sensitive parameters in the model (considered later for uncertainty analysis of the prediction scenarios), being for interburden layers:

- Layer 4 (6.8-10.7% change), and
- Layer 2 (7% change).

The scaled RMS generally increased when the vertical hydraulic conductivity was increased by a factor of 10. However, the model failed to converge when zones 4 and 6 in layer 2 were reduced by a factor of 0.1. This could be because this layer is relatively thick, and a very low Kv produces a very low leakage coefficient that makes the water level mound up to the upper layer, leading to instability of the numerical solution.

4.3.3 Sensitivity to Recharge

The results of the sensitivity analysis of recharge and river/drain conductance are presented in Table 4.7.

Table 4.7
Sensitivity analysis of recharge, river bed conductance, and drain conductance values

Sensitivity to Recharge				
Zone	**Calibrated Value**	**Layer**	**Multiplier**	**SRMS (%)**
1	11.2%	Applied to Highest Active Layer	0.5 1 2	9.96 8.94 8.38
2	1. 7%	Applied to Highest Active Layer	0.5 1 2	12.89 8.94 12.69
Sensitivity to River Conductance (m^2/d)				
Reach	**Calibrated Value**	**Layer**	**Multiplier**	**SRMS (%)**
All	25, 50	All	0.1 1 10	8.94 8.94 8.94
Sensitivity to Drain Conductance (m^2/d)				
Reach	**Calibrated Value**	**Layer**	**Multiplier**	**SRMS (%)**
All	50	1	0.1 1 10	8.94 8.94 8.94

Note: The basecase SRMS value is 8.94%.

Two zones representing alluvium and regolith recharge areas were tested, and the results showed that the adopted calibration rates of the recharge zones are optimal because the scaled RMS increases (ie. the calibration is worse), but not substantially. While Zone 2 (the regolith area) is the most sensitive to recharge, (low basecase value of 15 mm/yr; change in SRMS over sensitivity range of 42% to 44%), if this recharge value were to be increased, then the hydraulic conductivity in most underlying layers should also be increased to achieve calibration, and this is not warranted given what is known of the measured values. It should also be noted that recharge and Kh are correlated as a ratio, and it is possible for a different combination of values to achieve model calibration (the model "non-uniqueness" problem; MDBC (2001)).

The results of the sensitivity analysis for the river and drain bed conductance (Table 4.7) revealed that the model was insensitive (in terms of head and baseflow) to multiplying the calibration values by either 0.1 or 10 in all river or drain reaches.

The generally low sensitivity to model parameter changes indicates that the adopted calibration values are optimal.

SECTION 5 - BLOOMFIELD MODEL PREDICTION AND UNCERTAINTY ANALYSIS

5.1 BLOOMFIELD MINE DEWATERING PREDICTIONS

The calibrated Bloomfield model was applied to predict mine dewatering requirements, and the related hydrological impact of progressive mining, waste backfilling, and then post-mining recovery, in terms of changes to groundwater levels and groundwater-surface water interactions. Mine dewatering operations were simulated as described in Section 3.4, and the method of calculating the inflow volumes was also described in Section 3.4. The range of parameter values for sensitivity testing was outlined in Section 4.3. The model features for rivers and rainfall recharge were retained unchanged for these predictions.

The prediction model was configured with annual changes in terms of the area and level of drainage features to suit an initial Bloomfield mine plan provided on 29 November 2007. This mine plan has been modelled in four stages:

- the first stage is assumed to extend from Year 1 to Year 5;
- the second stage is two years only, Year 6 and Year 7;
- the third stage is planned to run from Year 8 to Year 10 and
- the fourth and final stage should be completed by the end of Year 11.

The Bloomfield prediction model also incorporates the completion of Donaldson open cut mining to the east of the Bloomfield pit, and the Abel underground mine south of Bloomfield as described in Section 3.4.

5.1.1 Model Parameter Changes with Time

There will be a change in hydraulic properties during open cut mining, with the material inside the pit area starting with in-situ rock properties, then being progressively replaced first by a temporary void and finally by waste backfill. The modelling approach needs to allow for changes with time to the hydraulic properties of the in-pit cells in accordance with the proposed mining/backfilling schedule. This progression from rock to void to waste will occur progressively across the mine throughout the mine life.

Modflow-Surfact does not automatically allow for changing of hydraulic conductivity parameters with time to represent the mining progression within the pit. However, the use of “time-slices” of short duration (generally 1 year) allows parameters to be changed periodically in specific areas. The horizontal and vertical hydraulic conductivity parameters and the specific yield parameters were changed with time and space in all Layers (1 to 8), to represent progressive mining and pit backfilling of the Bloomfield and Donaldson open cut mines.

Accordingly, the Bloomfield prediction model has been divided into 9 time slices representing 11 years of mining operation. The final water level conditions from each time-slice were specified as the initial conditions for the subsequent time-slice, and the parameters in the pit area were changed from one time-slice to the next to represent changes to the distribution of active areas. Higher permeability and storage parameters were applied to backfill areas (compared to the in-situ rock properties), with the backfill Kh set to 1m/d and the Kv set to 0.1m/d, while the specific yield was set to 0.05 for backfill areas.

The hydraulic conductivity (Kh and Kv) values and the specific yield values of the cells representing the mined and backfilled open cut areas of the coal seams, interburden and regolith units were increased for the specific mined-out areas of the pit that during any specific time-slice, with the change invoked in the model from the start of the backfilling process (assumed to be 2009 for Donaldson and at the commencement of the second stage in Year 5 for Bloomfield).

5.1.2 Bloomfield Mine Plan Time Slices and Dewatering Rates

The remaining 11 year mine life was simulated by a series of 9 sequential time slice models. Each year of the remaining mine life is represented by a separate time slice, except for the period 2014 to 2016, which is designed as one time slice but divided into three one-year stress periods. A stress period is the timeframe in the model when all hydrological stresses (eg. recharge and pumping) and hydraulic parameters are held constant. Each time-slice model was designed with a stress period of 365.25 days, 200 time steps and time-step multiplier of 1.07. The number of time steps and the time-step multiplier was selected to ensure the stability of the numerical solution and to increase the accuracy of the heads and fluxes during model simulation, consistent with best practice guidelines. The output water levels from one time-slice model were used as input starting heads for the subsequent time-slice.

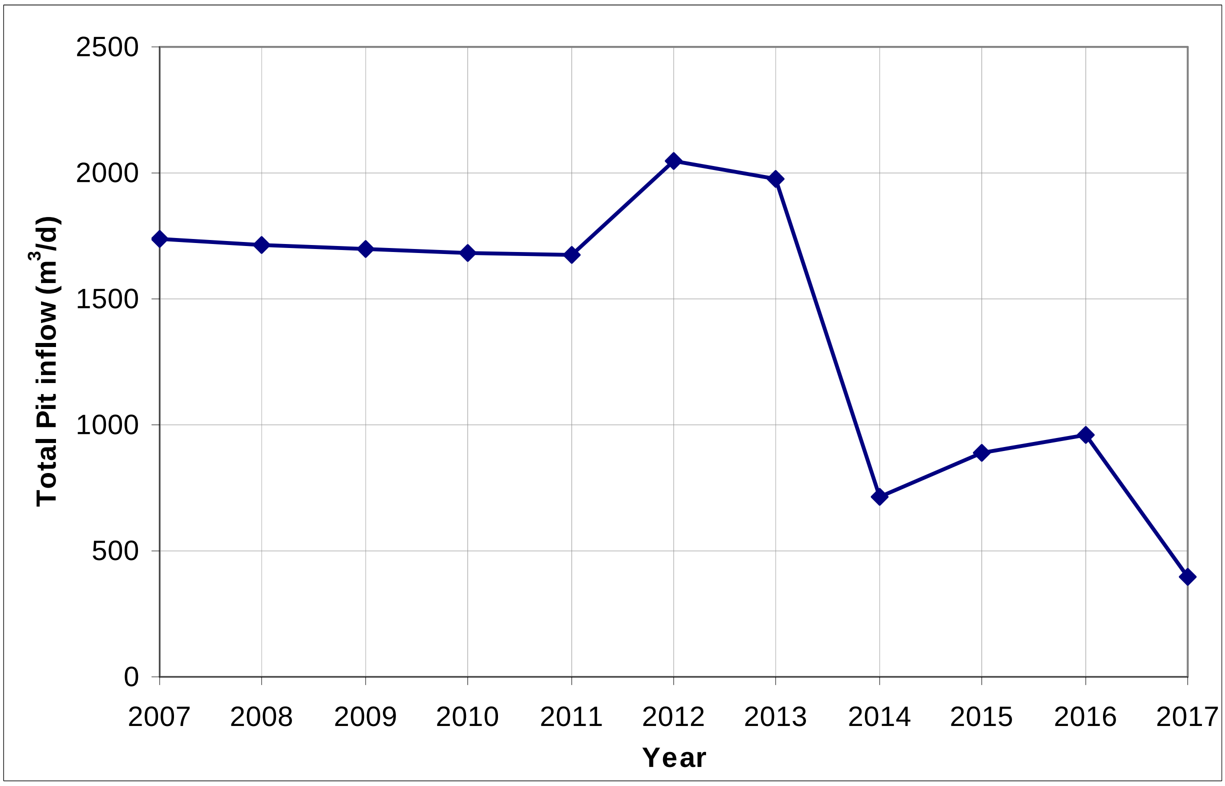
The model was run successfully for the 9 time-slices. The weighted average pit inflow for each layer and the total inflows are presented in Table 5.1 and Figure 5.1. The predicted average dewatering rate over 11 years is 1.4 ML/d, with a minimum of 0.4 ML/d (in Year 11) and a maximum of 2.1 ML/d (in Year 6).

Table 5.1
Predicted Bloomfield dewatering rates by model layer (9 Time-Slices)

Year	Weighted Average Pit Inflow *(m^3/d)								
	Layer 1	Layer 2	Layer 3	Layer 4	Layer 5	Layer 6	Layer 7	Layer 8	Total
1	0.0	0.0	0.0	5.4	0.0	759.8	467.6	504.6	**1737**
2	0.0	0.0	0.0	3.5	0.0	732.9	467.4	513.1	**1717**
3	0.0	0.0	0.0	2.5	0.0	721.8	463.1	511.8	**1699**
4	0.0	0.0	0.0	1.8	0.0	709.2	465.1	509.5	**1686**
5	0.0	0.0	0.0	0.2	0.0	702.6	460.0	508.5	**1671**
6	0.0	0.0	0.1	15.8	0.2	2030.1	0.0	0.0	**2046**
7	0.0	0.0	0.0	0.2	0.0	1972.5	0.0	0.0	**1973**
8	0.0	0.0	0.0	0.0	0.0	198.2	279.3	234.0	**711**
9	0.0	0.0	0.0	0.0	0.0	323.4	315.3	251.1	**890**
10	0.0	0.0	0.0	0.0	0.0	366.0	334.2	261.1	**961**
11	0.0	0.0	0.0	0.0	0.0	34.6	233.3	127.8	**396**
Ave	**0.0**	**0.0**	**0.0**	**2.7**	**0.0**	**777.4**	**316.8**	**311.0**	**1408**
Min	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**34.6**	**0.0**	**0.0**	**396**
Max	**0.0**	**0.0**	**0.1**	**15.8**	**0.2**	**2030.1**	**467.6**	**513.1**	**2046**

* Weighted average is calculated from instantaneous water balance values reported every 20 time steps for each layer

Figure 5.1
Predicted Bloomfield mine dewatering rates (9 time-slice model)



The Interburden layer (Layer 6) contributes most of the dewatering inflows. Although this layer has a regionally lower value for hydraulic conductivity than the overlying and underlying coal seam layers, it is 12 m thick compared to the 2 m thickness of the coal seams (Table 3.1). Furthermore, in the local mine area, the calibrated values for hydraulic conductivity are consistent for each of these layers (Appendix C), and hence the transmissivity of layer 6 is higher in the local mine areas than these coal seams. This combination of factors results in higher inflows from this layer, with a weighted average inflow rate over 11 years of 0.78 ML/d, and minimum and maximum weighted average rates of 0.02 ML/d in Year 11 and 2.03 ML/d in Year 6 respectively (Table 5.1).

Layer 7 (Big Ben Coal Seam) and Layer 8 (combination of deeper coal seams, interburden and basement) represent the second highest inflow after layer 6. For example, Layer 7 has a weighted average dewatering rate of 0.32 ML/d over 11 years, a minimum of 0.0 ML/d in years 2012 and 2013 and a maximum of 0.47 ML/d in 2008.

The weighted average dewatering rate for the other layers (layers 1 to 5) are relatively small, totalling about 0.03 ML/d (averaged over 11 years), and with Layer 1 (Alluvium and the Regolith) and layer 2 (Overburden above White's Creek Seam) producing almost no pit inflow.

5.2 PREDICTED BASEFLOW IMPACTS

The cumulative impact of mining at Bloomfield, Donaldson and Abel mining areas on groundwater baseflow discharges has been assessed for the nine stream reaches defined in Section 4. The model results show that there is only a minimal total reduction in groundwater baseflow to Wallis Creek and Buttai Creek in comparison with a pre-mining baseflow (Figure 5.2 and Figure 5.3).

Figure 5.2
Predicted baseflow during Bloomfield mine dewatering (9-year time-slice model)

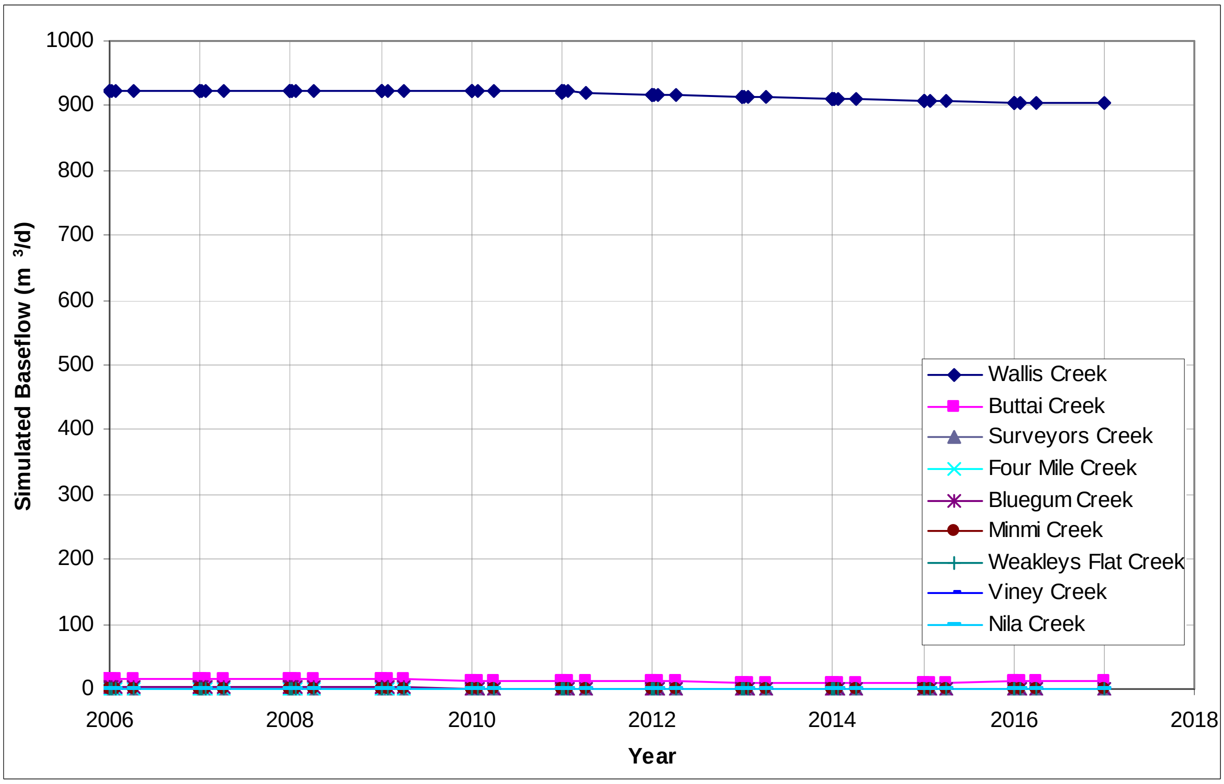
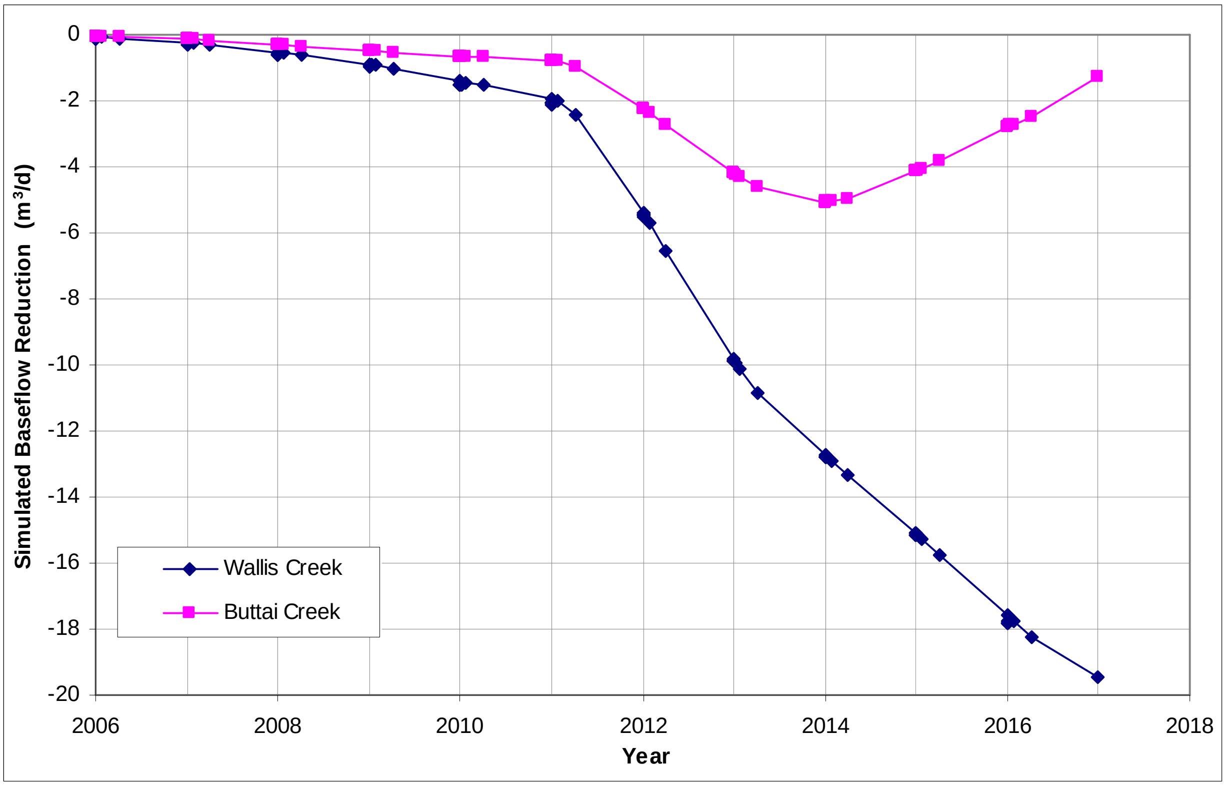


Figure 5.3
Predicted baseflow REDUCTION during Bloomfield mine dewatering (9-year time-slice model)



The model predicted very minor impacts on stream baseflow to Wallis and Buttai Creeks at the western boundary of the model, mainly from Bloomfield open cut mining.

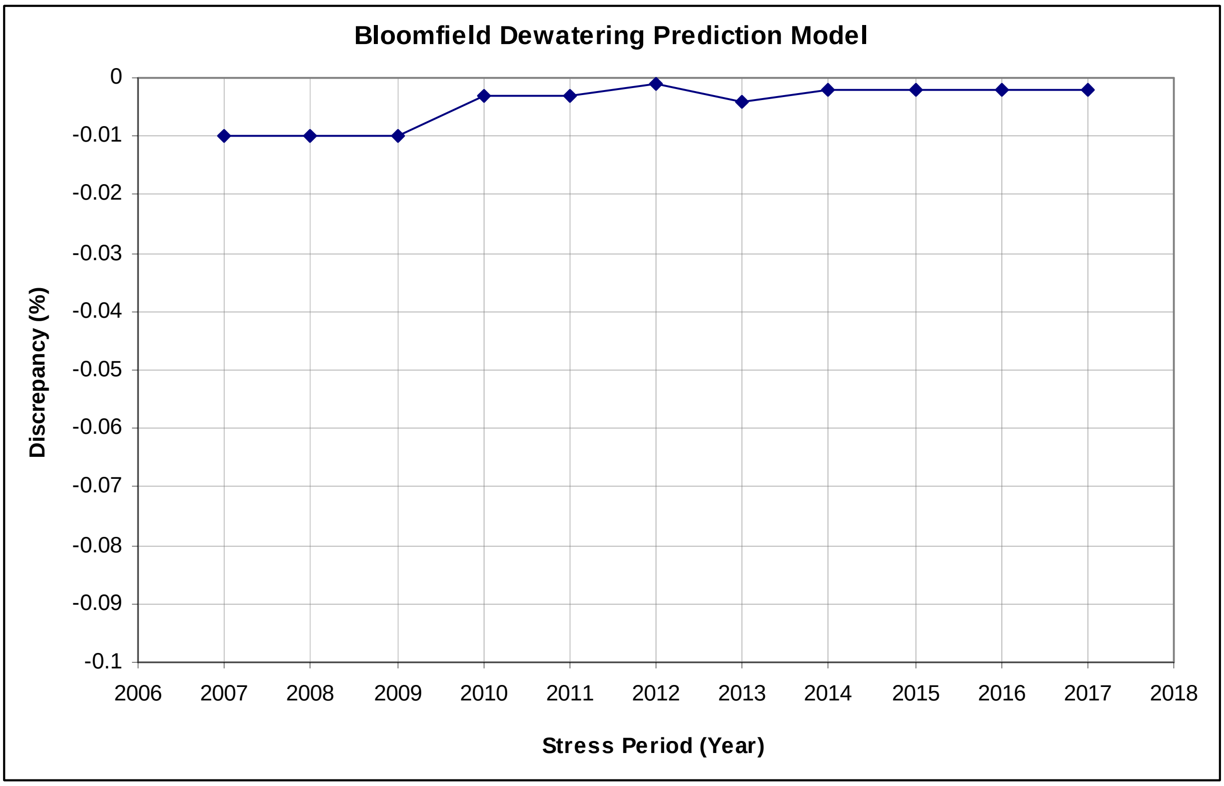
The maximum baseflow reduction is predicted to be around 19.4 kL/d (0.02 ML/d or 0.2 L/s) in Wallis Creek by the completion of mining in Year 11 (Figure 5.3), which is not practicably measurable with stream gauging accuracy and equates to only 2% of the current modelled baseflow of 923 kL/d. The predicted baseflow reduction in Buttai Creek is much smaller, reaching a maximum of just 5.1 kL/d (0.005 ML/d or 0.06 L/s) by the end of year 2014 (approximately 35% of current minor stream modelled baseflow of 14.5 kL/d) and then recovering to reach a reduction of 1.3 kL/d by the completion of mining in Year 11.

The model predicts that the Bloomfield proposal will have a very low impact (virtually not measurable in a practical sense) on baseflow in Wallis Creek, Buttai Creek and the other ephemeral creek baseflows.

5.3 BLOOMFIELD MODEL MASS BALANCE EVALUATION

The discrepancy between the cumulative volumes at the end of each stress period (i.e. the difference between the inflow and the outflow rates of the reported model mass balance) is a good indicator to evaluate the model mass balance and the stability of the numerical solution. The Bloomfield model runs were carried out with a head closure criterion of 0.1 m to enhance the stability of the numerical solution and to achieve a good mass balance for the entire model. The cumulative mass balance discrepancy plot for the 11-year time-slice modelling is presented in Figure 5.4, showing that the Bloomfield model performance is much better than the best practice criterion of a discrepancy of less than 1%.

Figure 5.4
Cumulative mass balance discrepancy plot



5.4 UNCERTAINTY MODEL SCENARIOS

This analysis assesses the uncertainties in the model predictions of mine inflow rates, and also provides an indication of the possible range of predicted dewatering volumes.

The uncertainty analysis was undertaken with a single 11-year model run of the mining period using the most sensitive parameters (Section 4.3). The single 11-year run was found to give consistent results to the 9 stage time-slice model, but involved much shorter run times and simpler data processing procedures for the purpose of uncertainty analysis.

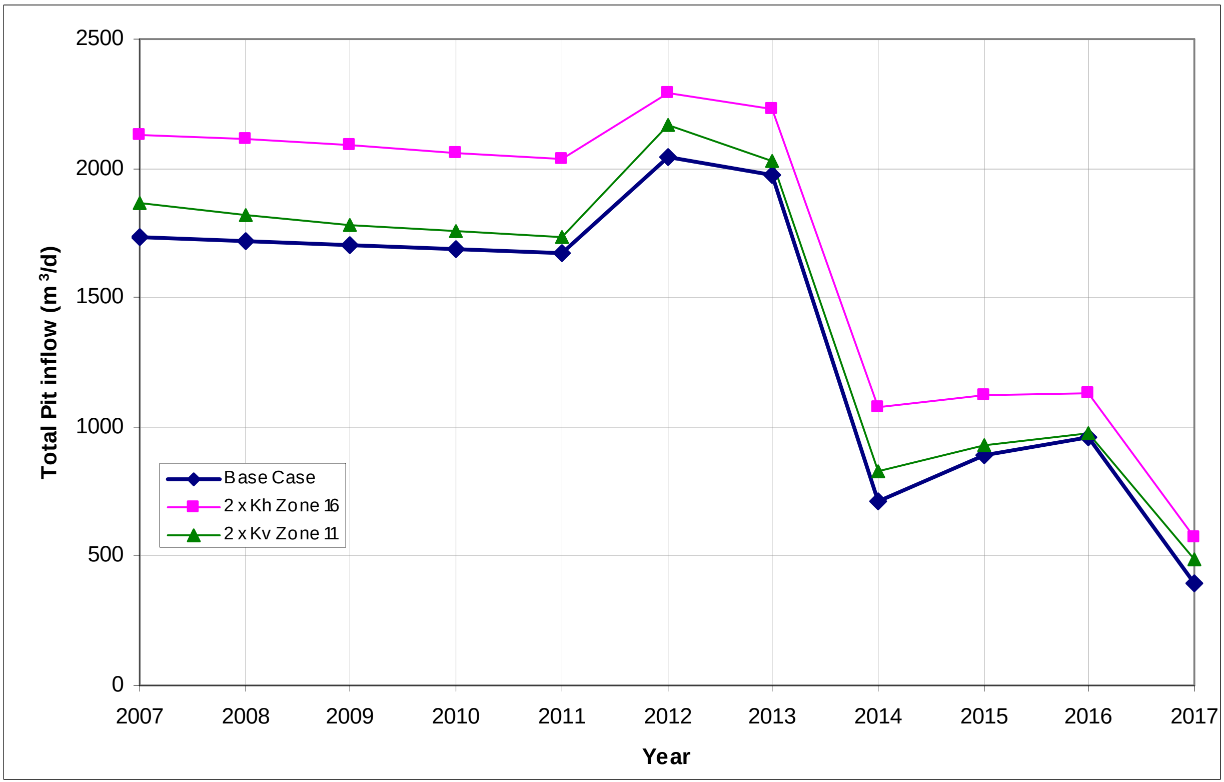
It was found from the sensitivity analysis of the model calibration performance (Section 4.3) that the model is generally not sensitive to parameter variations. However, the most sensitive parameters in the model were identified as the high horizontal hydraulic conductivity in Zone 16, which mainly represents the combined Permian Rathulba Formation (deeper coal seams, interburden and basement) that outcrop up-dip and north of Bloomfield (but noting that Zone 16 also extends though what are dummy layers 2 to 7 in this area), and also the high value of the vertical hydraulic conductivity in the interburden Formation (Layer 4).

Table 5.2 and Figure 5.5 summarise the uncertainty in predicted mine inflow rates due to multiplying the calibrated aquifer parameter values (Appendix C) by the same factors as were applied to the sensitivity analysis (Kh factors or 0.5 and 2.0, and Kv factors of 0.1 and 10).

Table 5.2
Bloomfield model range of uncertainty predictions in terms of predicted inflow

Uncertainty Analysis: Horizontal Hydraulic Conductivity of Zone 16 (Layers 2-8)			
		Calibrated Kh	**High Kh**
Layers 8		0.05 m/d	0.1 m/d
SRMS %		8.94%	9.93%
Layer	**Annual inflow**	**Mine Inflow Rates (ML/d) for Calibrated Kh**	**Mine Inflow Rates (ML/d) for High Kh**
	Min	0.40	0.57
Total	Max	2.05	2.29
	Ave	1.41	1.71
Uncertainty Analysis: Vertical Hydraulic Conductivity of the Interburden Formation (Layer 4)			
		Calibrated Kv	**High Kv**
Layer 4		0.001 m/d	0.01 m/d
SRMS %		8.94%	9.90%
Layer	**Annual inflow**	**Mine Inflow Rates (ML/d) for Calibrated Kh**	**Mine Inflow Rates (ML/d) for High Kh**
	Min	0.40	0.49
Total	Max	2.05	2.17
	Ave	1.41	1.49

Figure 5.5
Uncertainty in predicted Bloomfield mine dewatering rates



The results of the uncertainty prediction runs reveal that, by increasing the horizontal hydraulic conductivity in Zone 11 by 100% (from 0.05 m/d to 0.1 m/d) the yearly average dewatering rate would increase by 21% (from 1.41 ML/d to 1.71 ML/d). On the other hand, by increasing the vertical hydraulic conductivity in Zone 11 (Layer 4) by a factor of 10 (from 0.001 m/d to 0.01 m/d), the yearly average dewatering rate would increase by just 6% (from 1.41 ML/d to 1.49 ML/d)).

In simple terms, the range of uncertainty in predicted dewatering rates is small.

5.5 RECOVERY SIMULATION

The results at the end of the Bloomfield mine dewatering prediction (i.e. at the end of Year 11) were used as the initial condition for the post-mining recovery run, to show the hydrological responses due to ceasing mining. Aquifer parameters in the mined-out and backfilled open cut areas were increased from the base case values (refer to Section 5.1) to values appropriate for waste-rock backfill, and parameters were also changed to represent the residual pit void post–mining.

For the recovery run, some simplifying assumptions were invoked to represent the residual pit void. The residual open pit void is represented in the model with high permeability values (Kh = Kv = 1000 m/d) and high unconfined specific yield (Sy = 0.99) following the so-called “appropriate complexity high-K approach” (Ronayne et al, 2001). In addition, pit lake evaporation was activated at rates equivalent to 50% of the net pan evaporation rate (Table 2.3 gives annual evaporation of 1350 mm; a 50% pan factor gives 675 mm/yr, or 0.00185 m/d). Direct rainfall recharge was also applied to the pit lake area at 100% of the annual average rainfall, to give a rate of 895 mm/yr (higher than the adopted evaporation rate for the pit void lake).

Plots demonstrating recovery of water levels following cessation of mine dewatering are presented in Appendix D, as hydrographs of predicted water levels at key Bloomfield monitoring bores, and as contours of drawdown at the end of mining (Year 11), and at the end of a 100-year recovery period, which included a 10 years of further underground mining and dewatering at Abel after completion of Bloomfield. The recovery period was selected as 100 years to be consistent with NSW environmental standard criteria for mining operations.

The results show that virtual full recovery in the entire Bloomfield model area would occur by 2080 (i.e. about 60 years from the end of mining in Bloomfied in Year 11). However the results show full recovery had occurred in many bores within a few years from end of Bloomfield mining (for example, bores VW1(35m), VW1(46m), SP2-1 and SP2-2), with subsequent delays in full recovery for some bores at Bloomfield (such as VW6(96m), VW6(114m) and VW6(128m)) being due to Abel underground mining which ends 10 years later (in Year 21) than Bloomfield open cut mining (Year 11), and involves much greater drawdowns (eg. about 175 m in Abel bore CO72W; see Appendix D).

Post-mining water levels are predicted to recover to above the current levels in some parts of the mine area, for the following main reasons:

- firstly, the current groundwater levels include drawdown effects from mining activities in Bloomfield and Donaldson before 2008;
- secondly, the changes in aquifer parameters invoked for the in-pit cells during the mining and recovery periods.

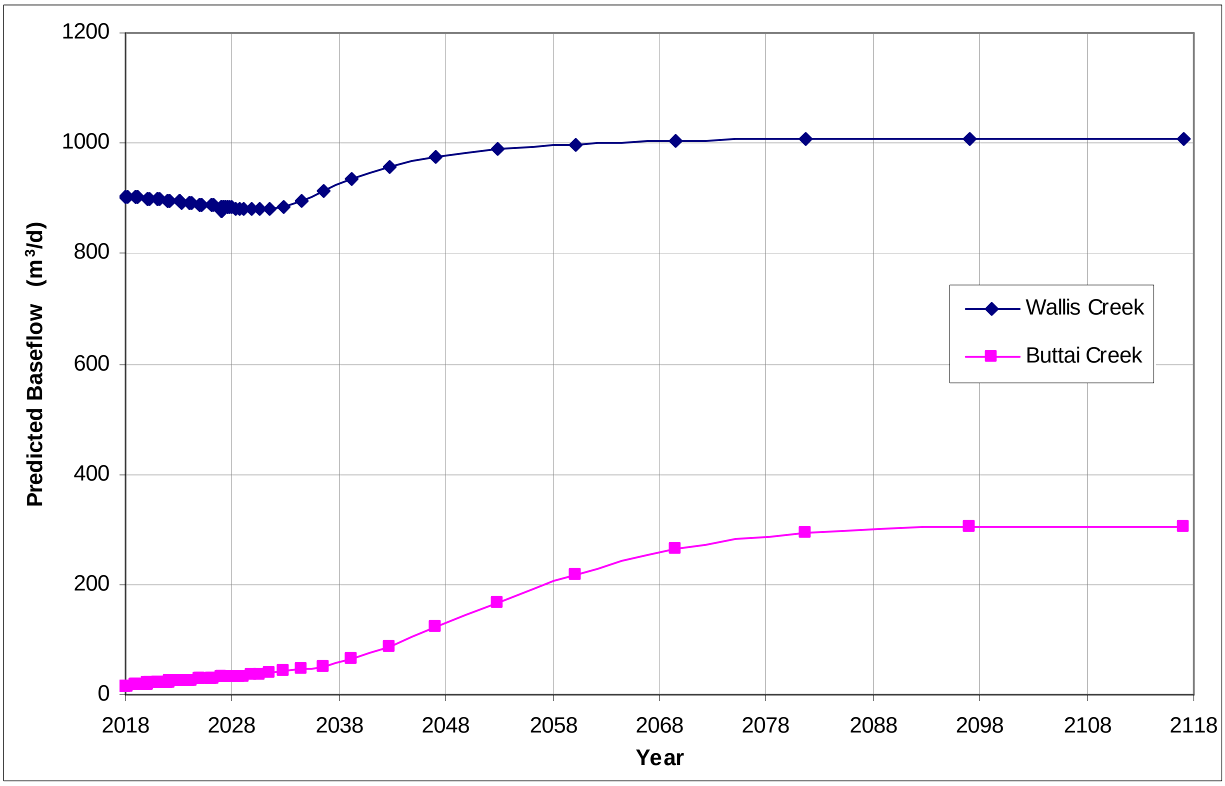
Finally, it should be remembered that the backfill material has been assigned a higher hydraulic conductivity (Kh = 1 m/d and Kv = 0.1 m/d) than the in-situ rock, and the void has been assigned high conductivity (Kh = Kv of 1000 m/d) and specific yield (Sy) of 0.99. These changes to the post-mining aquifer parameters result in a more uniform hydraulic interconnection along the pit than currently exists. The post-mining groundwater levels are predicted to stabilise at around 18 to 35 mAHD within the Bloomfield pit area, compared with Bloomfield groundwater levels predicted by steady state modelling that range to 25 mAHD in that area.

Figure 5.6 shows the baseflow for the nine creek reaches within the Bloomfield model area from the commencement of the mining simulation (2007) to the end of the recovery model run (2117). In summary, the baseflow contributions to Wallis Creek start to recover rapidly within 20 years following cessation of Bloomfield mining, and are fully re-stabilised at above the Bloomfield level by Year 2077 (i.e. 60 years after completion of Bloomfield mining).

Buttai Creek is also predicted to recover rapidly in one year and continued to increase to more than 20 times the current rate.

In summary, the model results show that the baseflows of the creeks within the influence of Bloomfield mining will fully recover to more than 100% of pre-2007 levels, due to the steady state model being affected by, past and current dewatering activities at Bloomfield and Donaldson open cuts.

Figure 5.6
Predicted baseflow during Bloomfield, Donaldson and Abel mine dewatering and recovery



SECTION 6 - BLOOMFIELD MODEL LIMITATIONS

All numerical models have limitations, due mainly to uncertainties in model input parameters, and also due to computational methods. The Bloomfield model limitations which need to be taken into consideration are summarised below:

- The model layer set-up is based on available bore log data, supplied by Bloomfield Collieries and other mining companies, which is not uniformly distributed across the model area. Some inaccuracies in layer elevations may have been introduced in a regional sense during the extension of layer elevations to the model boundaries, based on the assumed regional geology.
- Little data was available on surface water flows in the area. Major rivers, creeks and wetlands were implemented as Modflow River features with specified (constant) stage levels, to allow for leakage to or from the aquifer. All minor creeks are represented by Modflow Drain cells and are thus assumed to be influent.
- Recharge and evapotranspiration are assumed to be constant at average yearly rates, and seasonal or climatic variability is not included in the model. No measured values of recharge rates are available and hence there is uncertainty about actual recharge rates. Recharge values have been assigned within a plausible range to obtain a calibrated model, but values cannot be verified. The maximum possible rate of evaporation in the model is 250mm/yr, acting in areas of shallow (<3m) water levels. This is a best estimate based on available data and experienced judgement.
- There is a high level of uncertainty with respect to both vertical and horizontal distribution of hydraulic conductivity. Conductivities do not change with depth in the model to reflect progressive burial of coal and interburden. However, sensitivity and uncertainty scenario analysis indicates that the model calibration is robust, and the model results are not highly sensitive to potential errors in the assumed aquifer parameters.
- The model is discretised into 8 layers. Heads are averaged over one model layer and the further resolution of heads with depth cannot be as detailed as observed in the field using the current model configuration.
- There is insufficient data for a transient model calibration across the entire model area, or for a true pre-mining steady-state calibration. Steady-state and transient model calibrations are desirable for model verification. At this stage, model predictions are best estimates and have a degree of uncertainty as the sensitivity model runs demonstrate.
- Uncertainties exist on the “resistance to flow” between the interburden and the underground mine void, and between the alluvium/regolith and the underlying coal measures, which were simulated in the model using specified drain conductance values. The uncertainty has been addressed by running sensitivity scenarios, varying the conductance to establish the effect on model results.

In conclusion, the model results of mine inflows and drawdown effects can be regarded as a current best estimate based on the available data. However it should also be noted that the sensitivity and uncertainty scenario analysis indicates that the model calibration is robust, and the model results are not highly sensitive to potential errors or uncertainties in the assumed aquifer parameters.

SECTION 7 - REFERENCES

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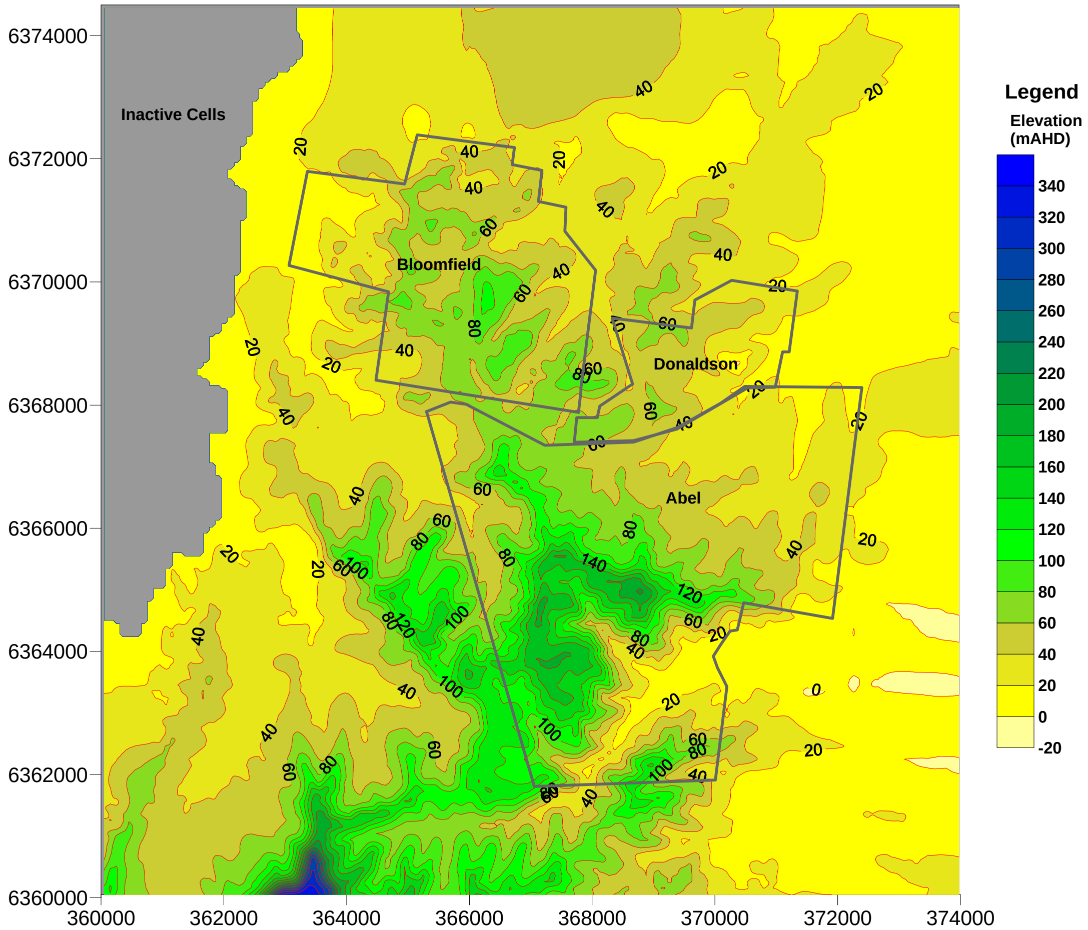
APPENDIX A

BLOOMFIELD MODEL LAYER ELEVATIONS

TOP OF LAYER 1



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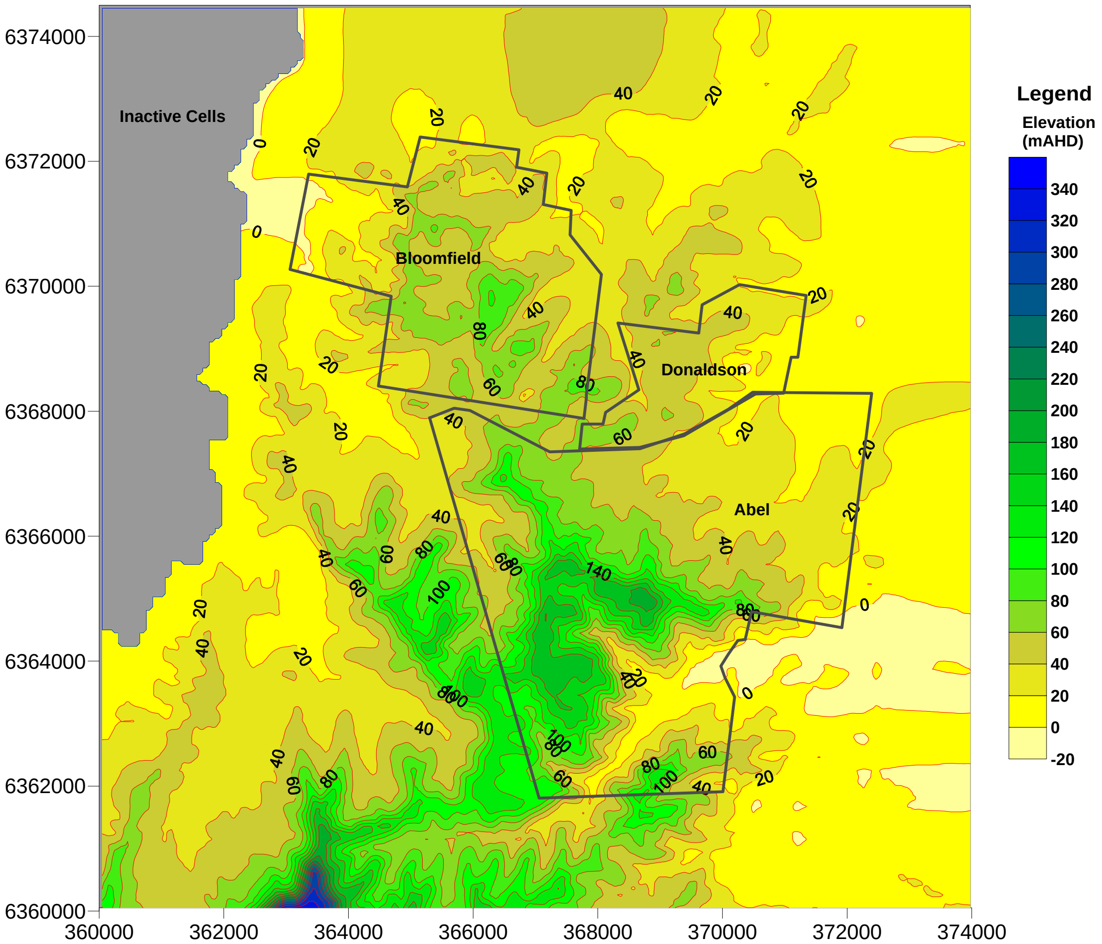

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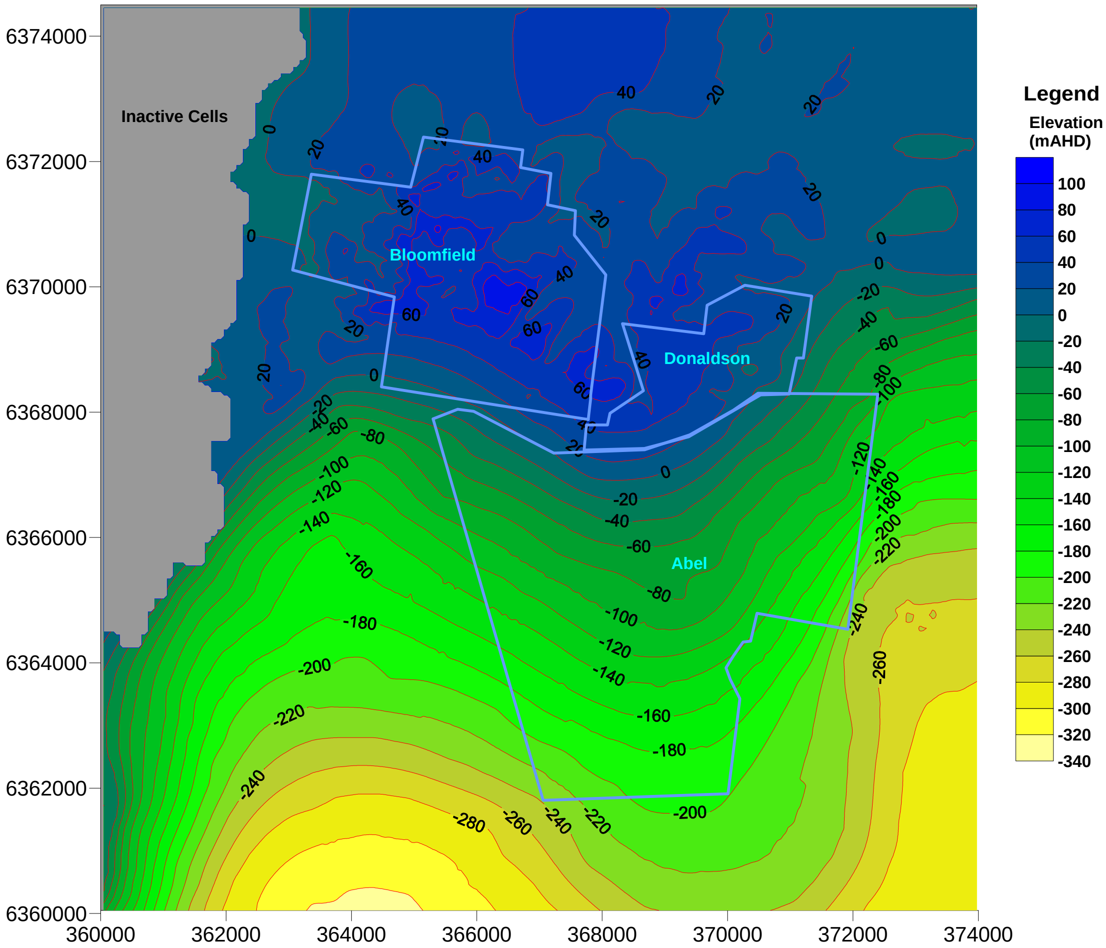

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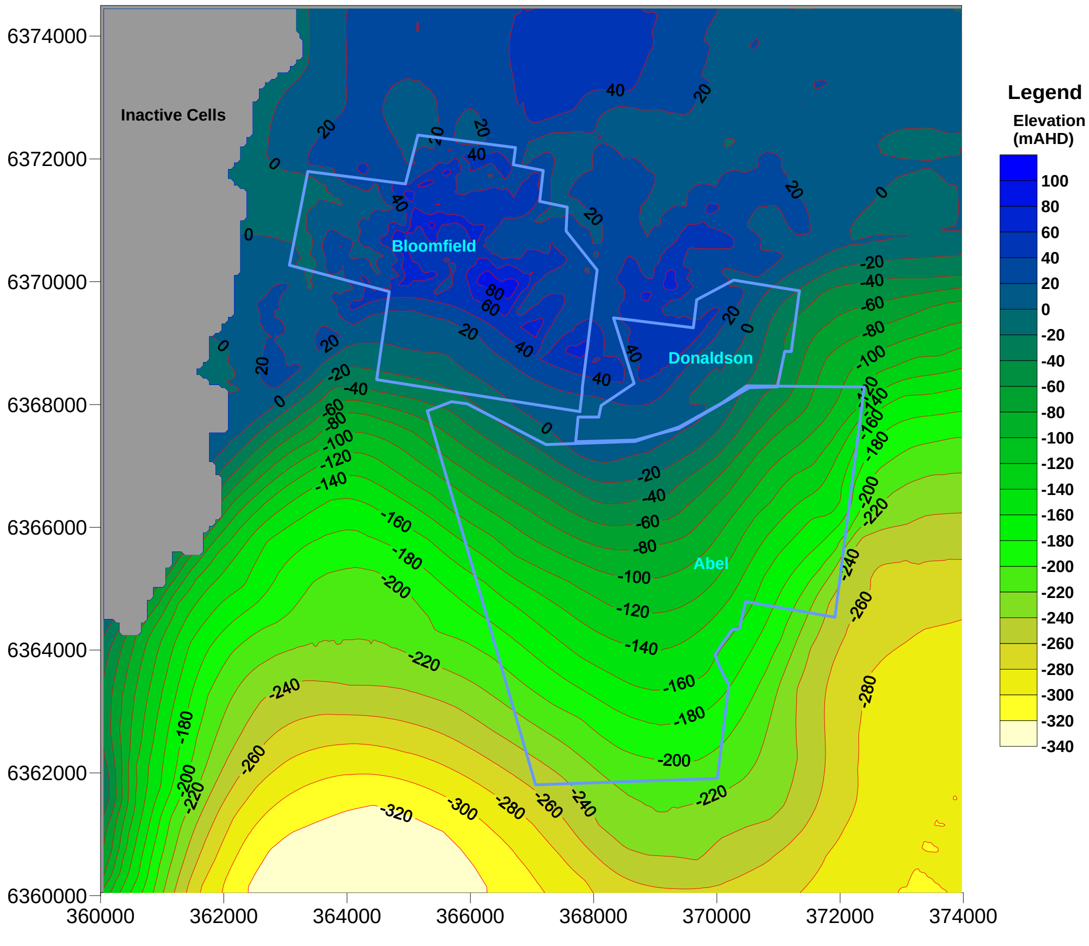

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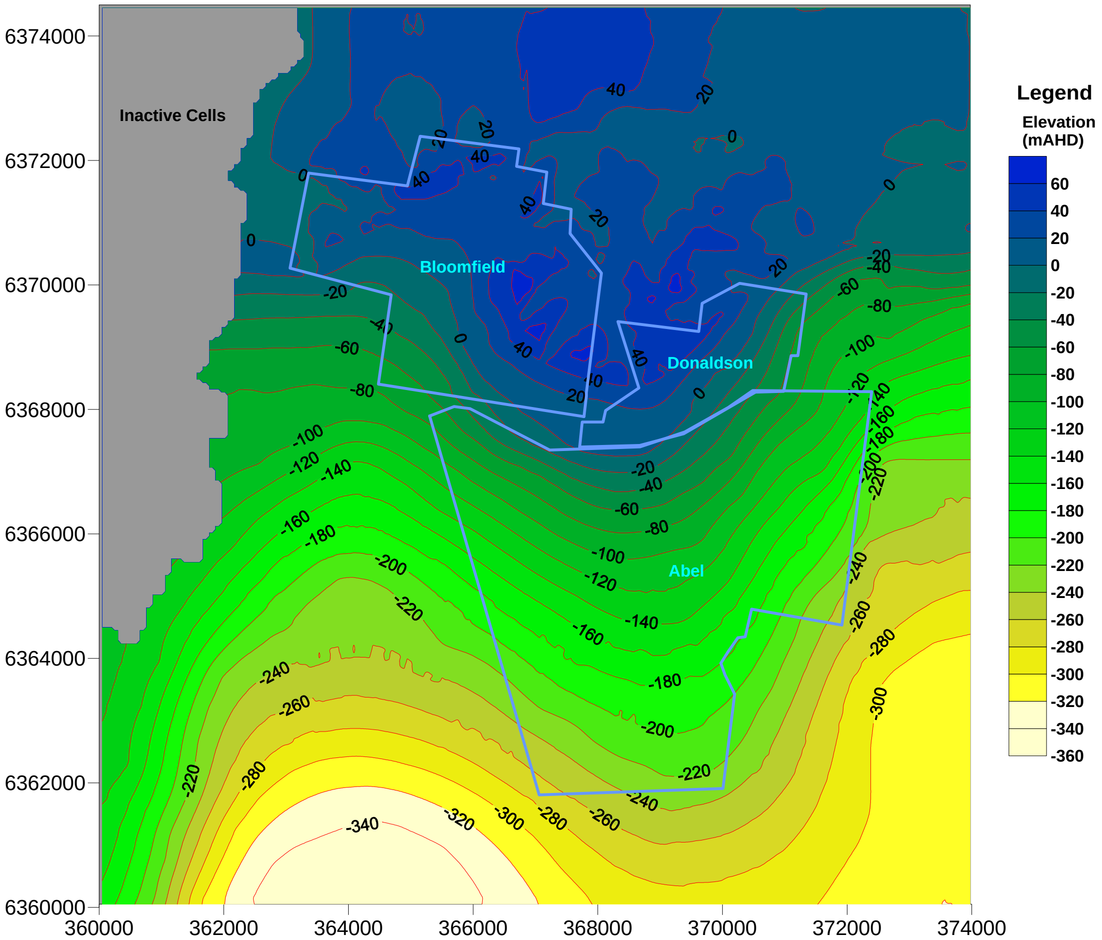

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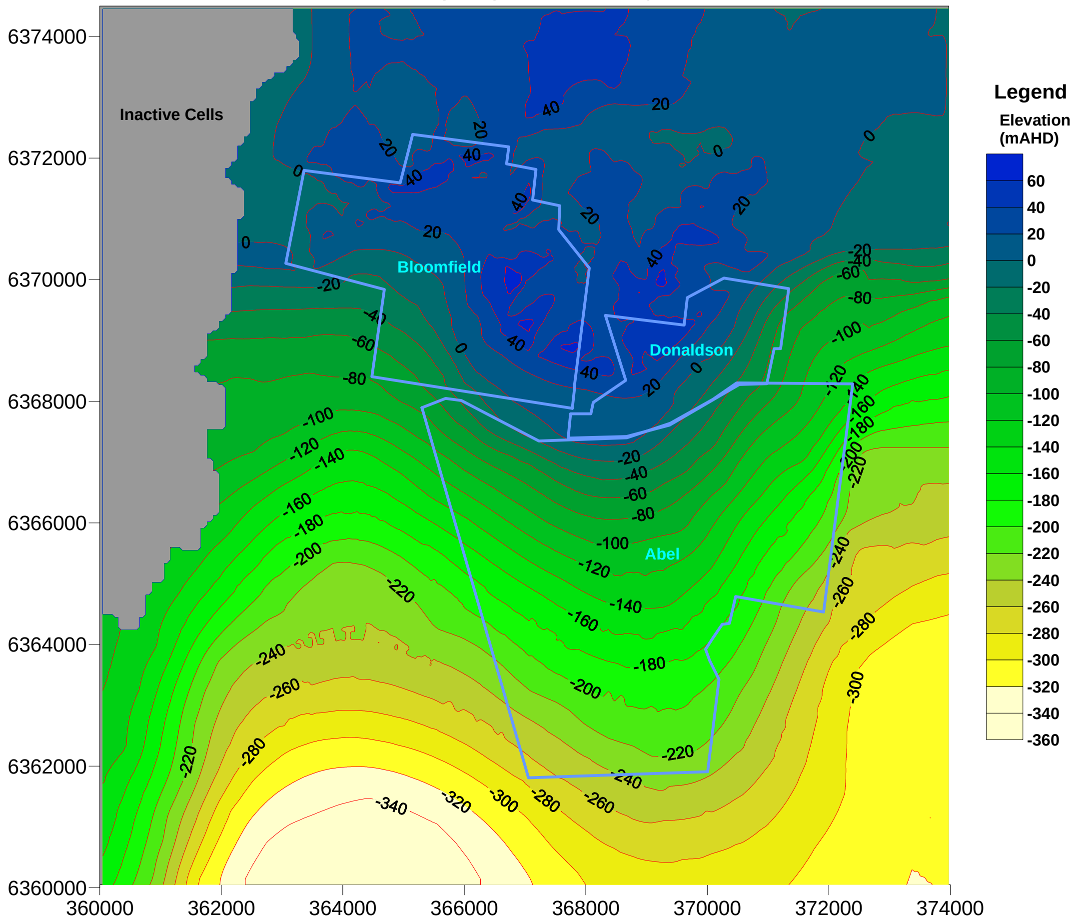
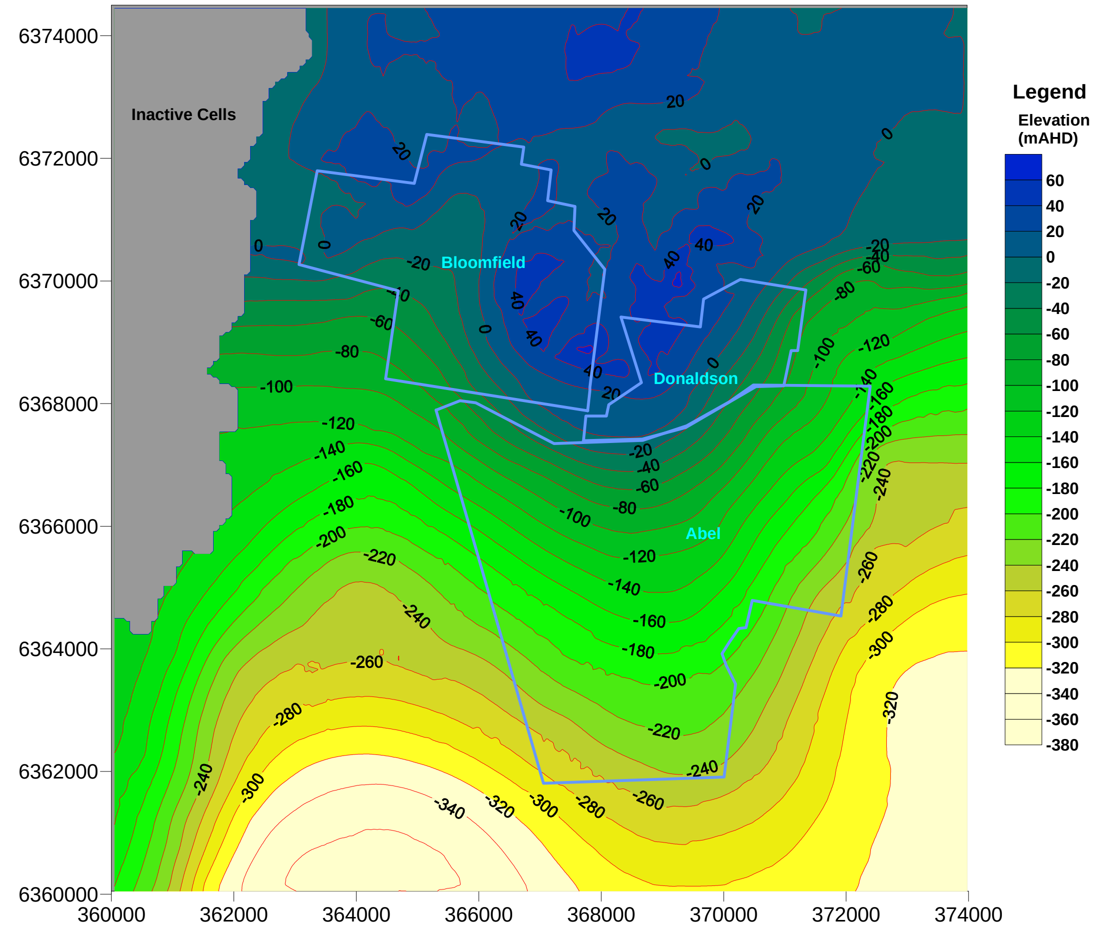
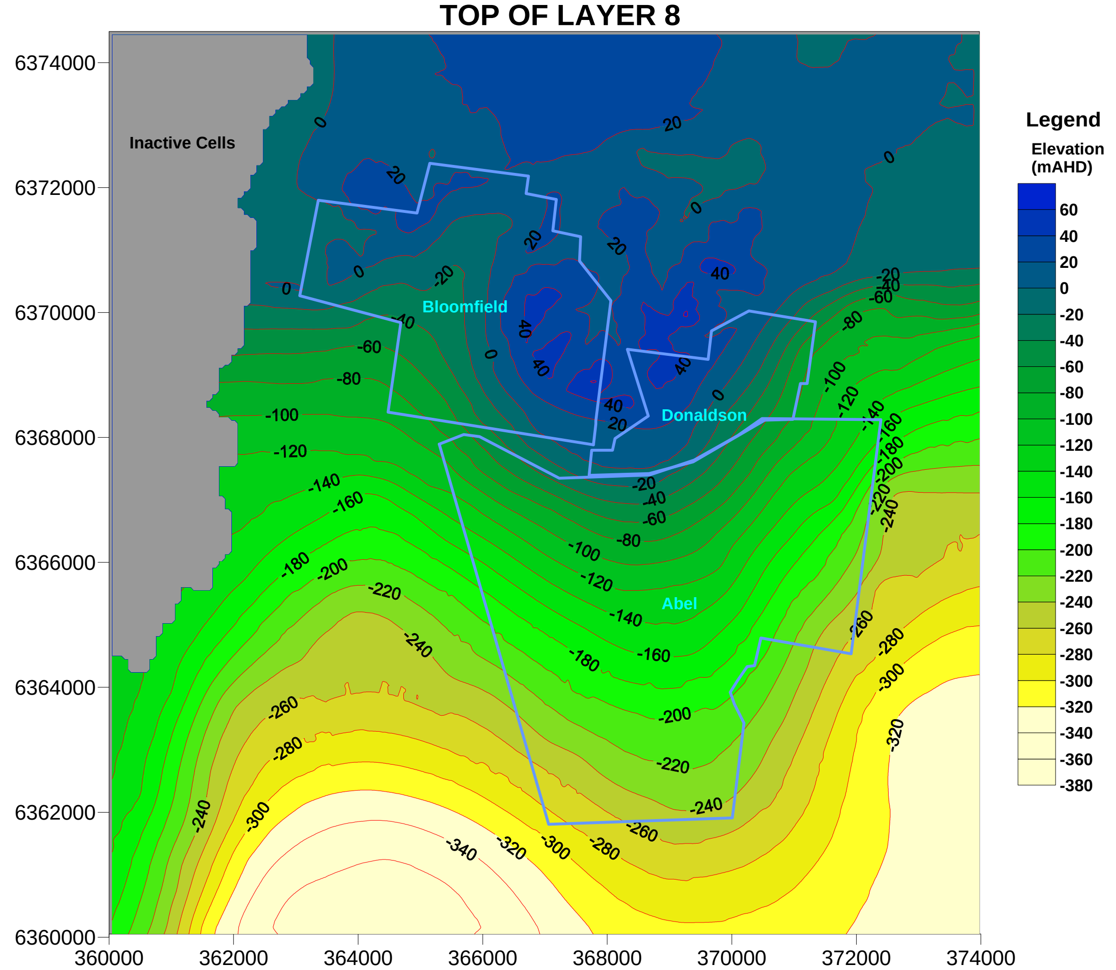


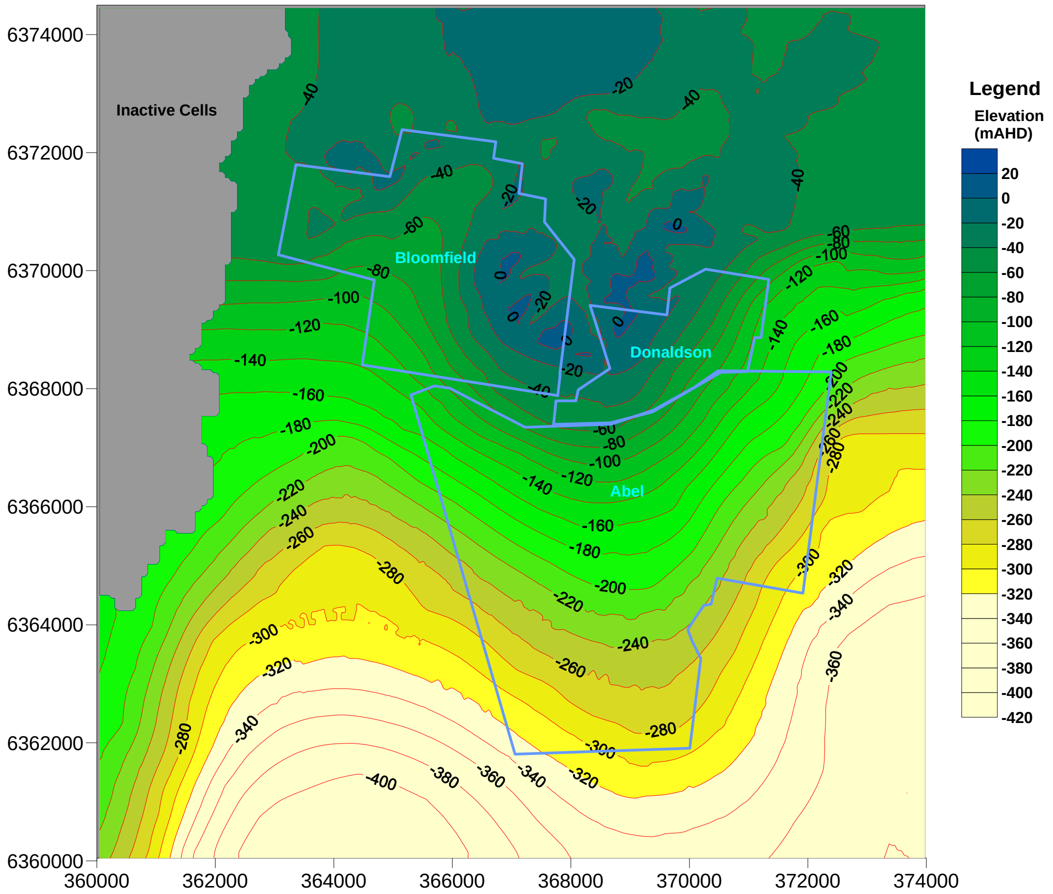
TOP OF LAYER 7



TOP OF LAYER 8



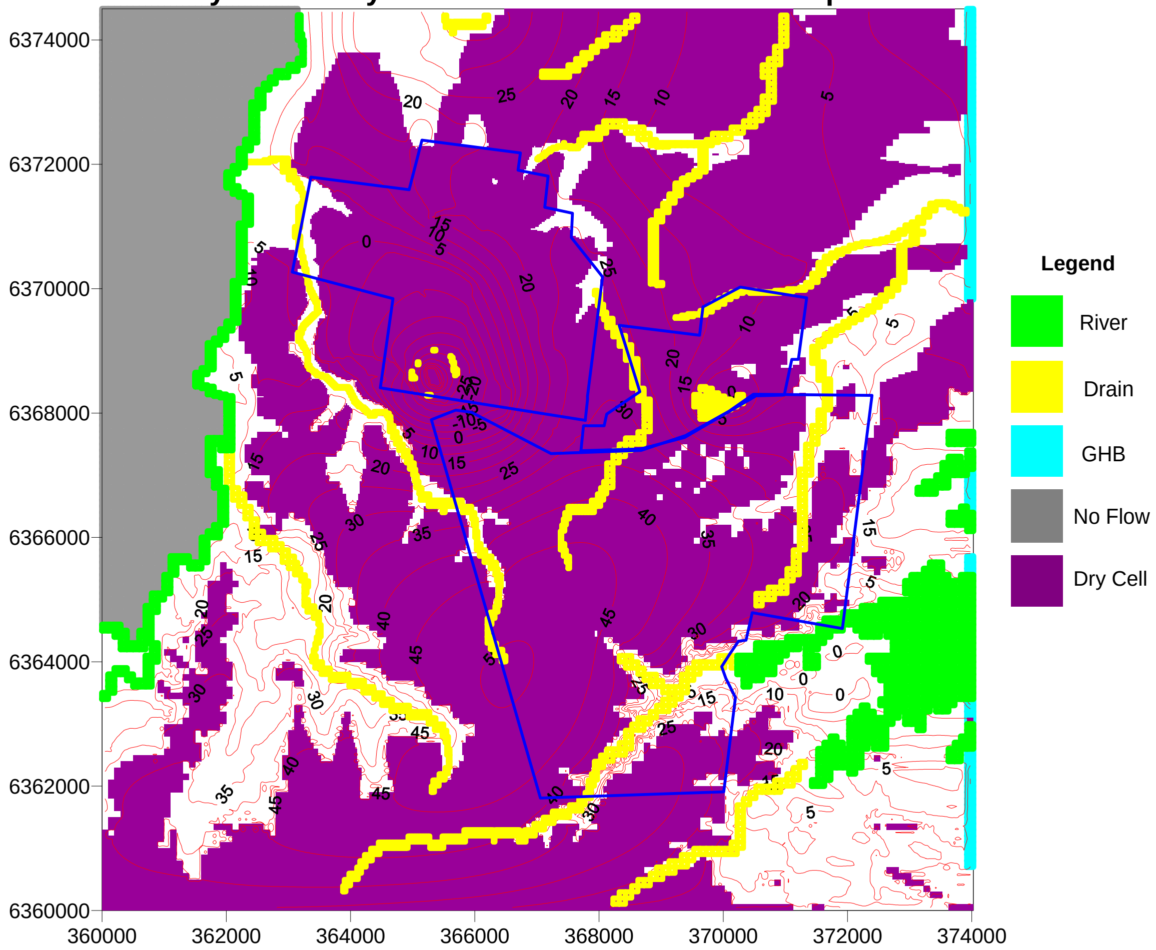
BOTTOM OF LAYER 8



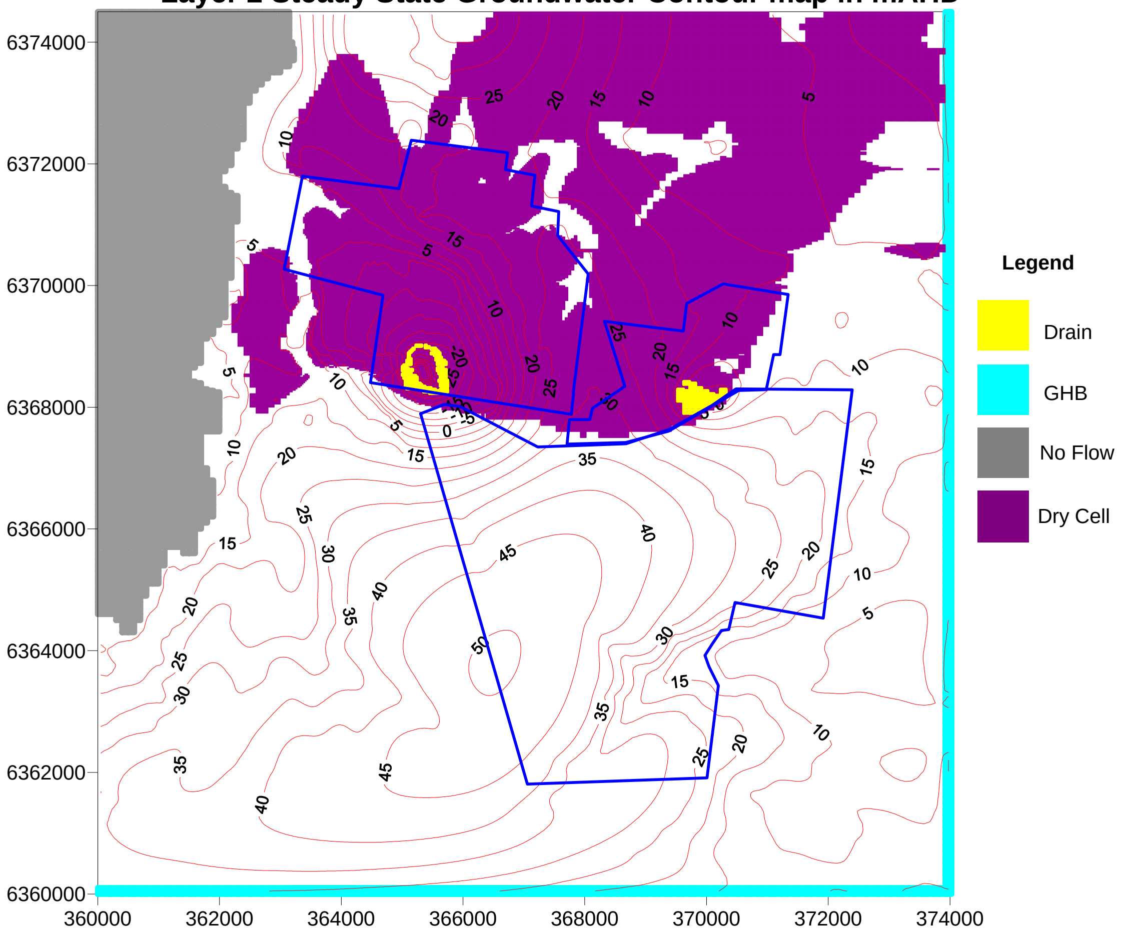
APPENDIX B

BLOOMFIELD MODEL STEADY STATE CALIBRATION
(LAYER BOUNDARY CONDITIONS AND GROUNDWATER CONTOUR MAPS)

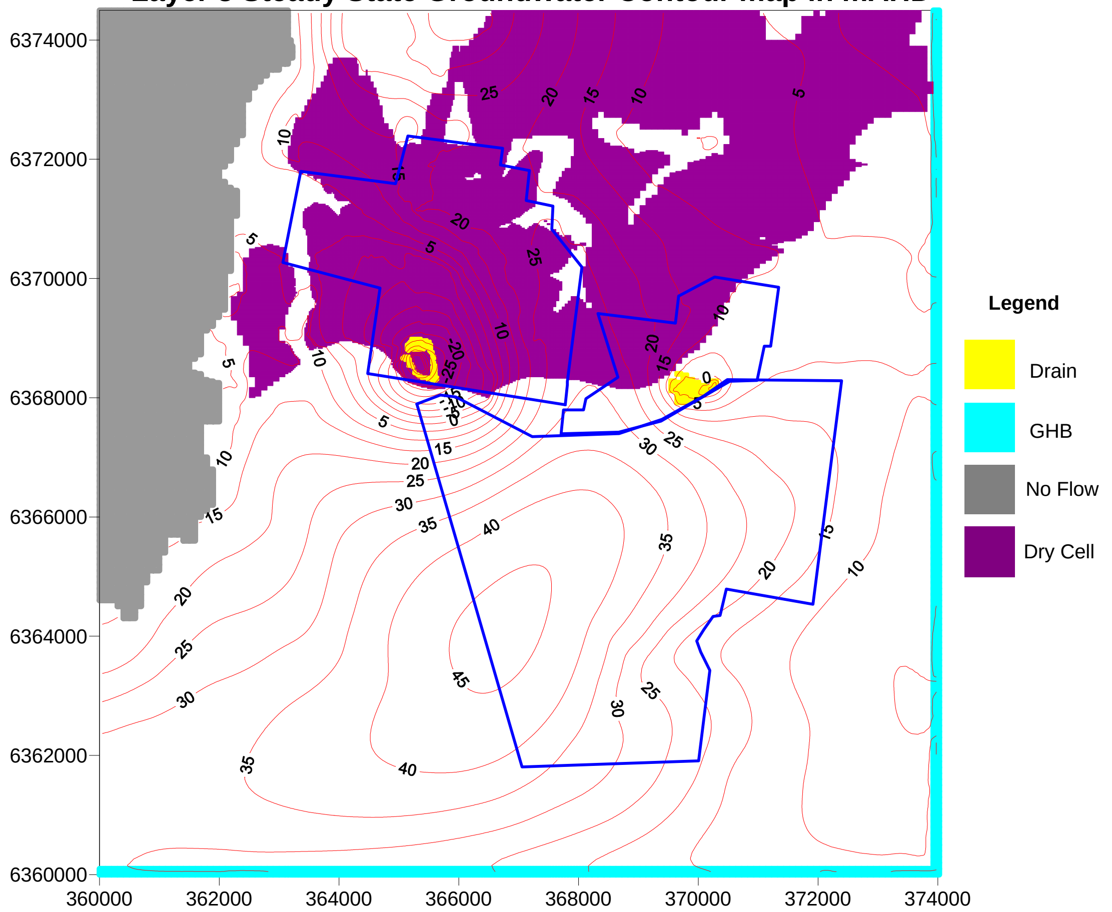
Layer 1 Steady State Groundwater Contour map in mAHD



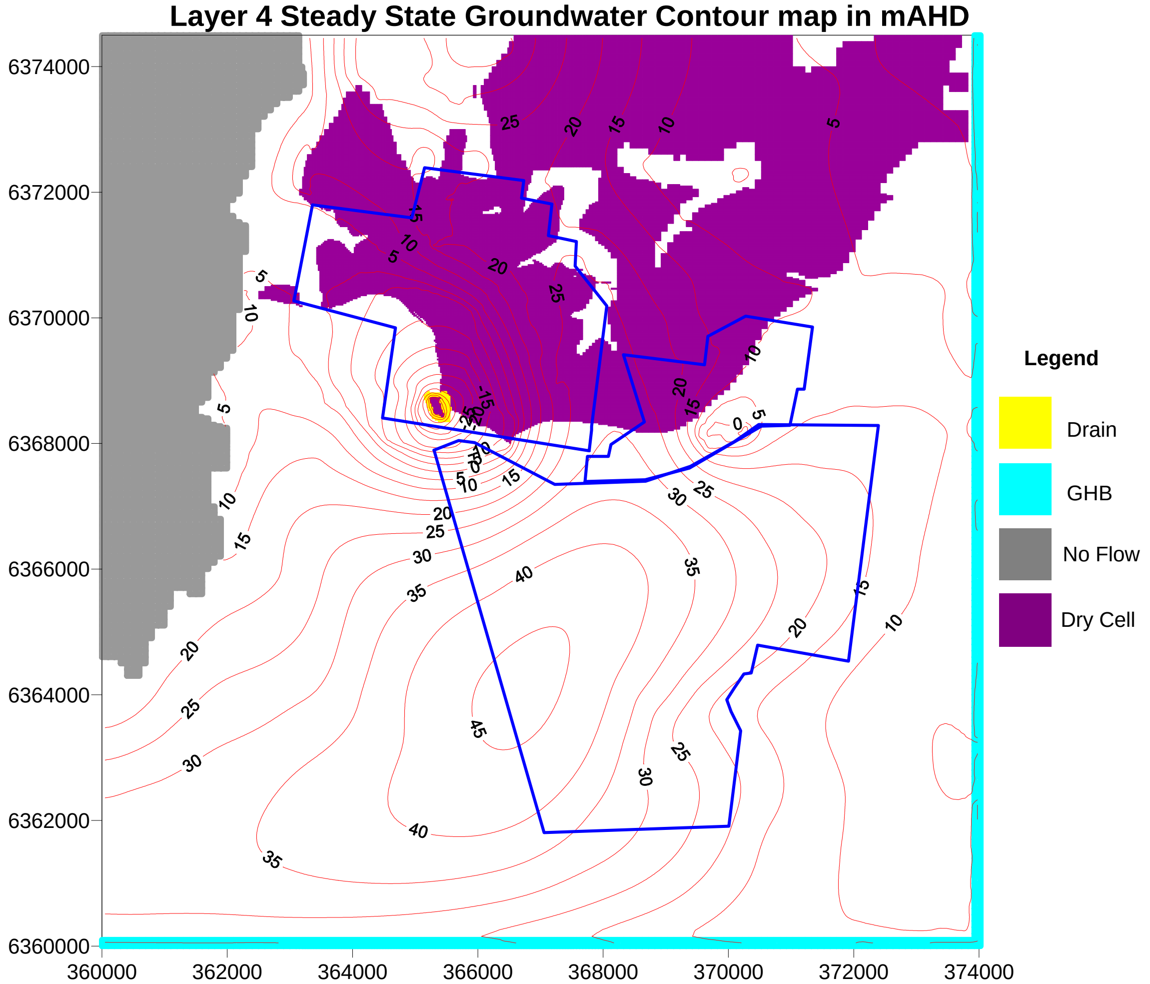
Layer 2 Steady State Groundwater Contour map in mAHD

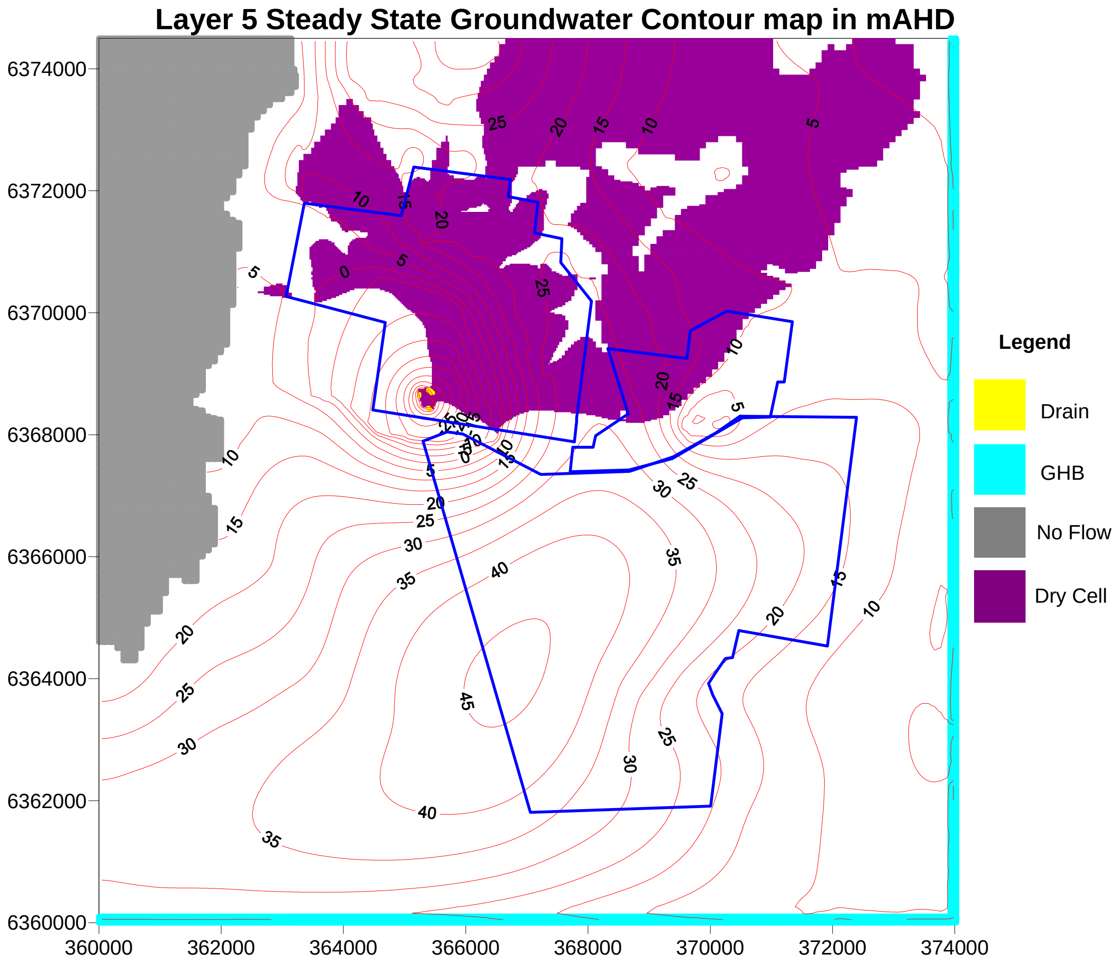


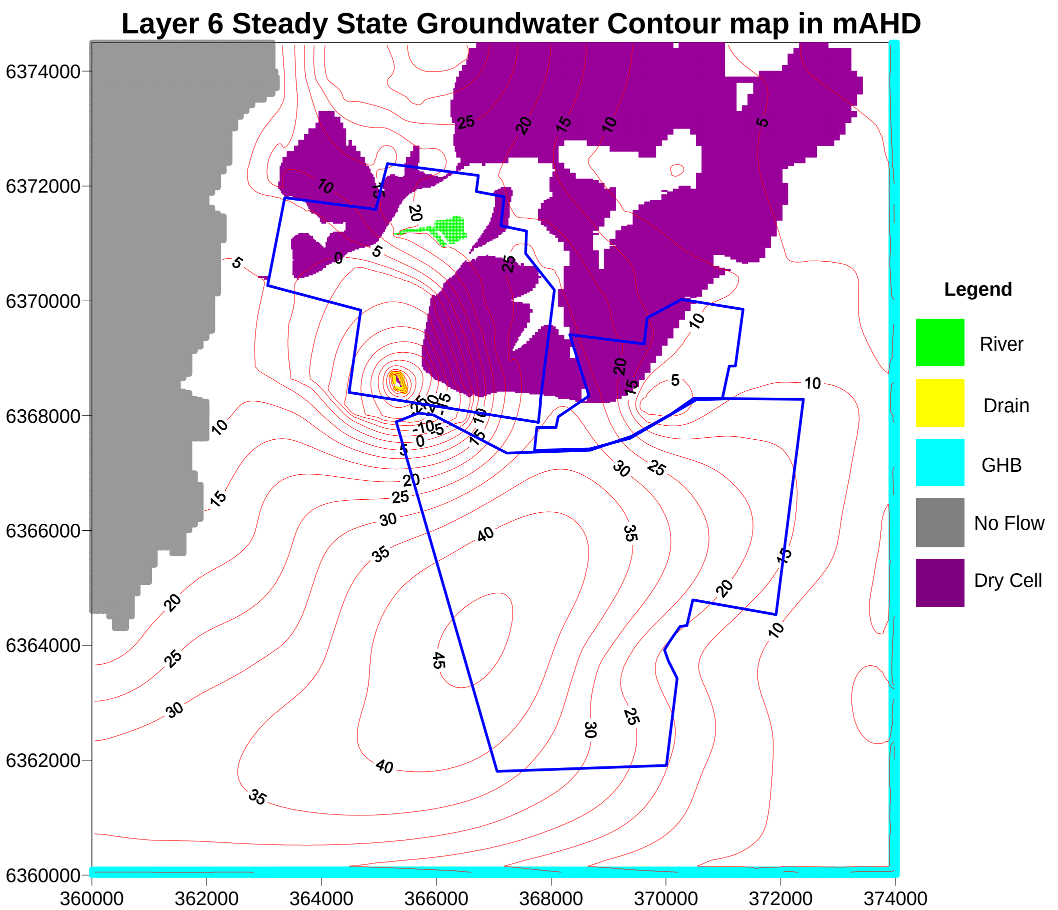
Layer 3 Steady State Groundwater Contour map in mAHD

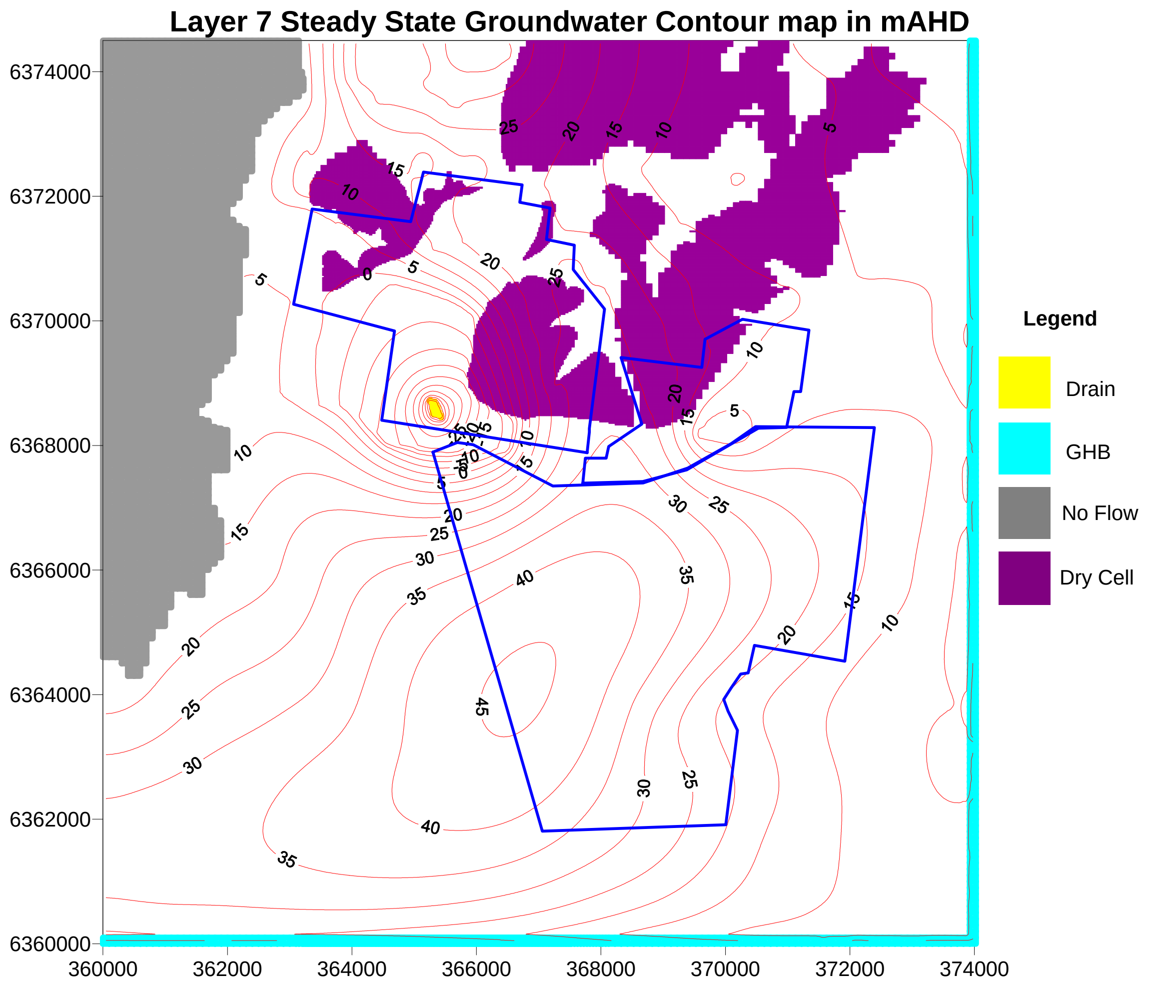


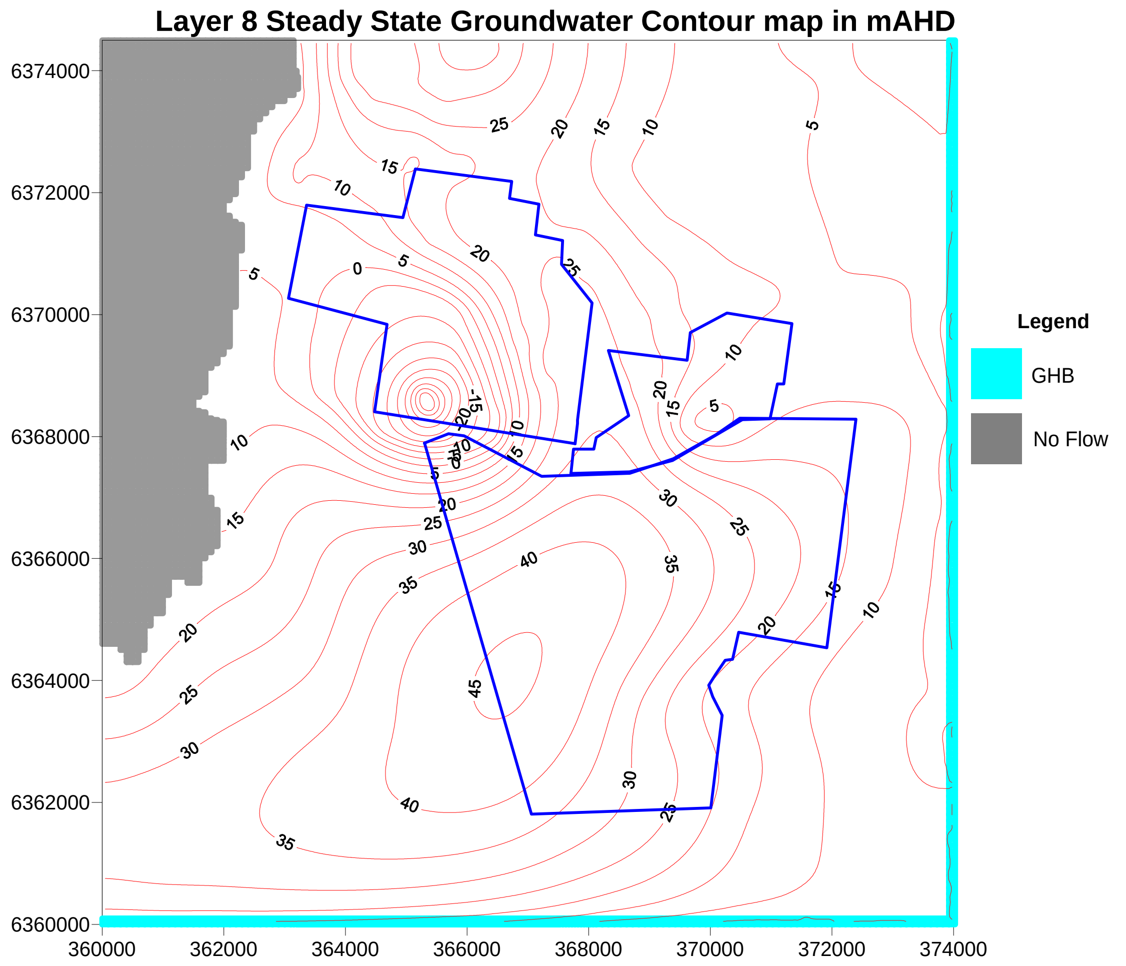
Layer 4 Steady State Groundwater Contour map in mAHD




Layer 5 Steady State Groundwater Contour map in mAHD
Legend
Drain
GHB
No Flow
Dry Cell


Layer 6 Steady State Groundwater Contour map in mAHD
Legend
River
Drain
GHB
No Flow
Dry Cell

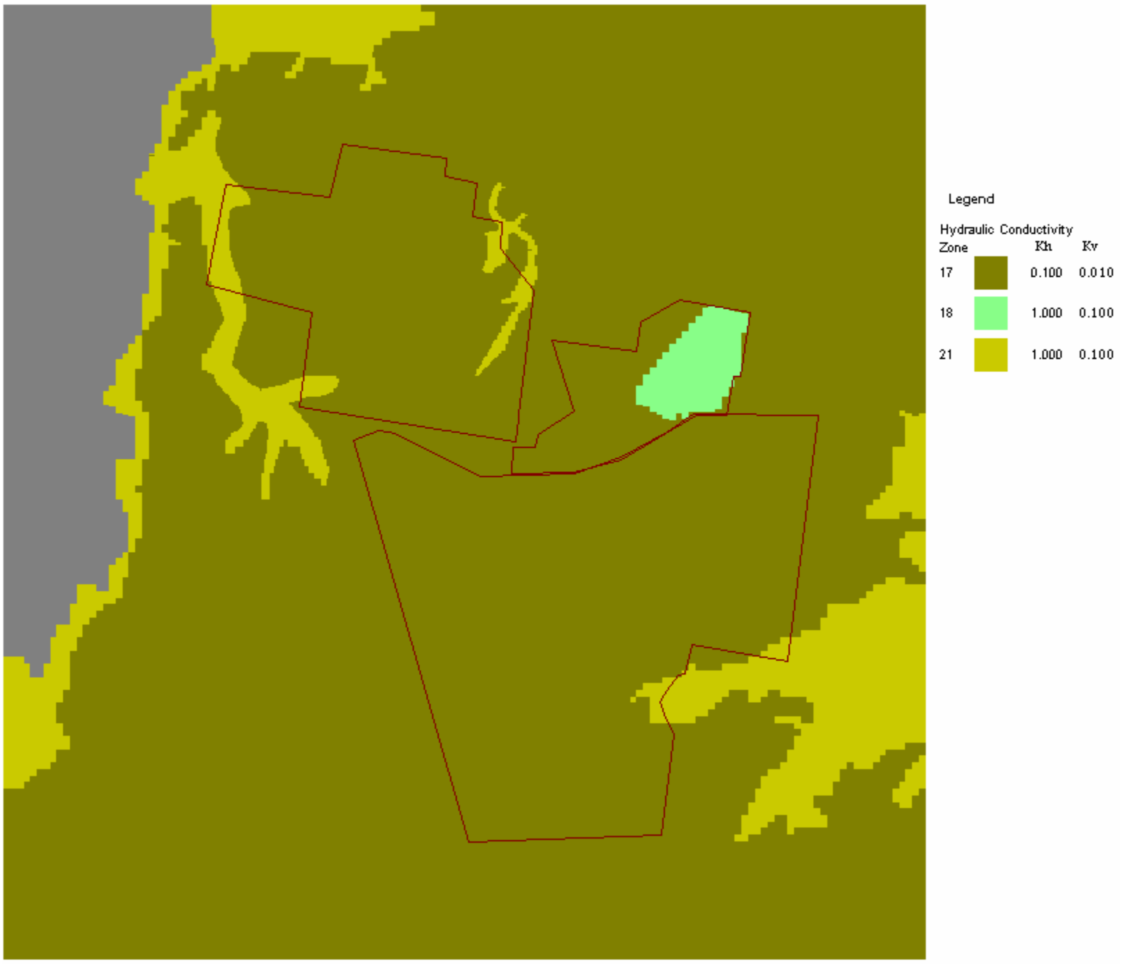

Layer 7 Steady State Groundwater Contour map in mAHD
Legend
Drain
GHB
No Flow
Dry Cell
6374000
6372000
6370000
6368000
6366000
6364000
6362000
6360000
360000
362000
364000
366000
368000
370000
372000
374000


Layer 8 Steady State Groundwater Contour map in mAHD
Legend
GHB
No Flow
6374000
6372000
6370000
6368000
6366000
6364000
6362000
6360000
360000
362000
364000
366000
368000
370000
372000
374000

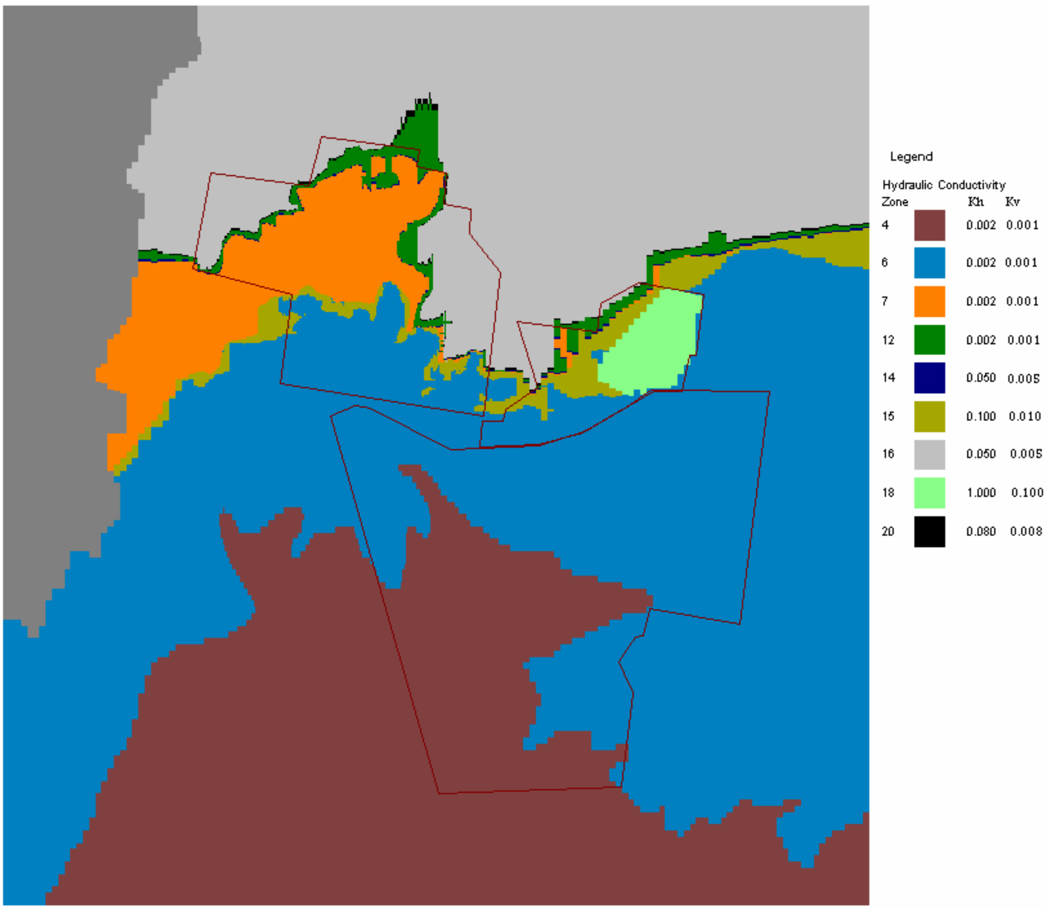
APPENDIX C

BLOOMFIELD MODEL CALIBRATED PARAMETERS

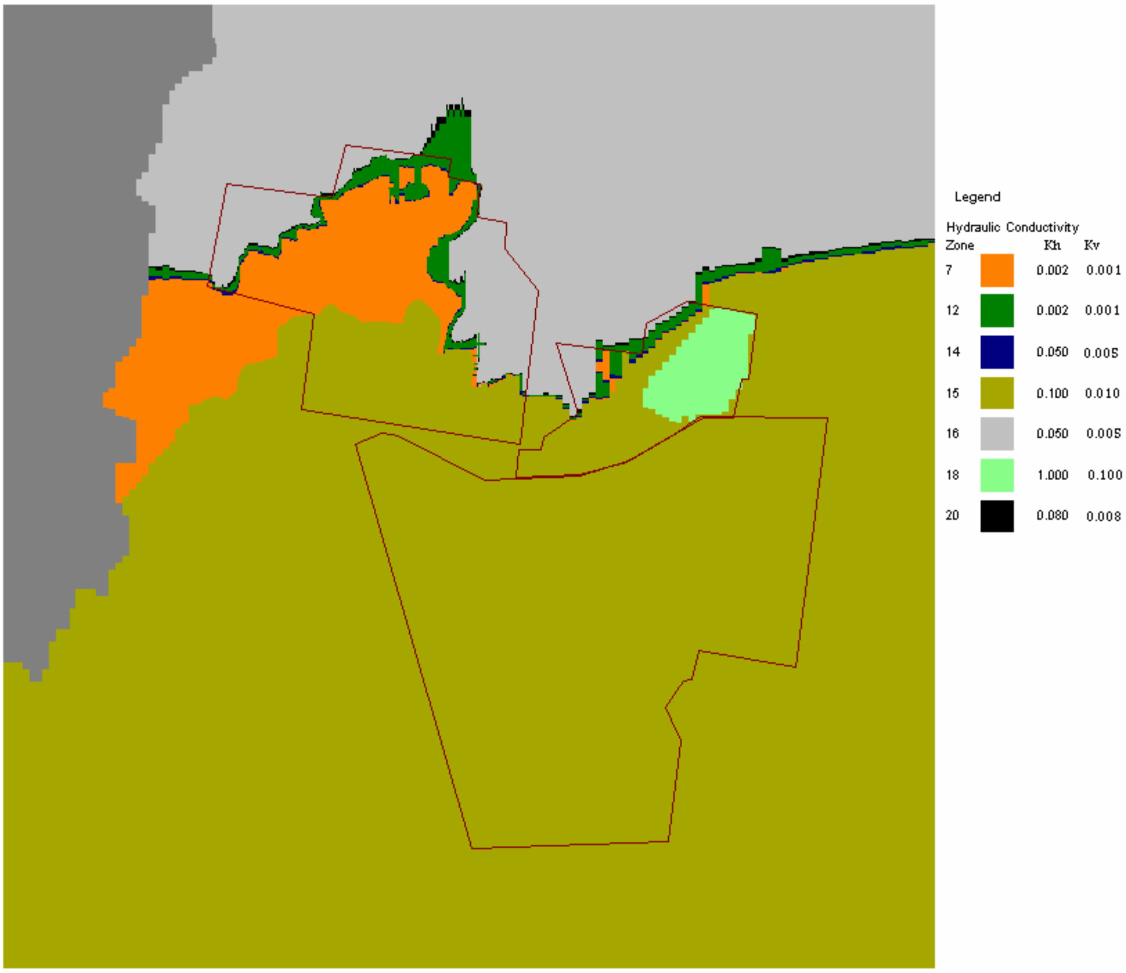
HORIZONTAL AND VERTICAL HYDRAULIC CONDUCTIVITY OF LAYER 1



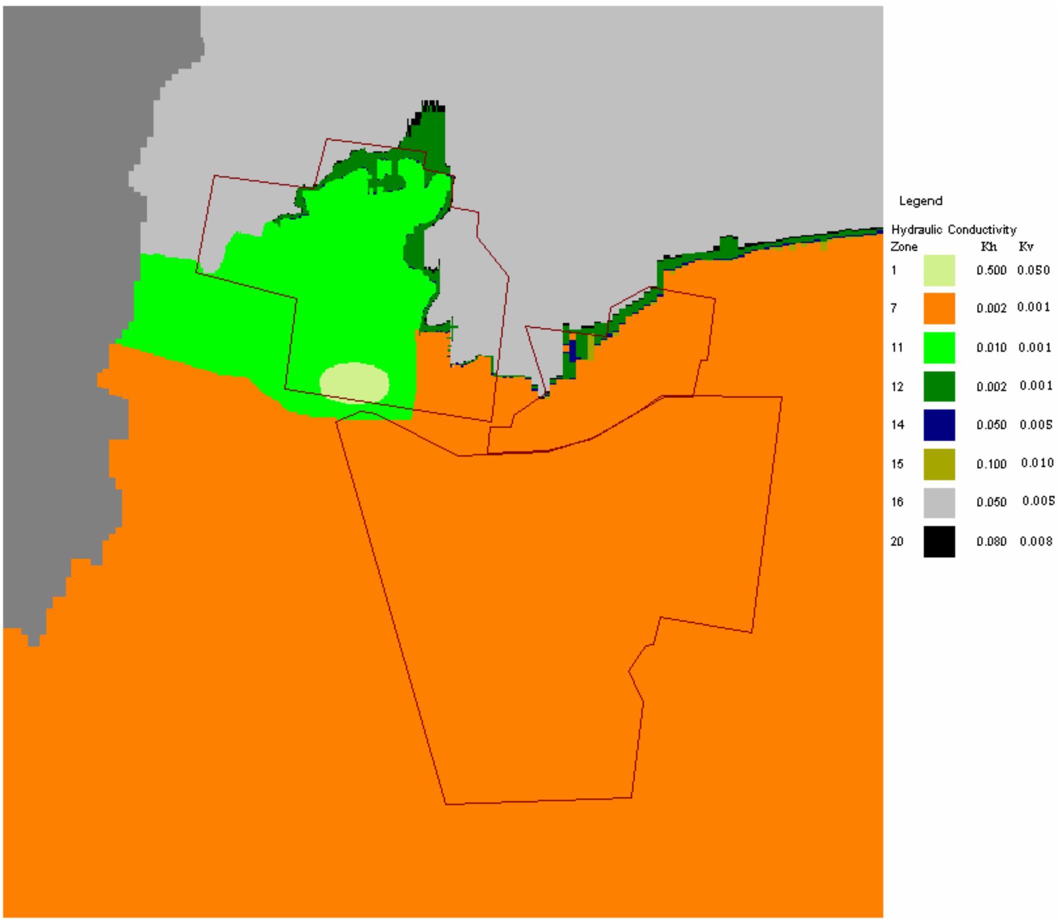
HORIZONTAL AND VERTICAL HYDRAULIC CONDUCTIVITY OF LAYER 2



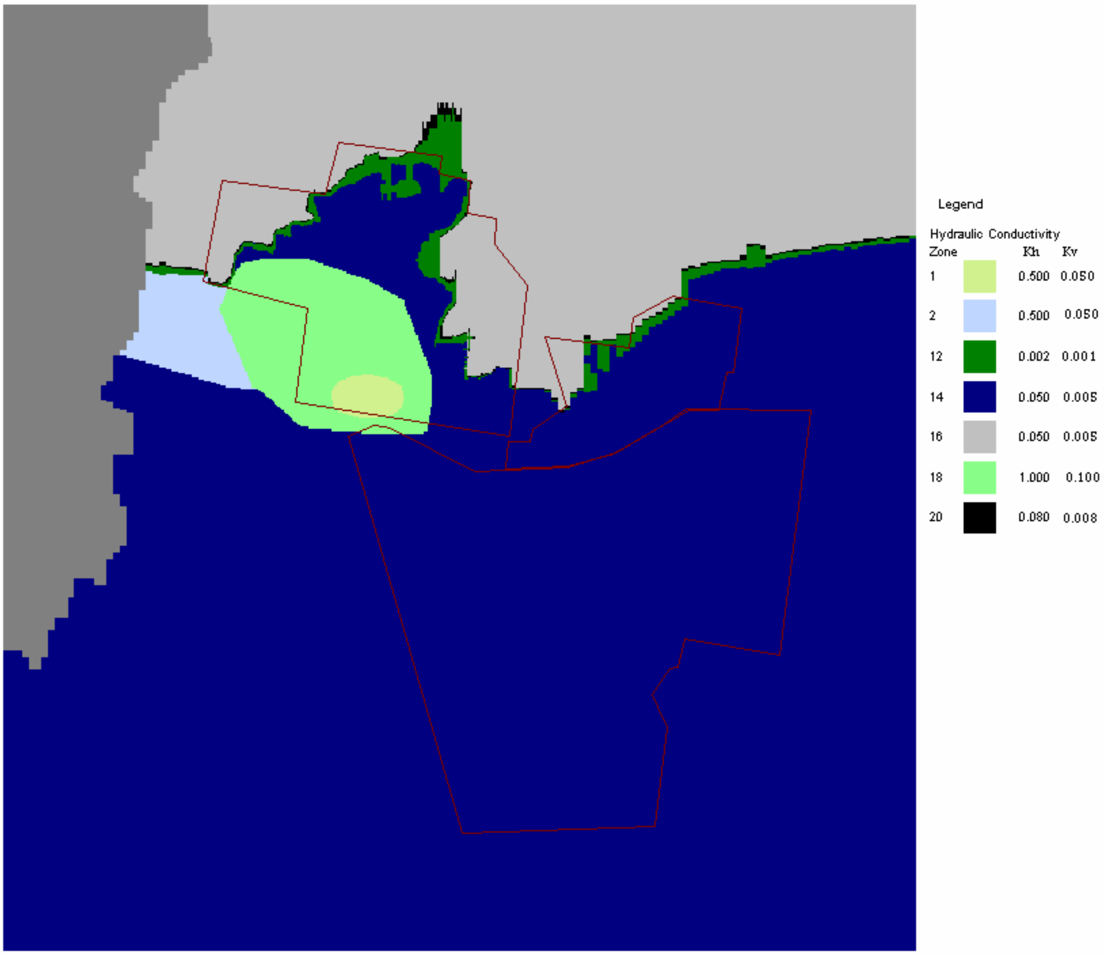
HORIZONTAL AND VERTICAL HYDRAULIC CONDUCTIVITY OF LAYER 3



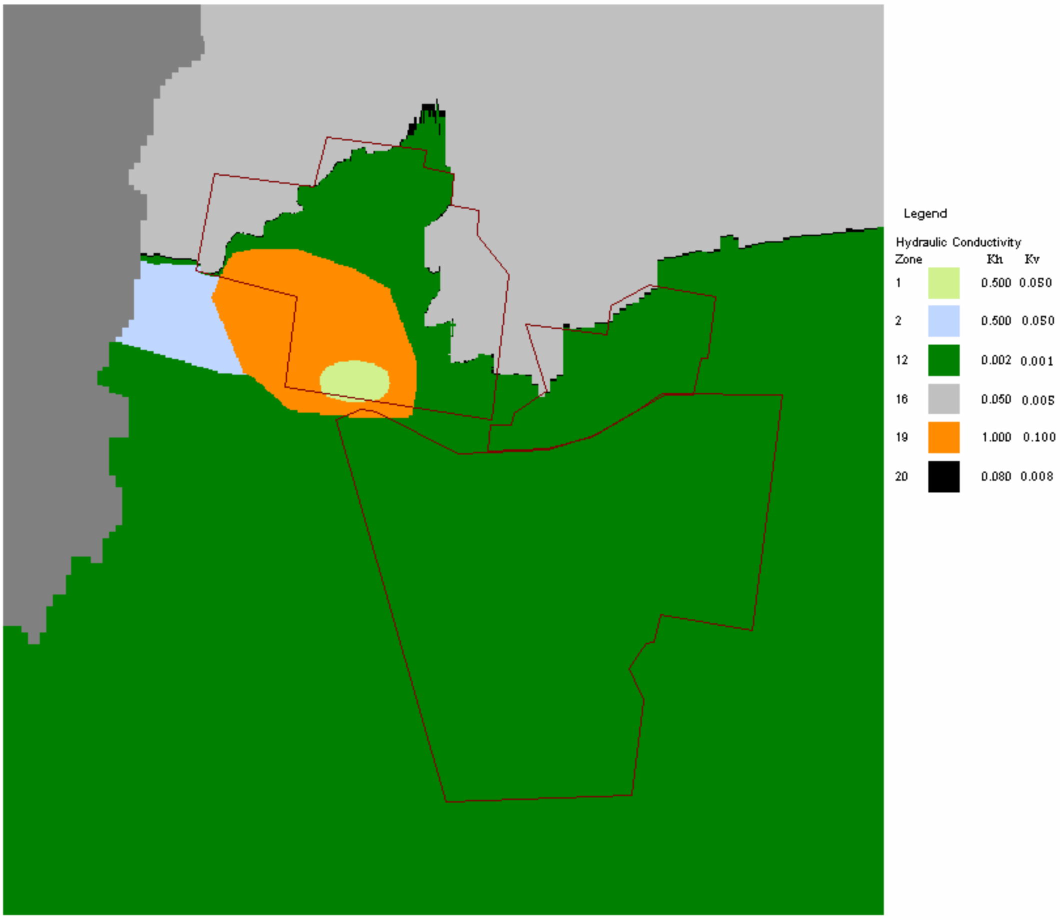
HORIZONTAL AND VERTICAL HYDRAULIC CONDUCTIVITY OF LAYER 4



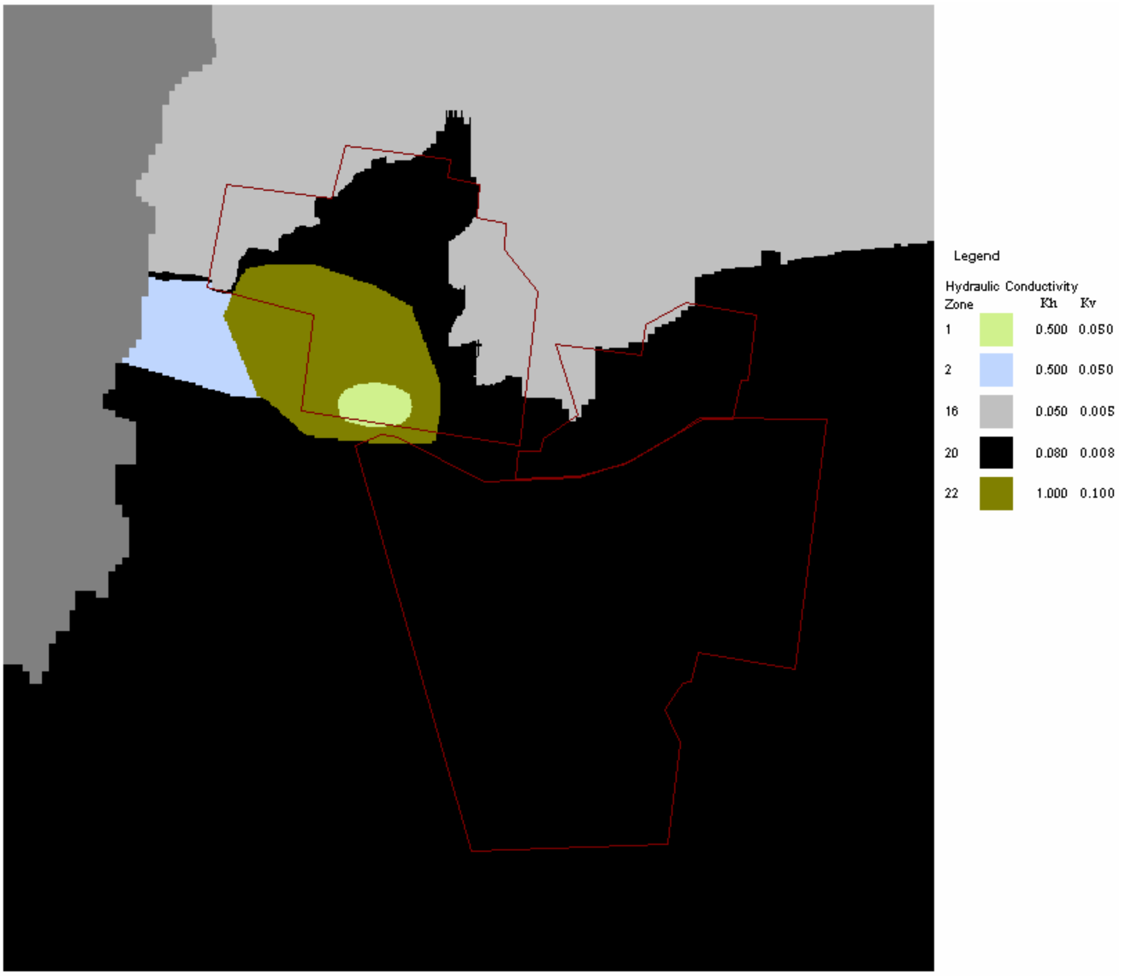
HORIZONTAL AND VERTICAL HYDRAULIC CONDUCTIVITY OF LAYER 5



HORIZONTAL AND VERTICAL HYDRAULIC CONDUCTIVITY OF LAYER 6

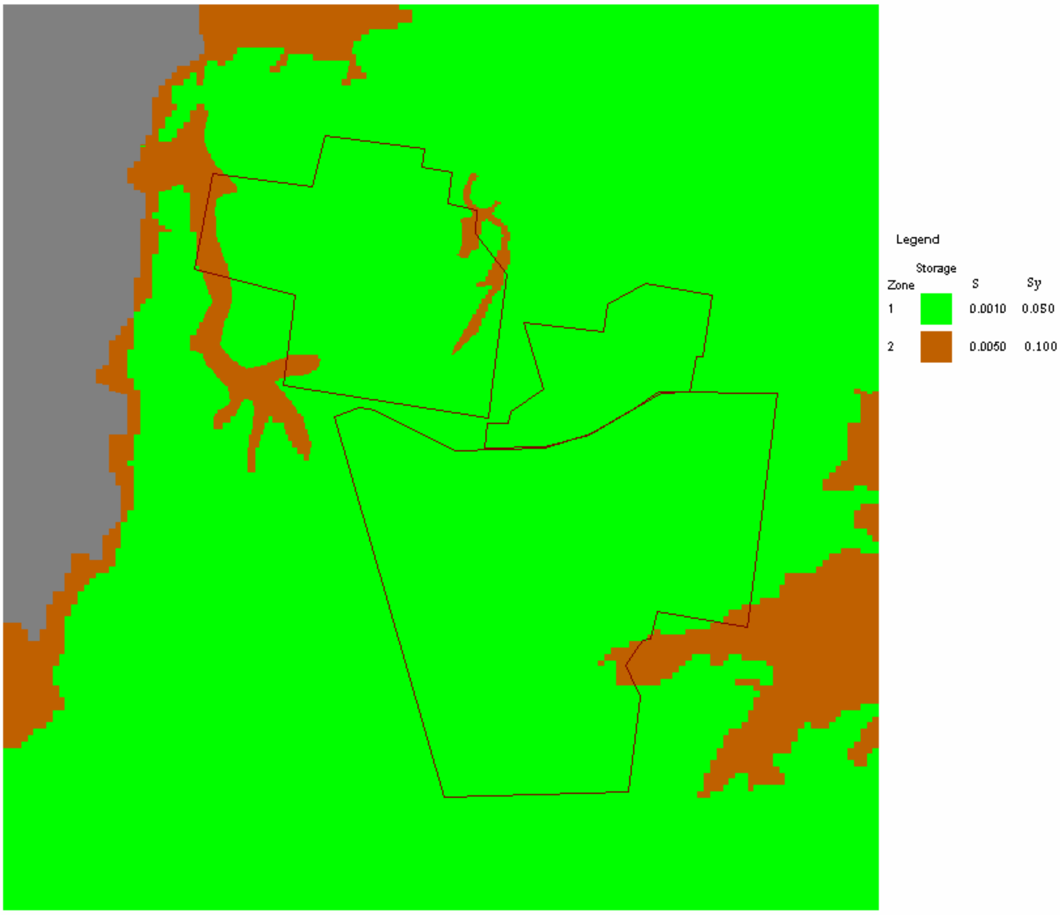


HORIZONTAL AND VERTICAL HYDRAULIC CONDUCTIVITY OF LAYER 7

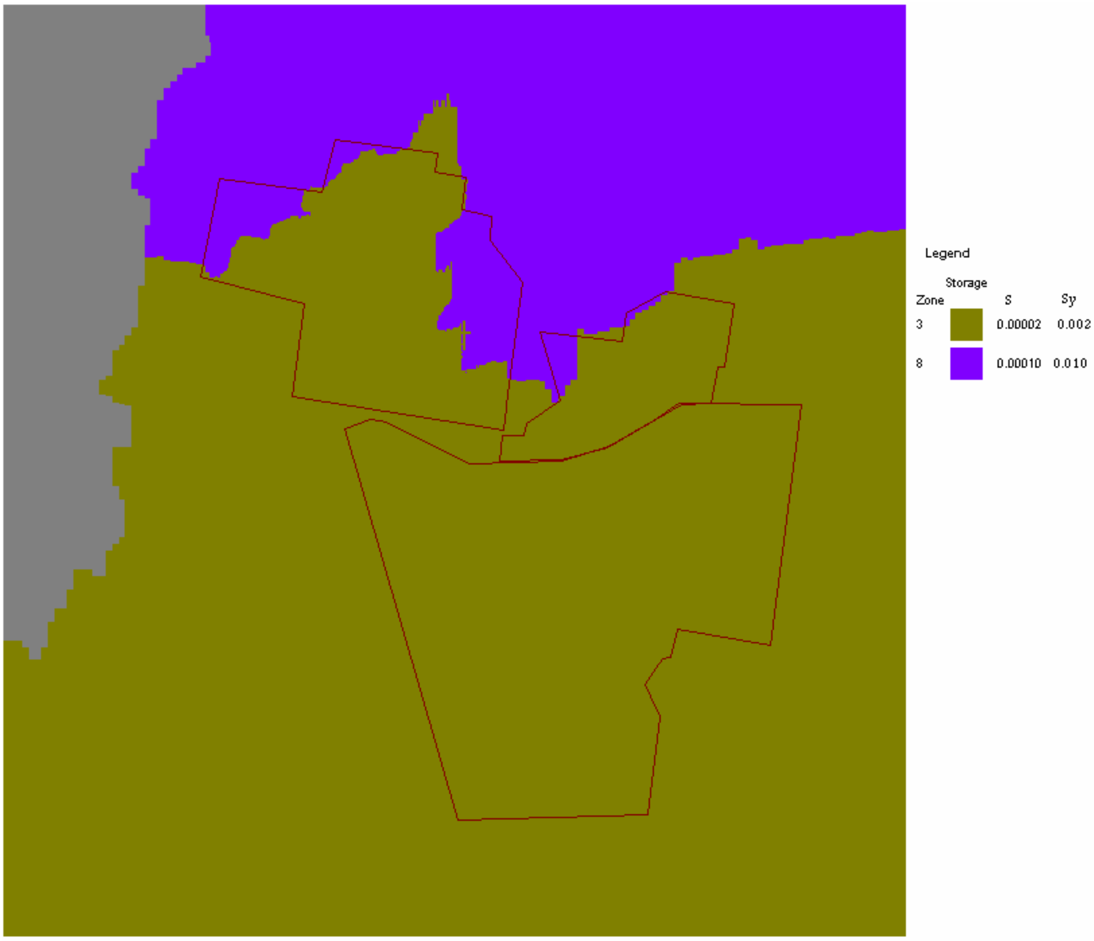


HORIZONTAL AND VERTICAL HYDRAULIC CONDUCTIVITY OF LAYER 8

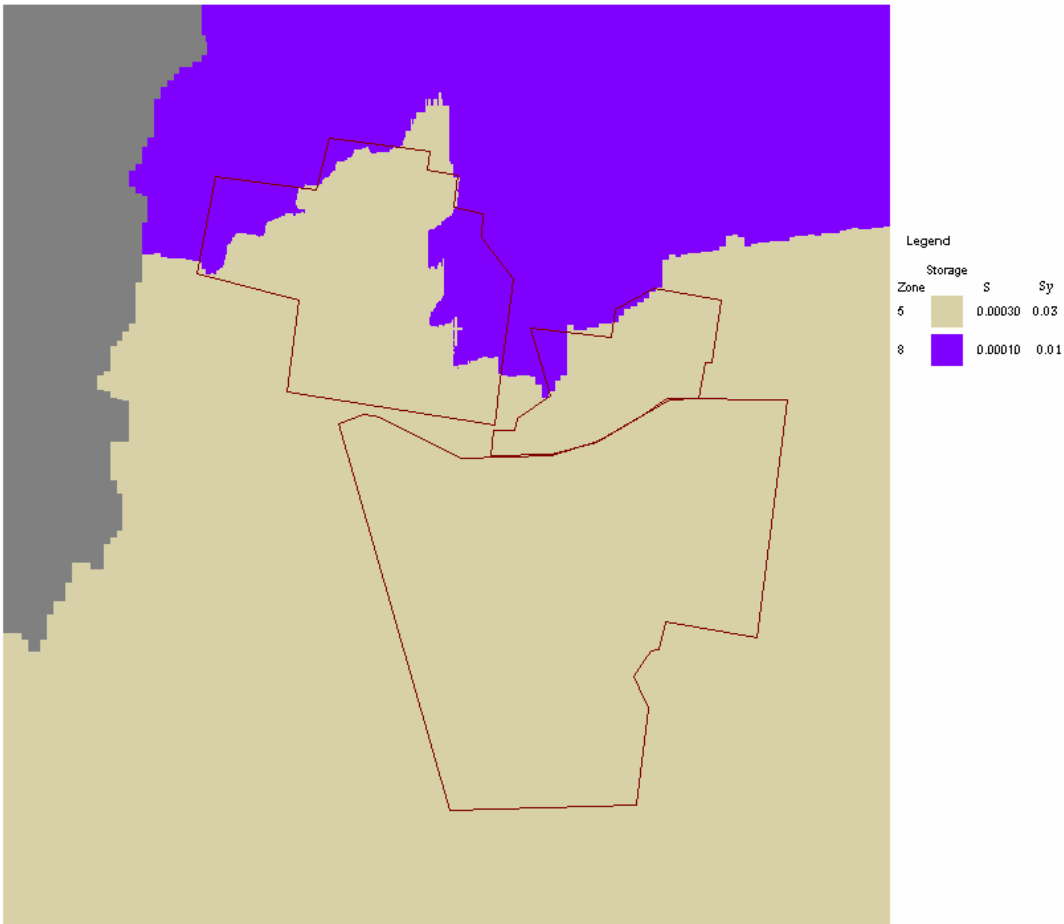
SPECIFIC YIELD AND STORAGE COEFFICIENT OF LAYER 1



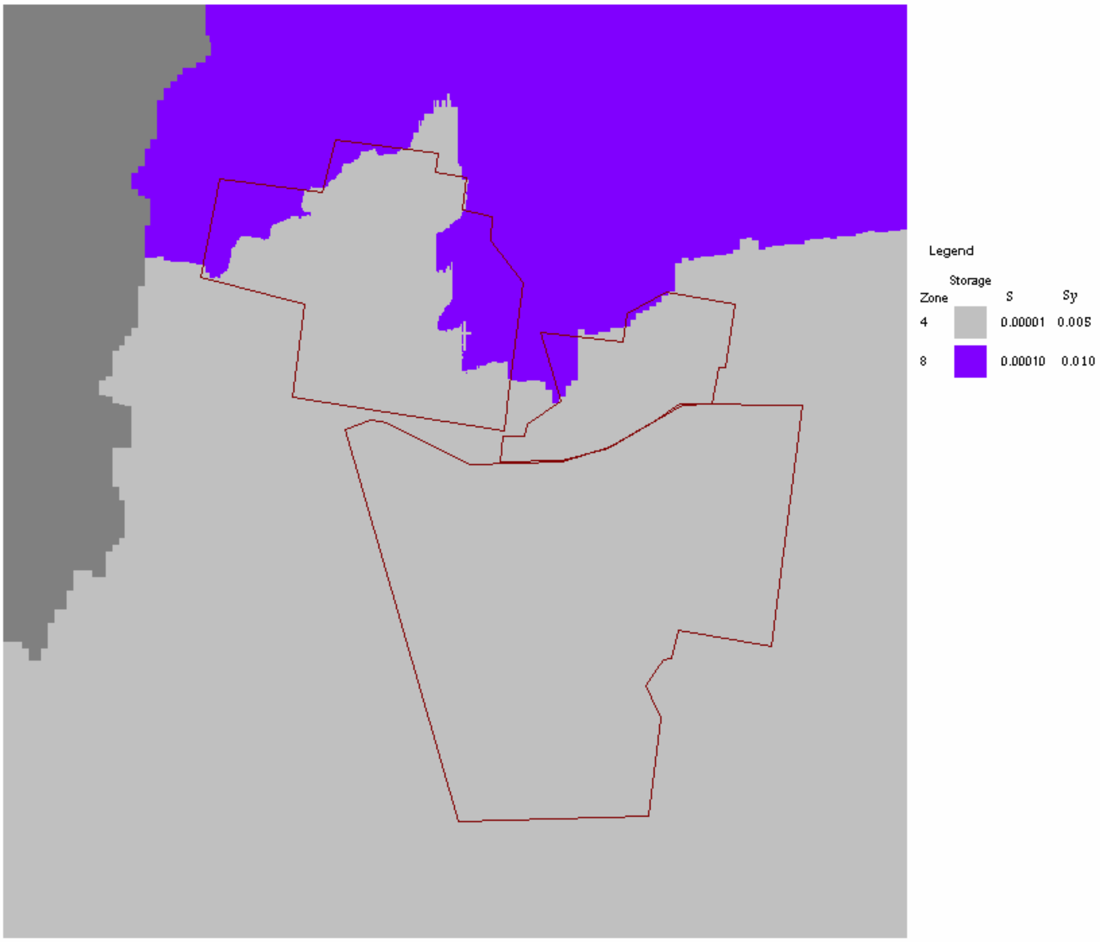
SPECIFIC YIELD AND STORAGE COEFFICIENT OF LAYER 2



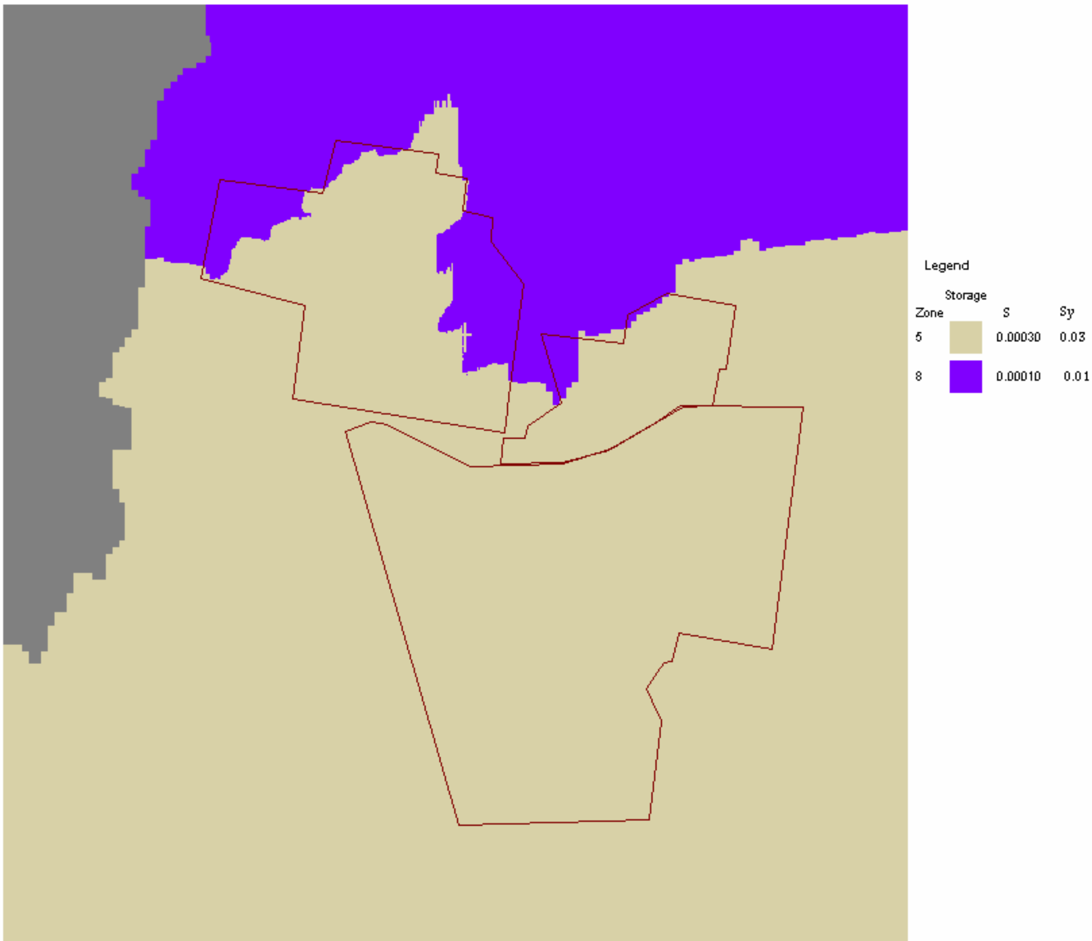
SPECIFIC YIELD AND STORAGE COEFFICIENT OF LAYER 3



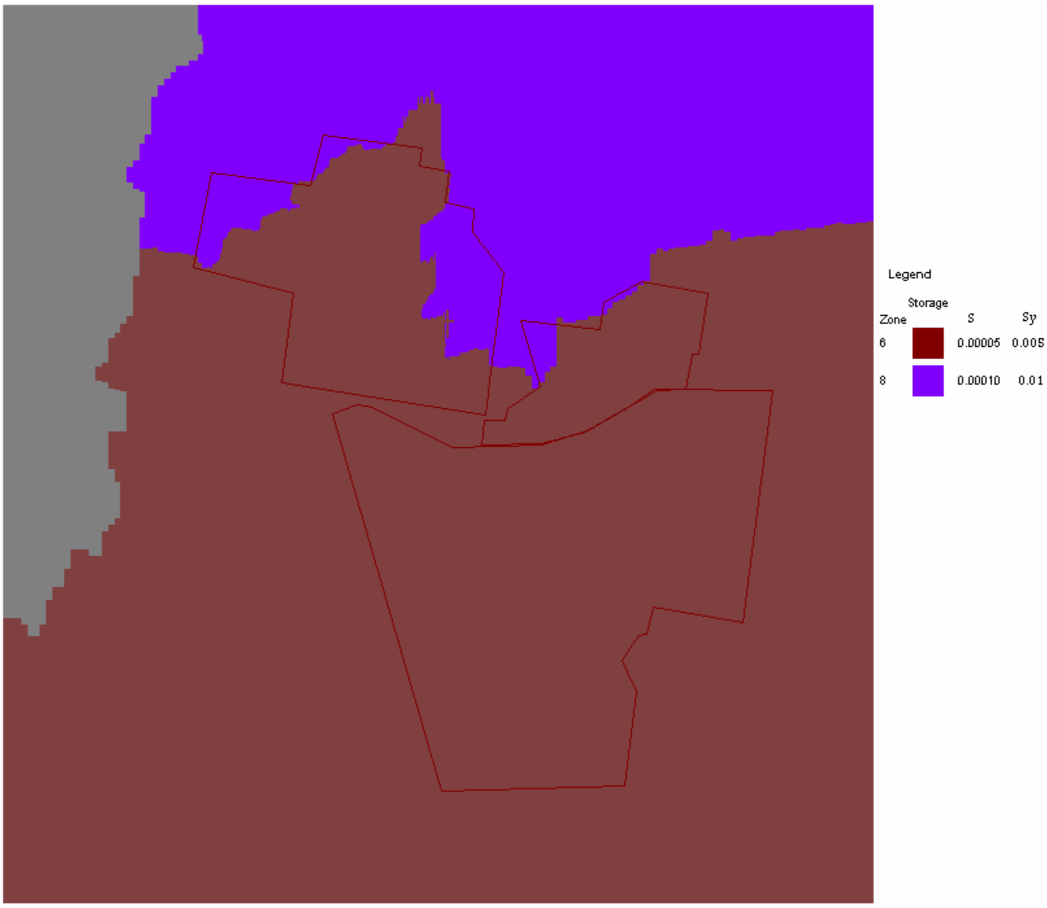
SPECIFIC YIELD AND STORAGE COEFFICIENT OF LAYER 4



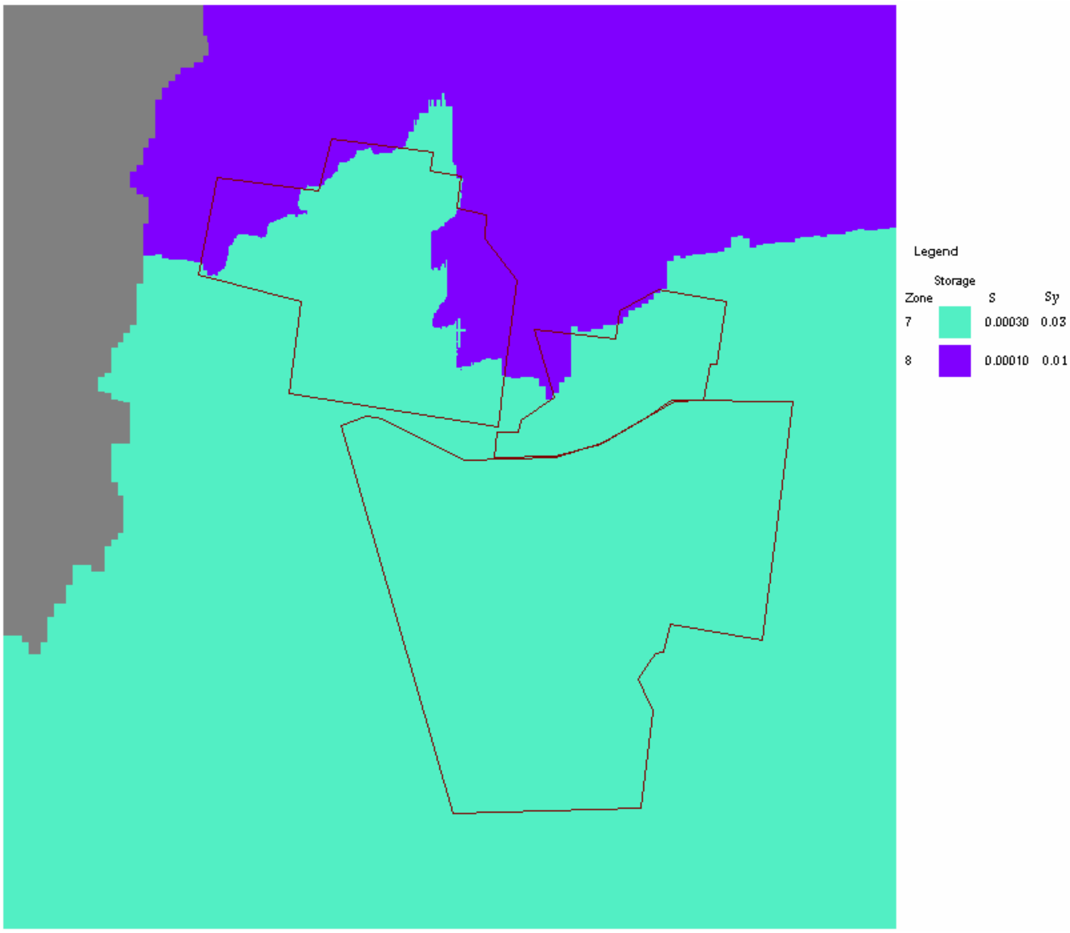
SPECIFIC YIELD AND STORAGE COEFFICIENT OF LAYER 5



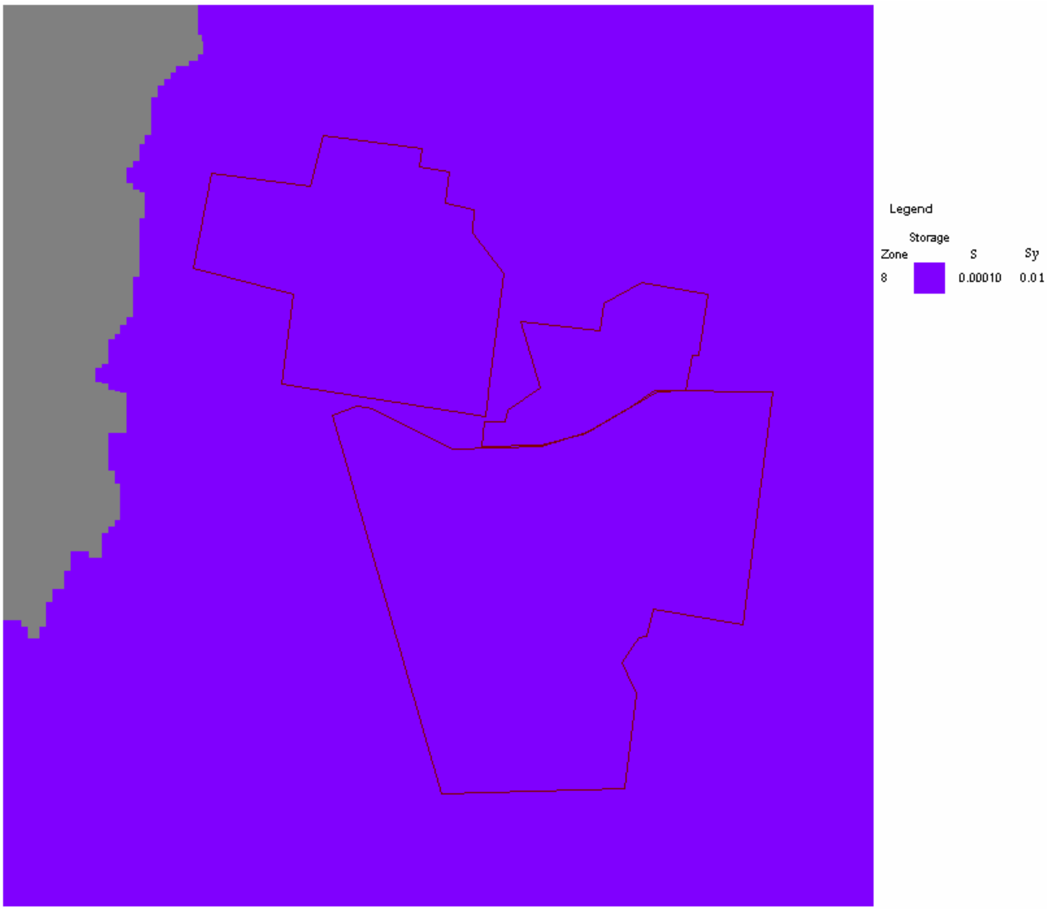
SPECIFIC YIELD AND STORAGE COEFFICIENT OF LAYER 6



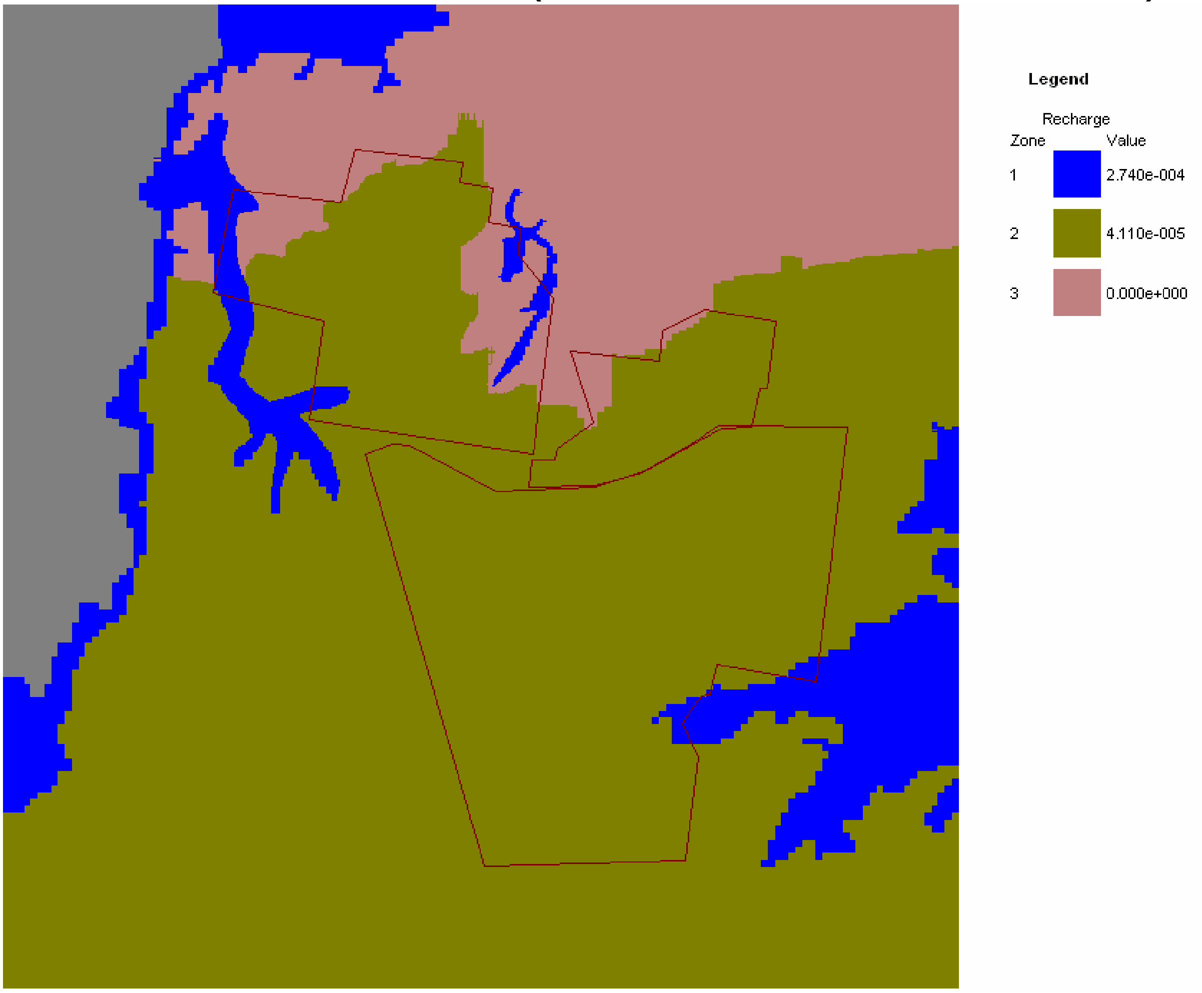
SPECIFIC YIELD AND STORAGE COEFFICIENT OF LAYER 7



SPECIFIC YIELD AND STORAGE COEFFICIENT OF LAYER 8



CALIBRATED RECHARGE ZONES (APPLIED TO THE HIGHEST ACTIVE LAYER)



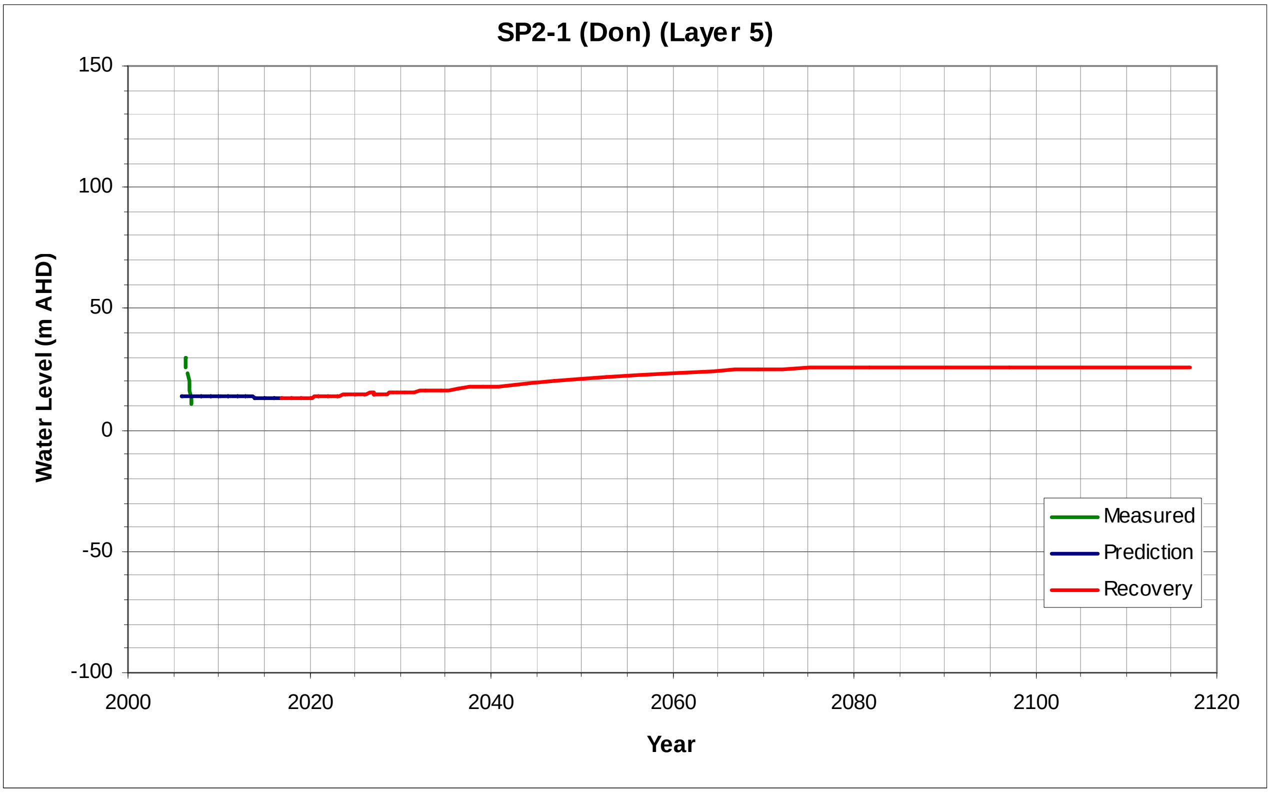
CALIBRATED EVT ZONES (APPLIED TO THE HIGHEST ACTIVE LAYER)

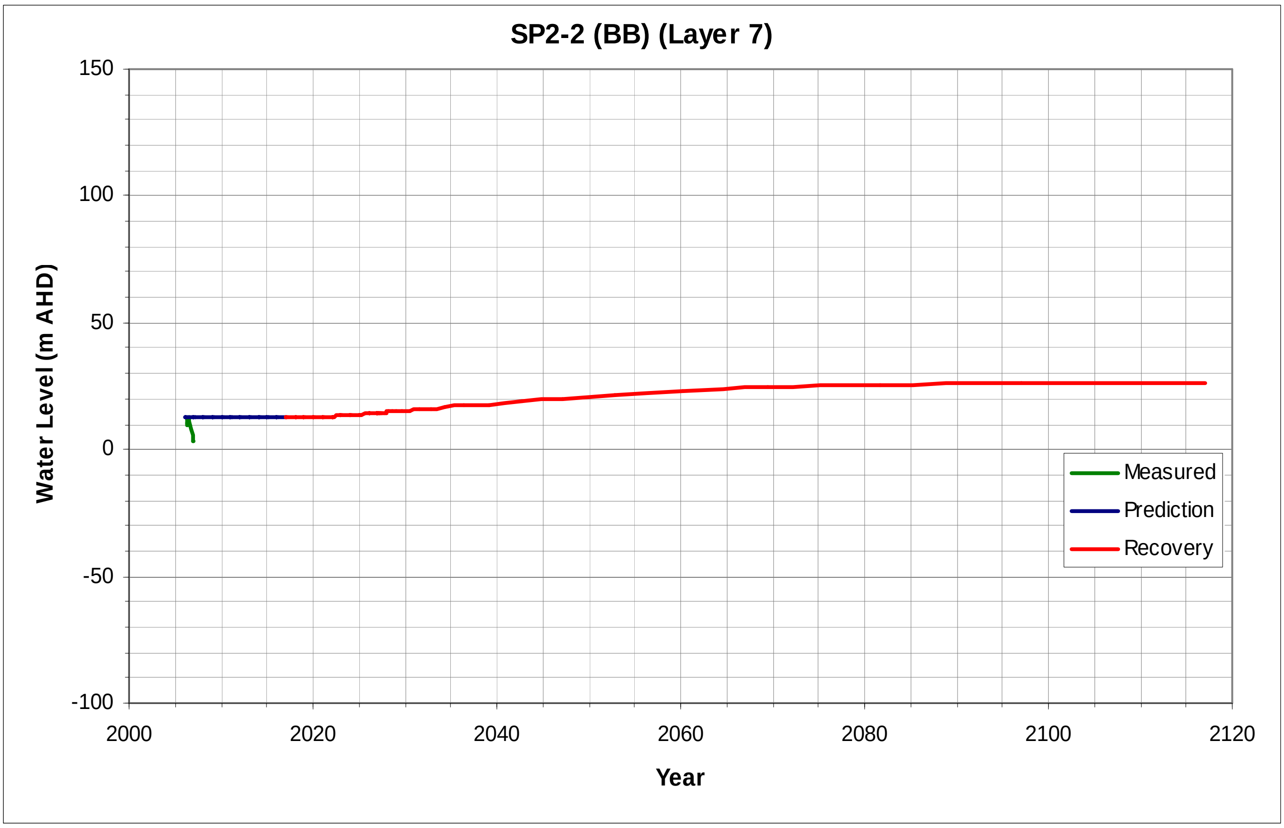
APPENDIX D

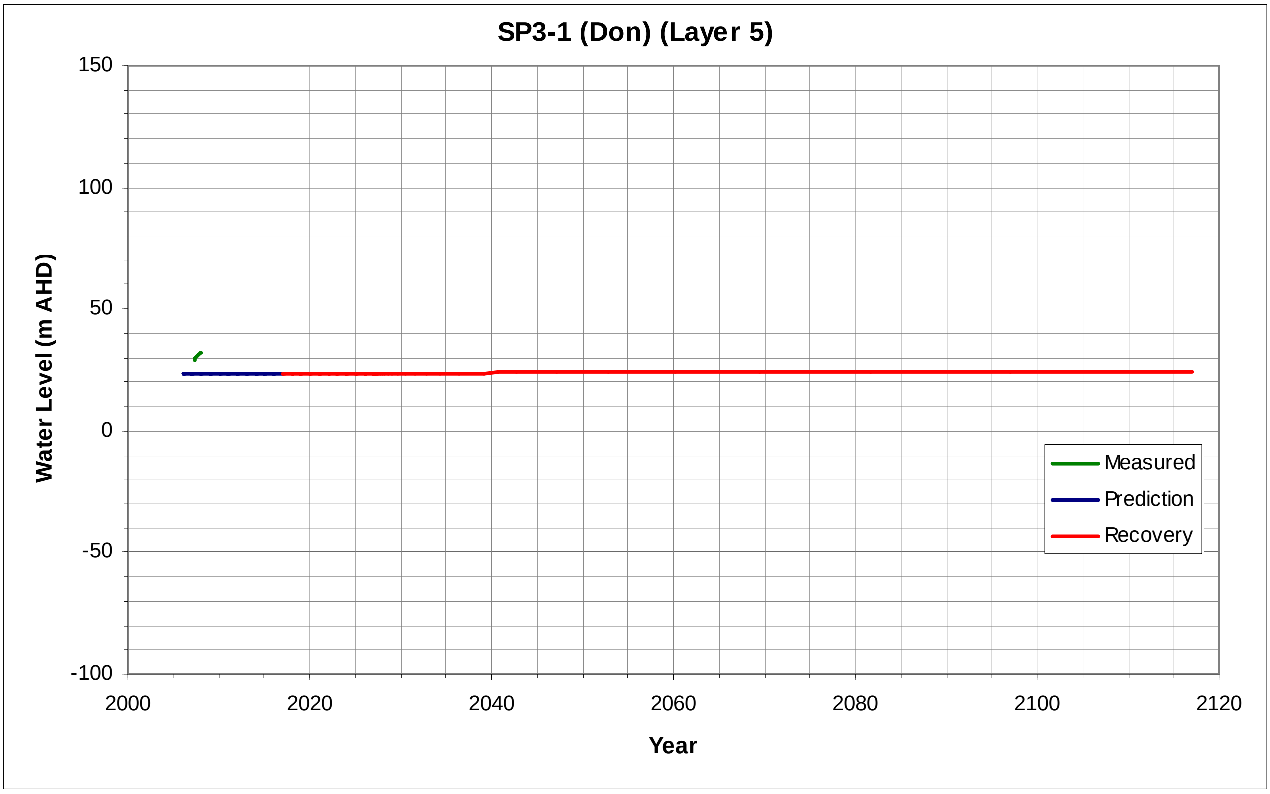
BLOOMFIELD MODEL MINING AND RECOVERY RUN RESULTS (HYDROGRAPHS AND CONTOUR MAPS)

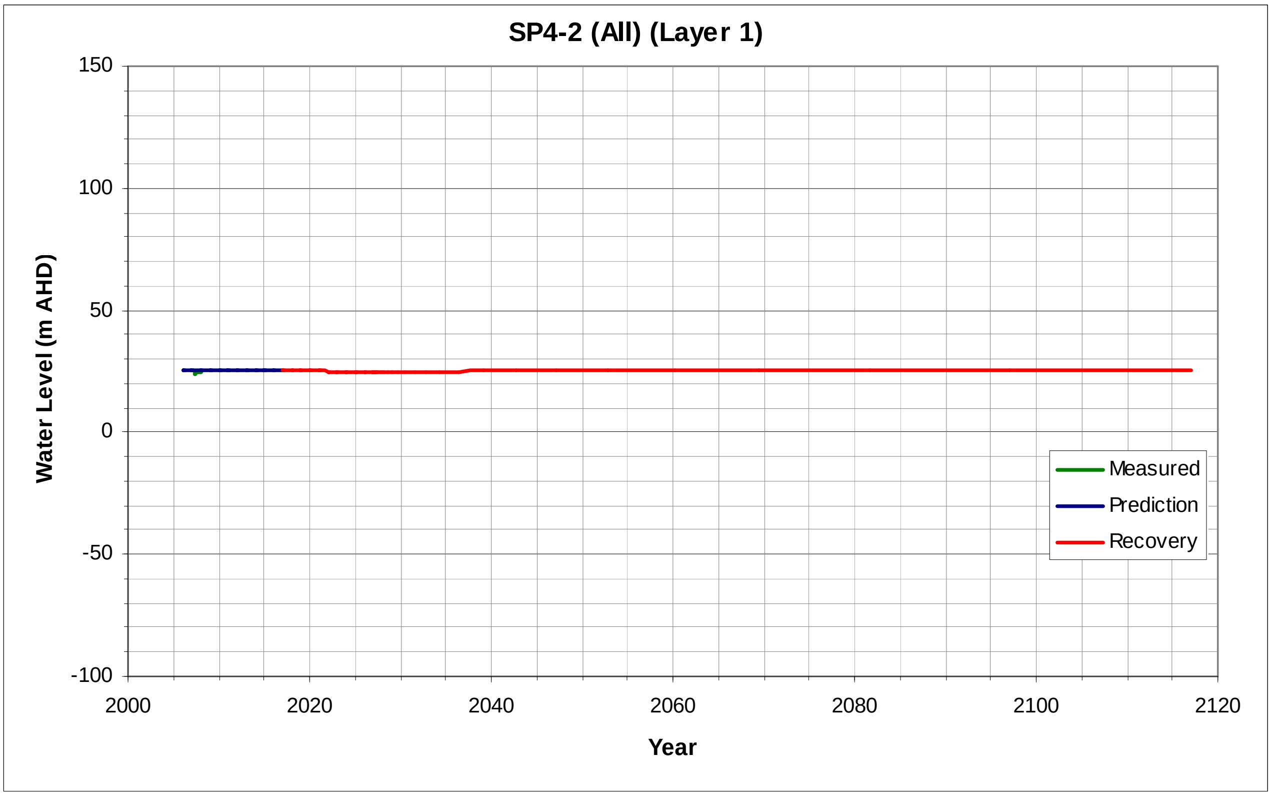

VW1-35m (Don) (Layer 5)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery


VW1-46m (BB) (Layer 7)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery


SP2-1 (Don) (Layer 5)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery


SP2-2 (BB) (Layer 7)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery


SP3-1 (Don) (Layer 5)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

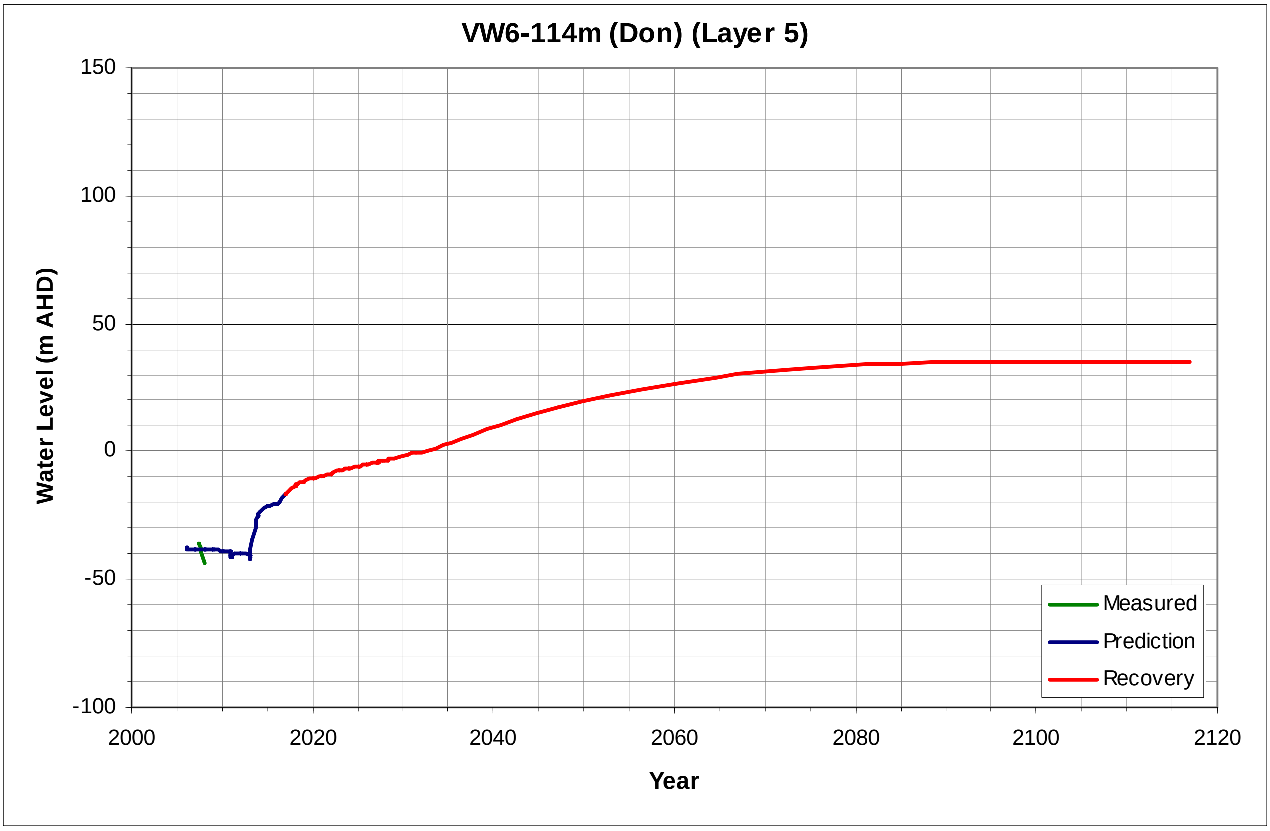

SP4-2 (All) (Layer 1)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

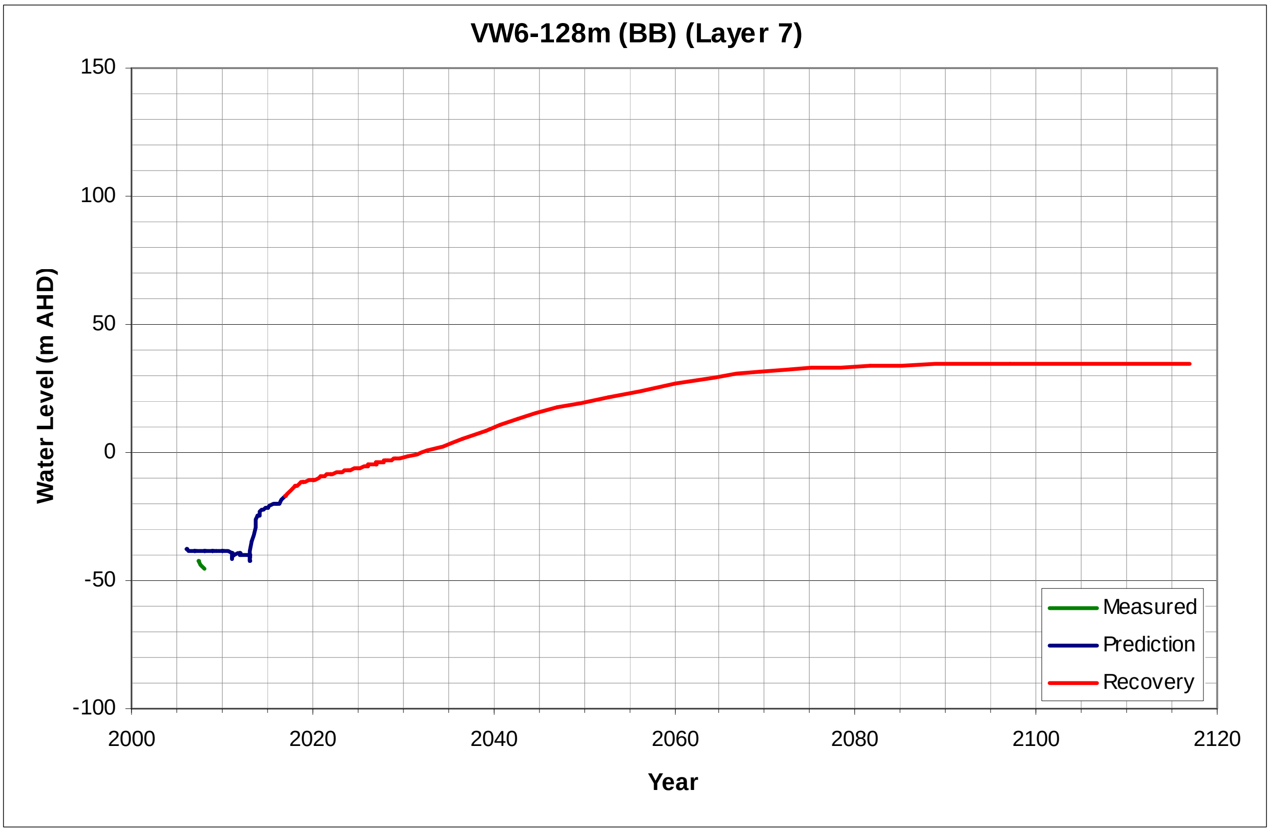

VW5-62m (WC) (Layer 4)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

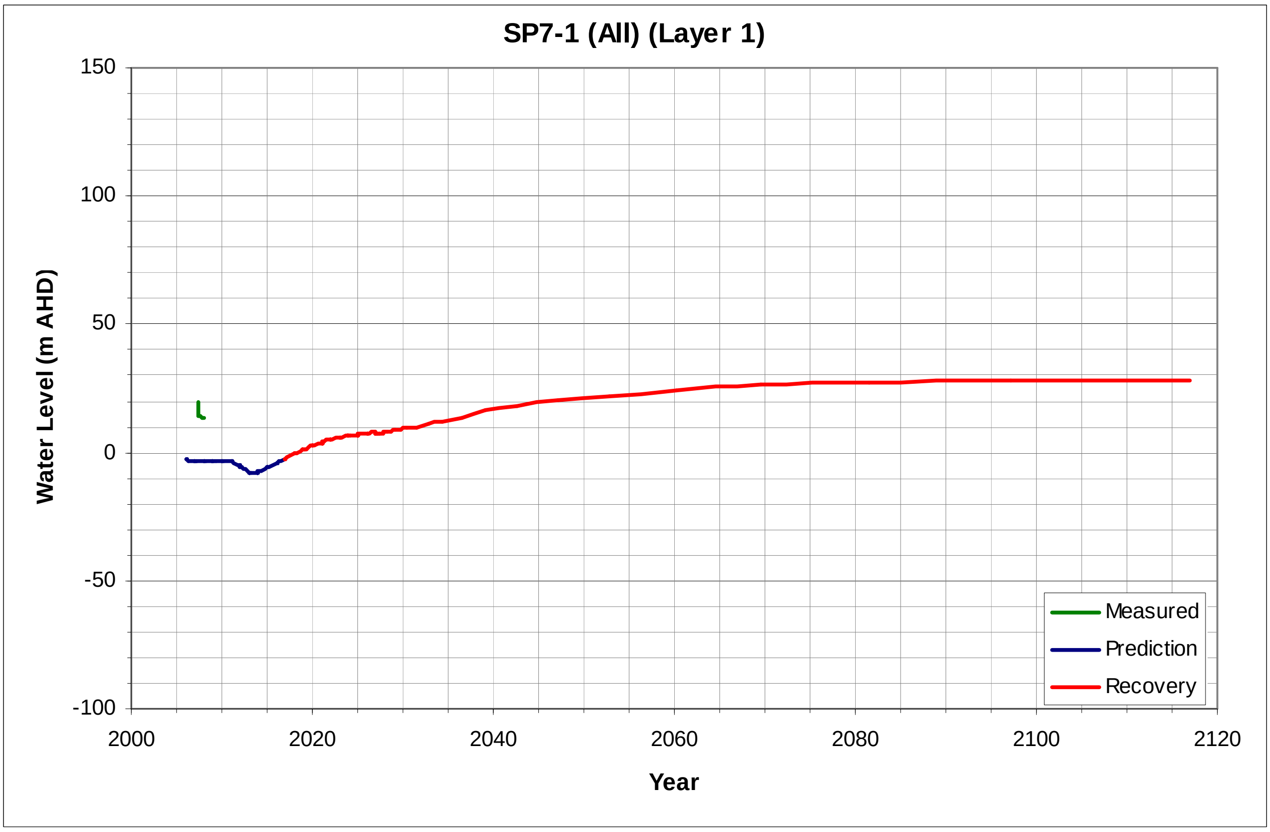

VW5-71m (Don) (Layer 5)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery


VW5-90m (BB) (Layer 7)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

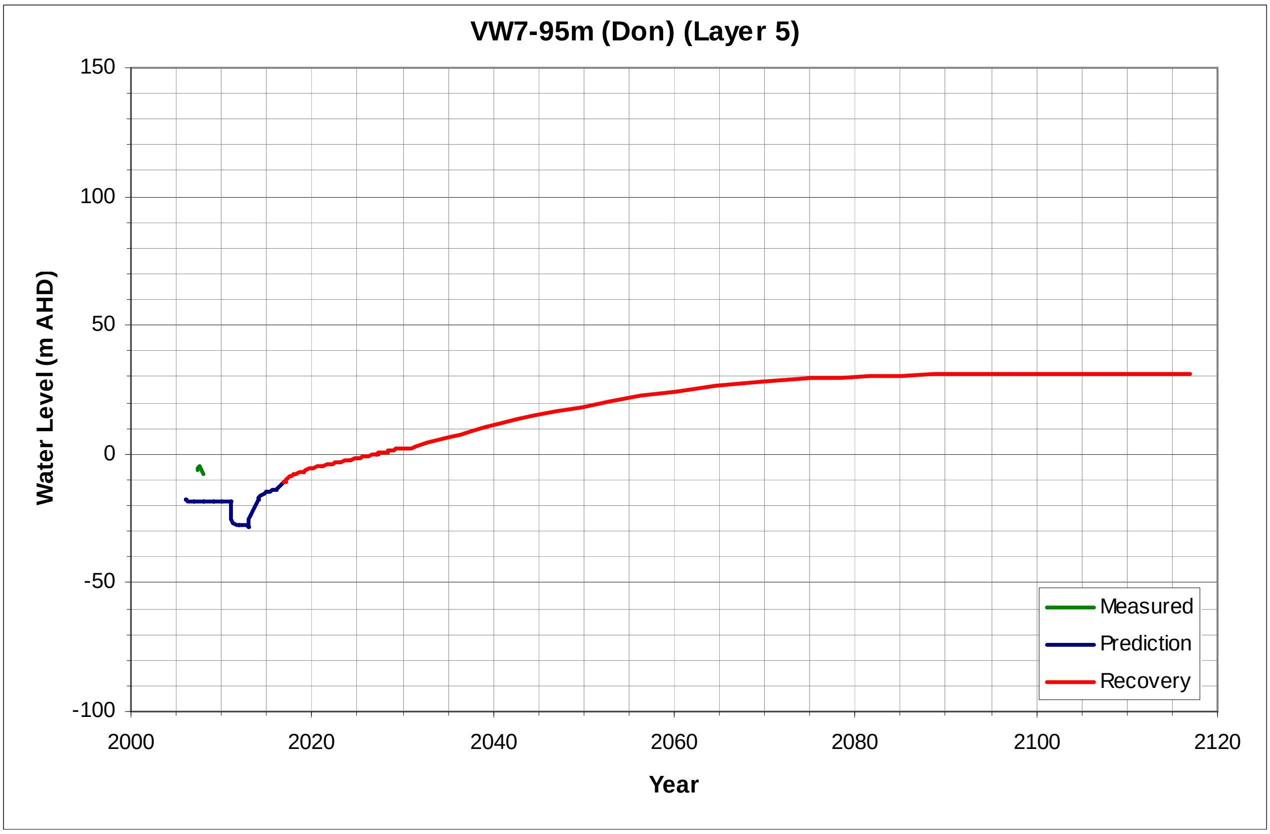

VW6-96m (WC) (Layer 4)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery


VW6-114m (Don) (Layer 5)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

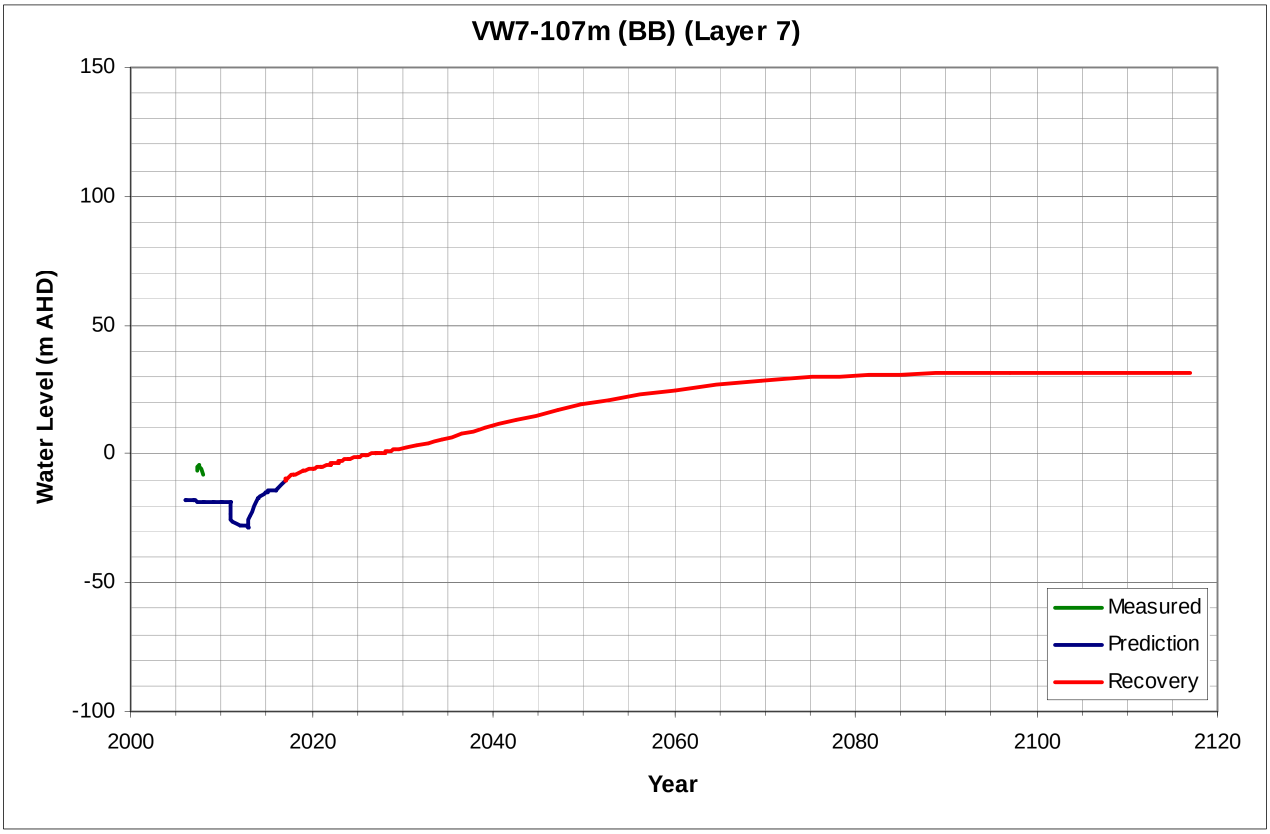

VW6-128m (BB) (Layer 7)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery


SP7-1 (All) (Layer 1)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

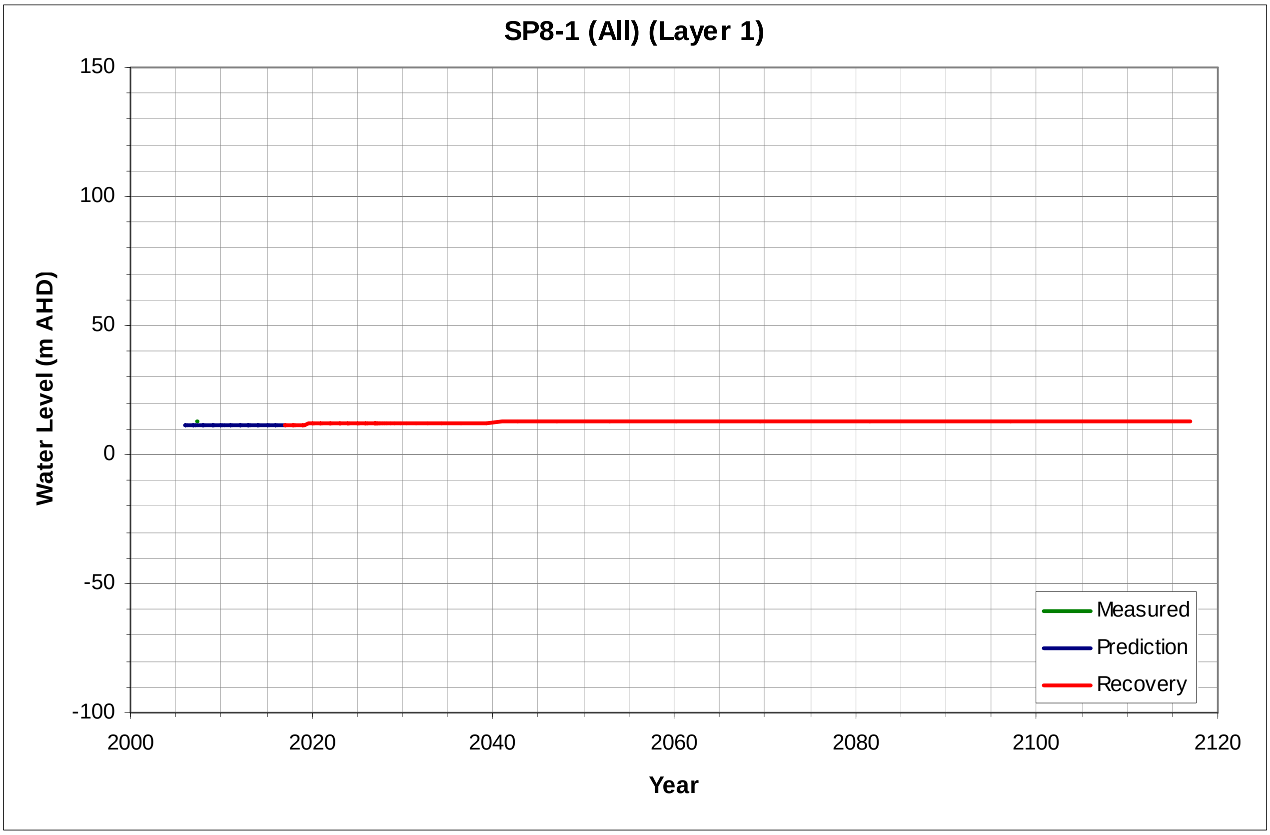

VW7-70m (WC) (Layer 4)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery



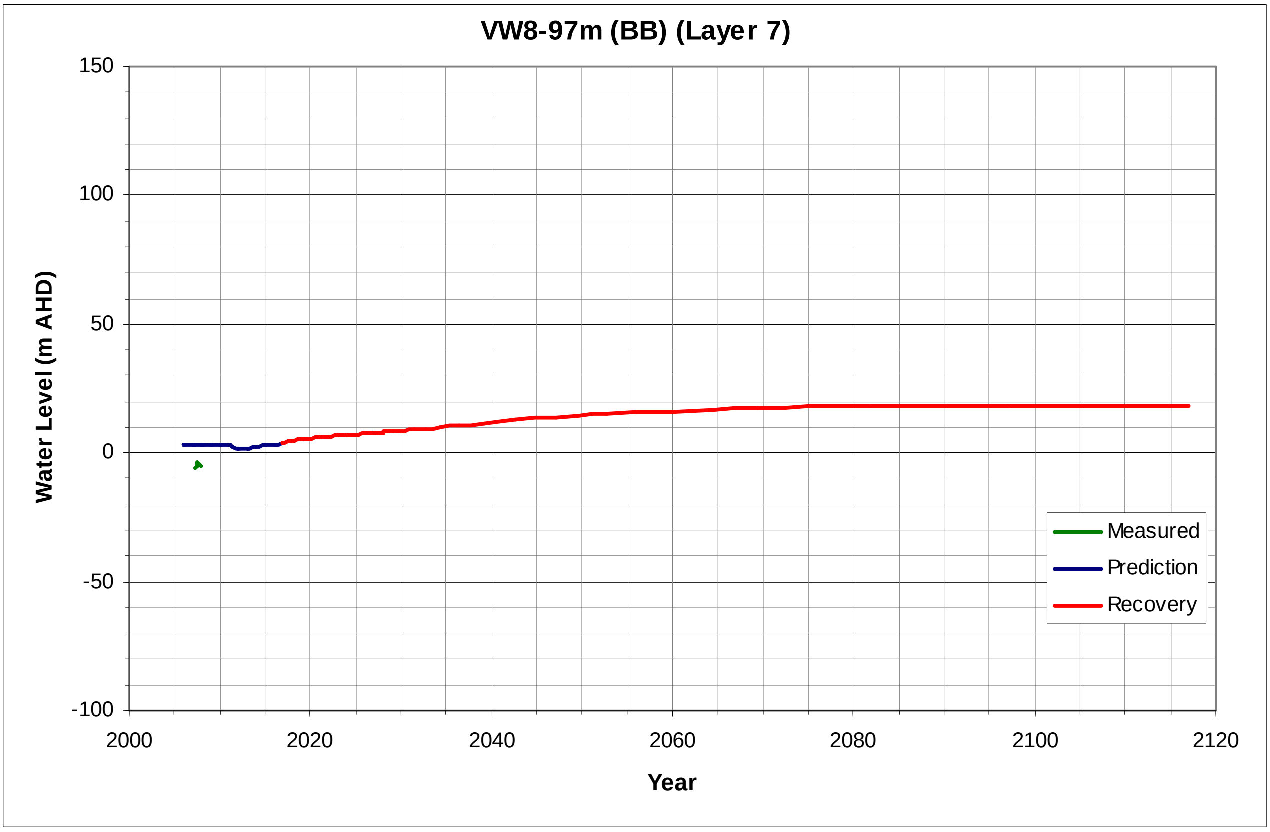
VW7-95m (Don) (Layer 5)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery



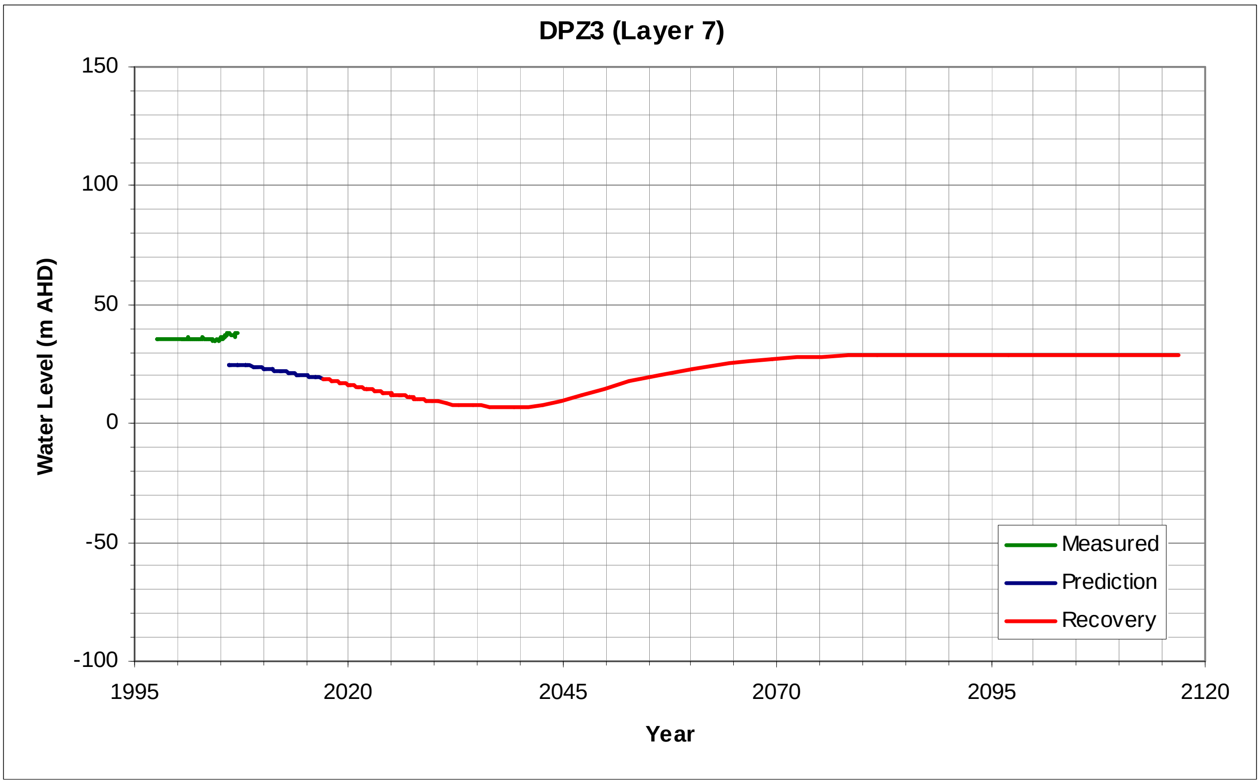
VW7-107m (BB) (Layer 7)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery


SP8-1 (All) (Layer 1)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

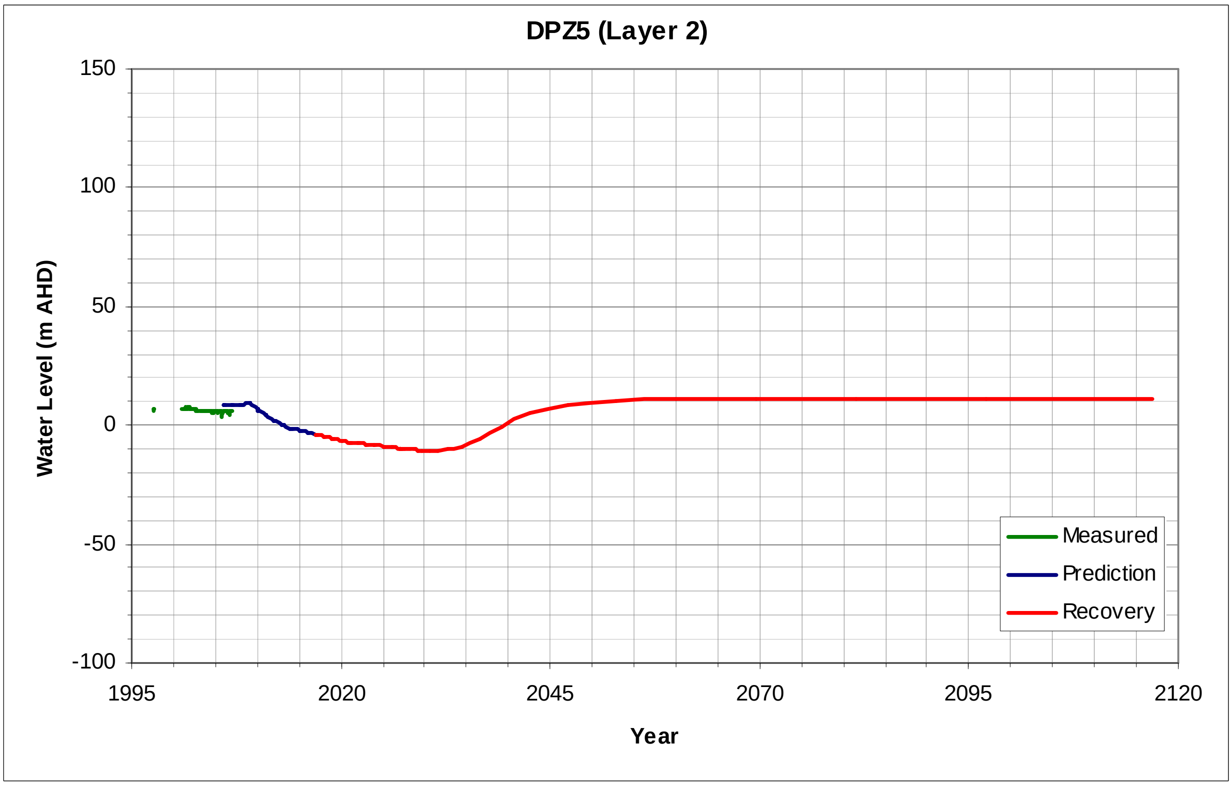

VW8-83m (Don) (Layer 5)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

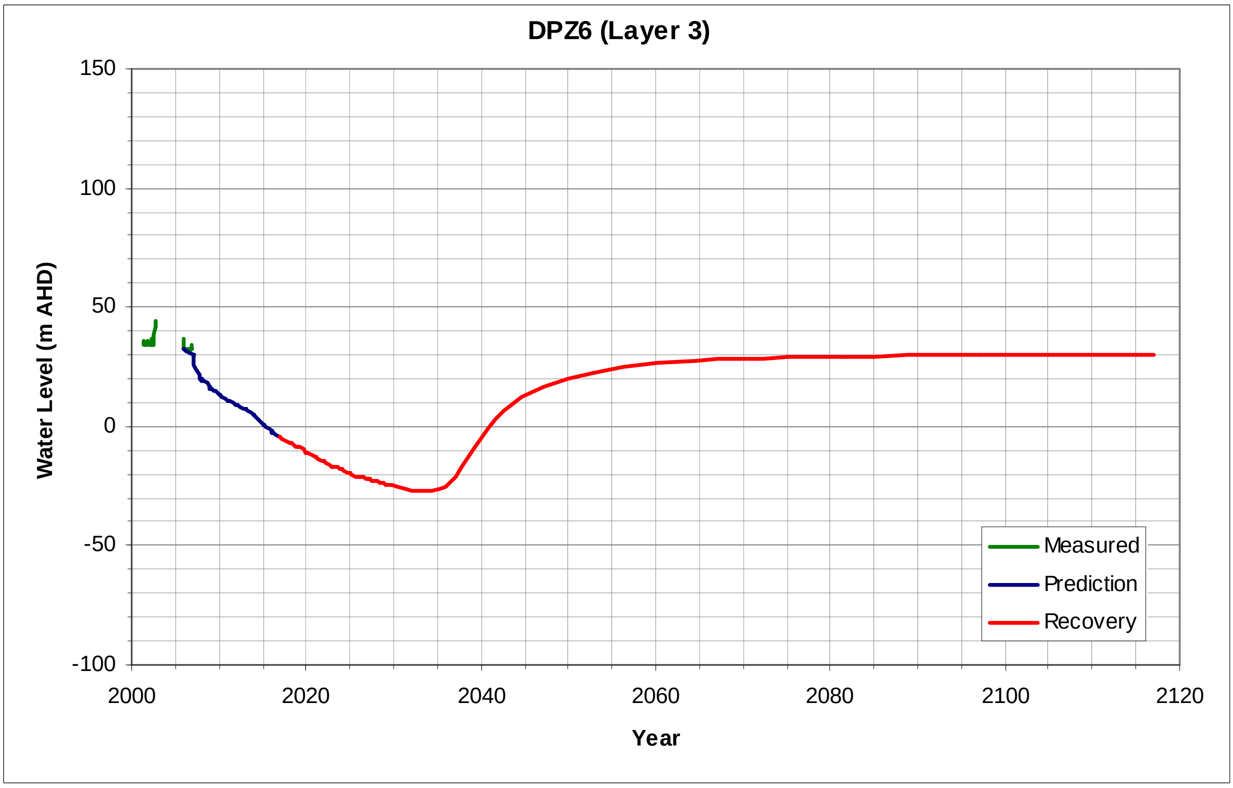


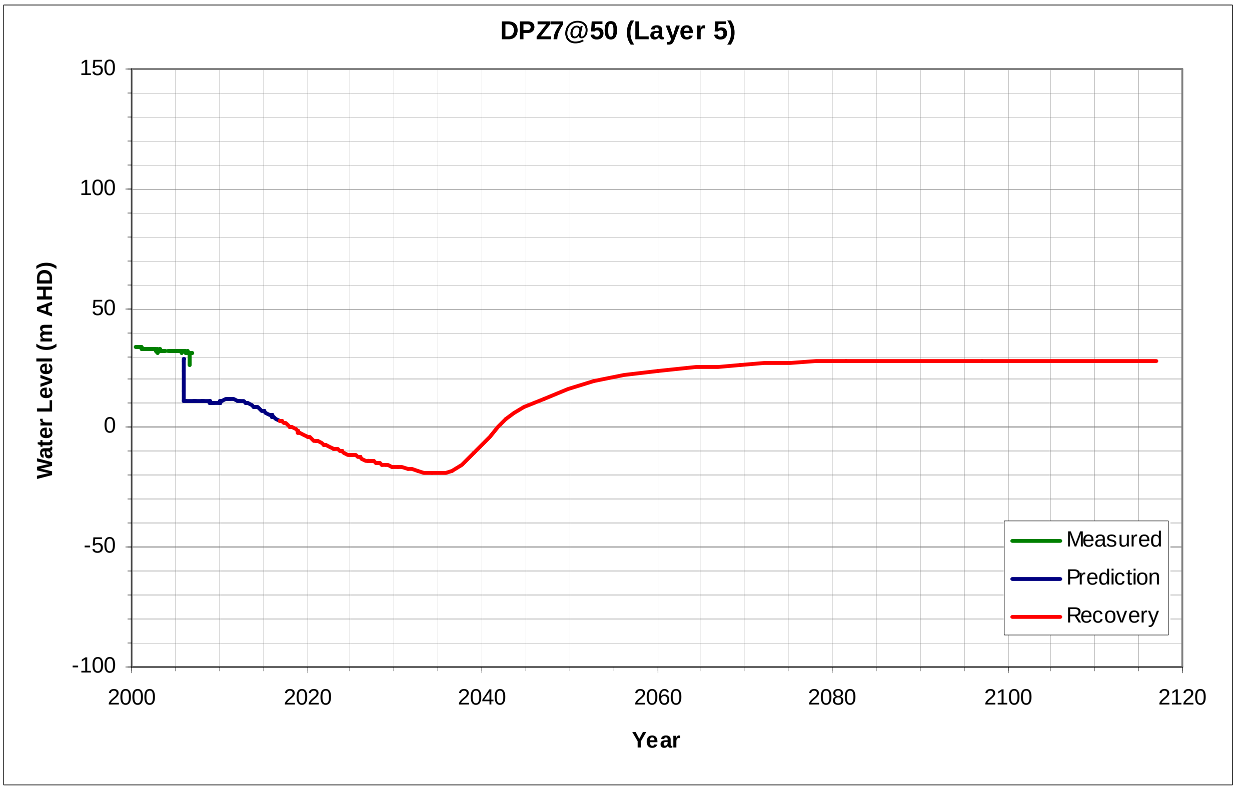
VW8-97m (BB) (Layer 7)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

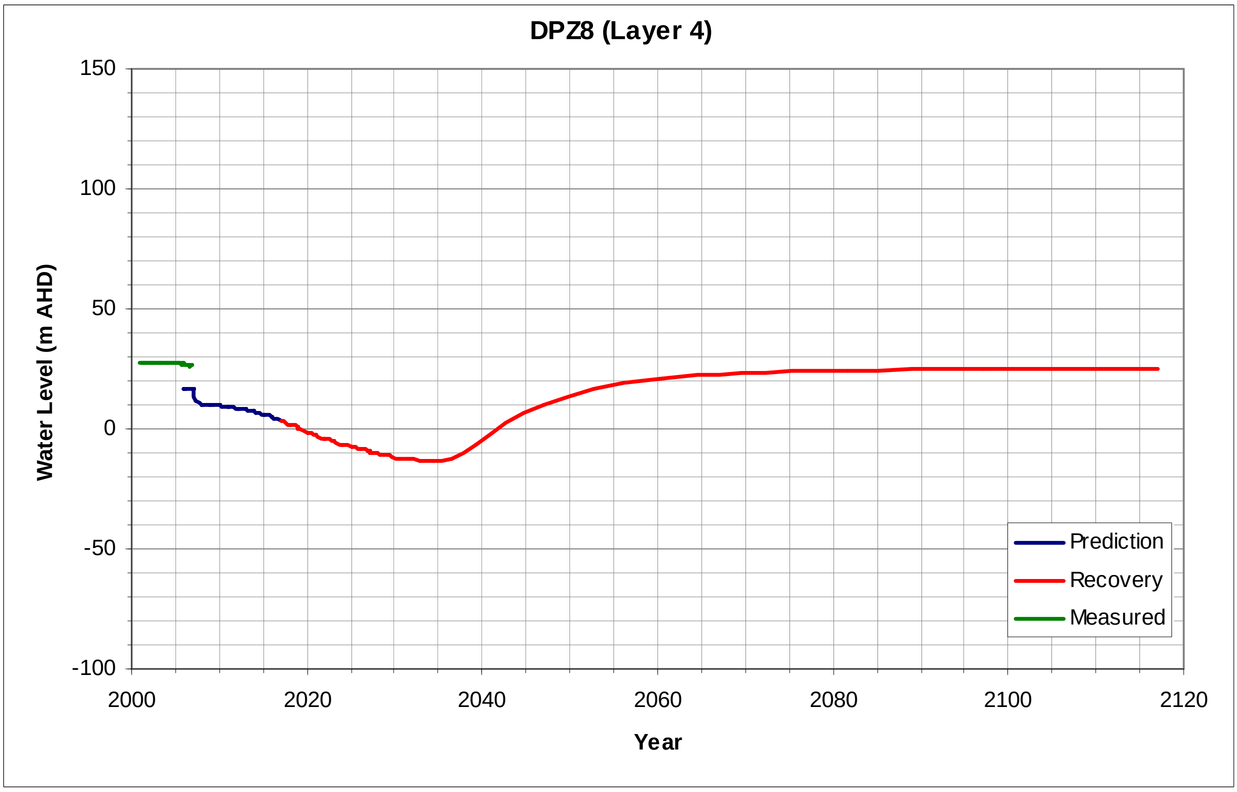


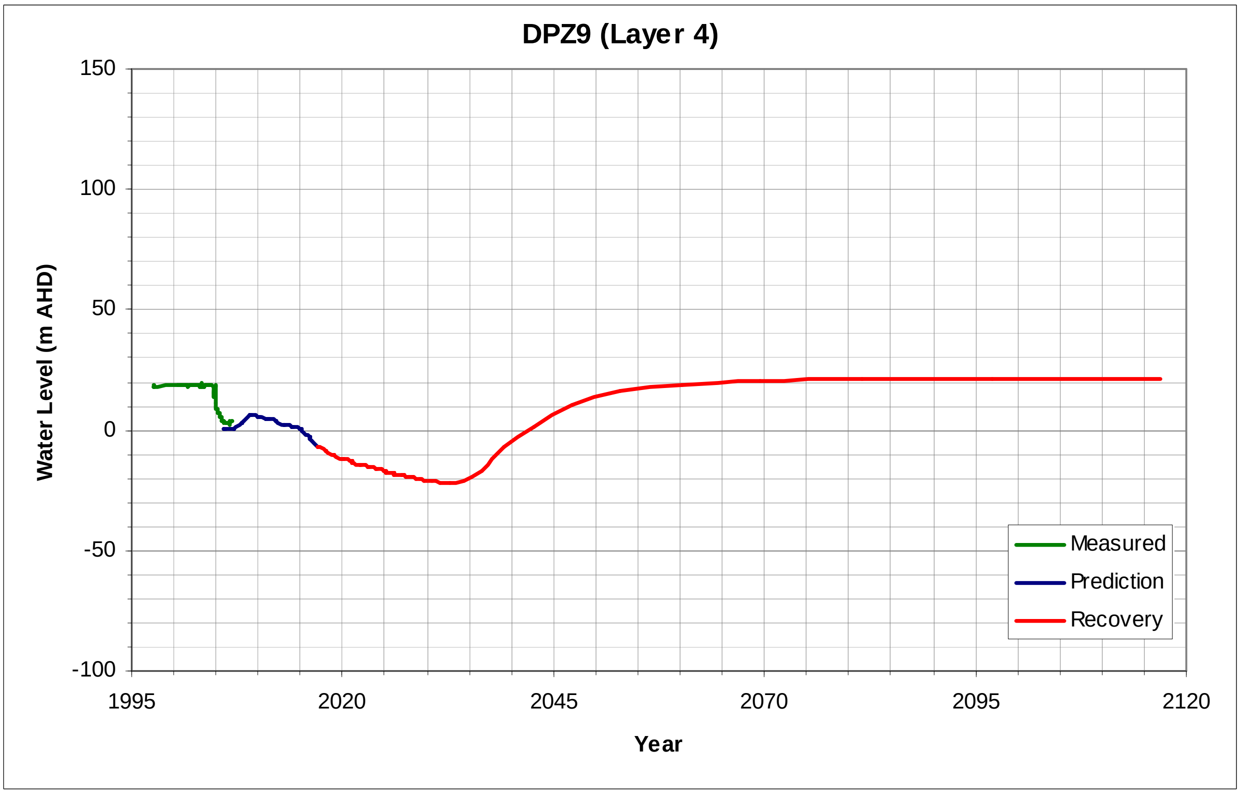
DPZ3 (Layer 7)
Water Level (m AHD)
150
100
50
0
-50
-100
1995
2020
2045
2070
2095
2120
Year
Measured
Prediction
Recovery

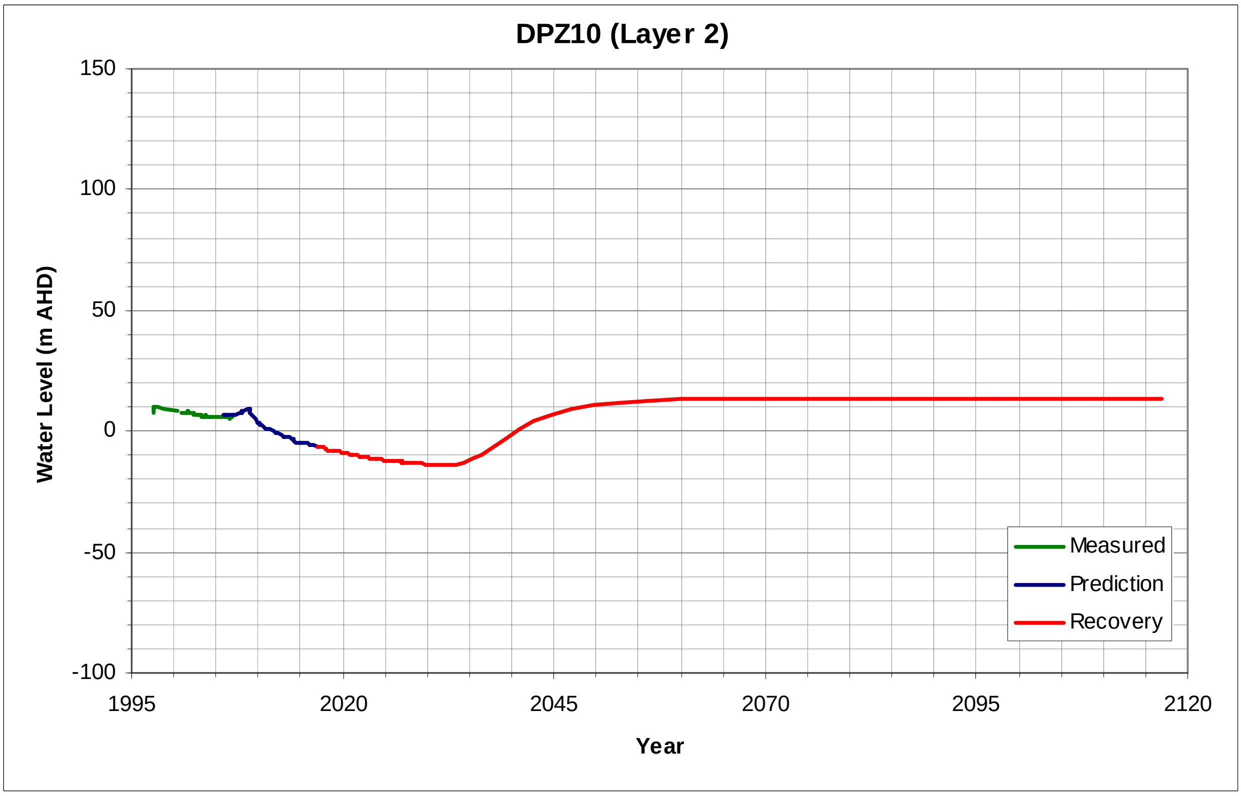

DPZ5 (Layer 2)
150
100
50
0
-50
-100
Water Level (m AHD)
1995
2020
2045
2070
2095
2120
Year
Measured
Prediction
Recovery

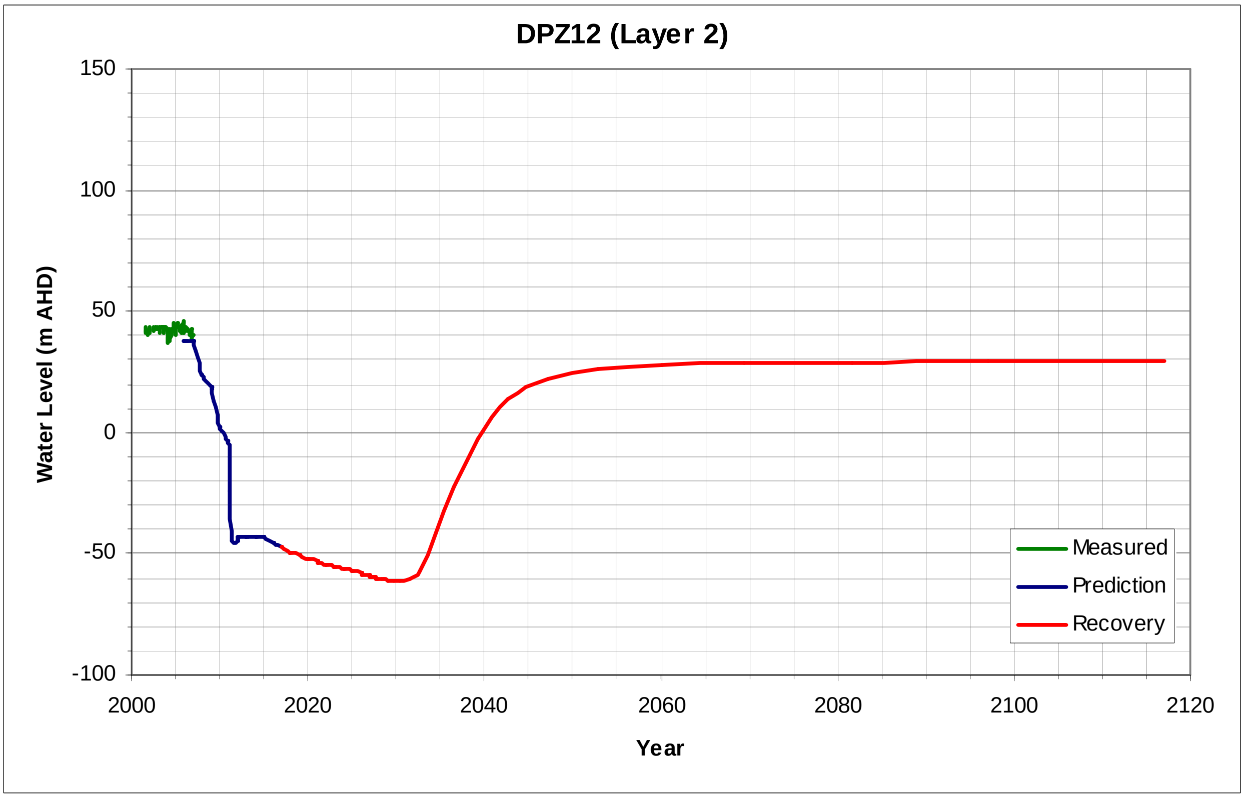

DPZ6 (Layer 3)
150
100
50
0
-50
-100
Water Level (m AHD)
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

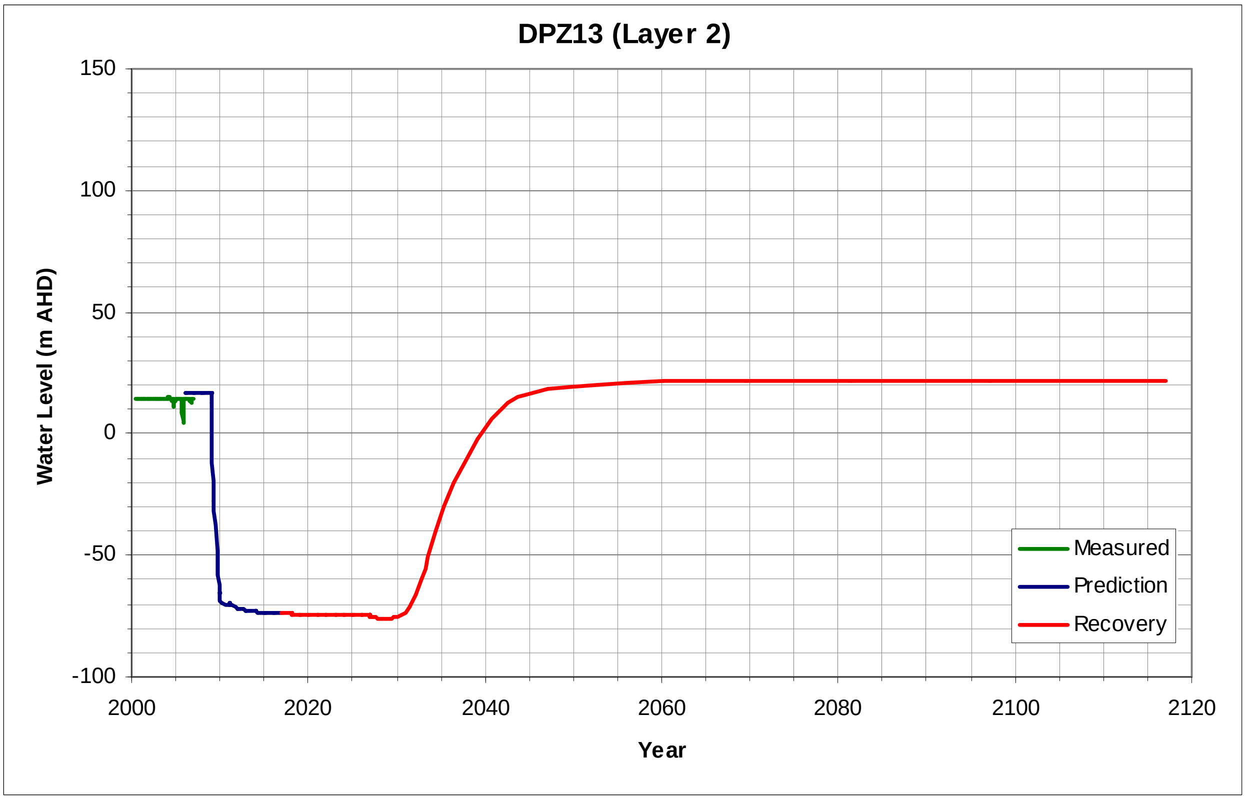

DPZ7@50 (Layer 5)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

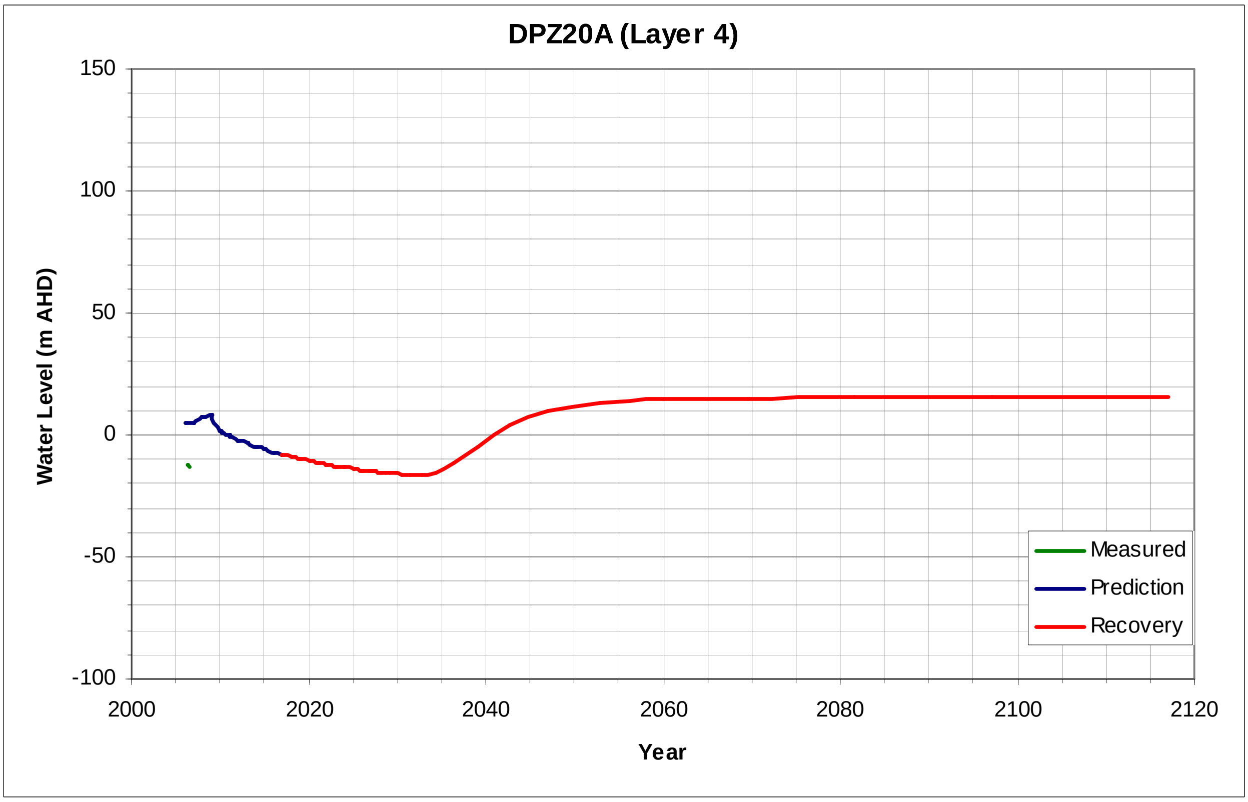

DPZ8 (Layer 4)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Prediction
Recovery
Measured

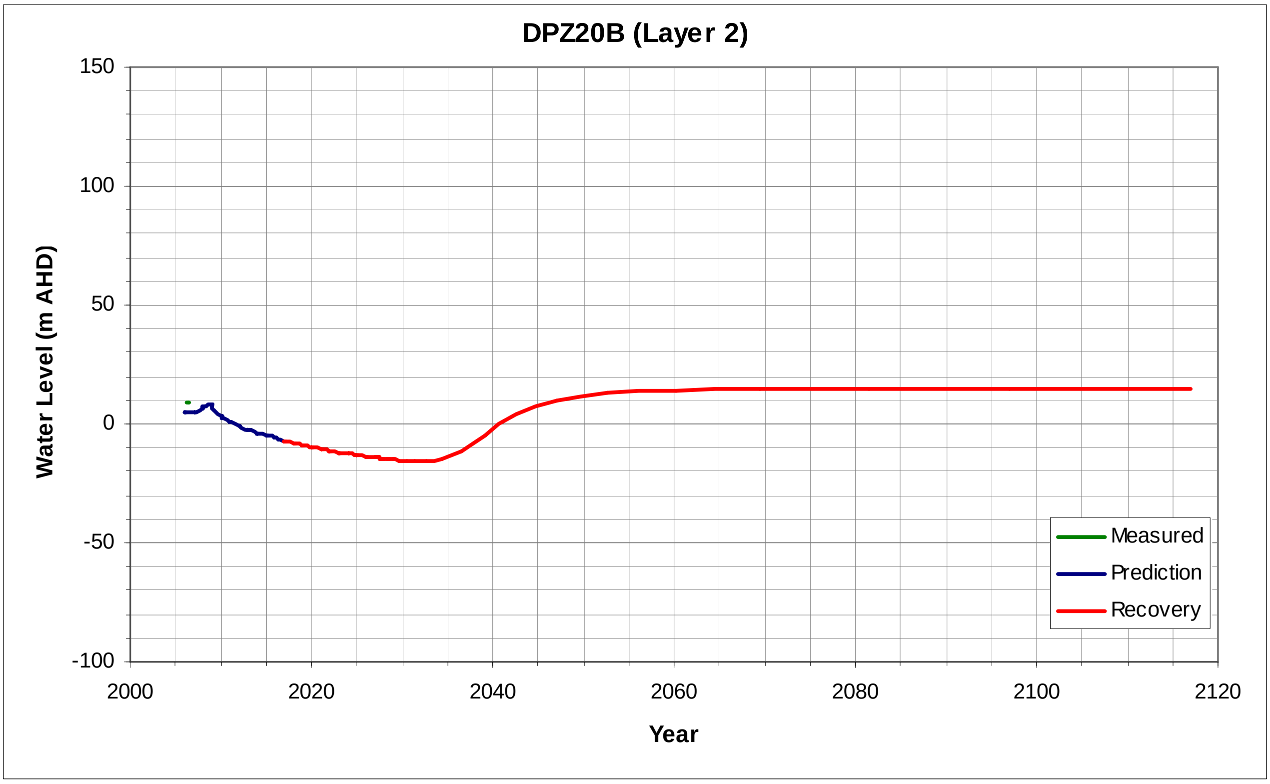

DPZ9 (Layer 4)
Water Level (m AHD)
150
100
50
0
-50
-100
1995
2020
2045
2070
2095
2120
Year
Measured
Prediction
Recovery

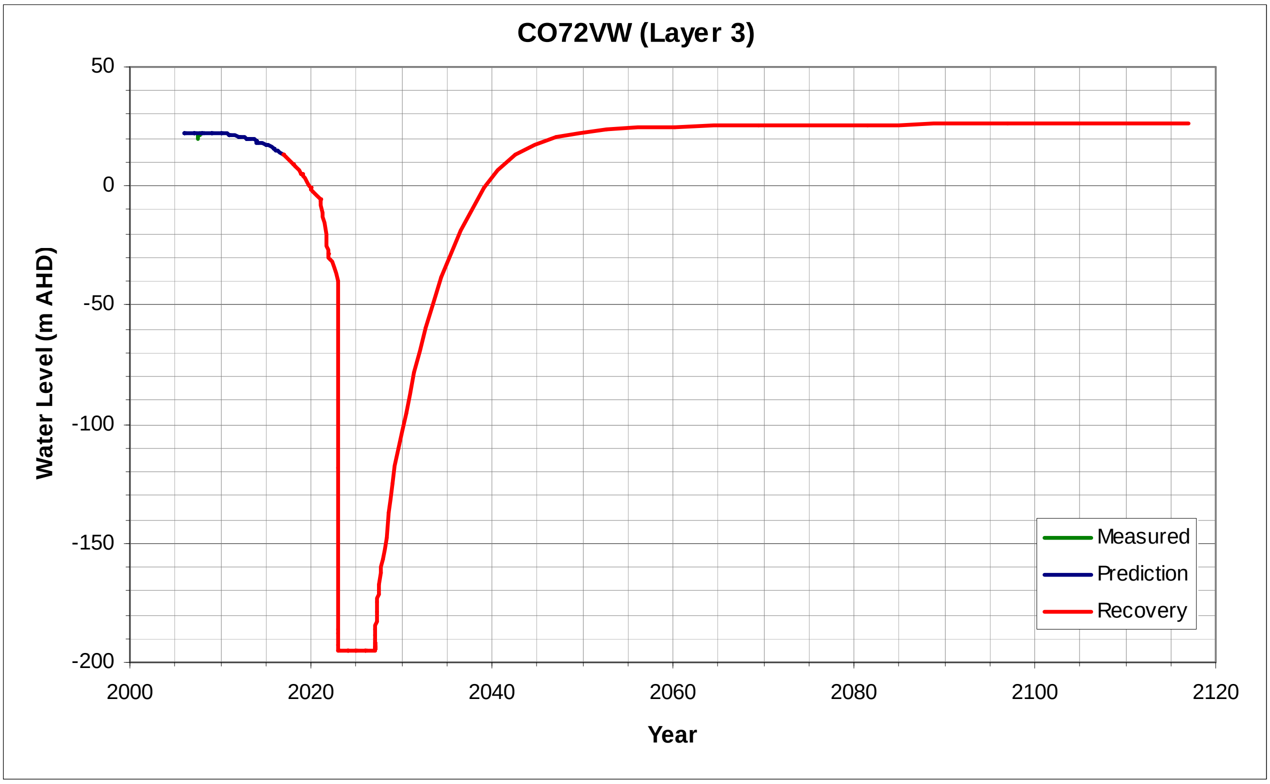

DPZ10 (Layer 2)
Water Level (m AHD)
150
100
50
0
-50
-100
1995
2020
2045
2070
2095
2120
Year
Measured
Prediction
Recovery

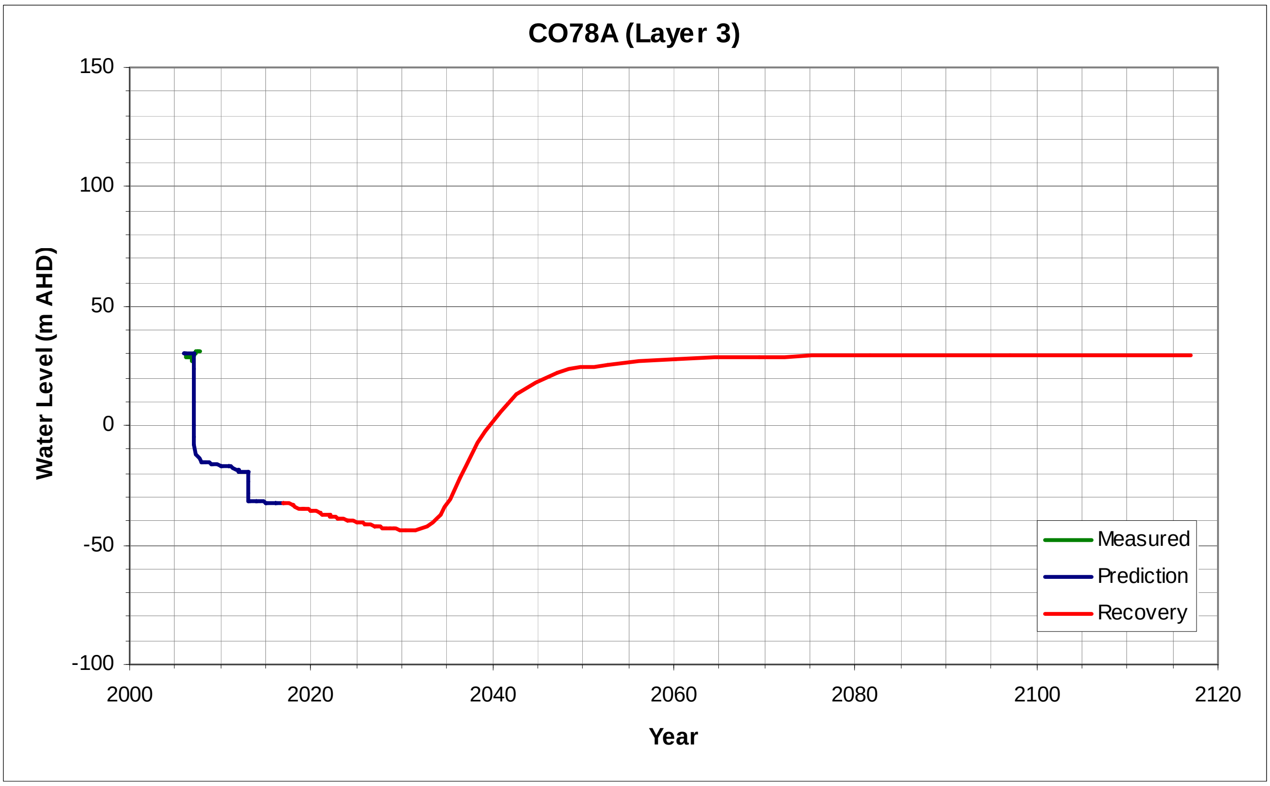

DPZ12 (Layer 2)
150
100
50
0
-50
-100
Water Level (m AHD)
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery


DPZ13 (Layer 2)
150
100
50
0
-50
-100
Water Level (m AHD)
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

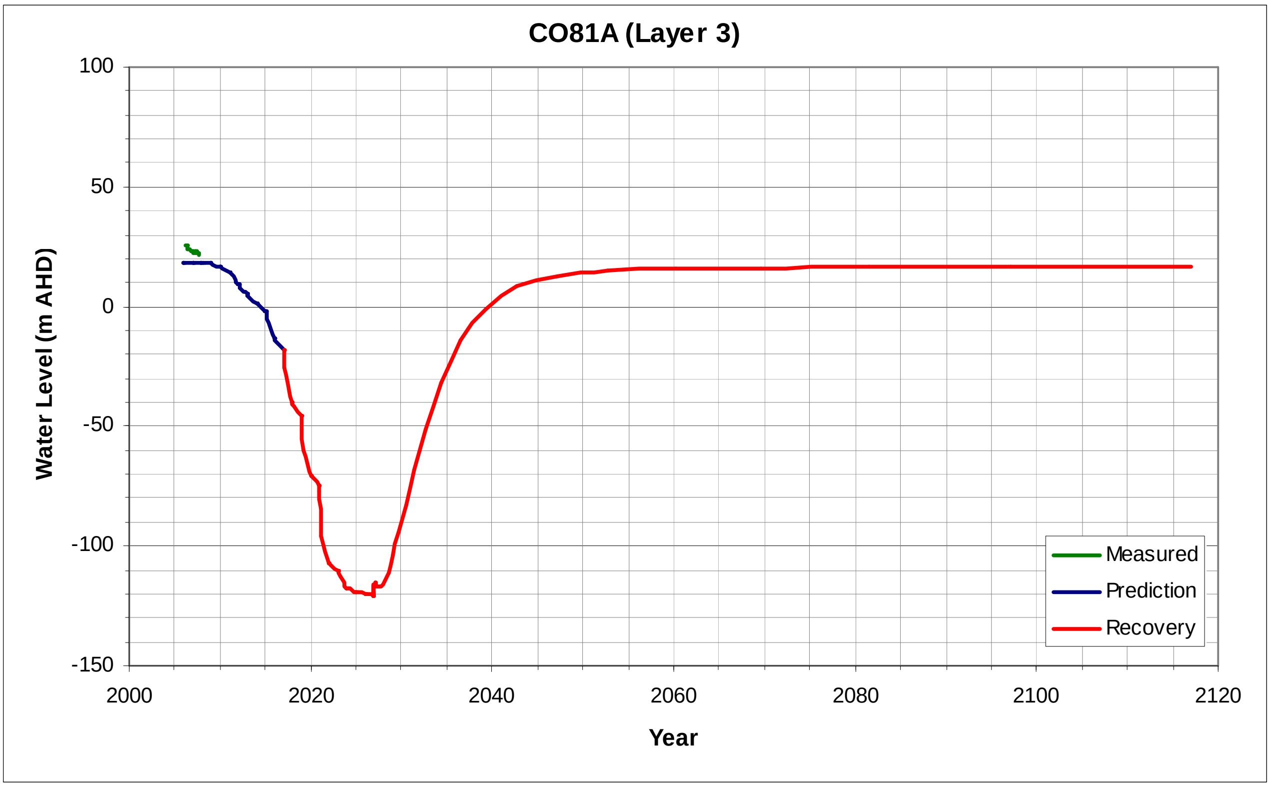

DPZ20A (Layer 4)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

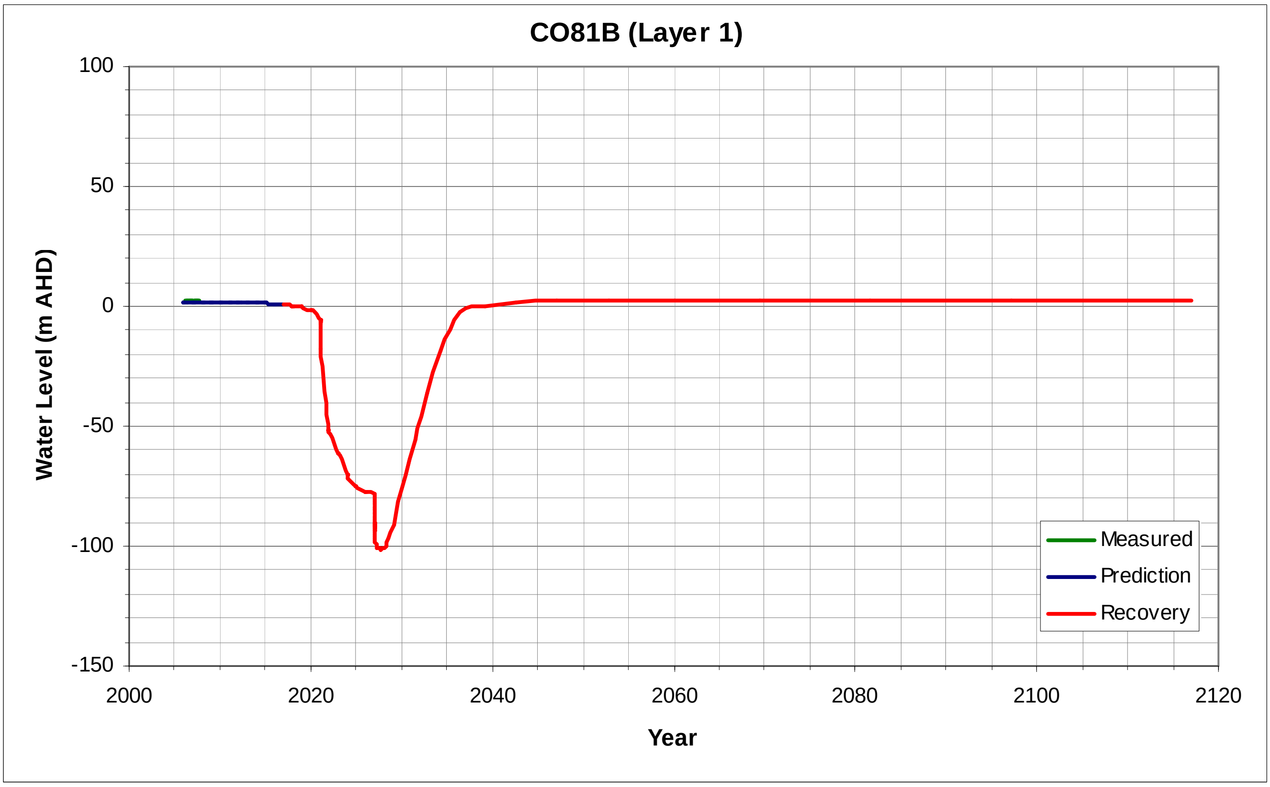

DPZ20B (Layer 2)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

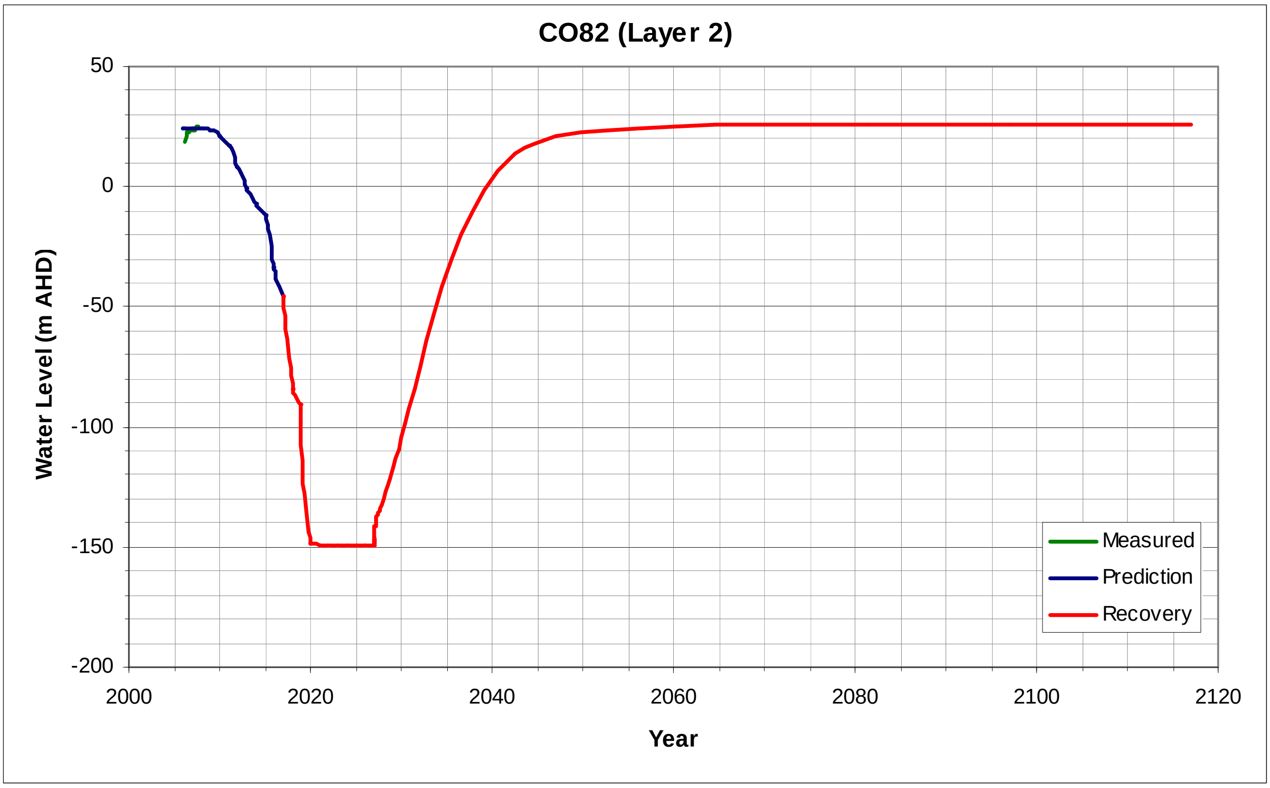

CO72VW (Layer 3)
Water Level (m AHD)
50
0
-50
-100
-150
-200
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

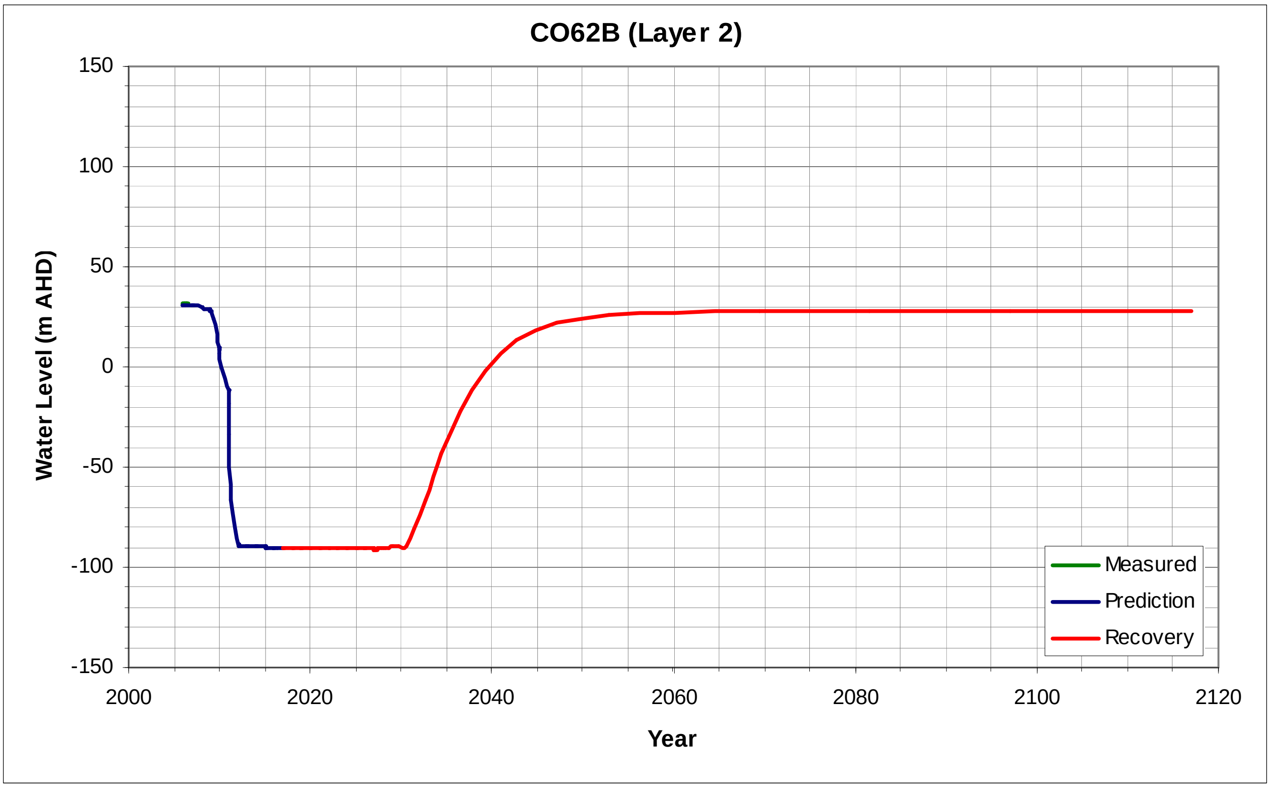

CO78A (Layer 3)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery


CO80 (Layer 3)
Water Level (m AHD)
100
50
0
-50
-100
-150
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

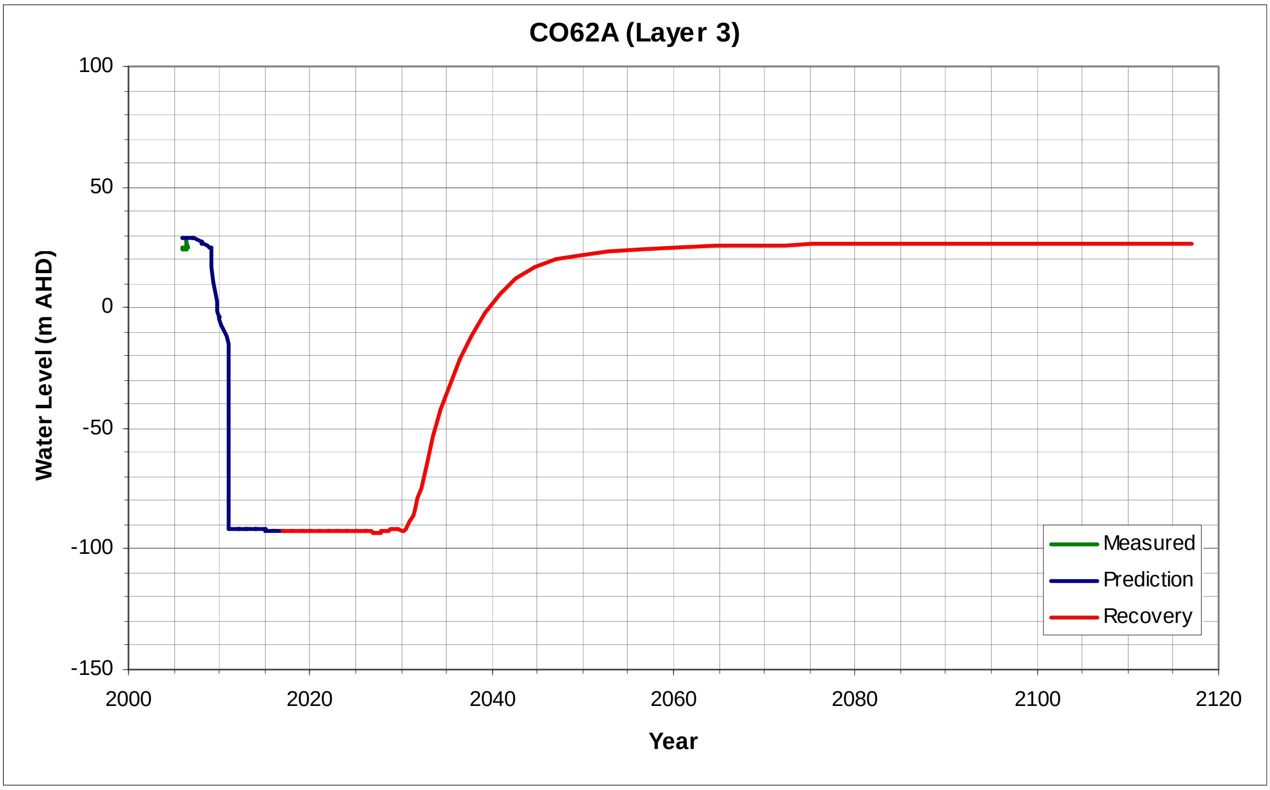

CO81A (Layer 3)
Water Level (m AHD)
100
50
0
-50
-100
-150
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery


CO81B (Layer 1)
Water Level (m AHD)
100
50
0
-50
-100
-150
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery


CO82 (Layer 2)
Water Level (m AHD)
50
0
-50
-100
-150
-200
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

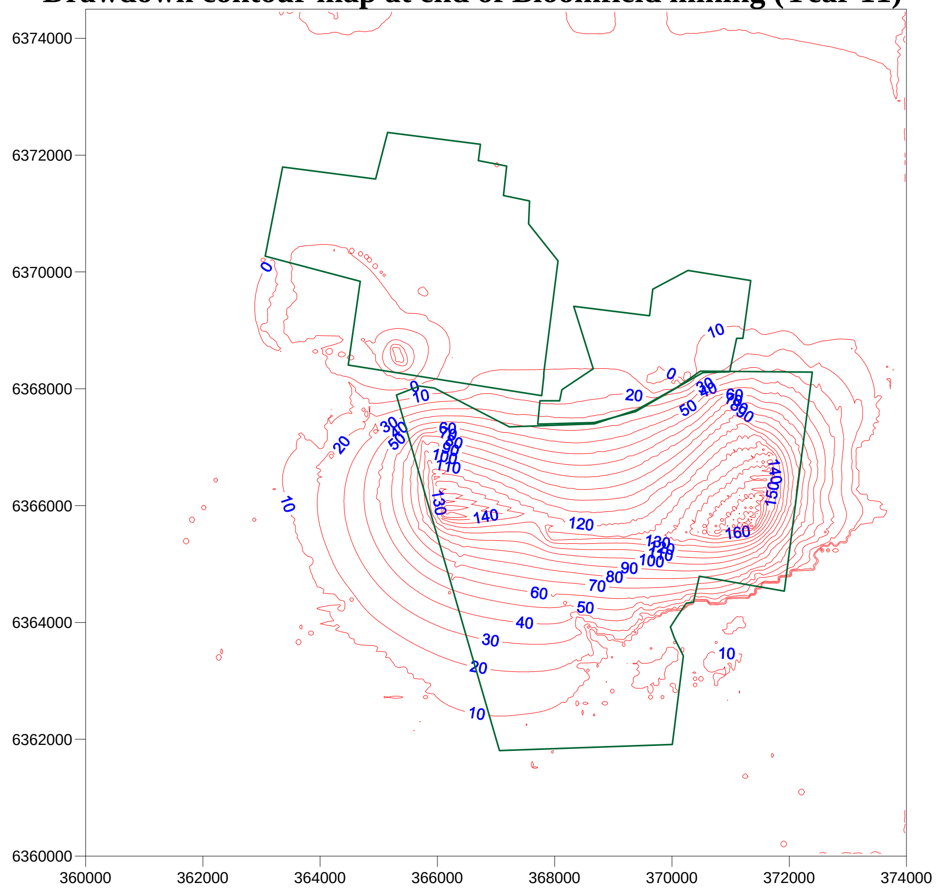


CO62B (Layer 2)
150
100
50
0
-50
-100
-150
2000
2020
2040
2060
2080
2100
2120
Water Level (m AHD)
Year
Measured
Prediction
Recovery

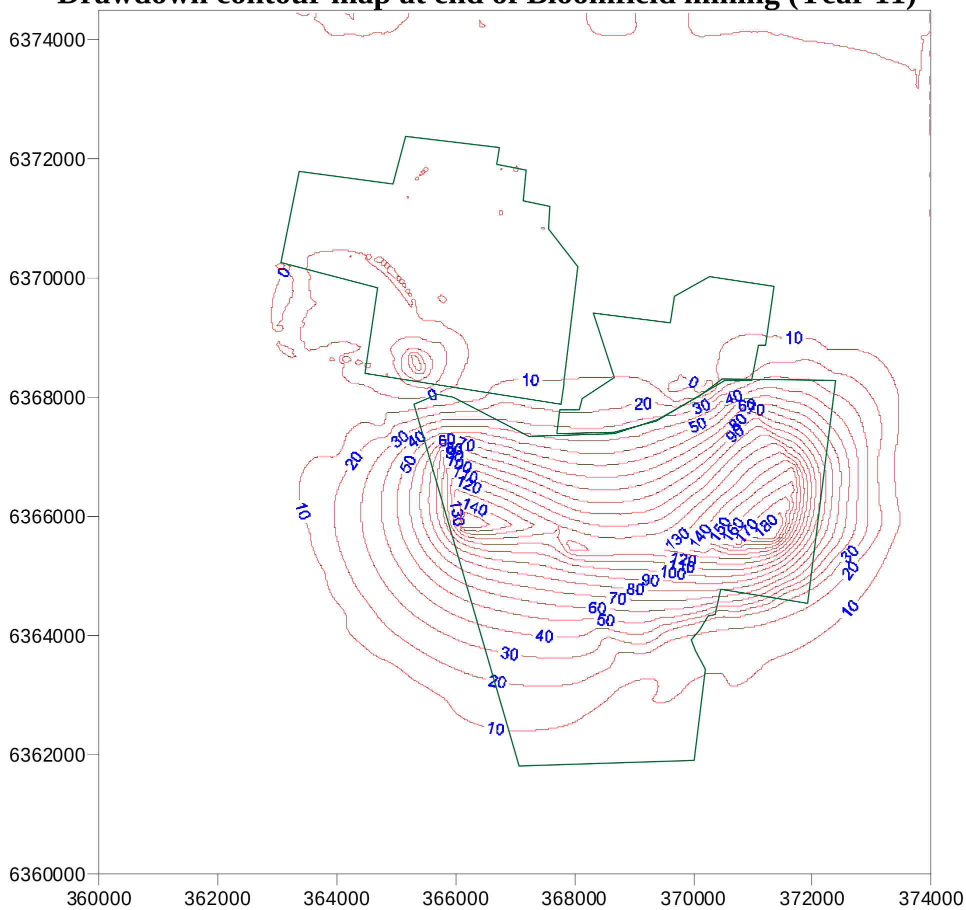


CO62A (Layer 3)
100
50
0
-50
-100
-150
2000
2020
2040
2060
2080
2100
2120
Water Level (m AHD)
Year
Measured
Prediction
Recovery

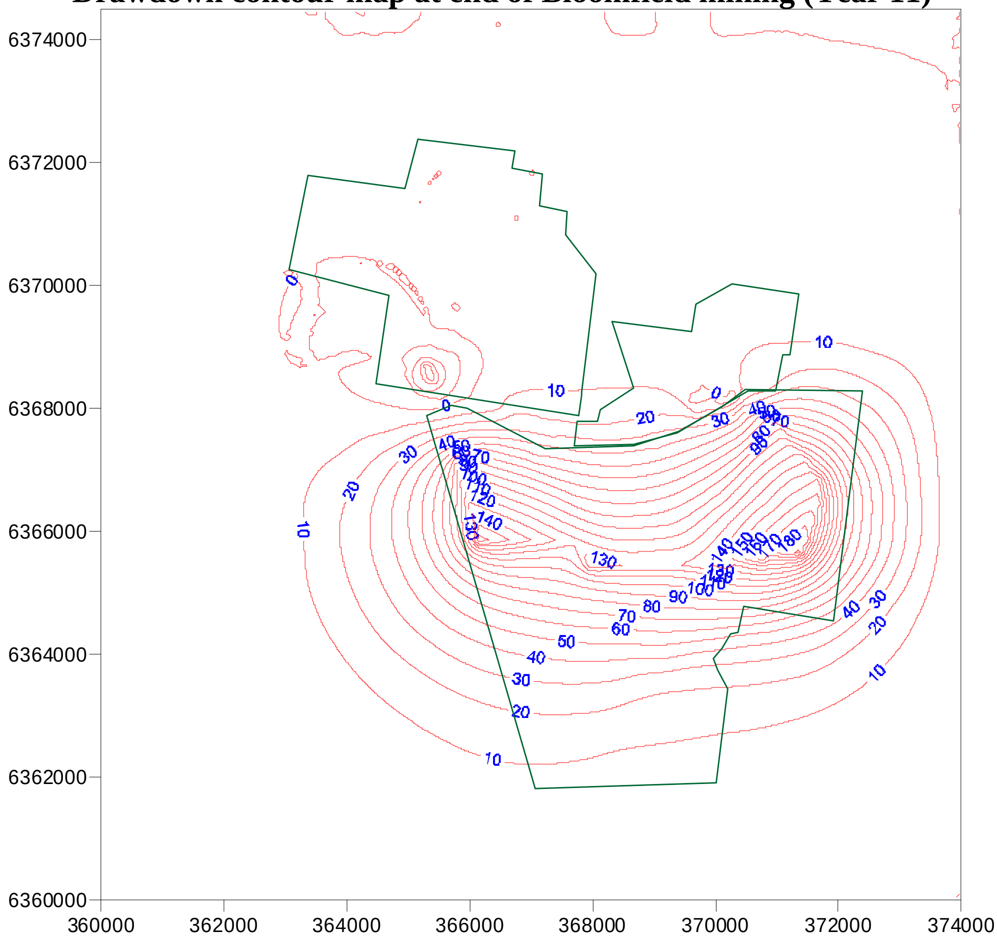
Layer 1
Drawdown contour map at end of Bloomfield mining (Year 11)



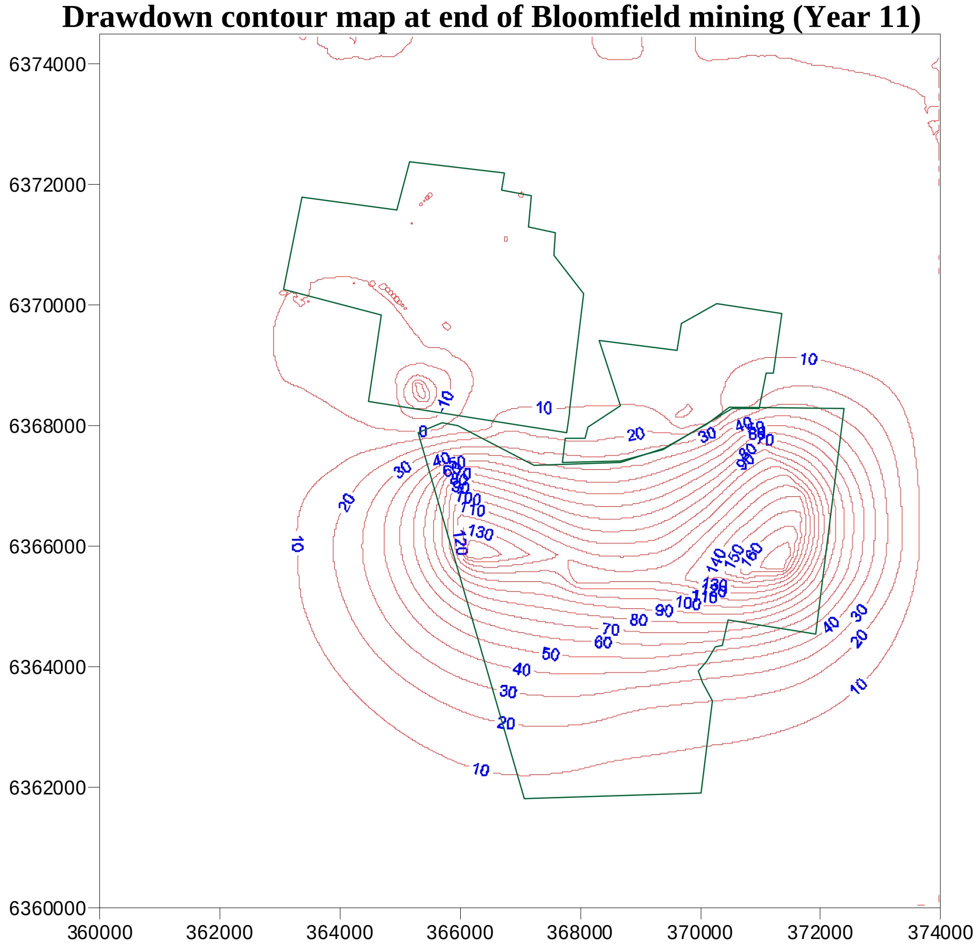
Layer 2
Drawdown contour map at end of Bloomfield mining (Year 11)



Layer 3
Drawdown contour map at end of Bloomfield mining (Year 11)

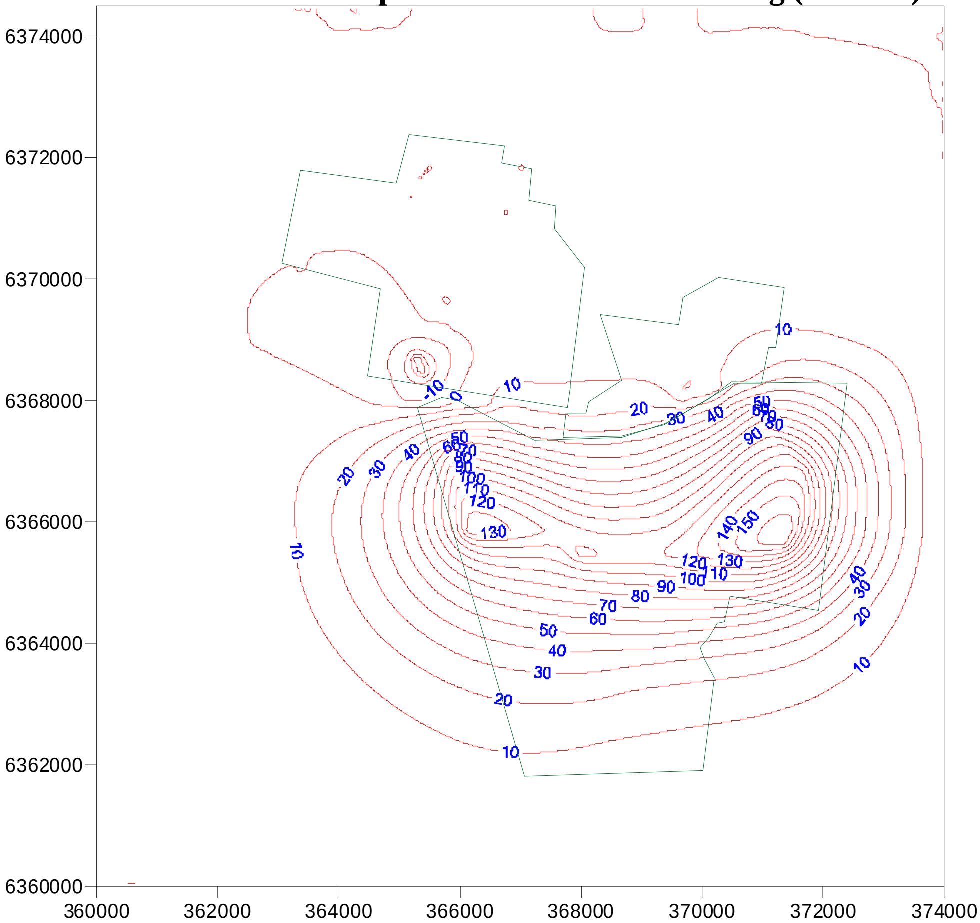


Layer 4
Drawdown contour map at end of Bloomfield mining (Year 11)



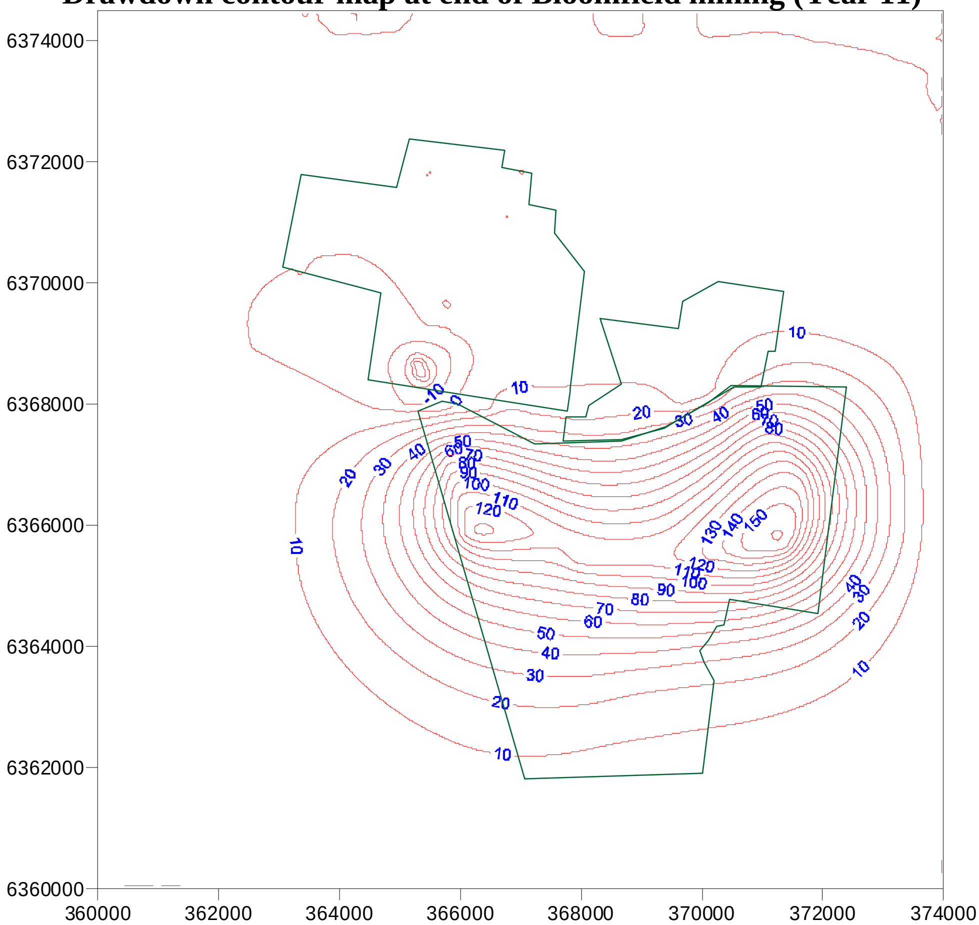
Layer 5

Drawdown contour map at end of Bloomfield mining (Year 11)

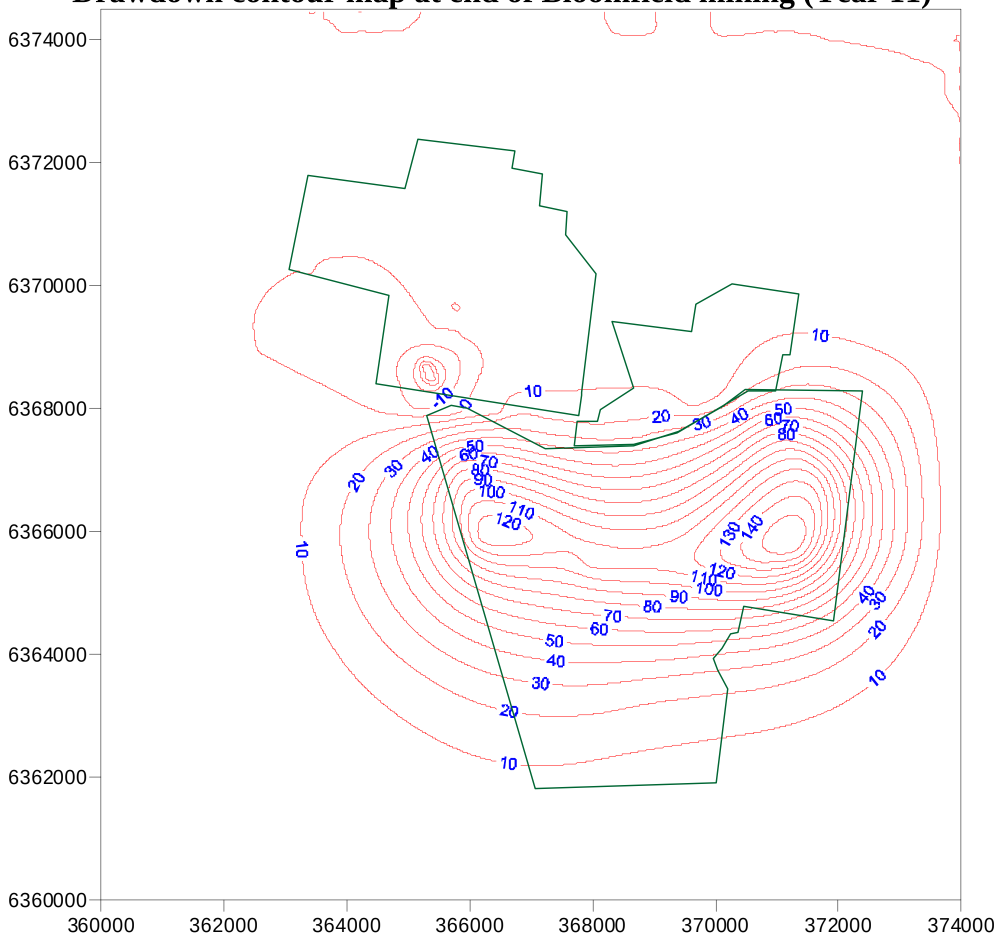


Layer 6

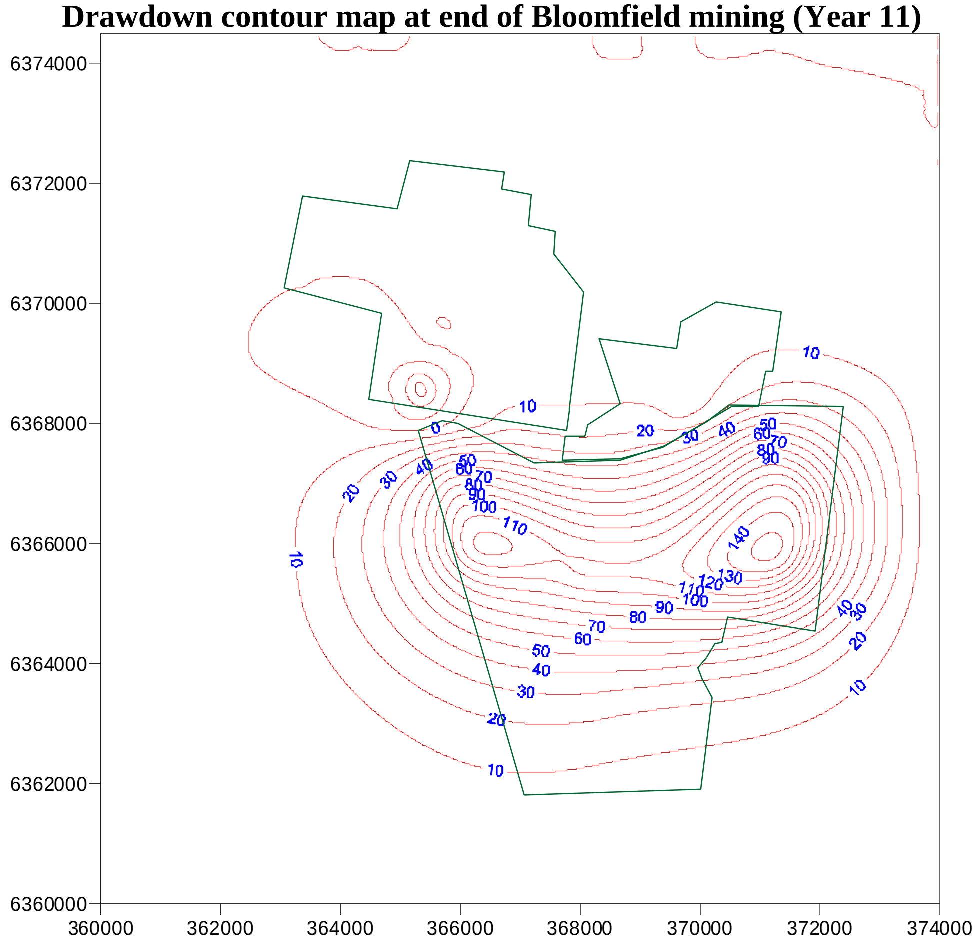
Drawdown contour map at end of Bloomfield mining (Year 11)



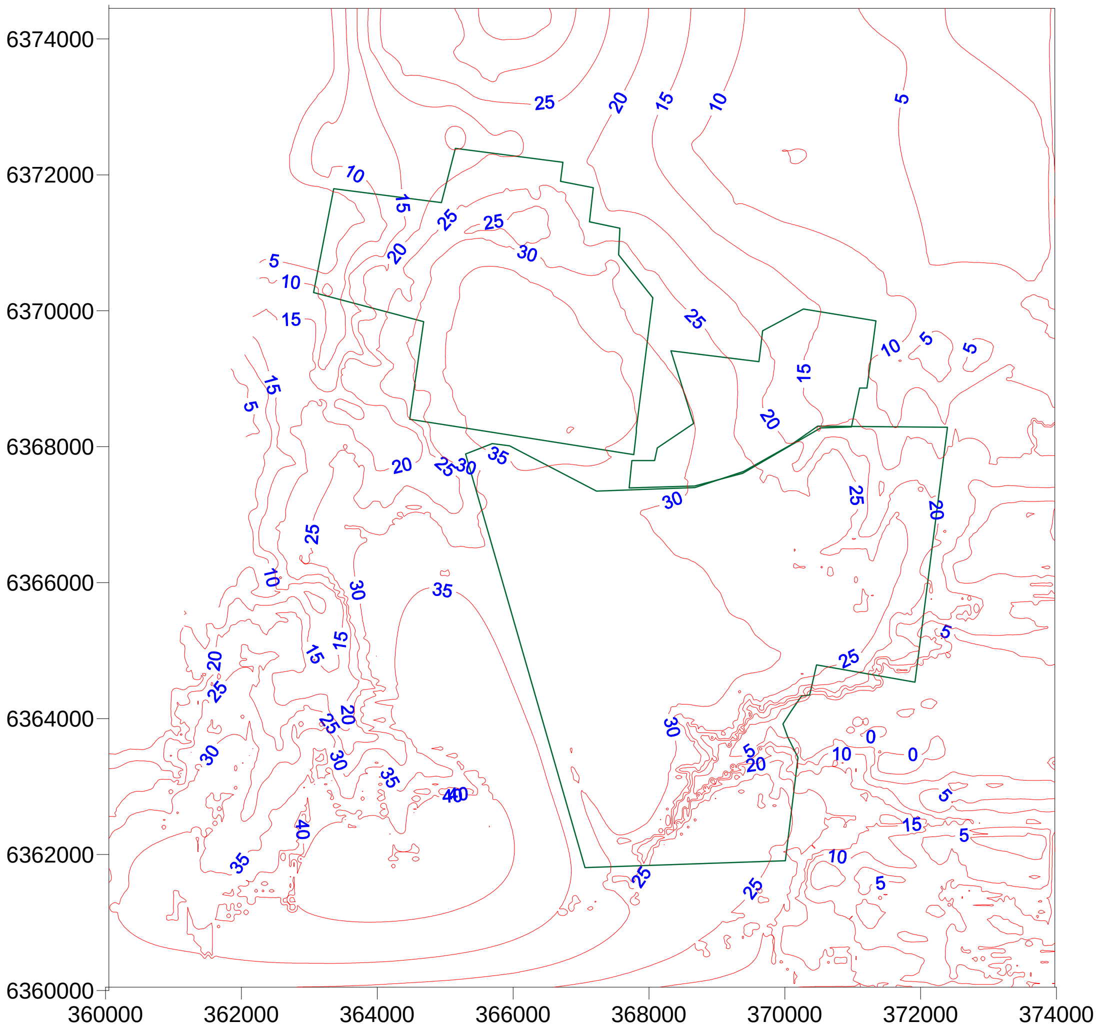
Layer 7
Drawdown contour map at end of Bloomfield mining (Year 11)



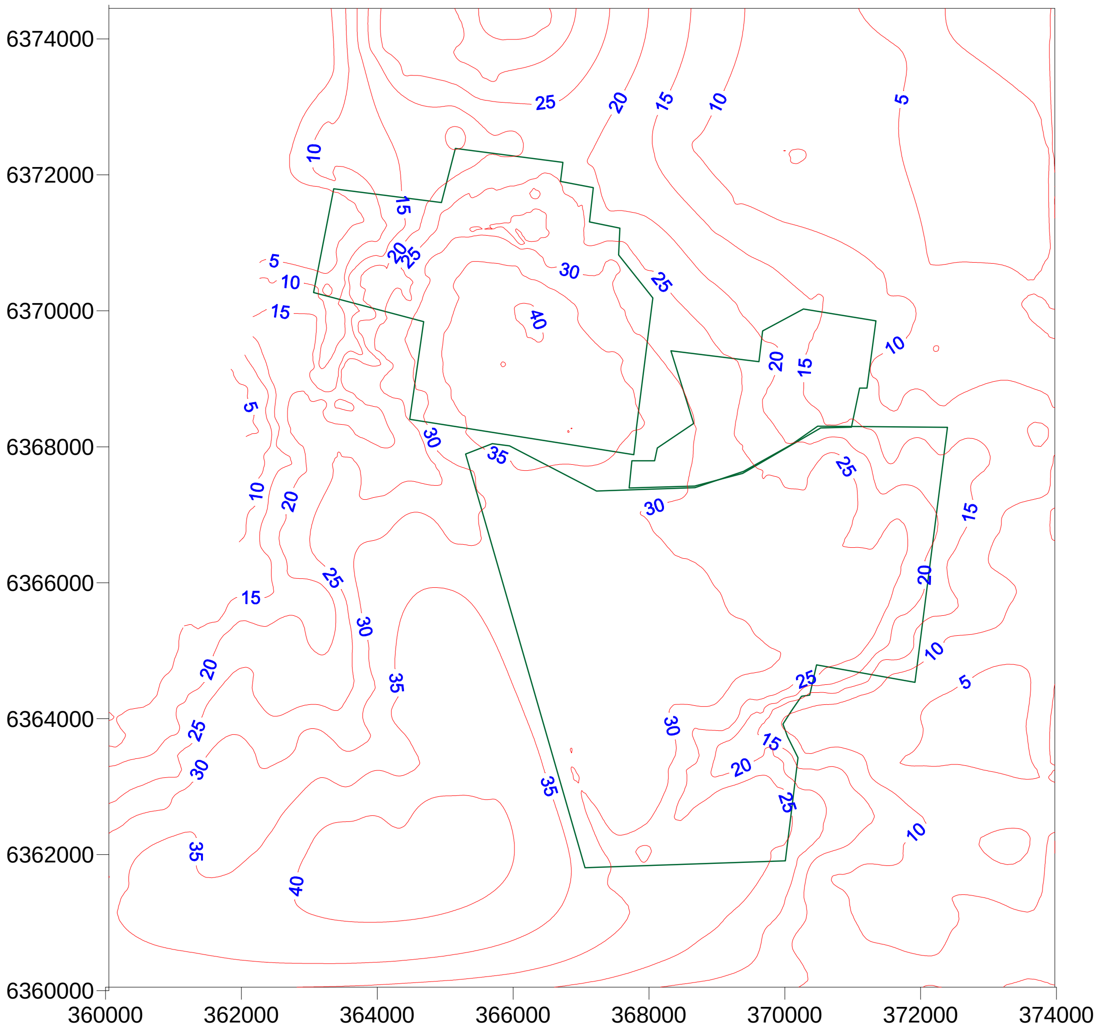
Layer 8
Drawdown contour map at end of Bloomfield mining (Year 11)



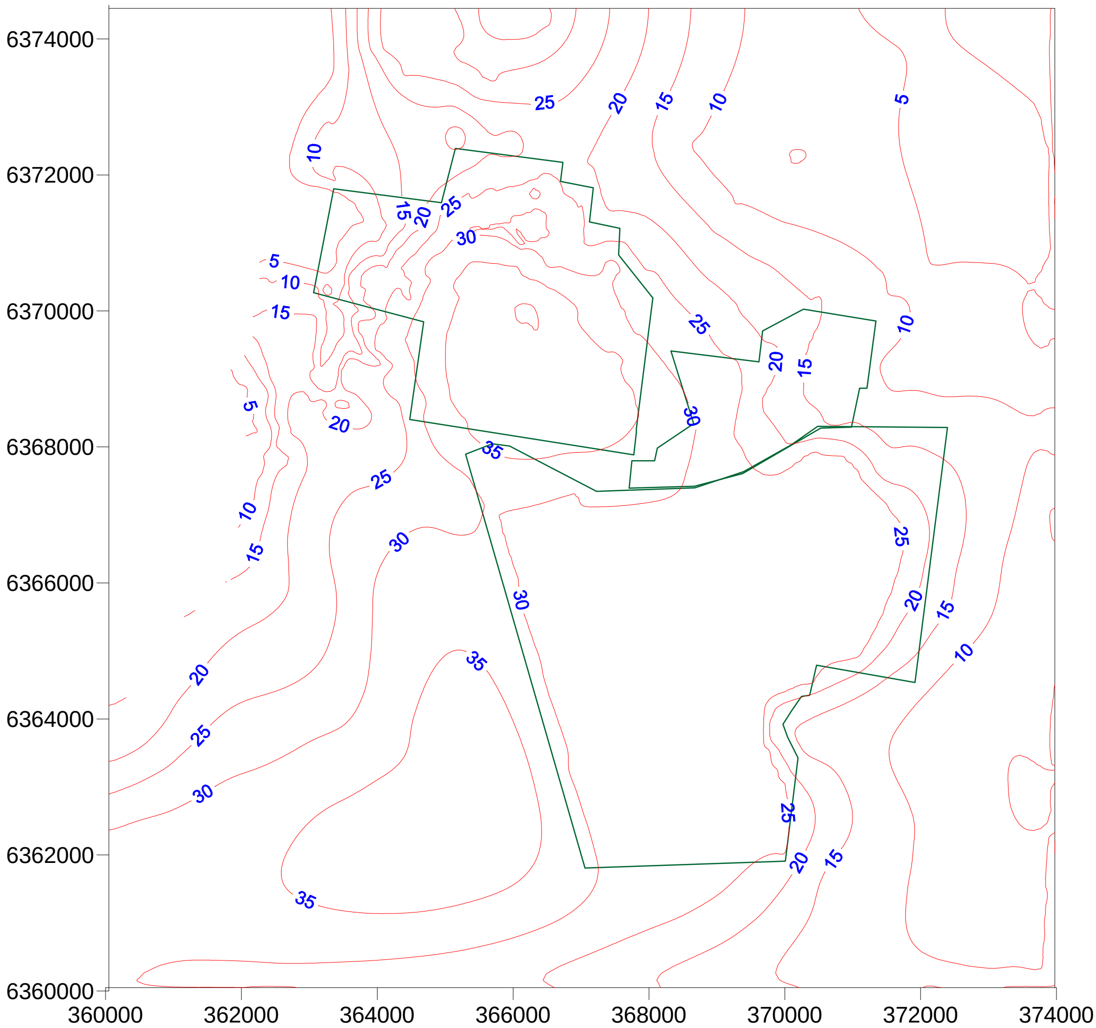
Layer 1
WATER LEVEL CONTOUR MAP AT END OF 100-YEAR RECOVERY PERIOD



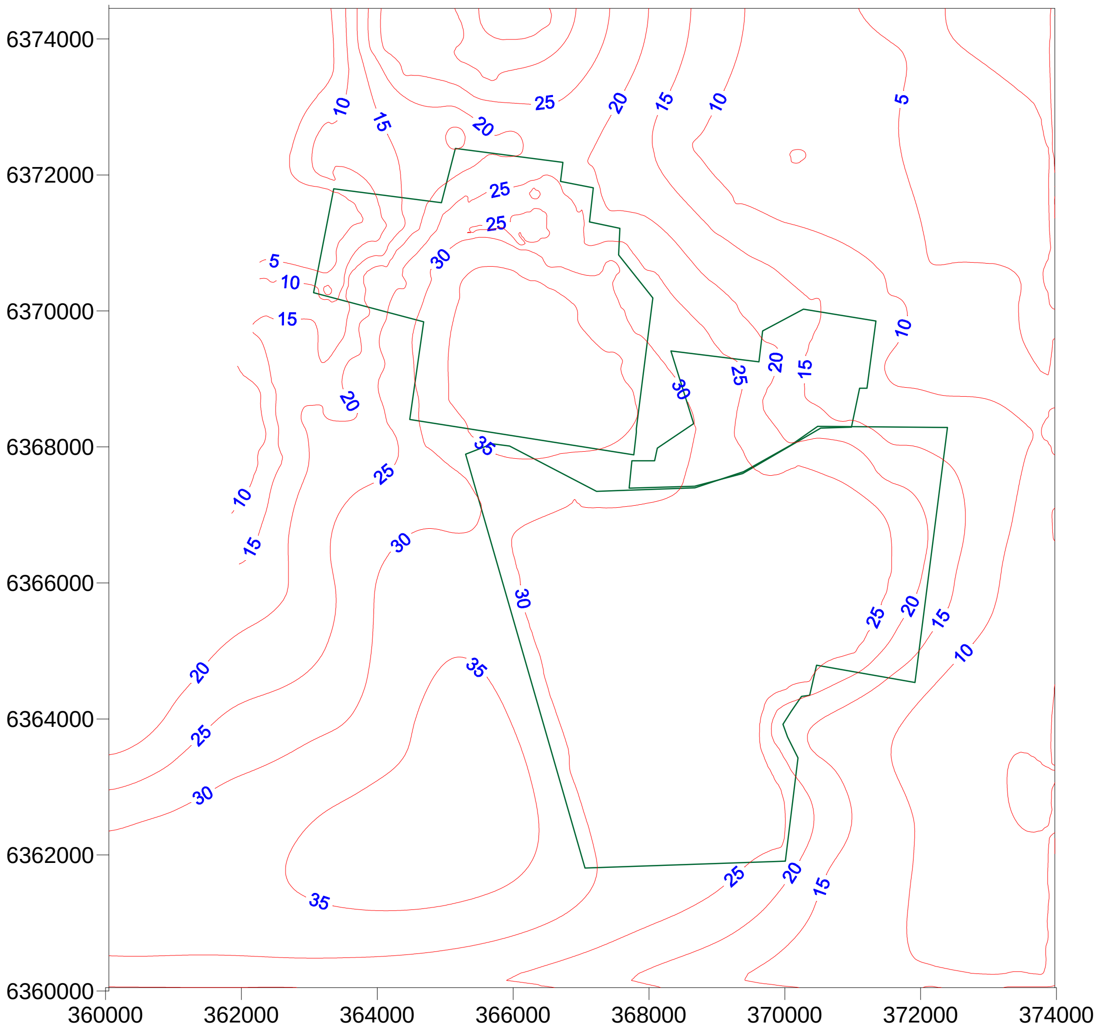
Layer 2
WATER LEVEL CONTOUR MAP AT END OF 100-YEAR RECOVERY PERIOD



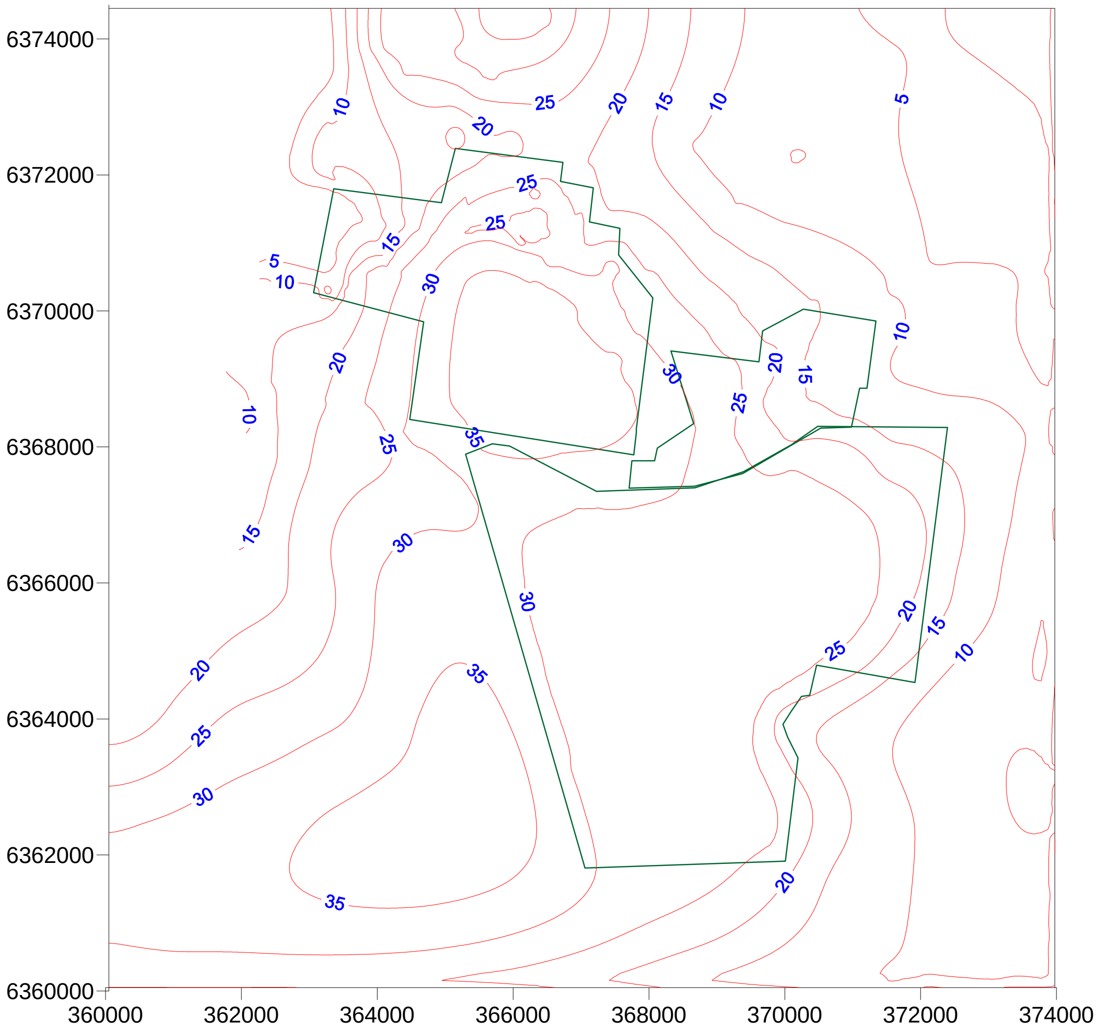
Layer 3
WATER LEVEL CONTOUR MAP AT END OF 100-YEAR RECOVERY PERIOD



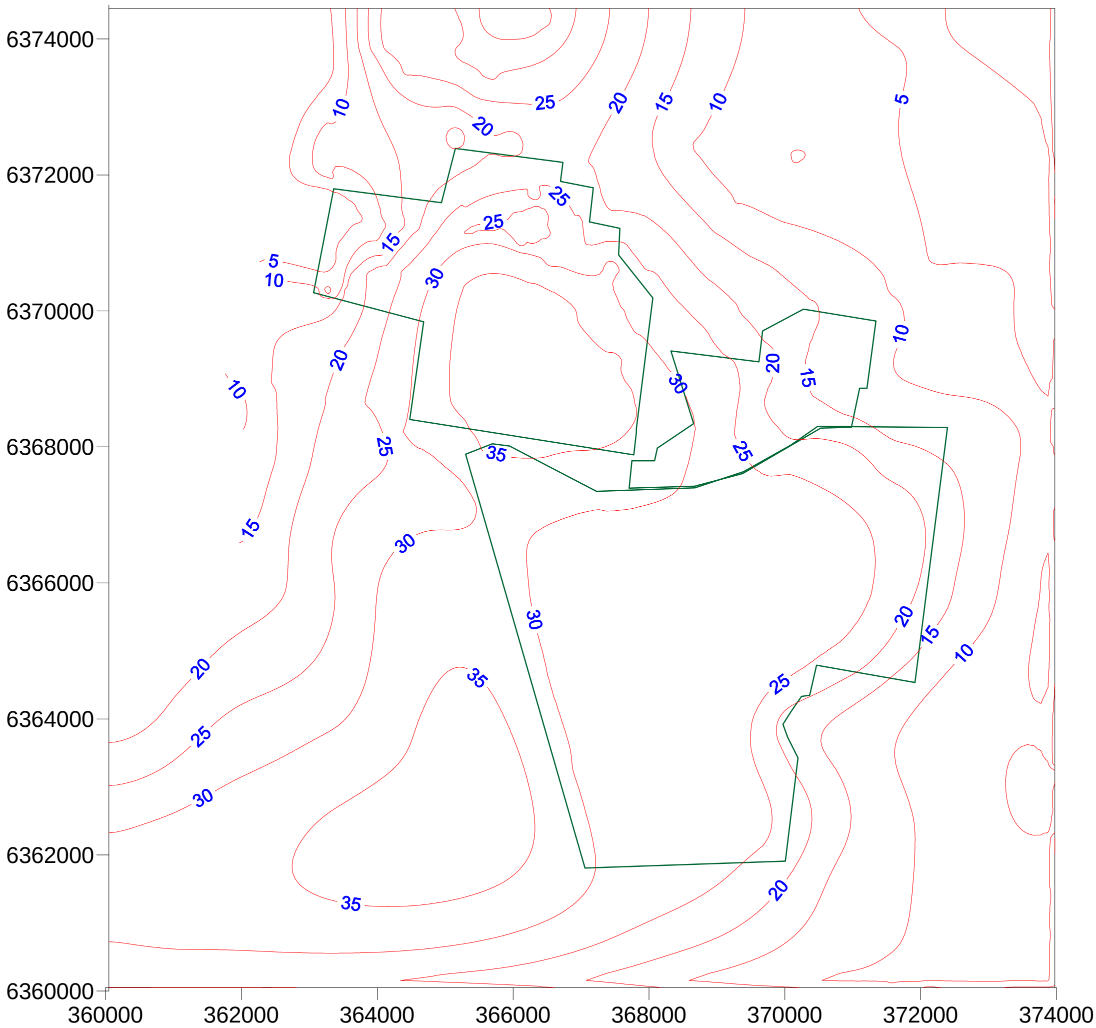
Layer 4
WATER LEVEL CONTOUR MAP AT END OF 100-YEAR RECOVERY PERIOD



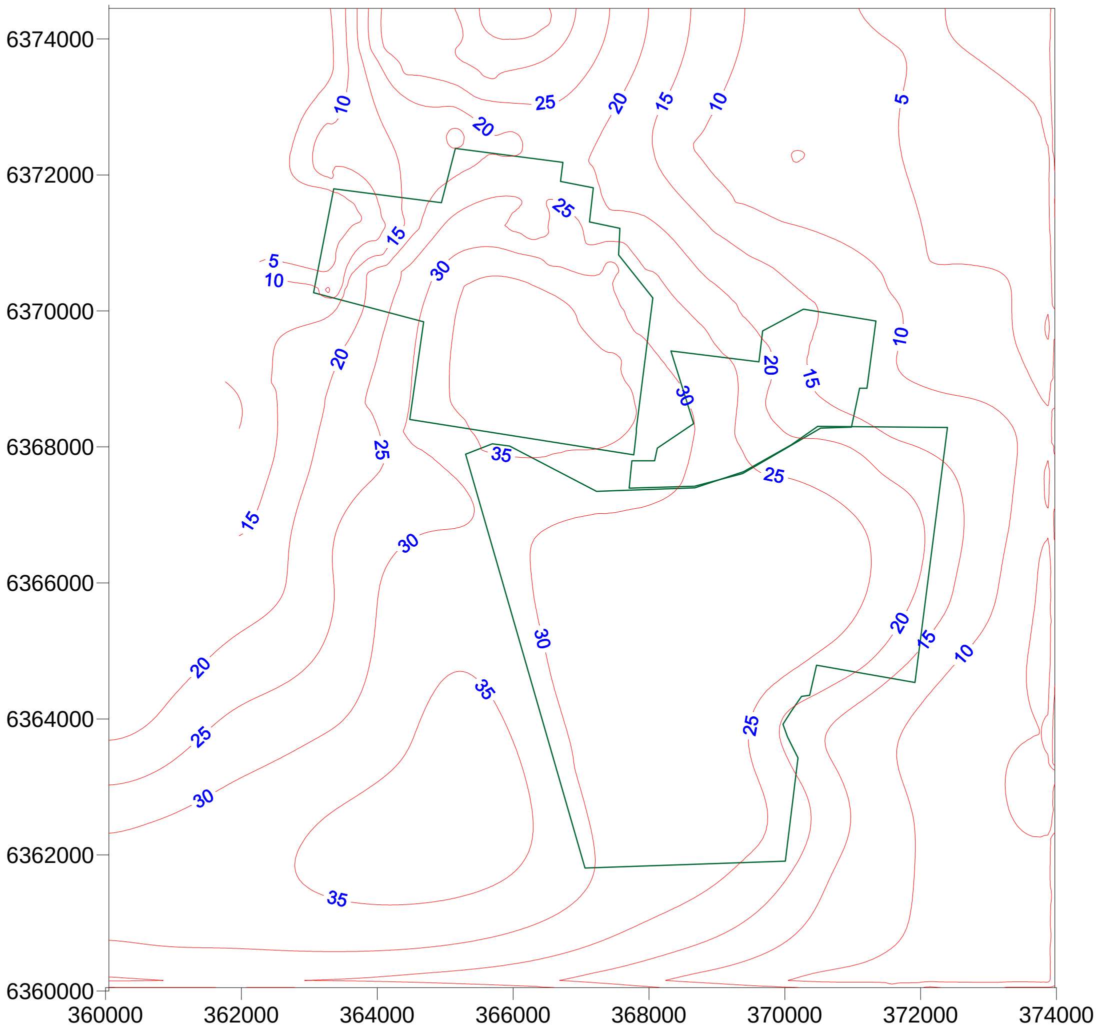
Layer 5
WATER LEVEL CONTOUR MAP AT END OF 100-YEAR RECOVERY PERIOD



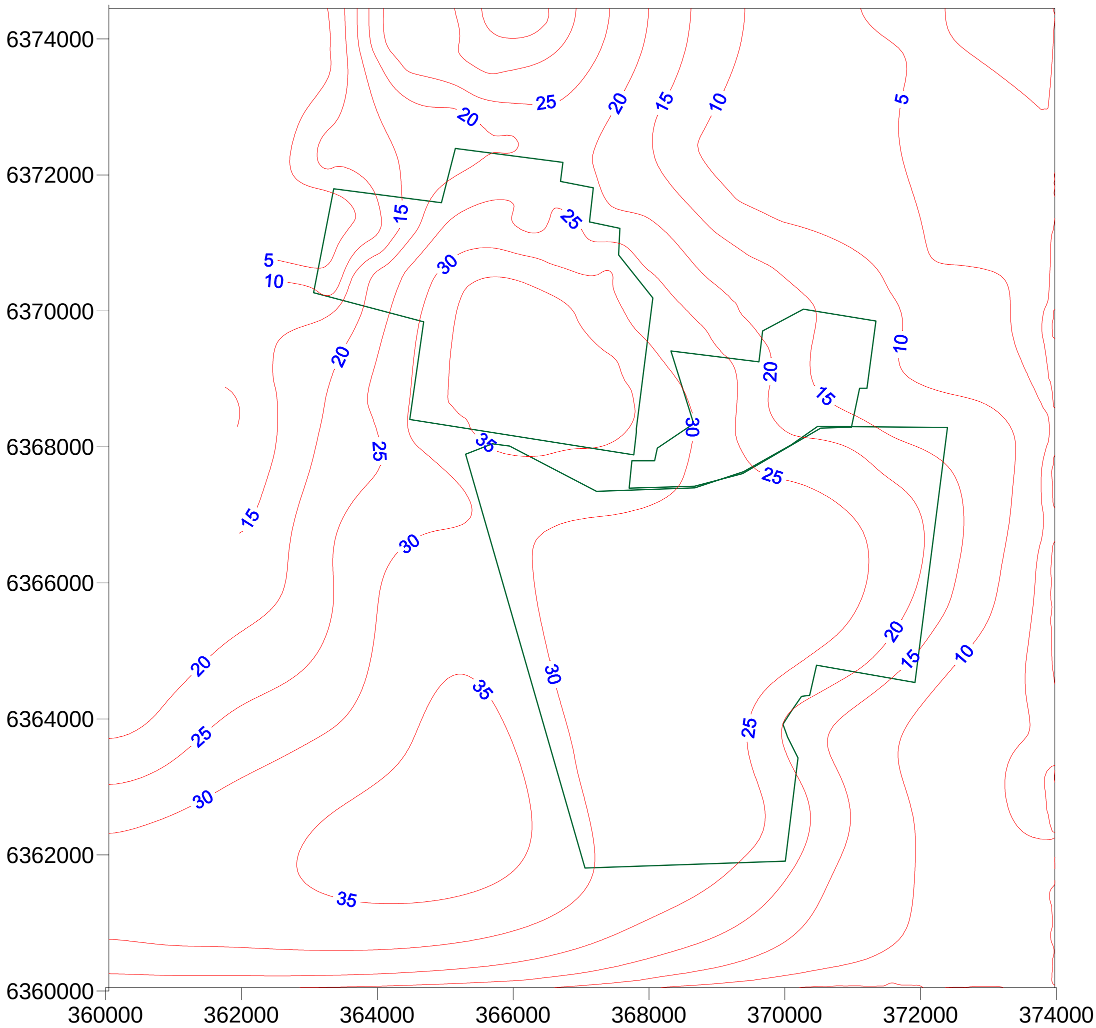
Layer 6
WATER LEVEL CONTOUR MAP AT END OF 100-YEAR RECOVERY PERIOD



Layer 7
WATER LEVEL CONTOUR MAP AT END OF 100-YEAR RECOVERY PERIOD



Layer 8
WATER LEVEL CONTOUR MAP AT END OF 100-YEAR RECOVERY PERIOD



Appendix I-2

Groundwater Impact Assessment
Appendices

Bloomfield Colliery Completion of Mining and Rehabilitation

Part 3A Environmental Assessment

November 2008

APPENDIX A

DWE REGISTERED BORES WITHIN 5 KM OF BLOOMFIELD PROJECT

DEPARTMENT OF WATER AND ENERGY
Work Summary

GW051353

Converted From HYDSYS

Licence : 20BL114994

Licence Status Active

	Authorised Purpose(s)	**Intended Purpose(s)**
	DOMESTIC	DOMESTIC
	STOCK	STOCK

Work Type : Bore open thru rock
Work Status : (Unknown)
Construct. Method : Rotary
Owner Type : Private

Commenced Date :
Completion Date : 01-Nov-1980
Final Depth : 49.70 m
Drilled Depth : 49.70 m

Contractor Name :
Driller :
Assistant Driller's Name :

Property : - ROBIN HILL
GWMA : -
GW Zone : -

Standing Water Level :
Salinity : 3001-7000 ppm
Yield :

Site Details

Site Chosen By

	County	Parish	Portion/Lot DP
Form A :	NORTHUMBERLAND	STOCKRINGTON	99
Licensed :	NORTHUMBERLAND	STOCKRINGTON	39

Region : 20 - HUNTER
River Basin : 210 - HUNTER RIVER
Area / District :

CMA Map : 9232-3N BERESFIELD
Grid Zone : 56/1 **Scale :** 1:25,000

Elevation :
Elevation Source : (Unknown)

Northing : 6365810
Easting : 365986
Latitude (S) : 32° 50' 15"
Longitude (E) : 151° 34' 5"

GS Map : 0053C4 **MGA Zone :** 56 **Coordinate Source :** GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing	P.V.C.	-0.30	1.50	114			Driven into Hole

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
22.60	23.10	0.50	Fractured	15.20		0.12			(Unknown)
24.90	25.20	0.30	Fractured	15.20		0.20			(Unknown)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.50	0.50	Soil Clay	Soil	
0.50	3.60	3.10	Sandstone Yellow	Sandstone	
3.60	3.90	0.30	Ironstone Shale	Ironstone	
3.90	10.70	6.80	Sandstone White	Sandstone	
3.90	10.70	6.80	Shale Seams	Shale	
10.70	11.90	1.20	Coal	Coal	
11.90	14.00	2.10	Sandstone Hard	Sandstone	
14.00	15.80	1.80	Shale	Shale	
15.80	22.60	6.80	Sandstone White	Sandstone	
22.60	25.60	3.00	Shale Water Supply	Shale	
25.60	49.70	24.10	Shale Black	Shale	

Remarks

*** End of GW051353 ***

DEPARTMENT OF WATER AND ENERGY
Work Summary

GW051647 *Converted From HYDSYS*

Licence : 20BL112319
Licence Status Active

Authorised Purpose(s)	**Intended Purpose(s)**
STOCK	STOCK

Work Type : Bore
Work Status : (Unknown)
Construct. Method : Rotary
Owner Type : Private

Commenced Date :
Completion Date : 01-Sep-1980
Final Depth : 12.00 m
Drilled Depth : 12.00 m

Contractor Name :
Driller : 1519 RYAN, Alan Francis
Assistant Driller's Name :

Property : - KARINYA
GWMA : -
GW Zone : -
Standing Water Level :
Salinity : (Unknown)
Yield :

Site Details

Site Chosen By

	County	Parish	Portion/Lot DP
Form A :	NORTHUMBERLAND	MAITLAND	L9 (1)
Licensed :	NORTHUMBERLAND	MAITLAND	L9 (P+ Port 1)

Region : 20 - HUNTER
River Basin : 210 - HUNTER RIVER
Area / District :
CMA Map : 9232-3N BERESFIELD
Grid Zone : 56/1 **Scale :** 1:25,000

Elevation :
Elevation Source : (Unknown)
Northing : 6373006
Easting : 362896
Latitude (S) : 32° 46' 20"
Longitude (E) : 151° 32' 10"

GS Map : 0053C4 **MGA Zone :** 56 **Coordinate Source :** GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;
H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details

(No Construction Details Found)

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

(No Water Bearing Zone Details Found)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.15	0.15	Topsoil	Topsoil	
0.15	3.00	2.85	Clay	Clay	
3.00	3.81	0.81	Sand Yellow	Sand	
3.81	4.57	0.76	Sand White	Sand	
4.57	6.10	1.53	Clay Sand	Clay	
6.10	12.00	5.90	Sandstone Hard	Sandstone	

Remarks

***** End of GW051647 *****

DEPARTMENT OF WATER AND ENERGY
Work Summary

GW078046

Licence : 20BL166664

Licence Status Active

Authorised Purpose(s) MONITORING BORE

Intended Purpose(s) MONITORING BORE

Work Type : Bore
Work Status : (Unknown)
Construct. Method : Backhoe
Owner Type :

Commenced Date :
Completion Date : 14-Nov-1997

Final Depth : 30.40 m
Drilled Depth : 30.40 m

Contractor Name : McDERMOTT DRILLING
Driller : DODDS
Assistant Driller's Name :

Property : - N/A
GWMA : 017 - HUNTER
GW Zone : -

Standing Water Level :
Salinity :
Yield :

Site Details

Site Chosen By
Geologist

	County	Parish	Portion/Lot DP
Form A :	NORTHUMBERLAND	STOCKRINGTON	LOT 92 DP 755260
Licensed :	NORTHUMBERLAND	STOCKRINGTON	92 755260

Region : 20 - HUNTER
River Basin :
Area / District :

CMA Map :
Grid Zone :
Scale :

Elevation :
Elevation Source :

Northing : 6368741
Easting : 368651

Latitude (S) : 32° 48' 41"
Longitude (E) : 151° 35' 49"

GS Map :
MGA Zone : 56
Coordinate Source :

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	Hole	0.00	30.40	96			Open Hole - Water
1	1	Opening	Screen	6.80	18.80				
1	1	Opening	Slots - Horizontal	6.80	18.80	55			PVC; SL: 12mm; A: 5mm
1		Annulus	Waterworn/Rounded	6.00	30.40				Ungraded; GS: 4-5mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
13.60	30.40	16.80		13.60			30.40		

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	9.20	9.20	SILTSTONE/MUDSTONE	Siltstone	
9.20	9.40	0.20	COAL	Coal	
9.40	11.20	1.80	SILTSTONE	Siltstone	
11.20	11.60	0.40	COAL	Coal	
11.60	30.40	18.80	SILTSTONE/SANDSTONE	Siltstone	

Remarks

*** End of GW078046 ***

DEPARTMENT OF WATER AND ENERGY
Work Summary

GW078047

Licence : 20BL166665

Licence Status Active

Authorised Purpose(s)	**Intended Purpose(s)**
MONITORING BORE	MONITORING BORE

Work Type : Bore
Work Status : (Unknown)
Construct. Method :
Owner Type :

Commenced Date : | **Final Depth :** 54.30 m
Completion Date : 14-Nov-1997 | **Drilled Depth :** 54.30 m

Contractor Name : McDERMOTT DRILLING
Driller :
Assistant Driller's Name :

Property : - N/A | **Standing Water Level :**
GWMA : 017 - HUNTER | **Salinity :**
GW Zone : - | **Yield :**

Site Details

Site Chosen By		**County**	**Parish**	**Portion/Lot DP**
Driller	**Form A :**	NORTHUMBERLAND	STOCKRINGTON	PT LOT 13 DP 755260
	Licensed :	NORTHUMBERLAND	STOCKRINGTON	13 755260

Region : 20 - HUNTER | **CMA Map :**
River Basin : | **Grid Zone :** | **Scale :**
Area / District :

Elevation : | **Northing :** 6368800 | **Latitude (S) :** 32° 48' 40"
Elevation Source : | **Easting :** 370784 | **Longitude (E) :** 151° 37' 11"

GS Map : | **MGA Zone :** 56 | **Coordinate Source :**

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	Hole	0.00	54.30	96			
1	1	Opening	Screen	25.20	49.20				
1	1	Opening	Slots - Horizontal	25.20	49.20	55			PVC; SL: 24mm; A: 5mm
1		Annulus	Waterworn/Rounded	24.90	49.20				Ungraded; GS: 4-5mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
22.80	54.30	31.50		22.80			54.30		

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	6.50	6.50	SILTSTONE	Siltstone	
6.50	12.00	5.50	SANDSTONE	Sandstone	
12.00	14.60	2.60	SILTSTONE/MUDSTONE	Siltstone	
14.60	15.40	0.80	COAL	Coal	
15.40	24.90	9.50	SILTSTONE	Siltstone	
24.90	27.70	2.80	COAL	Coal	
27.70	32.30	4.60	SILTSTONE/SANDSTONE	Siltstone	
32.30	33.40	1.10	COAL	Coal	
33.40	39.30	5.90	SANDSTONE	Sandstone	
39.30	39.90	0.60	COAL	Coal	
39.90	41.10	1.20	SILTSTONE/SANDSTONE	Siltstone	
41.10	43.50	2.40	COAL	Coal	
43.50	45.10	1.60	CLAYSTONE	Claystone	
45.10	49.40	4.30	COAL	Coal	
49.40	54.30	4.90	SILTSTONE	Siltstone	

Remarks

***** End of GW078047 *****

DEPARTMENT OF WATER AND ENERGY
Work Summary

GW078121

Licence : 20BL166667
Licence Status Active
Authorised Purpose(s) MONITORING BORE
Intended Purpose(s) MONITORING BORE

Work Type : Bore
Work Status : (Unknown)
Construct. Method :
Owner Type :

Commenced Date :
Completion Date : 14-Nov-1997
Final Depth : 43.00 m
Drilled Depth : 43.00 m

Contractor Name : McDERMOTT DRILLING
Driller :
Assistant Driller's Name :

Property : - N/A
GWMA : 017 - HUNTER
GW Zone : -
Standing Water Level :
Salinity :
Yield :

Site Details

Site Chosen By		County	Parish	Portion/Lot DP
Geologist	Form A :	NORTHUMBERLAND	STOCKRINGTON	LOT 10 DP 11875
	Licensed :	NORTHUMBERLAND	STOCKRINGTON	10 11875

Region : 20 - HUNTER
River Basin :
Area / District :
CMA Map :
Grid Zone :
Scale :

Elevation :
Elevation Source :
Northing : 6367262
Easting : 368619
Latitude (S) : 32° 49' 29"
Longitude (E) : 151° 35' 47"

GS Map :
MGA Zone : 56
Coordinate Source :

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	Hole	0.00	43.00	96			Open Hole - Water
1	1	Opening	Screen	26.70	42.50				
1	1	Opening	Slots	26.70	42.50	55			PVC; SL: 15.8mm
1		Annulus	Waterworn/Rounded	2.00	43.00				Ungraded; GS: 4-5mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
22.30	43.00	20.70		22.30			43.00		

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	14.00	14.00	SILTSTONE/SHALE	Siltstone	
14.00	16.00	2.00	SANDSTONE	Sandstone	
16.00	20.00	4.00	SILTSTONE/SHALE	Siltstone	
20.00	22.00	2.00	SANDSTONE	Sandstone	
22.00	25.40	3.40	SILTSTONE/SHALE	Siltstone	
25.40	25.90	0.50	COAL	Coal	
25.90	32.10	6.20	SANDSTONE	Sandstone	
32.10	32.60	0.50	COAL	Coal	
32.60	33.90	1.30	SANDSTONE	Sandstone	
33.90	35.60	1.70	COAL	Coal	
35.60	36.20	0.60	SANDSTONE	Sandstone	
36.20	37.00	0.80	COAL	Coal	
37.00	38.20	1.20	SANDSTONE/SILTSTONE	Sandstone	
38.20	38.60	0.40	COAL	Coal	
38.60	43.00	4.40	SILTSTONE	Siltstone	

Remarks

***** End of GW078121 *****

DEPARTMENT OF WATER AND ENERGY
Work Summary

GW078122

Licence : 20BL166668

Licence Status Active

Authorised Purpose(s) MONITORING BORE

Intended Purpose(s) MONITORING BORE

Work Type : Bore
Work Status : (Unknown)
Construct. Method :
Owner Type :

Commenced Date :
Completion Date : 14-Nov-1997

Final Depth : 35.40 m
Drilled Depth : 35.40 m

Contractor Name : McDERMOTT DRILLING
Driller :
Assistant Driller's Name :

Property : - N/A
GWMA : 017 - HUNTER
GW Zone : -

Standing Water Level :
Salinity :
Yield :

Site Details

Site Chosen By		County	Parish	Portion/Lot DP
Geologist	Form A :	NORTHUMBERLAND	STOCKRINGTON	LOT 10 DP 11875
	Licensed :	NORTHUMBERLAND	STOCKRINGTON	10 11875

Region : 20 - HUNTER
River Basin :
Area / District :

CMA Map :
Grid Zone :
Scale :

Elevation :
Elevation Source :

Northing : 6367663
Easting : 368666

Latitude (S) : 32° 49' 16"
Longitude (E) : 151° 35' 49"

GS Map :
MGA Zone : 56
Coordinate Source :

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	Hole	0.00	35.40	96			Open Hole - Water
1	1	Opening	Screen	19.50	35.00				
1	1	Opening	Slots - Horizontal	19.50	35.00	55			PVC; SL: 15.5mm; A: 5mm
1		Annulus	Waterworn/Rounded	19.20	35.40				Ungraded; GS: 4-5mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
23.10	51.30	28.20		23.10			35.40		

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	12.00	12.00	SANDSTONE/SILTSTONE	Sandstone	
12.00	12.40	0.40	COAL	Coal	
12.40	16.00	3.60	SILTSTONE	Siltstone	
16.00	19.50	3.50	SANDSTONE	Sandstone	
19.50	20.90	1.40	COAL	Coal	
20.90	22.00	1.10	SANDSTONE	Sandstone	
22.00	23.60	1.60	COAL	Coal	
23.60	24.40	0.80	SANDSTONE	Sandstone	
24.40	26.60	2.20	COAL	Coal	
26.60	28.00	1.40	SILTSTONE/CLAYSTONE	Siltstone	
28.00	31.70	3.70	COAL	Coal	
31.70	35.40	3.70	SANDSTONE	Sandstone	

Remarks

*** End of GW078122 ***

DEPARTMENT OF WATER AND ENERGY
Work Summary

GW078123

Licence : 20BL166669

Licence Status Active

Authorised Purpose(s) MONITORING BORE

Intended Purpose(s)

Work Type : Bore
Work Status : (Unknown)
Construct. Method :
Owner Type :

Commenced Date :
Completion Date : 14-Nov-1997

Final Depth : 33.00 m
Drilled Depth : 33.00 m

Contractor Name : McDERMOTT DRILLING
Driller :
Assistant Driller's Name :

Property : - N/A
GWMA : 017 - HUNTER
GW Zone : -

Standing Water Level :
Salinity :
Yield :

Site Details

Site Chosen By		County	Parish	Portion/Lot DP
Geologist	Form A :	NORTHUMBERLAND	STOCKRINGTON	LOT 92 DP 755260
	Licensed :	NORTHUMBERLAND	STOCKRINGTON	92 755260

Region : 20 - HUNTER
River Basin :
Area / District :

CMA Map :
Grid Zone :
Scale :

Elevation :
Elevation Source :

Northing : 6368165
Easting : 369309

Latitude (S) : 32° 49' 0"
Longitude (E) : 151° 36' 14"

GS Map :
MGA Zone : 56
Coordinate Source :

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	Hole	0.00	33.00	96			Other
1	1	Opening	Screen	20.20	32.20				
1	1	Opening	Slots - Horizontal	20.20	32.20	55			PVC; SL: 12mm; A: 5mm
1		Annulus	Waterworn/Rounded	12.50	32.20				Ungraded; GS: 4-5mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
24.40	33.00	8.60		24.40			33.00		

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	13.20	13.20	SANDSTONE/SILTSTONE	Sandstone	
13.20	15.30	2.10	COAL	Coal	
15.30	17.00	1.70	SILTSTONE	Siltstone	
17.00	17.90	0.90	COAL/SANDSTONE	Coal	
17.90	19.00	1.10	SILTSTONE	Siltstone	
19.00	19.70	0.70	COAL/SANDSTONE	Coal	
19.70	20.80	1.10	SANDSTONE	Sandstone	
20.80	23.20	2.40	COAL	Coal	
23.20	25.50	2.30	SANDSTONE/CLAYSTONE	Sandstone	
25.50	29.70	4.20	COAL	Coal	
29.70	33.00	3.30	SANDSTONE/SILTSTONE	Sandstone	

Remarks

***** End of GW078123 *****

DEPARTMENT OF WATER AND ENERGY
Work Summary

GW078124

Licence : 20BL166670

Licence Status Active

Authorised Purpose(s)	**Intended Purpose(s)**
MONITORING BORE	MONITORING BORE

Work Type : Bore
Work Status : (Unknown)
Construct. Method :
Owner Type :

Commenced Date :
Final Depth : 40.00 m
Completion Date : 14-Nov-1997
Drilled Depth : 37.00 m

Contractor Name : McDERMOTT DRILLING
Driller :
Assistant Driller's Name :

Property : - N/A
GWMA : 017 - HUNTER
GW Zone : -

Standing Water Level :
Salinity :
Yield :

Site Details

Site Chosen By
Geologist

	County	**Parish**	**Portion/Lot DP**
Form A :	NORTHUMBERLAND	STOCKRINGTON	PT LOT 13 DP755260
Licensed :	NORTHUMBERLAND	STOCKRINGTON	13 755260

Region : 20 - HUNTER
River Basin :
Area / District :

CMA Map :
Grid Zone :
Scale :

Elevation :
Elevation Source :

Northing : 6368018
Easting : 369883

Latitude (S) : 32° 49' 5"
Longitude (E) : 151° 36' 36"

GS Map :
MGA Zone : 56
Coordinate Source :

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	Hole	0.00	40.00	96			Open Hole - Water
1	1	Opening	Screen	12.50	36.50				
1	1	Opening	Slots - Horizontal	12.50	36.50	55			PVC; SL: 24mm; A: 55mm
1		Annulus	Waterworn/Rounded	11.10	40.00				Ungraded; GS: 4-5mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
18.60	40.00	21.40		18.60			40.00		

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	8.10	8.10	sandstone	Sandstone	
8.10	8.60	0.50	coal	Coal	
8.60	10.00	1.40	siltstone	Siltstone	
10.00	15.50	5.50	sandstone	Sandstone	
15.50	17.20	1.70	coal	Coal	
17.20	18.30	1.10	sandstone	Sandstone	
18.30	19.20	0.90	coal	Coal	
19.20	20.00	0.80	mudstone	Mudstone	
20.00	24.50	4.50	siltstone	Siltstone	
24.50	27.70	3.20	coal	Coal	
27.70	29.90	2.20	sandstone/claystone	Sandstone	
29.90	33.30	3.40	coal	Coal	
33.30	37.00	3.70	mudstone	Mudstone	

Remarks

***** End of GW078124 *****

DEPARTMENT OF WATER AND ENERGY
Work Summary

GW078127

Licence : 20BL166673

Licence Status Active

Authorised Purpose(s)	**Intended Purpose(s)**
MONITORING BORE	MONITORING BORE

Work Type : Bore
Work Status : (Unknown)
Construct. Method :
Owner Type :

Commenced Date : **Final Depth :** 30.00 m
Completion Date : 14-Nov-1997 **Drilled Depth :** 30.00 m

Contractor Name : McDERMOTT DRILLING
Driller :
Assistant Driller's Name :

Property : - NOT KNOWN **Standing Water Level :**
GWMA : 017 - HUNTER **Salinity :**
GW Zone : - **Yield :**

Site Details

Site Chosen By		**County**	**Parish**	**Portion/Lot DP**
Geologist	**Form A :**	NORTHUMBERLAND	STOCKRINGTON	LOT 82 DP 627798
	Licensed :	NORTHUMBERLAND	STOCKRINGTON	82 627799

Region : 20 - HUNTER **CMA Map :**
River Basin : **Grid Zone :** **Scale :**
Area / District :

Elevation : **Northing :** 6366406 **Latitude (S) :** 32° 49' 57"
Elevation Source : **Easting :** 369073 **Longitude (E) :** 151° 36' 4"

GS Map : **MGA Zone :** 56 **Coordinate Source :**

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	Hole	0.00	30.00	96			Open Hole - Water
1	1	Opening	Screen	14.30	26.30				
1	1	Opening	Slots - Horizontal	14.30	26.30	55			PVC; SL: 12mm; A: 5mm
1		Annulus	Waterworn/Rounded	1.00	30.00				Ungraded; GS: 4-5mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
16.60	30.00	13.40		16.60			30.00		

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	13.00	13.00	siltstone/mudstone	Siltstone	
13.00	17.00	4.00	mudstone	Mudstone	
17.00	30.00	13.00	siltstone/mudstone	Siltstone	

Remarks

***** End of GW078127 *****

DEPARTMENT OF WATER AND ENERGY
Work Summary

GW079892

Licence :

Licence Status Active

Authorised Purpose(s)

Intended Purpose(s) MONITORING BORE

Work Type : Bore
Work Status : (Unknown)
Construct. Method :
Owner Type :

Commenced Date : **Final Depth :**
Completion Date : **Drilled Depth :**

Contractor Name :
Driller :
Assistant Driller's Name :

Property : **Standing Water Level :**
GWMA : **Salinity :**
GW Zone : **Yield :**

Site Details

Site Chosen By

	County	Parish	Portion/Lot DP
Form A :	GLOUCESTER	TOMAREE	
Licensed :			

Region : 20 - HUNTER **CMA Map :**
River Basin : **Grid Zone :** **Scale :**
Area / District :

Elevation : 6.69 m (A.H.D.) **Northing :** 6372257 **Latitude (S) :** 32° 46' 46"
Elevation Source : **Easting :** 366598 **Longitude (E) :** 151° 34' 32"

GS Map : **MGA Zone :** 56 **Coordinate Source :**

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centraliser

Hole	Pipe	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details

(No Construction Details Found)

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

(No Water Bearing Zone Details Found)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments

Remarks

Form A Remarks:
RZM monitoring bore SK 6560

***** End of GW079892 *****

DEPARTMENT OF WATER AND ENERGY
Work Summary

GW080034

Licence :

Licence Status Active

Authorised Purpose(s)

Intended Purpose(s) MONITORING BORE

Work Type : Bore
Work Status : (Unknown)
Construct. Method :
Owner Type :

Commenced Date : **Final Depth :**
Completion Date : **Drilled Depth :**

Contractor Name :
Driller :
Assistant Driller's Name :

Property : **Standing Water Level :**
GWMA : **Salinity :**
GW Zone : **Yield :**

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A : GLOUCESTER	TOMAREE	
	Licensed :		

Region : 20 - HUNTER **CMA Map :**
River Basin : **Grid Zone :** **Scale :**
Area / District :

Elevation : 5.94 m (A.H.D.) **Northing :** 6370959 **Latitude (S) :** 32° 47' 28"
Elevation Source : **Easting :** 365222 **Longitude (E) :** 151° 33' 38"

GS Map : **MGA Zone :** 56 **Coordinate Source :**

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details

(No Construction Details Found)

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

(No Water Bearing Zone Details Found)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments

Remarks

Form A Remarks:
RZM MONITORING BORE SK 8368

***** End of GW080034 *****

APPENDIX B

PIEZOMETER CONSTRUCTION LOGS

Aquaterra Consulting Pty Ltd
Logging Sheet

BORES: Site 1

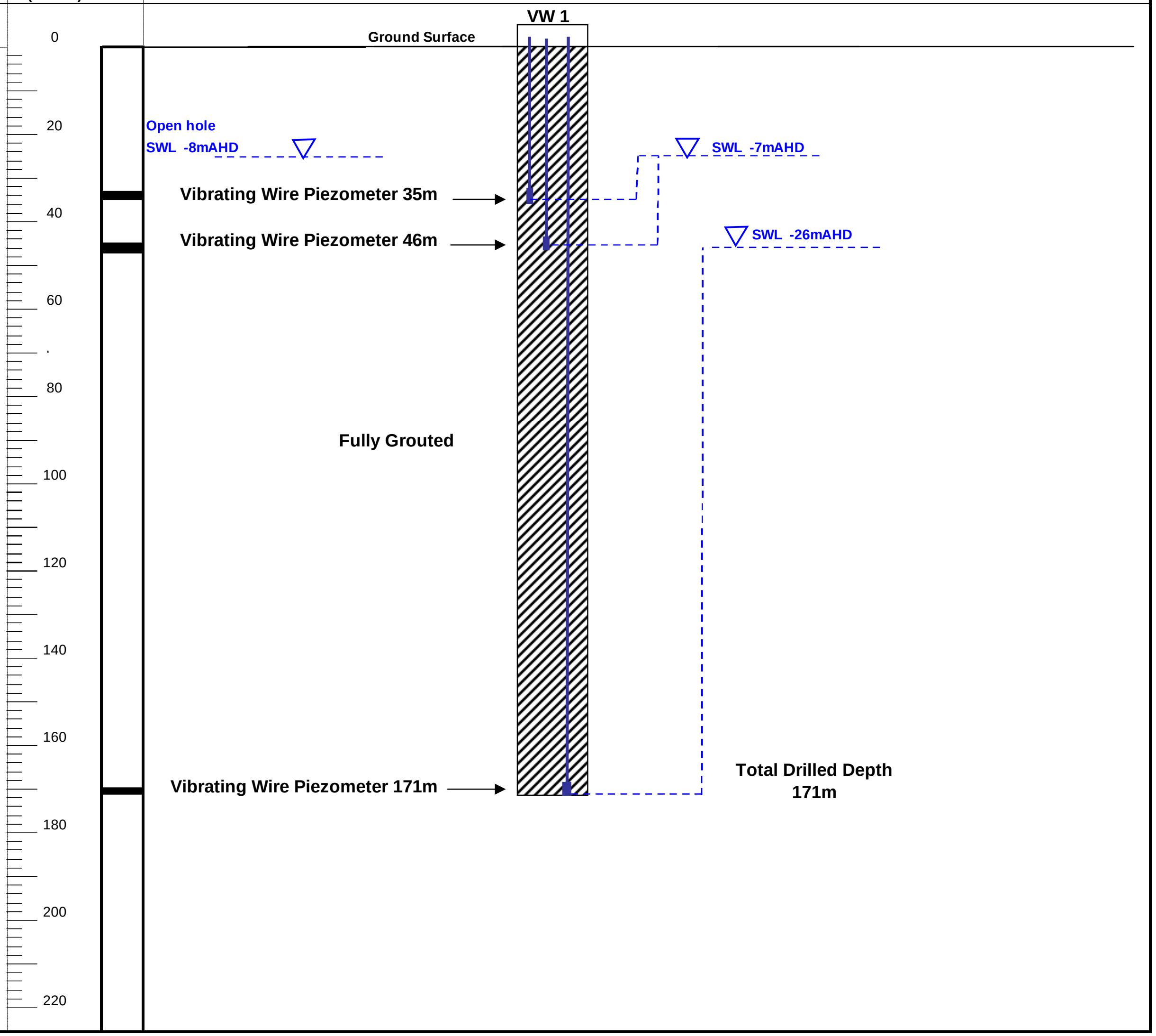
Client:	Bore:	Elevation (GL):	Elevation (TOC):	Stickup:	Drilling Contractor:	Date Started:	Date Finished:
Bloomfield Collieries Pty Ltd	**VW 1**	**17.4 mAHD**			**Hunter Drilling Services**	**27-Mar-07**	**12-Apr-07**

Project No: **S05**

Location:	Hole depths:	Supervised By:
Bloomfield Project	**As shown**	**R McCallum**

Description	Depth (metres)
Donaldson Seam (33.0 to 35.4m)	33.0–35.4
Big Ben Seam (44.3 to 47.2m)	44.3–47.2
Rathluba Seam (170 to 171.8m)	170–171.8

Well Construction Details:



Appendix B-1: Bore Logs - Site 1

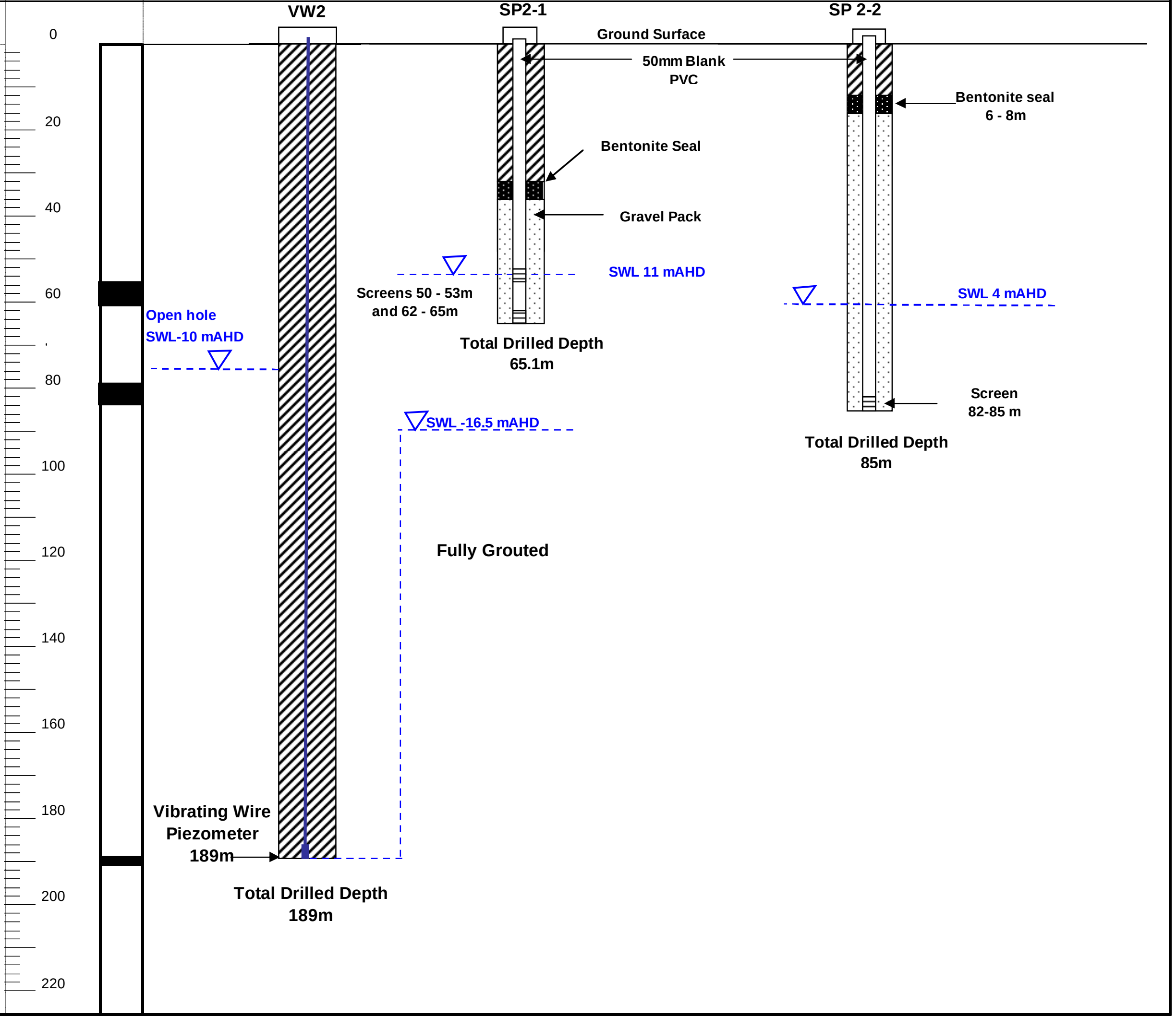
Aquaterra Consulting Pty Ltd
Logging Sheet

BORES: Site 2

Project No:	S05

Client:	Bore:	Elevation (GL):	Elevation (TOC):	Stickup:	Drilling Contractor:	Date Started:	Date Finished:
Bloomfield Collieries Pty Ltd	**VW2**	**65.2 mAHD**			**Hunter Drilling Services**	**20-Mar-07**	**27-Mar-07**
Location:	**SP2-1**	**65.2 mAHD**			**Hunter Drilling Services**	**20-Mar-07**	**27-Mar-07**
Bloomfield Project	**SP2-2**	**65.2 mAHD**			**Hunter Drilling Services**	**20-Mar-07**	**27-Mar-07**
			Hole depths: **As shown**			Supervised By: **R McCallum**	

Description	Depth (metres)	Well Construction Details:
Donaldson Seam (55.2 to 61.4m)		
Big Ben Seam (79 to 84m)		
Rathluba Seam (187.8 to 191.3m)		

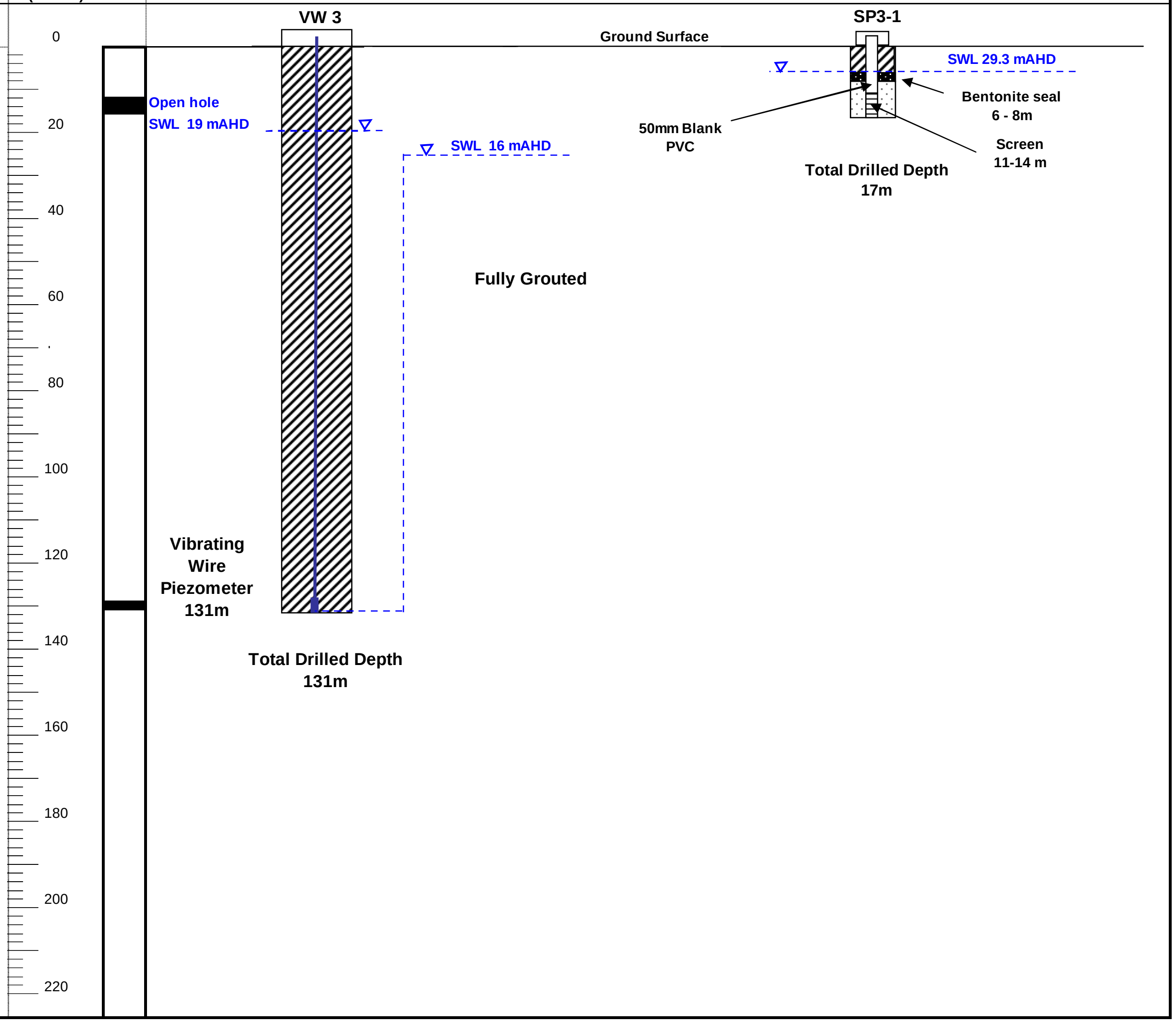


Aquaterra Consulting Pty Ltd
Logging Sheet

BORES: Site 3

						Project No:	**S05**
Client:	Bore:	Elevation (GL):	Elevation (TOC):	Stickup:	Drilling Contractor:	Date Started:	Date Finished:
Bloomfield Collieries Pty Ltd	**VW3**	**38.8 mAHD**			**Hunter Drilling Services**	**11-May-07**	**14-May-07**
Location:	**SP3-1**	**38.8 mAHD**			**Hunter Drilling Services**	**11-May-07**	**14-May-07**
Bloomfield Project							
			Hole depths: **As shown**			Supervised By: **R McCallum**	

Description	Depth (metres)	Well Construction Details:
Donaldson Seam (12 to 15.2m)		
Rathluba Seam (129.7 to 131.5m)		



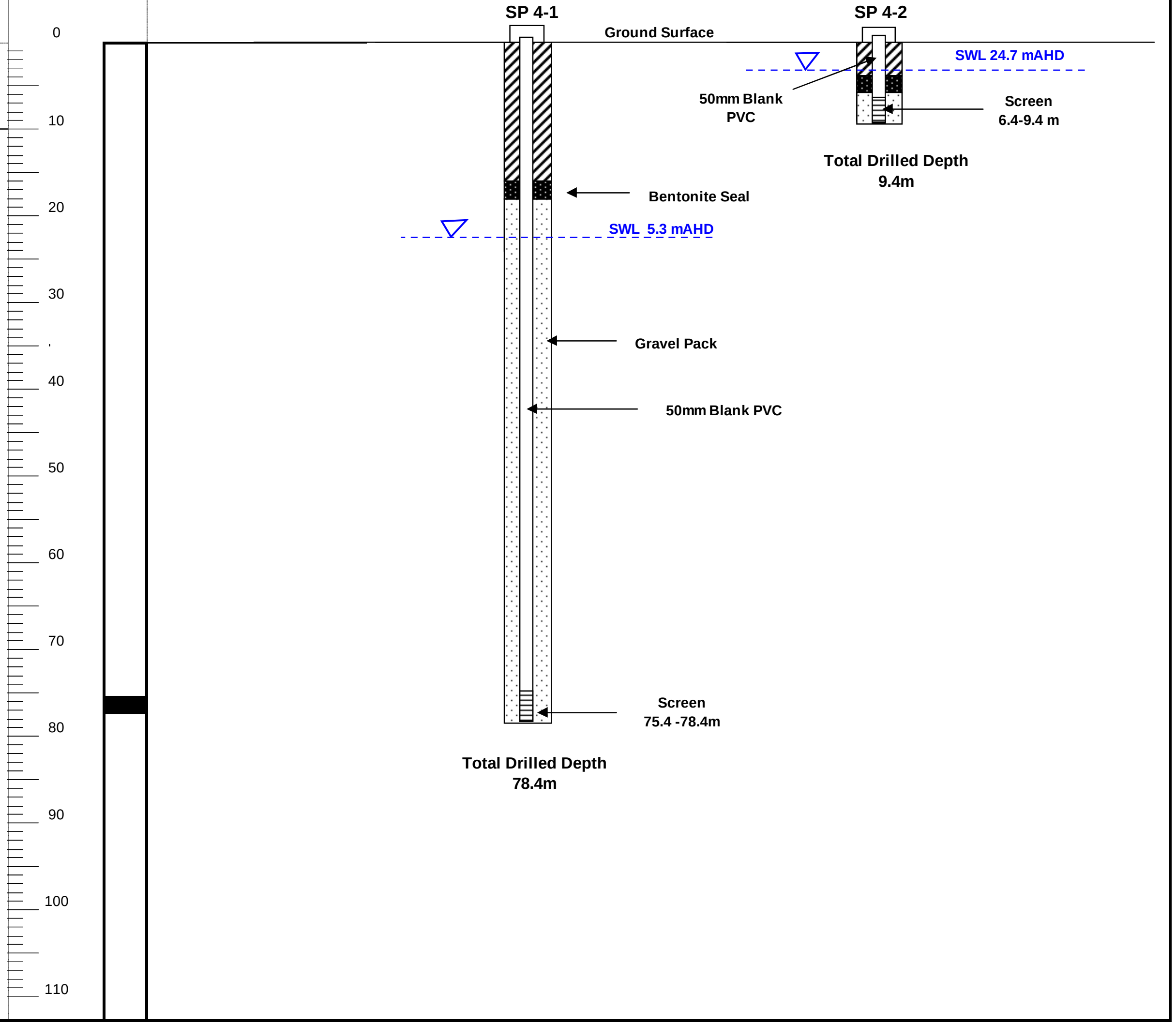
Aquaterra Consulting Pty Ltd
Logging Sheet

BORES: Site 4

Project No:	S05

Client:	Bore:	Elevation (GL):	Elevation (TOC):	Stickup:	Drilling Contractor:	Date Started:	Date Finished:
Bloomfield Collieries Pty Ltd	SP4-1	27.8 mAHD			Hunter Drilling Services	16-Mar-07	17-Mar-07
Location:	SP4-2	27.8 mAHD		0.25 m	Hunter Drilling Services	16-Mar-07	17-Mar-07
Bloomfield Project							
			Hole depths: As shown			Supervised By: R McCallum	

Description	Depth (metres)	Well Construction Details:
Alluvium / weathered Permian	0–10	
Rathluba Seam (75.4 to 77.4m)		

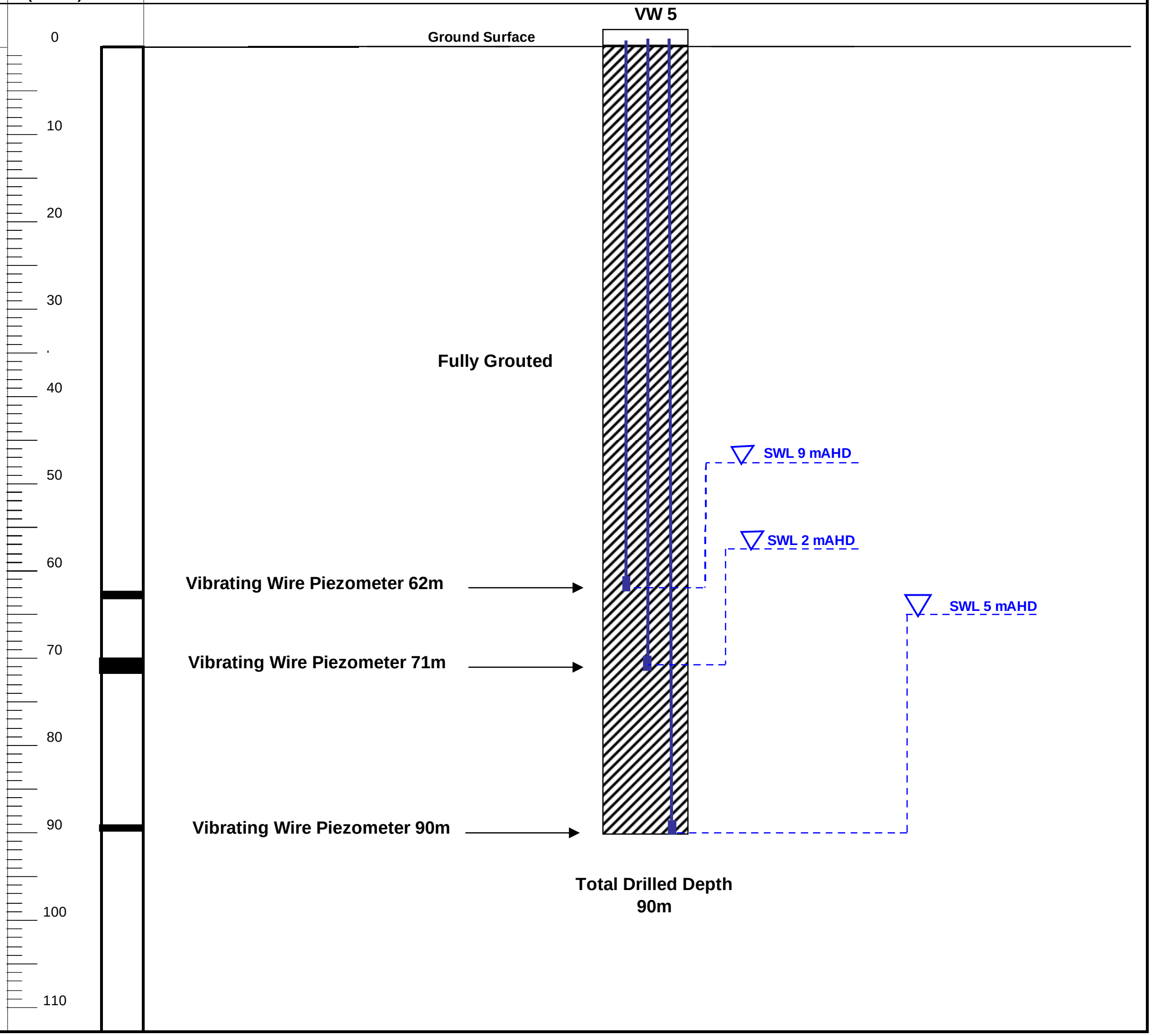


Aquaterra Consulting Pty Ltd
Logging Sheet

BORES: Site 5

						Project No:	S05
Client:	Bore:	Elevation (GL):	Elevation (TOC):	Stickup:	Drilling Contractor:	Date Started:	Date Finished:
Bloomfield Collieries Pty Ltd	**VW5**	**55.7 mAHD**			**Hunter Drilling Services**	**05-Apr-07**	**27-Apr-07**
Location:							
Bloomfield Project			**As shown**			Supervised By: **R McCallum**	

Description	Depth (metres)	Well Construction Details:
White Creek Seam (62.3 to 63.1m)		
Donaldson Seam (70.5 to 71.9m)		
Big Ben Seam (89.3 to 89.7m)		

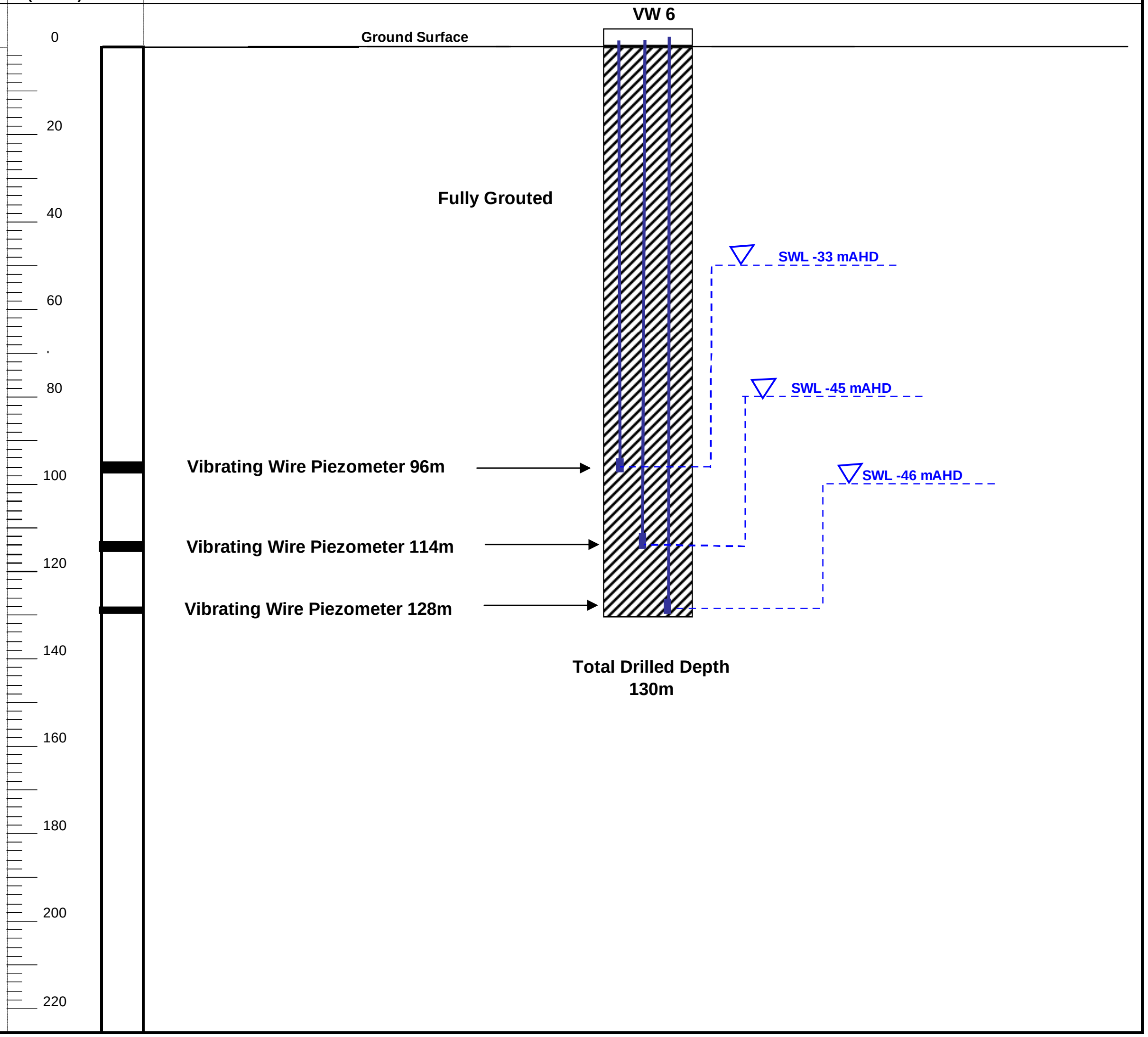


Aquaterra Consulting Pty Ltd
Logging Sheet

BORES: Site 6

						Project No:	S05
Client: Bloomfield Collieries Pty Ltd	Bore: VW6	Elevation (GL): 52.5 mAHD	Elevation (TOC): 52.75 mAHD	Stickup: 0.25 m	Drilling Contractor: Hunter Drilling Services	Date Started: 24-Apr-07	Date Finished: 27-Apr-07
Location: Bloomfield Project			Hole depths: As shown			Supervised By: R McCallum	

Description	Depth (metres)	Well Construction Details:
White Creek Seam (95.1 to 96.7m)		
Donaldson Seam (113.2 to 114.7m)		
Big Ben Seam (128 to 129.3m)		



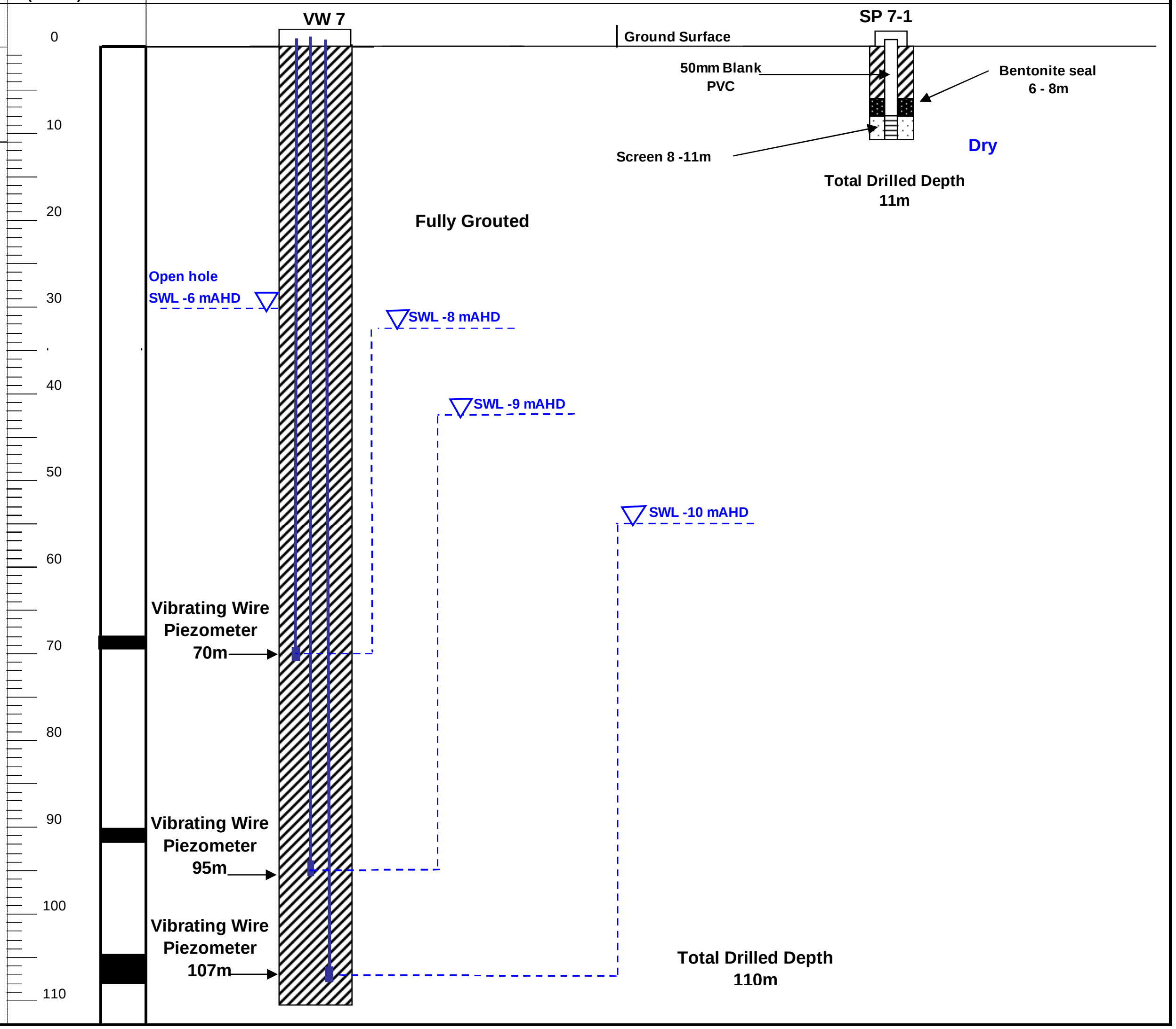
Aquaterra Consulting Pty Ltd
Logging Sheet

BORES: Site 7

Project No:	S05

Client:	Bore:	Depth:	Elevation (GL):	Elevation (TOC):	Stickup:	Drilling Contractor:	Date Started:	Date Finished:
Bloomfield Collieries Pty Ltd	VW7		24.9 mAHD			Hunter Drilling Services	18-Apr-07	24-Apr-07
Location:	SP7-1		24.9 mAHD			Hunter Drilling Services		
Bloomfield Project				As shown			Supervised By: R McCallum	

Description	Depth (metres)	Well Construction Details:
Alluvium / weathered Permian		
White Creek Seam (67.9 to 69.8m)		
Donaldson Seam (90.0 to 91.8m)		
Big Ben Seam (104.7 to 107.7m)		

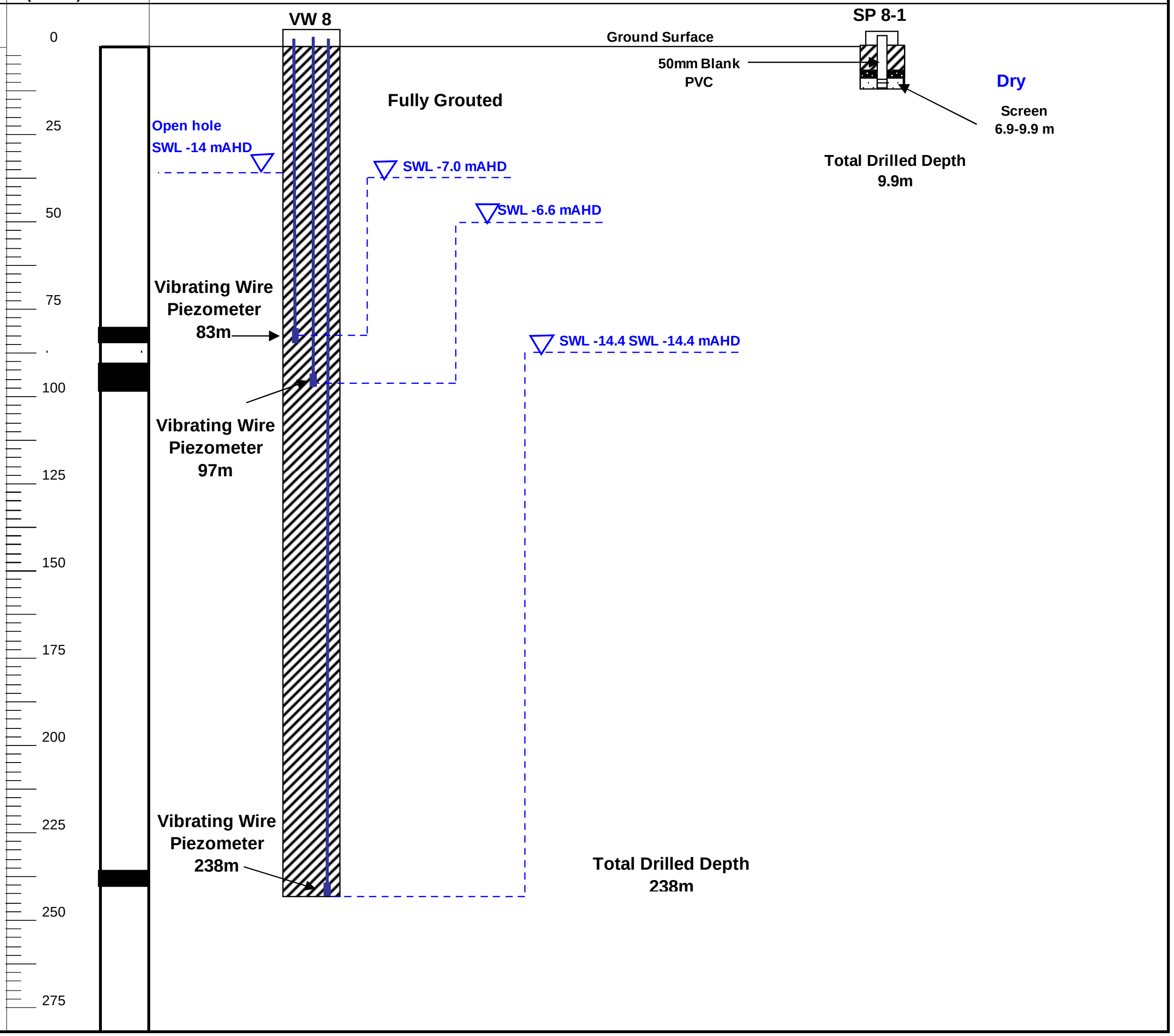


Aquaterra Consulting Pty Ltd
Logging Sheet

BORES: Site 8

							Project No:	**S05**
Client:	Bore:	Depth:	Elevation (GL):	Elevation (TOC):	Stickup:	Drilling Contractor:	Date Started:	Date Finished:
Bloomfield Collieries Pty Ltd	**VW8**		**22.5 mAHD**			**Hunter Drilling Services**	**29-Mar-07**	**18-Apr-07**
Location:	**SP8-1**		**22.5 mAHD**					
Bloomfield Project				**As shown**			Supervised By: **R McCallum**	

Description	Depth (metres)	Well Construction Details:
Alluvium		
Donaldson Seam (80.4 to 84m)		
Big Ben Seam (91.5 to 98.5m)		
Rathluba Seam (237.2 to 240.2m)		



APPENDIX C

GROUNDWATER MODELLING REPORT

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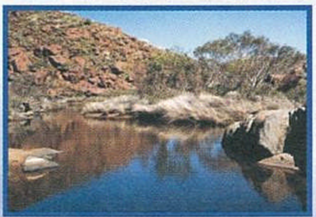
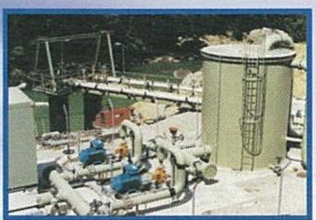
BLOOMFIELD COMPLETION OF MINING & REHABILITATION GROUNDWATER MODELLING





Prepared for: Peter Dundon & Associates Pty Ltd

Ref: A58/B1/R001e

May 2008

BLOOMFIELD COMPLETION OF MINING & REHABILITATION GROUNDWATER MODELLING

Document Status

Revision	Date	Revision Description
A	13 November, 2007	Draft for Client and Reviewer comment
B	3 March, 2008	Updated model scenarios
C	14 April, 2008	Incorporating edits from Peter Dundon
D	2 May 2008	Edits to Table 4.5 and Table 4.6
E	29 May 2008	Final draft minor edits

	Name	Position	Signature	Date
Originators:	Joel Georgiou	Groundwater Modeller	*J. Georgiou*	13 November, 2007
	Dr Mohammed Alkhatib	Groundwater Modeller	*M. Alkhatib*	28 May 2008
Reviewer:	Hugh Middlemis	Principal Water Resources Engineer	*H Middlemis*	28 May 2008

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EXECUTIVE SUMMARY

The Bloomfield Coal Mine Project is located approximately 20 kilometres north-west of Newcastle in the Hunter Valley of NSW. Coal has been mined on the site for approximately 170 years. Underground mining ceased on the site in 1992 and the current operation consists of open cut mining, a Coal Handling and Preparation Plant (CHPP) and a rail loading facility that transports processed coal to the Port of Newcastle. Bloomfield Collieries is seeking approval for the completion and rehabilitation of open cut mining. The continued use of the coal washery and rail loading facility (including the management of water associated with the washery, coarse reject and tailings disposal and coal handling) was approved in June 2007 as part of the Abel Underground Mine project (Donaldson Coal, 2006).

Bloomfield is currently in the final stages of its planned open cut mining program and is actively rehabilitating former mining areas on the site. The current average production rate is 0.8 million tonnes per annum (Mpta) of run of mine (ROM) coal. It is proposed to continue mining at this production rate in order to complete the mining and rehabilitation of the site. There is estimated to be approximately 9 million tonnes of viable run-of-mine (ROM) coal remaining on the site.

The Company engaged Peter Dundon and Associates to undertake a groundwater impact assessment study including water management relating to mine closure and post-mining. Peter Dundon and Associates in turn engaged Aquaterra to develop a numerical groundwater flow model to assist with the prediction of impacts.

This report details development of the Bloomfield Coal groundwater model, the results of the steady-state calibration, sensitivity analysis, predictive scenario modelling and prediction uncertainty assessment for mine dewatering operations and post-mining recovery. The steady-state model includes simulation of the past and present dewatering activities of Bloomfield and Donaldson open cut. Predictive modelling also includes the Abel coal project which is currently under development.

The modelling has been carried out in accordance with best practice guidelines for groundwater flow modelling (MDBC, 2001).

The main features of the Bloomfield groundwater model are:

- An **8-layered model** setup using the **MODFLOW** finite difference numerical code in conjunction with **SURFACT**. The SURFACT module allows both unsaturated and saturated flow conditions to be simulated; in this case, variably saturated flow has been simulated using SURFACT's pseudo soil function. The Groundwater Vistas interface software was employed.
- The **model domain** occupies an area of approximately 14km x 14.5km. The model boundaries to the north and west are set at the outcrop lines of the lowermost coal seam to be mined in the proposal, and have been set as no flow boundaries. In other specific areas, boundaries have been set as head-dependent flow boundaries, notably on the south-east at Hexham Swamp, and on the north-west at Wallis Creek. The southern model boundary is some distance from Bloomfield, and is also set as a head-dependent flow boundary.
- **Stream-aquifer interaction features** are incorporated into the Bloomfield model to represent the dynamic linkages between the surface water and groundwater systems along the major streams (using

MODFLOW's River and Drain packages). The model has been designed to allow for both groundwater discharge to the stream system ("baseflow"), and streambed leakage to the groundwater, for the major creeks and water bodies (Wallis Creek and Hexham Swamp). The Tailings Storage has been treated similarly. However, for the minor streams and tributaries (Buttai Creek, Surveyors Creek, Four Mile Creek, Bluegum Creek, Minmi Creek, Viney Creek, Weakleys Flat Creek and Nile Creek), the model allows for only groundwater discharge to the stream system (ie. utilising MODFLOW's DRAIN package).

- **Rainfall recharge and evapotranspiration processes** are incorporated into the model. Rainfall recharge rates in the model are varied spatially depending on topography and the location of Permian rock exposures. Evaporation processes are active wherever the water table is shallow, which is generally only in areas near the major creeks and their tributaries and also near surface water bodies like Hexham Swamp and the Tailings Storage.
- The **model grid** comprises varying cell sizes, from 25m x 25m in the central region where the Bloomfield open cut mine is located, to a maximum 100m x 100m at the outer limits of the model. This resulted in a grid mesh of 276 rows and 277 columns, with 8 model layers, giving a total of about 612,000 cells.
- The **8 model layers** represent the following designated hydrogeologic units:

  1. Weathered regolith and alluvial deposits.
  2. Represents all Permian strata above the Whites Creek seam. This layer includes the Sandgate, West Borehole and other minor coal seams.
  3. Whites Creek Seam.
  4. Interburden sediments
  5. Donaldson Coal Seam.
  6. Interburden sediments
  7. Big Ben Coal Seam.
  8. Combination of deeper coal seams, interburden and basement.

The modelling program comprised the following:

- **Steady state calibration**: to represent the current distribution of groundwater levels, for use as input to the initial conditions for the prediction scenarios.
- **Prediction modelling**: in which the calibrated model was used to predict the groundwater inflow rates to the proposed open cut mine, changes in groundwater levels, impacts on baseflow contribution to Wallis Creeks, tributaries and other water balance components.
- **Sensitivity analysis**: in which the sensitivity of the model to calibration parameter values was assessed by running the model multiple times with key parameters increased or decreased in turn.
- **Prediction uncertainty analysis**: in which the most sensitive model calibration parameters were applied to the mine dewatering prediction scenarios.
- **Post-mining recovery**: in which the model was run for 100 years after completion of mining.

The model-calculated mine dewatering inflows are very consistent with the current estimated inflows, and are predicted to average about 1400 kL/day over the 11-year mine life. Predicted dewatering impacts on groundwater levels and baseflow contributions are not significant in relation to seasonal variations, nor in terms of practical measurement resolution. The maximum reduction in baseflows is expected to be about 20 kL/d (0.2 L/sec.) in Wallis Creek by the end of Bloomfield open cut mining in year 11.

The post-mining recovery simulation indicates that groundwater levels would have substantially recovered within 20 years after completion of mining, and generally reached a post-mining equilibrium within about 40 years, and in many cases considerably earlier.

The comprehensive sensitivity and predictive uncertainty analysis indicates a small range in uncertainty in terms of the predicted mine inflow rates (generally within 10% to 20% of the adopted base case values) and in terms of the related effects of drawdown and baseflow, indicating that the calibration set of parameters is near optimal and the predictions are robust.

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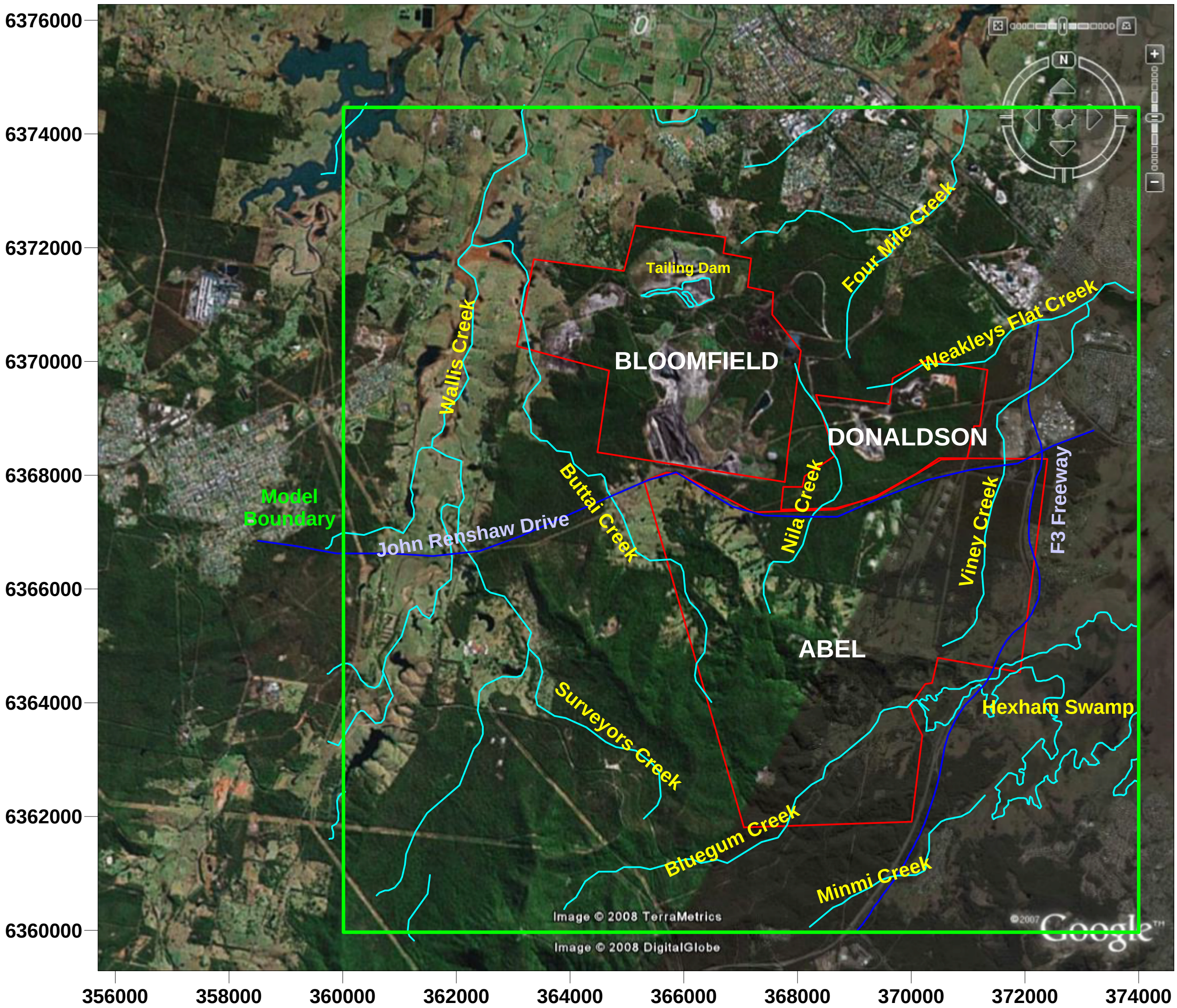
SECTION 1 - INTRODUCTION

The Bloomfield Coal Mine is an existing open cut mining operation located near Buttai in the Hunter Valley of NSW, about 25 km NW of Newcastle, and about 5km south of Maitland. The project site is located few kilometres west of the F3 Freeway and immediately North of John Renshaw Drive (Figure 1.1).

Figure 1.1
Bloomfield Coal Mine Location and Model Extent

(Green line denotes the model boundaries, mine lease areas shown in red)



Bloomfield Collieries Pty Ltd engaged Peter Dundon and Associates to undertake hydrogeological investigations to support the preparation of an EA in support of a Part 3A project application. As part of these investigations, Peter Dundon and Associates has engaged Aquaterra to develop a numerical groundwater flow model and carry out modelling studies. The main objectives of the modelling studies were to:

- investigate the dewatering requirements and potential impacts of Bloomfield open cut mining activities on aquifers, and also surface watercourses in the area, notably Wallis creek and Buttai Creek, and
- estimate potential cumulative impacts due to the influences of the nearby Abel underground mine and Donaldson open cut mine.

SECTION 2 - CONCEPTUAL HYDROGEOLOGY

The conceptual hydrogeological model for the area is based to a large degree on investigations undertaken by Peter Dundon and Associates and is summarised below.

2.1 GEOLOGY

The project area is underlain by Permian Tomago and Newcastle Coal Measures (Figure 2.1). The target seams of the remaining mining at Bloomfield are the Big Ben, Donaldson, Elwells Creek, Whites Creek and Upper and Lower Buttai Coal Seams (Figure 2.2).

Sediments above and below these coal seams comprise predominantly interbedded mudstone, siltstone and sandstone. The strata dip generally towards the south and south-west in the project area, which is situated on the western limb of the Four Mile Creek Anticline (Figure 2.2). To the west of Bloomfield along Wallis Creek, the bedrock is overlain by Quaternary alluvial deposits including gravel, sand, silt and clay. Alluvium also occurs along the floodplain of the Hunter River to the east and north-east. Further detail on geology is provided in Aquaterra (2008).

Surface topography in the Bloomfield project area ranges from less than 20 mAHD to more than 80 mAHD (Appendix A).

2.2 HYDROGEOLOGY

Overall, the coal measures are poorly permeable, but permeability is relatively higher in the coal seams. The interbedded sandstones and siltstones are of lower permeability (by at least one or two orders of magnitude) and offer very limited intergranular porosity and little secondary permeability and storage in joints.

Groundwater also occurs in the alluvium, which comprises mainly swamp, floodplain and estuarine sediments. Groundwater also occurs locally in the shallow weathered Permian, which extends to depths of 10-20 metres, and is more closely related hydrogeologically to the alluvium than to the deeper groundwater in the Permian coal measures. Groundwater levels measured in the alluvium and weathered Permian are quite variable, because the water levels are generally related to the local topographic elevations.

The potentiometric head within the coal seams is regionally-controlled, shows a consistent pattern across the project area (progressive decline with depth), and is generally unrelated to the local topographic elevation, as described in detail in Peter Dundon and Associates (2007). Deep piezometers in low-lying areas can indicate artesian coal seam conditions (piezometric water levels above ground level[1]). At more elevated sites, deeper piezometers show the groundwater levels to be up to 40 m lower than the near-surface groundwater. The large head differences between the shallow groundwater and deeper Permian groundwater levels, and the presence of artesian groundwater in the Permian in low-lying areas, are both indications of limited hydraulic connectivity between the alluvium/weathered overburden and the deeper coal measures.

[1] Water levels above ground surface in deeper piezometers generally occur only in low-lying areas, because the groundwater is confined, and is under pressure. The water level in a bore represents the groundwater pressure or head within the part of the aquifer that is screened, and the head is controlled by the elevation of the recharge zone for that horizon, usually some distance updip where that particular horizon outcrops. In the unconfined alluvium or weathered bedrock aquifers, the water level represents the level of saturation. A bore water level in the unconfined aquifer at the same elevation as the ground surface would be accompanied by seepage or boggy conditions around the bore.

Figure 2.1
Bloomfield Area Generalised Geology
(Model extent shown in blue; Bloomfield, Donaldson and Abel lease outlines shown in red)

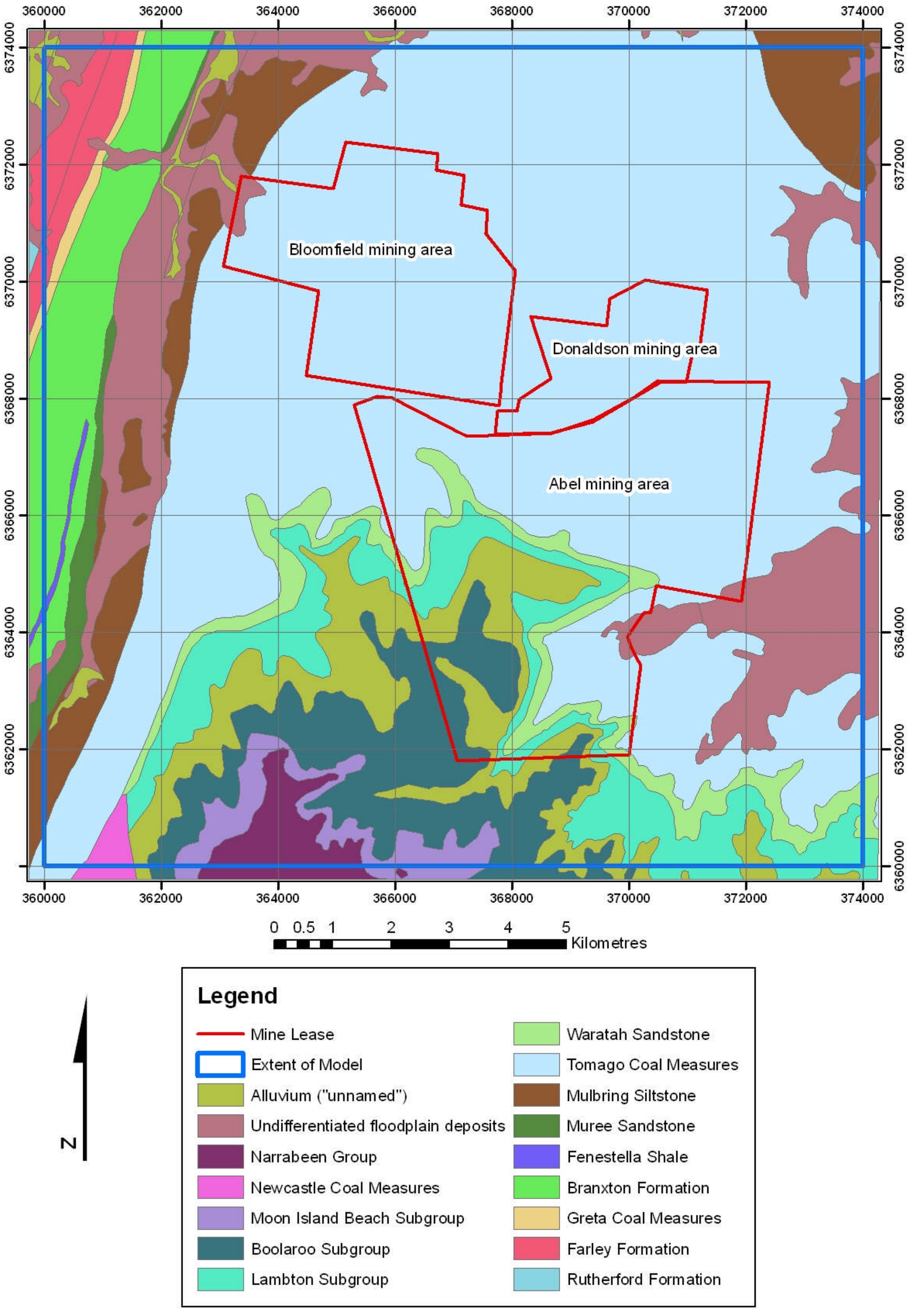
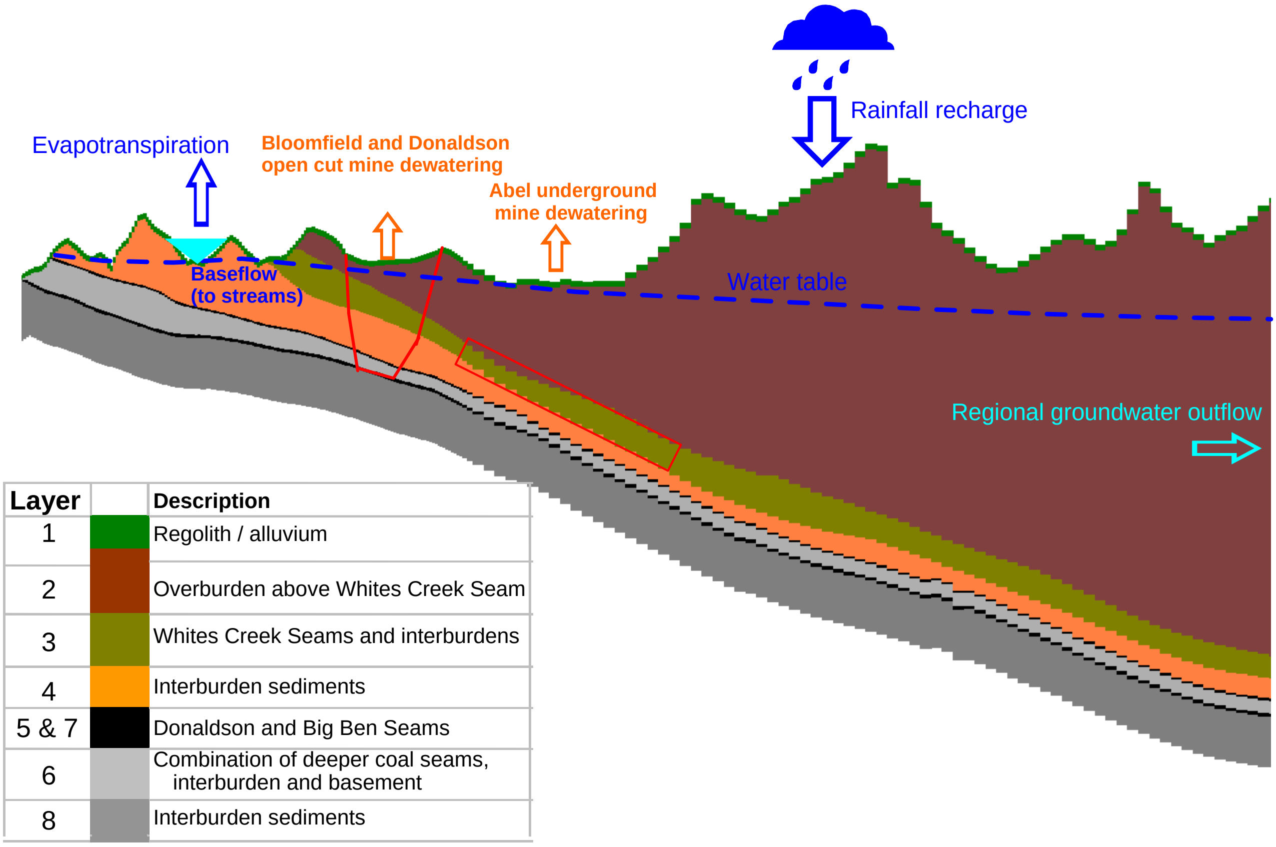


Figure 2.2
Bloomfield Area Regional Cross-Section and Conceptual Model



A summary of representative aquifer properties adopted for the main hydrogeological units in the model area is given in Table 2.1. These are based on hydraulic testing on the Bloomfield site, supplemented by previous investigations for the Abel and Donaldson projects, and experience in other parts of the Hunter Valley coalfields.

Table 2.1
Parameters of hydrogeological units

Units	Horizontal Hydraulic Conductivity (m/d)	Confined Storativity	Unconfined Specific Yield
Coal Seams	0.01 to 0.1	0.0001	0.01
Interburden (undisturbed)	0.001	0.00001	0.005
Interburden (disturbed by subsidence from underground mining)	0.1 to 10	0.0001	0.01 to 0.05
Alluvium	5 to 1 m/d	0.0001	0.1

Note: Vertical hydraulic conductivities in the coal measures are believed to be less than one tenth of the value of the horizontal hydraulic conductivities.

Groundwater within the coal measures is controlled by the recharge-discharge process, with highest groundwater levels in the northern parts of the lease area where the coal measures outcrop. Groundwater levels generally fall to the south and south-east in the direction of groundwater flow downdip to the locations of primary discharge. There is believed to be a component of lateral flow in the Coal Measures out of the model area over the southern and eastern model boundaries. The rate of flow across the model boundaries is believed to be limited due to the substantial burial of the coal seams under extensive cover of overburden material (several hundred metres thick).

Data on water levels are summarised in Section 4. The data indicates the influence of dewatering in the Bloomfield and Donaldson Mine areas, with distinct cones of depression centred on the current active open cuts.

2.3 RECHARGE

Long term records of rainfall data are available for a number of nearby stations, the closest being the East Maitland Bowling Club (32.7483S, 151.5833E; about 5 km NE of the Bloomfield mining area). Table 2.2 lists the mean monthly and annual rainfall, based on more than 90 years of daily rainfall data since 1902.

Table 2.2
Mean monthly rainfall at East Maitland Bowling Club (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Mean (mm)	89.0	94.1	96.5	87.4	70.3	84.2	58.1	52.2	54.8	65.5	61.6	81.3	895.0

Rainfall recharge occurs to both the coal seams where they outcrop, and to the surficial alluvium/weathered Permian aquifer system. The alluvial aquifers are believed to be in hydraulic continuity with Pambalong Nature Reserve and Hexham Swamp in the east, and with Wallis Creek to the west of the Bloomfield mining area. During periods of high stream flow, surface watercourses may also contribute to recharge to these alluvial aquifers. However, stream flows from rainfall runoff are reported to be short-lived after rainfall events. For most of the time, streamflows are maintained by groundwater discharge (baseflow).

The coal seams are recharged in areas of outcrop and shallow subcrop by direct infiltration of rainfall. Where covered by overburden, the coal seams are recharged primarily by lateral flow down-gradient from the outcrop areas, possibly also with a smaller component of downward percolation through the less permeable overburden.

Rainfall recharge rates within the hard rock outcrop area are believed to be relatively low (i.e. below 10 mm/yr). However, where alluvial deposits occur, recharge rates may be as high as 100 mm/yr. Rainfall recharge occurs in practice as an intermittent process, related to specific larger rainfall events. However, for the steady-state (“long term average”) groundwater model, rainfall recharge has been modelled by applying constant assumed effective recharge rates to the alluvium and hard-rock areas, rather than a time-dependent recharge mechanism.

2.4 GROUNDWATER DISCHARGE

In outcrop or shallow subcrop areas, groundwater discharge from the coal measures can occur through evaporation, seepage and spring flow where the water table intersects the land surface, and through baseflow contributions to creeks, rivers and the Hexham Swamp, including discharge to the alluvium where it occurs. Away from outcrop, discharge from the coal measures occurs by slow down-dip flow along bedding or other zones of enhanced permeability to the south and south-east to areas where the groundwater heads are lower, with ultimate discharge probably to the ocean.

Groundwater discharge from the alluvium and shallow weathered bedrock can occur by evapotranspiration, seepage and discharge to creeks or to the wetlands of Pambalong Nature Reserve, Hexham Swamp and Wallis Creek.

Due to the high groundwater salinity and low bore yields, there is almost no existing groundwater abstraction within the model area other than for coal mine dewatering (Donaldson, Bloomfield, etc). A small number of stock/domestic bores are registered in the DWE bore database.

Average A Class pan evaporation data is available for Cessnock (32.8093S 151.3490E) and Paterson (32.63S, 151.59E), and provide the closest data to the Bloomfield mining area. Table 2.3 summarises mean monthly evaporation rates, based on a 34 year period.

Table 2.3
Mean daily evaporation data for Cessnock and Paterson Stations (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cessnock	5.7	5.0	4.0	3.0	2.0	1.6	1.8	2.6	3.6	4.4	5.2	5.9
Paterson	6.0	5.2	4.2	3.4	2.4	2.2	2.5	3.4	4.4	5.2	5.9	7.0

Evaporation is included in the model using the Evapotranspiration (EVT) package of MODFLOW. The EVT parameter values adopted were a constant rate of 250 mm/yr and an extinction depth of 3 m, which allows EVT to be active in areas of shallow water table, such as in areas of low topography along surface water courses such as Wallis Creek and the Hexham Swamp area.

2.5 SURFACE DRAINAGE

The land surface within the Bloomfield mining lease area is located within the lower section of the Hunter River catchment and consists of low undulating hills. There are several surface water catchments in the model area, with associated creeks being generally ephemeral or sustained by small baseflow discharges, with the possible exception of Wallis Creek to the west.

The western part of the Bloomfield mining area lies within the Buttai Creek Catchment, which drains westwards into Wallis Creek and then into Hunter River east of Maitland. Wallis Creek is characterised by alluvial deposits developed along the river bed. Such deposits are also present in the east of the model area, around Hexham Swamp, which is protected from tidal influence by floodgates, and which also receives drainage from the Long Gully/Blue Gum Creek catchment from the southern part of the model area. The numerical model incorporates river/aquifer interactions, to enable quantification of the impacts of groundwater pumping on surface water features. This is important to assess whether mining is likely to lower water levels and reduce baseflow to permanent streams, although it should be noted that the streams in the Bloomfield project area are mainly ephemeral because baseflow support is relatively short, and extensive periods of no flow occur naturally.

SECTION 3 - IMPLEMENTATION OF CONCEPTUALISATION IN MODEL

3.1 MODEL SELECTION AND COMPLEXITY

The MODFLOW numerical groundwater flow modelling package was applied to early development of this medium complexity modelling study, operating under the Processing Modflow Pro software package (IES). However, the Vistas software package (ESI) has also been used during later stages when the Bloomfield model was refined and run under the MODFLOW-SURFACT numerical package for the final series of calibration and prediction model runs.

The MODFLOW-based numerical code is suitable for this study, particularly due to its industry-leading modules for simulating surface water and groundwater interaction.

MODFLOW-SURFACT is a module with which saturated/unsaturated flow conditions can be simulated to overcome problems with unsaturated (dewatered or dry) model cells and enhance the stability of the numerical solution. The variably-saturated flow simulation is implemented with the pseudo soil function of the MODFLOW SURFACT BCF4 package in the Bloomfield model.

The degree of model complexity required to accomplish the study objectives is a key issue (MDBC, 2001). In this case, a **medium complexity model** appropriate for impact assessment purposes was required.

3.2 MODEL EXTENT, LAYERS AND GRID

The Bloomfield model area of about 200 km^2 is shown in Figure 2.1. It includes the Bloomfield, Donaldson and Abel mining areas and extends to Northing 6,374,500, which includes the outcrop line of the Big Ben seam. The southern boundary has been set at Northing 6,360,000.

The eastern model boundary is located within the Hexham Swamp at Easting 374,000, about 2 km east of the F3 Freeway. The western model boundary is located at Easting 360,000 and is represented predominantly by Wallis Creek as discussed further in Section 3.3.

The cell size throughout the model is not uniform; it varies from 25 metres square at the Bloomfield Coal Mine area, and increases gradually up to 100 metres square near the model boundaries. This gives a grid mesh of 276 rows and 277 columns, producing a total of 76,452 cells per layer, or a total number of cells for 8 model layers of 611,616 (with about 94% of model cells active). The fine grid (25 x 25 m) was selected in the mining area to provide the capability for accurate modelling results, and also has the advantage of providing better resolution of the dipping layer geometry, and the areas of potentially steep groundwater gradients close to the open cuts. The Bloomfield model is medium-sized in terms of computing requirements, and involves substantial but not excessively long run times.

Eight model layers are used (Table 3.1), with coal seams and interburden represented independently. Layer 1 is unconfined (Modflow Type 1), while layers 2 to 8 are defined as semi-confined aquifers with variable Transmissivity (Modflow Type 3).

Table 3.1
Summary of Model Layers

Layer	Description	Extent	Assumed thickness (m)
1	Weathered regolith and alluvial deposits.	Extends over the entire model domain	Constant thickness of 5 m, below surface topography from DEM.
2	Represents numerous geological units comprising all overburden above Whites Creek seam (including Sandgate, West Borehole and other coal seams)	Layers 2 to 7 are active over the entire domain of the model. However, as deeper underlying units progress towards outcrop in the north (i.e. up-dip), the parameters of that particular layer change to represent the outcropping units (see Appendix B for detailed figures for Kh & Kv).	Pinches out to the north; greater than 450 m thick down-dip.
3	Whites Creek seam including the narrow interburden		Pinches out to the north; generally between 10m and 20m thick
4	Interburden sediments		Generally around 20 to 30m thick. Reaches thicknesses around 100m in the north-west.
5	Donaldson Coal Seam		Constant thickness of 2 m.
6	Interburden		Around 12 m thick.
7	Big Ben Coal Seam		Constant thickness of 2 m.
8	Combination of deeper coal seams, interburden and basement.	Extends across entire model. Also outcrops in layer 2 to 7 to the north.	Assumed constant 50 m thickness.

A detailed DEM data set for the Bloomfield mine area was combined with the lower accuracy regional DEM data set to create the top surface of Layer 1. Layer 3 geometry was based on xyz data supplied by Bloomfield Collieries and more regional data obtained from Donaldson Coal. The layer 2 thickness is thus defined as the difference between the base of layer 1 (5m below topography) and the top of the Whites Creek seam, with refinements as discussed below.

The base elevations of Layer 5 (Donaldson seam) and Layer 7 (Big Ben seam) were supplied by Bloomfield Collieries in xyz format. The data extent was confined to Bloomfield's mine lease area. The elevations of Bloomfield's coal seams (Layers 5 and 7) were extended regionally by using the base elevation of Layer 3 (Whites Creek seam). The regional base elevations of Layers 5 and 7 were set below the base of Layer 3 by 20 m and 35 m respectively. The layer thicknesses of Bloomfield's coal seams (Layers 5 and 7) have been based on bore logs provided by Bloomfield Collieries. Detailed data on layer elevation surfaces are presented in Appendix A.

3.3 MODEL BOUNDARY CONDITIONS

3.3.1 General Head Boundaries

Head-dependent flow boundaries (or Modflow GHB cells) have been used in all layers to represent external regional flows into and out of the model domain via the coal seams and interburden. Figures in Appendix B show the boundary conditions used in each model layer along with their specified head (H), and conductance (C). Generally, the GHB heads range from 38.9 mAHD at the south-west corner of the model domain, reducing linearly to 15.0 mAHD in the south-east corner. The GHB heads range from 15 mAHD in the south-east corner, reducing linearly to 1 mAHD in the north-eastern corner of the model domain. The GHB conditions for Layers 2 to 7 are similar to Layer 1. However, to achieve calibration of the model, the Layer 8 GHB heads values needed to be set slightly higher, with heads ranging between 15 and 20 mAHD. A conductance value (C) of 1000 has been assumed for all GHB cells.

3.3.2 River Boundaries

Major surface water features are represented in the Bloomfield model using Modflow's River (RIV) package.

Wallis Creek lies on much of the western model boundary, and is represented using Modflow River cells to allow for stream-aquifer interaction due to either leakage from the creek and/or baseflow from the alluvial aquifer (refer to Appendix B). A stage height of 0.5 m and a conductance (C) of 50 d^{-1} has been implemented conservatively to represent a relatively active stream system. The water level (H) of Wallis Creek has been set to 3 m below topography due to a lack of specific surface water monitoring points, which is consistent with approaches applied to a stream-aquifer interaction study by the NSW Department of Infrastructure, Planning and Natural Resources (Braaten and Gates, 2003).

The Hexham Swamp area forms part of the eastern model boundary and has been represented using Modflow's River cells (refer to Appendix B). The use of River cells allows water to flow into or leak out of the swamp according to the difference in heads between the aquifer and specified river cells that represent the swamp. The water level of the swamp (H) has been set at the topography, with a stage depth of 0.5m above that. A conductance value (C) of 25 d^{-1} has been adopted.

Bloomfield's tailings storage has been modelled using River cells in Layer 6 (refer to Appendix B). A water level of 20.5 mAHD has been adopted based on potentiometric level contours completed by Peter Dundon and Associates. A stage height of 0.5 m and a conductance (C) of 50 has been assumed.

3.3.3 Drain Boundaries

Modflow Drain cells have been used in the Bloomfield model to represent the process of groundwater discharge (baseflow) to minor streams, and also to represent mine dewatering drainage. The representation of mining operations is discussed further in Section 3.4.

Smaller creeks and minor streams in the model domain area are generally ephemeral, where significant flow occurs only for short periods after major rainfall events, and results in minor baseflow durations/volumes. The creeks represented with Drain cells in the Bloomfield model include Buttai Creek, Surveyors Creek, Bluegum Creek, Minmi Creek, and Four Mile Creek. Drain elevations have been set to topography with a conductance value of 50 d^{-1}.

3.3.4 Evapotranspiration

Evaporation is included in the model using the Evapotranspiration (EVT) package of MODFLOW. The EVT parameter values adopted were a constant maximum rate of 250 mm/yr with an extinction depth of 3 metres below the specified topographic surface. This effectively results in EVT being active in the model in areas of shallow water table and in areas of low topography along surface watercourses such as Wallis Creek and the Hexham Swamp area.

3.3.5 Recharge

The coal seams are recharged in areas of outcrop and shallow subcrop by direct infiltration of rainfall. Where covered by overburden, the coal seams are recharged primarily by lateral flow down-gradient from the outcrop areas, possibly also with a smaller component of downward percolation through the less permeable overlying overburden sediments.

Rainfall recharge rates within the hard rock outcrop area are believed to be relatively low (i.e. below 10 mm/yr). However, where alluvial deposits occur, recharge rates may be as high as 100 mm/yr. Rainfall recharge occurs in practice as an intermittent process, related to specific larger rainfall events. However, for the steady-state ("long term average") groundwater model, rainfall recharge has been modelled by applying constant assumed effective recharge rates, rather than a time-dependent recharge mechanism.

The recharge zones were set to the highest active layer in the Bloomfield model. Figures in Appendix B show three recharge distribution rates where applied to the highest active model cell. 100 mm/yr is applied to the high permeability alluvium areas, 0 mm/yr to the northern area of low permeability hard rock outcrop, and 15 mm/yr everywhere else.

3.4 SIMULATION OF MINING OPERATIONS

The dewatering operations for the Bloomfield open cut, Donaldson open cut and Abel underground mine are modelled by progressive assignment of Modflow drain cells to active mining areas in accordance with the respective project mine plans.

The open cut mining has been represented in the Bloomfield model using Drain cells within the mined coal seams (layers 1 to 8) and assuming a relatively high conductance (C) value of 1000 d^{-1} to ensure water levels are drawn down to the specified drain levels. The modelled drain elevations for the Bloomfield open cut mining from Year 1 to Year 11 were specified at the pit floor levels that were provided by the client.

The modelled drain elevations for the Donaldson future mine plan (Year 1 to Year 4) and the Abel underground mine (Year 2 to Year 21) were specified at levels consistent with the base of the relevant layers in those areas.

The Bloomfield mine drainage cells have been assigned progressively to active mining areas in accordance with the mine plans, through a series of 11 sequential transient model runs, each representing 1 year of the 11 year mine life for Bloomfield. This period also covers the remaining 4-year mine life for Donaldson (2007-2010). The mined out drain cells were then progressively re-set to normal Modflow aquifer cells in Donaldson and Bloomfield as waste rock was placed into the pit, in accordance with the waste backfilling plan. The model was extended another 10 years to cover completion of underground mining at Abel.

During the mining and post-mining recovery model runs, aquifer properties are changed to reflect the slightly increased permeability of backfill and also to represent any residual pit voids that may be left, which are expected to form pit void lakes.

A series of sensitivity runs has been undertaken to assess the impact of uncertainties in input parameters, and to provide an indication of the upper limit of dewatering volumes and drawdown and river baseflow impacts. This was followed by a post-mining recovery model run, to assess the rate of recovery of groundwater levels.

The pit inflow can be calculated by two methods - cumulative flux and weighted average:

- The **cumulative flux** was calculated by dividing the cumulative volume reported for each stress period by the stress period time.

- The **weighted average** was calculated by multiplying the model-calculated inflow rate at the end of a time step by the duration of the time step, summing the average volume and dividing by the stress period time (ie. this is essentially a step-wise integration of the area under the inflow curve).

The advantage of the weighted average method is that the dewatering inflow can be computed for each layer, whereas the cumulative flux method quantifies the lumped flux for all layers in the model. For the weighted average method, the drain cells that represent the pit in each layer have a specified reach number within the Groundwater Vistas software, and the flux for each specific reach (layer) is extracted from the mass balance hydrograph (this feature is not available for the cumulative flux).

In this model, the pit inflow in the Bloomfield mine was calculated using the weighted average method. Therefore, the head and the flux are saved every 20 time steps for each stress period. It was not practicable to save the head and flux every time step, because of file size constraints (even with every 20 time steps, the file size is about 250MB). As the model has 200 time steps per stress period, saving every 20 steps gives 10 values of head and flux output for each stress period, but at variable times due to the variable time step size. For example, with a time step multiplier 1.07, the time step durations at time steps 10, 50, 100 and 200 are 6.243E-05 days, 9.348E-04 days, 2.754E-2 days and 23.89 days, respectively.

Hence, the weighted average pit inflow was calculated as:

$$\tilde{X} = \frac{\sum_{i=1}^{n} W_i X_i}{\sum_{i=1}^{n} W_i}$$ Where:

$\tilde{X}$: is the weighted average pit inflow (m^3/d)

W_i : is the corresponding time step size (weight) for each pit inflow

X_i : is the pit inflow at the end of each time step at which head and flux are saved (m^3/d)

n: is the total number of readings (10, in this case).

SECTION 4 - BLOOMFIELD MODEL CALIBRATION AND SENSITIVITY ANALYSIS

4.1 STEADY STATE CALIBRATION

The groundwater model was developed initially in steady state (“long term average”) mode. True steady state model calibration to pre-mining conditions is not possible, as Bloomfield has been mining for 170 years, and there are no hydrological records available for this period. Short term transient water level records are available for the Donaldson bores since mining began in about 2001, but such data are not available for the Bloomfield site. Therefore, transient model calibration was not run at this stage of the Bloomfield model development, but a steady state run was used to represent the effects of ongoing mining developments to date as the initial conditions for the predictive simulations.

Steady state calibration has been based on the available water level data which includes the cumulative impacts of mining at the Bloomfield and Donaldson mines. The steady state calibration was achieved with sequential model runs by manually adjusting the horizontal and vertical hydraulic conductivities until the best fit was obtained between the observed and simulated water level.

In addition to the Bloomfield monitoring bores, there are several observation boreholes available from the Donaldson and Abel Mine areas that fall within the Bloomfield groundwater model area, and cover several different model layers. As the model includes the current state of the Bloomfield and Donaldson mining operations, calibration was based on the current water levels, i.e. mining water levels. In total, the model is calibrated using 43 piezometer points where 19 head targets are located in Donaldson Mine area (Group 1), 8 head targets in Abel Mine area (Group 2) and 19 head targets in Bloomfield Mine area (Group 3).

Very good model calibration performance has been demonstrated in quantitative and qualitative terms consistent with best practice guidelines (MDBC, 2001), by:

- scatter plots of modelled versus measured head, which show a good agreement between the observed and computed target values across all model layers (Table 4.1 and Figure 4.1);
- a statistics summary for the observed and modelled head targets through the model layers (Table 4.2)
- a very small water balance residual (Table 4.3); and
- contour plans of modelled heads for each layer consistent with observed values (Appendix B).

The scaled RMS value is the RMS value divided by the range of heads across the site, and forms the main quantitative performance indicator, consistent with best practice guidelines. This approach is consistent with the Australian best practice groundwater modelling guideline (MDBC, 2001). Table 4.1 and Figure 4.1 show these performance indicators, with a scaled root mean square (RMS) value of 8.94% (within the target range of 5-10%);.

The overall groundwater balance for the steady state Bloomfield model is summarised in Table 4.3. The total inflow is about 20 ML/d comprising rainfall recharge (52%) plus leakage from the rivers and streams (Hexham swamp, Wallis creek and Tailing Storage) into the aquifer (7%) and the boundary inflow (41%). This amount represents the total inflow into the aquifer system. The total outflow of the aquifer system (20 ML/d) includes evapotranspiration (37%) plus discharge from the groundwater into the river (baseflow of 10%) plus dewatering rate from Donaldson open cut mine (2%) and Bloomfield open cut mine (8%) and the boundary outflow (43%). The discrepancy between the total inflow and outflow for the steady state simulation period was only -0.01%.

Having achieved acceptable calibration of the model, the model was applied to predictive transient modelling (Section 6) to assess the impact of progressive mining operations on the water balance in the model area. Particular interest was placed on the regional change in groundwater levels during mining and after mine closure, on changes in flows to surface water courses, including Wallis Creek, Four Mile Creek and their tributary streams, and on the predictive mine water volumes.

Table 4.1
Steady state calibration performance in the Bloomfield model

Calibration Parameters		Value	Value Units
Count	n	43	-
Sum of Residuals	R	25.71	m
Sum of Absolute Residuals	SR	240.01	m
Scaled Mean Sum of Residuals	SMSR	0.72	%
Root Mean Square	RMS	7.38	m
Scaled RMS	SRMS	8.94	%
Root Mean Fraction Square	RMFS	131.32	%
Scaled RMFS	SRMFS	17.33	%
Coefficient of Determination	CD	1.00	-

Figure 4.1
Scatter Plot for Bloomfield Steady-State Calibration

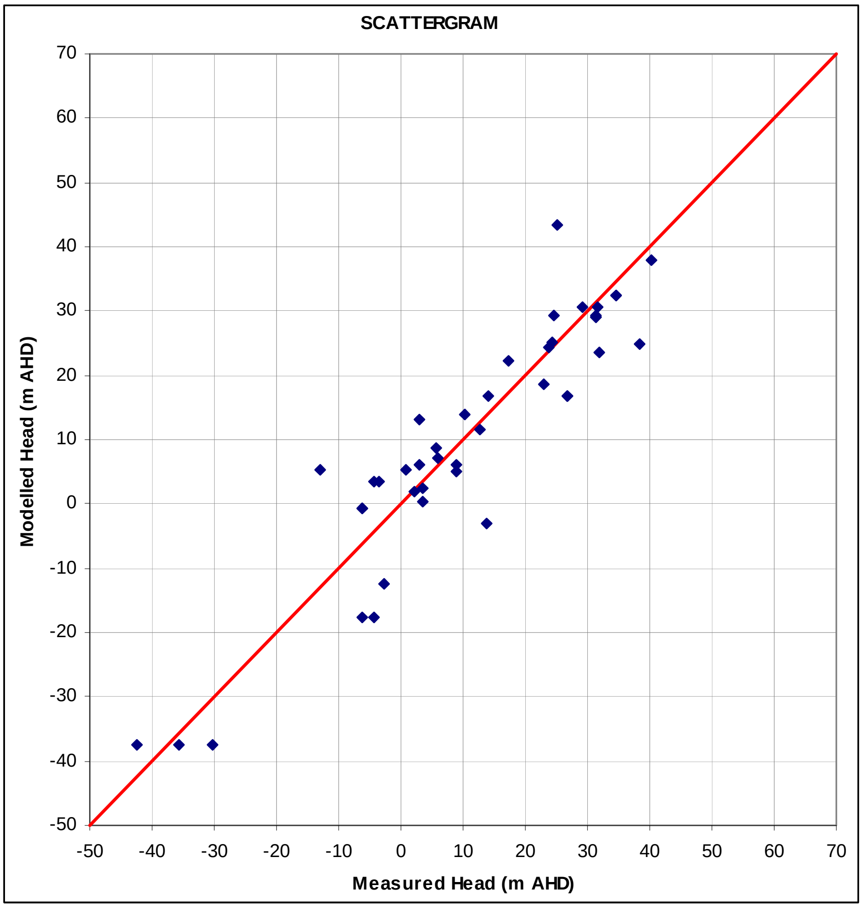


Table 4.2
Steady State calibration data set for Bloomfield Model

Bore Name	Easting (MGA)	Northing (MGA)	Observed Head (mAHD)	Simulated Head (mAHD)	Head Difference (m)	Group*	Layer
VW1-35m (Don)	363632	6370167	-6.2	-0.76	-5.44	3	5
VW1-46m (BB)	363632	6370167	-6.2	-0.76	-5.44	3	7
SP2-1 (Don)	365112	6371264	10.4	13.91	-3.51	3	5
SP2-2 (BB)	365112	6371264	3.1	13.08	-9.98	3	7
SP3-1 (Don)	366732	6371893	32	23.58	8.42	3	5
SP4-2 (All)	367612	6370989	24.4	25.03	-0.63	3	1
VW5-62m (WC)	366700	6368083	8.8	6.16	2.64	3	4
VW5-71m (Don)	366700	6368083	3	6.07	-3.07	3	5
VW5-90m (BB)	366700	6368083	0.9	5.23	-4.33	3	7
VW6-96m (WC)	365337	6368293	-30.3	-37.42	7.12	3	4
VW6-114m (Don)	365337	6368293	-35.6	-37.41	1.81	3	5
VW6-128m (BB)	365337	6368293	-42.3	-37.38	-4.92	3	7
SP7-1 (All)	364619	6368701	13.8	-2.98	16.78	3	1
VW7-70m (WC)	364619	6368701	-2.8	-12.34	9.54	3	4
VW7-95m (Don)	364619	6368701	-4.4	-17.72	13.32	3	5
VW7-107m (BB)	364619	6368701	-6.2	-17.74	11.54	3	7
SP8-1 (All)	363072	6369003	12.6	11.62	0.98	3	1
VW8-83m (Don)	363072	6369003	-4.2	3.54	-7.74	3	5
VW8-97m (BB)	363072	6369003	-3.4	3.53	-6.93	3	7
DPZ3	368774	6368610	38.44	24.91	13.53	1	7
DPZ5	371282.9	6368855	5.78	8.59	-2.81	1	2
DPZ6	368613.7	6367357	34.61	32.51	2.10	1	2
DPZ6	368613.7	6367357	34.61	32.31	2.30	1	3
DPZ7@50	368808	6367648	31.46	29.19	2.27	1	3
DPZ7@50	368808	6367648	31.46	29.14	2.32	1	4
DPZ7@50	368808	6367648	31.46	29.11	2.35	1	5
DPZ8	369332	6368059	26.72	16.80	9.92	1	3
DPZ8	369332	6368059	26.72	16.8	9.92	1	4
DPZ9	369802.9	6368000	3.46	0.47	2.99	1	3
DPZ9	369802.9	6368000	3.46	2.43	1.03	1	4
DPZ10	370918.5	6368535	5.98	7.08	-1.10	1	2
DPZ12	369114.4	6366414	40.24	37.80	2.44	1	2
DPZ13	371222.8	6367537	14.08	16.88	-2.80	1	2
DPZ20A	370540	6368439	-13.1	5.24	-18.34	1	4
DPZ20B	370540	6368439	8.9	4.91	3.99	1	2
CO72VW	369927	6362562	17.31	22.21	-4.90	2	3
CO78A	367140	6367054	29.12	30.61	-1.49	2	3
CO80	368040	6365176	25.18	43.51	-18.33	2	3
CO81A	369992	6364001	22.99	18.65	4.34	2	3
CO81B	369992	6364001	2.24	1.85	0.39	2	1
CO82	370319.4	6364647	23.71	24.44	-0.73	2	2
C062B	370143	6366248	31.5	30.68	0.82	2	2
C062A	370143	6366248	24.6	29.28	-4.68	2	3
Average			**10.89**	**10.29**			
Minimum			**-42.3**	**-37.42**			
Maximum			**40.24**	**43.51**			
Range			**82.54**	**80.93**			

***Note:** Group 3 represents Bloomfield bores, Group 2 Abel bores and Group 1 Donaldson bores.

Table 4.3
Groundwater budget for Bloomfield model Steady State calibration

Component	Groundwater Inflow (ML/d)	Groundwater Outflow (ML/d)
Recharge	10.41	0
Evapotranspiration (EVT)	0	7.47
River- Hexham Swamp	1.31	0.93
River- Wallis Creek	0.08	1.00
Tailings Storage	0.03	0.00
Drains- ephemeral creeks and streams	0	0.02
Drains- Donaldson Mine	0	0.39
Drains- Bloomfield Mine	0	1.69
Head-dependent flow (GHB)	8.12	8.46
Wells	0	0
TOTAL	**19.95**	**19.96**
Discrepancy (%)	**-0.01**	

4.2 STEADY STATE BASEFLOW

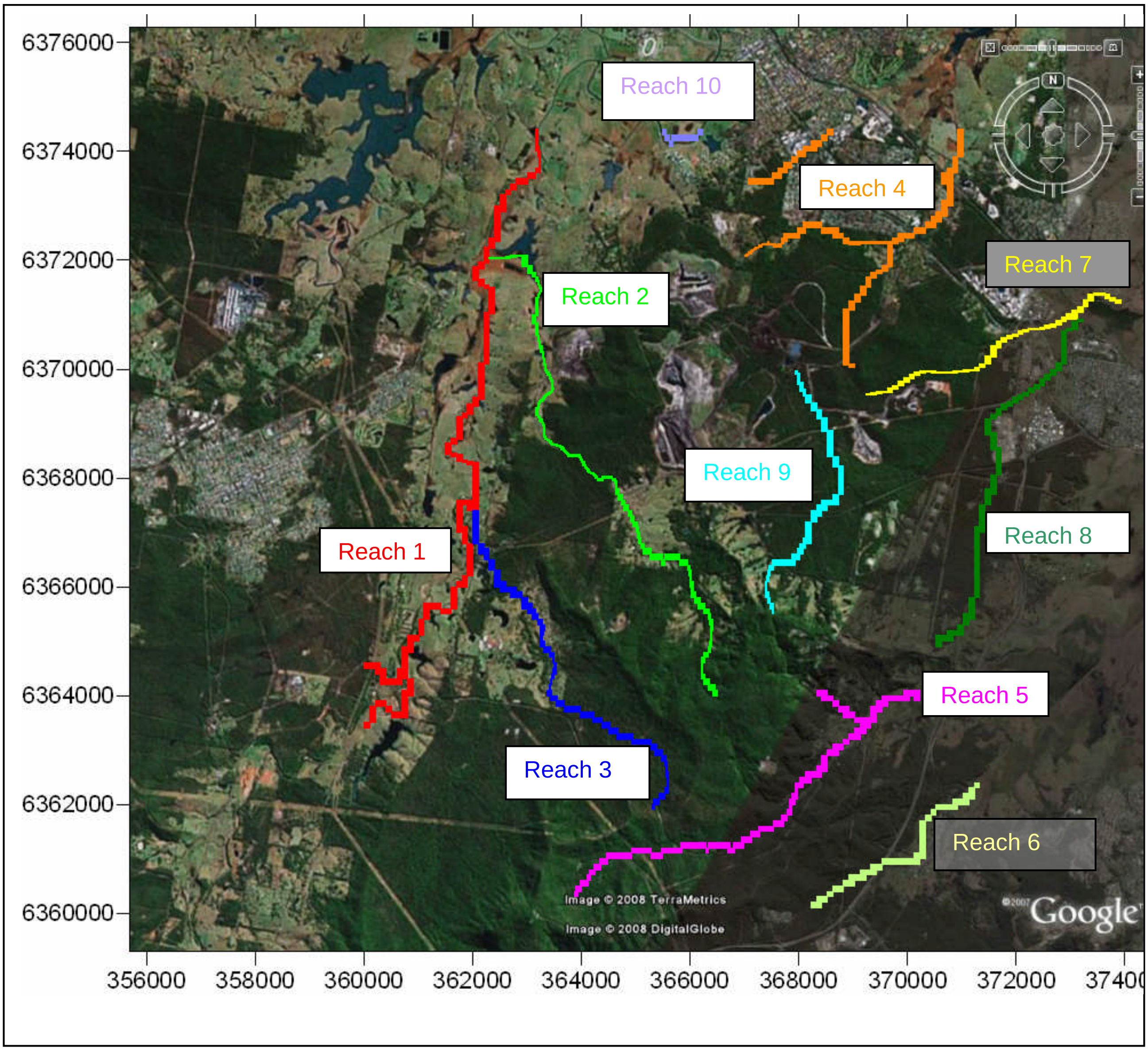
The rivers, streams and surface drainage area described in Section 2.5 were divided into nine reaches in the Bloomfield groundwater model to evaluate the groundwater discharge (baseflow) contributions.

Figure 4.2 depicts the location of these reaches and Table 4.4 describes their location in the model area and the computed baseflow values during the steady state calibration.

Table 4.4
Calculated baseflow for Bloomfield Steady State calibration model

Reach No.	Location	Layer	Baseflow (m^3/d)
1	Wallis Creek	1	923.38
2	Buttai Creek	1	14.51
3	Surveyors Creek	1	0
4	Four Mile Creek	1	0
5	Bluegum Creek	1	1.95
6	Minmi Creek	1	0
7	Weakleys Flat Creek	1	0
8	Viney Creek	1	0
9	Nila Creek	1	0

Figure 4.2
Reach Locations Map



4.3 SENSITIVITY ANALYSIS

4.3.1 Approach

Sensitivity analysis was carried out to assess the sensitivity of the model calibration to the assumed input parameters or boundary conditions, by quantifying the changes to the model response. The sensitivity analysis is carried out by decreasing and increasing each input parameter or boundary condition, and evaluating the impacts of the changes on the calibration statistics. Any parameter that results in a change to the scaled RMS statistics by a significant amount can identify a sensitive parameter in the model. The base SRMS value for these runs is 8.94%.

Table 4.5 summarises the parameters and the spatial zones that were tested during the sensitivity analysis. All hydraulic conductivity zones in the model were tested by applying multipliers to the horizontal hydraulic conductivity (Kh) of 0.5 (decrease) and 2 (increase) to the calibrated model values, whereas the vertical hydraulic conductivity (Kv) was changed by multipliers of 0.1 and 10 because models are usually not sensitive to small changes in Kv. The calibrated model aquifer hydraulic parameter values and zones are shown in Appendix C.

Two recharge zones representing the lowest and highest recharge areas were also examined in this process by changing their values by multipliers of 0.5 and 2.

River bed conductance and drain conductance for tributary streams for all reaches in the model were multiplied by 0.1 and 10. In this case, the sensitivity was evaluated in relation to aquifer head via the standard SRMS statistic, and also to predicted river baseflow.

Table 4.5
Parameters, zones and the multipliers tested in the sensitivity analysis process

Parameter	Zone	Calibrated Value	Layer	Model	Multiplier
Horizontal Hydraulic Conductivity	17	0.1 m/d	1	Steady-state	0.5, 2
	18	1 m/d	1, 2, 3, 5	Steady-state	0.5, 2
	21	1 m/d	1	Steady-state	0.5, 2
	4	0.002 m/d	2	Steady-state	0.5, 2
	6	0.002 m/d	2	Steady-state	0.5, 2
	7	0.002 m/d	4	Steady-state	0.5, 2
	12	0.002 m/d	6	Steady-state	0.5, 2
	14	0.05 m/d	5	Steady-state	0.5, 2
	15	0.1 m/d	3	Steady-state	0.5, 2
	16	0.05 m/d	8	Steady-state	0.5, 2
	20	0.08 m/d	7	Steady-state	0.5, 2
	1	0.5 m/d	4, 5, 6, 7	Steady-state	0.5, 2
	11	0.01 m/d	4	Steady-state	0.5, 2
	2	0.5 m/d	5, 6, 7	Steady-state	0.5, 2
	19	1 m/d	6	Steady-state	0.5, 2
	22	1 m/d	7	Steady-state	0.5, 2
Vertical Hydraulic Conductivity	17	0.01 m/d	1	Steady-state	0.1, 10
	18	0.1 m/d	1, 2, 3, 5	Steady-state	0.1, 10
	21	0.1 m/d	1	Steady-state	0.1, 10
	4	0.001 m/d	2	Steady-state	0.1, 10
	6	0.001 m/d	2	Steady-state	0.1, 10
	7	0.001 m/d	4	Steady-state	0.1, 10
	12	0.001 m/d	6	Steady-state	0.1, 10
	14	0.005 m/d	5	Steady-state	0.1, 10
	15	0.01 m/d	3	Steady-state	0.1, 10
	16	0.005 m/d	8	Steady-state	0.1, 10
	20	0.008 m/d	7	Steady-state	0.1, 10
	1	0.05 m/d	4, 5, 6, 7	Steady-state	0.1, 10
	11	0.001	4	Steady-state	0.1, 10
	2	0.05	5, 6, 7	Steady-state	0.1, 10
	19	0.1	6	Steady-state	0.1, 10
	22	0.1	7	Steady-state	0.1, 10
Recharge	1	2%	Applied to the Highest Active Layer	Steady-state	0.5, 2
	2	2.67%	Applied to the Highest Active Layer	Steady-state	0.5, 2
River Bed Conductance	**All River Reaches in the Model**			Steady-state	0.1, 10
Drain Conductance	**All Drain Reaches in the Model**			Steady-state	0.1, 10

4.3.2 Horizontal and Vertical Hydraulic Conductivity (Kh and Kv)

The results for the horizontal hydraulic conductivity (Kh) sensitivity analysis are summarised in Table 4.6 for 16 zones, which are defined over 8 model layers. The generally low sensitivity to hydraulic conductivity values indicates that the adopted calibration values are optimal, with the most sensitive parameters in the model (considered later for uncertainty analysis of the prediction scenarios), being:

- Layer 8, the basement layer, which includes coal measures sediments beneath the Big Ben Seam (0.05 m/d basecase value; sensitivity range of 8.3% to 11.1% change in SRMS) and
- Layer 3, which represents the Whites Creek Seam (0.1 m/d basecase value; sensitivity range of 2.9% to 4.8% change in SRMS).

Other zones showed a slight decrease in the scaled RMS when they were multiplied by 0.5, and the RMS generally increases slightly if the hydraulic conductivity values are increased by factor of 2.

Table 4.6
Sensitivity analysis of horizontal and vertical hydraulic conductivity values in the Bloomfield model

Horizontal Hydraulic Conductivity (m/d)					Vertical Hydraulic Conductivity (m/d)				
Zone	**Calibrated Value (m/d)**	**Layer**	**Multiplier**	**SRMS (%)**	**Zone**	**Calibrated Value (m/d)**	**Layer**	**Multiplier**	**SRMS (%)**
			0.5	8.95				0.1	8.94
17	0.1	1	**1**	**8.94**	17	0.01	1	**1**	**8.94**
			2	8.93				10	8.94
			0.5	8.97				0.1	8.94
18	1	1, 2, 3, 5	**1**	**8.94**	18	0.1	1, 2, 3, 5	**1**	**8.94**
			2	8.93				10	8.94
			0.5	8.95				0.1	8.94
21	1	1	**1**	**8.94**	21	0.1	1	**1**	**8.94**
			2	8.93				10	8.94
			0.5	8.98				0.1	
4	0.002	2	**1**	**8.94**	4	0.001	2	**1**	**8.94**
			2	8.90				10	8.87
			0.5	8.99				0.1	
6	0.002	2	**1**	**8.94**	6	0.001	2	**1**	**8.94**
			2	8.89				10	9.56
			0.5	8.95				0.1	9.14
7	0.002	4	**1**	**8.94**	7	0.001	4	**1**	**8.94**
			2	8.93				10	8.96
			0.5	8.94				0.1	8.85
12	0.002	6	**1**	**8.94**	12	0.001	6	**1**	**8.94**
			2	8.95				10	9.06
			0.5	8.95				0.1	8.90
14	0.05	5	**1**	**8.94**	14	0.005	5	**1**	**8.94**
			2	8.94				10	8.95
			0.5	9.37				0.1	8.90
15	0.1	3	**1**	**8.94**	15	0.01	3	**1**	**8.94**
			2	9.20				10	8.95
			0.5	9.68				0.1	
16	0.05	8	**1**	**8.94**	16	0.005	8	**1**	**8.94**
			2	9.93				10	9.04
			0.5	8.97				0.1	8.91
20	0.08	7	**1**	**8.94**	20	0.008	7	**1**	**8.94**
			2	8.92				10	8.95
			0.5	8.75				0.1	8.86
1	0.5	4, 5, 6, 7	**1**	**8.94**	1	0.05	4, 5, 6, 7	**1**	**8.94**
			2	9.88				10	9.02
			0.5	8.92				0.1	8.33
11	0.01	4	**1**	**8.94**	11	0.001	4	**1**	**8.94**
			2	8.98				10	9.90
			0.5	9.05				0.1	8.94
2	0.5	5, 6, 7	**1**	**8.94**	2	0.05	5, 6, 7	**1**	**8.94**
			2	8.85				10	8.94
			0.5	9.04				0.1	8.94
19	1	6	**1**	**8.94**	19	0.1	6	**1**	**8.94**
			2	9.24				10	8.94
			0.5	8.93				0.1	8.95
22	1	7	**1**	**8.94**	22	0.1	7	**1**	**8.94**
			2	8.98				10	8.94

Note: The basecase SRMS value is 8.94%.

Again, the generally low sensitivity to vertical hydraulic conductivity values shown in Table 4.6 indicates that the adopted calibration values are optimal, with the most sensitive parameters in the model (considered later for uncertainty analysis of the prediction scenarios), being for interburden layers:

- Layer 4 (6.8-10.7% change), and
- Layer 2 (7% change).

The scaled RMS generally increased when the vertical hydraulic conductivity was increased by a factor of 10. However, the model failed to converge when zones 4 and 6 in layer 2 were reduced by a factor of 0.1. This could be because this layer is relatively thick, and a very low Kv produces a very low leakage coefficient that makes the water level mound up to the upper layer, leading to instability of the numerical solution.

4.3.3 Sensitivity to Recharge

The results of the sensitivity analysis of recharge and river/drain conductance are presented in Table 4.7.

Table 4.7
Sensitivity analysis of recharge, river bed conductance, and drain conductance values

Sensitivity to Recharge				
Zone	**Calibrated Value**	**Layer**	**Multiplier**	**SRMS (%)**
1	11.2%	Applied to Highest Active Layer	0.5 1 2	9.96 8.94 8.38
2	1. 7%	Applied to Highest Active Layer	0.5 1 2	12.89 8.94 12.69
Sensitivity to River Conductance (m^2/d)				
Reach	**Calibrated Value**	**Layer**	**Multiplier**	**SRMS (%)**
All	25, 50	All	0.1 1 10	8.94 8.94 8.94
Sensitivity to Drain Conductance (m^2/d)				
Reach	**Calibrated Value**	**Layer**	**Multiplier**	**SRMS (%)**
All	50	1	0.1 1 10	8.94 8.94 8.94

Note: The basecase SRMS value is 8.94%.

Two zones representing alluvium and regolith recharge areas were tested, and the results showed that the adopted calibration rates of the recharge zones are optimal because the scaled RMS increases (ie. the calibration is worse), but not substantially. While Zone 2 (the regolith area) is the most sensitive to recharge, (low basecase value of 15 mm/yr; change in SRMS over sensitivity range of 42% to 44%), if this recharge value were to be increased, then the hydraulic conductivity in most underlying layers should also be increased to achieve calibration, and this is not warranted given what is known of the measured values. It should also be noted that recharge and Kh are correlated as a ratio, and it is possible for a different combination of values to achieve model calibration (the model “non-uniqueness” problem; MDBC (2001)).

The results of the sensitivity analysis for the river and drain bed conductance (Table 4.7) revealed that the model was insensitive (in terms of head and baseflow) to multiplying the calibration values by either 0.1 or 10 in all river or drain reaches.

The generally low sensitivity to model parameter changes indicates that the adopted calibration values are optimal.

5.1 BLOOMFIELD MINE DEWATERING PREDICTIONS

The calibrated Bloomfield model was applied to predict mine dewatering requirements, and the related hydrological impact of progressive mining, waste backfilling, and then post-mining recovery, in terms of changes to groundwater levels and groundwater-surface water interactions. Mine dewatering operations were simulated as described in Section 3.4, and the method of calculating the inflow volumes was also described in Section 3.4. The range of parameter values for sensitivity testing was outlined in Section 4.3. The model features for rivers and rainfall recharge were retained unchanged for these predictions.

The prediction model was configured with annual changes in terms of the area and level of drainage features to suit an initial Bloomfield mine plan provided on 29 November 2007. This mine plan has been modelled in four stages:

- the first stage is assumed to extend from Year 1 to Year 5;
- the second stage is two years only, Year 6 and Year 7;
- the third stage is planned to run from Year 8 to Year 10 and
- the fourth and final stage should be completed by the end of Year 11.

The Bloomfield prediction model also incorporates the completion of Donaldson open cut mining to the east of the Bloomfield pit, and the Abel underground mine south of Bloomfield as described in Section 3.4.

5.1.1 Model Parameter Changes with Time

There will be a change in hydraulic properties during open cut mining, with the material inside the pit area starting with in-situ rock properties, then being progressively replaced first by a temporary void and finally by waste backfill. The modelling approach needs to allow for changes with time to the hydraulic properties of the in-pit cells in accordance with the proposed mining/backfilling schedule. This progression from rock to void to waste will occur progressively across the mine throughout the mine life.

Modflow-Surfact does not automatically allow for changing of hydraulic conductivity parameters with time to represent the mining progression within the pit. However, the use of “time-slices” of short duration (generally 1 year) allows parameters to be changed periodically in specific areas. The horizontal and vertical hydraulic conductivity parameters and the specific yield parameters were changed with time and space in all Layers (1 to 8), to represent progressive mining and pit backfilling of the Bloomfield and Donaldson open cut mines.

Accordingly, the Bloomfield prediction model has been divided into 9 time slices representing 11 years of mining operation. The final water level conditions from each time-slice were specified as the initial conditions for the subsequent time-slice, and the parameters in the pit area were changed from one time-slice to the next to represent changes to the distribution of active areas. Higher permeability and storage parameters were applied to backfill areas (compared to the in-situ rock properties), with the backfill Kh set to 1m/d and the Kv set to 0.1m/d, while the specific yield was set to 0.05 for backfill areas.

The hydraulic conductivity (Kh and Kv) values and the specific yield values of the cells representing the mined and backfilled open cut areas of the coal seams, interburden and regolith units were increased for the specific mined-out areas of the pit that during any specific time-slice, with the change invoked in the model from the start of the backfilling process (assumed to be 2009 for Donaldson and at the commencement of the second stage in Year 5 for Bloomfield).

5.1.2 Bloomfield Mine Plan Time Slices and Dewatering Rates

The remaining 11 year mine life was simulated by a series of 9 sequential time slice models. Each year of the remaining mine life is represented by a separate time slice, except for the period 2014 to 2016, which is designed as one time slice but divided into three one-year stress periods. A stress period is the timeframe in the model when all hydrological stresses (eg. recharge and pumping) and hydraulic parameters are held constant. Each time-slice model was designed with a stress period of 365.25 days, 200 time steps and time-step multiplier of 1.07. The number of time steps and the time-step multiplier was selected to ensure the stability of the numerical solution and to increase the accuracy of the heads and fluxes during model simulation, consistent with best practice guidelines. The output water levels from one time-slice model were used as input starting heads for the subsequent time-slice.

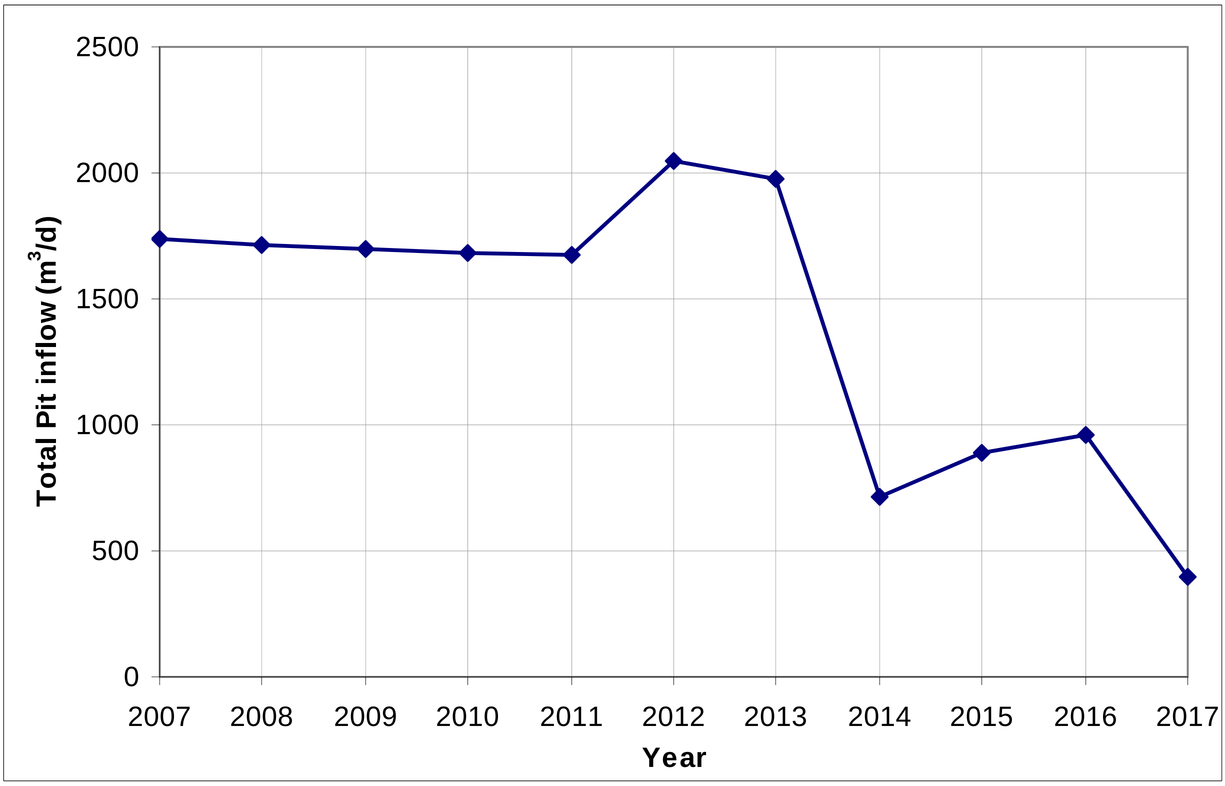
The model was run successfully for the 9 time-slices. The weighted average pit inflow for each layer and the total inflows are presented in Table 5.1 and Figure 5.1. The predicted average dewatering rate over 11 years is 1.4 ML/d, with a minimum of 0.4 ML/d (in Year 11) and a maximum of 2.1 ML/d (in Year 6).

Table 5.1
Predicted Bloomfield dewatering rates by model layer (9 Time-Slices)

Year	**Weighted Average Pit Inflow *(m^3/d)**								
	Layer 1	Layer 2	Layer 3	Layer 4	Layer 5	Layer 6	Layer 7	Layer 8	Total
1	0.0	0.0	0.0	5.4	0.0	759.8	467.6	504.6	**1737**
2	0.0	0.0	0.0	3.5	0.0	732.9	467.4	513.1	**1717**
3	0.0	0.0	0.0	2.5	0.0	721.8	463.1	511.8	**1699**
4	0.0	0.0	0.0	1.8	0.0	709.2	465.1	509.5	**1686**
5	0.0	0.0	0.0	0.2	0.0	702.6	460.0	508.5	**1671**
6	0.0	0.0	0.1	15.8	0.2	2030.1	0.0	0.0	**2046**
7	0.0	0.0	0.0	0.2	0.0	1972.5	0.0	0.0	**1973**
8	0.0	0.0	0.0	0.0	0.0	198.2	279.3	234.0	**711**
9	0.0	0.0	0.0	0.0	0.0	323.4	315.3	251.1	**890**
10	0.0	0.0	0.0	0.0	0.0	366.0	334.2	261.1	**961**
11	0.0	0.0	0.0	0.0	0.0	34.6	233.3	127.8	**396**
Ave	**0.0**	**0.0**	**0.0**	**2.7**	**0.0**	**777.4**	**316.8**	**311.0**	**1408**
Min	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**34.6**	**0.0**	**0.0**	**396**
Max	**0.0**	**0.0**	**0.1**	**15.8**	**0.2**	**2030.1**	**467.6**	**513.1**	**2046**

* Weighted average is calculated from instantaneous water balance values reported every 20 time steps for each layer

Figure 5.1
Predicted Bloomfield mine dewatering rates (9 time-slice model)



The Interburden layer (Layer 6) contributes most of the dewatering inflows. Although this layer has a regionally lower value for hydraulic conductivity than the overlying and underlying coal seam layers, it is 12 m thick compared to the 2 m thickness of the coal seams (Table 3.1). Furthermore, in the local mine area, the calibrated values for hydraulic conductivity are consistent for each of these layers (Appendix C), and hence the transmissivity of layer 6 is higher in the local mine areas than these coal seams. This combination of factors results in higher inflows from this layer, with a weighted average inflow rate over 11 years of 0.78 ML/d, and minimum and maximum weighted average rates of 0.02 ML/d in Year 11 and 2.03 ML/d in Year 6 respectively (Table 5.1).

Layer 7 (Big Ben Coal Seam) and Layer 8 (combination of deeper coal seams, interburden and basement) represent the second highest inflow after layer 6. For example, Layer 7 has a weighted average dewatering rate of 0.32 ML/d over 11 years, a minimum of 0.0 ML/d in years 2012 and 2013 and a maximum of 0.47 ML/d in 2008.

The weighted average dewatering rate for the other layers (layers 1 to 5) are relatively small, totalling about 0.03 ML/d (averaged over 11 years), and with Layer 1 (Alluvium and the Regolith) and layer 2 (Overburden above White's Creek Seam) producing almost no pit inflow.

5.2 PREDICTED BASEFLOW IMPACTS

The cumulative impact of mining at Bloomfield, Donaldson and Abel mining areas on groundwater baseflow discharges has been assessed for the nine stream reaches defined in Section 4. The model results show that there is only a minimal total reduction in groundwater baseflow to Wallis Creek and Buttai Creek in comparison with a pre-mining baseflow (Figure 5.2 and Figure 5.3).

Figure 5.2
Predicted baseflow during Bloomfield mine dewatering (9-year time-slice model)

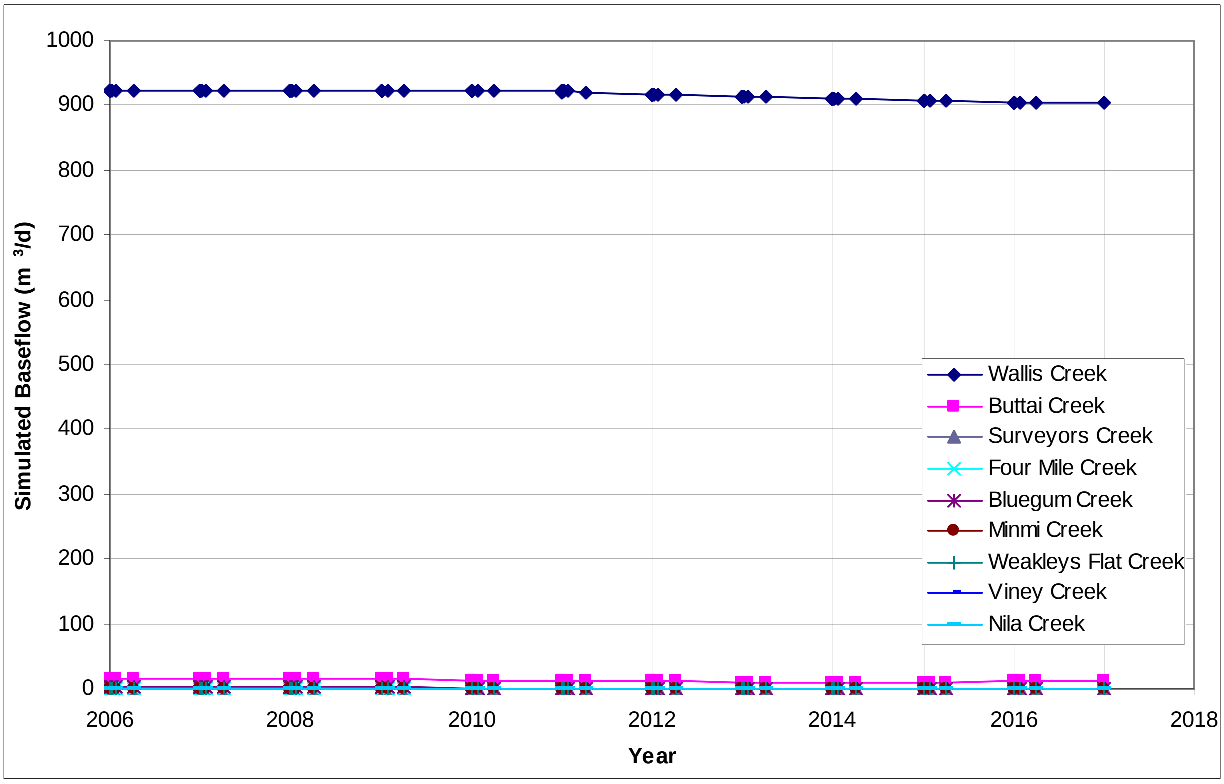
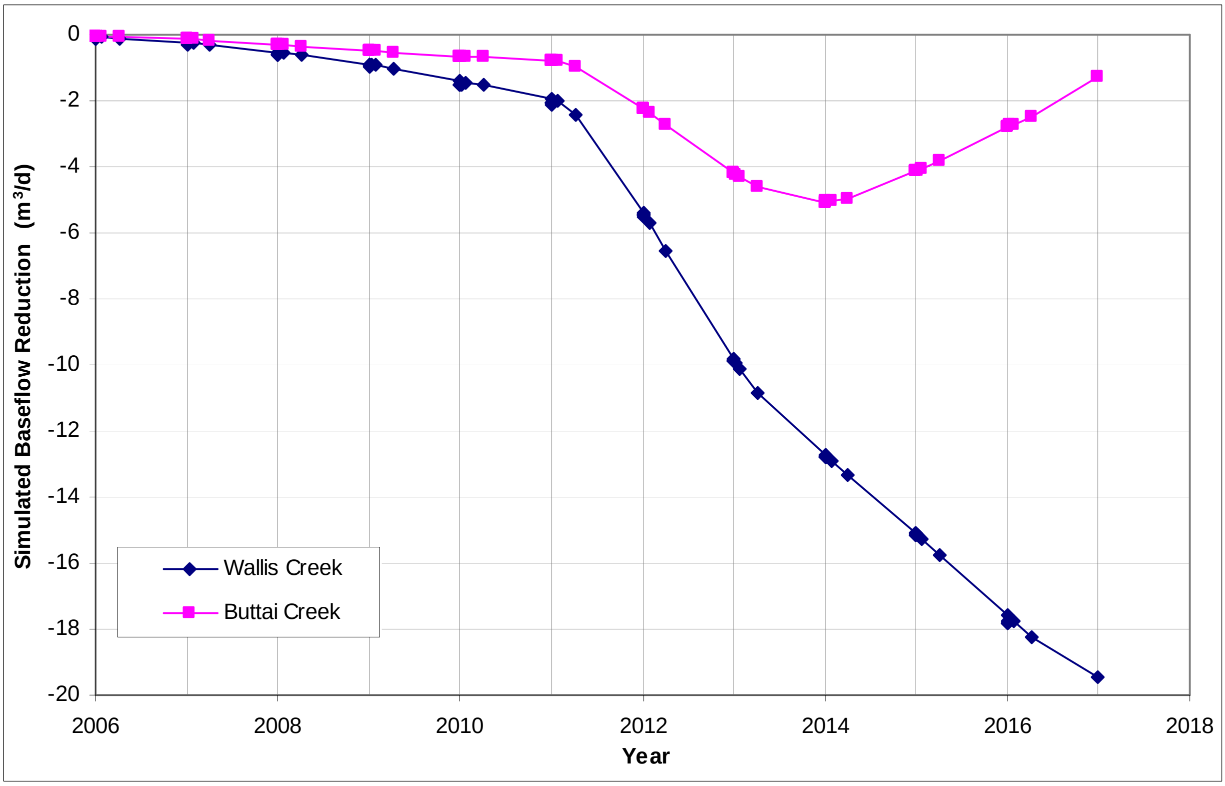


Figure 5.3
Predicted baseflow REDUCTION during Bloomfield mine dewatering (9-year time-slice model)



The model predicted very minor impacts on stream baseflow to Wallis and Buttai Creeks at the western boundary of the model, mainly from Bloomfield open cut mining.

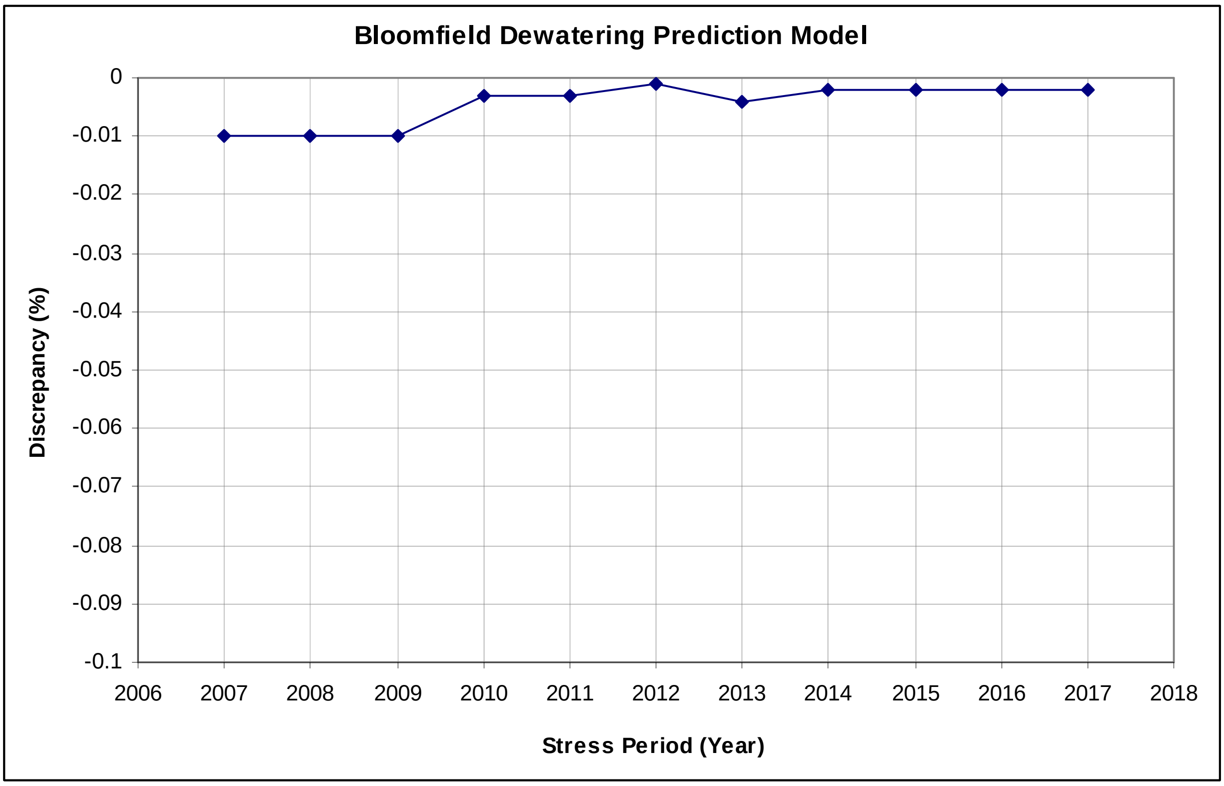
The maximum baseflow reduction is predicted to be around 19.4 kL/d (0.02 ML/d or 0.2 L/s) in Wallis Creek by the completion of mining in Year 11 (Figure 5.3), which is not practicably measurable with stream gauging accuracy and equates to only 2% of the current modelled baseflow of 923 kL/d. The predicted baseflow reduction in Buttai Creek is much smaller, reaching a maximum of just 5.1 kL/d (0.005 ML/d or 0.06 L/s) by the end of year 2014 (approximately 35% of current minor stream modelled baseflow of 14.5 kL/d) and then recovering to reach a reduction of 1.3 kL/d by the completion of mining in Year 11.

The model predicts that the Bloomfield proposal will have a very low impact (virtually not measurable in a practical sense) on baseflow in Wallis Creek, Buttai Creek and the other ephemeral creek baseflows.

5.3 BLOOMFIELD MODEL MASS BALANCE EVALUATION

The discrepancy between the cumulative volumes at the end of each stress period (i.e. the difference between the inflow and the outflow rates of the reported model mass balance) is a good indicator to evaluate the model mass balance and the stability of the numerical solution. The Bloomfield model runs were carried out with a head closure criterion of 0.1 m to enhance the stability of the numerical solution and to achieve a good mass balance for the entire model. The cumulative mass balance discrepancy plot for the 11-year time-slice modelling is presented in Figure 5.4, showing that the Bloomfield model performance is much better than the best practice criterion of a discrepancy of less than 1%.

Figure 5.4
Cumulative mass balance discrepancy plot



5.4 UNCERTAINTY MODEL SCENARIOS

This analysis assesses the uncertainties in the model predictions of mine inflow rates, and also provides an indication of the possible range of predicted dewatering volumes.

The uncertainty analysis was undertaken with a single 11-year model run of the mining period using the most sensitive parameters (Section 4.3). The single 11-year run was found to give consistent results to the 9 stage time-slice model, but involved much shorter run times and simpler data processing procedures for the purpose of uncertainty analysis.

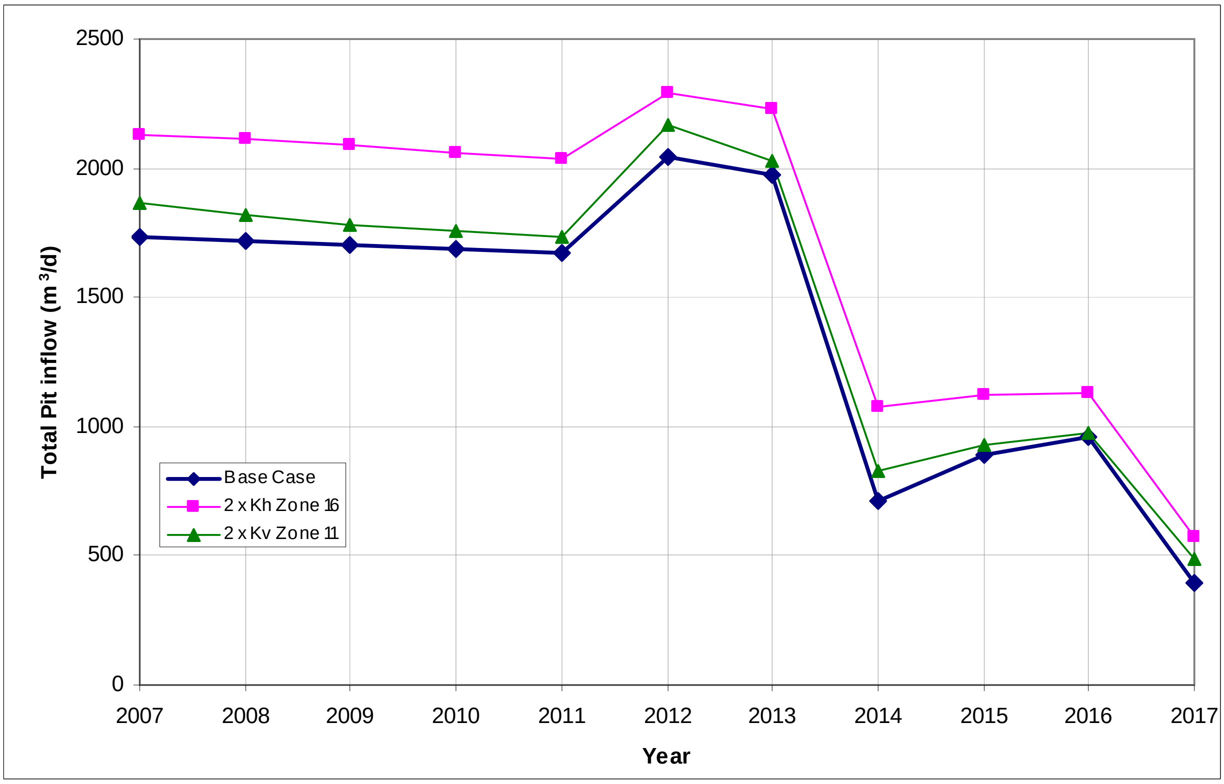
It was found from the sensitivity analysis of the model calibration performance (Section 4.3) that the model is generally not sensitive to parameter variations. However, the most sensitive parameters in the model were identified as the high horizontal hydraulic conductivity in Zone 16, which mainly represents the combined Permian Rathulba Formation (deeper coal seams, interburden and basement) that outcrop up-dip and north of Bloomfield (but noting that Zone 16 also extends though what are dummy layers 2 to 7 in this area), and also the high value of the vertical hydraulic conductivity in the interburden Formation (Layer 4).

Table 5.2 and Figure 5.5 summarise the uncertainty in predicted mine inflow rates due to multiplying the calibrated aquifer parameter values (Appendix C) by the same factors as were applied to the sensitivity analysis (Kh factors or 0.5 and 2.0, and Kv factors of 0.1 and 10).

Table 5.2
Bloomfield model range of uncertainty predictions in terms of predicted inflow

Uncertainty Analysis: Horizontal Hydraulic Conductivity of Zone 16 (Layers 2-8)			
Layers 8		Calibrated Kh	High Kh
		0.05 m/d	0.1 m/d
SRMS %		8.94%	9.93%
Layer	Annual inflow	Mine Inflow Rates (ML/d) for Calibrated Kh	Mine Inflow Rates (ML/d) for High Kh
	Min	0.40	0.57
Total	Max	2.05	2.29
	Ave	1.41	1.71
Uncertainty Analysis: Vertical Hydraulic Conductivity of the Interburden Formation (Layer 4)			
Layer 4		Calibrated Kv	High Kv
		0.001 m/d	0.01 m/d
SRMS %		8.94%	9.90%
Layer	Annual inflow	Mine Inflow Rates (ML/d) for Calibrated Kh	Mine Inflow Rates (ML/d) for High Kh
	Min	0.40	0.49
Total	Max	2.05	2.17
	Ave	1.41	1.49

Figure 5.5
Uncertainty in predicted Bloomfield mine dewatering rates



The results of the uncertainty prediction runs reveal that, by increasing the horizontal hydraulic conductivity in Zone 11 by 100% (from 0.05 m/d to 0.1 m/d) the yearly average dewatering rate would increase by 21% (from 1.41 ML/d to 1.71 ML/d). On the other hand, by increasing the vertical hydraulic conductivity in Zone 11 (Layer 4) by a factor of 10 (from 0.001 m/d to 0.01 m/d), the yearly average dewatering rate would increase by just 6% (from 1.41 ML/d to 1.49 ML/d)).

In simple terms, the range of uncertainty in predicted dewatering rates is small.

5.5 RECOVERY SIMULATION

The results at the end of the Bloomfield mine dewatering prediction (i.e. at the end of Year 11) were used as the initial condition for the post-mining recovery run, to show the hydrological responses due to ceasing mining. Aquifer parameters in the mined-out and backfilled open cut areas were increased from the base case values (refer to Section 5.1) to values appropriate for waste-rock backfill, and parameters were also changed to represent the residual pit void post–mining.

For the recovery run, some simplifying assumptions were invoked to represent the residual pit void. The residual open pit void is represented in the model with high permeability values (Kh = Kv = 1000 m/d) and high unconfined specific yield (Sy = 0.99) following the so-called “appropriate complexity high-K approach” (Ronayne et al, 2001). In addition, pit lake evaporation was activated at rates equivalent to 50% of the net pan evaporation rate (Table 2.3 gives annual evaporation of 1350 mm; a 50% pan factor gives 675 mm/yr, or 0.00185 m/d). Direct rainfall recharge was also applied to the pit lake area at 100% of the annual average rainfall, to give a rate of 895 mm/yr (higher than the adopted evaporation rate for the pit void lake).

Plots demonstrating recovery of water levels following cessation of mine dewatering are presented in Appendix D, as hydrographs of predicted water levels at key Bloomfield monitoring bores, and as contours of drawdown at the end of mining (Year 11), and at the end of a 100-year recovery period, which included a 10 years of further underground mining and dewatering at Abel after completion of Bloomfield. The recovery period was selected as 100 years to be consistent with NSW environmental standard criteria for mining operations.

The results show that virtual full recovery in the entire Bloomfield model area would occur by 2080 (i.e. about 60 years from the end of mining in Bloomfied in Year 11). However the results show full recovery had occurred in many bores within a few years from end of Bloomfield mining (for example, bores VW1(35m), VW1(46m), SP2-1 and SP2-2), with subsequent delays in full recovery for some bores at Bloomfield (such as VW6(96m), VW6(114m) and VW6(128m)) being due to Abel underground mining which ends 10 years later (in Year 21) than Bloomfield open cut mining (Year 11), and involves much greater drawdowns (eg. about 175 m in Abel bore CO72W; see Appendix D).

Post-mining water levels are predicted to recover to above the current levels in some parts of the mine area, for the following main reasons:

- firstly, the current groundwater levels include drawdown effects from mining activities in Bloomfield and Donaldson before 2008;
- secondly, the changes in aquifer parameters invoked for the in-pit cells during the mining and recovery periods.

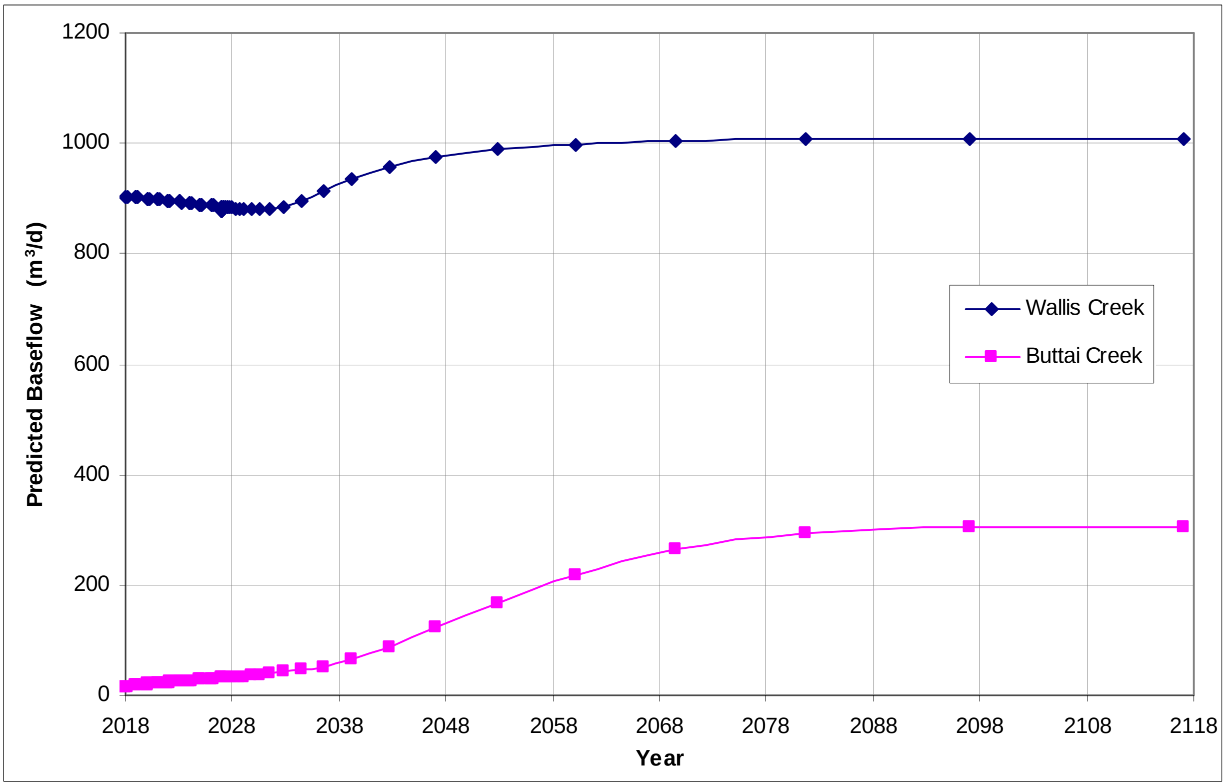
Finally, it should be remembered that the backfill material has been assigned a higher hydraulic conductivity (Kh = 1 m/d and Kv = 0.1 m/d) than the in-situ rock, and the void has been assigned high conductivity (Kh = Kv of 1000 m/d) and specific yield (Sy) of 0.99. These changes to the post-mining aquifer parameters result in a more uniform hydraulic interconnection along the pit than currently exists. The post-mining groundwater levels are predicted to stabilise at around 18 to 35 mAHD within the Bloomfield pit area, compared with Bloomfield groundwater levels predicted by steady state modelling that range to 25 mAHD in that area.

Figure 5.6 shows the baseflow for the nine creek reaches within the Bloomfield model area from the commencement of the mining simulation (2007) to the end of the recovery model run (2117). In summary, the baseflow contributions to Wallis Creek start to recover rapidly within 20 years following cessation of Bloomfield mining, and are fully re-stabilised at above the Bloomfield level by Year 2077 (i.e. 60 years after completion of Bloomfield mining).

Buttai Creek is also predicted to recover rapidly in one year and continued to increase to more than 20 times the current rate.

In summary, the model results show that the baseflows of the creeks within the influence of Bloomfield mining will fully recover to more than 100% of pre-2007 levels, due to the steady state model being affected by, past and current dewatering activities at Bloomfield and Donaldson open cuts.

Figure 5.6
Predicted baseflow during Bloomfield, Donaldson and Abel mine dewatering and recovery



SECTION 6 - BLOOMFIELD MODEL LIMITATIONS

All numerical models have limitations, due mainly to uncertainties in model input parameters, and also due to computational methods. The Bloomfield model limitations which need to be taken into consideration are summarised below:

- The model layer set-up is based on available bore log data, supplied by Bloomfield Collieries and other mining companies, which is not uniformly distributed across the model area. Some inaccuracies in layer elevations may have been introduced in a regional sense during the extension of layer elevations to the model boundaries, based on the assumed regional geology.
- Little data was available on surface water flows in the area. Major rivers, creeks and wetlands were implemented as Modflow River features with specified (constant) stage levels, to allow for leakage to or from the aquifer. All minor creeks are represented by Modflow Drain cells and are thus assumed to be influent.
- Recharge and evapotranspiration are assumed to be constant at average yearly rates, and seasonal or climatic variability is not included in the model. No measured values of recharge rates are available and hence there is uncertainty about actual recharge rates. Recharge values have been assigned within a plausible range to obtain a calibrated model, but values cannot be verified. The maximum possible rate of evaporation in the model is 250mm/yr, acting in areas of shallow (<3m) water levels. This is a best estimate based on available data and experienced judgement.
- There is a high level of uncertainty with respect to both vertical and horizontal distribution of hydraulic conductivity. Conductivities do not change with depth in the model to reflect progressive burial of coal and interburden. However, sensitivity and uncertainty scenario analysis indicates that the model calibration is robust, and the model results are not highly sensitive to potential errors in the assumed aquifer parameters.
- The model is discretised into 8 layers. Heads are averaged over one model layer and the further resolution of heads with depth cannot be as detailed as observed in the field using the current model configuration.
- There is insufficient data for a transient model calibration across the entire model area, or for a true pre-mining steady-state calibration. Steady-state and transient model calibrations are desirable for model verification. At this stage, model predictions are best estimates and have a degree of uncertainty as the sensitivity model runs demonstrate.
- Uncertainties exist on the “resistance to flow” between the interburden and the underground mine void, and between the alluvium/regolith and the underlying coal measures, which were simulated in the model using specified drain conductance values. The uncertainty has been addressed by running sensitivity scenarios, varying the conductance to establish the effect on model results.

In conclusion, the model results of mine inflows and drawdown effects can be regarded as a current best estimate based on the available data. However it should also be noted that the sensitivity and uncertainty scenario analysis indicates that the model calibration is robust, and the model results are not highly sensitive to potential errors or uncertainties in the assumed aquifer parameters.

SECTION 7 - REFERENCES

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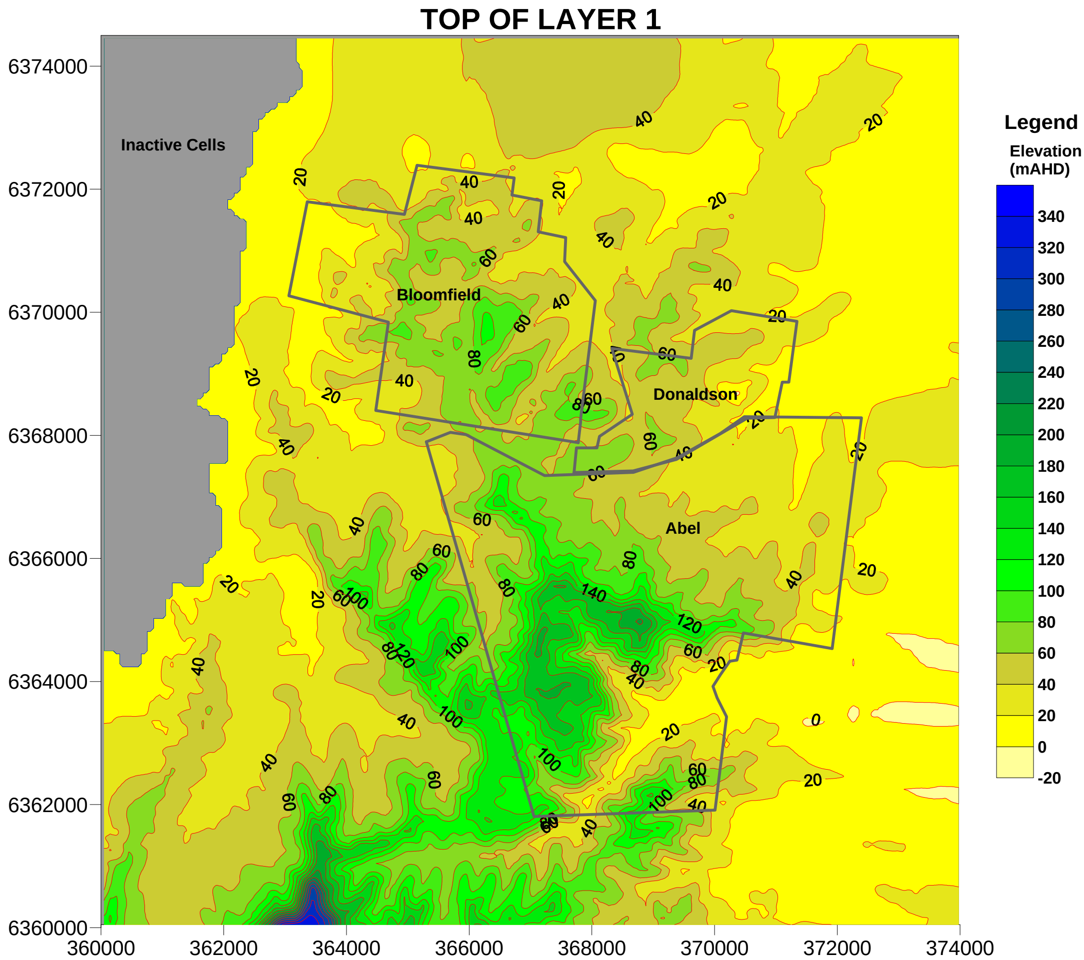
APPENDIX A

BLOOMFIELD MODEL LAYER ELEVATIONS


TOP OF LAYER 1
Inactive Cells
Bloomfield
Donaldson
Abel
Legend
Elevation (mAHD)
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
-20
6374000
6372000
6370000
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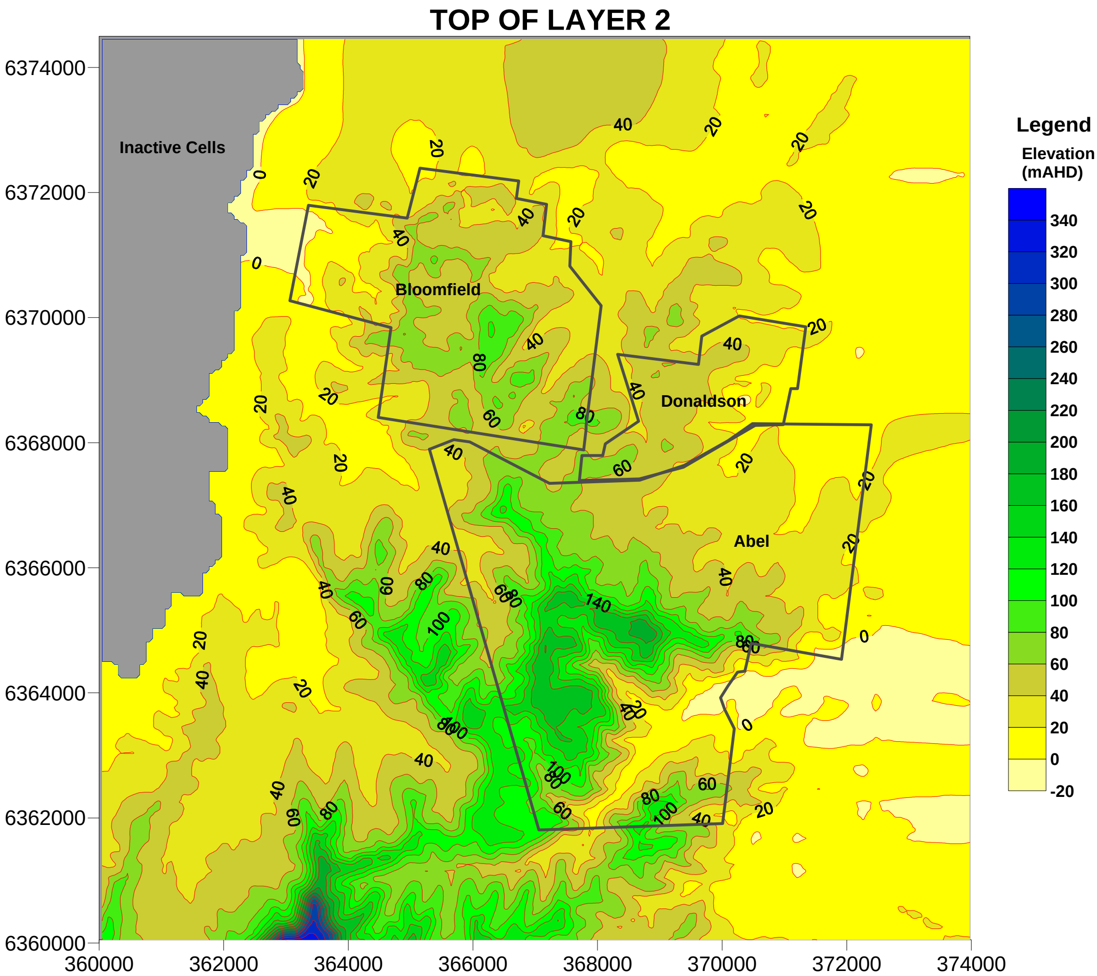
374000


TOP OF LAYER 2
Inactive Cells
Bloomfield
Donaldson
Abel
Legend
Elevation (mAHD)
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
-20
6374000
6372000
6370000
6368000
6366000
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360000
362000
364000
366000
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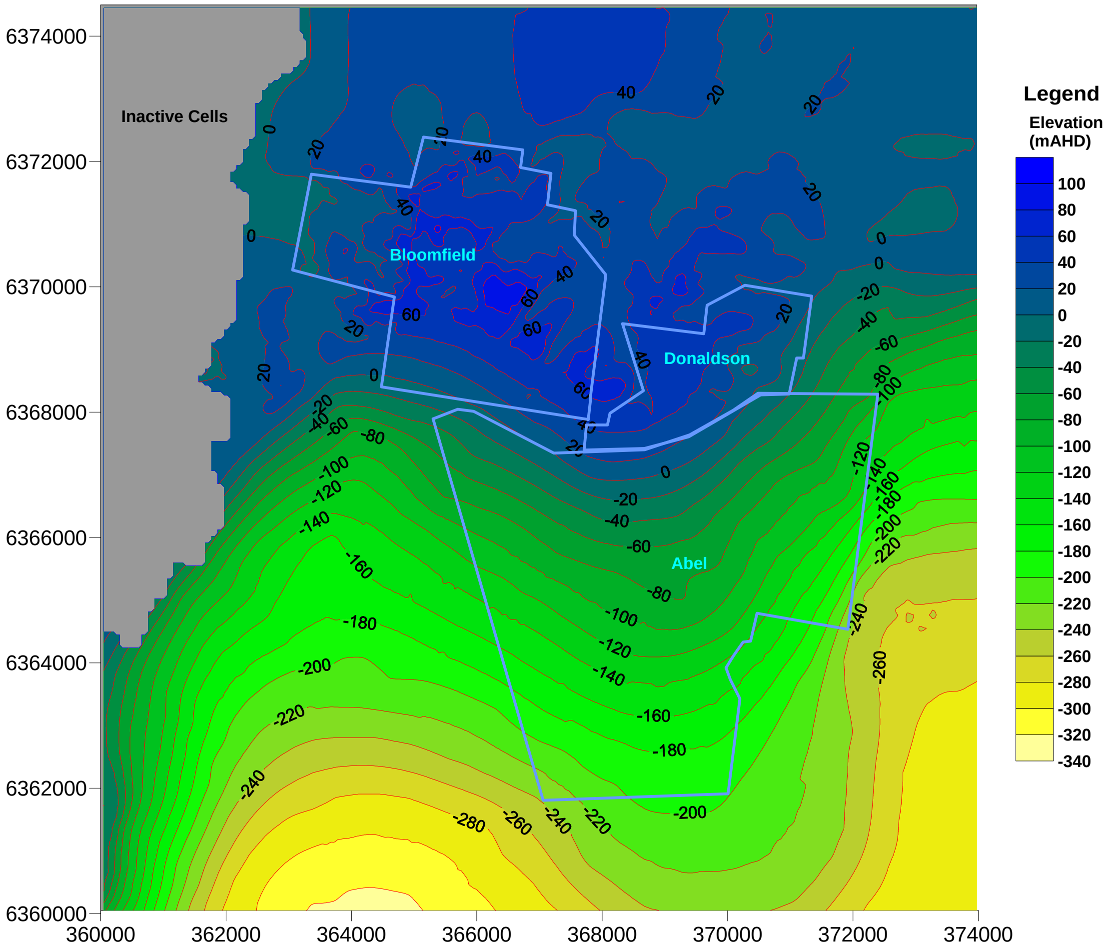
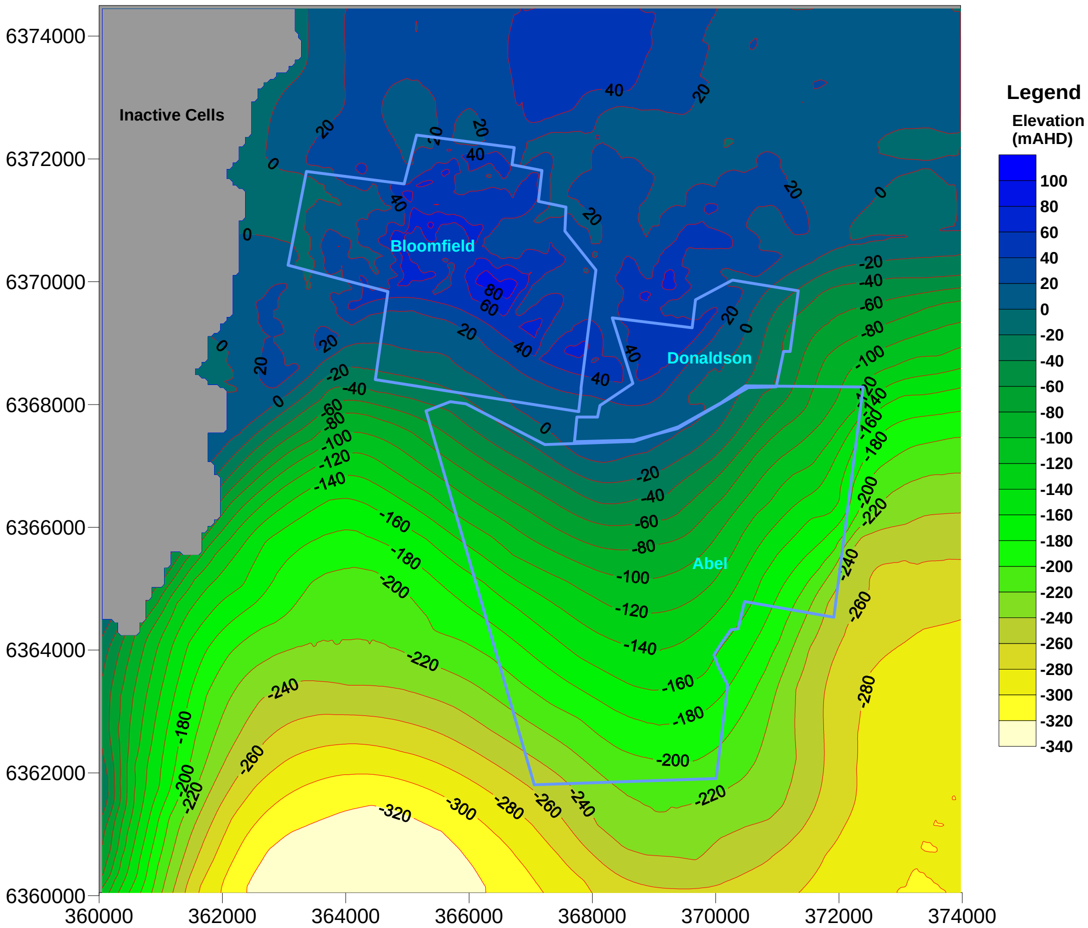
370000
372000
374000

TOP OF LAYER 3



TOP OF LAYER 4



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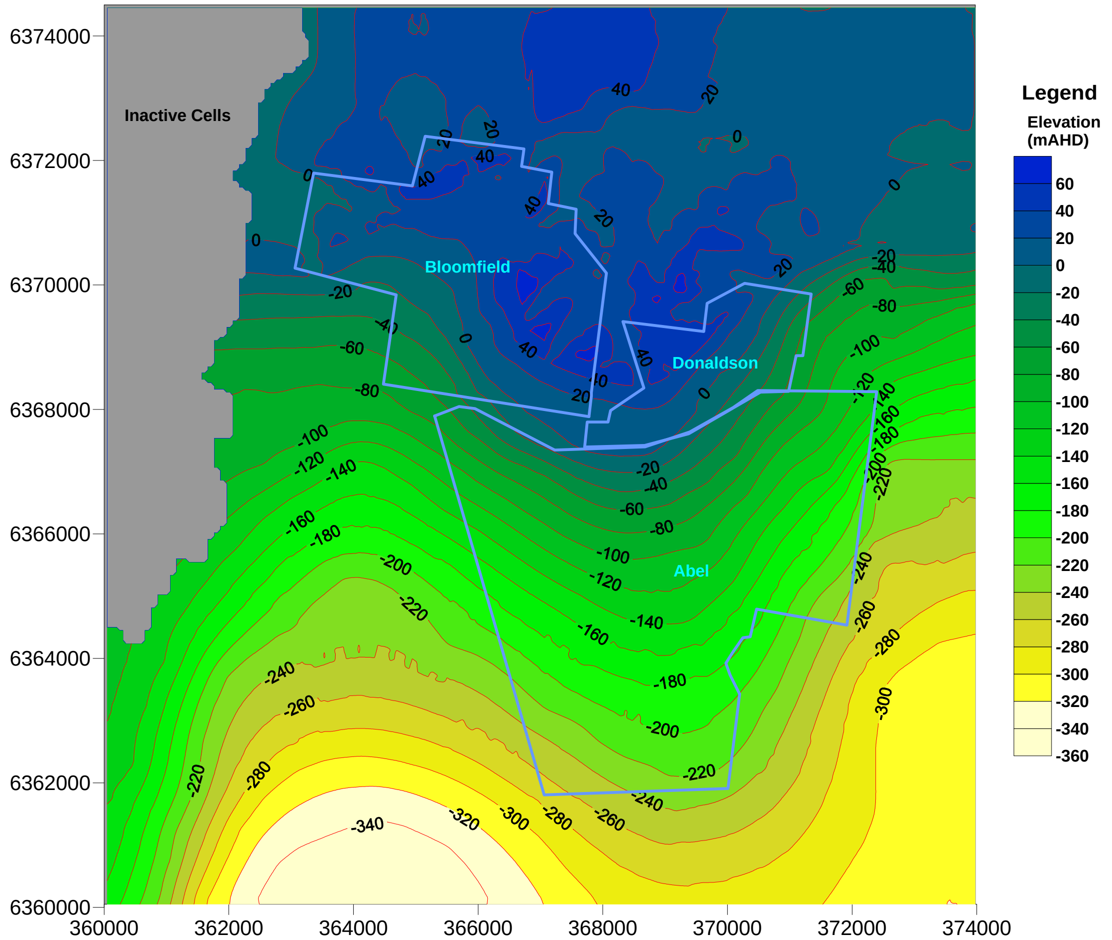
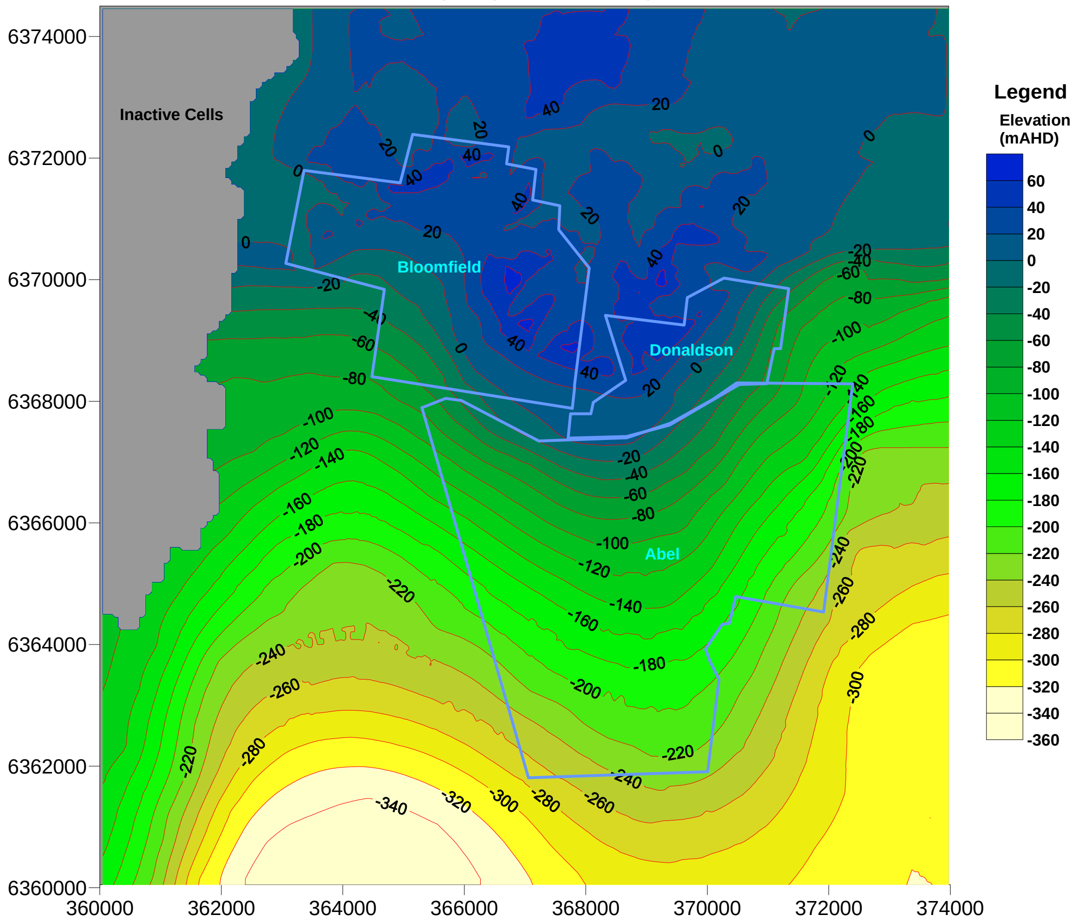
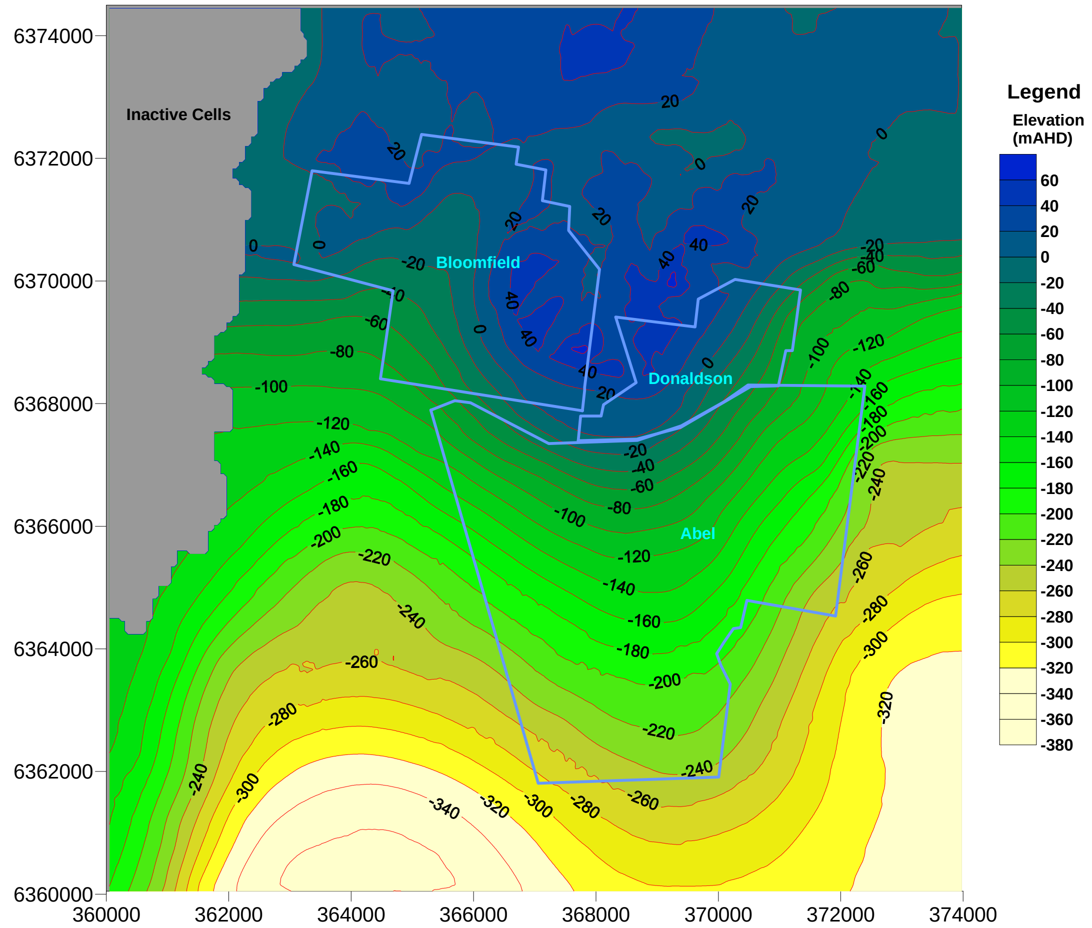


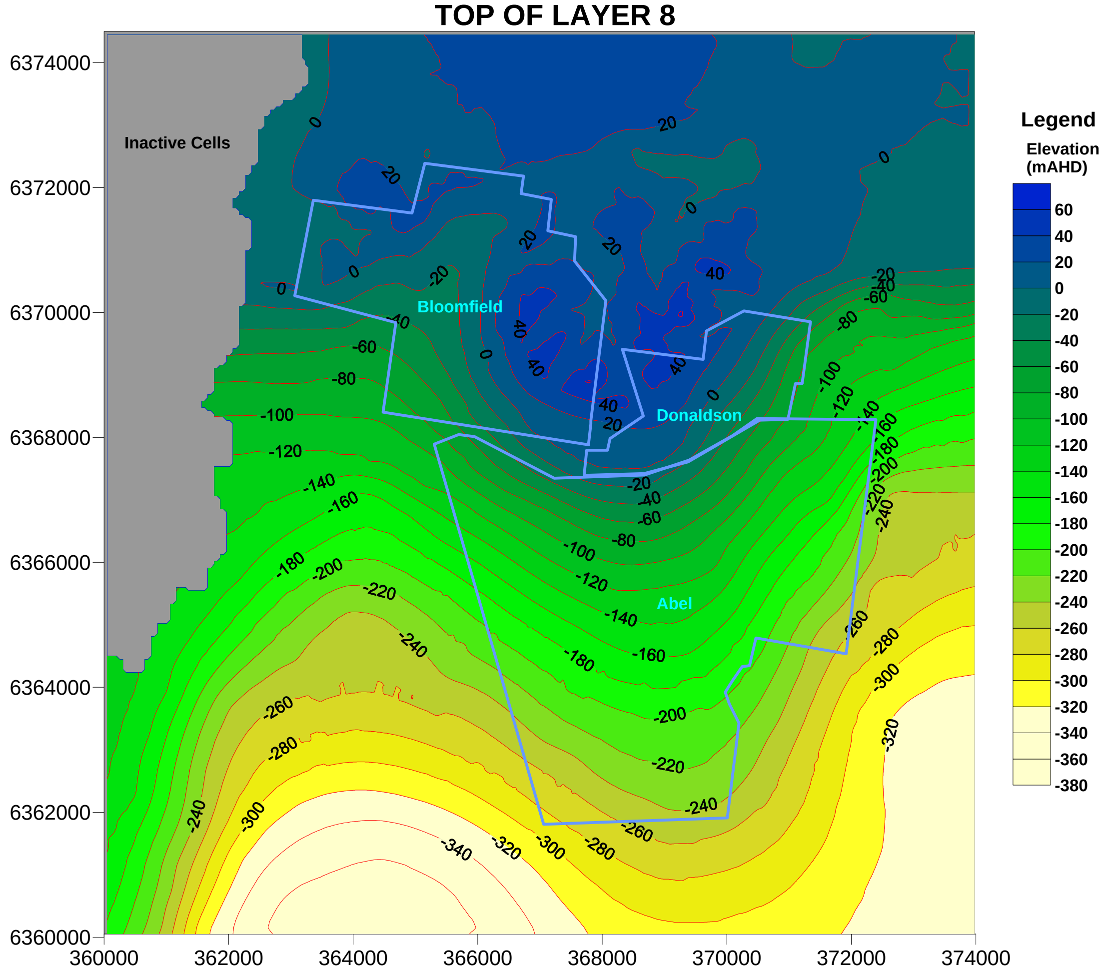
TOP OF LAYER 6



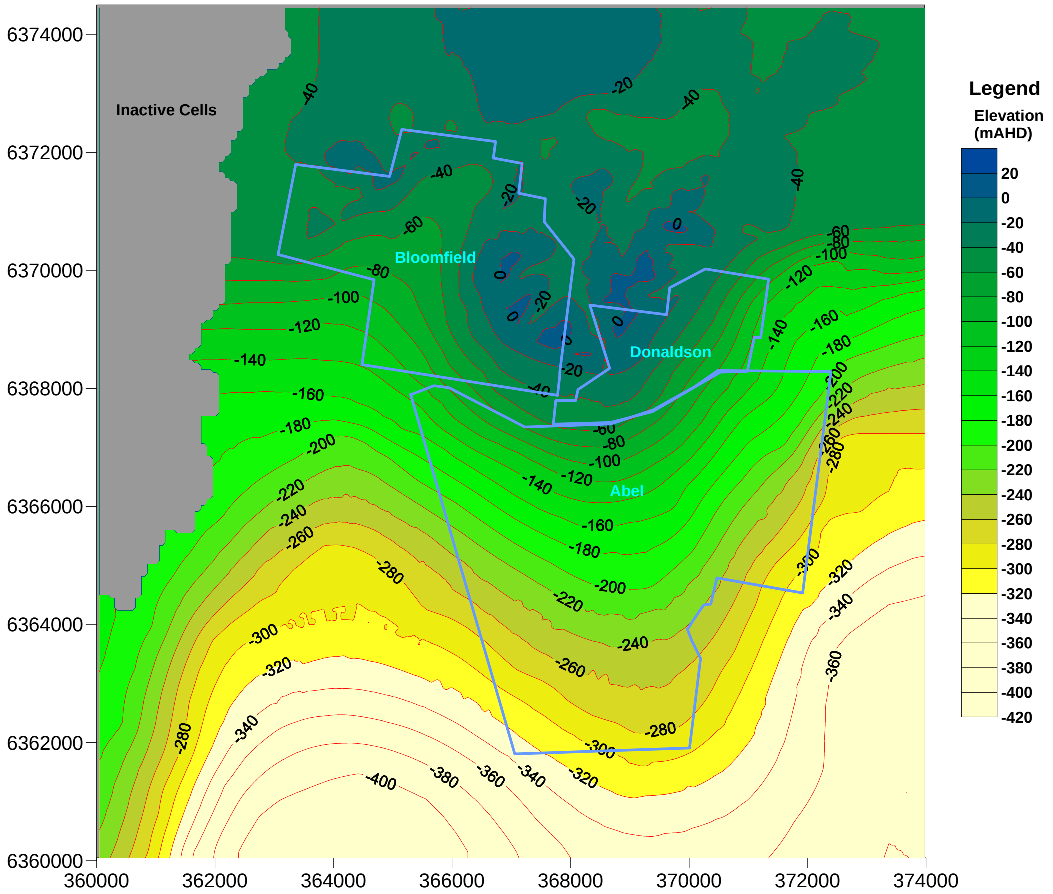
TOP OF LAYER 7



TOP OF LAYER 8



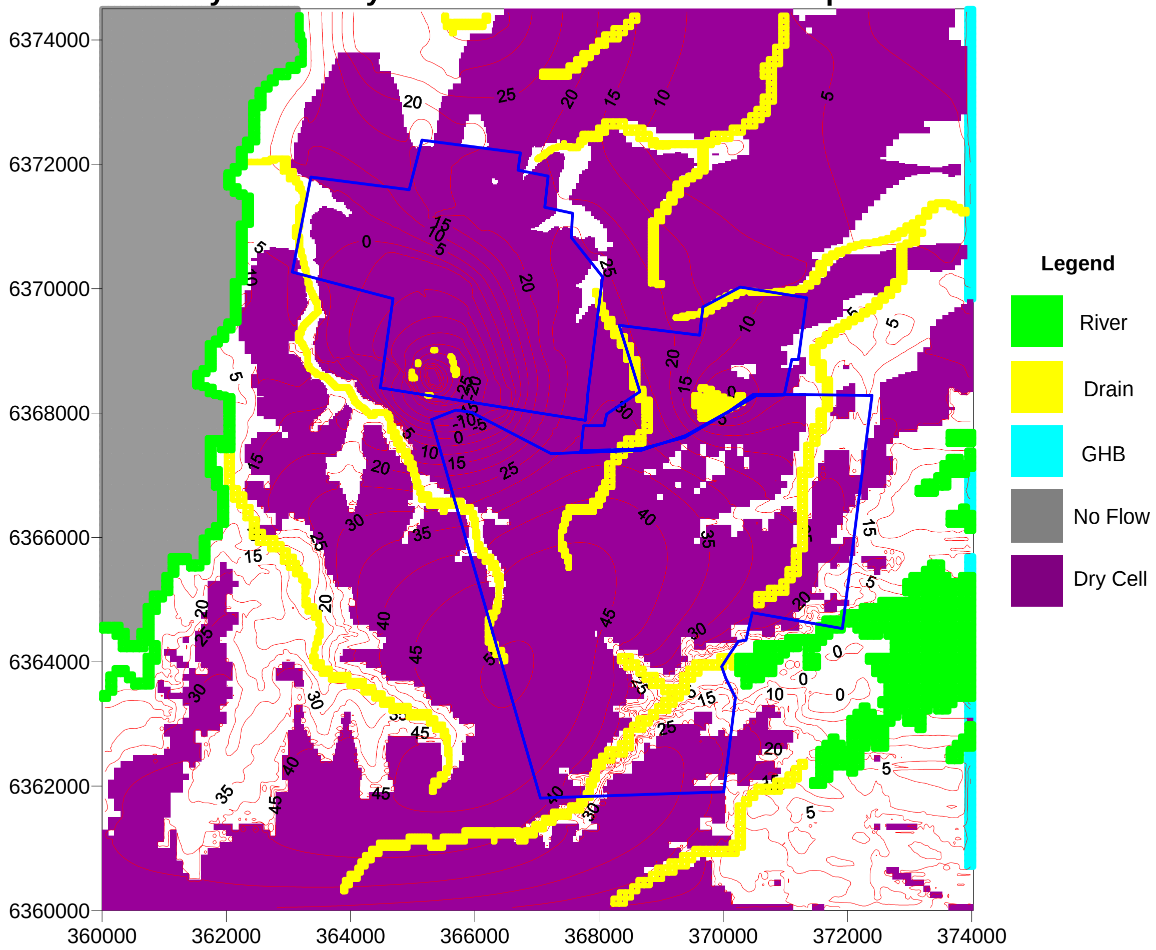
BOTTOM OF LAYER 8



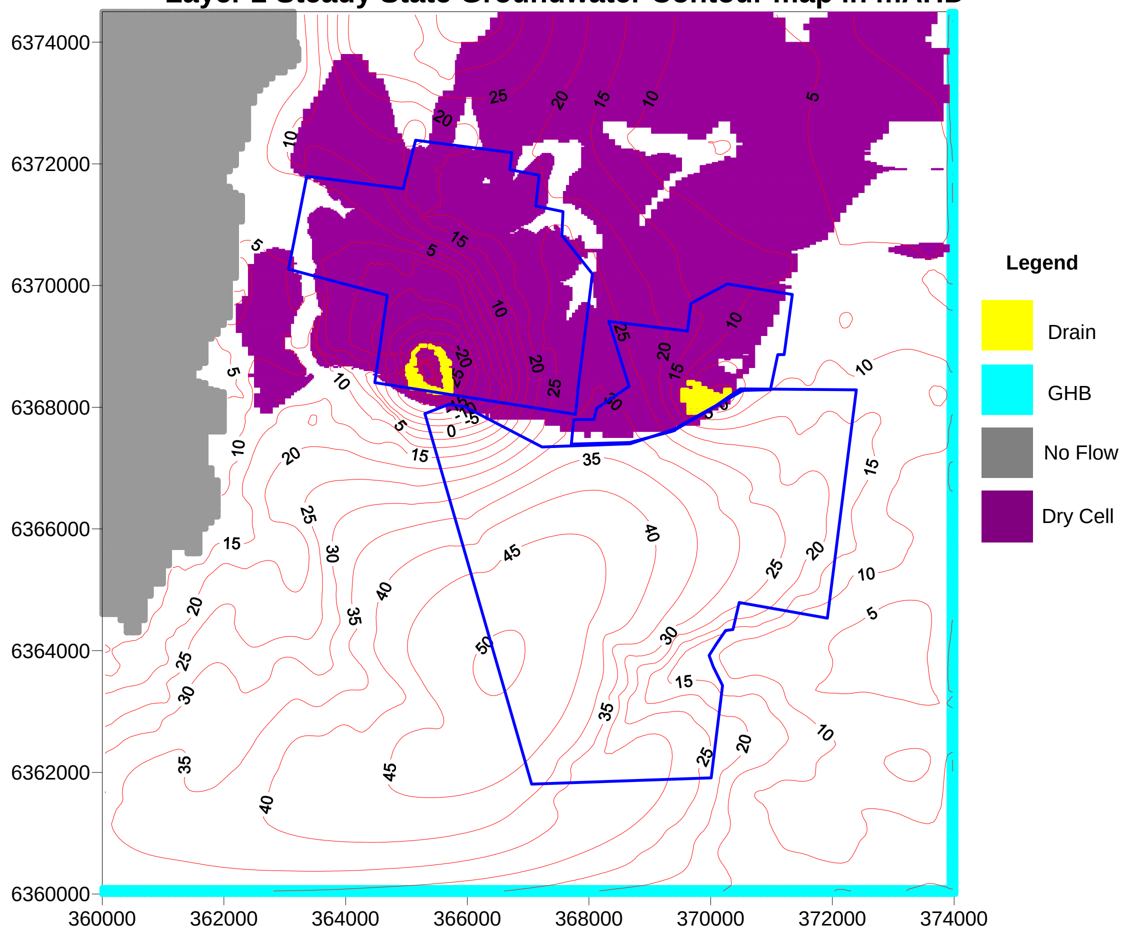
APPENDIX B

BLOOMFIELD MODEL STEADY STATE CALIBRATION
(LAYER BOUNDARY CONDITIONS AND GROUNDWATER CONTOUR MAPS)

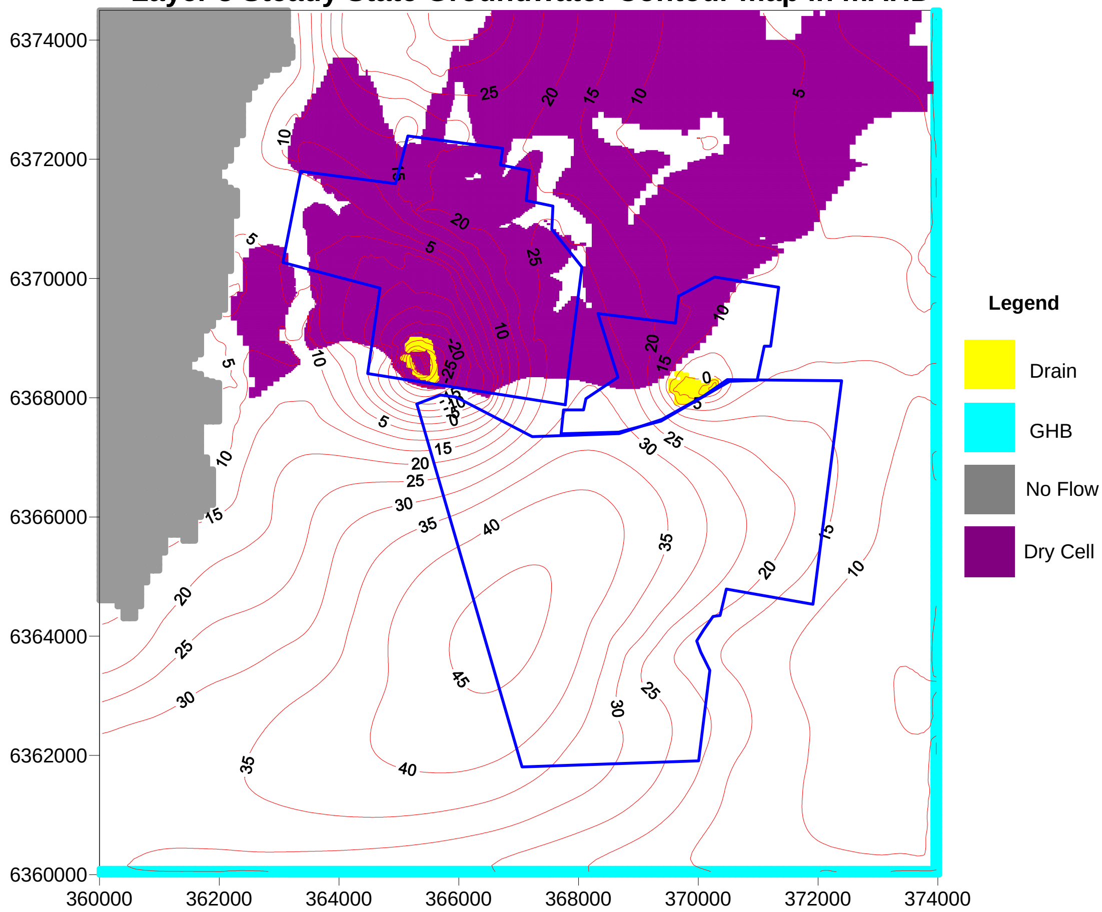
Layer 1 Steady State Groundwater Contour map in mAHD



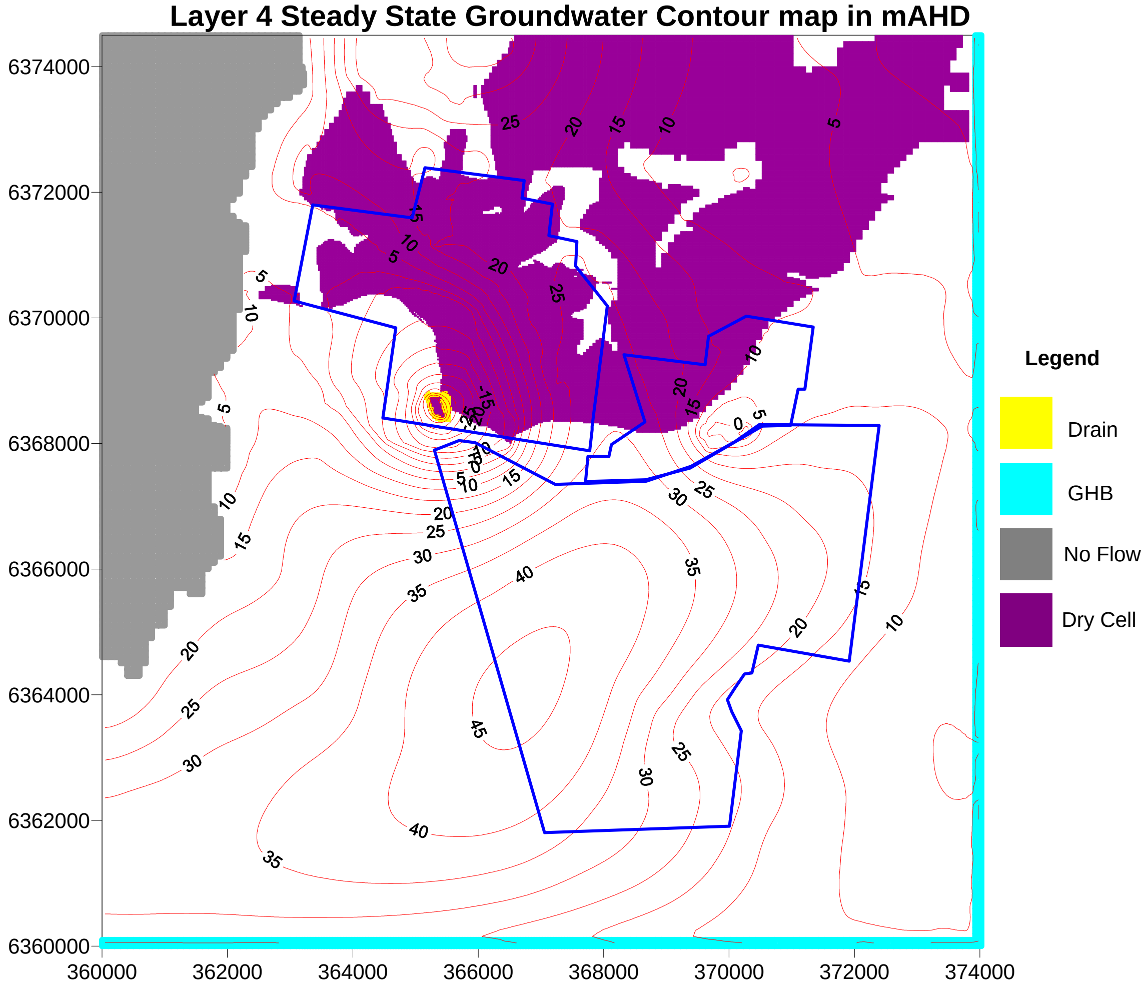
Layer 2 Steady State Groundwater Contour map in mAHD

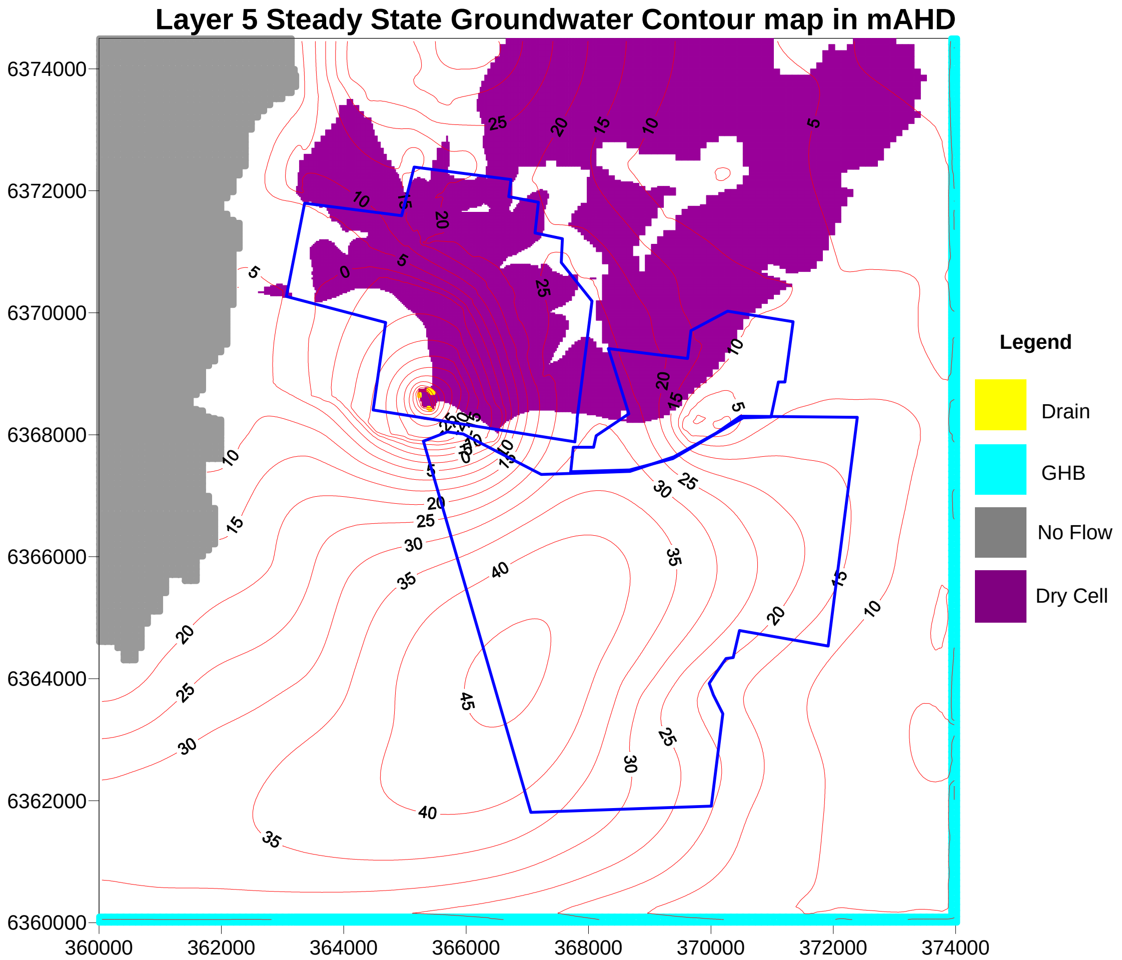


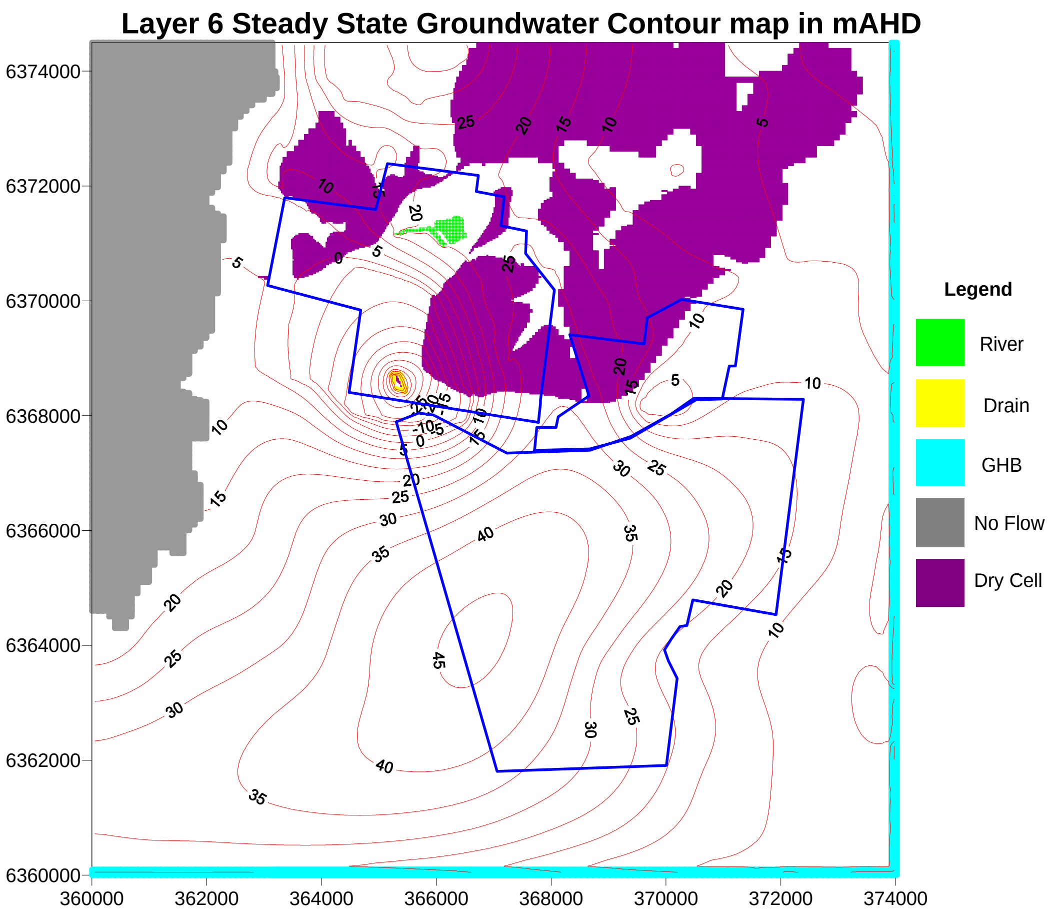
Layer 3 Steady State Groundwater Contour map in mAHD



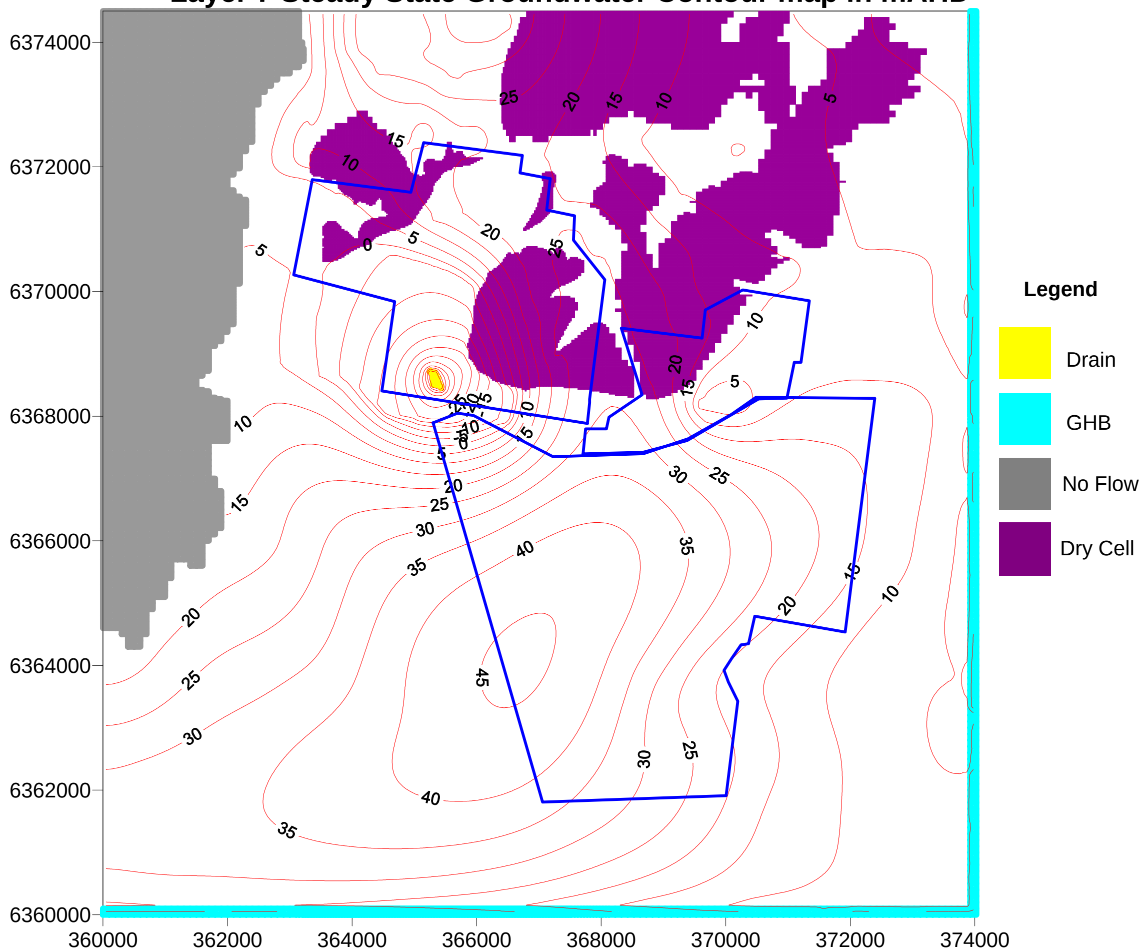
Layer 4 Steady State Groundwater Contour map in mAHD



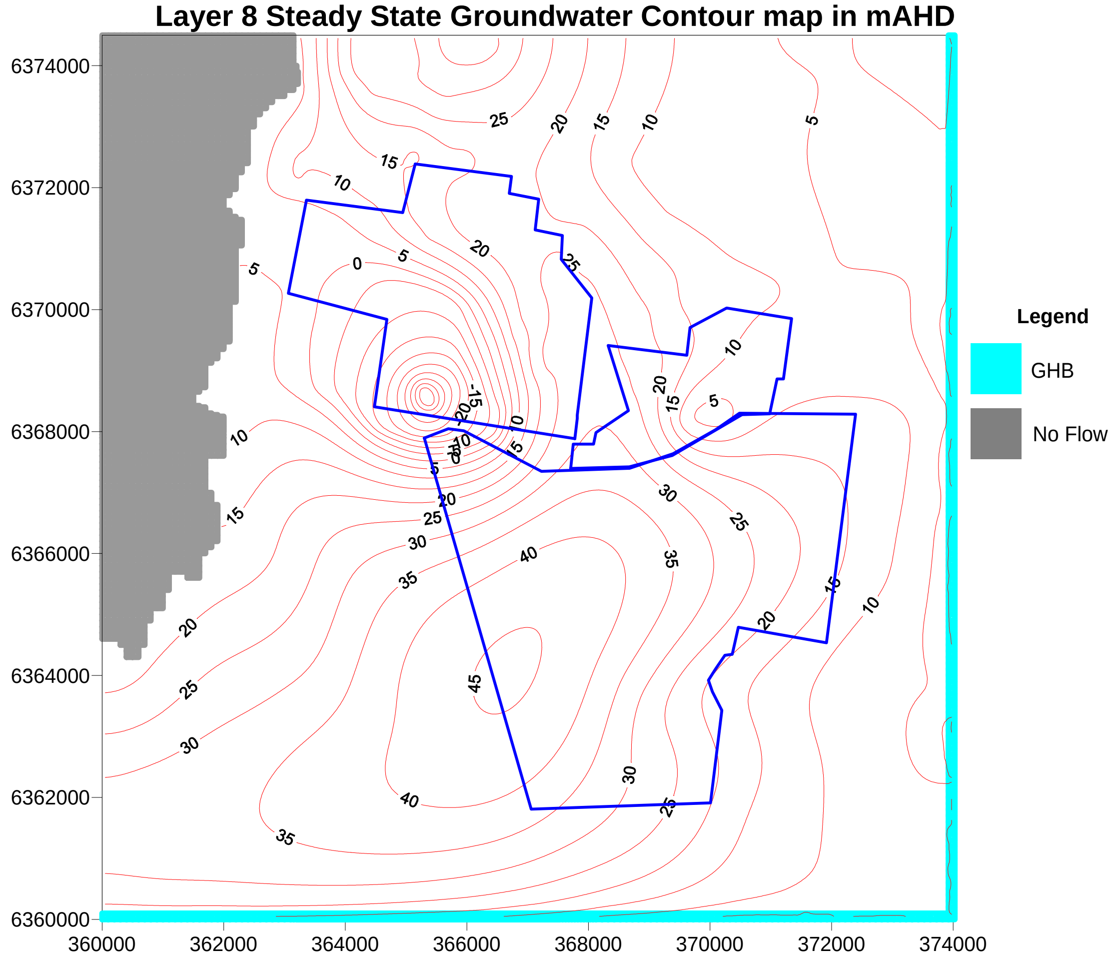

Layer 5 Steady State Groundwater Contour map in mAHD
Legend
Drain
GHB
No Flow
Dry Cell
6374000
6372000
6370000
6368000
6366000
6364000
6362000
6360000
360000
362000
364000
366000
368000
370000
372000
374000


Layer 6 Steady State Groundwater Contour map in mAHD
Legend
River
Drain
GHB
No Flow
Dry Cell
6374000
6372000
6370000
6368000
6366000
6364000
6362000
6360000
360000
362000
364000
366000
368000
370000
372000
374000

Layer 7 Steady State Groundwater Contour map in mAHD



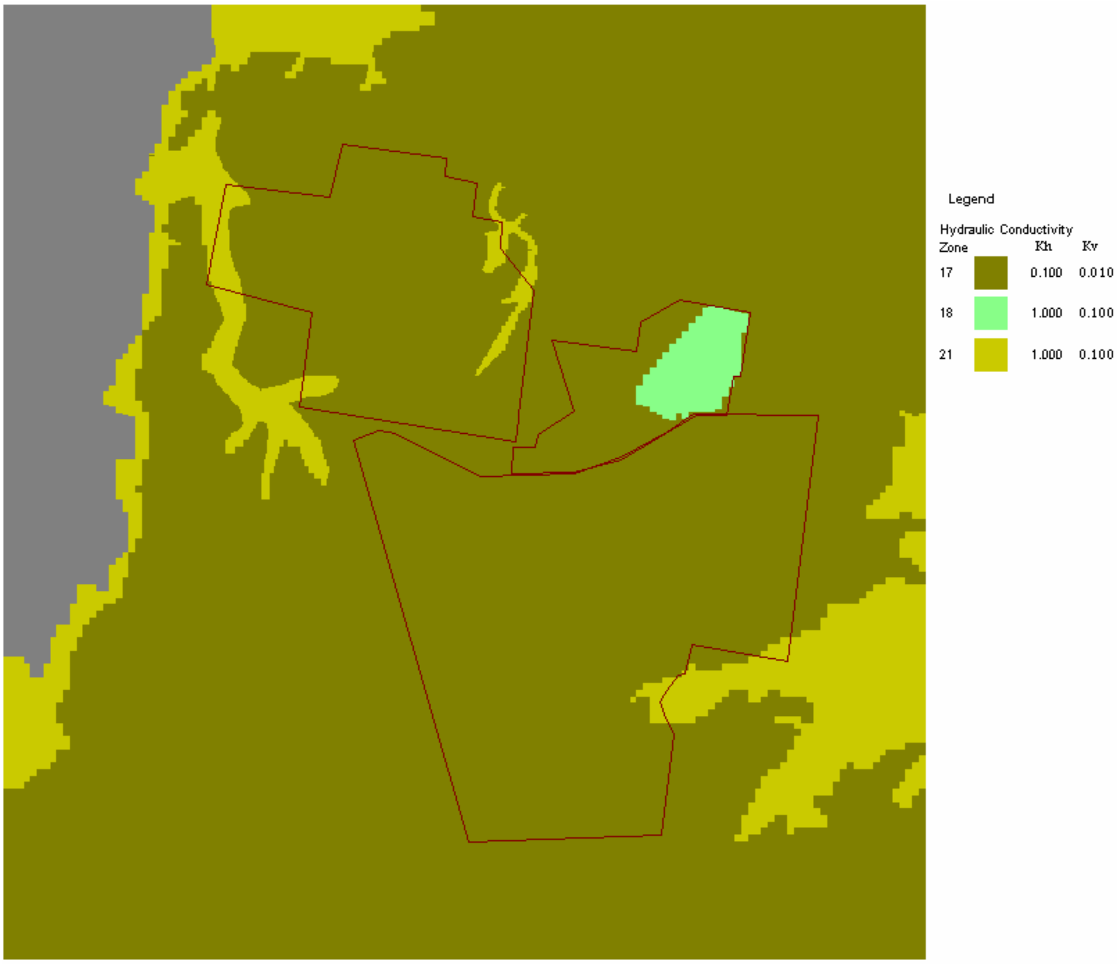
Layer 8 Steady State Groundwater Contour map in mAHD



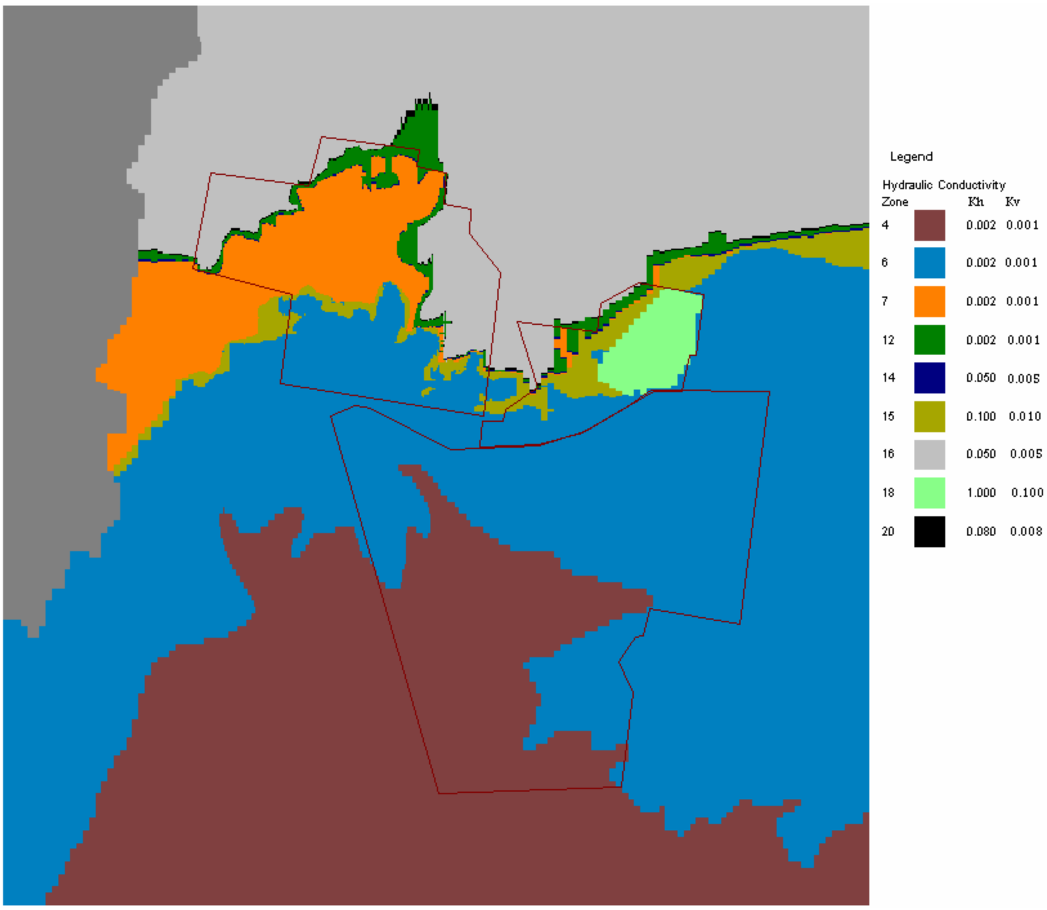
APPENDIX C

BLOOMFIELD MODEL CALIBRATED PARAMETERS

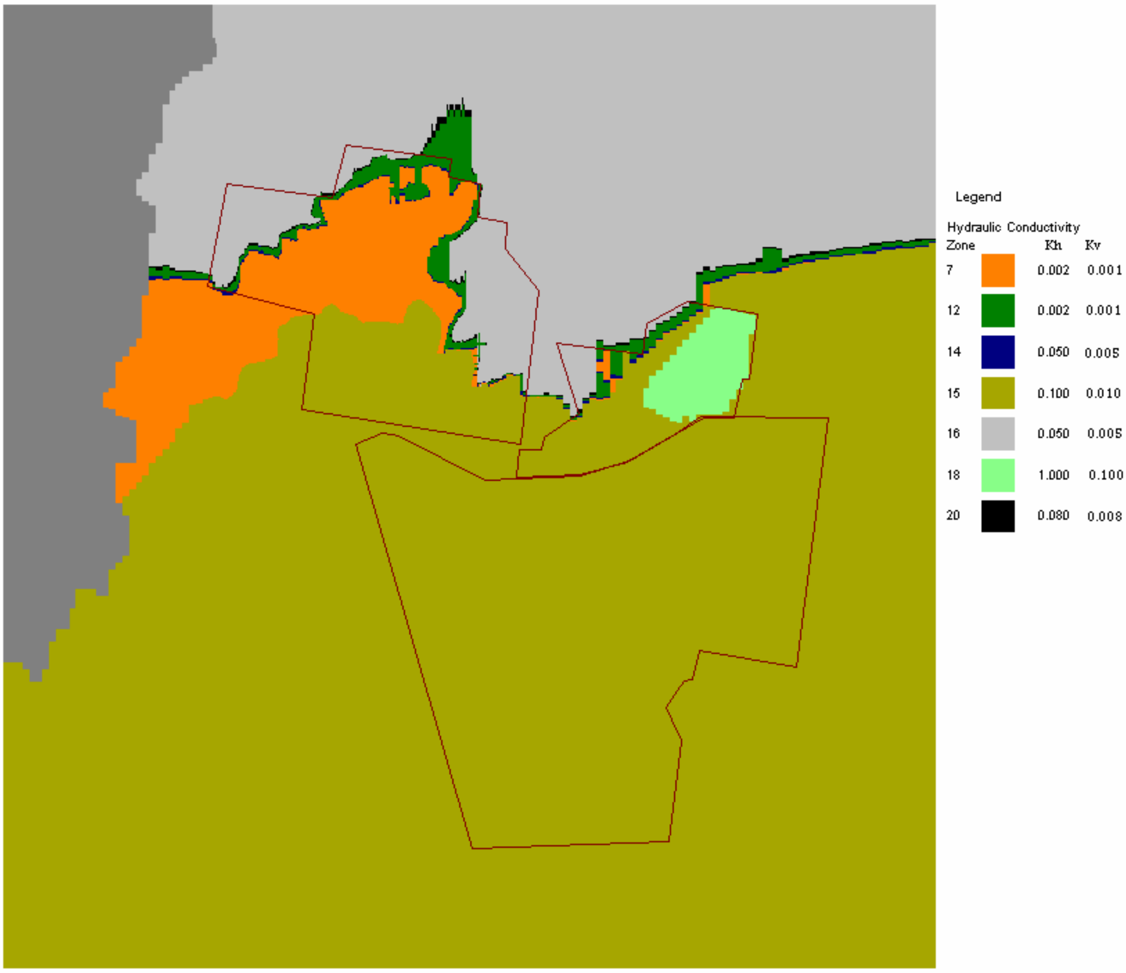
HORIZONTAL AND VERTICAL HYDRAULIC CONDUCTIVITY OF LAYER 1



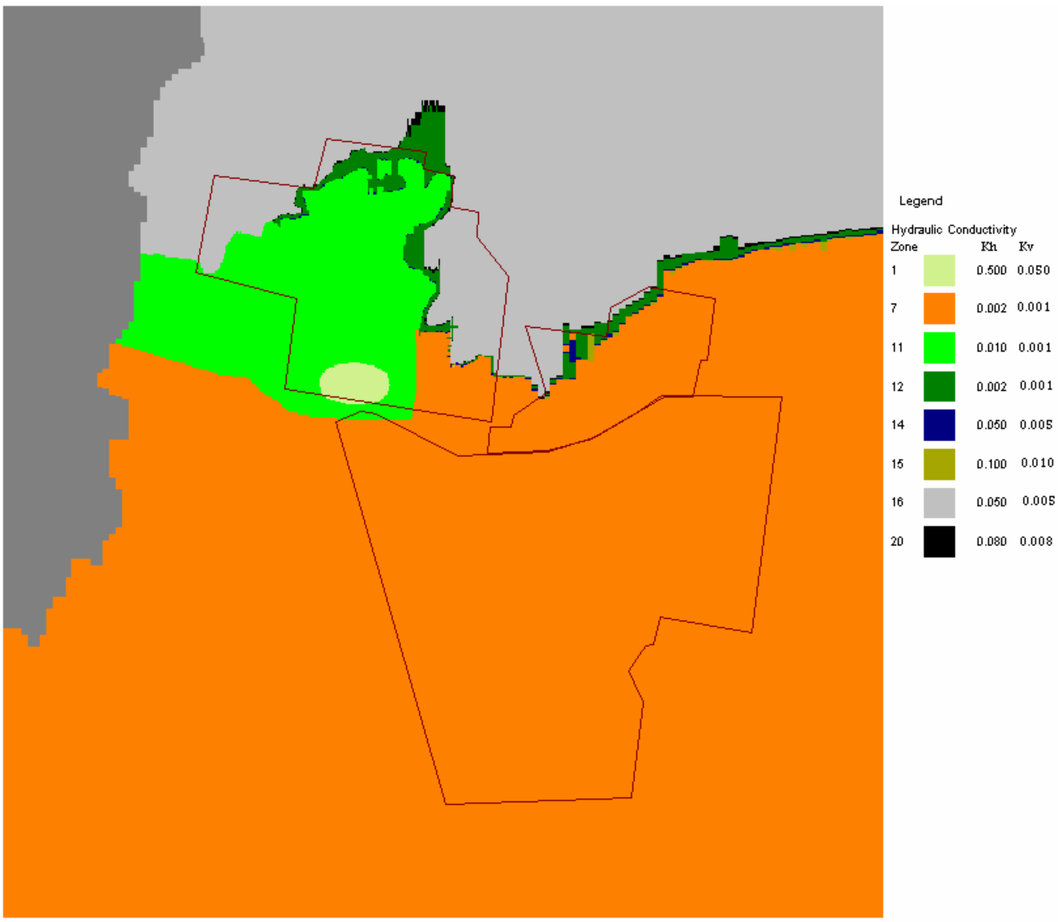
HORIZONTAL AND VERTICAL HYDRAULIC CONDUCTIVITY OF LAYER 2



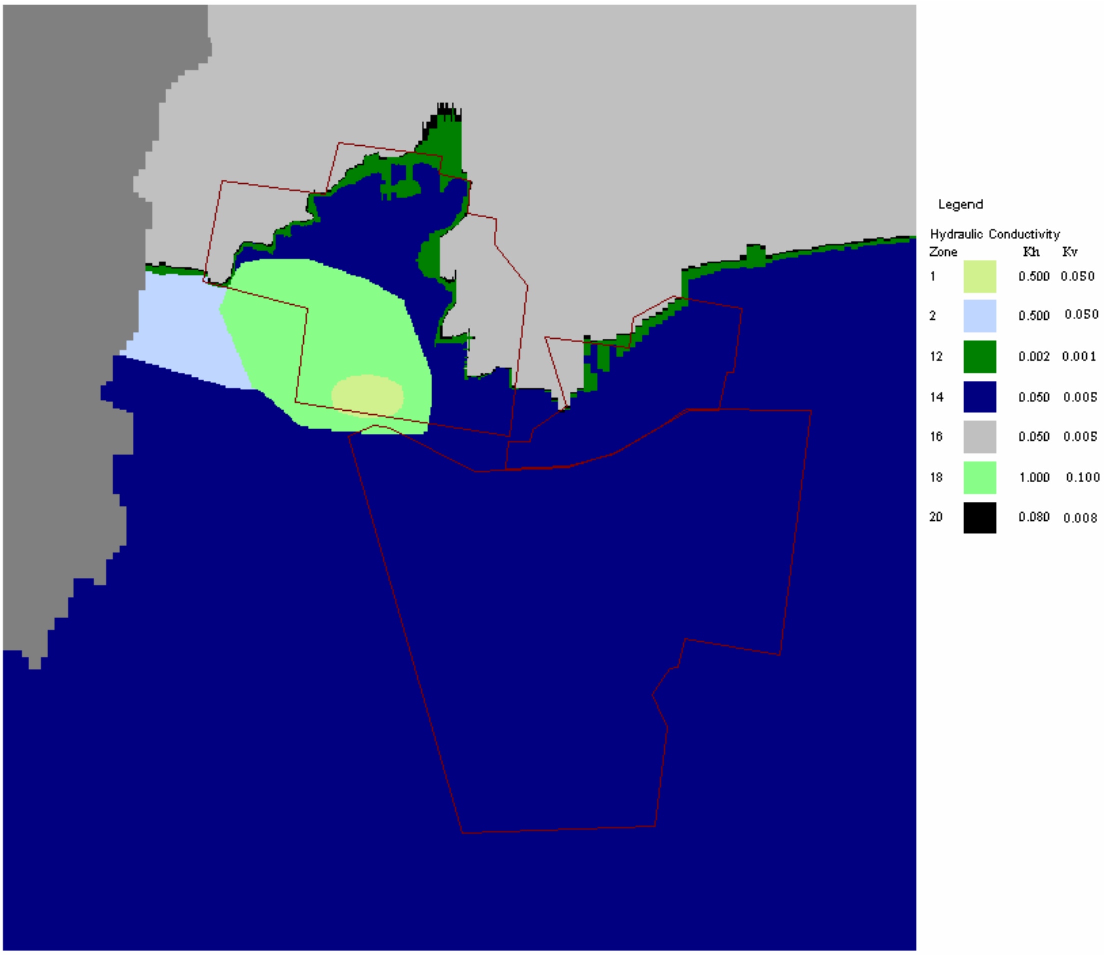
HORIZONTAL AND VERTICAL HYDRAULIC CONDUCTIVITY OF LAYER 3



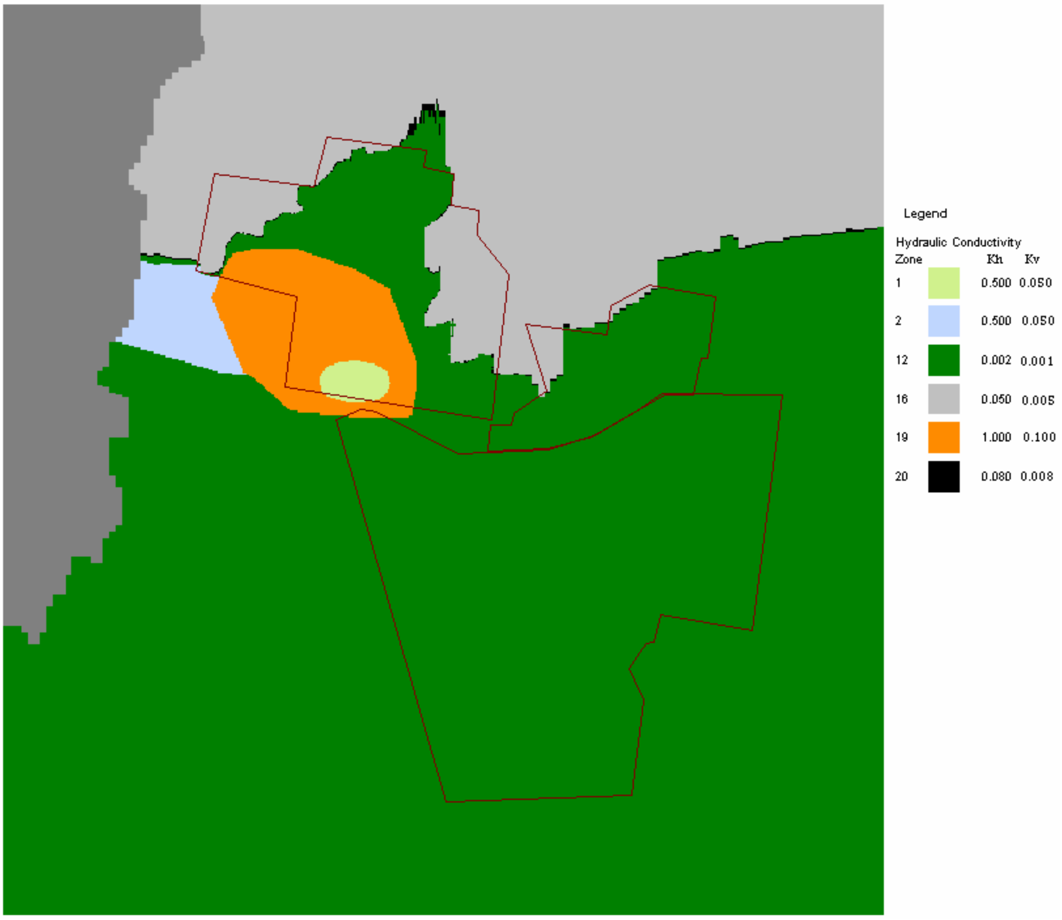
HORIZONTAL AND VERTICAL HYDRAULIC CONDUCTIVITY OF LAYER 4



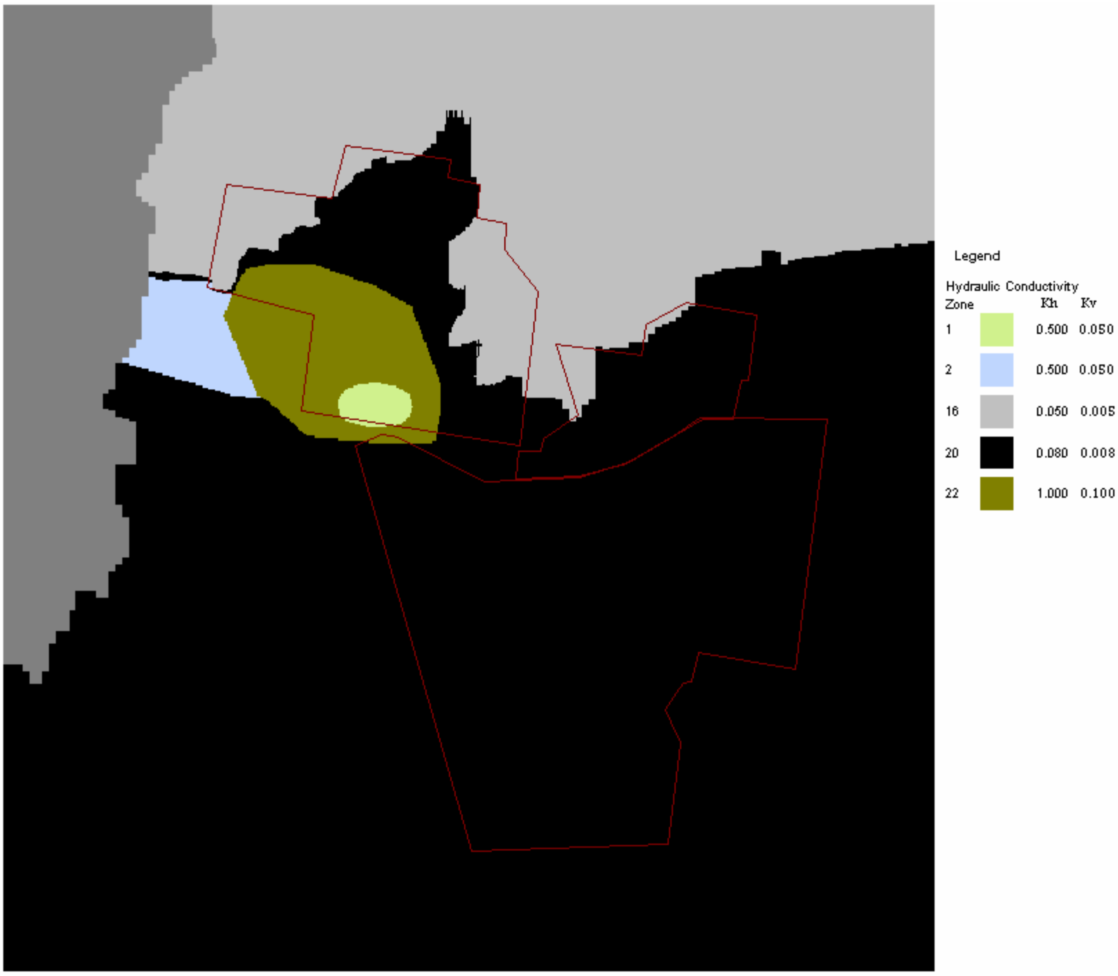
HORIZONTAL AND VERTICAL HYDRAULIC CONDUCTIVITY OF LAYER 5



HORIZONTAL AND VERTICAL HYDRAULIC CONDUCTIVITY OF LAYER 6

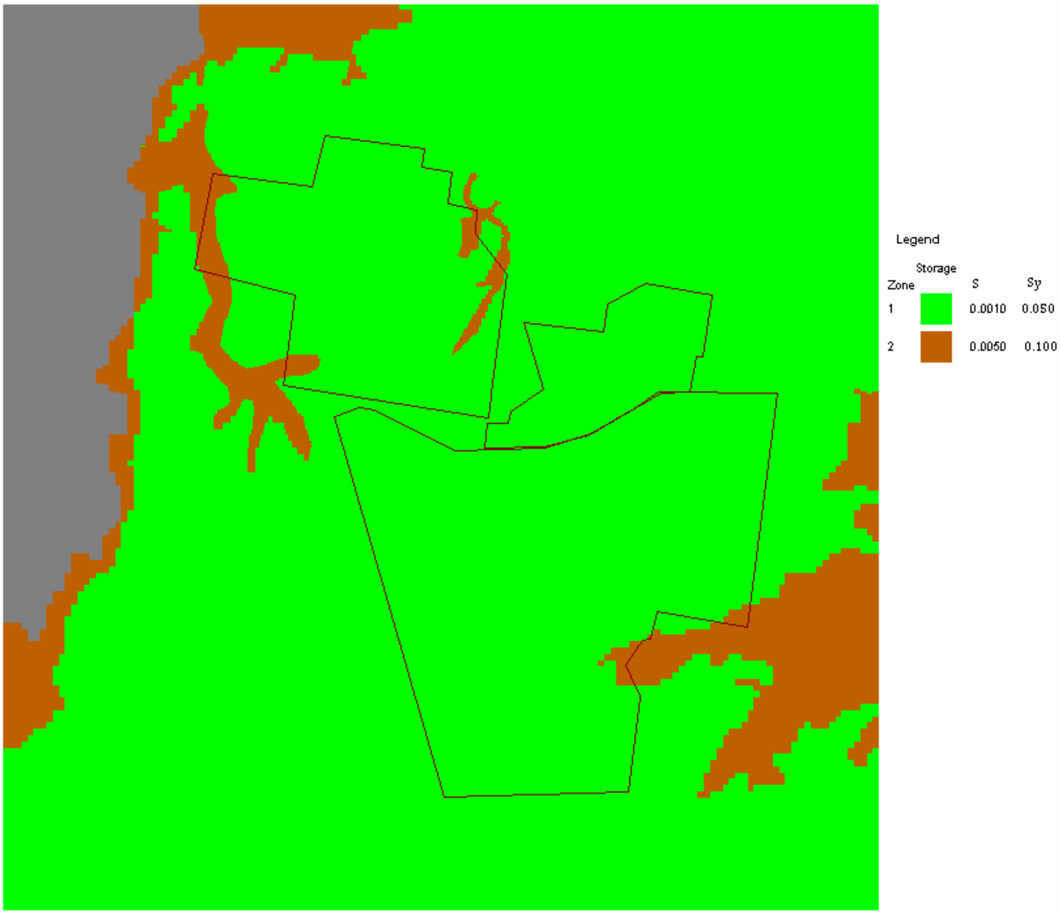


HORIZONTAL AND VERTICAL HYDRAULIC CONDUCTIVITY OF LAYER 7

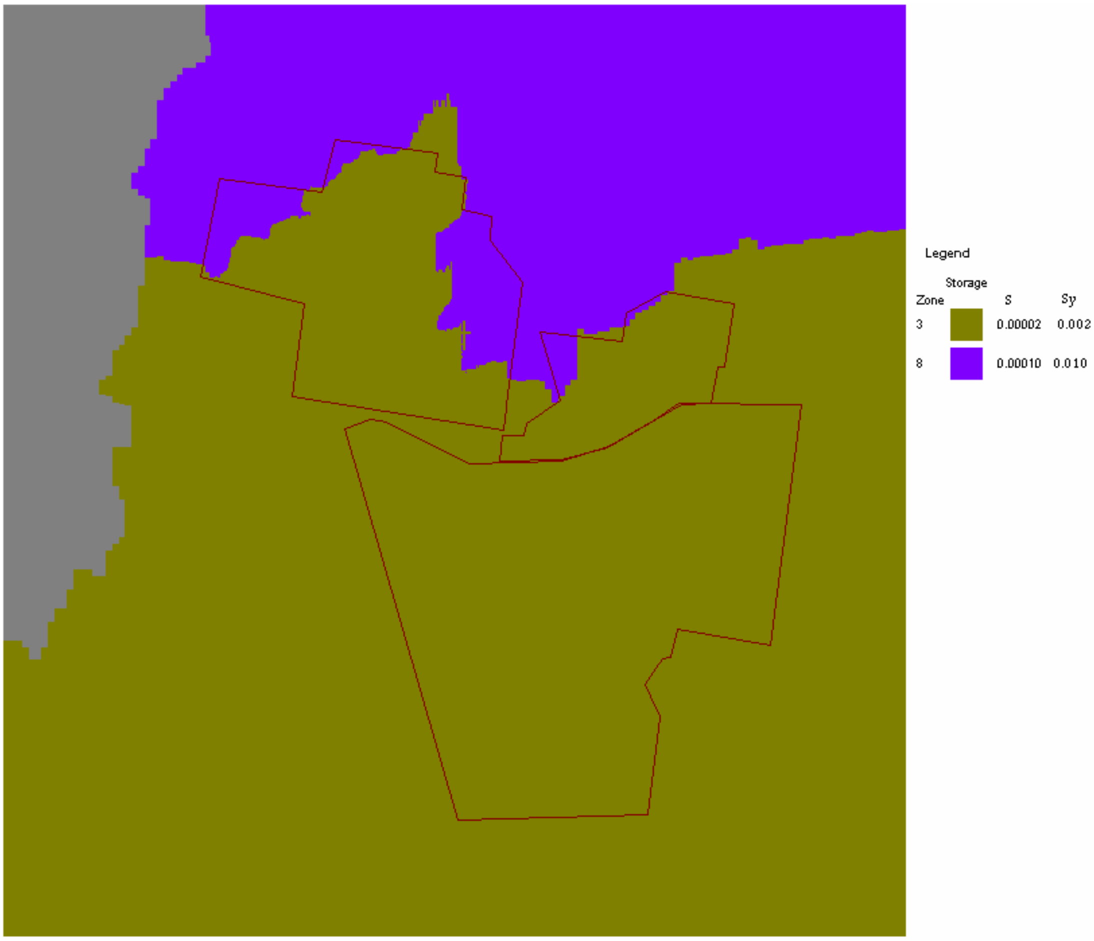


HORIZONTAL AND VERTICAL HYDRAULIC CONDUCTIVITY OF LAYER 8

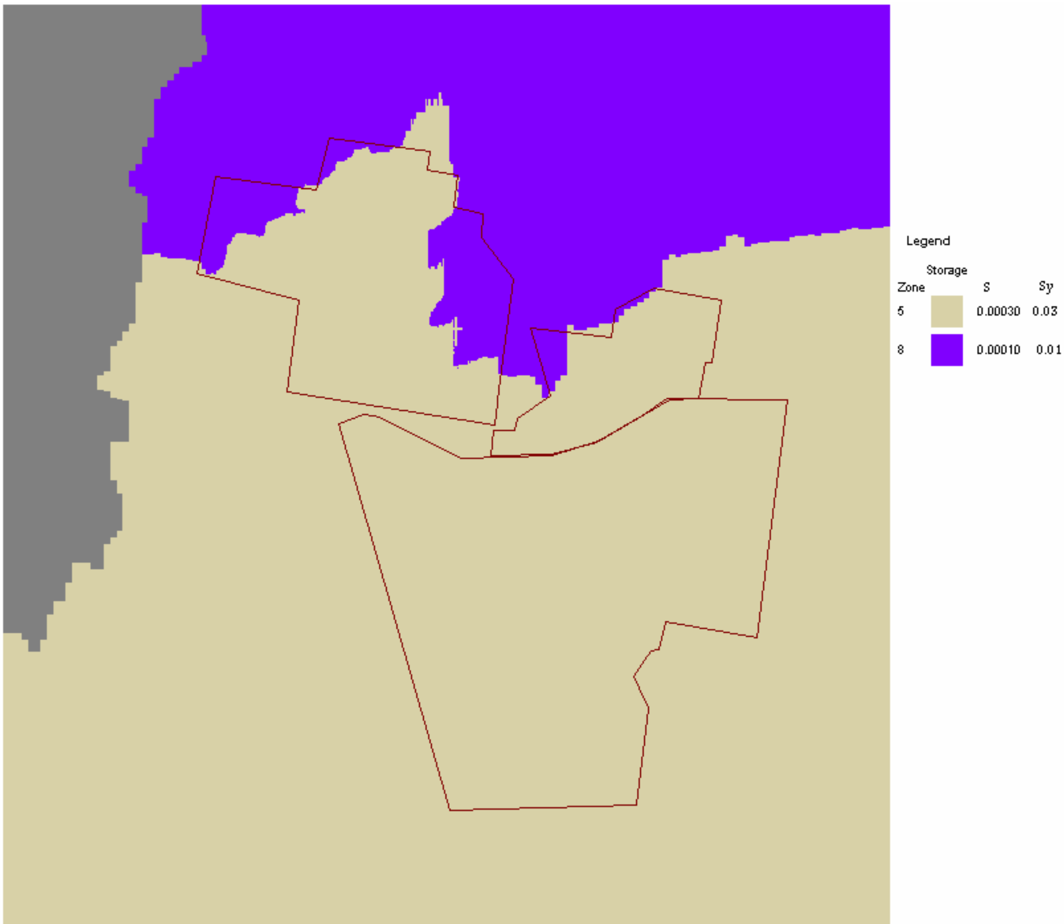
SPECIFIC YIELD AND STORAGE COEFFICIENT OF LAYER 1



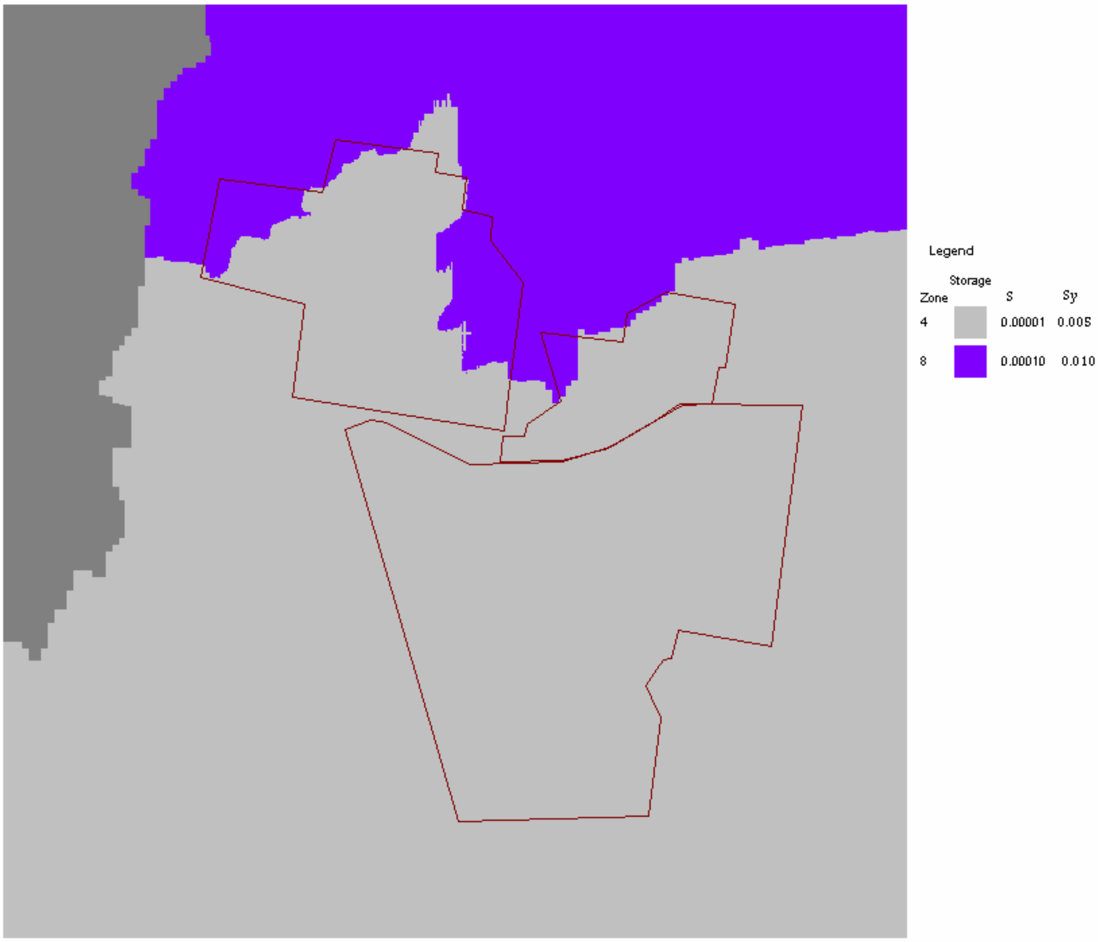
SPECIFIC YIELD AND STORAGE COEFFICIENT OF LAYER 2



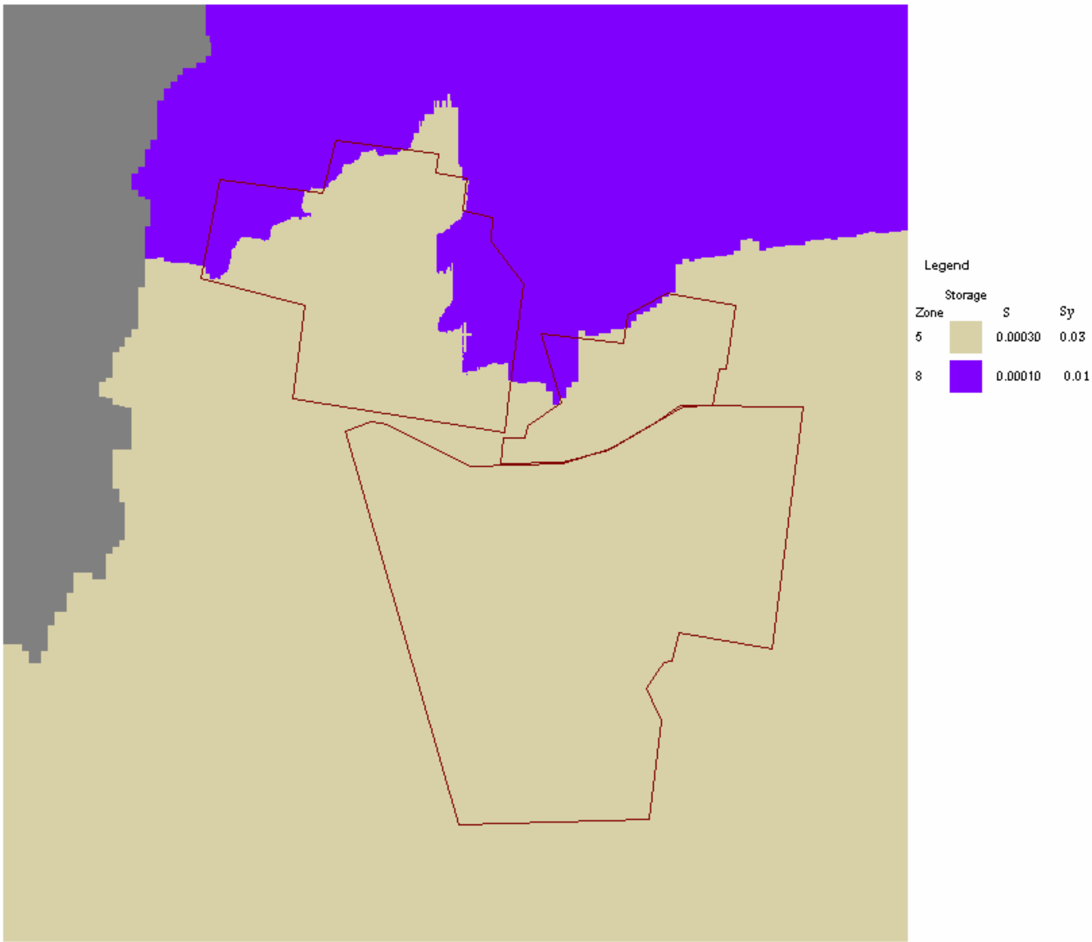
SPECIFIC YIELD AND STORAGE COEFFICIENT OF LAYER 3



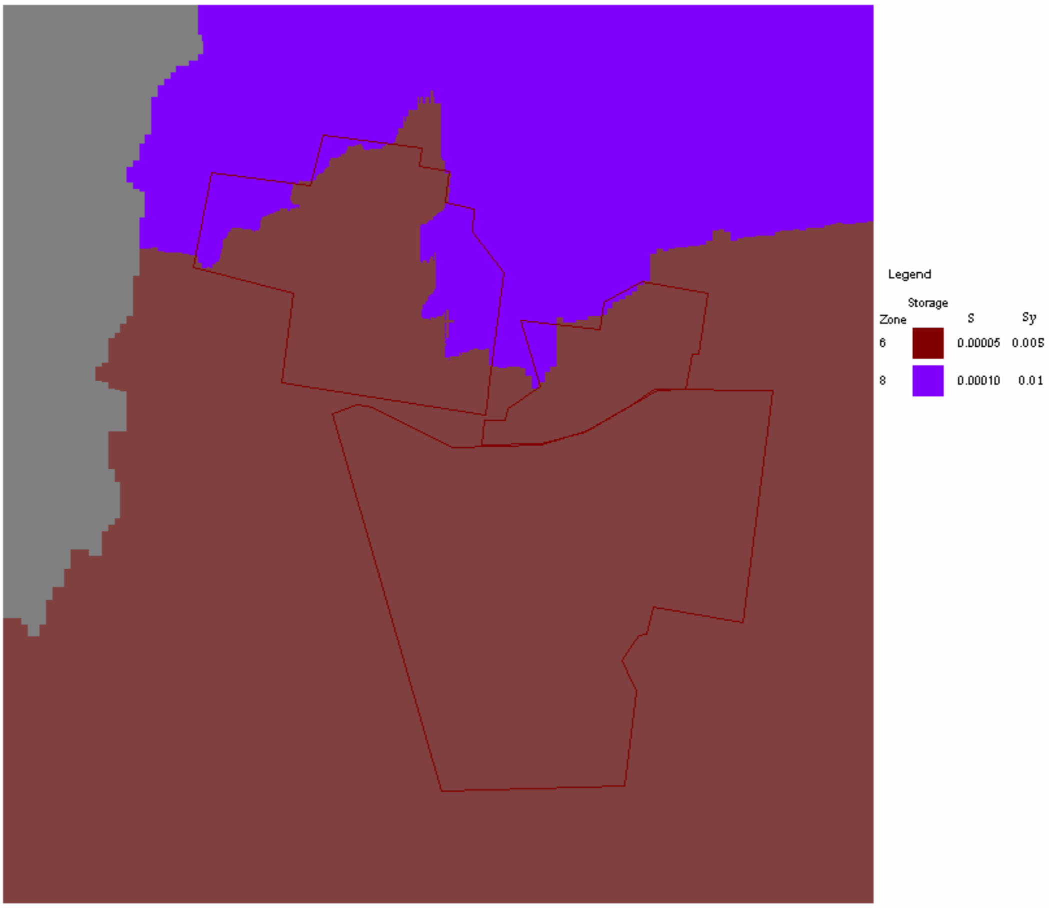
SPECIFIC YIELD AND STORAGE COEFFICIENT OF LAYER 4



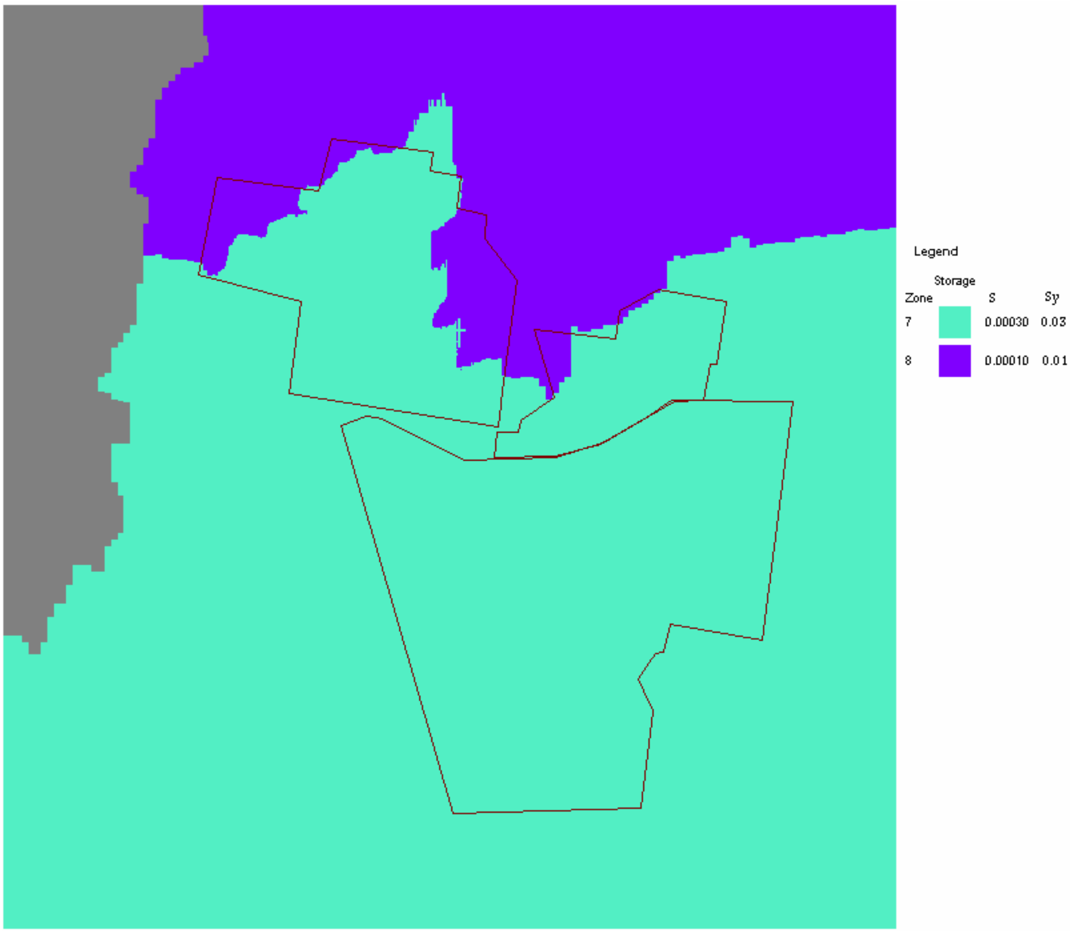
SPECIFIC YIELD AND STORAGE COEFFICIENT OF LAYER 5



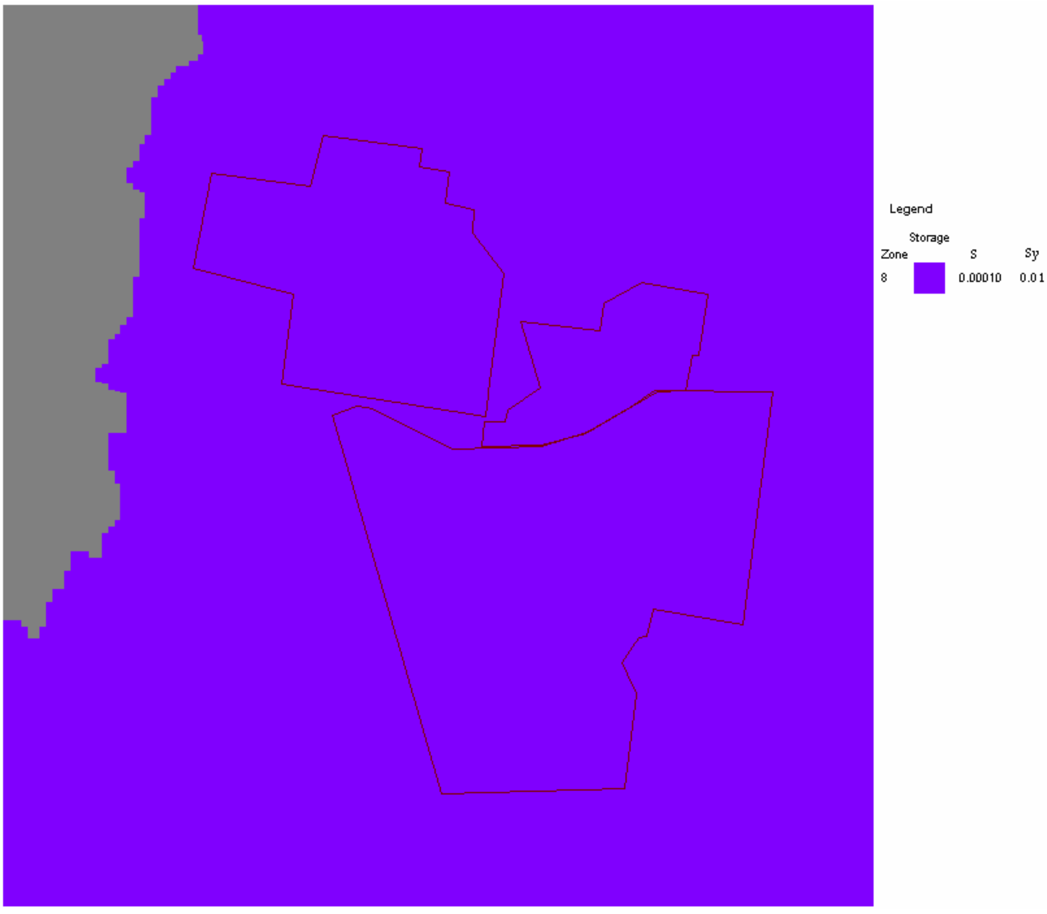
SPECIFIC YIELD AND STORAGE COEFFICIENT OF LAYER 6



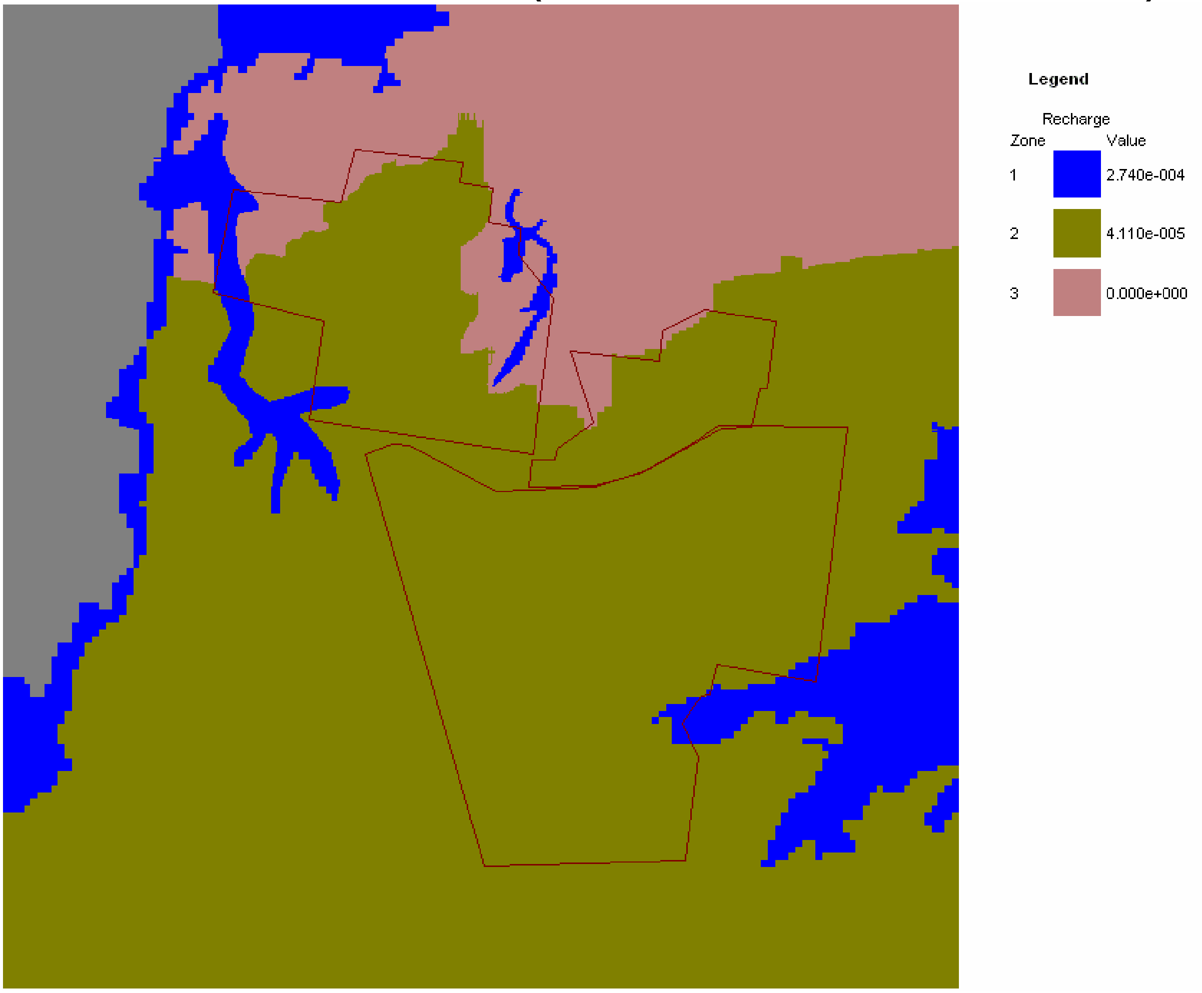
SPECIFIC YIELD AND STORAGE COEFFICIENT OF LAYER 7



SPECIFIC YIELD AND STORAGE COEFFICIENT OF LAYER 8



CALIBRATED RECHARGE ZONES (APPLIED TO THE HIGHEST ACTIVE LAYER)



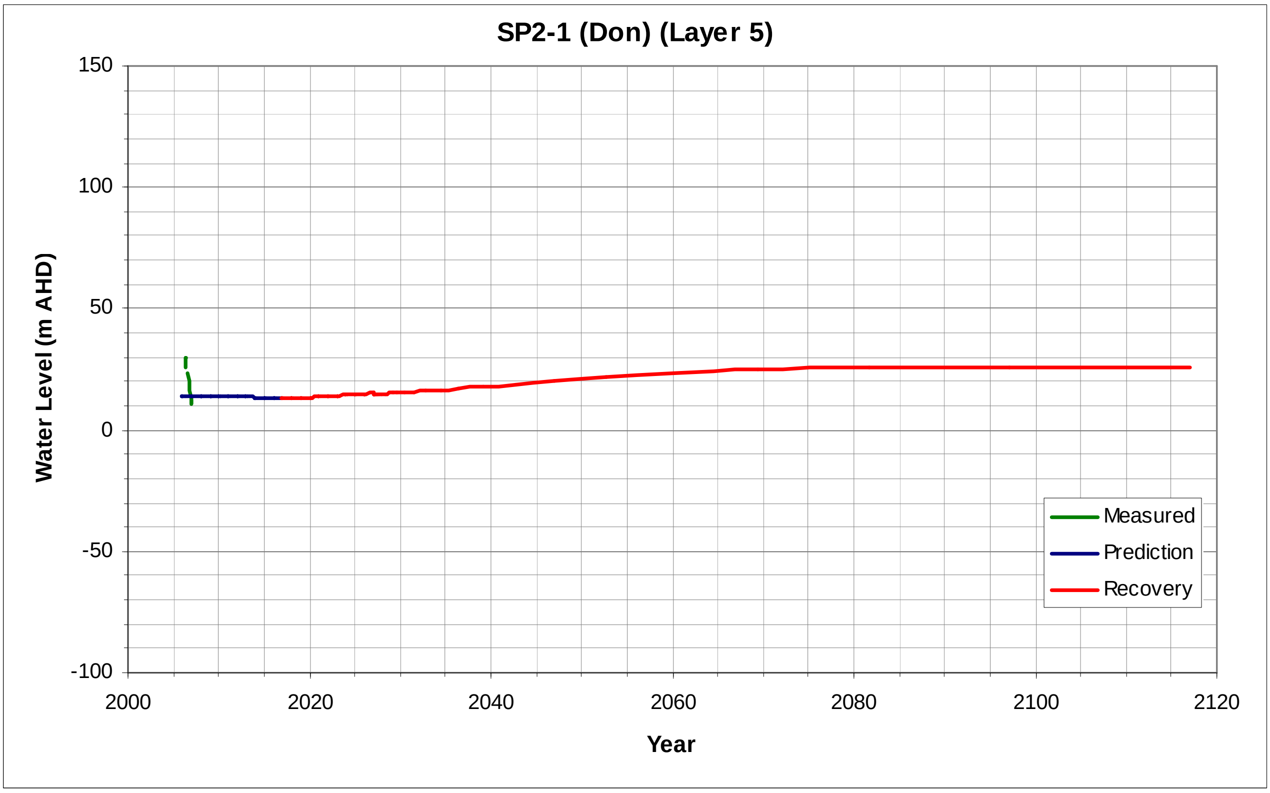
CALIBRATED EVT ZONES (APPLIED TO THE HIGHEST ACTIVE LAYER)

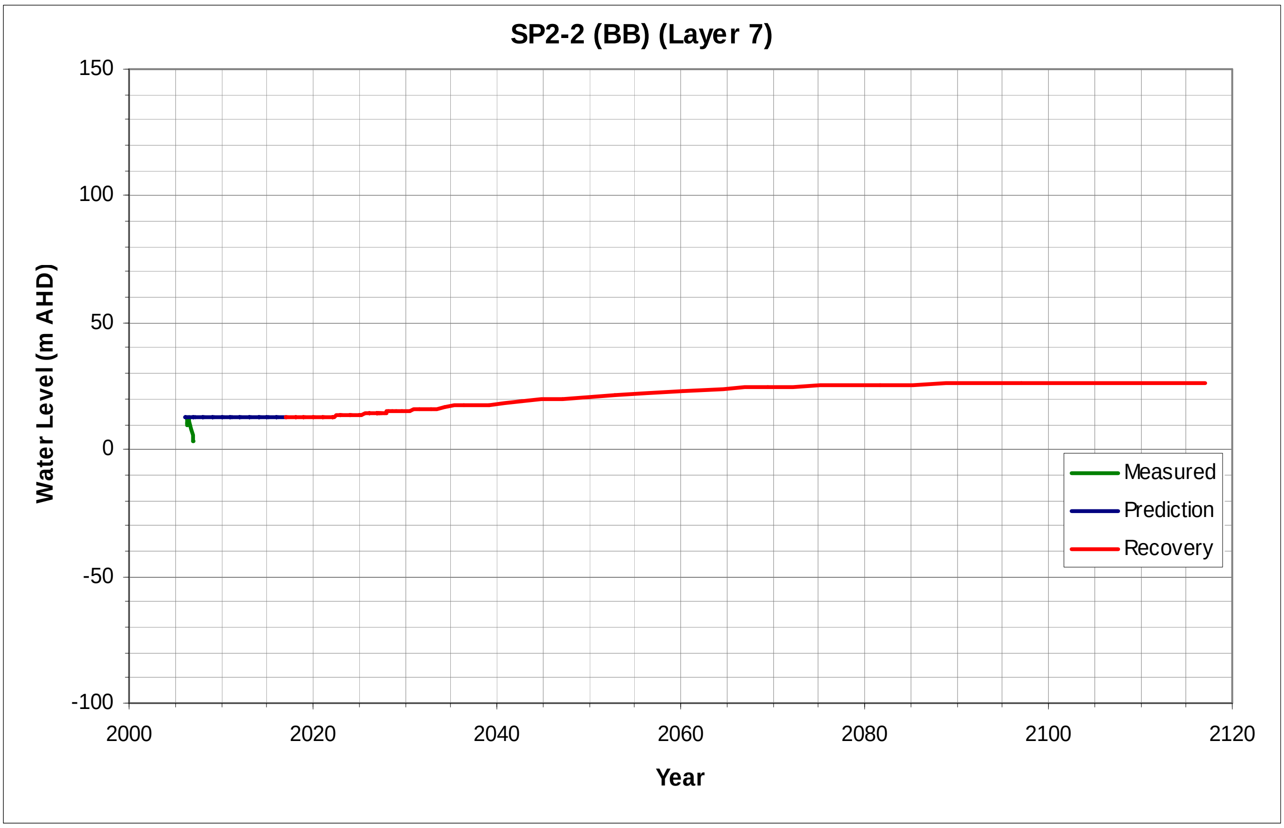
APPENDIX D

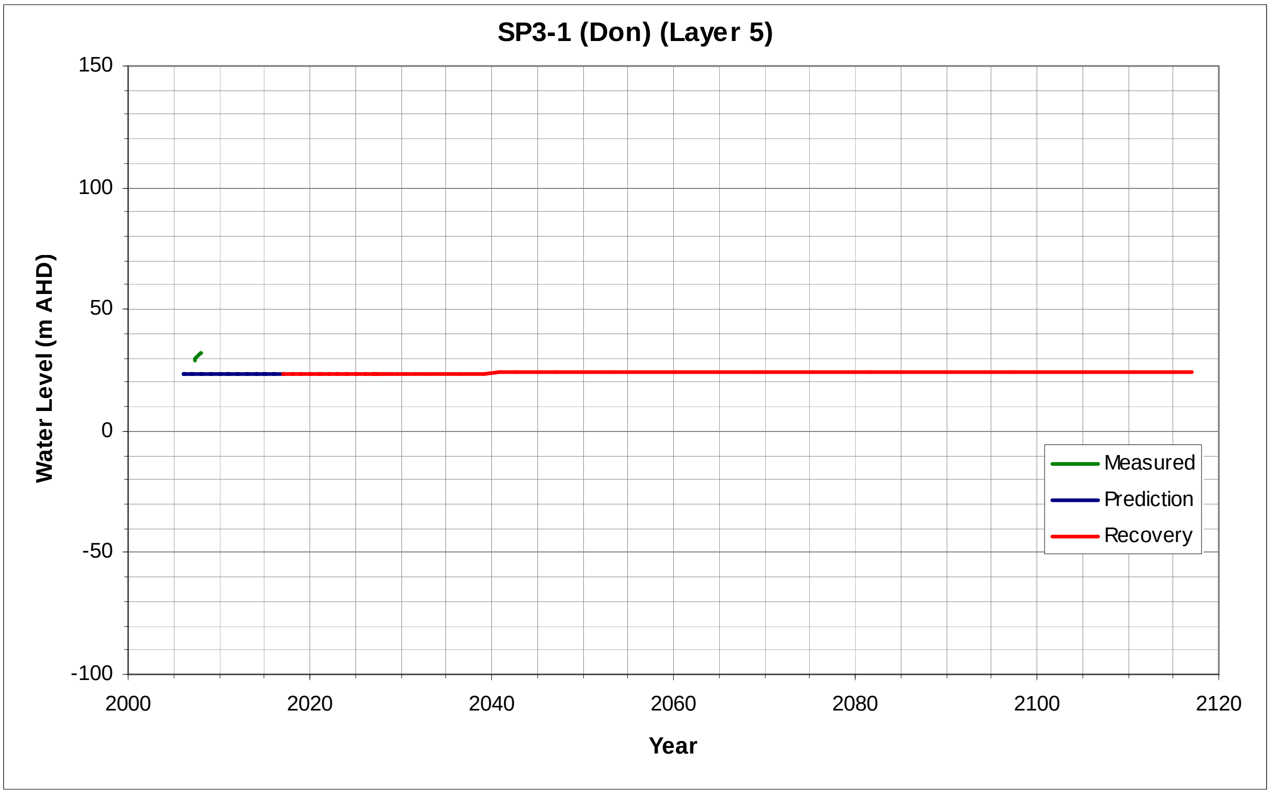
BLOOMFIELD MODEL MINING AND RECOVERY RUN RESULTS (HYDROGRAPHS AND CONTOUR MAPS)

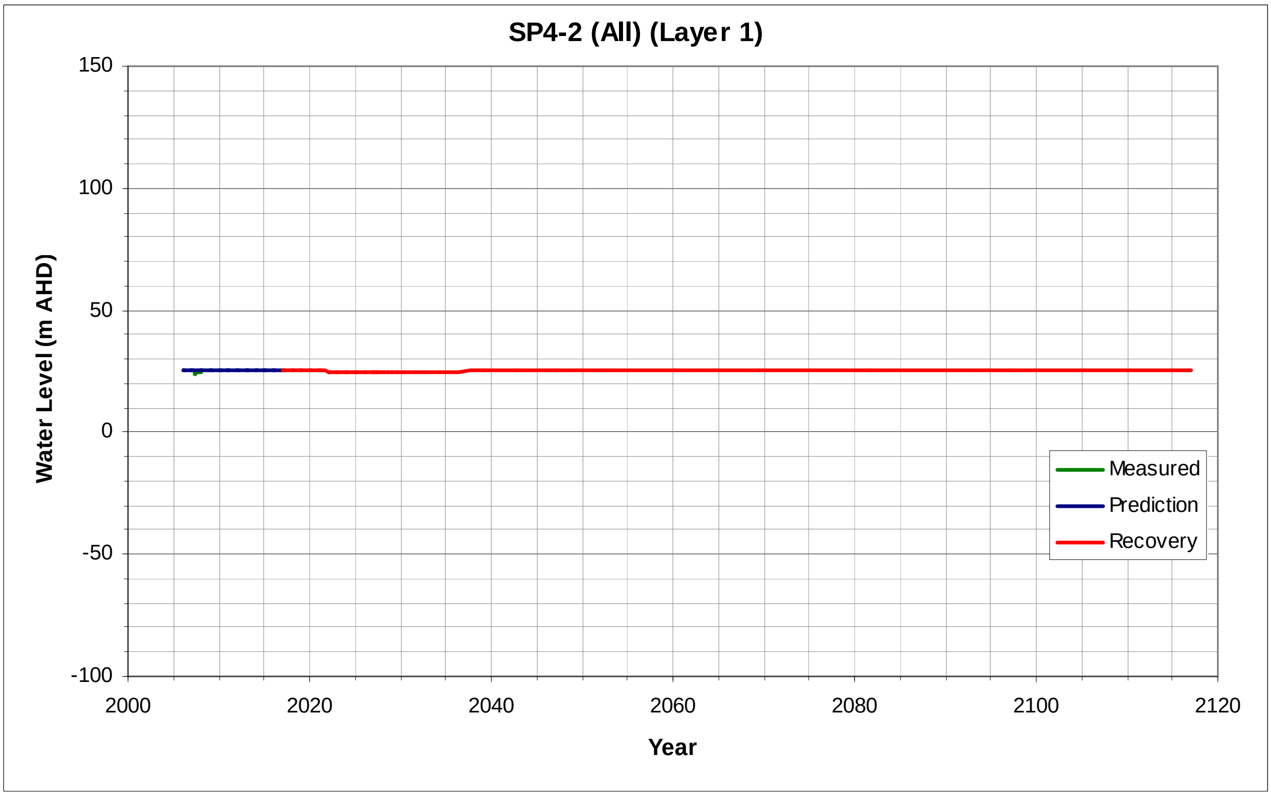

VW1-35m (Don) (Layer 5)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery


VW1-46m (BB) (Layer 7)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery


SP2-1 (Don) (Layer 5)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery


SP2-2 (BB) (Layer 7)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery


SP3-1 (Don) (Layer 5)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

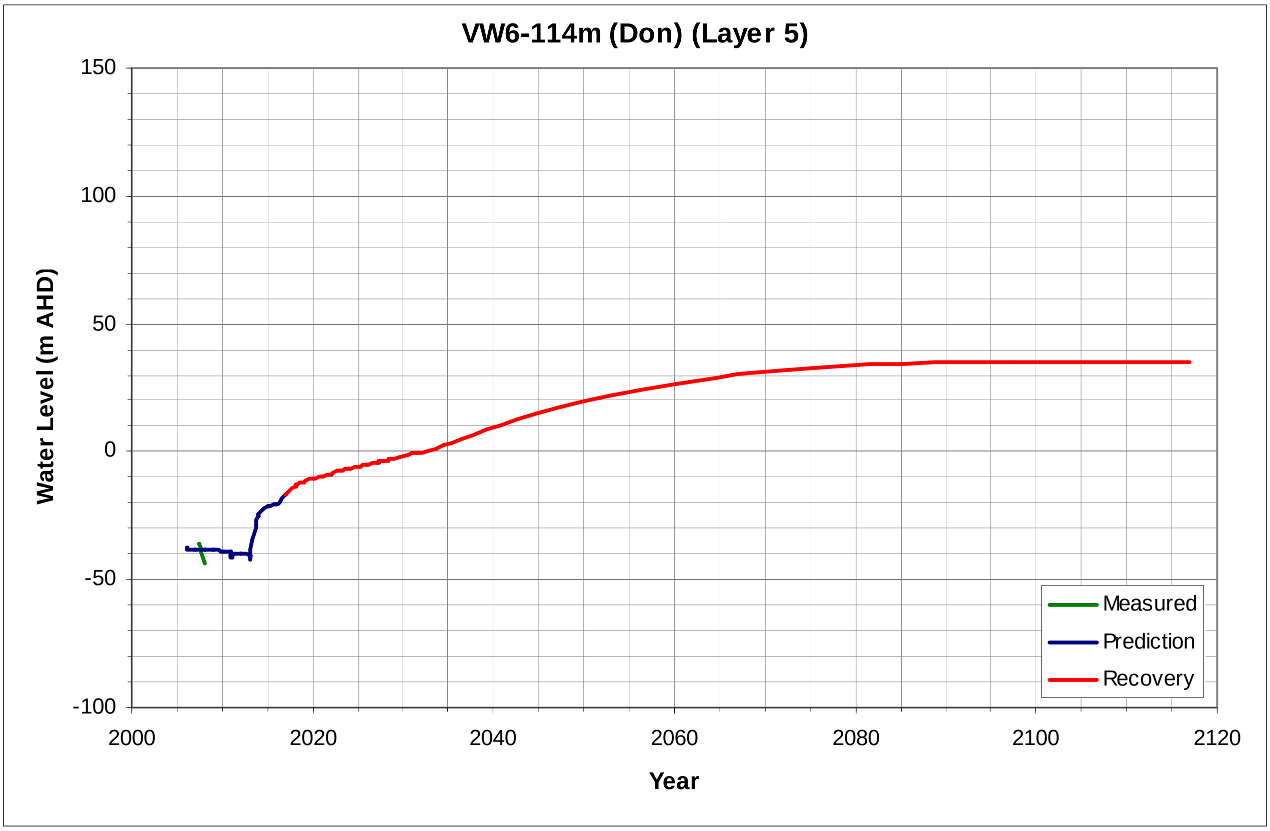

SP4-2 (All) (Layer 1)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

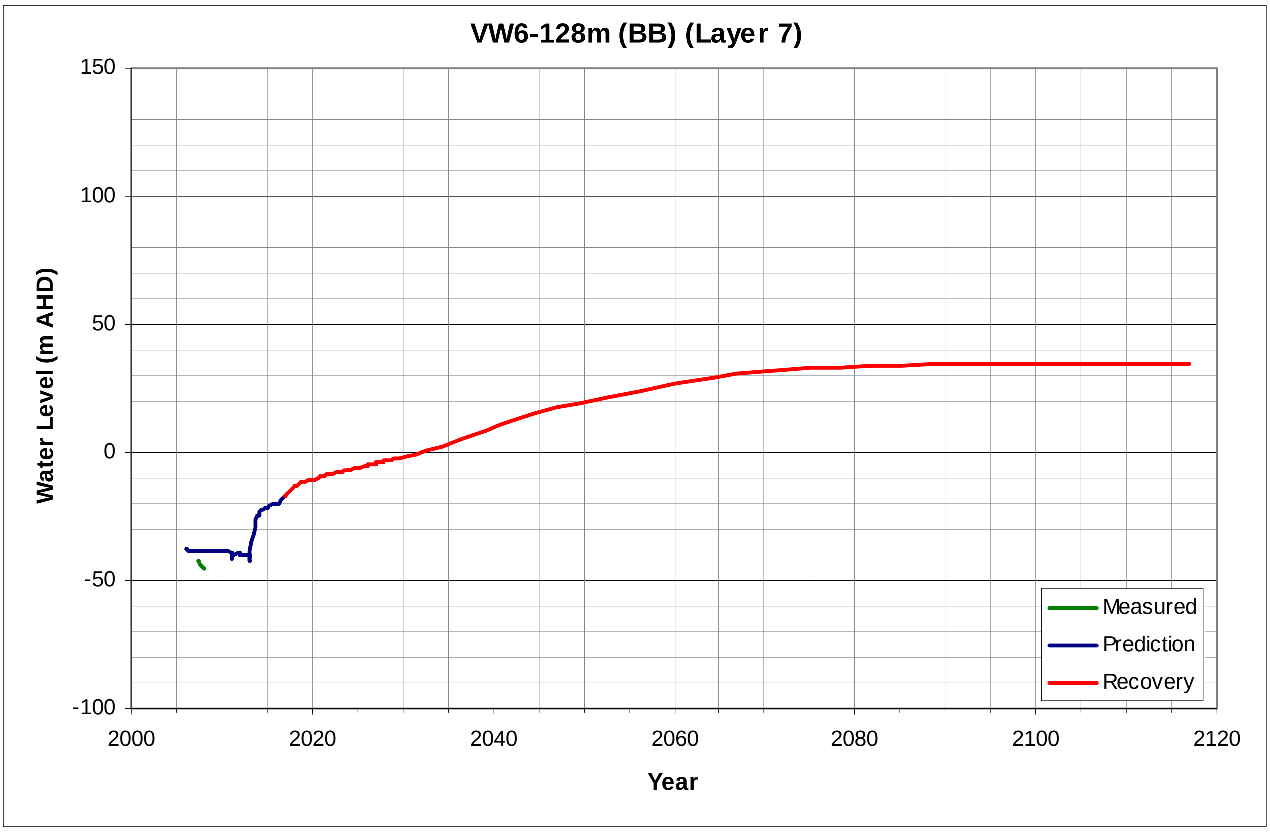

VW5-62m (WC) (Layer 4)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

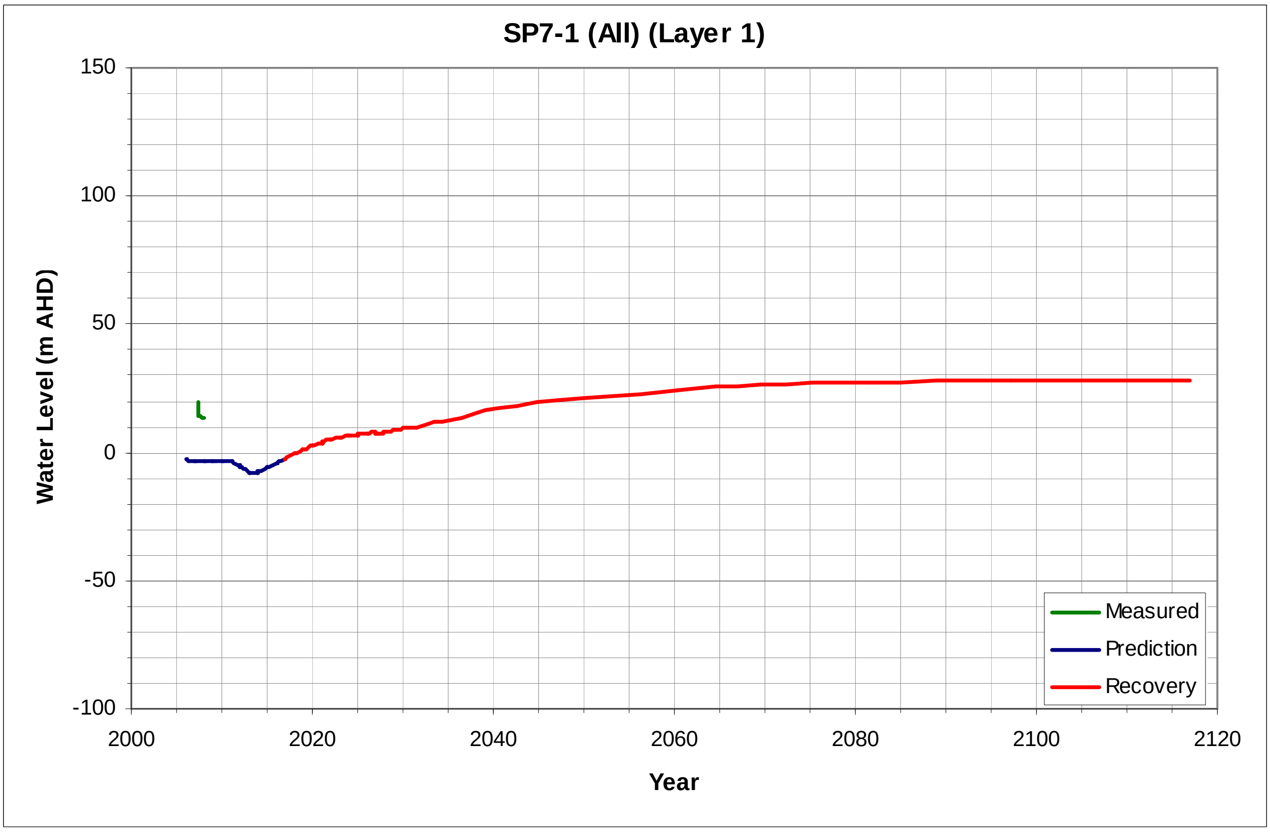

VW5-71m (Don) (Layer 5)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery


VW5-90m (BB) (Layer 7)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

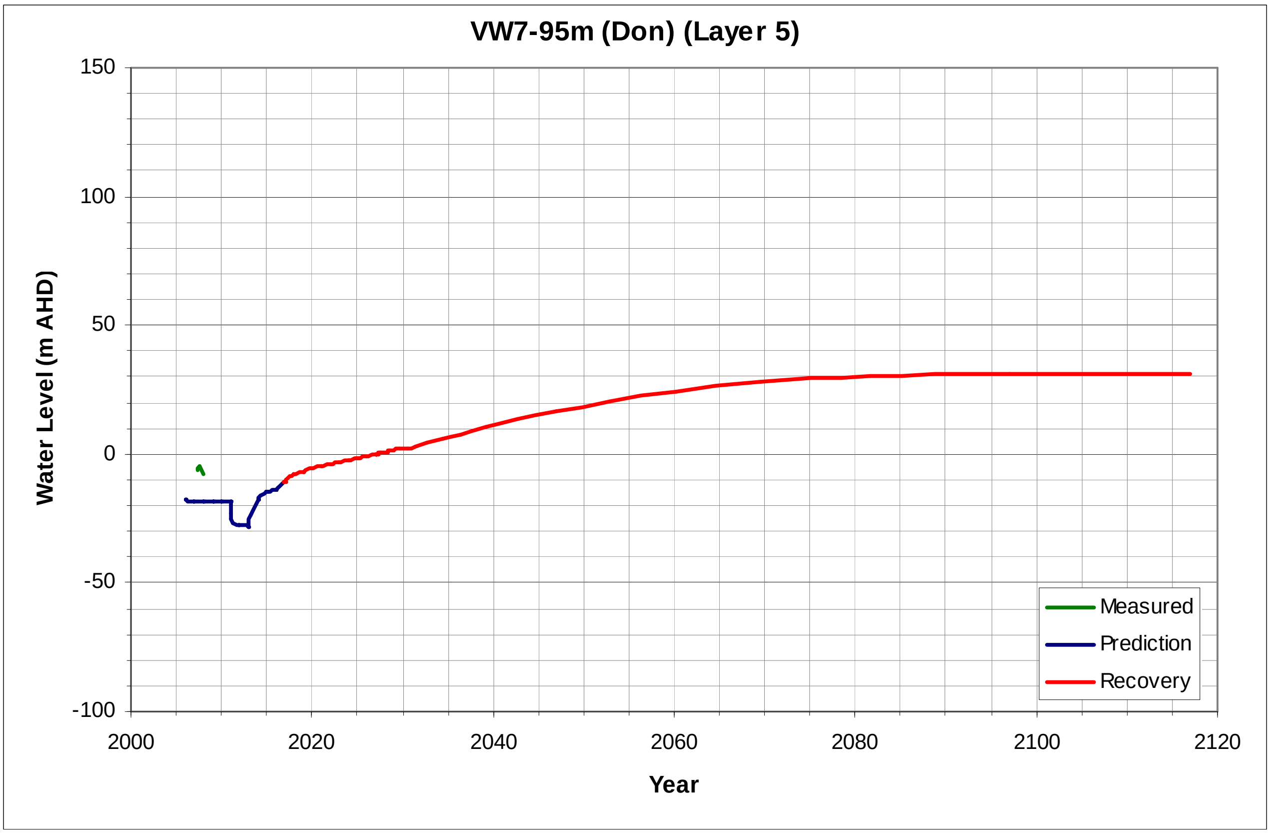

VW6-96m (WC) (Layer 4)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery


VW6-114m (Don) (Layer 5)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

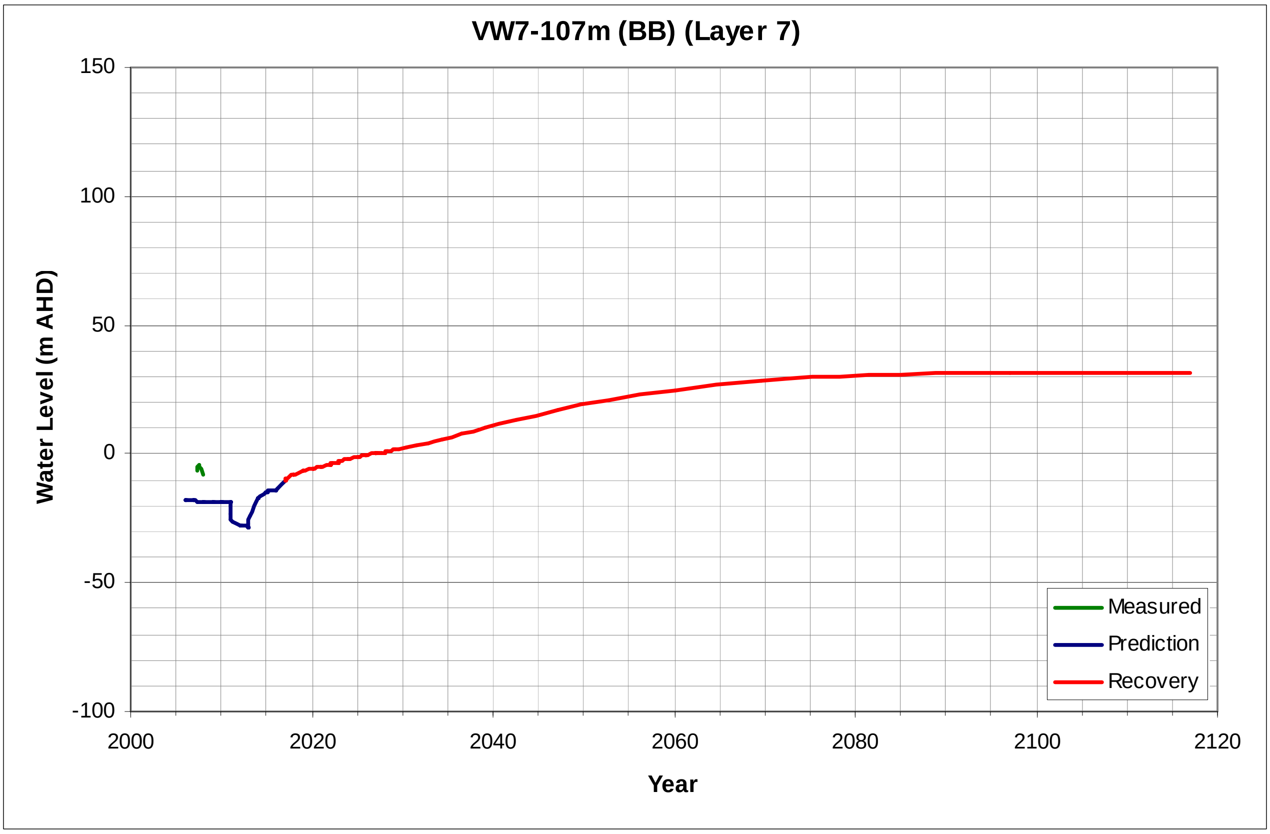

VW6-128m (BB) (Layer 7)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery


SP7-1 (All) (Layer 1)
150
100
50
0
-50
-100
Water Level (m AHD)
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

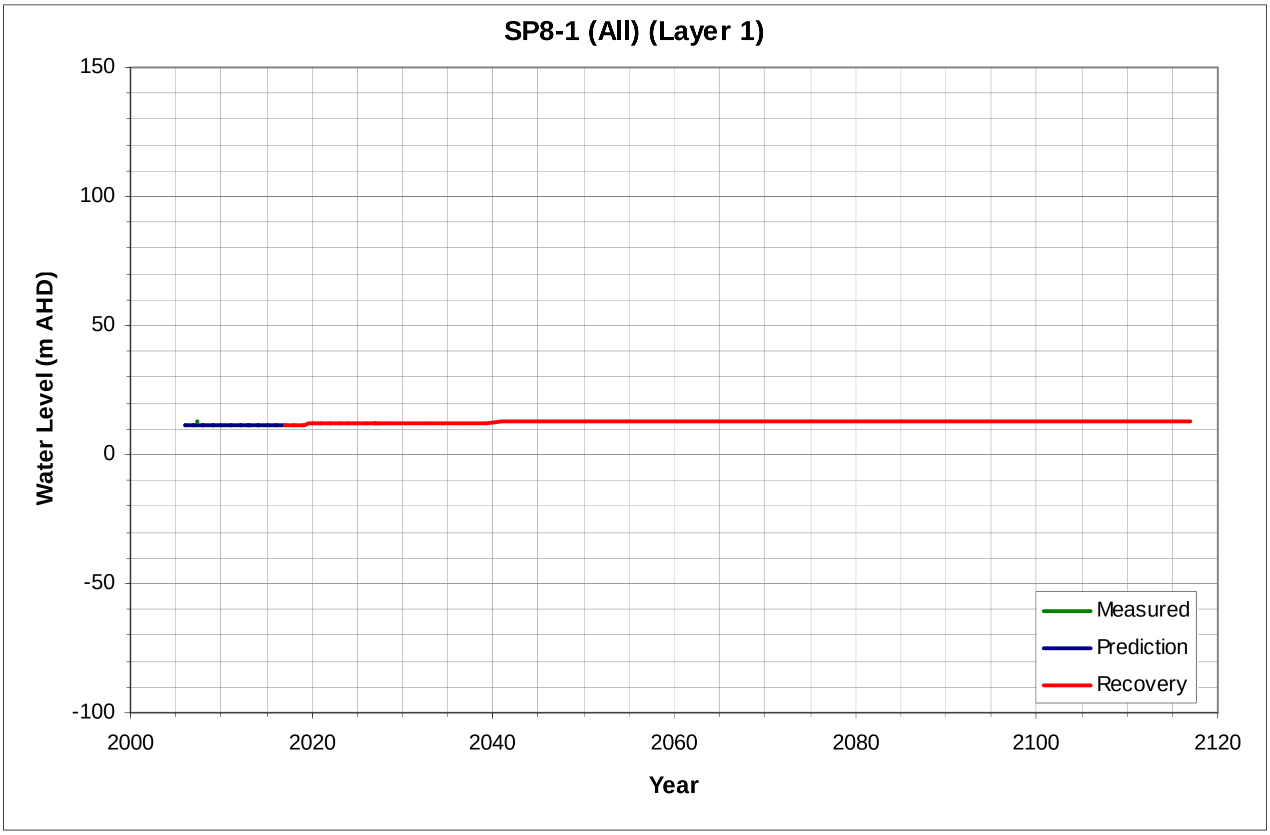

VW7-70m (WC) (Layer 4)
150
100
50
0
-50
-100
Water Level (m AHD)
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery



VW7-95m (Don) (Layer 5)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

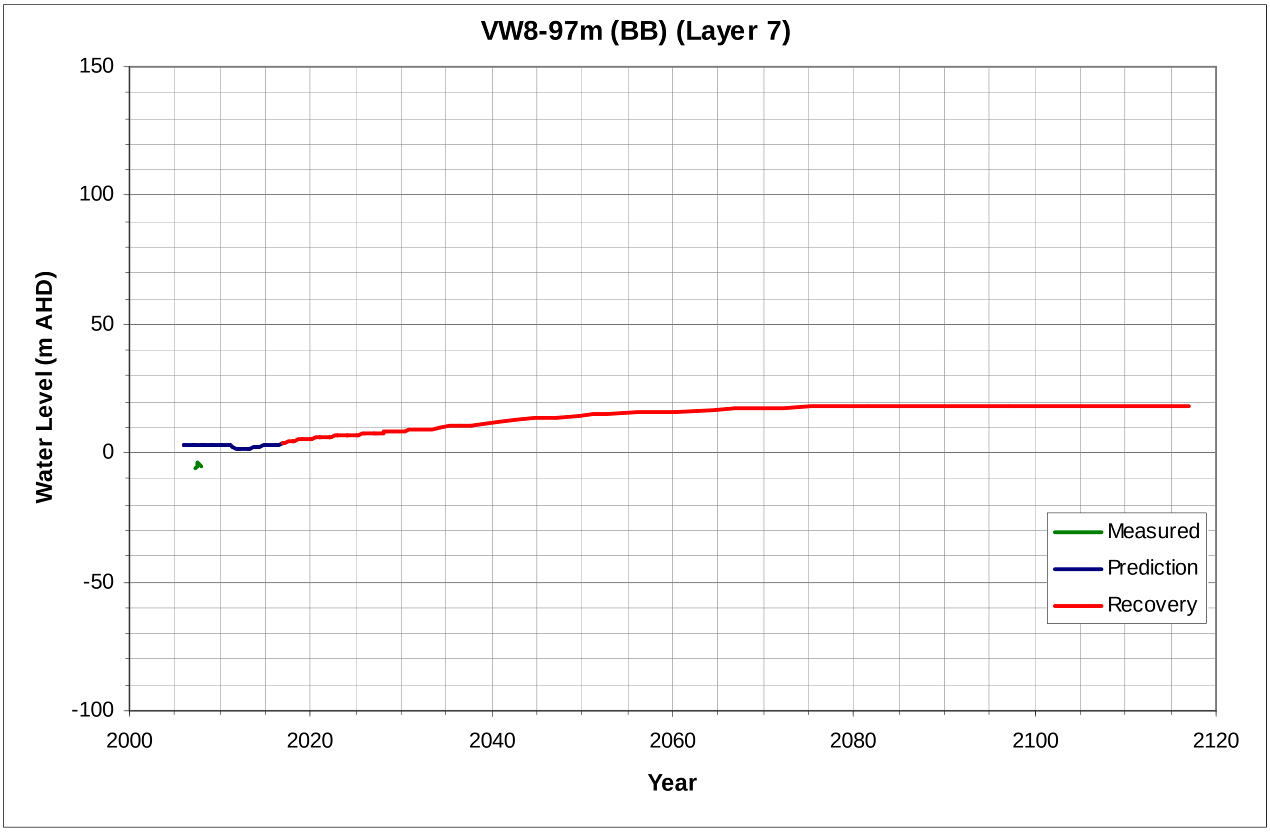


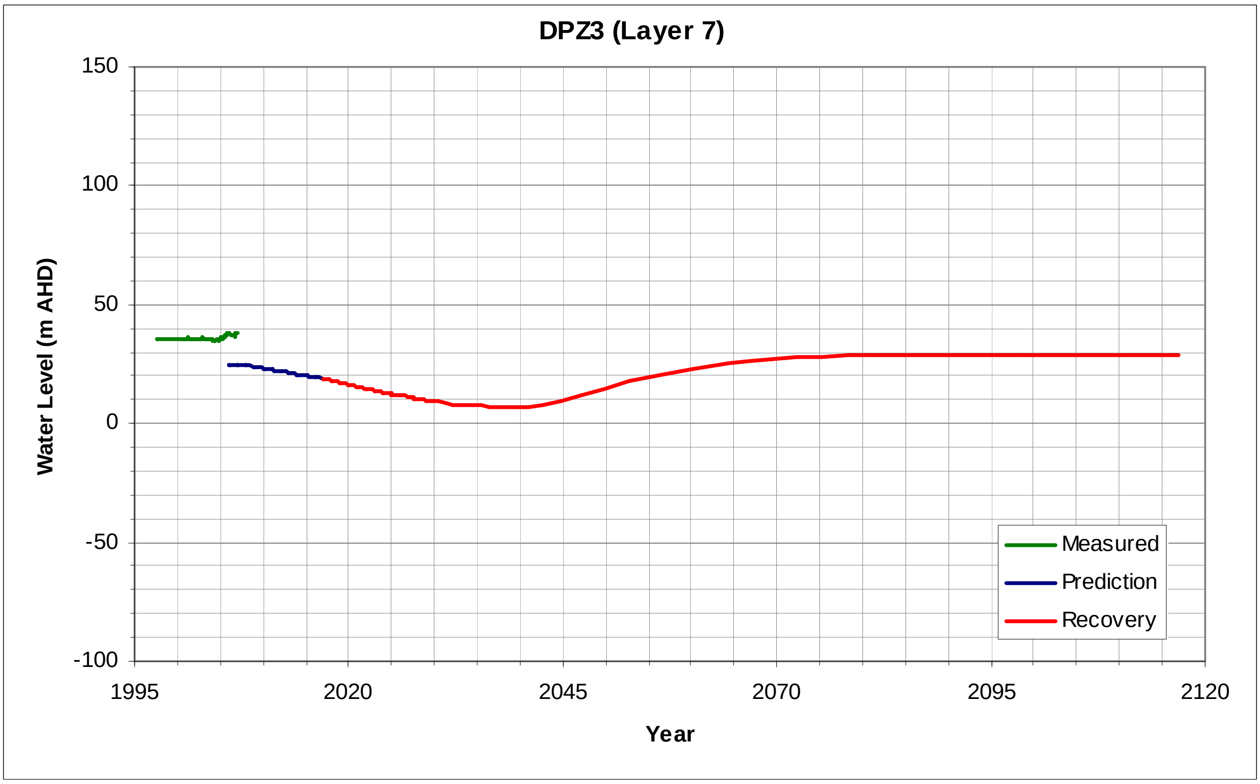
VW7-107m (BB) (Layer 7)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

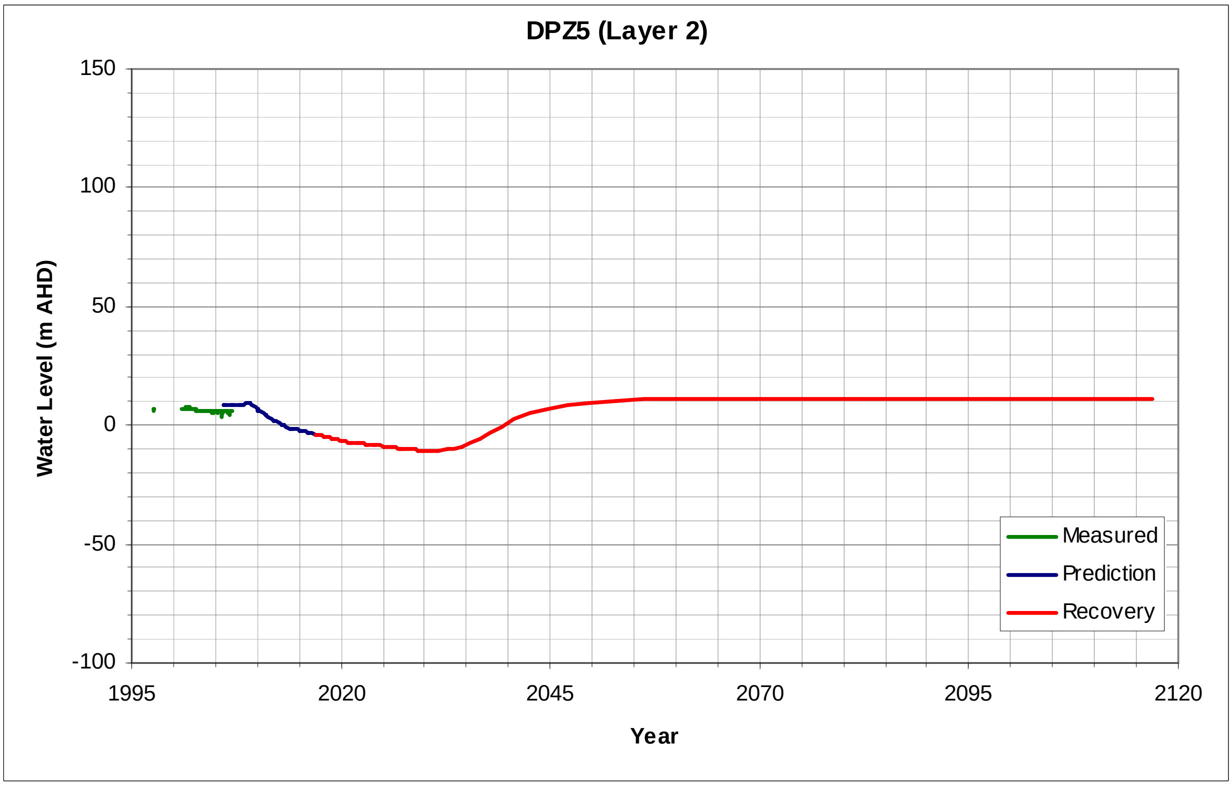


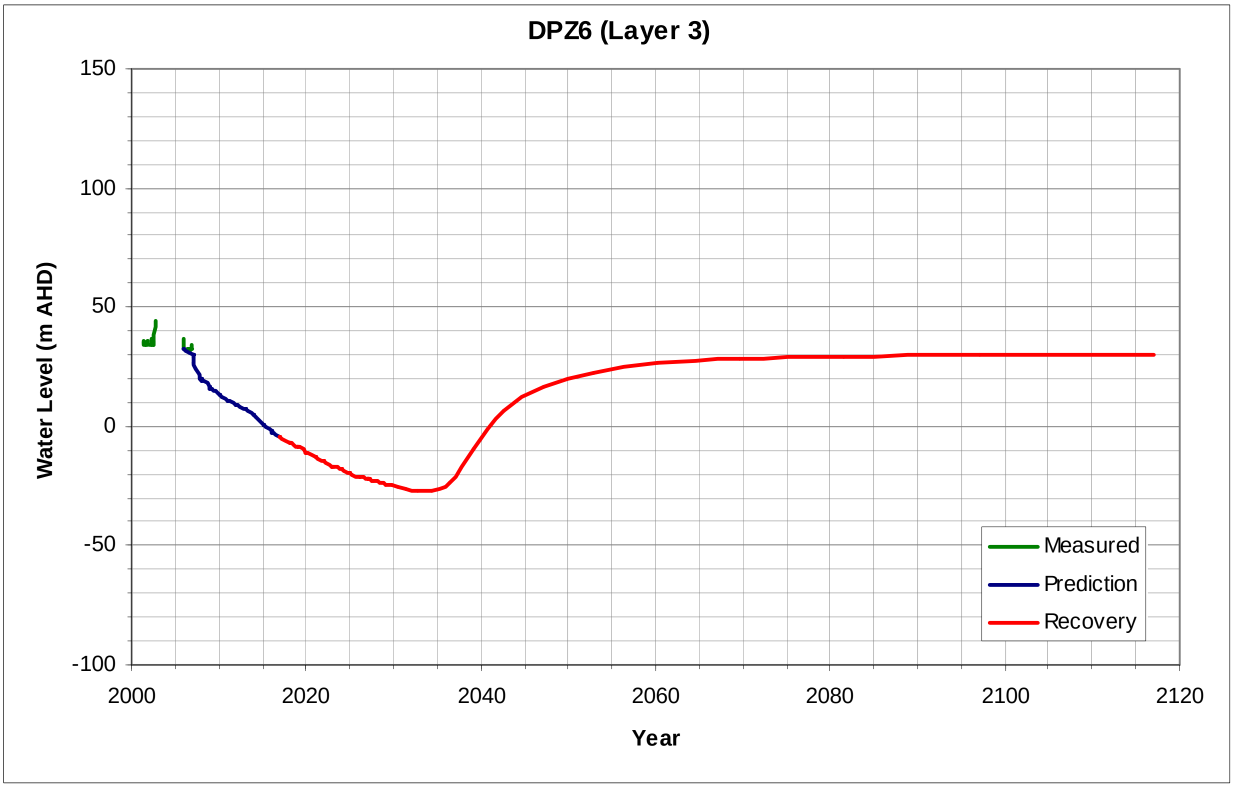
SP8-1 (All) (Layer 1)
150
100
50
0
-50
-100
Water Level (m AHD)
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

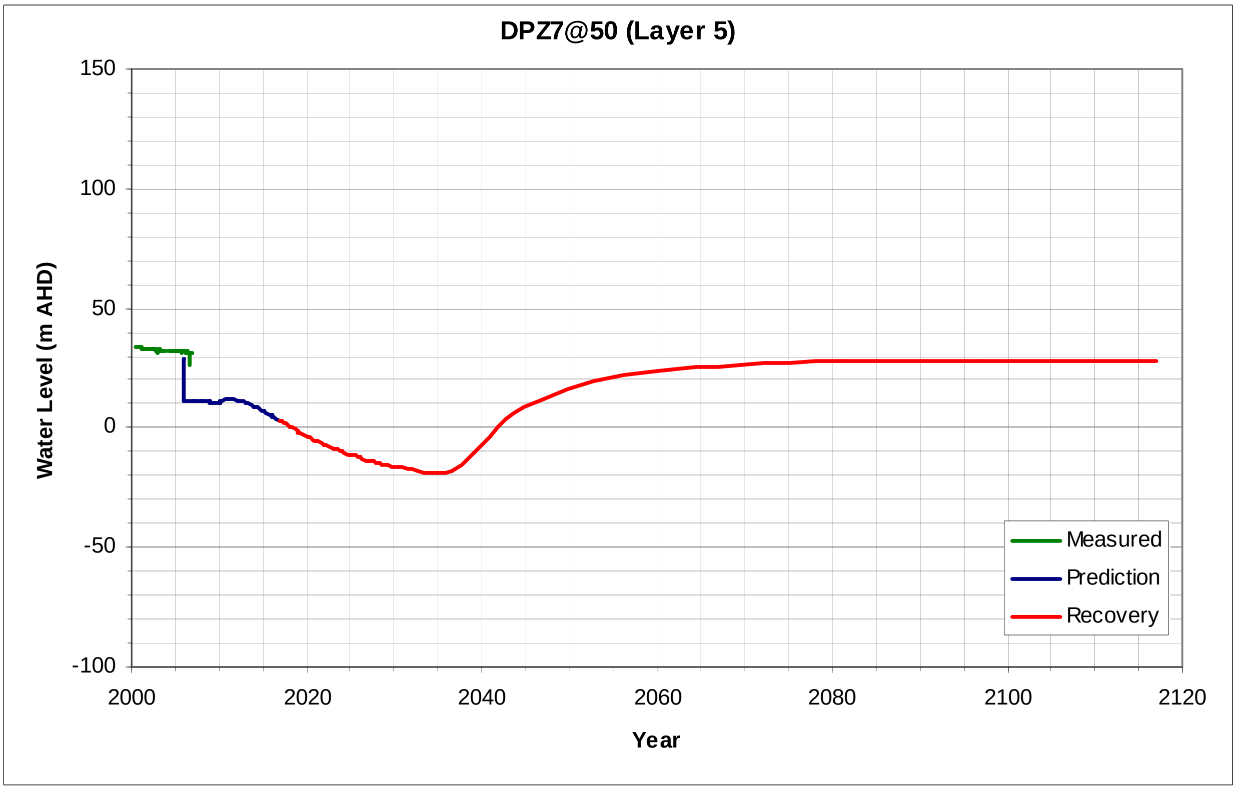
VW8-83m (Don) (Layer 5)
150
100
50
0
-50
-100
Water Level (m AHD)
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery


VW8-97m (BB) (Layer 7)
150
100
50
0
-50
-100
Water Level (m AHD)
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

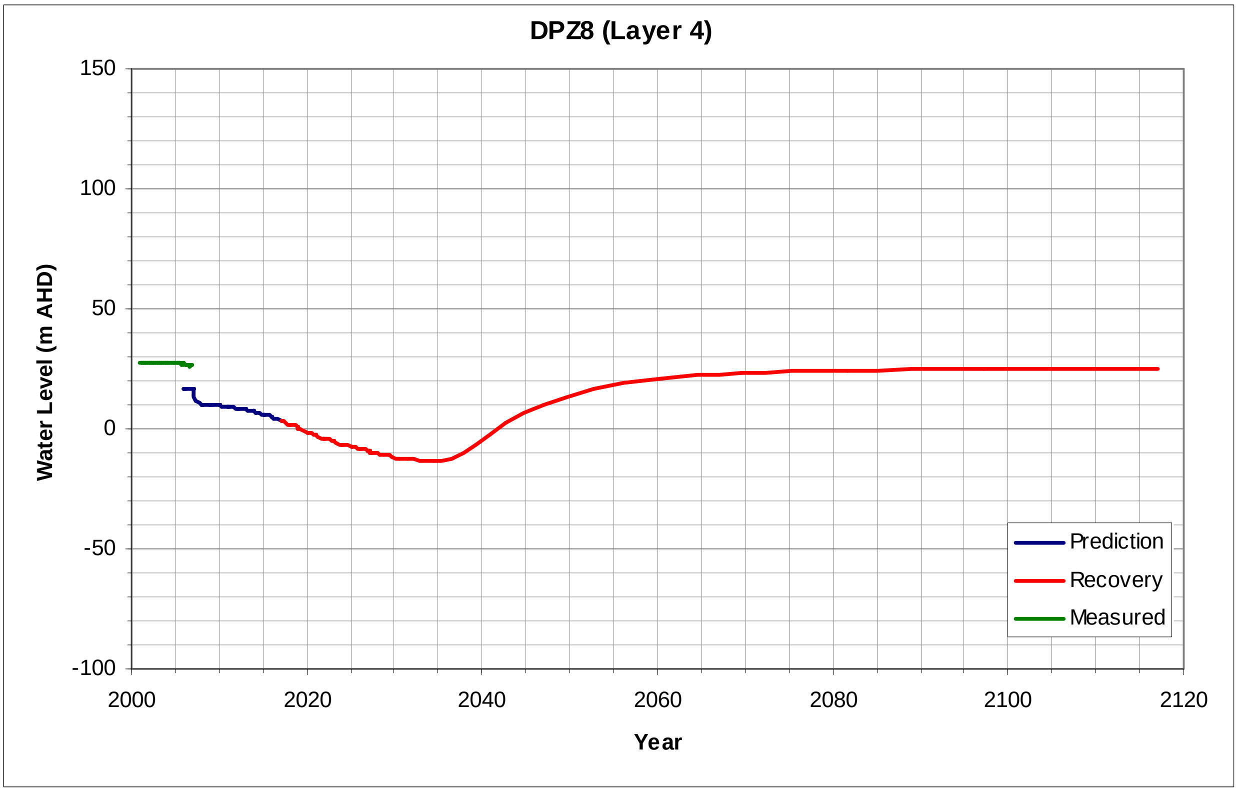

DPZ3 (Layer 7)
150
100
50
0
-50
-100
Water Level (m AHD)
1995
2020
2045
2070
2095
2120
Year
Measured
Prediction
Recovery


DPZ5 (Layer 2)
Water Level (m AHD)
150
100
50
0
-50
-100
1995
2020
2045
2070
2095
2120
Year
Measured
Prediction
Recovery

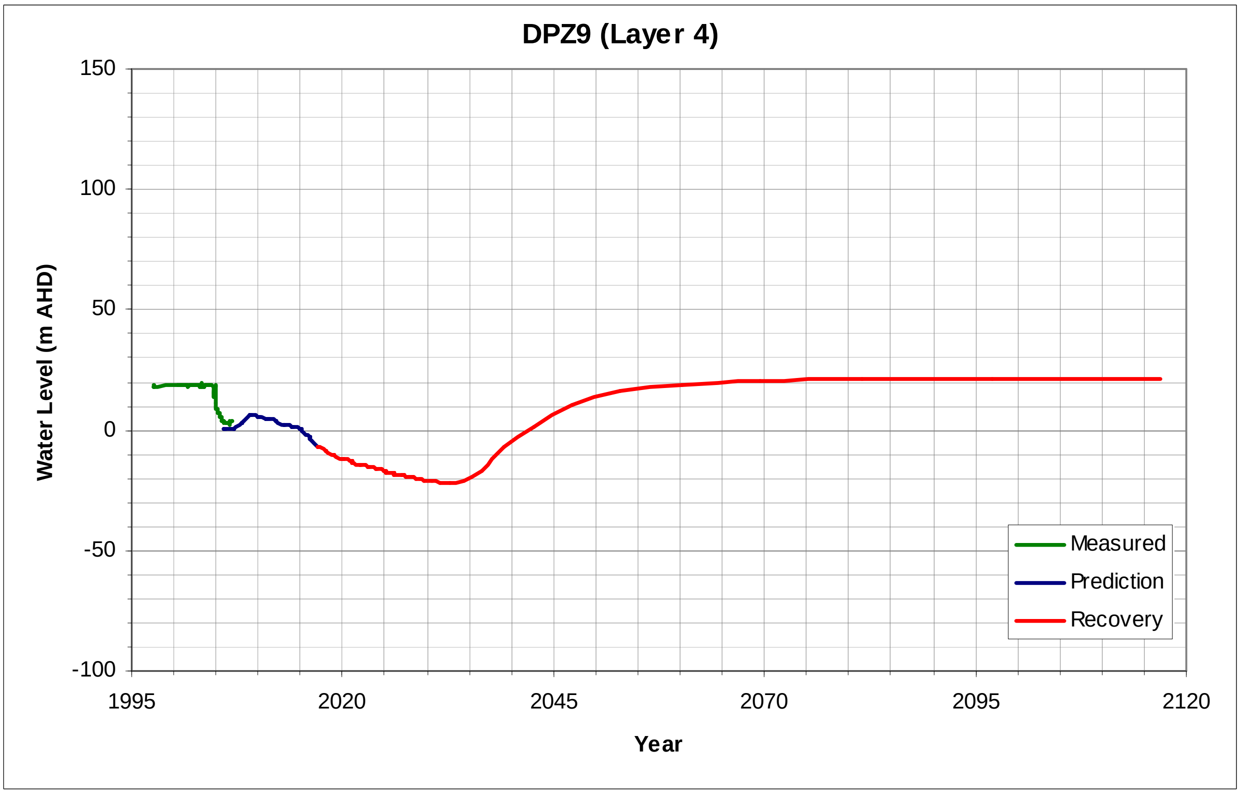

DPZ6 (Layer 3)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

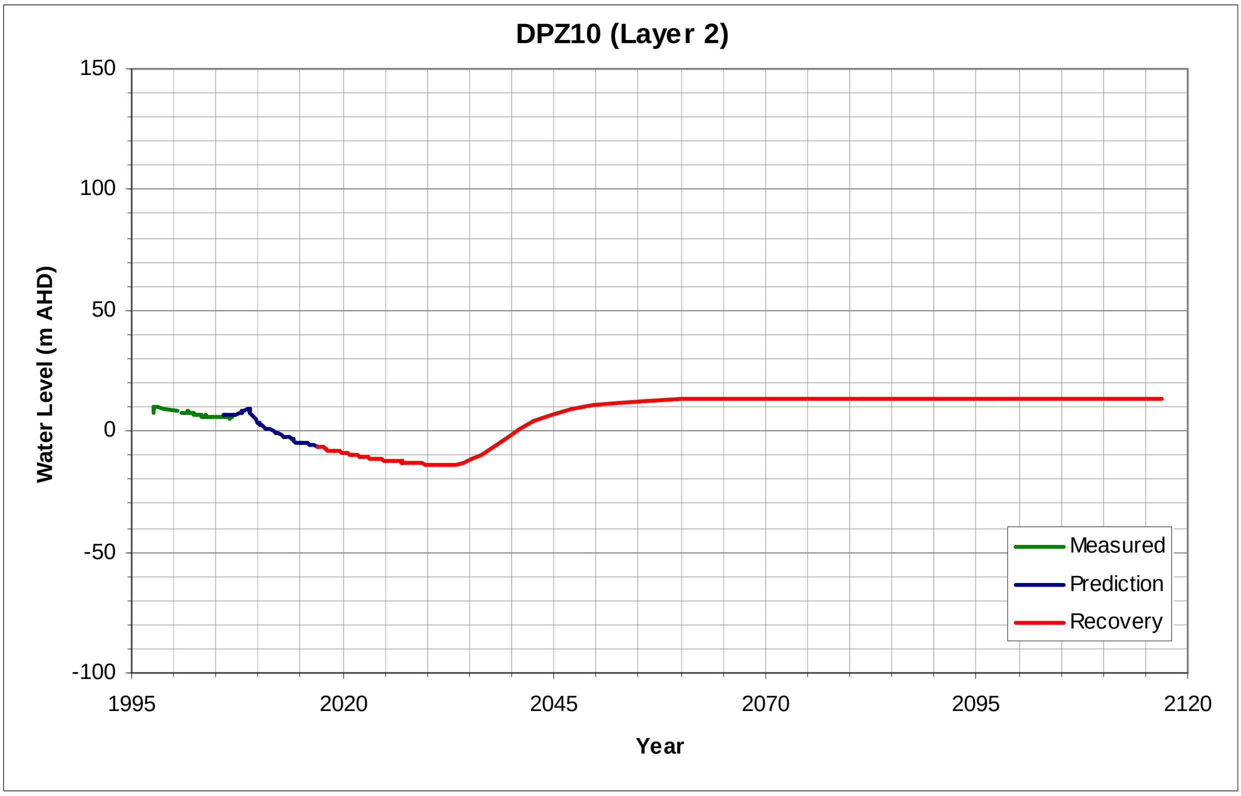


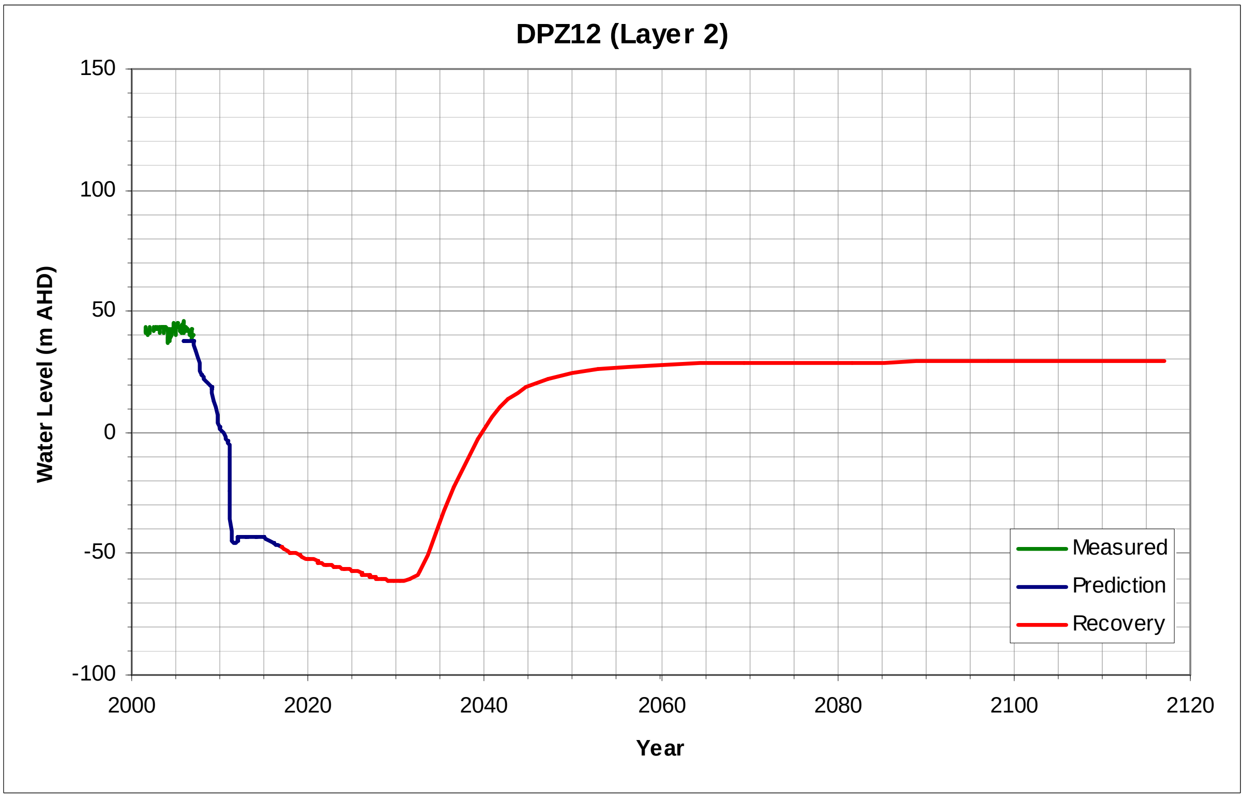
DPZ7@50 (Layer 5)
150
100
50
0
-50
-100
Water Level (m AHD)
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

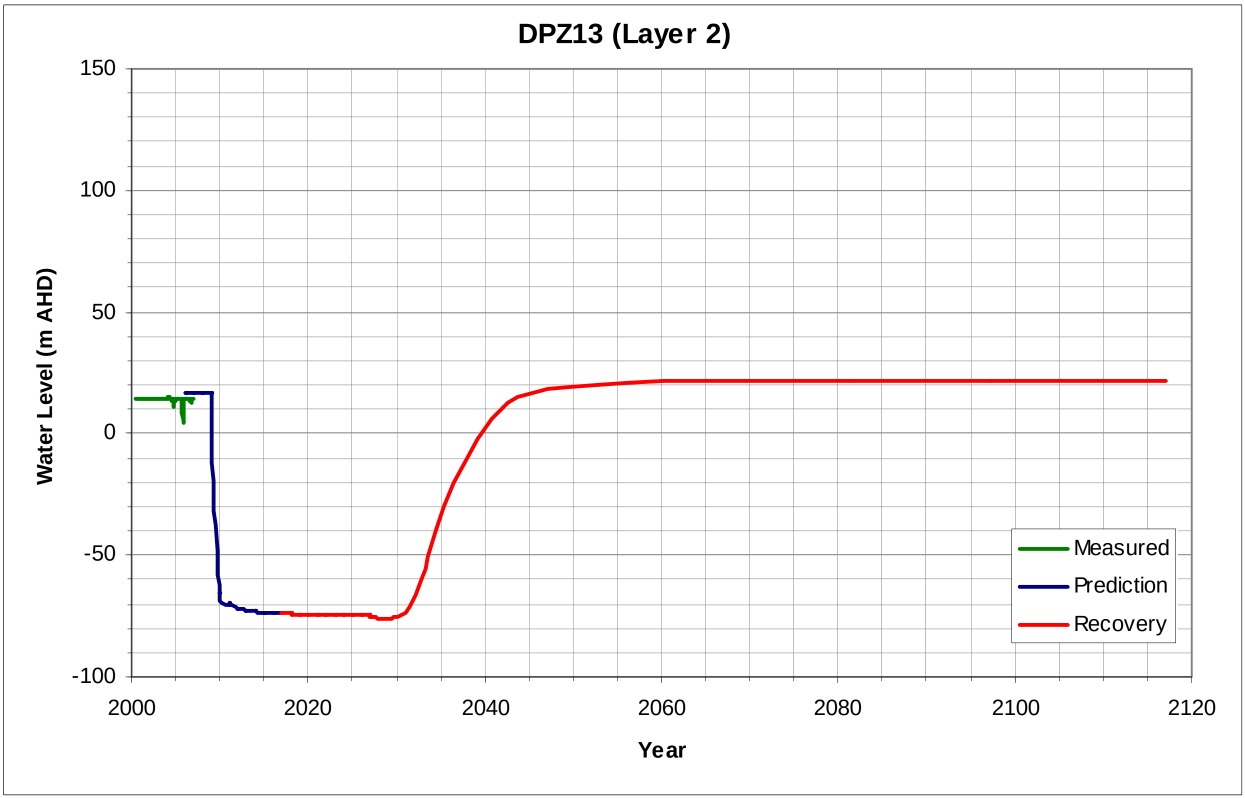


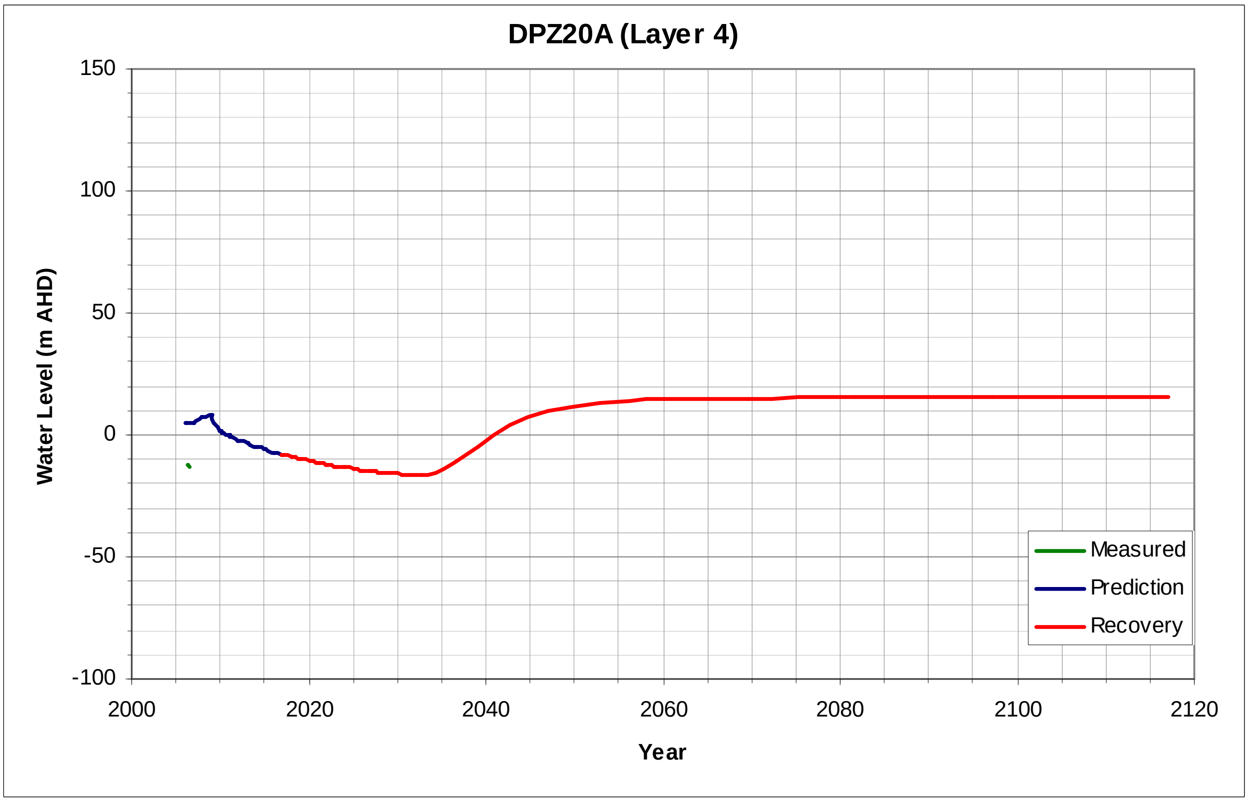
DPZ8 (Layer 4)
150
100
50
0
-50
-100
Water Level (m AHD)
2000
2020
2040
2060
2080
2100
2120
Year
Prediction
Recovery
Measured

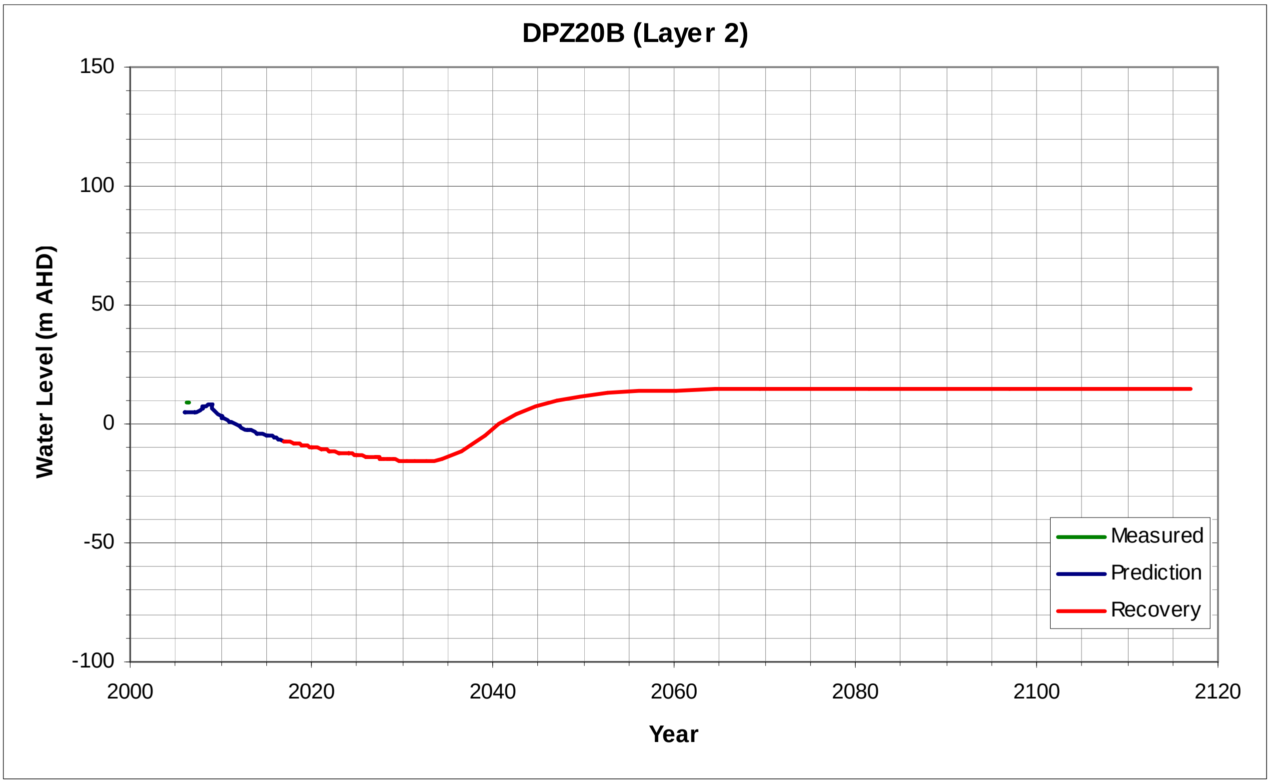

DPZ9 (Layer 4)
150
100
50
0
-50
-100
Water Level (m AHD)
1995
2020
2045
2070
2095
2120
Year
Measured
Prediction
Recovery

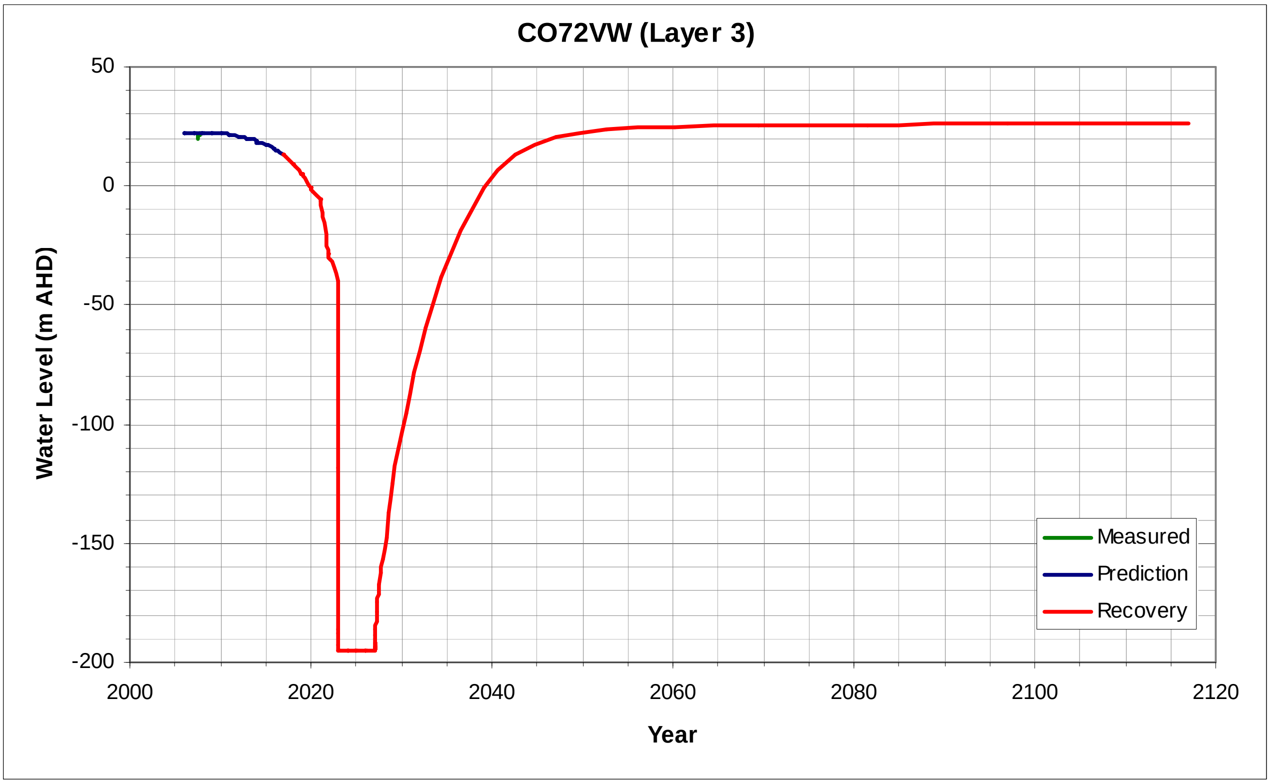

DPZ10 (Layer 2)
150
100
50
0
-50
-100
Water Level (m AHD)
1995
2020
2045
2070
2095
2120
Year
Measured
Prediction
Recovery

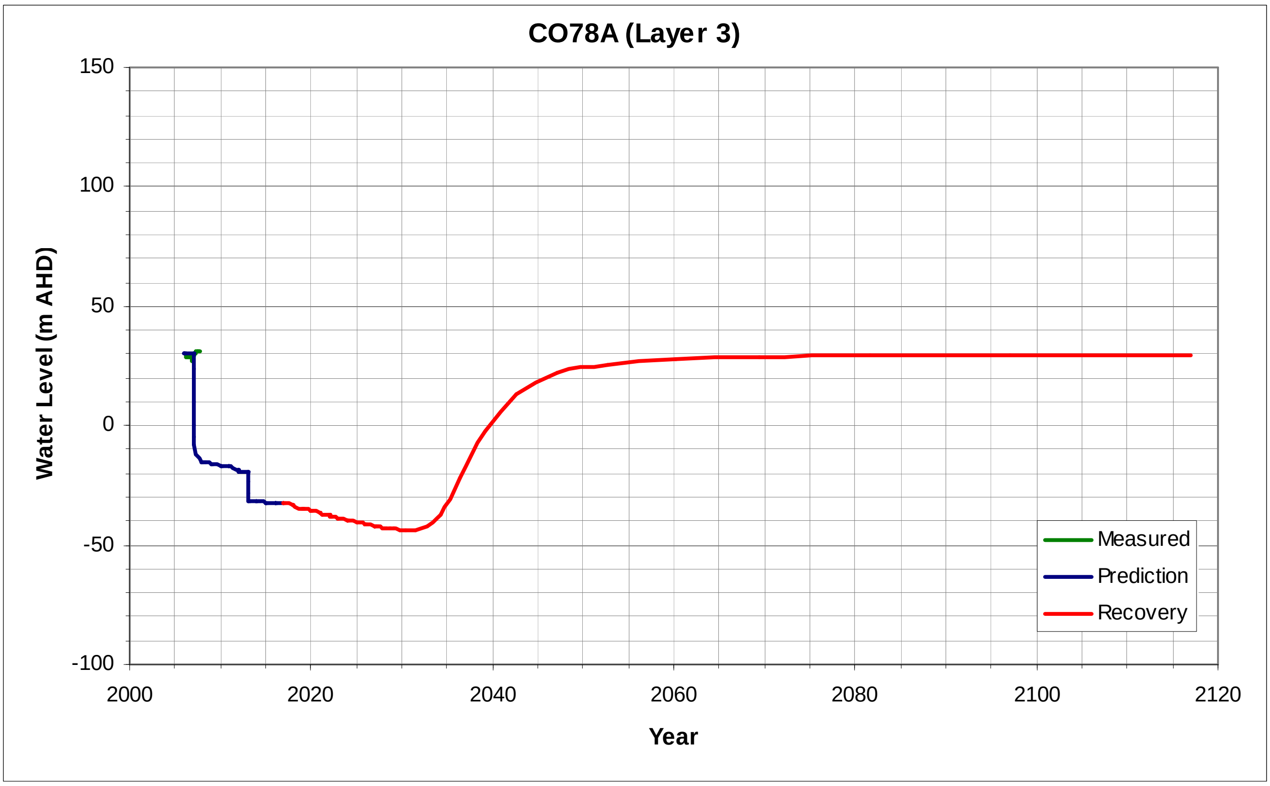

DPZ12 (Layer 2)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery


DPZ13 (Layer 2)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

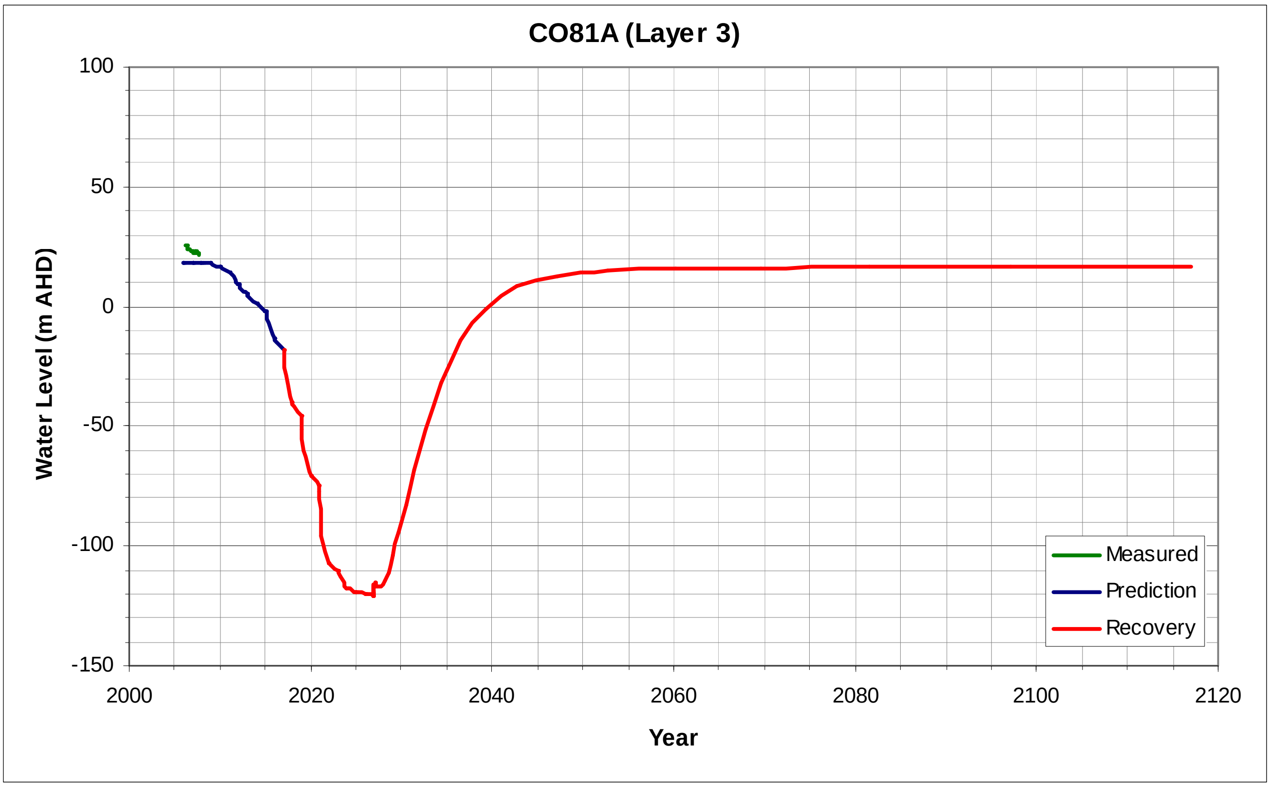

DPZ20A (Layer 4)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

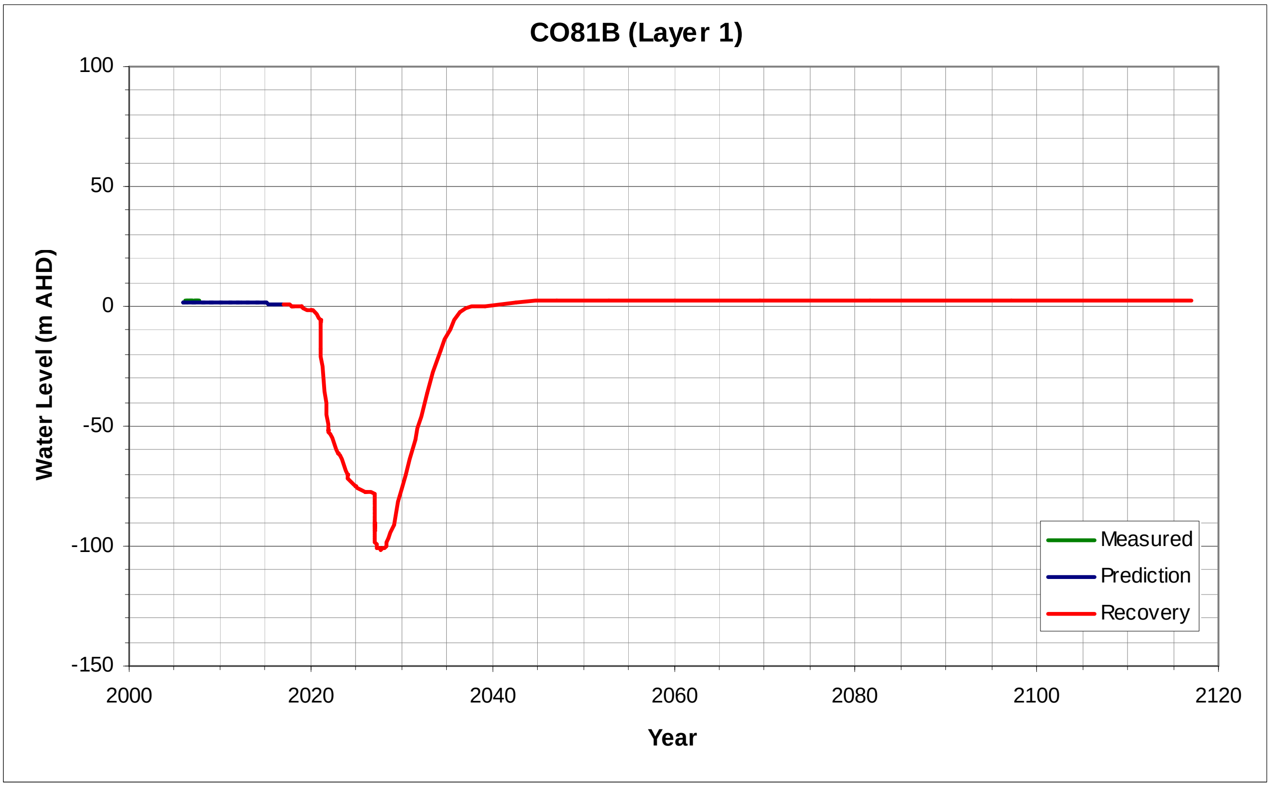

DPZ20B (Layer 2)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

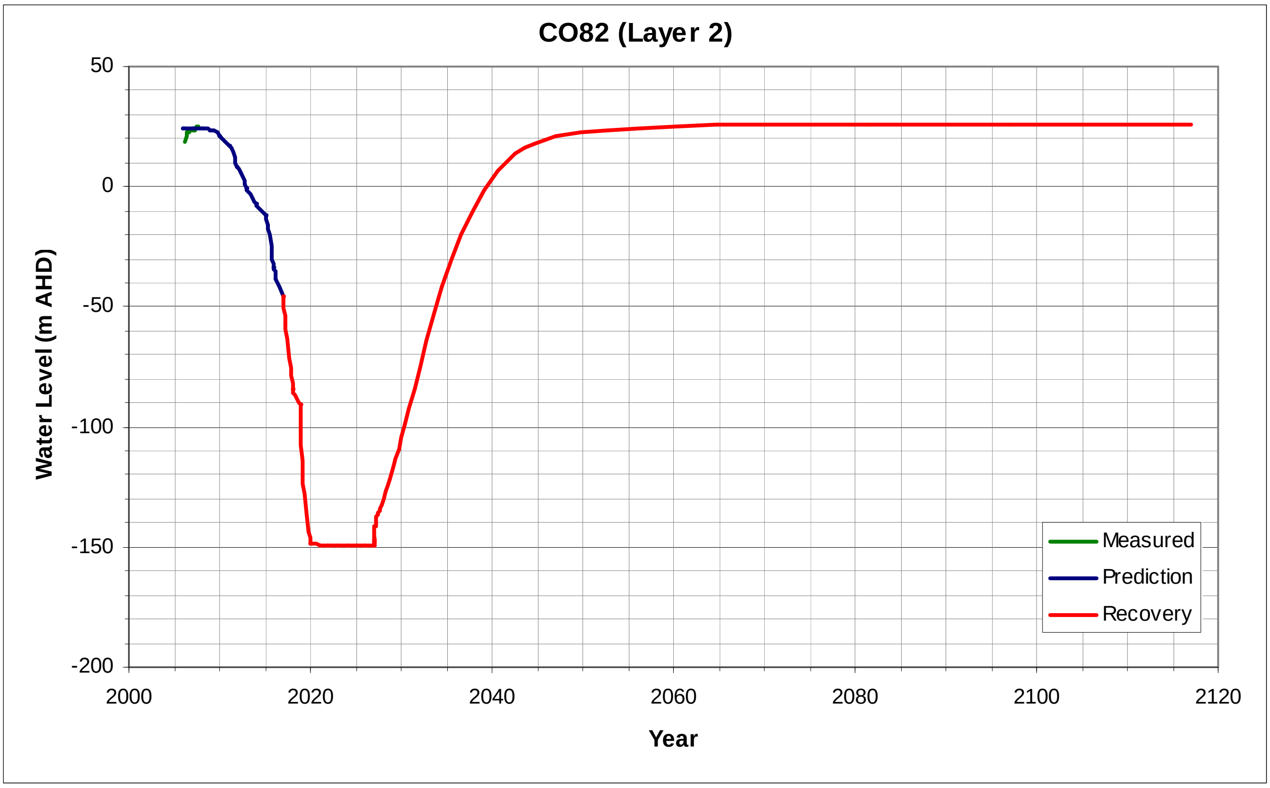

CO72VW (Layer 3)
Water Level (m AHD)
50
0
-50
-100
-150
-200
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

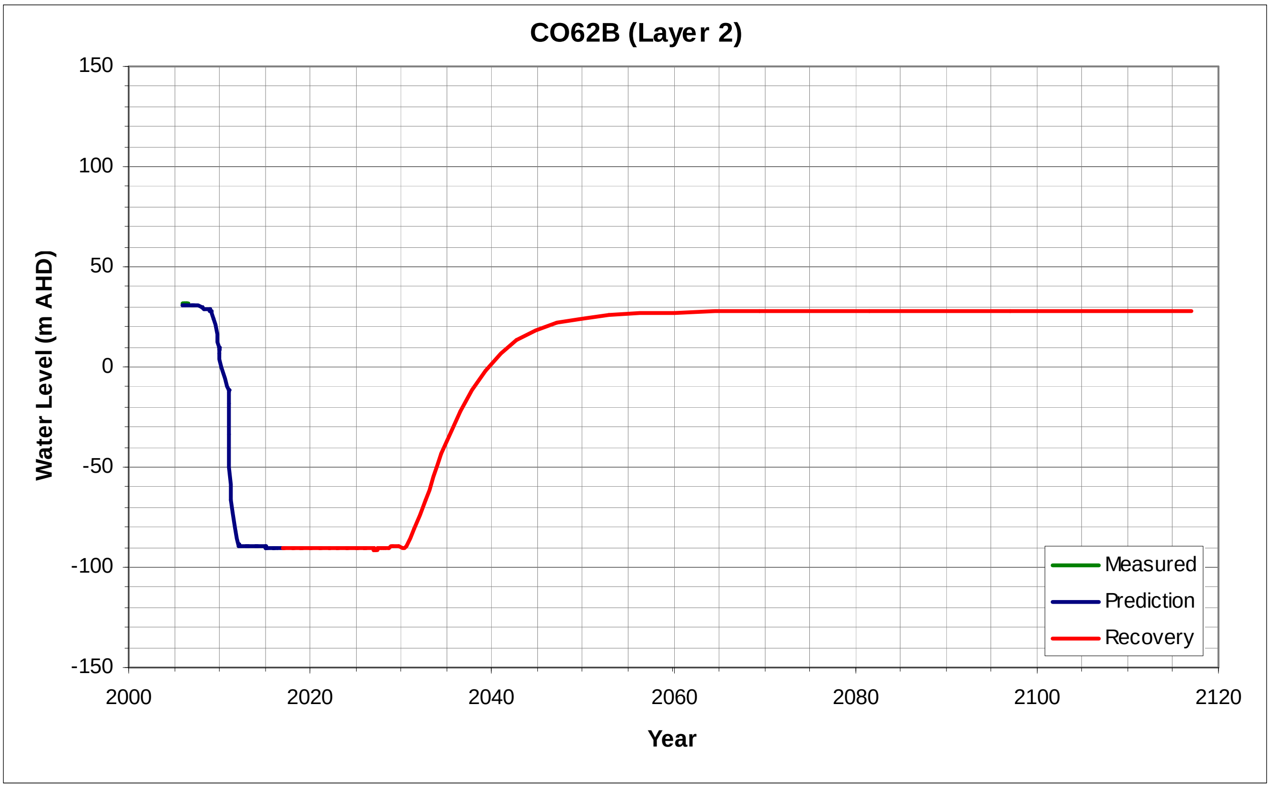

CO78A (Layer 3)
Water Level (m AHD)
150
100
50
0
-50
-100
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery


CO80 (Layer 3)
100
50
0
-50
-100
-150
Water Level (m AHD)
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

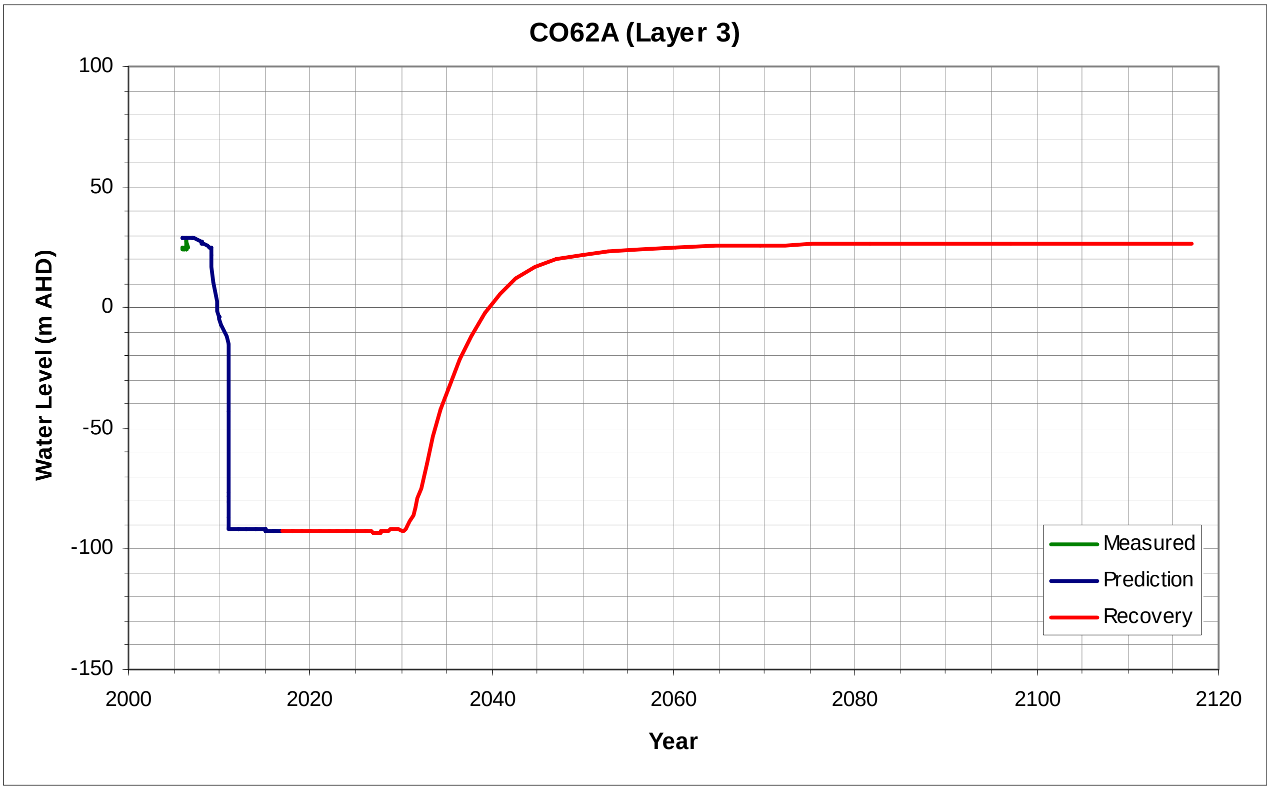

CO81A (Layer 3)
100
50
0
-50
-100
-150
Water Level (m AHD)
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery


CO81B (Layer 1)
Water Level (m AHD)
100
50
0
-50
-100
-150
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery


CO82 (Layer 2)
Water Level (m AHD)
50
0
-50
-100
-150
-200
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

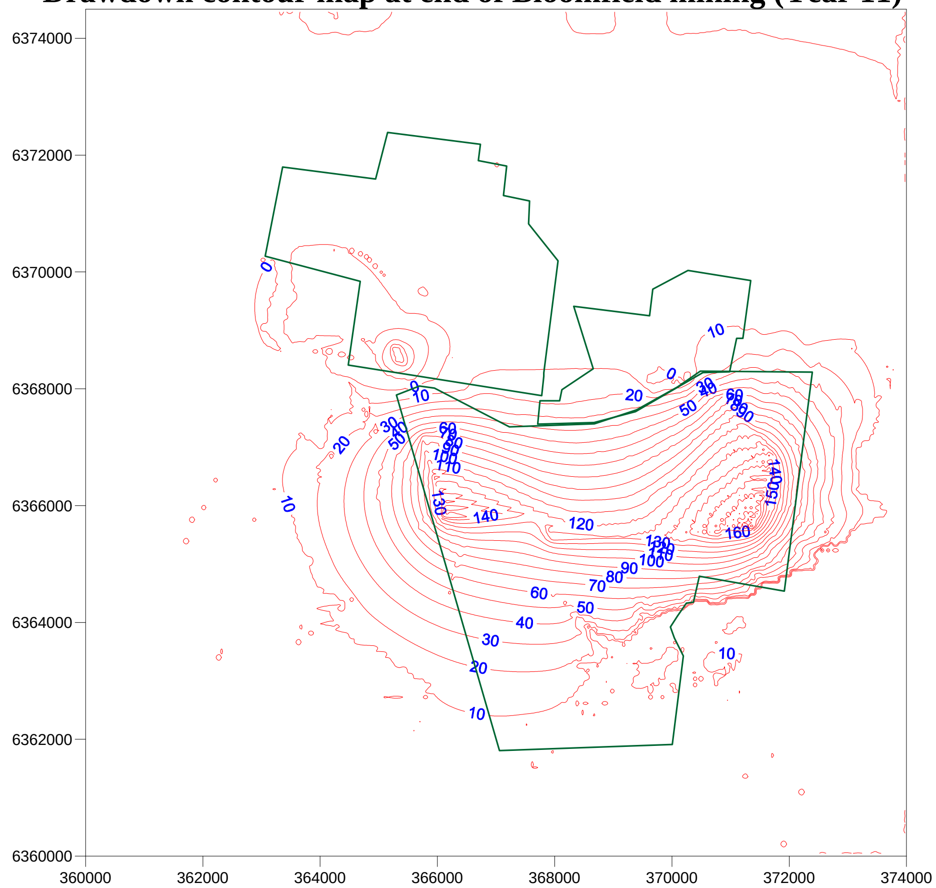


CO62B (Layer 2)
Water Level (m AHD)
150
100
50
0
-50
-100
-150
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

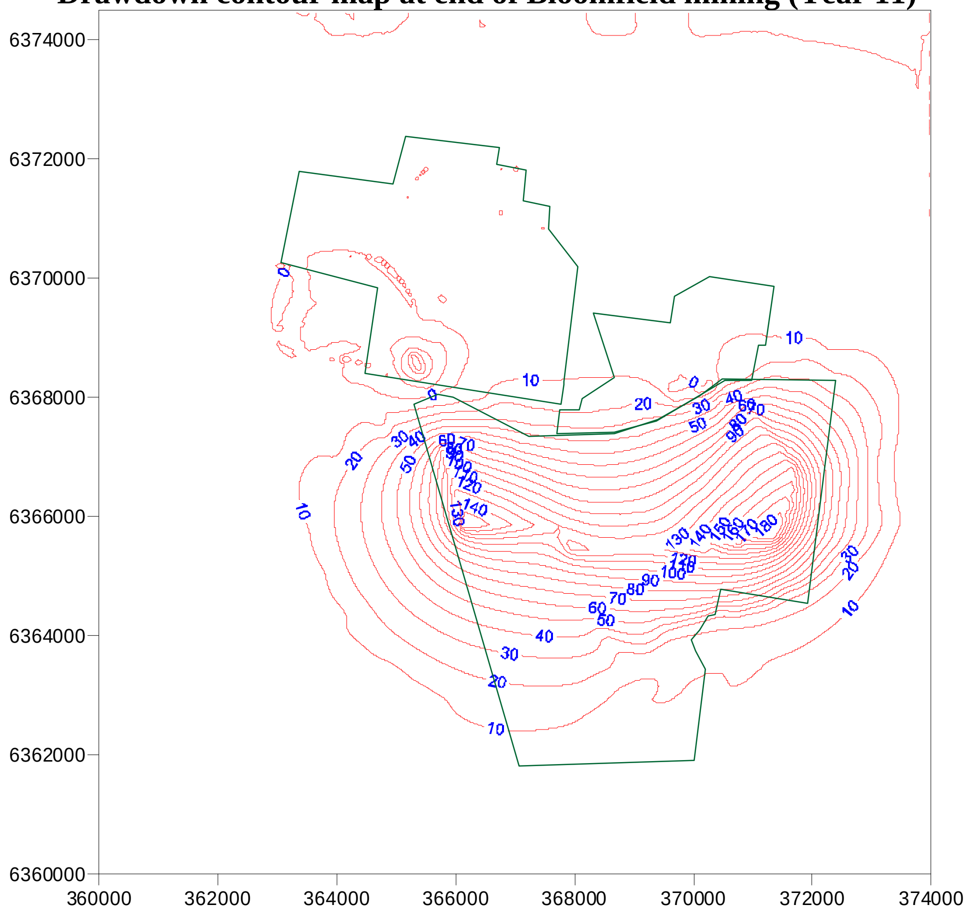


CO62A (Layer 3)
Water Level (m AHD)
100
50
0
-50
-100
-150
2000
2020
2040
2060
2080
2100
2120
Year
Measured
Prediction
Recovery

Layer 1
Drawdown contour map at end of Bloomfield mining (Year 11)

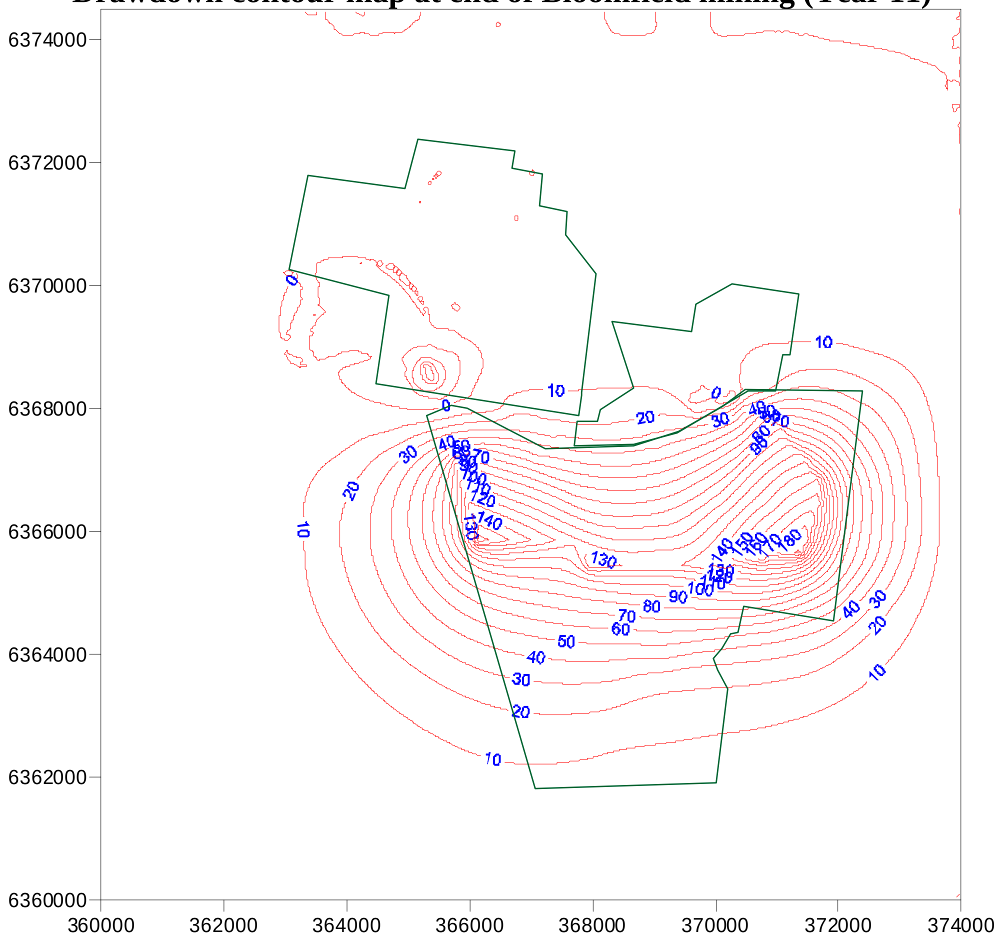


Layer 2
Drawdown contour map at end of Bloomfield mining (Year 11)



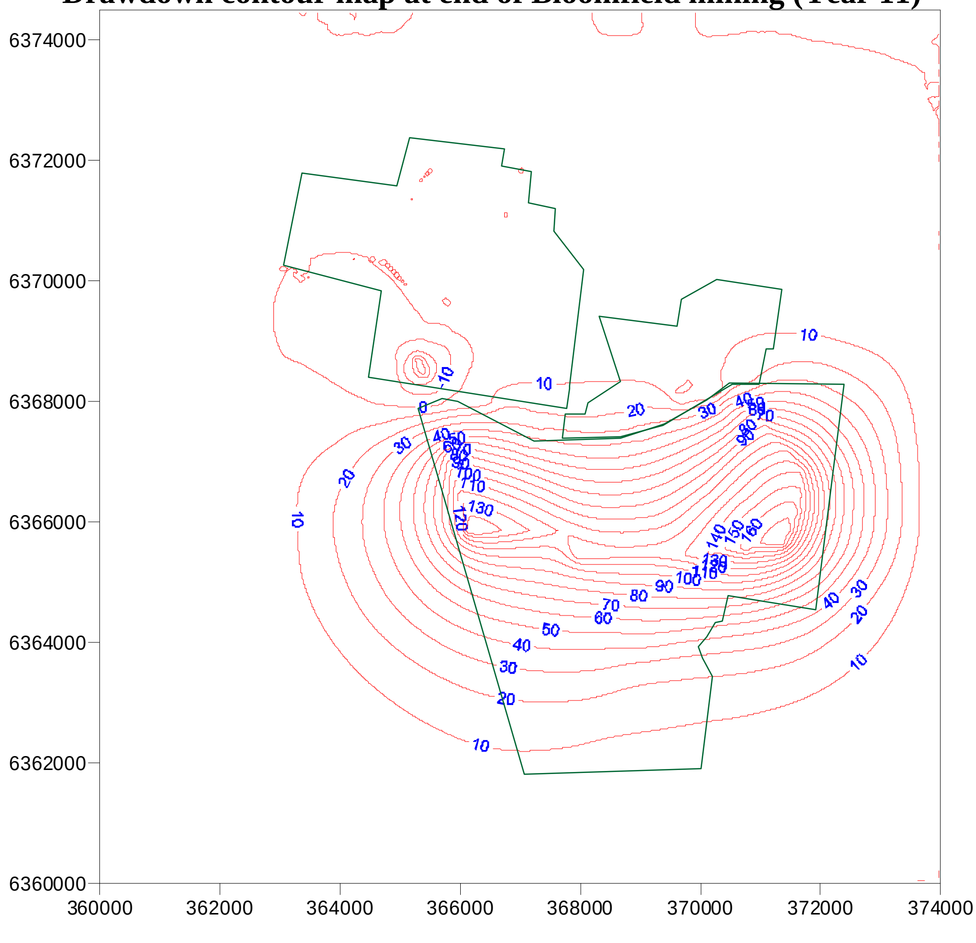
Layer 3

Drawdown contour map at end of Bloomfield mining (Year 11)

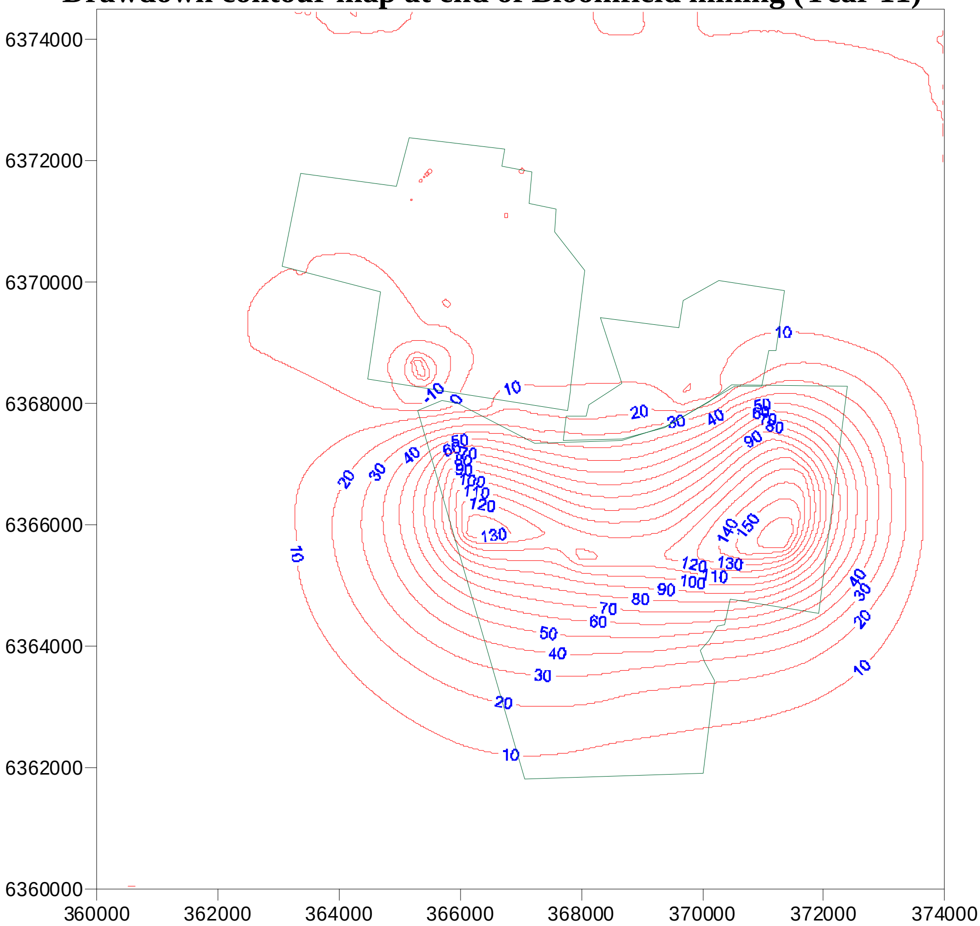


Layer 4

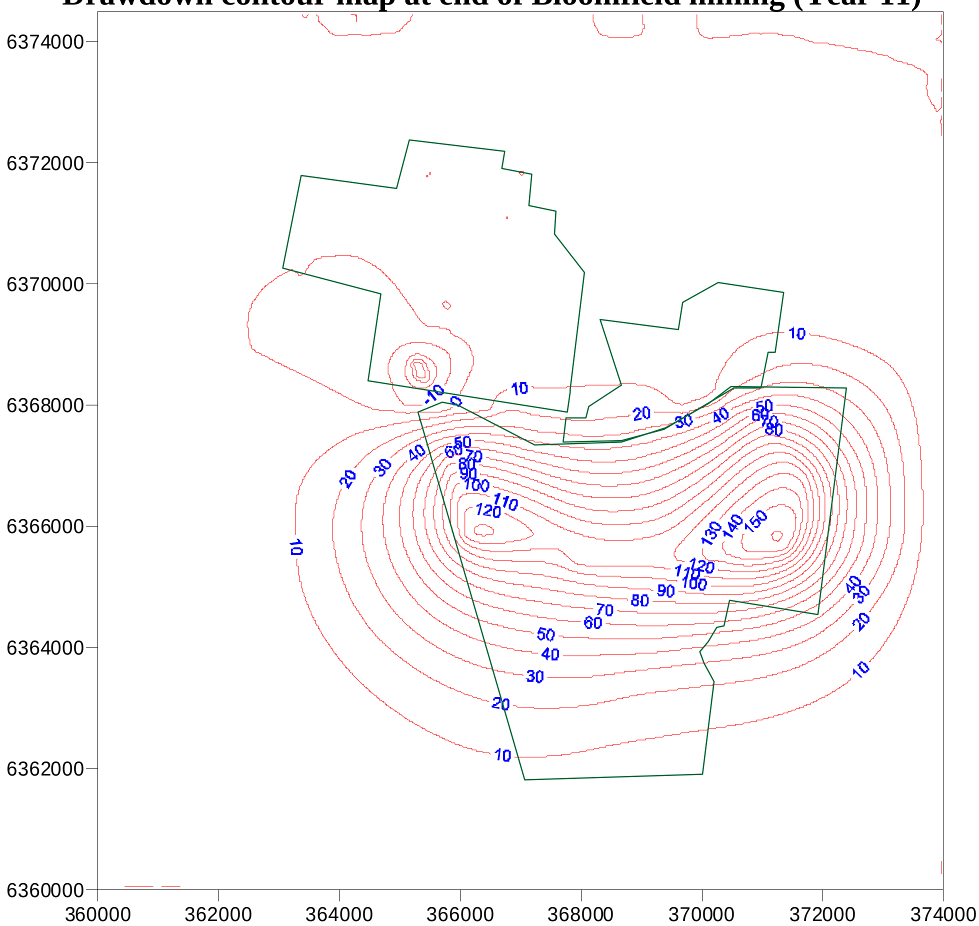
Drawdown contour map at end of Bloomfield mining (Year 11)



Layer 5
Drawdown contour map at end of Bloomfield mining (Year 11)

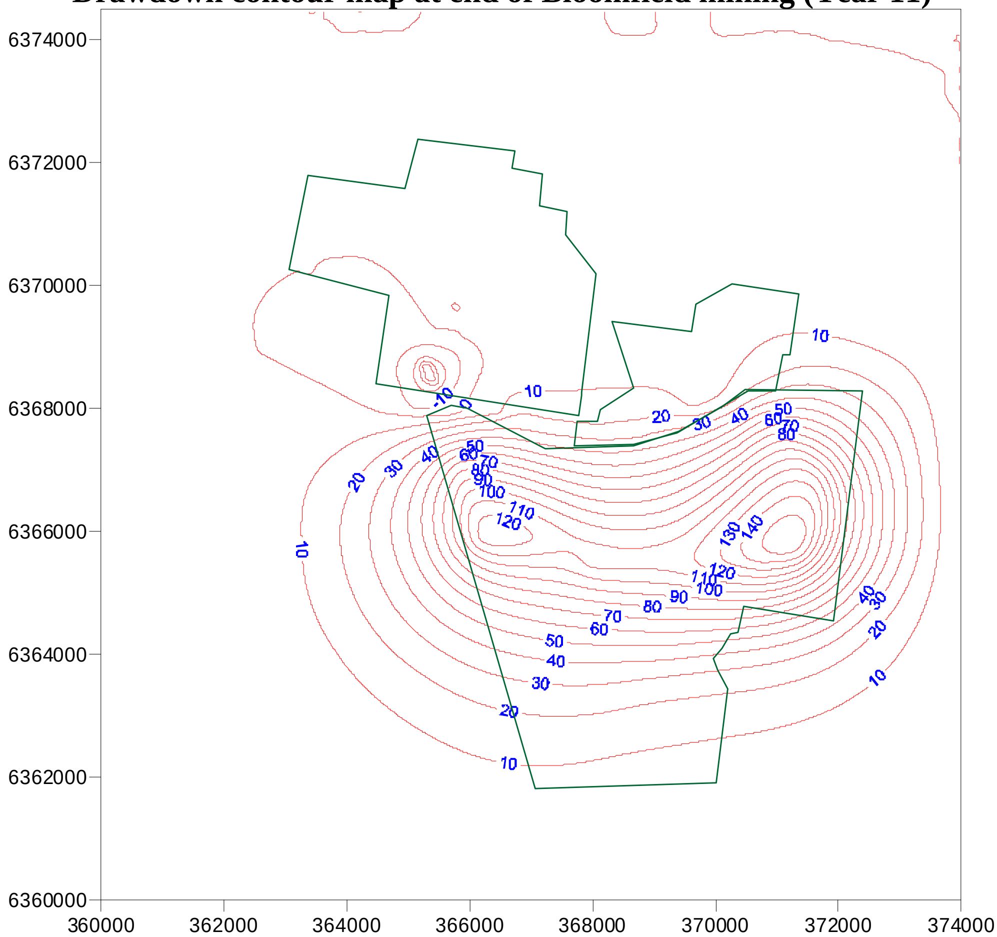


Layer 6
Drawdown contour map at end of Bloomfield mining (Year 11)



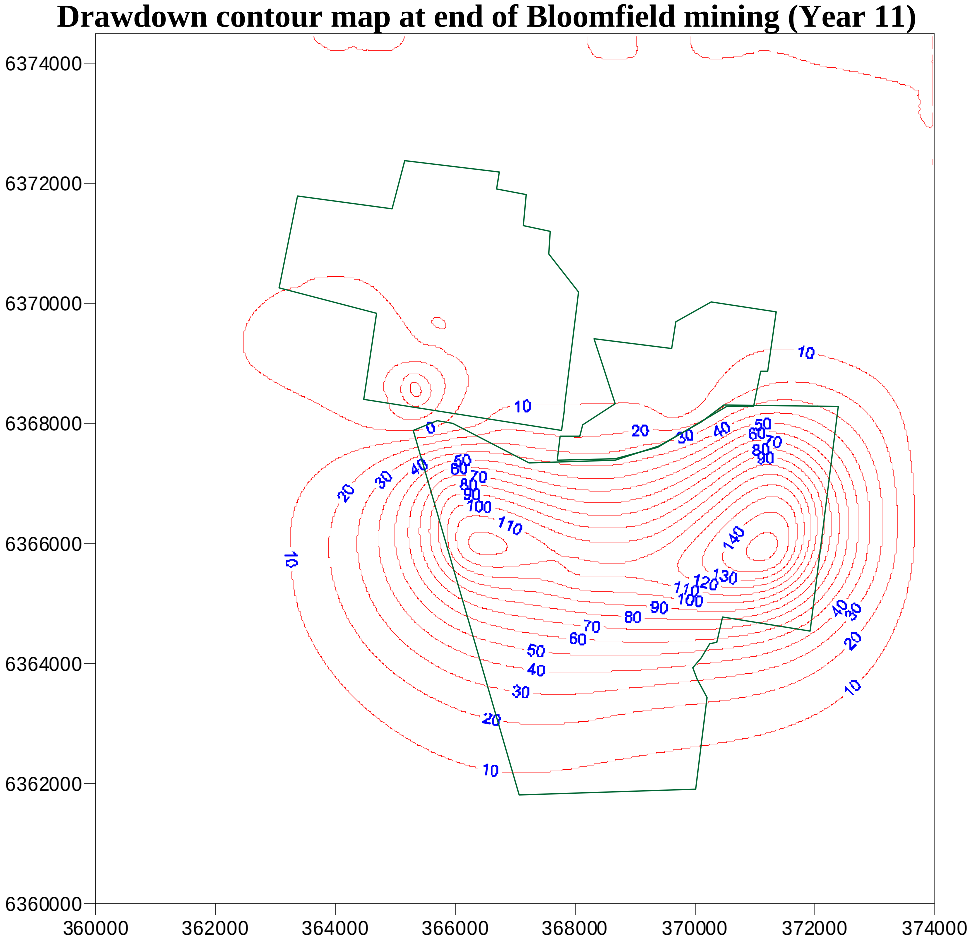
Layer 7

Drawdown contour map at end of Bloomfield mining (Year 11)

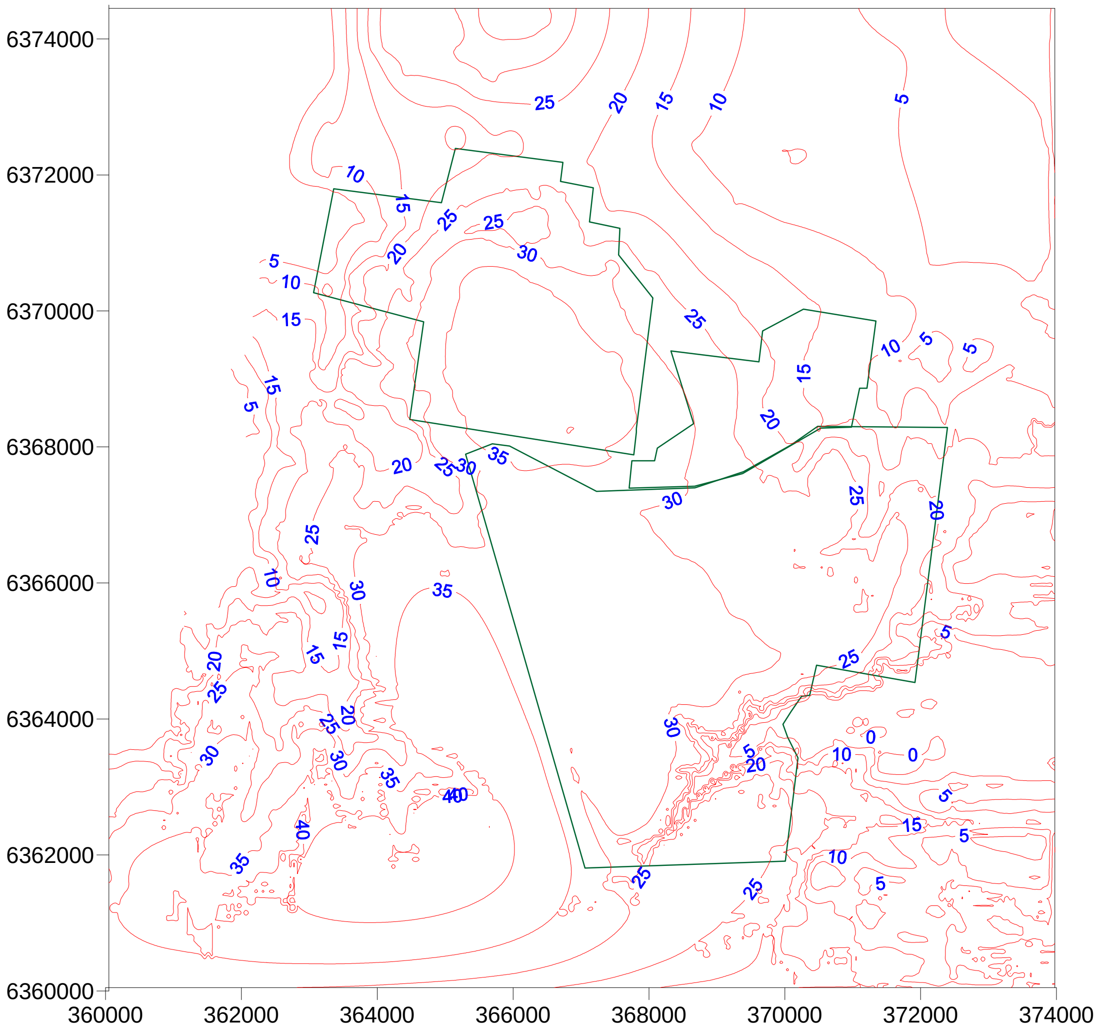


Layer 8

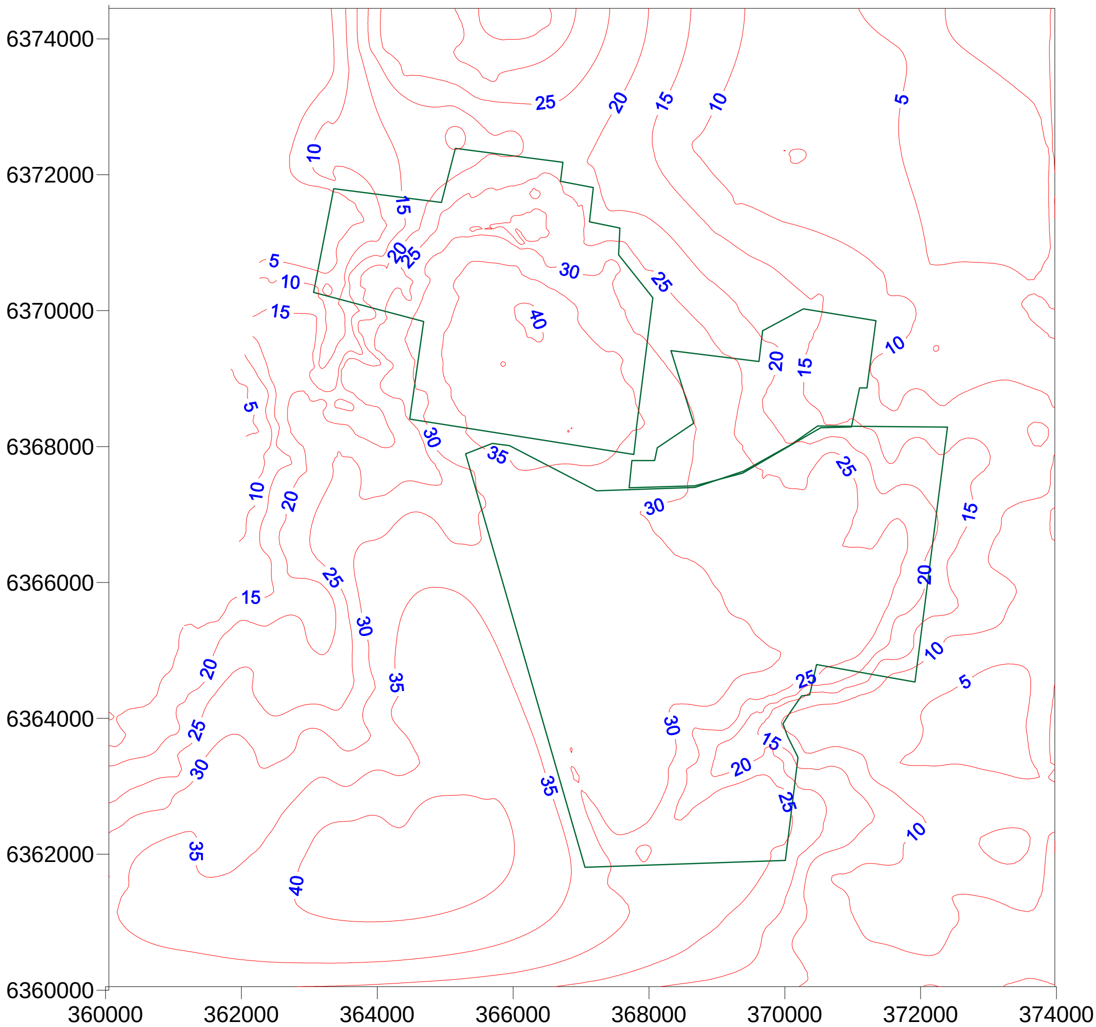
Drawdown contour map at end of Bloomfield mining (Year 11)



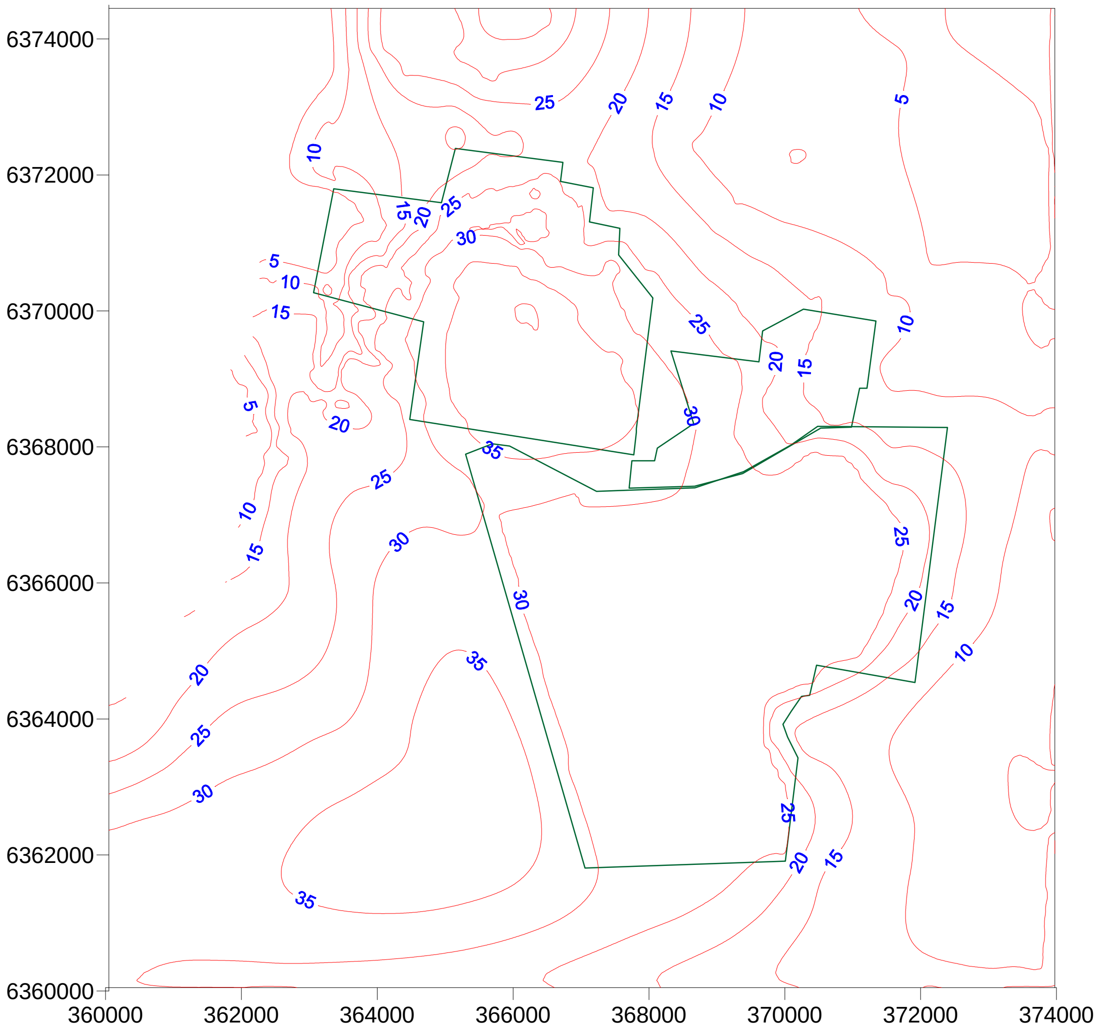
Layer 1
WATER LEVEL CONTOUR MAP AT END OF 100-YEAR RECOVERY PERIOD



Layer 2
WATER LEVEL CONTOUR MAP AT END OF 100-YEAR RECOVERY PERIOD

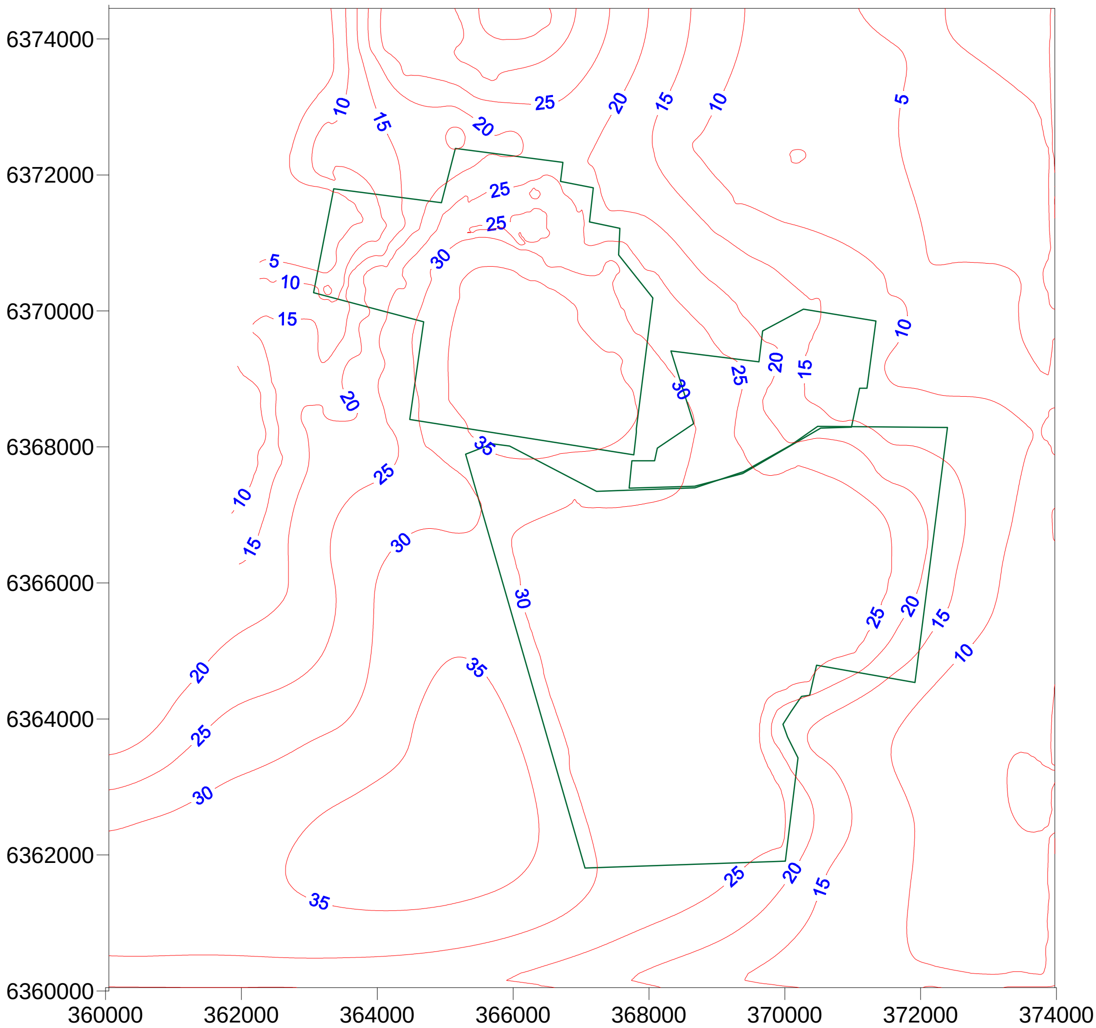


Layer 3
WATER LEVEL CONTOUR MAP AT END OF 100-YEAR RECOVERY PERIOD

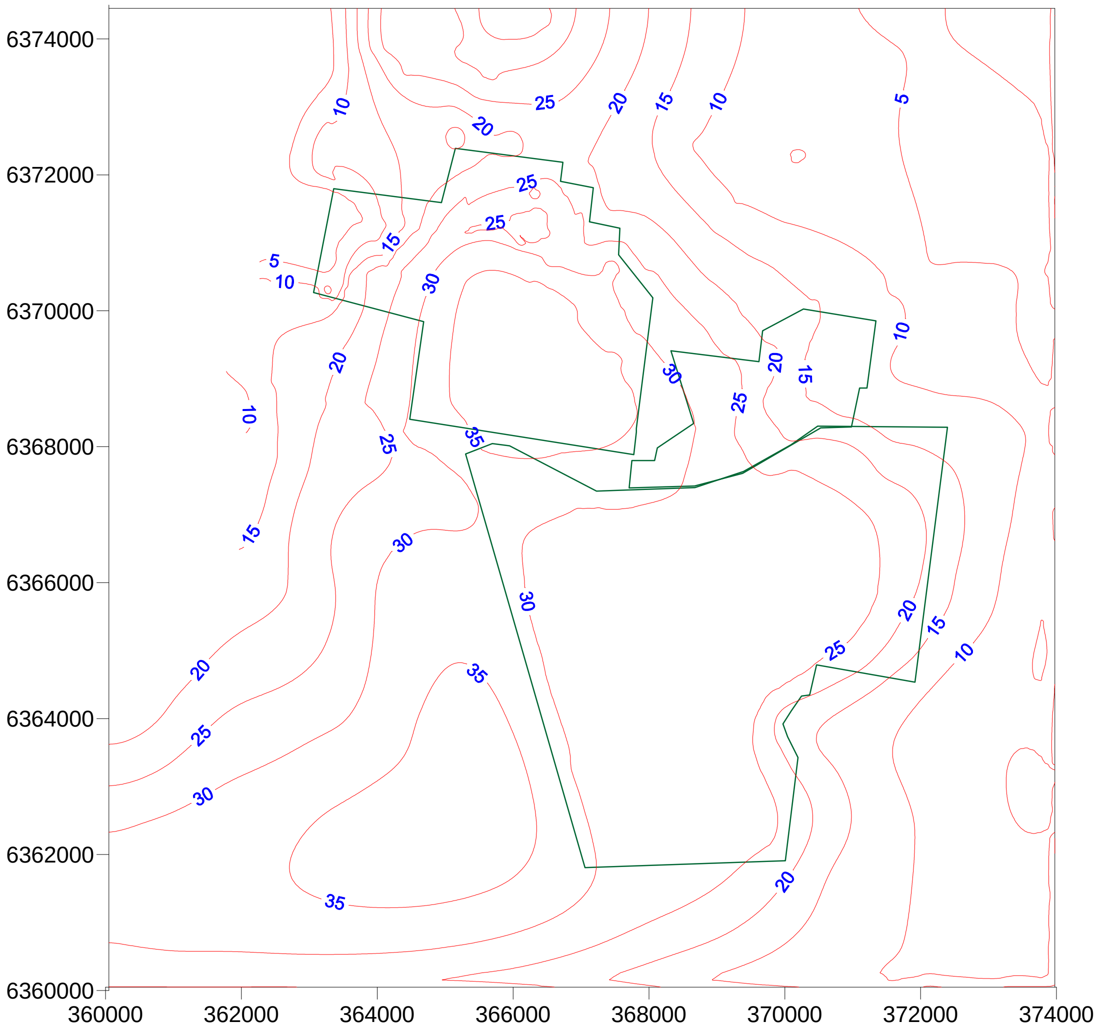


Layer 4

WATER LEVEL CONTOUR MAP AT END OF 100-YEAR RECOVERY PERIOD

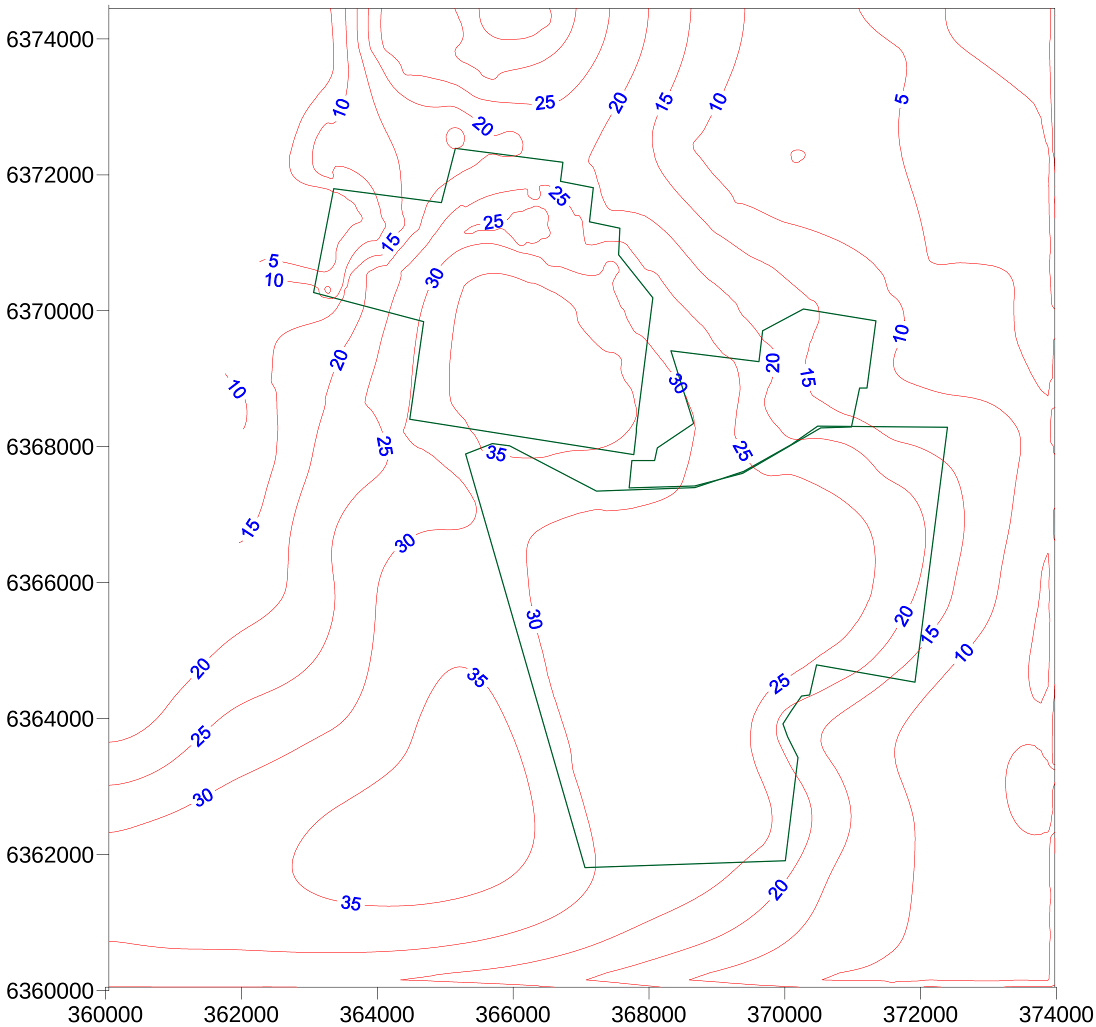


Layer 5
WATER LEVEL CONTOUR MAP AT END OF 100-YEAR RECOVERY PERIOD

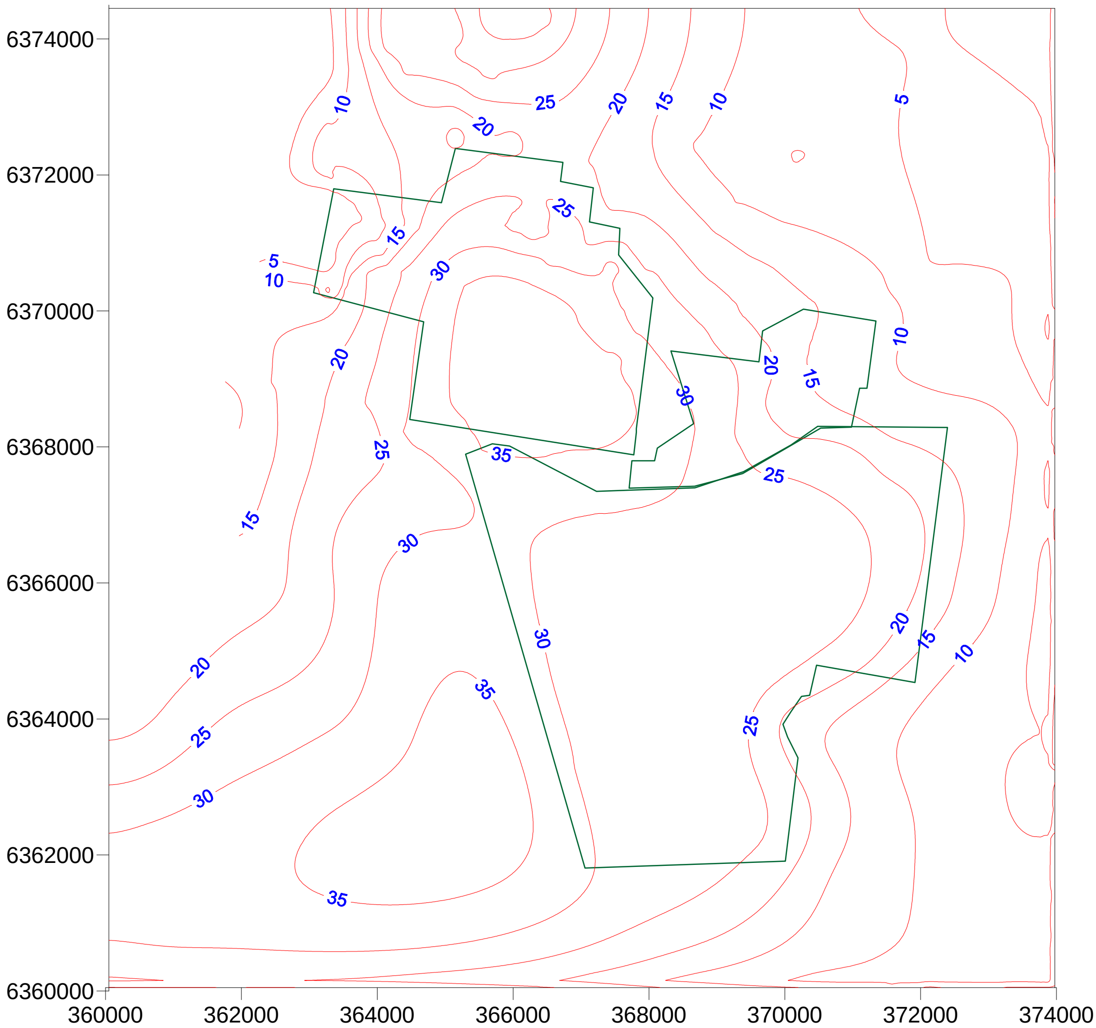


Layer 6

WATER LEVEL CONTOUR MAP AT END OF 100-YEAR RECOVERY PERIOD



Layer 7
WATER LEVEL CONTOUR MAP AT END OF 100-YEAR RECOVERY PERIOD



Layer 8
WATER LEVEL CONTOUR MAP AT END OF 100-YEAR RECOVERY PERIOD