Tasman Extension Project
Environmental Impact Statement

SECTION 4

ENVIRONMENTAL ASSESSMENT

Resource Strategies

DONALDSON COAL
Part of Gloucester Coal

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4 ENVIRONMENTAL ASSESSMENT

The following sub-sections present the environmental assessment for the Project, including:

- a description of the existing environment, including descriptions of components of the existing Tasman Underground Mine and its environmental management regime and environmental performance, where relevant;
- an assessment of the potential impacts associated with the Project, including cumulative impacts;
- a description of the measures that would be implemented to avoid, minimise, mitigate and/or offset the potential impacts of the Project;
- contingency plans and/or adaptive management for managing any potentially significant residual risks to the environment; and
- a description of the ongoing mitigation measures, management and monitoring that would be implemented by Donaldson Coal.

The assessment of the potential impacts of the Project was conducted in accordance with the DGRs (Section 1.2 and Attachment 1), and in consideration of the outcomes of consultation with key stakeholders, including the community (Section 3), and the results of the Environmental Risk Assessment (ERA) (Section 4.1 and Appendix O).

The assessment of potential subsidence impacts and subsequent environmental consequence is based on the subsidence performance measures described in Section 2.6.3. An adaptive management approach would be applied to achieve the subsidence performance measures (Section 2.9.3 and Figure 2-10).

A summary of other major projects that may interact with the Project and potentially give rise to cumulative impacts is provided in Attachment 4. Potential cumulative impacts have been considered, where relevant, in the specialist studies and are described in the sub-sections below.

Mitigation measures, management, monitoring and reporting have been developed as a result of the environmental assessment for the Project and are described in each relevant sub-section and summarised in Section 7.

4.1 ENVIRONMENTAL RISK ASSESSMENT

In accordance with the DGRs, an ERA was undertaken to identify key potential environmental issues for further assessment in this EIS. The ERA was conducted in August 2011, and was facilitated by a risk assessment specialist (SP Solutions, 2012).

The ERA workshop was used to identify key potential environmental issues for further assessment in this EIS. The key potential environmental issues identified during the ERA workshop are summarised in Table 4-1 and addressed in Sections 4.2 to 4.19, as well as the relevant appendices to this EIS.

The risk assessment team consisted of representatives from:

- Donaldson Coal;
- DgS (*subsidence*);
- Evans & Peck (*surface water*);
- Fluvial Systems (*geomorphology*);
- RPS Aquaterra (*groundwater*);
- Hunter Eco (*biodiversity*);
- Biosphere Environmental Consultants (*biodiversity*);
- PAEHolmes (*air quality and greenhouse gas*);
- SLR Consulting (*noise*);
- Halcrow (*road transport*);
- Ardill Payne & Partners (*land contamination and civil design*); and
- Resource Strategies.

The risks associated with the potential environmental issues shown in Table 4-1 were ranked in accordance with the frameworks detailed in Australian Standard/New Zealand Standard (AS/NZS) 31000:2009 *Risk Management – Principles and Guidelines*, *MDG1010 Risk Management Handbook for the Mining Industry* (DPI, 1997) and Handbook (HB) 203: 2006 *Environmental Risk Management – Principles and Process* (Standards Australia/Standards New Zealand, 2006).

With the implementation of the proposed risk treatment measures, all of the potential issues were ranked within the "Medium – As Low as Reasonably Practicable" or "Low" range by the risk assessment team. The ERA is provided in full as Appendix O.

Table 4-1
Key Potential Environmental Issues

Environmental Issue/ Subject Area	Description of Issue	EIS Section/Appendix
Land Resources and Landforms	Subsidence impacts on steep landforms (including cliff lines and steep slopes).	Sections 4.2 and 4.3 and Appendix A
	Subsidence related impacts on the recreational and aesthetic values of the Sugarloaf State Conservation Area.	Sections 4.2, 4.3 and 4.19 and Appendices A, E, F and G
Land Resources and Landforms/Visual	Visual impacts of subsidence related impacts on cliff lines.	Sections 4.2, 4.3 and 4.19 and Appendix A
Groundwater/Surface Water	Impacts on surface water drainage and near surface groundwater as a result of potential connective cracking between underground workings and the surface.	Sections 4.2, 4.4 and 4.6 and Appendices A, B and C
Stream Geomorphology	Subsidence related impacts on geomorphology of streams.	Section 4.2 and 4.5 and Appendices A and D
Biodiversity	Impacts on *Tetratheca juncea* population.	Section 4.8 and Appendix F
	Impacts on groundwater dependent ecosystems.	Section 4.8 and Appendices A, B, C and F
	Impacts on fauna as a result of construction and operational activities associated with the new pit top.	Section 4.9 and Appendix G
Aboriginal Heritage	Project related impacts on known Aboriginal heritage items.	Section 4.10 and Appendices A and K
	Project related impacts on unknown Aboriginal heritage items.	Section 4.10 and Appendices A and K
Road Transport	Impacts of Project road movements on the safety and performance of the road network (including traffic associated with coal haulage, employees and deliveries).	Section 4.12 and Appendix H
Noise	Noise impacts on nearby residences as a result of construction and operation associated with the new pit top.	Section 4.13 and Appendix I

4.2 SUBSIDENCE

Subsidence is the vertical and horizontal movement of the land surface as a result of the extraction of underlying coal. These land surface movements are generically referred to as subsidence effects. The different types of subsidence effects are described in Section 2.6.2, including systematic subsidence movements, far-field horizontal movements and sub-surface strata movements.

A detailed Subsidence Assessment was prepared by DgS (2012) and is presented in Appendix A. The Subsidence Assessment:

- identifies natural and built features that could be affected by subsidence;
- models predicted cumulative subsidence effects associated with the indicative mining layout in the West Borehole Seam and approved mining in the Fassifern Seam;
- develops appropriate SCZs (subsidence control zones) to achieve Donaldson Coal's proposed subsidence performance measures for significant natural and built surface features (Section 2.6.3);
- assesses the likely subsidence impacts on natural and built features, in consideration of the cumulative subsidence effects and SCZs; and
- recommends mitigation measures, management and monitoring for natural and built features.

The Subsidence Assessment (Appendix A) demonstrates that potential subsidence impacts can be appropriately mitigated and managed.

Detailed Extraction Plans would be prepared prior to the commencement of mining in each area. Extraction Plans would include subsidence predictions based on the final development heading, panel and pillar extraction layouts and would demonstrate that the subsidence performance measures for surface features (Section 2.6.3) can be achieved.

The Extraction Plan process would involve the review and evaluation of subsidence monitoring results and would apply an adaptive management approach to the SCZs to achieve the subsidence performance measures.

A summary of observed subsidence impacts at the existing Tasman Underground Mine is provided in Section 4.2.1. The subsidence prediction methodology is described in Section 4.2.2 and a summary of the subsidence predictions for the Project is provided in Section 4.2.3.

The types of subsidence impacts that would potentially occur as a result of the predicted subsidence effects are summarised in Section 4.2.4. An assessment of the potential consequences of the subsidence impacts is provided in Section 4.2.5, including relevant cross-references to sub-sections with further detail. Section 4.2.6 describes the subsidence mitigation measures, management and monitoring.

4.2.1 Subsidence Impacts Observed at the Existing Tasman Underground Mine

Secondary extraction commenced at the Tasman Underground Mine in March 2008. Monitoring of subsidence movements and impacts above extracted panels at the Tasman Underground Mine is undertaken in accordance with approved SMPs.

Monitoring includes subsidence surveys, visual inspections and photographic monitoring of surface features, such as cliffs, rock outcrops, tracks, drainage lines and Aboriginal heritage sites. Apart from some recent observations of minor tensile cracking on an access track, there has been no observed and/or reported subsidence impacts on cliffs, rock outcrops, drainage lines, tracks or Aboriginal heritage sites (Donaldson Coal, 2010a, 2010b).

There have been no observed and/or reported service difficulties resulting from subsidence impacts on surface infrastructure and no community complaints in regard to subsidence impacts (Donaldson Coal, 2010b).

4.2.2 Prediction Methodology

A geological model of the West Borehole Seam mining area was developed by DgS (Appendix A) based on known geological structure locations (Section 2.2) and data from 34 exploration boreholes, including bore logs, core testing data (point load and immersion tests) and geophysical logging.

Predictions of systematic subsidence movements for the indicative mining layout in the West Borehole Seam were made using the Australian Coal Association Research Program (ACARP) (2003) and Holla (1987) empirical subsidence models, based on the geological model of the mining area. The ACARP (2003) model is derived from a comprehensive database of measured subsidence, strain, tilt and curvature in the Newcastle, Hunter Valley, Western and Southern Coalfields (Appendix A).

The Subsidence Assessment (Appendix A) includes predictions of ‘mean' and ‘upper 95% confidence limit’ subsidence effects. The credible worst-case prediction is normally the upper 95% confidence limit (Appendix A).

Appendix A provides a more detailed description of the subsidence prediction methodologies and includes a validation of the performance of the subsidence prediction methodology at the Abel Underground Mine and the existing Tasman Underground Mine, which have similar geological conditions and mining methods.

4.2.3 Prediction of Subsidence Effects

Subsidence effects are the deformation of the ground mass caused by mining, including all mining induced ground movements.

Systematic subsidence movements are described by the following parameters: subsidence, tilt, curvature and associated strains (tensile and compressive strains) (Section 2.6.2).

The magnitude of subsidence varies across a panel with pillar extraction. The greatest amount of vertical movement (subsidence) occurs in the centre of the panel with total pillar extraction. Compressive strains generally occur near the centre of the panel, while tensile strains generally occur near the sides or ends of the panel (Appendix A).

A summary of the range of predicted maximum total subsidence, tilts, curvature and strains above panels for total pillar extraction is provided in Table 4-2.

Table 4-2
Maximum Predicted Subsidence, Tilt, Curvatures and Strains for the Indicative Mining Layout in the West Borehole Seam

Subsidence Parameter	Mean	Upper 95% Confidence Limit
Maximum Subsidence above a Panel (m)	0.33 to 1.26	0.58 to 1.27
Maximum Tilt above a Panel (mm/m)	3 to 40	5 to 60
Maximum Horizontal Displacement above a Panel (mm)	32 to 401	48 to 602
Maximum Hogging Curvature above a Panel (km^{-1})	0.20 to 1.94	0.30 to 2.91
Maximum Tensile Strain above a Panel (mm/m)[1]	2 to 19	3 to 29
Maximum Sagging Curvature above a Panel (km^{-1})	0.25 to 2.46	0.38 to 3.69
Maximum Compressive Strain above a Panel (mm/m)[1]	3 to 25	4 to 37

Source: After Appendix A.

[1] Predicted strains are 'smooth profile' strains. Discontinuous displacements can occasionally result in secondary curvatures and strains that exceed predicted 'smooth profile' values by 2 to 4 times.

Some panels would have lower subsidence than the parameters summarised in Table 4-2 as partial pillar extraction or no secondary extraction (i.e. limiting extraction to first workings) would occur in some areas to meet subsidence performance measures for surface features (Section 2.6.3).

The caving and subsidence development process above a pillar extraction panel usually results in sub-surface fracturing and shearing of sedimentary strata in the overburden. The extent of fracturing and shearing is dependent on mining geometry and overburden geology.

The overburden may be divided into essentially three or four zones of surface and subsurface fracturing defined in ascending order (i.e. from the seam level) as the (Section 2.6.2 and Appendix A):

- caved zone;
- fractured zone;
- continuous or constrained zone; and
- surface zone.

These zones can also be described as the 'continuous subsurface fracturing' zone (comprising the caved and fractured zones) and the 'discontinuous subsurface fracturing' zone (comprising the constrained zone).

Within the continuous subsurface fracturing zone, cracking is likely to result in a direct hydraulic connection to the workings, if a subsurface (or shallow surface) aquifer is intersected (Appendix A). A summary of the predicted likelihood of connective cracking to the surface as determined by DgS (2012) is provided in Table 4-3.

Bending and/or curvature deformation of the rock strata is expected within the discontinuous subsurface fracturing zone, resulting in a general increase in horizontal and vertical permeability (Appendix A). This type of fracturing does not usually provide a direct flow path or connection to the mine workings, but may interact with surface cracks, joints or faults. Predictions for the height of the discontinuous subsurface fracturing zone are provided in Appendix A.

4.2.4 Subsidence Impacts

Subsidence impacts are the physical changes to the ground and its surface caused by the subsidence effects described in Sections 2.6.2 and 4.2.3. A summary of subsidence impacts as a result of the Project is provided below.

Surface Cracking

Cracking occurs on the surface when there is sufficient 'bending' of the overburden as the subsidence trough develops.

In areas of total pillar extraction, surface cracks between 50 and 300 mm are likely to develop above the goaf (Appendix A). These surface cracks could be greater than 600 mm in areas of adverse or anomalous geological or topographical conditions (Appendix A).

DgS (2012) determined it is 'very unlikely' that surface cracks would develop above areas of first workings pillars and 'unlikely' that they would develop above partial pillar extraction panels (where subsidence magnitudes <300 mm) (i.e. within SCZs).

Table 4-3
Likelihood of Connective Cracking to the Surface above Partial and Total Pillar Extraction Panels

Level of Pillar Extraction	Depth of Cover (m)	Likelihood of Connective Cracking to Surface
First workings (no secondary extraction)	>50	Not Credible (<1%)
Partial pillar extraction	>50	Unlikely (5-10%) to Very Unlikely (1-5%)
Total pillar extraction	<50	Likely (25-75%)
	50 – 80	Possible (10-25%)
	80 – 100	Unlikely (5-10%)
	>100	Very Unlikely (1-5%)

Source: After Appendix A.

Changes in Stream Bed Gradients

Pre-mining and post-mining surface level profiles along Surveyors Creek 2 are presented in Figure 4-1a, including a comparison of the post-mining surface levels with and without the implementation of SCZs to achieve the subsidence performance measures (Section 2.6.3). Predicted subsidence and the change in gradient along Surveyors Creek 2 are presented in Figure 4-1b.

Pre-mining and post-mining surface level profiles along other streams above the West Borehole Seam mining area are presented in the Subsidence Assessment (Appendix A).

Ponding and Changes in Stream Alignment

Ponding refers to the potential for 'closed-form' depressions to develop at the surface after mining beneath gentle slopes and relatively flat terrain.

Analysis of the pre-mining and post-mining surface levels suggests that ponding (if it occurs) would be likely to develop near existing streams (Appendix A). DgS (2012) determined that depressions with maximum depths of between 0.1 and 0.7 m may occur outside of existing stream alignments after mining in the West Borehole Seam is completed.

Actual ponding depths would depend upon several other factors, such as rain duration, surface cracking and effective percolation and evapo-transpiration rates, in addition to the post-mining surface levels (Appendix A).

Slope Instability and Erosion

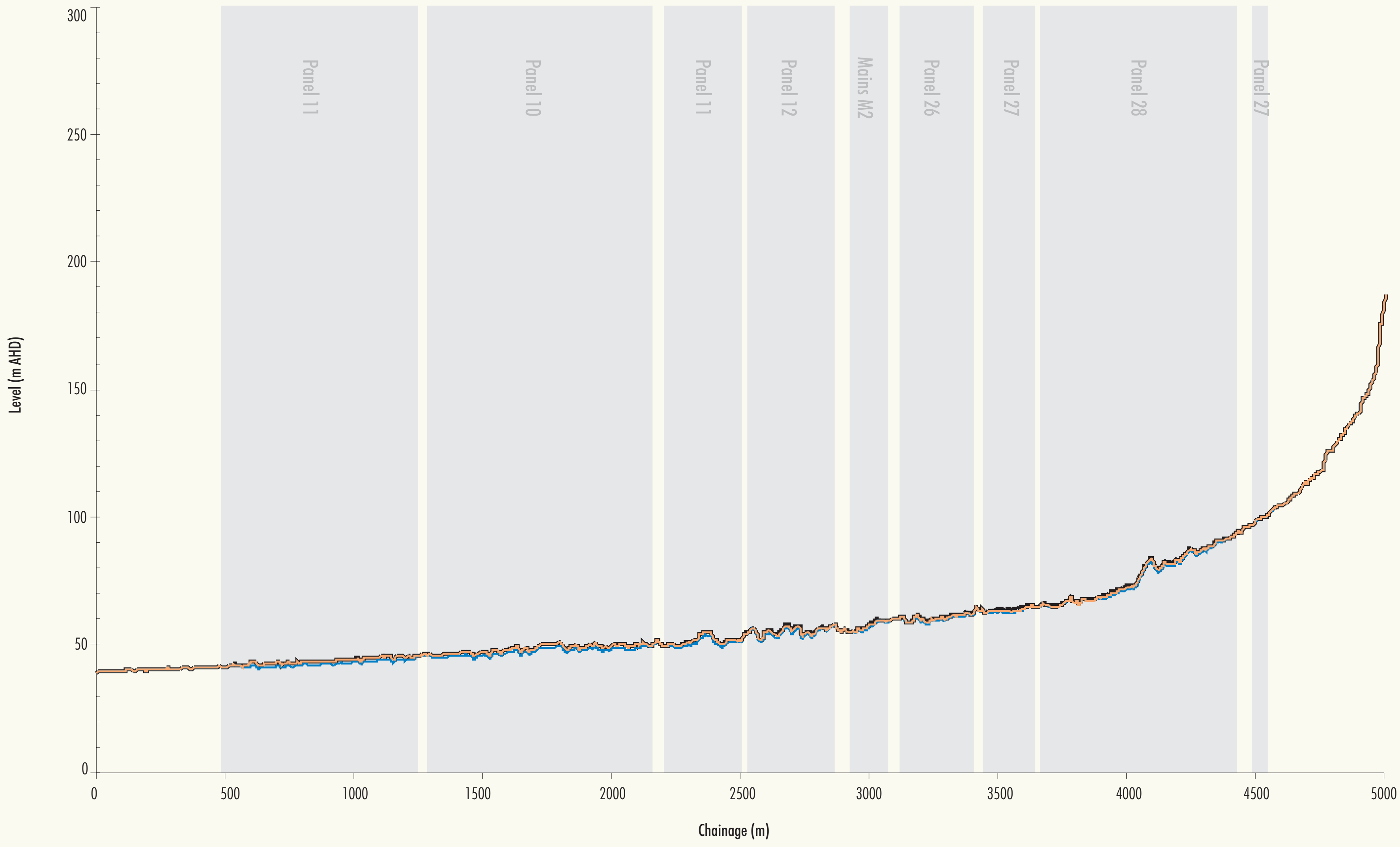
Local pillar extraction mining has not resulted in any large scale, *en-masse* sliding instability due to mine subsidence (or other natural weathering processes, etc.) in undulating terrain with slopes up to approximately 1 in 2 (Appendix A).

In general, it is possible that localised instability could occur where slopes are steeper than 1 in 2 and if the slopes are also affected by mining induced cracking and increased erosion rates due to subsidence in excess of 300 mm (Appendix A). Therefore, SCZs would be applied to steep slopes greater than 1 in 2 and cliff line areas to minimise environmental consequences and impacts to public safety (Section 2.6.3). The proposed subsidence performance measures can be achieved for slopes between 1 in 3 and 1 in 2 without limiting extraction (Appendix A).

The cumulative subsidence effects along the steep slopes and cliff line areas are unlikely to result in cracking, toppling or slope instability after completion of mining in the Fassifern and West Borehole Seams (Appendix A).

The rate of erosion may increase significantly in areas with exposed dispersive and/or reactive alluvial or residual soils or tuffaceous claystone and where slope gradients are increased by more than 2% (>20 mm/m) (Appendix A). DgS (2012) determined that changes in slope gradient sufficient to accelerate erosion processes would be unlikely within areas of partial pillar extraction or first workings only (i.e. within SCZs).

Slope instability, rock fall and erosion occur naturally along steep slopes and cliff line areas due to natural weathering and tree root wedging processes (Plate 4-1). In some circumstances it may be difficult to differentiate between natural and mining induced processes.



Source: Appendix A

LEGEND
Bord and Pillar Panel
Pre-mining
Without Subsidence Control Zones
With Subsidence Control Zones

TASMAN EXTENSION PROJECT

FIGURE 4-1a
Post-mining Surface Levels
Along Surveyors Creek 2

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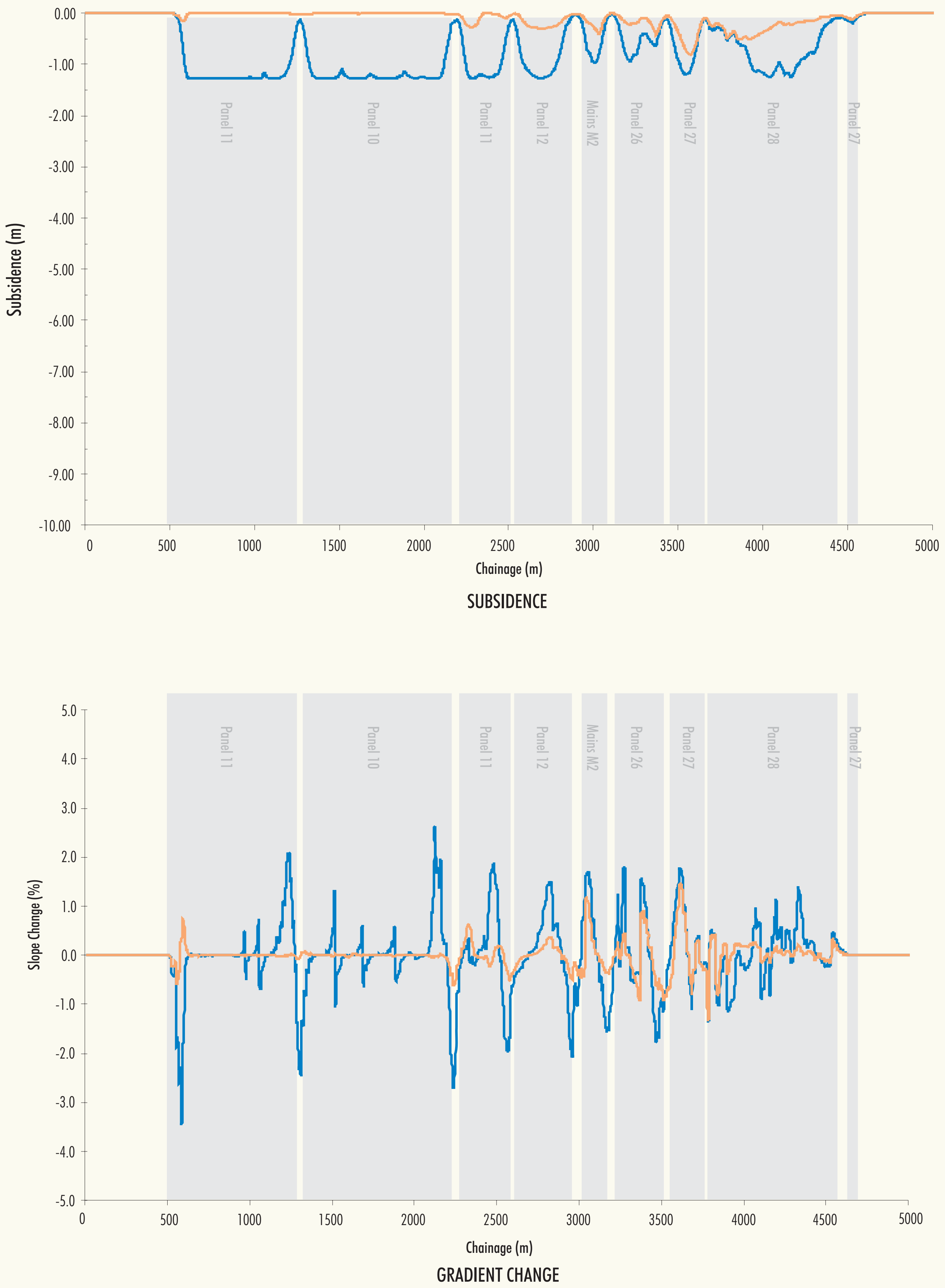
DCL-09-01 EIS Sect 4_002A



Source: Appendix A

LEGEND
Bord and Pillar Panel
Without Subsidence Control Zones
With Subsidence Control Zones

Resource Strategies

TASMAN EXTENSION PROJECT

FIGURE 4-1b
Subsidence and Gradient Change Along Surveyors Creek 2

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DCL-09-01 EIS Sect 4_001C

Plate 4-1 – Natural Slope Erosion on Sugarloaf Range

Depressurisation of Groundwater Aquifers

Continuous subsurface fracturing would result in pressure loss within the groundwater system due to a direct hydraulic connection to the underground workings (Section 4.2.3). Discontinuous subsurface fracturing would result in an increase in rock mass storage capacity and horizontal permeability (Appendix A).

An assessment of the potential impacts on the groundwater resource as a result of subsurface fracturing is conducted in Appendix B and summarised in Section 4.4.

4.2.5 Potential Consequences of Subsidence on Key Natural and Built Features

An assessment of the potential consequences of the subsidence impacts described in Section 4.2.4 is provided below, including relevant cross-references to sub-sections with further detail.

DgS (2012) concluded that overall the assessed range of potential subsidence and far-field displacement impacts would be manageable for the majority of the site features, based on the analysis outcomes and discussions with stakeholders to date (Appendix A).

Streams

The mine layout would be designed to achieve negligible environmental consequences for the third order portion of Surveyors Creek 2 within the West Borehole Seam mining area (i.e. negligible diversion of flows and negligible change in the natural behaviour of pools) (Section 2.6.3).

Subsidence impacts on other streams within the mining area would be managed to achieve not more than minor environmental consequences and negligible connective cracking to the underground workings (Section 2.6.3).

DgS (2012) assessed that the use of partial pillar extraction areas beneath streams would provide a high level of protection from continuous fracturing from surface to seam (Appendix A).

Potential subsidence consequences for fluvial geomorphology and stream flow are assessed in Sections 4.5 and 4.6 and Appendices C and D.

Cliffs and Steep Slopes

The mine layout would be designed to achieve no additional risk to public safety and only minor impacts to steep slope and cliff line areas (resulting in negligible environmental consequence) (Sections 2.6.3 and 4.3.2). Mitigation measures, management and monitoring for cliffs and steep slopes are described in Section 4.3.3.

An assessment of potential impacts of slope instability on visual character is provided in Section 4.19.

Land Use and Land Resources

Potential consequences on land resources and land use (e.g. recreation, conservation, forestry and agriculture) as a result of subsidence impacts are assessed in Section 4.3.

Groundwater Dependent Ecosystems and Riparian Vegetation

The mine layout would be designed to achieve negligible environmental consequences to Coastal Warm Temperate – Sub Tropical Rainforest and Alluvial Tall Moist Forest, which are considered groundwater dependent ecosystems and are listed as EECs (Section 2.6.3). Environmental consequences to an area of Uplands Paperbark Thicket (potentially a groundwater dependent ecosystem) would be negligible due to the implementation of other SCZs.

The mine layout would be designed to achieve negligible environmental consequences to the Hunter Lowlands Redgum Forest community (an EEC) that is present along the third order portion of Surveyors Creek 2 (Section 2.6.3).

DgS (2012) assessed that the use of partial pillar extraction areas beneath groundwater dependent ecosystems and riparian vegetation would provide a high level of protection from continuous fracturing from surface to seam (Appendix A).

Potential consequences for flora as a result of subsidence impacts are assessed in Section 4.8 and Appendix F.

Aboriginal Heritage

Potential consequences (e.g. cracking) may occur to sandstone-based Aboriginal heritage sites as a result of subsidence.

Potential consequences for Aboriginal heritage as a result of subsidence impacts are assessed in Section 4.10 and Appendix K.

Principal Residences and Residential Structures

There are currently three privately-owned principal residences within the underground mining areas (Figure 4-2).

Mining under principal residences would be restricted to first workings only (i.e. non-subsiding) within a 26.5° angle of draw resulting in less than 20 mm of subsidence (unless agreed otherwise with the landholder) (Section 2.6.3 and Box 4-1). As a result, subsidence impacts to principal residences would be minimal.

This would also reduce impacts to structures located adjacent to principal residences (e.g. water tanks and on-site effluent disposal areas) (Appendix A).

Other residential structures that are located further away from the principal residence (e.g. fences and driveways) are likely to be impacted by mine subsidence. These structures would be fully repaired or compensated as described in Section 4.2.6.

DgS (2012) indicates that the majority of subsidence movements likely to affect undermined properties would occur within a period of approximately six to eight weeks after each panel is extracted (Appendix A).

BOX 4-1
PRINCIPAL RESIDENCES
SUBSIDENCE MANAGEMENT

Private Residence East of Sheppeard Drive*

<u>Project subsidence performance measures:</u>

- Maintain safety.
- Serviceability to be maintained and/or fully compensated.
- Damage must be fully repaired or compensated.

<u>Project subsidence control zone:</u>

- First workings only within 26.5° angle of draw resulting in less than 20 mm subsidence, 5 mm/m tilt and 2 mm/m strain (may be relaxed if agreement reached with the owner).

<u>Project subsidence control outcomes:</u>

- No more than minimal impact on the residence, unless otherwise agreed by the owner.
- Long-term stable pillar (i.e. non-subsiding) left under each principal residence, unless otherwise agreed by the owner.

Refer to Table 2-3 for details.
*Appendix A.

Infrastructure and Improvements and Private Landholdings

The potential impacts of subsidence effects on infrastructure and improvements are assessed in Appendix A. Infrastructure and improvements with more than 20 mm predicted subsidence from mining in the West Borehole Seam include (Figure 4-2):

- electrical infrastructure (i.e. TransGrid and Ausgrid electricity transmission lines);
- telecommunication infrastructure (i.e. FOCs and copper telecommunication cables);
- Sheppeard Drive and associated drainage infrastructure; and
- fire trails and other minor tracks and roads.

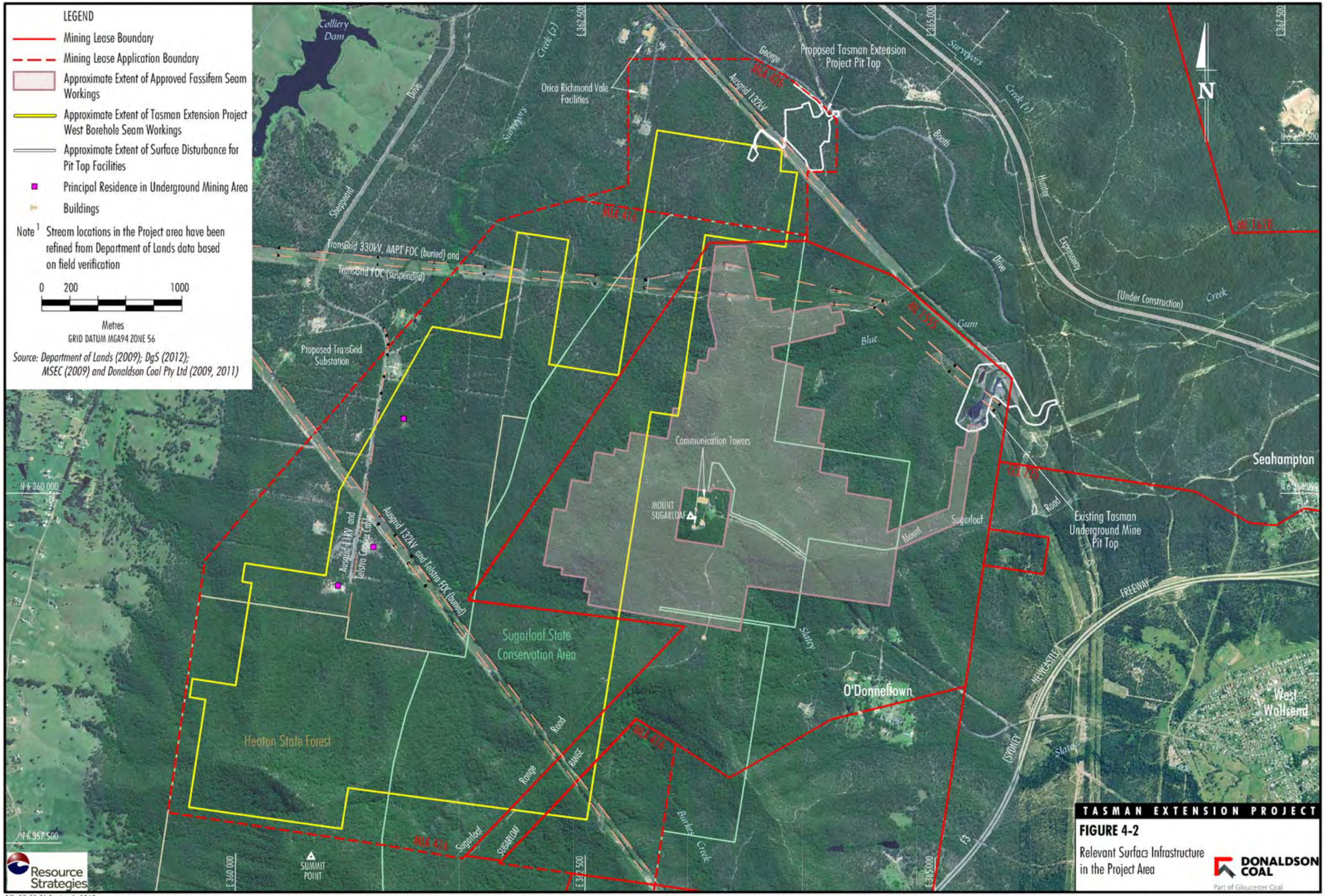


FIGURE 4-2
Relevant Surface Infrastructure in the Project Area

DCL-09-01 EA Section 4_106C

The mine layout would be designed to maintain safety and serviceability for electrical infrastructure and FOCs (Section 2.6.3 and Box 4-2). Any minor damage to these items would be fully repaired or compensated as described in Section 4.2.6.

BOX 4-2
KEY INFRASTRUCTURE SUBSIDENCE MANAGEMENT

Ausgrid 132 kV Transmission Line Easement*

Project subsidence performance measures:

- Maintain safety and serviceability.
- No damage to structures or loss of service for communication towers on Mount Sugarloaf.
- Damage must be fully repaired or compensated for FOCs, TransGrid and Ausgrid towers.

Project subsidence control zone:

- First workings only within 45° angle of draw resulting in less than 2 mm subsidence and 10 mm horizontal displacement for communication towers on Mount Sugarloaf.
- Partial extraction with stable remnant pillars resulting in less than 300 mm of subsidence for FOCs (unless cables can be relocated by agreement with the infrastructure owner or is suspended on electricity transmission towers).
- First workings only within 26.5° angle of draw resulting in less than 20 mm subsidence, 5 mm/m tilt and 2 mm/m strain for TransGrid towers (may be relaxed if cruciform footings can be installed and agreement reached with the infrastructure owner).
- Maximum extraction for Ausgrid towers (except where within another SCZ).

Project subsidence control outcomes:

- Maintenance of key infrastructure safety and serviceability and repair or compensation for any subsidence related damage.
- Implementation of management measures agreed with infrastructure owners in advance of associated subsidence.

Refer to Table 2-3 for details.
*Appendix A.

Negligible subsidence impacts are anticipated on the communication towers on Mount Sugarloaf, the Orica Richmond Vale facilities[1], the proposed TransGrid substation on Sheppeard Drive, George Booth Drive and the Hunter Expressway (currently under construction) (Appendix A).

4.2.6 Mitigation Measures, Management and Monitoring

The SCZs would mitigate impacts to significant surface features (Section 2.6.3). DgS (2012) considers that the proposed SCZs to achieve the subsidence performance measures are conservative, and the SCZs would be confirmed through subsidence monitoring and adaptive management as mining progresses (Appendix A).

Extraction Plans would be prepared prior to the commencement of mining in each area to demonstrate that the subsidence performance measures can be achieved. The Extraction Plan process would apply an adaptive management approach to the SCZs to achieve the performance measures (Section 2.6.3).

Mitigation measures and management for subsidence impacts on land resources, groundwater, stream geomorphology, surface water, aquatic ecology, flora, terrestrial fauna, Aboriginal heritage and visual character are summarised in Sections 4.3 to 4.10 and 4.19.

Principal Residences and Residential Structures

Donaldson Coal commits to restricting extraction to non-subsiding first workings only under principal residences (unless agreed otherwise with the landholder). Donaldson Coal would only consider one residence per private lot as a 'principal residence'. Once the mining layout has been finalised, Extraction Plans would be developed progressively over the life of the Project and would include:

- specific subsidence assessment for principal residences and residential structures (improvements) on properties potentially impacted by the Project;
- consultation with owners and/or occupiers of properties, including provision of detailed subsidence assessments and the opportunity for individual discussions with Donaldson Coal;

[1] Includes an ammonium nitrate emulsion production facility and technical and research facility off George Booth Drive.

- pre-mining inspections of the property by Donaldson Coal and the MSB (with the approval of the landholder/occupier) to:
  - undertake a structural assessment to determine tolerable limits for subsidence to the principal residence in consideration of the dwelling construction, size, footings and surface conditions;
  - identify and record pre-existing condition of the structure; and
  - identify and discuss any areas of concern to the landholder/occupier;
- development of a mining layout that maintains subsidence parameters within tolerable limits for a principal residence; and
- using the information gathered above, development of a Built Features Management Plan[2] for each property.

The Built Features Management Plan would be provided to the landholder/occupier prior to mining in the area and would include:

- easy-to-read plan of the property in relation to the final mining layout;
- details of predicted subsidence impacts and associated probabilities of these impacts occurring;
- the expected timing of mine subsidence;
- a specific subsidence monitoring plan to monitor subsidence impacts during and following mining, including visual inspections and structure surveys;
- implementation of appropriate pre-mining mitigation measures to minimise impacts, where appropriate;
- the process for identifying and rectifying any impacts to structures that may occur as a result of mining; and
- contact details for Donaldson Coal should any further information be required.

[2] The term Built Features Management Plan is used through the EIS Main Report to be consistent with the terminology in contemporary Project Approvals and Development Consents. These documents are also referred to as Property Subsidence Management Plans (Appendix A).

In the event of any mine subsidence damage to any residential structure (improvement), claims are lodged with the MSB (Section 6.3.1). If a claim is accepted, the MSB may offer the owner the option of having the repairs carried out by the MSB's contractors or of having the MSB provide a financial settlement. The usual practice is for the MSB to arrange, supervise and pay for the repairs (MSB, 2007). The MSB covers all improvements located outside a proclaimed mine subsidence district and most improvements within a mine subsidence district (Section 6.3.1).

In circumstances where the owner of the principal residence and Donaldson Coal can agree to terms which permit secondary workings under the principal residence, Donaldson Coal would negotiate a detailed plan of management and compensation accordingly.

Infrastructure and Improvements

Measures to mitigate and manage the impacts of subsidence on surface infrastructure would be developed in detail in consultation with the infrastructure owner as a component of future Extraction Plans.

Mitigation measures and management would be documented in Built Features Management Plans, which would be developed as part of the Extraction Plans. Built Feature Management Plans would include:

- pre-mining inspections of structural stability and susceptibility to subsidence;
- implementation of appropriate pre-mining mitigation measures to minimise impacts, where appropriate (e.g. installation of cruciform footings beneath suspension transmission towers);
- implementation of an appropriate subsidence monitoring program, including subsidence surveys and visual monitoring at appropriate frequencies;
- development of appropriate remedial measures for any subsidence impacts, including a commitment to mitigate, repair, replace or compensate any impacts in a timely manner;
- development of Trigger Action Response Plans for unexpected subsidence impacts; and
- development of protocols for the distribution of results to relevant stakeholders.

Subsidence Monitoring

Surface subsidence monitoring data would be collected in accordance with the subsidence monitoring programs detailed in the Extraction Plans. Subsidence monitoring would include transverse and longitudinal subsidence lines above each panel, and survey lines/pegs around features of interest (e.g. principal residences, Aboriginal heritage sites and TransGrid towers).

Monitoring of sub-surface fracture heights above pillar extraction panels in the West Borehole Seam would be conducted through the installation of extensometers and piezometers.

The subsidence monitoring data would be reviewed as part of the Extraction Plan and reporting processes to assist with the management of risks associated with subsidence, validate subsidence predictions and inform the adaptive management process.

4.3 LAND RESOURCES, LAND USES, CLIMATE AND BUSHFIRE REGIME

Land resources include the topographical features and natural landforms and the soil landscapes. Land uses in the Project area are influenced by the available land resources.

A description of the land resources, land uses, climate and bushfire regime in the Project area is provided in Section 4.3.1. Potential impacts on land resources, land uses and the bushfire regime as a result of underground mining and surface activities are described in Section 4.3.2. Mitigation measures, management and monitoring for potential impacts are summarised in Section 4.3.3.

4.3.1 Existing Environment

Landforms and Topography

The topography of the Project area is dominated by the Sugarloaf Range, which extends from the Watagan Mountains (in the south) to Mount Sugarloaf (in the north). Mount Vincent is, at 426 m Australian Height Datum (AHD), the highest point on Sugarloaf Range, and is located to the south of the Project. Mount Sugarloaf has an elevation of 412 m AHD and is the highest topographical point in the Project area.

The western section of the Project area extends beneath the lower elevated areas leading towards the Surveyors Creek and Wallis Creek floodplain. The south-eastern section of the Project area includes the lower elevated Slatey Creek area. The existing pit top facility and part of the existing Fassifern Seam mining area are located within the Blue Gum Creek catchment which flows east to Hexham Swamp.

The Sugarloaf Range is dominated by Triassic sandstone and siltstone sediments from the Narrabeen Group. The Permian Newcastle Coal Measures outcrop on the lower slopes and flatter areas surrounding Sugarloaf Range.

The land overlying the extent of the West Borehole Seam mining area ranges in elevation from 40 to 370 m AHD (Plate 4-2).

Within the extent of surface disturbance for the new pit top facility, the elevation varies between approximately 50 to 80 m AHD, and is characterised by undulating terrain.

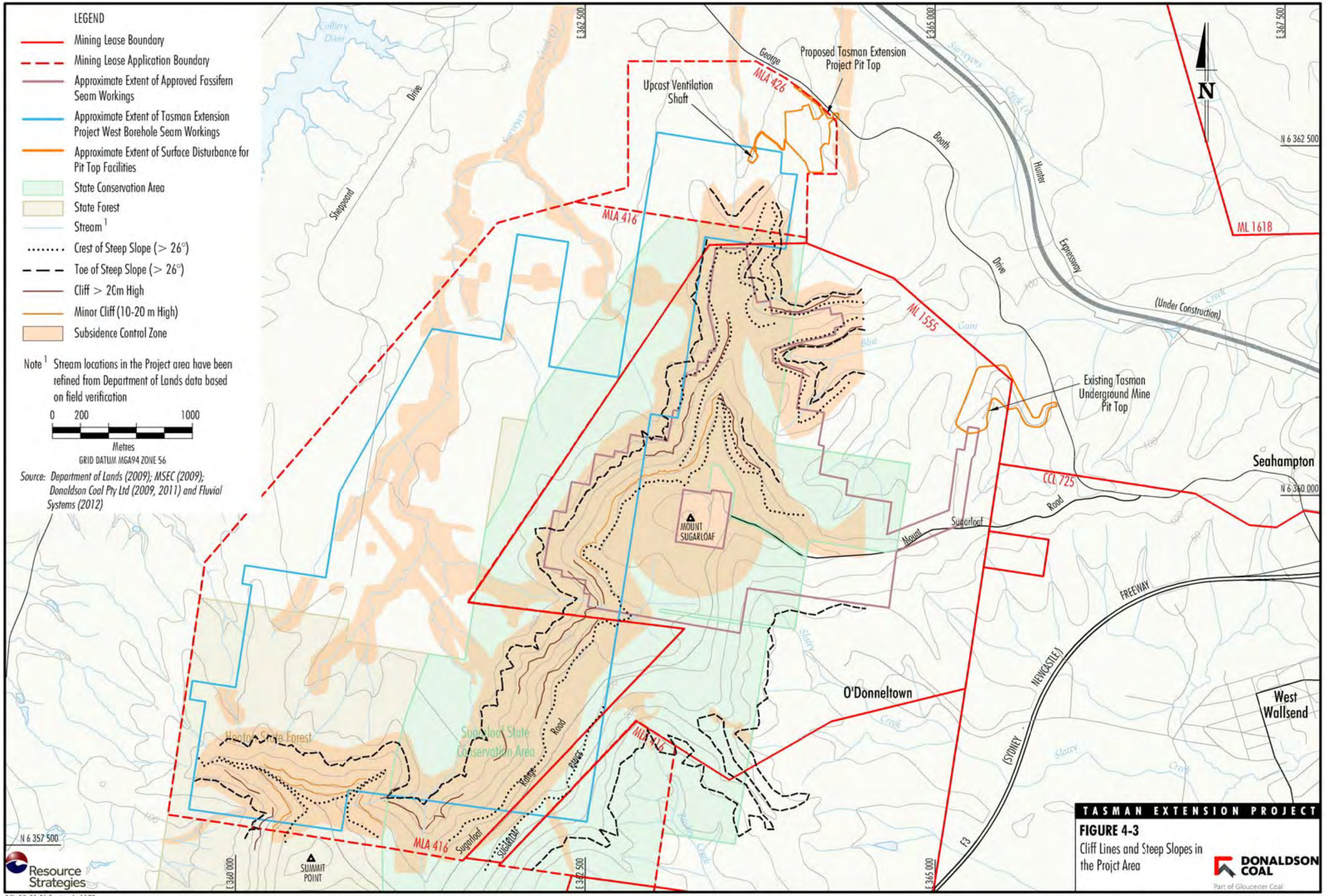
Cliff Lines and Steep Slopes

Steep slopes are present along the Sugarloaf Range within the Project area. There is approximately 10 km of slopes with a gradient greater than 18° within the Project area (Appendix A). The slopes along the Sugarloaf Range include a variety of forms including continuous cliff lines, overhangs, cliff terraces, discontinuous rock outcrops, talus slopes and other vegetated steep slopes.

Distinctive cliff lines are formed within sandstone of the Triassic Narrabeen Group along the Sugarloaf Range (Figure 4-3 and Plate 4-3).

DgS (2012) estimated from aerial Light Detection and Ranging (LIDAR) surveys and site inspections that there are approximately 4.9 km of continuous cliffs between 10 to 60 m high and 4.4 km of minor continuous cliffs between 5 to 10 m high within the West Borehole Seam mining area (Appendix A). Numerous discontinuous, minor cliffs or rock formations between 2 to 5 m high also exist along sections of the steep slopes associated with the ridges (Appendix A).

Large sandstone talus boulders (approximately 2 to 5 m in diameter) form rocky steep slopes below the cliffs between 28° and 45° slope and extend for approximately 100 m down to the foot slopes (Plate 4-4).



TASMAN EXTENSION PROJECT

FIGURE 4-3

Cliff Lines and Steep Slopes in the Projct Area

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Resource Strategies

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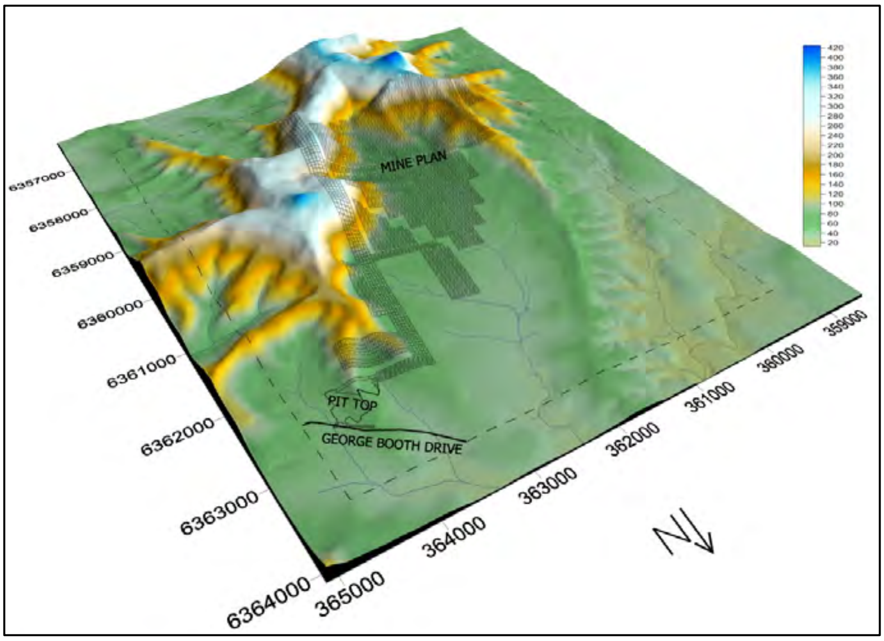


Source: Appendix F.

Plate 4-2 – Topography in the West Borehole Seam Mining Area

Source: Appendix A.

Plate 4-3 – Sandstone Cliff on Sugarloaf Range

Source: Appendix A.

Plate 4-4 – Talus Slope on Sugarloaf Range

Natural instability occurs within the cliff lines and steep slopes of the Project area, primarily due to the undercutting of mudstone beds and the release of overlying sandstone blocks along existing orthogonal joint patterns (Appendix A). Tree-root wedging is also a contributing factor to natural cliff face instability (Appendix A).

Soils

The Sugarloaf Range is dominated by Triassic sandstone and siltstone sediments from the Narrabeen Group, while the surrounding lower slopes and adjacent terrain are dominated by Permian Newcastle Coal Measures with a band of Triassic Tomago Coal Measures to the west of the Sugarloaf Range (NSW Department of Environment and Climate Change [DECC], 2008).

Soil landscapes in the vicinity of the Project have been mapped by the former NSW Department of Land and Water Conservation as described in the document *Soil Landscapes of the Newcastle 1:100,000 Sheet* (Matthei, 1995).

Soil landscapes across the Project area are shown on Figure 4-4. Table 4-4 summarises the key characteristics, the dominant soil materials and the fertility of each soil landscape within the Project area.

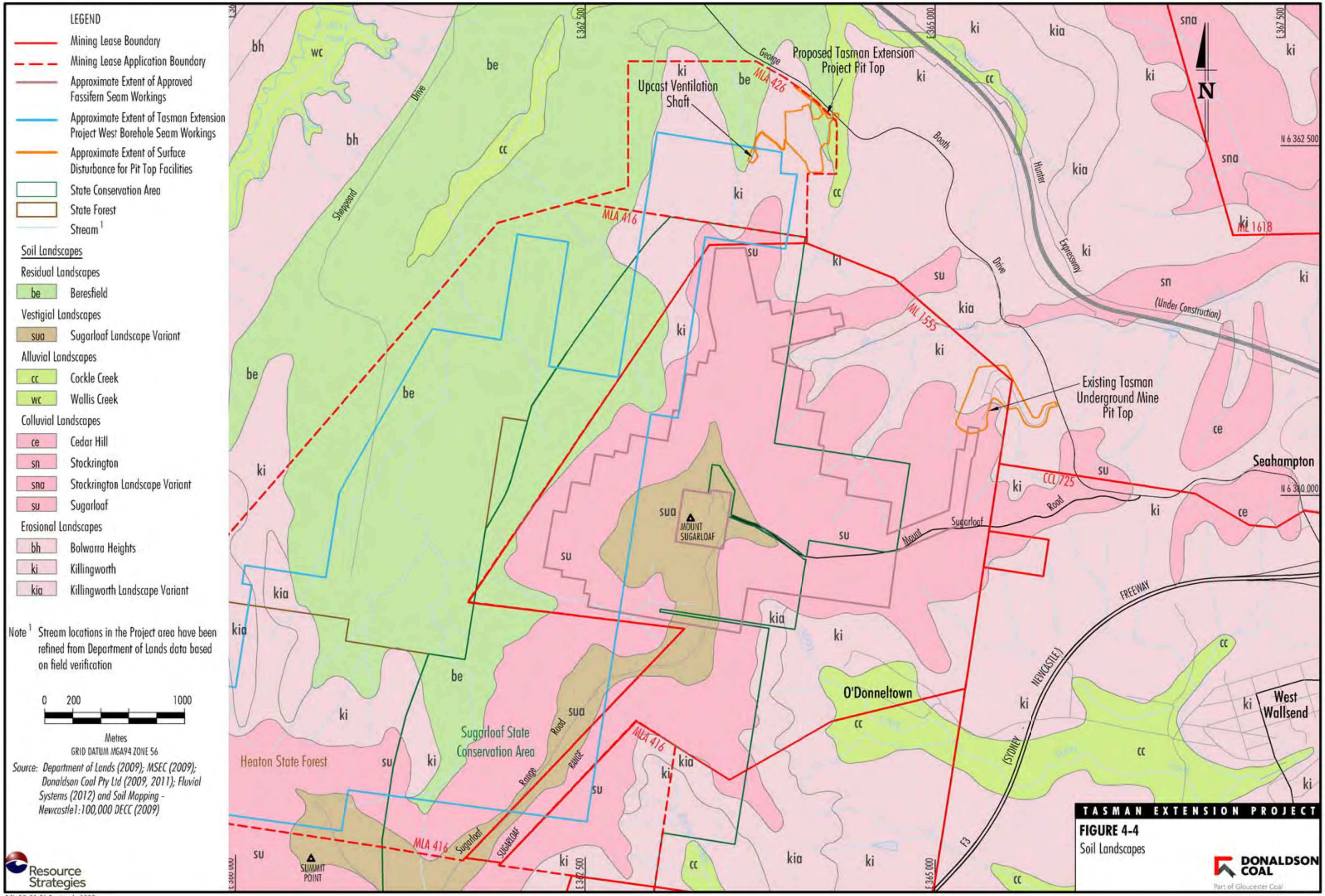


FIGURE 4-4
Soil Landscapes

DCL-09-01 EA Section 4_103D

Table 4-4
Soil Landscapes of the Project Area

Soil Landscape	Characteristics	Dominant Soil Materials	Soil Fertility
Residual Landscapes			
Beresfield	• Undulating low hills and rises on Permian sediments. • Generally moderate limitations for cultivation and low limitations for grazing. • Limitations include water erosion hazard, high foundation hazard, and localised steep slopes, high run-on, seasonal waterlogging and rock outcrops.	• Friable brownish black loam (topsoil). • Hardsetting dull yellowish brown sandy loam (topsoil). • Pedal brown plastic mottled clay (subsoil). • Reddish brown plastic pedal clay (subsoil). • Gleyed “puggy” silty clay (subsoil).	• Moderate to low soil material suitability as a growth medium. • Low soil profile suitability as a growth medium. • Moderate soil volumes for root penetration.
Vestigial Landscapes			
Sugarloaf Landscape Variant	• Summit surfaces and crests on sandstone and siltstone sediments of the Narrabeen Group in the Sugarloaf Range. • High limitations for cultivation and moderate limitations for grazing. • Limitations include shallow soils, water erosion hazard, rock outcrops and localised seasonal waterlogging, foundation hazard and high run-on.	• Brownish black sandy clay loam (topsoil). • Bleached, massive sandy clay loam (topsoil). • Earthy bright yellowish brown sandy clay (subsoil).	• Generally low soil material suitability as a growth medium. • Moderate soil profile suitability as a growth medium. • Restricted soil volumes for root penetration.
Colluvial Landscapes			
Sugarloaf	• Rolling to steep mountains on sandstone and siltstone sediments of the Narrabeen Group in the Sugarloaf Range. • High to severe limitations for cultivation and grazing. • Limitations include steep slopes, mass movement hazard, rock fall hazard, water erosion hazard, foundation hazard and localised rock outcrops and shallow soils.	• Brownish black sandy clay loam (topsoil). • Bleached, massive sandy clay loam (topsoil). • Bright yellowish brown pedal mottled clay (subsoil). • Earthy bright yellowish brown sandy clay (subsoil).	• Generally low soil material suitability as a growth medium. • Low soil profile suitability as a growth medium. • Generally high soil volumes for root penetration.

Table 4-4 (Continued)
Soil Landscapes of the Project Area

Soil Landscape	Characteristics	Dominant Soil Materials	Soil Fertility
Erosional Landscapes			
Killingworth	• Undulating to rolling hills and low hills on Newcastle Coal Measures. • High limitations for cultivation and moderate limitations for grazing. • Limitations include water erosion hazard, seasonal waterlogging on lower slopes and localised high run-on, foundation hazard, shallow soils and rock outcrops.	• Brownish black pedal loam (topsoil). • Bleached hardsetting loamy sand to sandy clay loam (topsoil). • Pedal yellowish brown clay (subsoil).	• Very low soil material suitability as a growth medium. • Low to moderate soil profile suitability as a growth medium. • Low to moderate soil volumes for root penetration.
Killingworth Landscape Variant	• Undulating to rolling hills and low hills on Newcastle Coal Measures. • High limitations for cultivation and moderate limitations for grazing. • Limitations include water erosion hazard and localised high run-on, steep slopes, mass movement hazard, shallow soils, rock outcrops and foundation hazard.		
Alluvial Landscapes			
Cockle Creek	• Narrow floodplains, alluvial fan deposits and broad delta deposits. • Moderate limitations for cultivation and low limitations for grazing. • Limitations include flooding hazard, seasonal waterlogging, water erosion hazard, high run-on, foundation hazard and localised waterlogging and permanently high watertables.	• Brownish black sandy loam (topsoil). • Hardsetting bleached sandy clay loam (topsoil). • Dull yellowish brown pedal clay (subsoil). • Earthy mottled sandy clay (subsoil).	• Moderate to low soil material suitability as a growth medium. • Low soil profile suitability as a growth medium. • Restricted soil volumes for root penetration.

Source: After Matthei (1995).

The Sugarloaf colluvial soil landscape unit occurs on the sandstone and siltstone sediments of the Narrabeen Group on the slopes of the Sugarloaf Range (Figure 4-4). The Sugarloaf vestigial soil landscape variant occurs on the undulating to rolling broad summit surfaces and narrow, stony ridges and crests of the Sugarloaf Range, with gradients <20% (Matthei, 1995).

The Killingworth erosional soil landscape unit (and landscape variant) occurs on sediments of the Newcastle Coal Measures on the easterly facing slopes and foothills of the Sugarloaf Range (Matthei, 1995). The Beresfield residual soil landscape unit occurs on the undulating low hills and rises on Permian sediments to the west of the Sugarloaf Range (Figure 4-4).

The Cockle Creek alluvial soil landscape unit occurs on Surveyors Creek 2 downstream of the Project area, on the tributary to Surveyors Creek near the new pit top facility, and on Slatey Creek near O'Donneltown (Figure 4-4).

There are generally moderate to severe limitations for cultivation on soil landscapes across the Project area (Table 4-4). Limitations to grazing are low to moderate across the Project area, except within the Sugarloaf soil landscape unit which has high to severe limitations due to the steep slopes and cliff lines (Table 4-4).

There are no soils identified as having acid sulphate potential within the Project area (Appendix C).

Land Use

A large portion of the Project area comprises the Sugarloaf State Conservation Area and Heaton State Forest. This vegetation forms part of a corridor of contiguous vegetation that links Sugarloaf Range to the Watagan Mountains in the south (DECC, 2008). Sugarloaf State Conservation Area and Heaton State Forest are used for recreational purposes by bushwalkers, off-road vehicles and trail bikes.

The Keepa Keepa Elders Corporation (a registered Aboriginal group) has a prior agreement to use a portion of the Heaton State Forest for educational purposes (Appendix K).

Existing development within and immediately surrounding the Project area includes (Figure 4-2):

- electrical infrastructure (i.e. TransGrid and Ausgrid electricity transmission lines);
- telecommunication infrastructure (i.e. FOCs and copper telecommunication cables);
- Sydney-Newcastle (F3) Freeway, Hunter Expressway (under construction), George Booth Drive, Sheppeard Drive, Mount Sugarloaf Road and other minor tracks and roads;
- the Orica Richmond Vale facilities off George Booth Drive;
- public lookout and picnic area on Mount Sugarloaf;
- rural residential properties along Sheppeard Drive;
- locality of O'Donneltown and township of Seahampton; and
- the existing Tasman Underground Mine.

The Tasman Underground Mine commenced in May 2006, with underground mining commencing in September 2006. The operations at the current underground mining area are supported by the existing Tasman Underground Mine pit top facility which is located off George Booth Drive (Figure 4-2).

Other operational mines in the vicinity of the Project include (Figure 1-1):

- West Wallsend Colliery, approximately 5 km south-east;
- Westside Colliery, approximately 6 km south-east;
- Abel Underground Mine, approximately 10 km north-east;
- Donaldson Open Cut Mine, approximately 10 km north-east; and
- Bloomfield Colliery, approximately 10 km north-northeast.

Portions of the Project area have been historically mined by the Stockrington No. 2 Colliery in the West Borehole Seam.

Agricultural Land Use and Land Capability

There are no agricultural enterprises located within the West Borehole and Fassifern Seam underground mining areas or the new pit top facility and upcast ventilation shaft areas.

Rural land capability is a method of evaluating the quality of rural land. Rural land capability is an eight class classification system based on assessment of biophysical characteristics categorising land in terms of general limitations such as erosion hazard, climate and slope (Emery, 1985).

Regional rural land capability mapping (DECC, 2009a) was used to evaluate the quality of rural land within the Project area and is shown on Figure 4-5. The following rural land capability classes are mapped within the Project area:

- Class IV – suitable for grazing with occasional cultivation.
- Class VI – suitable for grazing with no cultivation.
- Class VII – land best protected by green timber.
- Class VIII – areas incapable of sustaining agricultural or pastoral production (e.g. cliffs).

The major factor influencing the classification of the land was slope, with Classes IV and VI located on the flatter areas and Classes VII and VIII located on the steeper slopes.

Agricultural suitability mapping has not been completed for the Project area.

The Project area does not include any "regionally significant agricultural land" identified in the Lower Hunter Regional Strategy (DoP, 2006).

On the basis of the above and the inherent soil fertility of the soil landscapes in the Project area, there is considered to be no highly valuable agricultural lands or resources.

Meteorology

Long-term local meteorological records are available from the Commonwealth Bureau of Meteorology (BoM) meteorological stations (Table 4-5). Short-term records are available from the on-site automatic weather stations (AWS) located at the Tasman Underground Mine and the Donaldson Open Cut Mine.

The Tasman Underground Mine AWS was installed in November 2006 and is operated in accordance with the Development Consent (DA 274-9-2002). The AWS monitors a number of meteorological parameters, including rainfall, temperature at 2 m and 10 m and wind speed/direction.

A summary of meteorological parameters in the vicinity of the Project relevant to the environmental studies in this EIS are provided below.

Rainfall

The long-term average annual rainfall at meteorological stations in close proximity to the Project varies from approximately 766 mm at the Cessnock (Nulkaba) meteorological station to approximately 966 mm at the Mulbring (Vincent St) weather station (Table 4-5). The highest monthly average rainfalls are in January and February (Table 4-5).

Generally the rainfall records indicate moderate seasonality, with higher rainfall being recorded in the late summer and autumn and lower rainfall during the spring and winter.

Temperature

Long-term, monthly-average daily maximum and minimum temperatures show that temperatures are warmest from November to March and coolest in the winter months of June, July and August (Table 4-5).

Monthly-average daily maximum temperatures are highest in January (approximately 30 degrees Celsius [ºC]) and monthly-average daily minimum temperatures are lowest in July (between 4.6ºC and 6.1ºC) (Table 4-5).

Evaporation

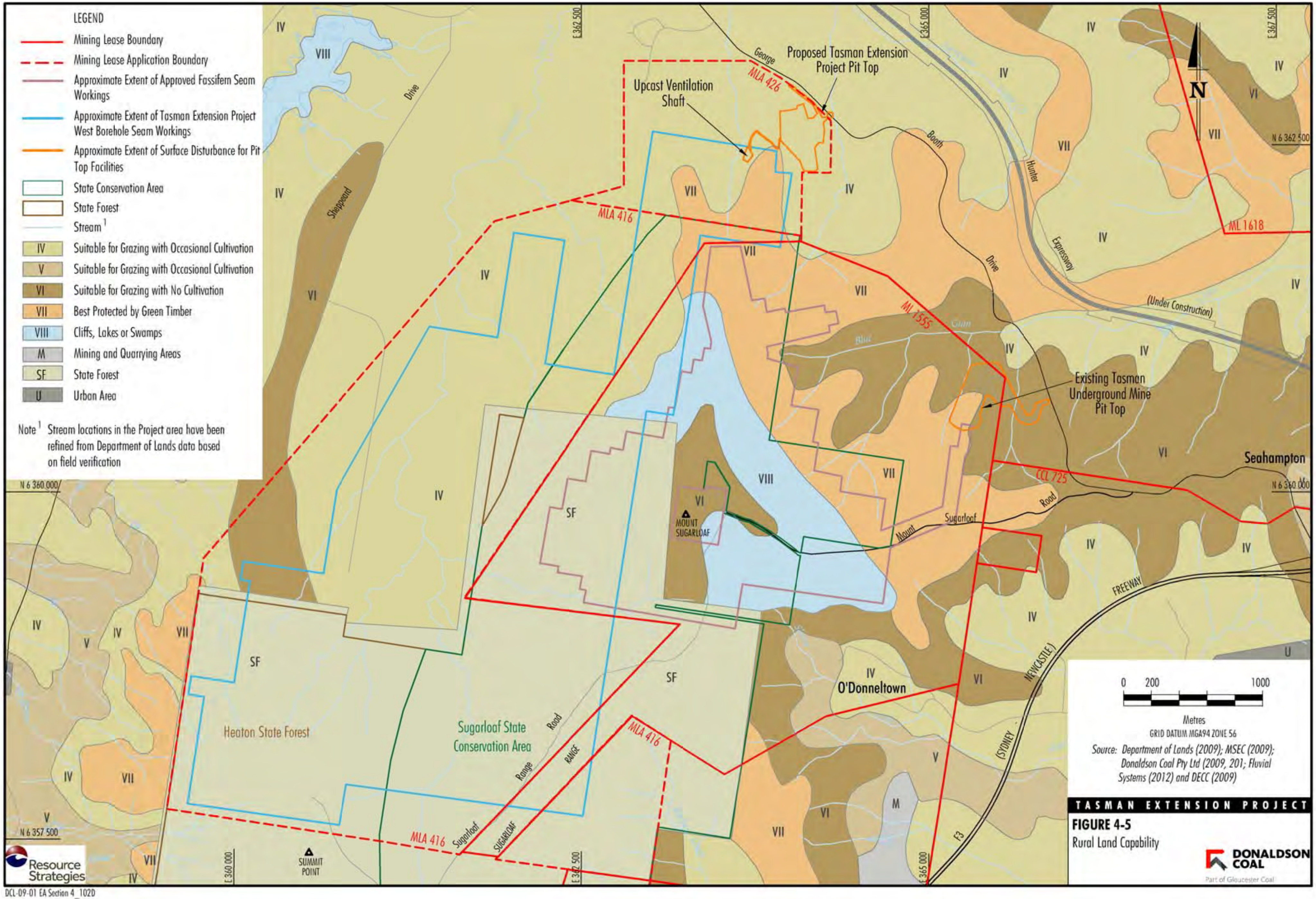
Evaporation records are available from the Cessnock (Nulkaba) and Paterson (Tocal AWS) meteorological stations, which have recorded average annual evaporation of approximately 1,327 mm and 1,562 mm, respectively (Table 4-5).

The highest monthly-average evaporation is in December and January and the lowest monthly-average evaporation is in June (Table 4-5). Measured monthly-average evaporation exceeds the measured monthly-average rainfall in all months, except June (Table 4-5).

Wind Speed and Direction

As part of the air quality assessment of this EIS (Appendix J), annual and seasonal wind speeds and directions were evaluated using available 15-minute averages of wind speed and direction data for 2010 from the Tasman Underground Mine AWS.

The annual and seasonal windroses for the Tasman Underground Mine AWS are provided in Appendix J.



LEGEND
Mining Lease Boundary
Mining Lease Application Boundary
Approximate Extent of Approved Fassifern Seam Workings
Approximate Extent of Tasman Extension Project West Borehole Seam Workings
Approximate Extent of Surface Disturbance for Pit Top Facilities
State Conservation Area
State Forest
Stream 1
IV Suitable for Grazing with Occasional Cultivation
V Suitable for Grazing with Occasional Cultivation
VI Suitable for Grazing with No Cultivation
VII Best Protected by Green Timber
VIII Cliffs, Lakes or Swamps
M Mining and Quarrying Areas
SF State Forest
U Urban Area
Note 1 Stream locations in the Project area have been refined from Department of Lands data based on field verification
Upcast Ventilation Shaft
Proposed Tasman Extension Project Pit Top
Existing Tasman Underground Mine Pit Top
MLA 426
MLA 416
ML 1555
ML 1618
CCL 725
George Booth Drive
Hunter Expressway (Under Construction)
Mount Sugarloaf Road
MOUNT SUGARLOAF
SUMMIT POINT
Seahampton
O'Donneltown
Heaton State Forest
Sugarloaf State Conservation Area
Sugarloaf Range Road
FREEWAY
(SYDNEY - NEWCASTLE)
F3
N
E 362 500
E 365 000
E 367 500
E 360 000
N 6 362 500
N 6 360 000
N 6 357 500
0 200 1000
Metres
GRID DATUM MGA94 ZONE 56
Source: Department of Lands (2009); MSEC (2009); Donaldson Coal Pty Ltd (2009, 201; Fluvial Systems (2012) and DECC (2009)
TASMAN EXTENSION PROJECT
FIGURE 4-5
Rural Land Capability
Resource Strategies
DONALDSON COAL
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DCL-09-01 EA Section 4_102D

Table 4-5
Relevant Long-term Meteorological Information

Period of Record	Average Daily Temperature (ºC)[1]				Average Monthly Rainfall (mm)[1, 2]				Average Monthly Evaporation (mm)[2, 3]	
	Cessnock (Nulkaba) (61242)		Paterson (Tocal AWS) (61250)		Morpeth Post Office (61046)	Mulbring (Vincent St) (61048)	Cessnock (Nulkaba) (61242)	East Maitland Bowling Club (61034)	Cessnock (Nulkaba) (61242)	Paterson (Tocal AWS) (61250)
	Minimum	Maximum	Minimum	Maximum						
	1966-2012		1967-2012		1884-2010	1932-2007	1966-2012	1902-1994	1966-2012	1967-2012
January	17.7	30.4	17.6	29.7	90.5	101.8	87.9	89.0	177	192
February	17.7	29.6	17.6	28.8	100.5	124.0	105.1	94.1	140	148
March	15.5	27.6	15.6	27	111.1	117.8	85.3	96.5	121	130
April	11.7	24.6	12.4	24.2	83.1	74.2	58.2	87.4	84	99
May	8.5	21.1	9.6	20.6	74	75.2	54.2	70.3	59	74
June	6	18.2	7.5	17.8	84.8	96.3	60.2	84.2	45	63
July	4.6	17.8	6.1	17.3	64	51.3	32.6	58.1	53	74
August	4.9	19.8	6.6	19.3	54.2	62.5	37.1	52.2	78	105
September	7.8	22.7	8.9	22.3	55.5	52.6	43.8	54.8	105	132
October	11	25.3	11.5	24.9	63	65.2	59.3	65.5	136	161
November	13.9	27.4	14	26.7	69	70.3	72.7	61.6	153	174
December	16.1	29.3	16.2	29	86.8	82.7	70.7	81.3	177	208
Annual Average Total	**-**	**-**	**-**	**-**	***933.2***	***966.3***	***765.7***	***895.0***	***1,327***	***1,562***

1 Source: BoM (2012).

2 Source: Appendix B.

3 As measured by Class A Evaporation Pan.

For the duration of the collection period the annual windrose shows a prominent westerly pattern of winds, with winds from the north-east and the southern quadrants also prominent. The annual average wind speed is 2.3 metres per second (m/s), with calm periods (i.e. winds less than 0.5 m/s) recorded by the Tasman Underground Mine AWS approximately 15% of the time during 2010 (Appendix J).

Bushfire Regime

The Project area is mapped as bushfire prone land by the Cessnock City Council and Lake Macquarie City Council, with the majority of the area mapped as Vegetation Category 1.

The Project is located within the jurisdiction of the Lake Macquarie Bush Fire Management Committee (BFMC) and the Hunter BFMC, which follow the LGA boundaries of Lake Macquarie and Cessnock, respectively. Bushfire risk management plans have been prepared by the Lake Macquarie BFMC (2011) and the Hunter BFMC (2009).

The bushfire season in the Project area generally occurs from August/September to March and is typically associated with north-westerly winds, high daytime temperatures and low relative humidity (Lake Macquarie BFMC, 2011; Hunter BFMC, 2009).

The major sources of ignition for bush fires in the Project area and surrounds include (Lake Macquarie BFMC, 2011; Hunter BFMC, 2009):

- illegal burning activities;
- arson/incendiarism;
- car dumping;
- escapes from legal burning;
- lightning; and
- arcing of electrical power lines.

High intensity bushfires in the Sugarloaf State Conservation Area generally occur between late spring and the end of summer (DECC, 2008). Arson is a recurring problem in parts of the Sugarloaf State Conservation Area with incidents occurring in most summer seasons (DECC, 2008).

For some vegetation within the Project area there has been over a decade since the last fire, with only one or two fires recorded (Hunter BFMC, 2009).

Donaldson Coal implements a Bushfire Management Plan for the existing Tasman Underground Mine as part of the Health and Safety Management System. The Bushfire Management Plan was prepared in consultation with the RFS. The existing Tasman Underground Mine pit top is also included in the Lake Macquarie Bush Fire Risk Management Plan (Lake Macquarie BFMC, 2011).

4.3.2 Potential Impacts

Landforms

SCZs for cliff lines and steep slopes would be implemented for the Project (Section 2.6.3 and Box 4-3) to have no more than a minor impact on the topographic feature, and negligible environmental consequence. The cumulative subsidence effects along the steep slopes and cliff line areas are unlikely to result in cracking, toppling or slope instability after completion of mining in the Fassifern and West Borehole Seams (Appendix A).

Slope instability and rock falls occur naturally along steep slopes and cliff lines areas due to natural weathering and tree root wedging processes (Appendix A). In some circumstances it may be difficult to differentiate between natural and mining induced processes.

Due to the difficulties in distinguishing between natural and mining induced instabilities, DgS (2012) predicts any impacts on cliff lines and steep slopes would represent in the order of 3 to 5% of the cliff face and steep slope areas.

Soil and Erosion Potential

Potential impacts of the Project on soils would relate primarily to:

- disturbance of *in-situ* soil resources within surface disturbance areas (e.g. new pit top facility, upcast ventilation shaft, exploration and subsidence remediation activities);
- alteration of soil structure beneath infrastructure items, hardstand areas and roads;
- possible soil contamination resulting from spillage of fuels, lubricants and other chemicals;

BOX 4-3
CLIFFS AND STEEP SLOPES SUBSIDENCE MANAGEMENT

Cliffs within the Project Area*

Project subsidence performance measures:

- Minor impact resulting in negligible environmental consequence.
- No additional risk to public safety.

Project subsidence control zone:

- First workings only within 30 m of a cliff line greater than 20 m in length resulting in less than 150 mm subsidence.
- Partial extraction with stable remnant pillars resulting in less than 300 mm of subsidence for all other cliff lines and steep slopes with greater than 1 in 2 slope.

Project subsidence control outcomes:

- No more than minor impact on the topographic feature, and negligible environmental consequence.

Refer to Table 2-3 for details.
*Appendix A.

- increased erosion and sediment movement due to exposure of soils during construction of the new pit top facility and upcast ventilation shaft, exploration and subsidence remediation activities;
- alteration of physical and chemical soil properties (e.g. structure, fertility, permeability and microbial activity) due to soil stripping and stockpiling operations; and
- potential for increased erosion and sediment movement due to surface cracking or changes in gradient as a result of subsidence.

As described in Section 4.3.1, the soil landscapes within the Project area are susceptible to water erosion.

The potential for surface cracking and increases in soil erosion as a result of subsidence is described in Section 4.2.4. It is unlikely that these impacts would occur within SCZs (Appendix A). Mitigation measures to manage potential impacts on soil resources outside SCZs are described in Section 4.3.3.

Land Uses

As described in Section 2, the Project would largely comprise underground mining activities, with only limited surface disturbance being required outside the existing and new pit top facilities (e.g. line of sight clearing may be required for subsidence monitoring, however, this would nominally be located along or adjacent to existing tracks).

Subsidence performance measures (Section 2.6.3) would minimise potential impacts on the conservation and recreational values of the Sugarloaf State Conservation Area and Heaton State Forest, including performance measures for streams, cliffs, steep slopes and groundwater dependent ecosystems. Residual environmental consequences for groundwater, stream geomorphology, surface water, ecology, heritage, amenity and visual character within Sugarloaf State Conservation Area and Heaton State Forest are summarised in Sections 4.4 to 4.11, 4.13, 4.14 and 4.19.

Mining operations and associated activities within Heaton State Forest would be conducted in accordance with the conditions of the relevant mining tenement and necessary occupation permits (Section 6.3.1). Surface works within Heaton State Forest would be undertaken in consultation with Forests NSW and would aim to minimise potential disruption on forestry operations.

Areas of Sugarloaf State Conservation Area and Heaton State Forest are unlikely to require closure from the public. In the event that subsidence impacts require remediation within Sugarloaf State Conservation Area or Heaton State Forest (e.g. areas of surface cracking), there may be temporary closure of some areas to maintain public safety in consultation with the OEH or Forests NSW.

Public Safety Management Plans would be prepared as a component of the Extraction Plan process and would include management measures and Trigger Action Response Plans to mitigate impacts on public safety due to anticipated or unanticipated impacts.

Potential impacts on built features as a result of Project subsidence are described in Appendix A and summarised in Section 4.2.5. As described in Section 4.2.6, specific management measures would be implemented for the management of key surface features, which would be developed as the Project progresses as a component of the Extraction Plan process.

Agricultural Land Use

The Project is anticipated to have no material adverse impact on agricultural resources, agricultural production or associated enterprises within the Project area on the basis of the following:

- there are no agricultural enterprises located within the Project underground mining areas or the new pit top facility and upcast ventilation shaft areas (Section 4.3.1);
- the Project would involve only a small amount of surface disturbance (approximately 11 hectares [ha]);
- the portions of the Project area within Sugarloaf State Conservation Area and Heaton State Forest are not available for agricultural purposes;
- no "regionally significant agricultural land" or highly valuable agricultural lands or resources have been identified in the Project area based on generally low soil fertility and the land not being suitable for regular cultivation (Section 4.3.1);
- potential impacts as a result of Project subsidence (Section 4.2) would not significantly impede the future use of land for agriculture;
- there would be no material impacts on downstream water resources (Section 4.6); and
- no significant impacts on the safety, efficiency and performance of the road network are expected to arise as a direct result of the Project (Section 4.12).

Therefore, no specific mitigation measures for agriculture are considered necessary for the Project.

Land Contamination Potential

Potential land contamination risks were identified as part of the Preliminary Hazard Analysis (PHA) (Section 4.18 and Appendix N) and include spills, fires and explosions associated with the transport, storage and usage of hydrocarbons and chemicals.

The potential for acid generation during construction activities is considered to be very low as there are no soils identified as having acid sulphate potential within the Project area (Section 4.3.1) and the box cut would generally involve excavation of weathered material.

Bushfire Hazard

Any uncontrolled bushfires originating from Project activities may present potentially serious impacts to residents along Sheppeard Drive, in O'Donneltown and other rural properties, Sugarloaf State Conservation Area, Heaton State Forest and other surrounding areas. Similarly, fires originating in nearby bushland or rural areas could pose a significant risk to Project infrastructure and Donaldson Coal staff, contractors and equipment. Smoke from bushfires can also have adverse impacts on the operation of mine ventilation, major transportation routes (road and rail), tourism operations, urban interface areas and hospitals (Hunter BFMC, 2009).

The degree of potential impact would vary with climatic conditions (e.g. temperature and wind) and the quantity of available fuel.

Self-heating of coal can give rise to smouldering fires in coal stockpiles. However, the likelihood of spontaneous combustion at the Project is considered very low as West Borehole Seam coal has low to medium potential for spontaneous combustion and there would be only temporary stockpiling of coal at the pit top facilities (Appendix N).

The continuation and expansion of surface activities for the Project could increase the potential for fire generation. However, given the range of management measures proposed to be in place to manage the behaviour of people in the Project area and the maintenance of fire-fighting equipment on-site, it is unlikely that there would be an increase in fire frequency resulting from the Project. The PHA (Appendix N) includes consideration of the potential for bushfire.

4.3.3 Mitigation Measures, Management and Monitoring

Landforms

Subsidence and photographic monitoring of cliff lines and steep slopes would occur during and following mining to validate that the subsidence performance measures are being achieved. Monitoring would involve observations of any cracking along ridges, increased erosion down slopes, seepage in footslope areas and drainage path adjustments that may indicate unanticipated impacts on cliff lines and steep slopes.

Land Management Plans would be prepared as part of the Extraction Plan process and would detail monitoring programs and Trigger Action Response Plans in the unlikely event of slope instability. Management measures for slope instability may include infilling of surface cracks and/or removal of unstable boulders. An adaptive management approach would be applied to the mine design should unanticipated impacts be observed.

Signage would be erected near cliff lines and steep slopes in public areas while mine subsidence is occurring as part of the Public Safety Management Plans which would be prepared as part of the Extraction Plan process.

Soil and Erosion Potential

The existing Site Water Management Plan for the Tasman Underground Mine would be revised to include the construction and operation of the new pit top facility.

Mitigation measures, management and remediation for impacts on soil resources as a result of subsidence would be outlined in the Land Management Plans as a component of the Extraction Plans.

Specific mitigation measures and management during construction and temporary disturbance activities, operation of surface infrastructure and subsidence impacts are described below.

Construction and Temporary Disturbance

The following management measures would be implemented during the stripping of soils for surface disturbance activities for the Project:

- Areas of disturbance would be stripped progressively, as required, to reduce potential erosion and sediment generation.
- Areas of disturbance requiring soil stripping would be clearly defined following vegetation clearing.
- Topsoil and subsoil stripping during periods of high soil moisture content (i.e. following heavy rain) would be avoided to reduce the likelihood of damage to soil structure.

During surface disturbance activities, erosion and sediment control would be designed in consideration of *Managing Urban Stormwater: Soils and Construction* (Landcom, 2004).

Rehabilitation of temporary disturbance areas is described in Section 5.3.

Operation of Surface Infrastructure

During the continued operation of the existing pit top facility as part of the Project, the water management system at the existing pit top facility would continue as per the existing and approved water management system described in Section 2.1.5.

Water management measures would be implemented at the new pit top facility to control erosion and sediment migration as described in Sections 2.9.2 and 4.6.3.

Subsidence Impacts

Surface crack repair works may need to be implemented for the Project, in particular along public roads and streams.

Based on the implementation of the SCZs, surface cracking is unlikely to occur within 1st and 2nd order streams with a depth of cover of less than 80 m (i.e. SCZs would be implemented for 1st and 2nd order streams where the depth of cover to the stream is less than 80 m [Table 2-3 of Section 2.6.2]) and is very unlikely to occur along the 3rd order portion of Surveyors Creek 2 (Appendix A). Therefore, surface cracking along streams is likely to be limited to 1st and 2nd order streams with greater than 80 m depth of cover (Appendix A).

The requirement and methodology for any erosion and sediment control and remediation techniques would be determined in consideration of:

- potential impacts when unmitigated, including potential risks to public safety and the potential for self-healing or long-term degradation;
- potential impacts of the control/remediation technique, including site accessibility; and
- consultation with relevant stakeholders.

Control and remediation measures to limit erosion and sediment migration as a result of subsidence may include (Section 5.3.6):

- filling of cracks and minor erosion holes;
- installation of sediment fences downslope of subsidence induced erosion areas;
- stabilisation of erosion areas using rock or other appropriate materials; and
- revegetation using brush matting, seeding or tubestock.

Monitoring would be undertaken to identify the need and subsequent success of the erosion and sediment control and remediation measures.

Land Use

Mitigation measures and management with respect to potential impacts of the Project on stream geomorphology, surface water, aquatic ecology, flora and terrestrial fauna within Sugarloaf State Conservation Area and Heaton State Forest are provided in Sections 4.5.3, 4.6.3, 4.7.3, 4.8.3 and 4.9.3, respectively.

Public Safety Management Plans would be prepared as a component of the Extraction Plan process and would include management measures and Trigger Action Response Plans to mitigate impacts on public safety due to anticipated or unanticipated impacts. This would include signage in public areas currently undergoing mine subsidence.

Surface works in Sugarloaf State Conservation Area would be undertaken in consultation with OEH and in accordance with any necessary approvals (Section 6.4). Surface works within Heaton State Forest would be undertaken in consultation with Forests NSW and would aim to minimise potential disruption on forestry operations.

Mitigation measures, management and monitoring of potential impacts of subsidence on built features are provided in Section 4.2.6. Any subsidence impacts on access tracks within Sugarloaf State Conservation Area and Heaton State Forest would be stabilised and then remediated as soon as practicable (e.g. weather and access permitting) following the completion of subsidence in the area.

Section 5 describes the rehabilitation principles for surface disturbance areas, including temporary disturbance areas in Sugarloaf State Conservation Area and Heaton State Forest. Project rehabilitation works would include activities that would be undertaken progressively (e.g. monitoring and exploration areas) and activities that would be undertaken at the cessation of the Project (e.g. decommissioning and rehabilitation of the upcast ventilation shaft and new pit top facility).

Land Contamination

A number of hazard control and mitigation measures would be implemented for the Project (Section 4.18).

General measures to reduce the potential for contamination of land would include the following:

- Contractors transporting dangerous goods would be appropriately licensed in accordance with the provisions of the *Australian Code for the Transport of Dangerous Goods by Road and Rail* (ADG Code) (National Transport Commission, 2007).
- On-site consumable storage areas would be designed with appropriate bunding and would be operated, where applicable, in compliance with the requirements of AS 1940 *The Storage and Handling of Flammable and Combustible Liquids*.
- Fuel storage areas would be regularly inspected and maintained.

Additional general fuel and waste management measures that would typically be implemented during activities such as construction and exploration works to reduce the potential for land contamination would include:

- the provision and maintenance of portable chemical toilet facilities;
- the management of fuels, oils and other hydrocarbons to minimise the risk of spills which would cause soil contamination;

- the collection of rubbish and waste materials for regular disposal off-site; and
- the removal of construction/exploration equipment from site on completion of activities.

Investigations would be undertaken at mine closure to identify and remediate any contaminated soil materials in accordance with the requirements of the NSW *Contaminated Land Management Act, 1997* (Section 5.4.5).

Bushfire Hazard

In addition to environmental and social responsibilities, there exists significant economic incentive to prevent fire damage to mining infrastructure, equipment and surrounding land uses. Fire awareness and fire safety training would continue to be included in the induction of appropriate Donaldson Coal staff and contractors.

The new pit top facility and upcast ventilation shaft would be constructed in compliance with AS 3959-2009 *Construction of buildings in bushfire-prone areas*.

The existing Bushfire Management Plan would be revised for the Project in consultation with the RFS and in consideration of *Planning for Bush Fire Protection* (RFS, 2006). The Bushfire Management Plan would include fuel management and general housekeeping practices, procedures to minimise the risk of bushfire, emergency response to bushfire and evacuation procedures for personnel at the surface facilities and underground.

Other mitigation measures and management to reduce the potential risk of bushfire include:

- appropriate storage of chemicals, fuel, gas and dangerous substances in accordance with relevant Australian Standards and legislation;
- power reticulation designed to Australian Standards and legislation;
- maintenance of appropriate fire breaks and/or radiation zones;
- housekeeping activities (i.e. site would be kept clean and tidy and fire hazards removed where practicable);
- fire fighting equipment and spill kits located in on-site vehicles and infrastructure (where appropriate);
- provision of adequate water supply on-site for fire fighting purposes;
- construction of internal roads at the new pit top facility to provide two-wheel drive all weather access; and
- installation of appropriate fencing and security to discourage unauthorised access to the pit top facilities.

Meteorological Monitoring

Meteorological monitoring would continue for the Project, including the installation of an AWS at the new pit top facility.

The meteorological data recorded would continue to assist in the interpretation of groundwater, surface water, noise and air quality monitoring data (Sections 4.4, 4.6, 4.13 and 4.14).

4.4 GROUNDWATER

A Groundwater Assessment for the Project was undertaken by hydrogeological experts RPS Aquaterra (2012) and is presented in Appendix B.

A description of existing groundwater resources, including baseline data, is provided in Section 4.4.1. Section 4.4.2 describes the potential impacts of the Project including cumulative impacts, and Section 4.4.3 outlines mitigation measures, management and monitoring.

4.4.1 Existing Environment

Hydrogeological Data

A number of groundwater studies have previously been undertaken by Donaldson Coal, and for other surrounding mining projects, including:

- groundwater investigations undertaken for the Donaldson Open Cut Coal Mine in 1998;
- hydrogeological studies undertaken for the existing Tasman Underground Mine in 2002;
- a groundwater investigation undertaken for the Abel Underground Mine in 2006; and
- a groundwater investigation undertaken for the Bloomfield Colliery in 2008.

As part of these studies, numerous groundwater monitoring bores were installed and core samples were collected. Many of these groundwater monitoring bores were maintained and form part of an ongoing monitoring network in the Project region (Appendix B).

Previous studies also included hydraulic conductivity testing of core samples from the Project region.

RPS Aquaterra (2012) analysed data from the previous studies as part of the groundwater investigation program for the Project.

To extend the monitoring coverage, a further seven groundwater monitoring sites (i.e. multi-level vibrating wire piezometers) were installed in exploration holes in the Project area (Appendix B).

The locations of groundwater monitoring bores in the Project region, including those installed for the Project, are shown on Figure 4-6.

Hydrogeological Regime

Two distinct aquifer systems occur within the Project area (Appendix B):

- a fractured rock aquifer system in the coal measures, with groundwater flow occurring mainly in the coal seams; and
- a shallow aquifer system in the unconsolidated sediments of the colluvium associated with incised channels of Surveyors Creek in elevated terrain, and alluvium outside the immediate Project area associated with Wallis Creek and the lower reaches of Surveyors Creek (north of George Both Drive).

Groundwater levels in the coal measures have a regional pattern. The groundwater levels are controlled by the topographic elevations where specific coal seams outcrop or subcrop (i.e. their recharge zones), and the elevations of the discharge zones to the Hunter River estuary and Hexham Swamp (to the east of the Project) (Appendix B).

Groundwater flows down gradient from the recharge zones towards the discharge areas, generally in a south-easterly direction (Appendix B). Groundwater flow is predominantly parallel to strata, and occurs mostly within the coal seams.

Groundwater levels in the shallow aquifer system are closely related to topography, with flow patterns broadly similar to the surface flow patterns (Appendix B).

Recharge of this system occurs by rainfall infiltration, and groundwater flows down gradient towards the local surface drainages. In the most elevated areas, alluvium is absent, and the regolith is unsaturated (Appendix B). No alluvium is present in the Project area (Appendix B).

There is very little flow from the shallow to deeper strata under natural conditions.

Groundwater Quality

The salinity of groundwater in the Project region is variable, levels ranging from less than 600 to more than 16,000 microSiemens per centimetre (µS/cm) (Appendix B).

Within the existing Tasman Underground Mine area, salinity levels in the Fassifern Seam workings are generally less saline (i.e. less than 1,500 µS/cm electrical conductivity [EC]) than in the aquifers above the Fassifern Seam (2770 to 5280 µS/cm), as the Fassifern Seam receives relatively direct rainfall recharge from adjacent areas of sub-crop (Appendix B).

The pH of the groundwater in the Project region is generally close to neutral, or slightly acidic, with pH values ranging from 6.2 to 7.4 (Appendix B).

Three samples collected from a bore completed in the Fassifern Seam were found to be moderately acidic, with pH around 4.7. These samples all contained very high concentrations of dissolved iron, ranging from 272 to 1,245 milligrams per litre (mg/L). This bore was located very close to an outcrop of the Fassifern Seam, where the coal seam is likely to be readily exposed to the atmosphere (Appendix B).

Further description of groundwater quality in the Project region is provided in Appendix B. A description of surface water quality is provided in Section 4.6.1 and Appendix C.

Existing Groundwater Users

Groundwater use in the vicinity of the Project is negligible, as there are no significant useable aquifers underlying, or close to, the Project area (Appendix B).

There are nine registered bores within approximately 5 km of the Project area (NOW database of registered groundwater bores) (Figure 4-6).

Four of these registered bores are monitoring bores associated with the Tasman Underground Mine. Of the remaining registered bores, none are located within aquifers with the potential to be hydraulically connected to the Project (Appendix B).

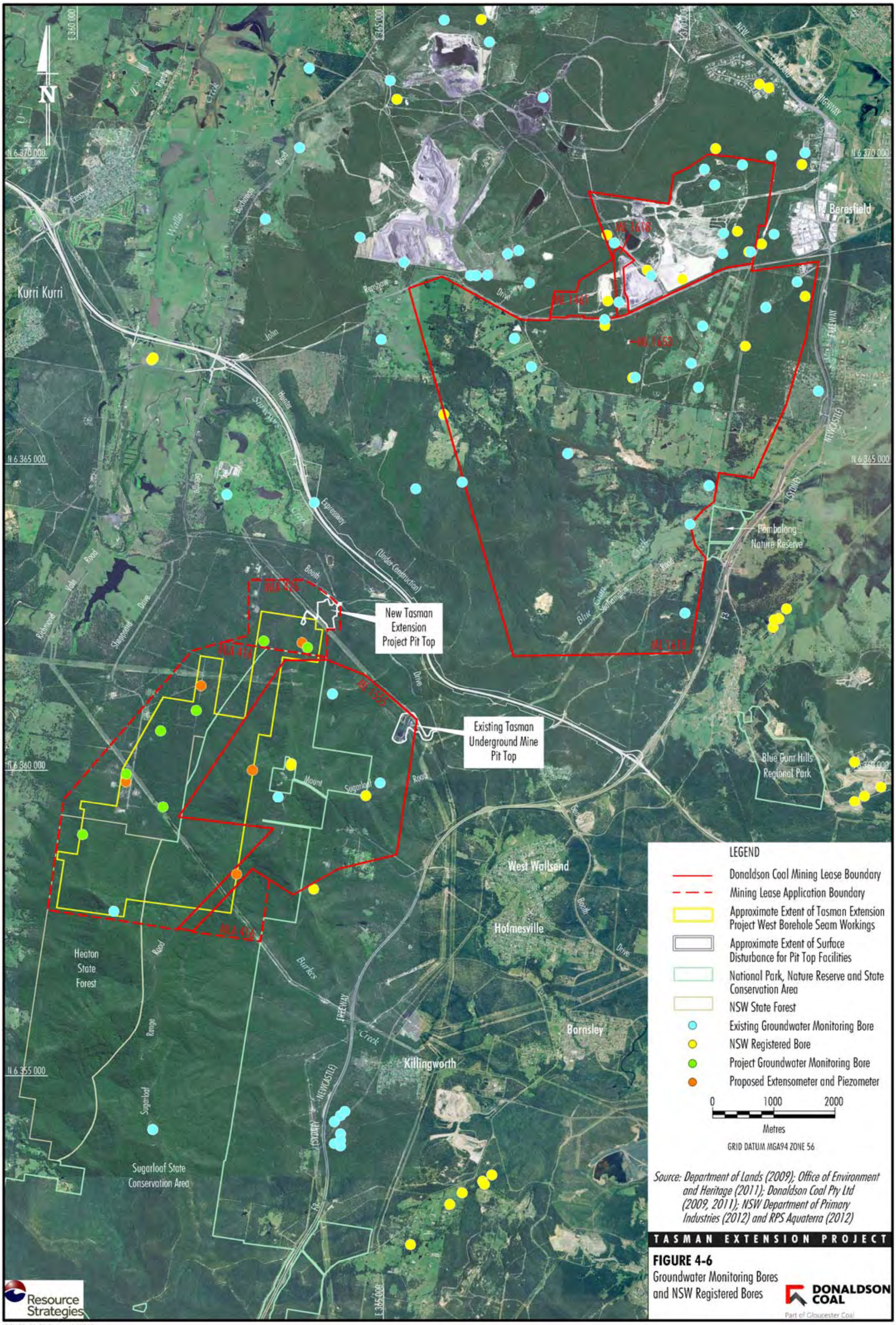


FIGURE 4-6
Groundwater Monitoring Bores and NSW Registered Bores

Existing Environmental Performance

Groundwater level and groundwater quality monitoring for the existing Tasman Underground Mine is conducted in accordance with the requirements of DA 274-9-2002.

Review of all AEMRs prepared for the Tasman Underground Mine to date indicates that no reportable incidents associated with groundwater have occurred.

No adverse impacts on the Blum Gum Creek as a result of the Tasman Underground Mine have been observed or reported to date.

Notwithstanding the above, in January 2011, an impact on baseflow within a tributary of Slatey Creek near O'Donneltown was reported to Donaldson Coal. In response to this report, Donaldson Coal undertook a monitoring program of the tributary including water quality samples, groundwater levels and observations of stream flow.

Information on the water quality and stream flow in the tributary prior to mining is based solely on anecdotal evidence, however reviews by Peter Dundon and RPS Aquaterra determined:

- Temporary loss of stream flow in the tributary was likely caused by decrease in seepage from the Great Northern Seam and/or Fassifern Seam as a result of depressurisation of the aquifer(s) caused by underground mining, in combination with other environmental factors, such as a period of lower rainfall.
- Resumption of stream flow in the tributary in March 2011 was possibly due to completion of mining in Panels 1 and 2 at the Tasman Underground Mine, which are located closest to the seam outcrop near the tributary and downdip of the remainder of the panels. Water flow in the tributary should be naturally sustainable in the future, as water levels in the downdip areas of the Fassifern Seam recover.
- Changes in the water quality of the tributary were possibly caused by sediments in the stream bed oxidising while desaturated leading to the generation of iron oxides and acidity. Water quality in the tributary has been observed to improve significantly.

The type of impacts on baseflow within Slatey Creek described above are not expected to occur due to Project mining in the West Borehole Seam, as the Project mining is not located immediately adjacent to a seam outcrop. The potential impacts of mining in the West Borehole Seam are described in Section 4.4.2.

4.4.2 Potential Impacts

Groundwater Prediction Methodology

A detailed description of the groundwater prediction methodology is provided in Appendix B, and is summarised below.

Groundwater Model

A regional groundwater model was developed for the Project, which built upon the previous groundwater model developed for the Abel Underground Mine Environmental Assessment (EA). In accordance with Project Approval for the Abel Underground Mine (PA 05_0136), improvements were made to the groundwater model to address comments received following an independent review of the model (on behalf of the DP&I) during the assessment phase of the Abel Underground Mine EA (Appendix B).

The groundwater model covered a surface extent of approximately 550 square kilometres (km^2), including the Tasman Underground Mine, Abel Underground Mine, Donaldson Open Cut Mine, Bloomfield Colliery and West Wallsend Colliery mining areas (Appendix B).

Geological features (e.g. alluvium, colluvium, overburden and coal seams) within the model domain were conceptualised by 20 model layers (Appendix B).

The groundwater model for the Project was developed in accordance with best practice guidelines (Appendix B).

Model Calibration

Model calibration was undertaken in two phases.

Initial calibration of the groundwater model was undertaken for steady state conditions, where the predicted groundwater levels were compared with long-term average groundwater levels (Appendix B). The steady state calibration was undertaken to provide initial conditions for the transient calibration.

A transient calibration was conducted for the period 2006 to 2010. The results of the transient calibration were used to determine whether the groundwater levels predicted by the model were responding to actual groundwater level changes associated with mining (e.g. in the Tasman and Abel Underground Mines) (Appendix B).

The results of modelled versus actual groundwater levels for 82 monitored piezometers showed reasonable agreement across all model layers. Key calibration statistics were consistent with the relevant groundwater modelling guideline (Appendix B).

Predictive Modelling

Predictive modelling was conducted for the life of the Project, with the annual development of underground mining reflected in the groundwater model.

The predictive groundwater modelling also considered the cumulative impacts associated with continued mining in other existing mining operations in the area, and accounted for known historical abandoned mining areas (Appendix B).

Groundwater Inflows

Groundwater inflows in the West Borehole Seam workings are predicted to be approximately 0.2 megalitres per day (ML/day) within the first year of mining, increasing to a peak of approximately 1.35 ML/day in 2024, before decreasing to less than 0.6 ML/day by the end of mining (Appendix B).

As described in Section 2.9.2, groundwater inflows would be captured in sumps, and piped to a mine water storage dam. Water stored in the mine water storage dam would not be transferred off-site, rather it would either be used to meet underground mining requirements (e.g. for cooling and underground dust suppression) or would be returned directly into historic workings in the West Borehole Seam.

Groundwater Level Impacts

Mining Phase

During mining, the West Borehole Seam and overburden overlying the mining area are predicted to be de-watered (Appendix B).

Outside of the mining area, groundwater level drawdowns of 5 m or more within the Permian strata (i.e. coal measures) could occur up to 2 km from the Project following completion of coal extraction (Appendix B).

The geometry of the mine layout for the Project effectively compartmentalises the mine and its impacts within the region. Potential impacts to groundwater levels associated with the Project are limited to the east due to the buffering effect of the abandoned workings in the West Borehole Seam. Potential impacts to the west of the Project are limited by the sub-crop of the strata (Appendix B).

Under pre-mining conditions, and during mining, the shallow regolith is generally unsaturated (i.e. dry), with groundwater only occurring in the colluvium on the lower slopes and valley colluvium associated with Surveyors Creek down gradient of the Project Area.

The area of dry regolith is predicted to increase slightly due to the Project, and groundwater level drawdown of up to 15 m in the partially saturated regolith could occur along the hillslope to the north-west of the Project, with drawdown receding to approximately 5 m within 1 km of the Project (Appendix B).

Potential impacts to groundwater levels within the colluvium associated with the Surveyors Creek catchment are predicted to be insignificant (Appendix B).

No alluvium is present within the Project Area (Appendix B).

Groundwater levels in strata below the West Borehole Seam are predicted to be unaffected by the Project (Appendix B).

Post-mining

The groundwater model was used to predict potential residual impacts from the Project for 100 years following the cessation of mining.

Recovery of groundwater levels is predicted to occur relatively rapidly (i.e. within a 25 to 30 year period) in areas downdip of the Project (Appendix B). For a small area in the south of the Project area, residual drawdown is predicted to remain in the lower interburden.

The changes in the Permian strata do not significantly affect the shallow regolith, and as there is negligible impact on Surveyors Creek during mining no residual impact is anticipated (Appendix B).

Stream Baseflows

The Project is predicted to have a very limited impact on baseflow to Surveyors Creek (i.e. a maximum reduction in baseflow of 0.0045 ML/day is predicted to occur as a result of the Project) (Appendix B).

A description of the potential impacts to surface flow regime associated with predicted changes in baseflow in Surveyors Creek is provided in Section 4.6.2 and Appendix C.

Impacts to baseflow in other streams/creeks in the Project region would also be negligible (Appendix B).

Groundwater Dependent Ecosystems

Impacts on flows and groundwater levels within the colluvium associated with the Surveyors Creek catchment are predicted to be insignificant, both during mining and post-mining. Therefore it is very unlikely that groundwater dependent ecosystems associated with Surveyors Creek would be impacted by the Project (Appendix B).

Further description regarding the potential impacts to groundwater dependent ecosystems is provided in Section 4.8.2.

Climate Change and Groundwater

The potential groundwater impacts of the Project, in the context of global climate change, has been considered and is presented in Appendix B.

4.4.3 Mitigation Measures, Management and Monitoring

Water Management Plans

Water Management Plans would be prepared for the Project as part of the Extraction Plan process (i.e. Extraction Plans would be prepared prior to the commencement of mining in each area).

Groundwater Monitoring

As described in Section 4.4.1, an extensive regional groundwater monitoring program exists for the existing Donaldson Coal operations. Groundwater monitoring would continue at the locations (operated by Donaldson Coal) shown on Figure 4-6.

The monitoring network established for the Project (Figure 4-6) would be maintained and regular measurement of groundwater levels within all vibrating wire piezometers and standpipes would be conducted. Two additional multilevel vibrating wire piezometers would also be installed, at the proposed locations shown on Figure 4-6.

Monitoring of groundwater inflow rates and the quality of groundwater inflow would also be conducted once mining commences.

Validation of sub-surface fracture heights above pillar extraction panels in the West Borehole Seam would be conducted through the installation of extensometers and piezometers (Figure 4-6).

The details of additional groundwater monitoring sites would be included in the Water Management Plans. The results of groundwater monitoring would be reported in the AEMRs for the Project.

Groundwater Model Review

The groundwater model predictions for the Project would be validated following the completion of mining of the north-south mains heading and Panel 1. This would be detailed in the Water Management Plans prepared for the Project.

Further reviews of the groundwater model would be conducted every five years during the Project.

Should actual groundwater levels/inflows significantly differ from those predicted, an adaptive management approach would be applied to manage potential impacts.

4.5 STREAM GEOMORPHOLOGY

An assessment of the geomorphic character of streams in the West Borehole Seam mining area and potential risks to geomorphic character was undertaken by Fluvial Systems (2012) and is presented in Appendix D.

Section 4.5.1 provides a description of the existing geomorphic character of streams in the West Borehole Seam mining area and Section 4.5.2 describes the potential risks to the geomorphic character as a result of potential subsidence impacts. Section 4.5.3 outlines mitigation measures, management and monitoring.

4.5.1 Existing Environment

Existing Performance

As described in Section 4.2.1, monitoring of subsidence movements and impacts above extracted panels at the Tasman Underground Mine is undertaken in accordance with approved SMPs, and includes subsidence surveys, visual inspections and photographic monitoring of surface features, including drainage lines.

There has been no observed and/or reported subsidence impacts on drainage lines during current operations (Section 4.2.1).

Study Methodology and Area

Characterisation of the geomorphology of streams in the West Borehole Seam mining area (i.e. the fluvial geomorphology) was conducted by Fluvial Systems (2012) at two measurement scales:

- geomorphic stream type at the stream reach scale (i.e. hundreds to thousands of metres); and
- geomorphic features at the stream cross-section and reach scale (i.e. tens to hundreds of metres).

The characterisation of fluvial geomorphology was based on a combination of field survey and desktop analysis of existing data. The field survey was undertaken by Fluvial Systems over the period 4 to 9 April 2011, and involved walking the lengths of the majority of streams in the West Borehole Seam mining area.

The characterisation of the fluvial geomorphology was conducted by Fluvial Systems (2012) for the stream reaches shown in Figure 4-7. Assessment of potential risks to geomorphic character was determined by Fluvial Systems (2012) for an area defined by the perimeter of the proposed West Borehole Seam underground mine workings, or expanded to the 2 mm subsidence contour (as sourced from DgS [2012]) where this contour extended beyond the proposed underground mining workings (Appendix D).

Definition of the Stream Network

The stream network was defined as those streams marked on 1:25,000 topographic maps, corrected with field data where necessary (Appendix D).

The streams in the West Borehole Seam mining area generally drain in a northerly direction from upper Surveyors Creek, which joins Wallis Creek to the north of the West Borehole Seam mining area. Wallis Creek joins the Hunter River at Maitland. A short length of the Wallis Creek headwater stream also lies within the West Borehole Seam mining area. This creek flows west into Wallis Creek.

None of the tributaries to Surveyors Creek or Wallis Creek are named, and as such, the streamlines were assigned the names shown on Figure 4-7.

Geomorphic Stream Type

The geomorphic stream types of steams were classified by Fluvial Systems (2012), consistent with the River Styles® framework (Brierley and Fryirs, 2000, 2005, 2006; Fryirs and Brierley, 2006). As the River Styles® framework was designed to be applied at a large scale, a greater level of detail was applied for the geomorphic stream type classification, based on stream characteristics identified during the field survey.

In the West Borehole Seam mining area, the streams were all within confined valley settings, and therefore exhibited no proper floodplain development. However, the streams differed in terms of bed particle size, channel form and channel continuity (Appendix D).

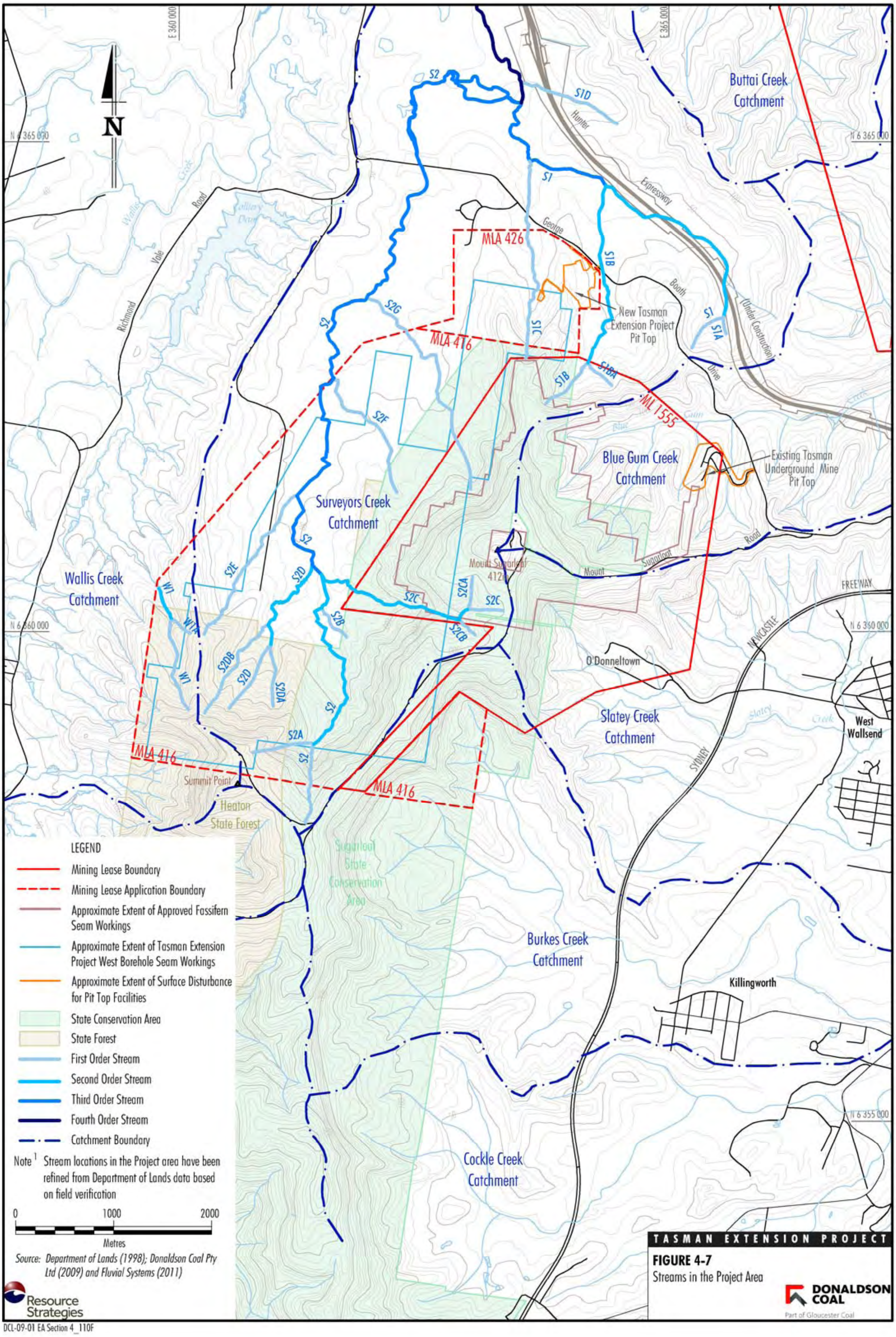
The classification of geomorphic stream type therefore comprised two main groups, as shown in Figure 4-8 (Appendix D):

- confined valley streams in bedrock with coarse-grained bed material; and
- streams formed on valley fill with fine-grained bed material.

The confined, coarse-grained streams were classified as the Headwater geomorphic stream type (Figure 4-8) (Appendix D).

The fine-grained streams were classified as one of six geomorphic stream types, depending on a combination of continuity, relative depth, and whether or not a flat sand-bed was present (Figure 4-8) (Appendix D).

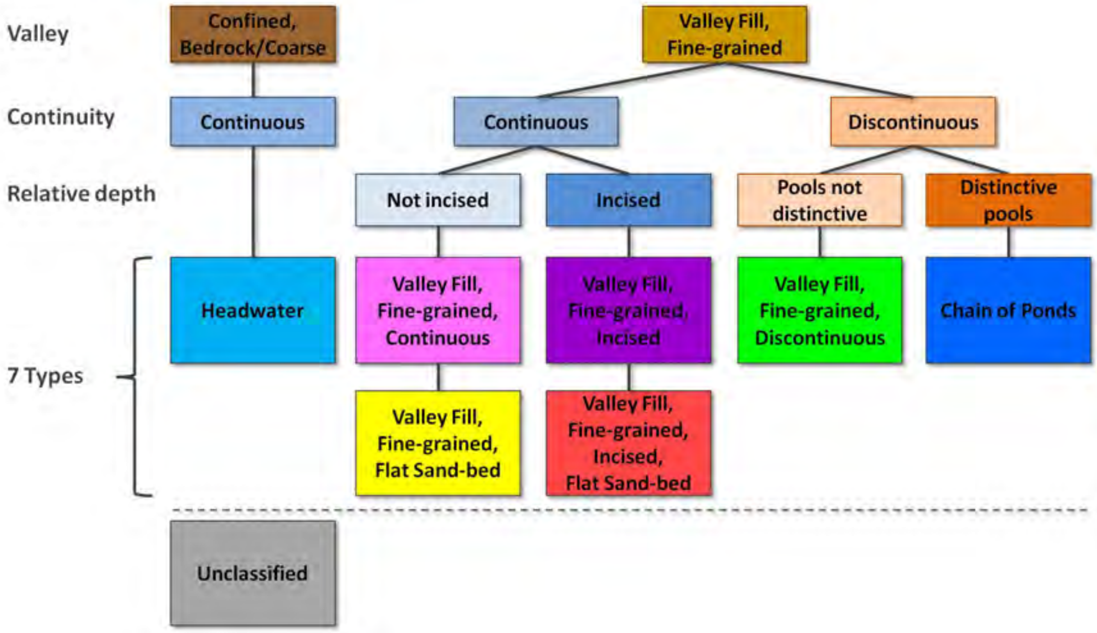
For some streams, the geomorphic stream type was unclassified (Figure 4-8) (Appendix D). This applied to streams where there was insufficient information to classify the stream as one of the geomorphic stream types identified in Figure 4-8, or where it was not considered necessary to classify the stream, as it fell outside the West Borehole Seam mining area (Appendix D).



TASMAN EXTENSION PROJECT

FIGURE 4-7
Streams in the Project Area

DCL-09-01 EA Section 4_110F



Source: After Appendix D.

Figure 4-8 – Classification of Geomorphic Stream Types

The classification of geomorphic stream type for streams in the West Borehole Seam mining area is shown on Figure 4-9. These geomorphic types are specific to the West Borehole Seam mining area, and are a sub-set of the many geomorphic stream types found in Australia (Appendix D).

Geomorphic Features

The following geomorphic features for the streams in the West Borehole Seam mining area were observed during the field survey (Appendix D):

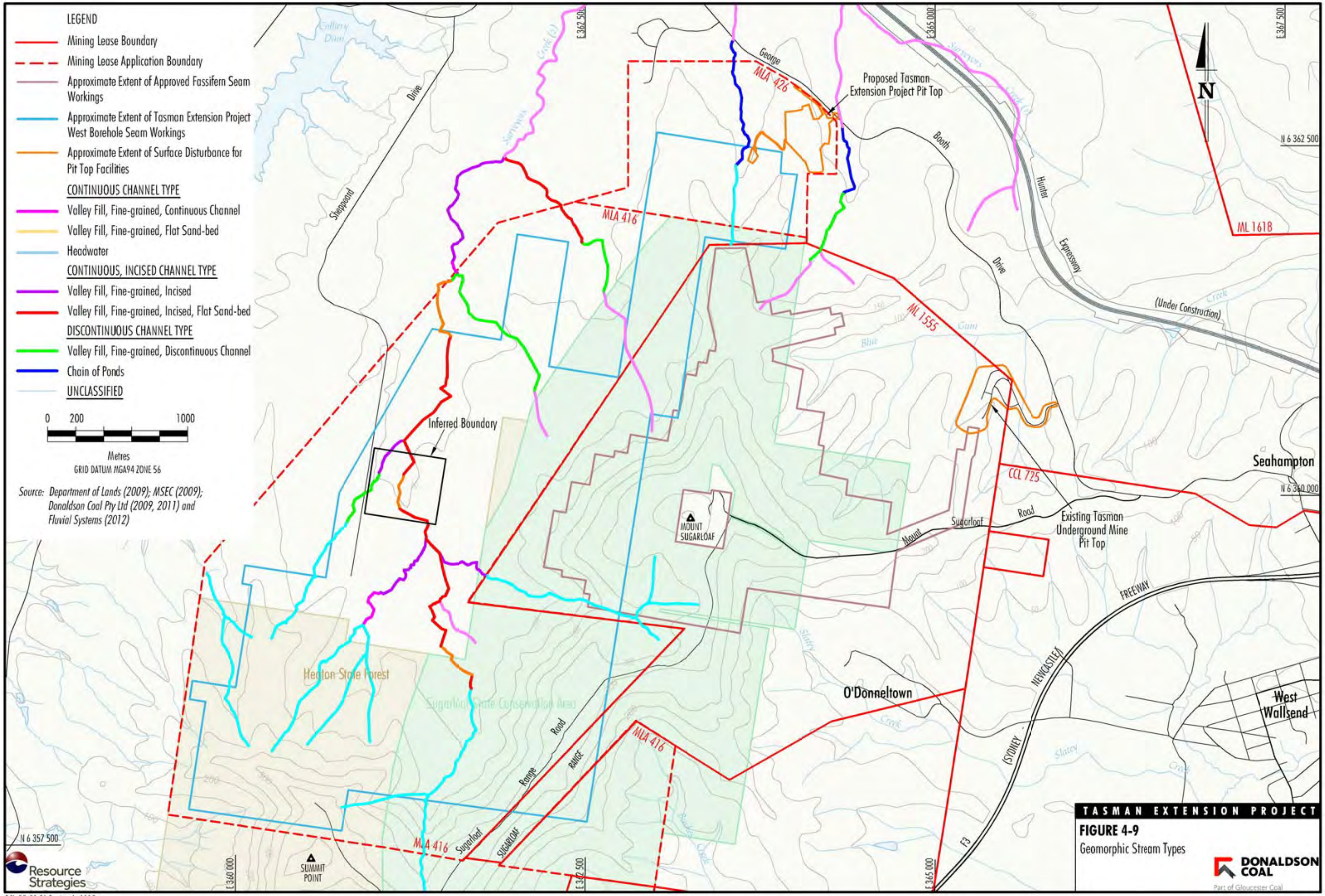
- continuous defined channel (bed and banks present);
- indistinct channel (flow path but no clear bed and banks);
- incised gully (channel deeper than expected for a stable stream);
- pool (either wet or dry);
- hydraulic control (shallow area that controls flow level);
- cascade/waterfall (length of steeply-sloping rock or boulder in headwaters);
- knickpoint (vertical drop in channel bed, which can be in headwaters in rocks or boulders, or in fine grained sediments in lower valley settings);
- head of creek (upstream extent of a headwater channel);
- channel junction (where two streams meet);
- track crossing (where a track passes directly over or through the stream); and
- ponded water presence.

Examples of geomorphic features found within the Project area are shown on Plates 4-5 to 4-10.

Existing Geomorphic Condition

All streams in the West Borehole Seam mining area were assessed by Fluvial Systems (2012) as being in good geomorphic condition, on the basis that (Appendix D):

- the streams and their catchments are essentially undisturbed, with the exception of isolated short lengths where the streams cross high voltage power line easements, narrow lightly used tracks, or roads with properly formed culverts; and
- although some of the stream lengths were identified as being incised, and flat-sand beds were present in places, there was no evidence that these were unnatural features.



TASMAN EXTENSION PROJECT

FIGURE 4-9

Geomorphic Stream Types

DONALDSON COAL

Part of Gloucester Coal

DCL-09-01 EA Section 4_111C

Plate 4-5 Headwater Stream Type

Plate 4-6 Knickpoint in bedrock marking the transition between Headwater Type and Valley Fill, Fine-grained, Incised Stream Type

Plate 4-7 Chain-of-ponds Stream Type (example of a pool containing water on the day of survey)

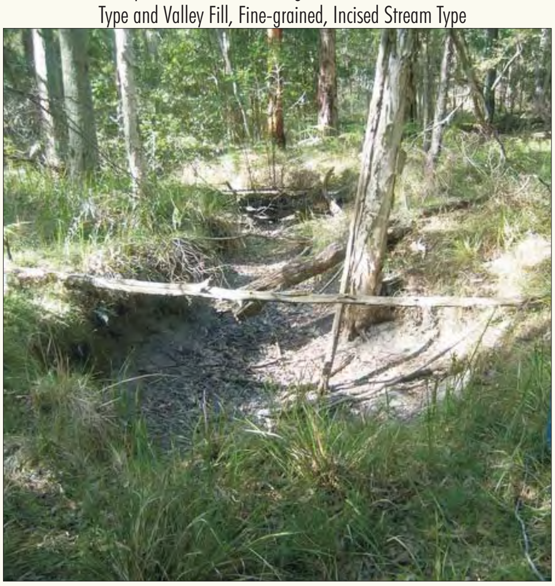


Plate 4-8 Chain-of-ponds Stream Type (example of a pool not containing water on the day of survey)

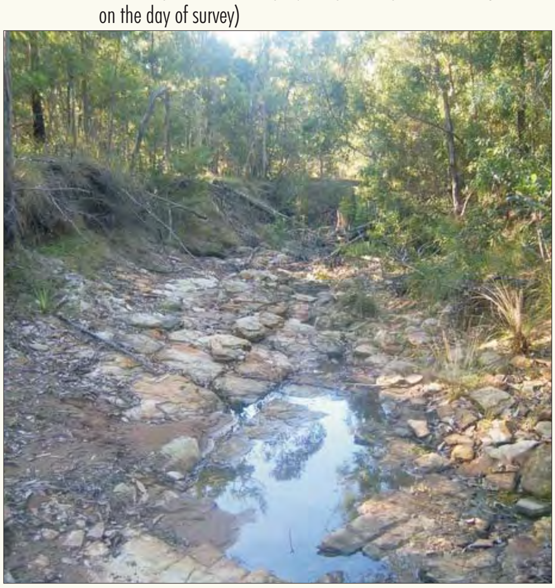


Plate 4-9 Example of Bedrock Outcrop

Plate 4-10 Channel incised into fine-grained valley fill (sand-rich) with flat sand-bed

Source: Fluvial Systems (2012)

TASMAN EXTENSION PROJECT

Plates 4-5 to 4-10
Fluvial Geomorphic Features

DONALDSON COAL
Part of Gloucester Coal

Resource Strategies

4.5.2 Potential Impacts

Risk Assessment Methodology

There is limited surface disturbance associated with the Project, and as such, the potential risks to the geomorphic character (i.e. form and process) of streams in the West Borehole Seam mining area were considered by Fluvial Systems (2012) to be associated with potential subsidence impacts.

The potential risks to geomorphic character of streams in the West Borehole Seam mining area associated with potential subsidence impacts were assessed by Fluvial Systems (2012) using a risk assessment method.

The risk to geomorphic character was considered by Fluvial Systems (2012) to be dependent on the following:

- Geomorphic fragility of the stream, which is a function of both the potential for changes to the stream due to potential subsidence impacts, and the resilience of the stream to potential subsidence impacts.
- The existing geomorphic condition of the streams in the West Borehole Seam mining area.
- Relative subsidence (i.e. the change in bedslope due to subsidence, relative to the existing bedslope of a particular stream, as well as the distributions of bedslopes for the various geomorphic stream types within the West Borehole Seam mining area).

Geomorphic Fragility

The fragility of the stream types in the West Borehole Seam mining area was assessed by Fluvial Systems (2012) relative to the fragility categories defined by Cook and Schneider (2006), and described in Appendix D, and in consideration of potential subsidence impacts. Potential subsidence impacts were predicted by DgS (2012).

Table 4-6 describes potential threat levels to geomorphic fragility associated with potential subsidence impacts.

The potential subsidence impact identified by Fluvial Systems (2012) as having the greatest potential threat to geomorphic fragility was the upstream migration of knickpoints. On this basis, the following geomorphic stream types were considered by Fluvial Systems (2012) to have “high” geomorphic fragility:

- “Valley Fill, Fine Grained, Continuous” – as potential for knickpoint migration with incision may lead to stream migration or avulsion.
- “Valley Fill, Fine Grained, Discontinuous” – as potential for knickpoint migration with incision may lead to stream migration or avulsion.
- “Chain of Ponds” – knickpoints are stable in these stream types, and as such, knickpoint migration may alter the pond formation. In addition, subsidence impacts have the potential to create new pools or enlarge existing pools.

Table 4-6
Potential Level of Threat to Stream Geomorphology

Potential Subsidence Impact	Potential Level of Threat to Stream Geomorphology
Cliff fall in upper headwaters	Headwaters are naturally highly variable in form, so geomorphic impact is small. Primarily a geotechnical issue.
Cracking of bedrock sections of stream beds	Leakage through cracks in rock beds can reduce baseflow and drain pools, but this does not directly impact sediment transport or bed stability. Primarily a geotechnical and hydrological issue.
Sinking of sand-bed sections of streams	This stream type would probably be resilient through rapid infilling of subsided areas with sand (high transport rate).
Hydraulic control points that maintain the depth of water in pools could subside	There are few pools within the area proposed for mining, and the most important pools (chain-of-ponds stream type reaches) are mostly downstream of the area affected by subsidence, and therefore at low risk.
Reversal of flow direction	The streams have sufficiently high gradient that reversal of flow direction is unlikely.
Knickpoint migration upstream of areas of subsided stream bed	A potential threat, particularly in areas immediately downstream of existing knickpoints, and where subsidence increases stream gradient beyond the natural range of variation.

Source: After Appendix D.

In addition, the geomorphic stream type "Valley Fill, Fine Grained, Incised" was considered by Fluvial Systems (2012) to have "medium" fragility due to the potential for knickpoint migration. The fragility of this geomorphic stream type was considered to be lower than for the geomorphic stream types listed above (i.e. "medium" fragility as opposed to "high"), because active knickpoints were identified in the existing "Valley Fill, Fine Grained, Incised" streams lengths, and therefore, the incised stream lengths are not conducive to avulsion.

All other geomorphic stream types were considered by Fluvial Systems (2012) to have "low" fragility.

Existing Geomorphic Condition

As discussed in Section 4.5.1, all streams in the West Borehole Seam mining area were assessed as being in good geomorphic condition.

Relative Subsidence

Relative subsidence was defined by Fluvial Systems (2012) as the change to the stream slope due to potential subsidence impacts. A more steeply sloping bed in the upstream direction was considered by Fluvial Systems (2012) to result in a greater threat to geomorphic character, as the more steeply sloping bed may cause formation of a knickpoint that migrates upstream and scours the bed and banks.

Where the slope of a stream length was predicted to change by less than 5% (due to potential subsidence impacts), it was considered an insignificant threat to geomorphic character (Appendix D).

In addition, potential subsidence impacts were only considered to be a threat to geomorphic character if the post-mining stream slope for a particular stream length was above the 90th percentile slope value for existing streams of the same geomorphic stream type within the West Borehole Seam mining area (Appendix D). For instances where post-mining slopes of a stream length exceeded the 90th percentile slope value for the existing streams, the threat to geomorphic character for that stream length was considered by Fluvial Systems (2012) to increase with an increased percentage change in slope due to subsidence.

The relative subsidence for stream lengths (average 6 m long) was determined based on subsidence profiles provided by DgS (2012) for streams S2, S2E, S2D, S2C, and S2F (as identified on Figure 4-7). Relative subsidence was not determined for the other streams identified in Figure 4-7.

Potential Risk to Geomorphic Character

Using the methodology described in Appendix D, the risk to geomorphic character was determined by Fluvial Systems (2012) over short stream lengths (average 6 m long) as follows:

1. The subsidence threat levels were determined, based on a combination of the existing geomorphic condition and the calculated relative subsidence of each stream length (Table 4-7).
2. The geomorphic fragility was determined for each stream length (as described above).
3. The risk to geomorphic character was determined, based on a combination of the subsidence threat level and geomorphic fragility (Table 4-8).

For the majority of the stream lengths (i.e. approximately 99% of total length) within the West Borehole Seam mining area, the potential risk to geomorphic character was determined by Fluvial Systems (2012) to be "insignificant" (Figure 4-10).

For a few isolated, short stream lengths, the potential risk to geomorphic character was determined by Fluvial Systems (2012) to be "low", "moderate" or "high" (Figure 4-10). As such, ongoing monitoring of potential impacts to geomorphic character (Section 4.5.3) would target these locations. If necessary, mitigation measures (Section 4.5.3) would be implemented to mitigate long-term environmental consequences.

The stream lengths where the highest potential risk was identified were located on the "Valley-fill, Fine-grained, Discontinuous" geomorphic stream type on S2F, as these stream sections were identified as having high fragility (due to the potential for knickpoint migration), and high relative subsidence (Appendix D).

The unassessed streams (i.e. where subsidence profiles were not available) were steep headwater streams, and one unclassified stream. Based on the similarities between the geomorphic characteristics of the assessed and unassessed streams, it was considered by Fluvial Systems (2012) that the potential risks to the geomorphic character of the unassessed streams would be "insignificant".

Table 4-7
Methodology for Determining Subsidence Threat Levels

Relative subsidence		Geomorphic condition		
		Good	Moderate	Poor
	$S_A \leq P_{90}S_B$ or $S_R \leq 1.05$	Insignificant	Insignificant	Insignificant
	$S_A > P_{90}S_B$ and $1.05 < S_R \leq 1.25$	Low	Moderate	High
	$S_A > P_{90}S_B$ and $1.25 < S_R \leq 1.50$	Moderate	High	High
	$S_A > P_{90}S_B$ and $S_R > 1.50$	High	High	High

Source: After Appendix D.

Notes: S_A = slope before mining; S_B = slope after mining; $S_R = S_A/S_B$; $P_{90}S_B$ = 90th percentile of slope before mining for geomorphic stream type.

Table 4-8
Methodology for Determining Risk to Geomorphic Character

Geomorphic Fragility		Subsidence threat level[1]			
		High	Moderate	Low	Insignificant
	High	High	High	Moderate	Insignificant
	Medium	High	Moderate	Low	Insignificant
	Low	Low	Low	Low	Insignificant

Source: After Appendix D.

[1] Determined using the methodology shown in Table 4-7.

4.5.3 Mitigation Measures, Management and Monitoring

Monitoring Program

The proposed subsidence monitoring for the Project (i.e. survey lines and visual inspections before and after mining) (Section 4.2.6) would provide relevant information for the monitoring of potential impacts to the geomorphic character for streams in the West Borehole Seam mining area.

In addition to the proposed subsidence monitoring for the Project, permanent reference points for annual photographic recording would be established at the locations on the streams where a low/moderate/high risk to geomorphic character was identified (Figure 4-10) in the Water Management Plans prepared as part of the Extraction Plan process. These photographs would be assessed to determine potential impacts to geomorphic character at these locations, with the results reported as part of the Extraction Plan process.

In addition, the survey conducted for the assessment of the geomorphic character of streams in the West Borehole Seam mining area would be repeated to identify potential impacts to geomorphic character. Fluvial Systems (2012) considers that the geomorphic response to subsidence would likely be slow, and as such, the geomorphic survey would be repeated at a frequency of at least five years.

Mitigation Measures and Management

The key subsidence-related risk to the geomorphic character of streams in the West Borehole Seam mining area was identified as the development, and upward migration, of knickpoints (Appendix D).

Potential impacts to geomorphic character of streams in the West Borehole Seam mining area would be managed through a process of adaptive management that would include the following:

- monitoring (as described above) would detect if, and where, any potential impacts associated with knick point development and migration have occurred;

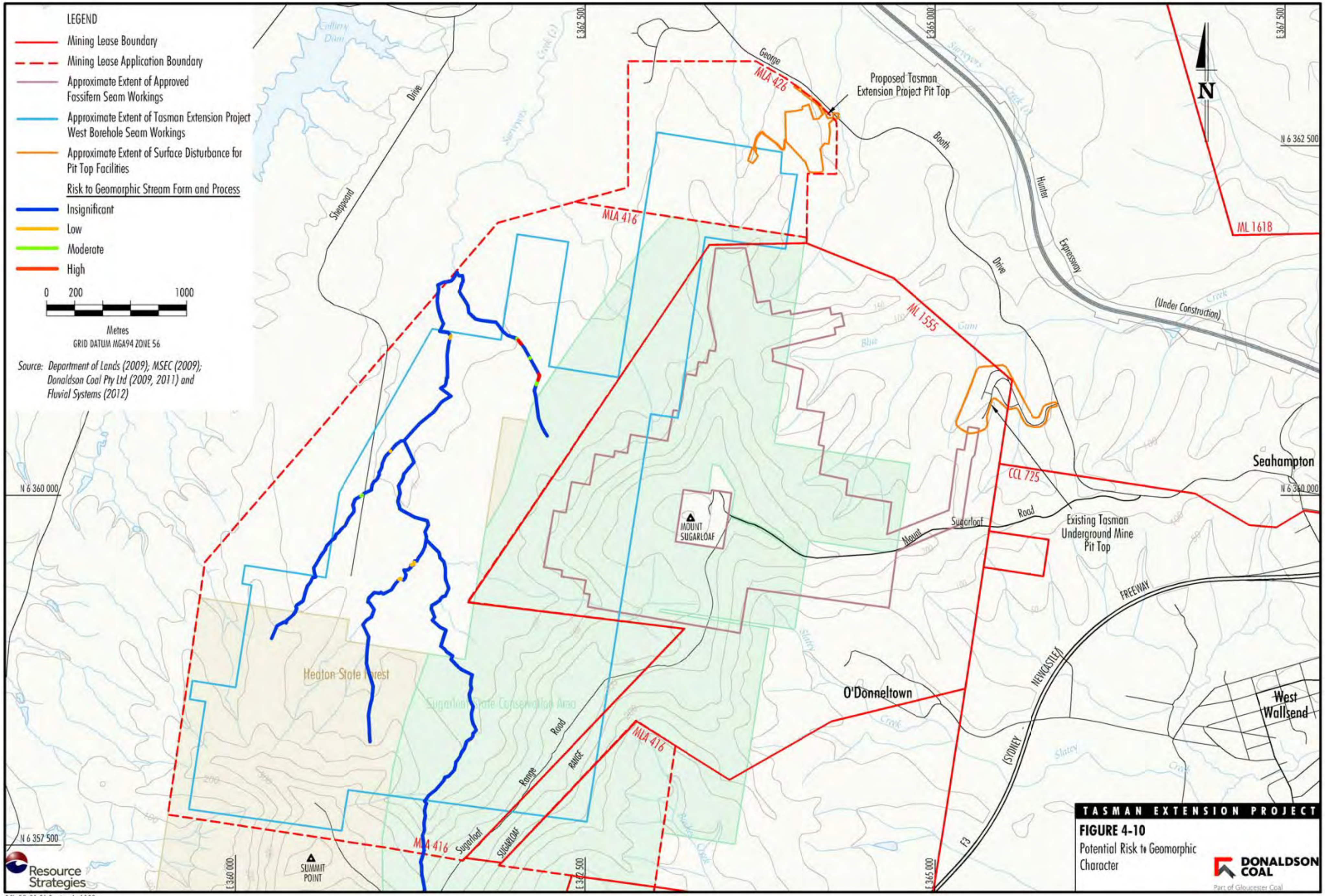


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FIGURE 4-10

Potential Risk to Geomorphic Character

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- an assessment would be made to determine the potential consequences of any identified potential impacts; and
- in consideration of the potential impacts of the unmitigated impact and any control/remediation technique, appropriate control/remediation works would be implemented.

For streams in the West Borehole Seam mining area, large wood structures are considered to be the most appropriate control works for the mitigation of knick point development and migration (Appendix D). However, if it is determined during the adaptive management process that control/remediation structures are required, the most suitable structure would be assessed on a case-specific basis, and in consultation with relevant stakeholders.

4.6 SURFACE WATER

A Surface Water Assessment for the Project was undertaken by Evans & Peck (2012) and is presented in Appendix C.

The water management systems for the existing Tasman Underground Mine and proposed Project are described in Sections 2.1.5 and 2.9, respectively.

A description of existing surface water resources, including baseline data, is provided in Section 4.6.1. Section 4.6.2 describes the potential impacts of the Project including cumulative impacts, and Section 4.6.3 outlines mitigation measures, management and monitoring.

4.6.1 Existing Environment

Baseline Surface Water Data

Evans & Peck (2012) analysed Donaldson Coal databases and data made available by Commonwealth and State government agencies, local councils and surrounding mining operations/projects, including:

- rainfall and evaporation records from the BoM weather stations;
- rainfall records from the Tasman Underground Mine meteorological station;
- NOW gauging station flow data on Congewai Creek, Swamp Creek, Wallis Creek, Muggyrang Creek, Jilliby Creek and Jigadee Creek;
- water quality data from the Tasman Underground Mine monitoring sites on Surveyors Creek and Blue Gum Creek;
- water quality data from NOW and RMS monitoring sites on Surveyors Creek, Blue Gum Creek and Wallis Creek;
- further water quality data for Wallis Creek, sourced from the City Wide Settlement Strategy prepared by the Cessnock City Council (2003);
- water usage data from the Tasman Underground Mine water management system, including water requirements for underground mining, haul road dust suppression, the wheel wash and potable water supply; and
- other additional geological and regional topographic mapping data.

In addition, the Surface Water Assessment has considered the requirements of relevant water legislation, policies and plans, including the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources, 2009* (Appendix C and Attachment 6).

Catchment Areas

The West Borehole Seam mining area lies predominantly within the Surveyors Creek catchment, and the new pit top facility lies entirely within the Surveyors Creek catchment (Figure 4-7).

The tributaries of Surveyors Creek located within the Project area are ephemeral. When flow is present (i.e. following rainfall) these tributaries generally drain in a northerly or westerly direction, and converge to the north of the Project area (Figure 4-7).

Surveyors Creek converges with Wallis Creek near John Renshaw Drive, approximately 4 km north of the Project. Wallis Creek discharges into the Hunter River near Maitland approximately 10 km downstream of the confluence with Surveyors Creek.

In addition to the Surveyors Creek catchment, the West Borehole Seam mining area also lies within a small area of the headwaters of Burkes Creek (which drains to Lake Macquarie via Cockle Creek) and a small area of the headwaters of an un-named tributary which drains to the existing 'Colliery Dam' water storage (the 'Colliery Dam' overflows to Wallis Creek) (Figure 4-7).

The Fassifern Seam mining area lies predominantly within the Surveyors Creek and Blue Gum Creek catchments, with a small area lying within the Slatey Creek catchment (Figure 4-7). Blue Gum Creek discharges to Hexham Swamp at the Pambalong Nature Reserve.

Land Use, Topography and Soils

The Project area contains two distinct landforms relevant to the surface water flow regime (Appendix C):

- steep slopes radiating from Mount Sugarloaf (412 m AHD), Summit Point and the Sugarloaf Range (>300 m AHD); and
- moderate to low slopes below approximately 100 m AHD that occur predominantly in the northern and western portion of the Surveyors Creek catchment.

A large portion of the Project area is undisturbed, comprising vegetation within the Sugarloaf State Conservation Area and Heaton State Forest (Section 4.3.1).

Downstream of the Project area, the catchment of Surveyors Creek (located upstream of George Booth Drive) is cleared or partially cleared for rural residential development, with many existing tracks present (Appendix C).

There are three main soil landscapes within the West Borehole Seam mining area. These are the Beresfield (residual landscapes), Sugarloaf (colluvial landscapes) and Killingworth (erosional landscapes) (Appendix C). A description of these soil landscapes is provided in Table 4-4.

No acid sulphate soils have been identified within the Project area (Appendix C).

Existing Flow Regime

No continuous streamflow or peak flow gauging was available for the catchments within the Project area (Appendix C).

Although no direct gauged flow data was available, the likely hydrological characteristics of the catchments within the Project area were inferred based on gauging data (i.e. from NOW gauging stations) and concurrent rainfall data for catchment areas considered by Evans & Peck (2012) to have similar characteristics (Appendix C) to the sub-catchments of Surveyors Creek within the Project area (i.e. relatively small catchments containing steep forested land).

The expected hydrological characteristics, under various climatic conditions, for the sub-catchments within the West Borehole Seam mining area include:

- Runoff as a percentage of average annual rainfall from the steep rocky headwater catchments is likely to be slightly higher than for catchments that contain significant areas of valley fill material.
- Runoff from areas of valley fill is expected to include a larger proportion of baseflow into the creek which would be reflected in more persistent flow.
- The rainfall regime in a particular year is expected to have a significant effect on the total annual runoff, with annual runoff potentially ranging from 20% of the average to approximately 200% (a factor of 10) for the 10th percentile (1 in 10 dry) year and 90th percentile (1 in 10 wet) year. In contrast, rainfall between a 1 in 10 dry and 1 in 10 wet year varies by a factor of approximately two.

The expected flow duration curves for the Surveyors Creek 2 sub-catchment (i.e. at the confluence of S2 and S2G [Figure 4-7]) are provided on Figure 4-11.

Surface Water Quality

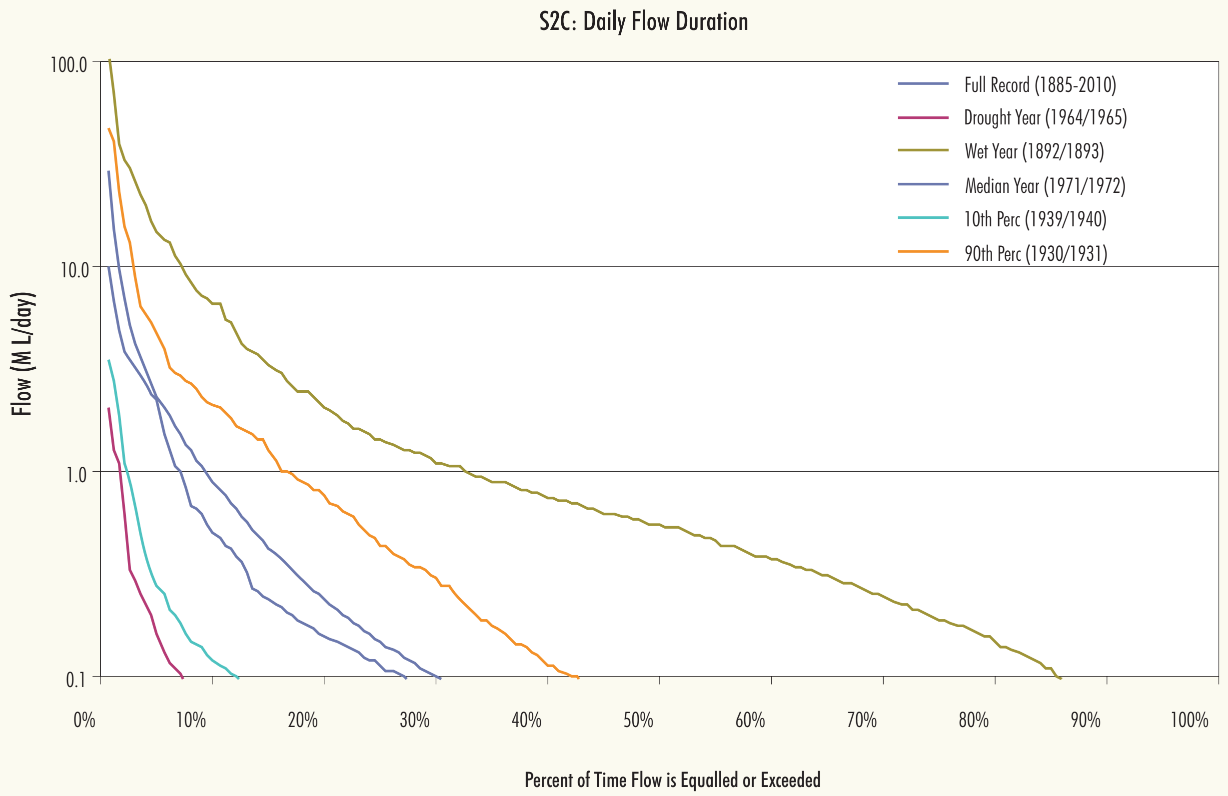
Surface water quality data in the Project region has been analysed based on water quality monitoring sites operated by Donaldson Coal, the RMS and the NOW (Appendix C). Water quality monitoring sites in close proximity to the Project are shown on Figure 4-12.

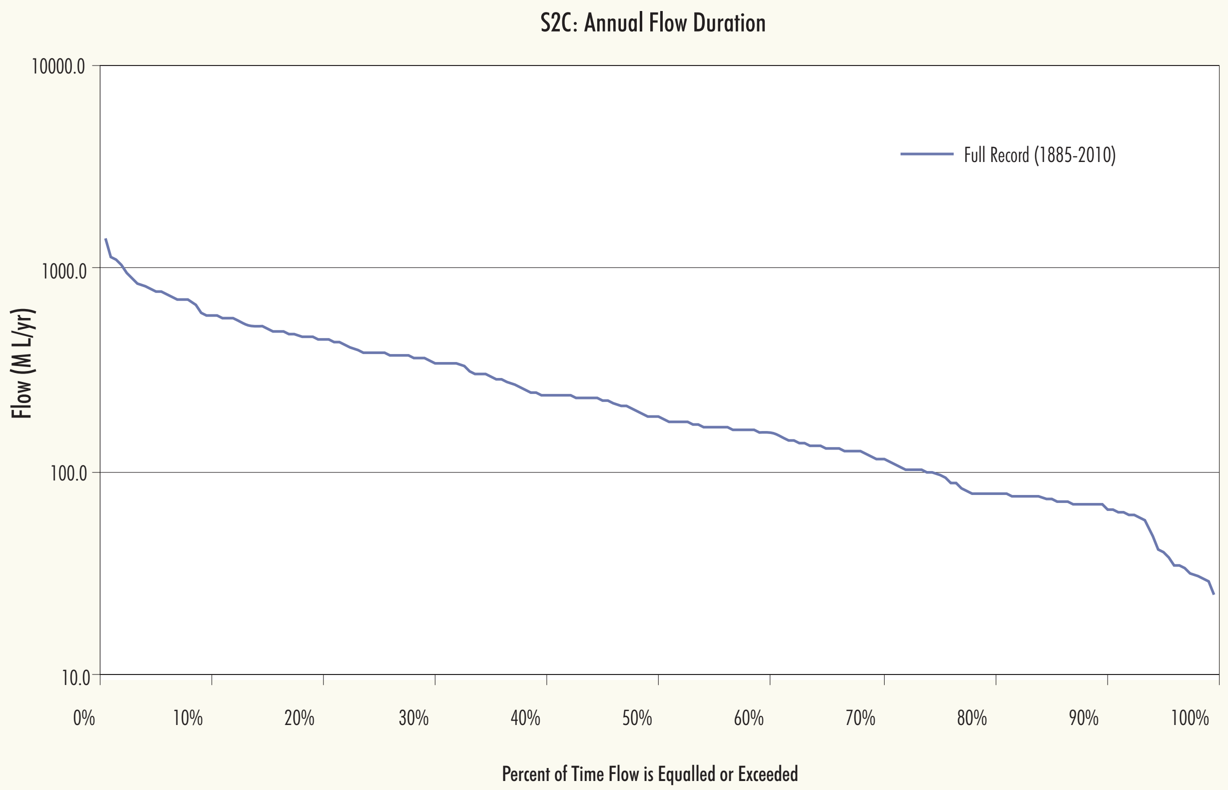
A detailed description of the water quality data is provided in Appendix C, and summarised below.

In general, there is no indication that surface water quality in Blue Gum Creek has been adversely affected by existing mining operations (Appendix C). A discussion of potential water quality impacts in a tributary of Slatey Creek are described in Section 4.4.1.

Electrical Conductivity (EC)

The range of EC levels varies between monitoring sites. EC levels were considered to be dependent on the contribution of groundwater flows to the surface water, with headwater creeks (where groundwater seepage comprises a higher proportion of total flow) generally experiencing higher salinity levels, in particular, seepage from coal seams outcropping on Sugarloaf Range (Appendix C).





Source: Appendix C

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FIGURE 4-11

Expected Flow Duration Curves for Surveyors Creek 2

Resource Strategies

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All sites exhibit a range of EC within the range specified for the Australian and New Zealand Environment Conservation Council (ANZECC) default trigger values for lowland streams of 125 to 2,200 µS/cm.

pH

The range of pH levels varies between catchments, however this is considered to be due to natural variations in catchment characteristics (e.g. geology) as opposed to existing mining operations.

pH levels are generally within the ANZECC default trigger values for lowland streams of pH 5 to 8, with some monitored data falling outside this range, including at Site 6 (Figure 4-12), which is located within a relatively pristine catchment.

Turbidity and Total Suspended Solids

The relatively pristine catchments in which water quality monitoring was conducted experience turbidity levels above the ANZECC default trigger values for lowland streams of 6 to 50 nephelometric turbidity units (NTU), however total suspended solids levels are relatively low. This suggests that turbidity levels are influenced by factors other than suspended solids (Appendix C).

Metals

Measured concentrations of metals for aluminium, cadmium, chromium, magnesium, copper and zinc are above the default ANZECC trigger values.

The previous mining in the area was in the West Borehole Seam, which is approximately 200 m below the Fassifern Seam (currently mined at the Tasman Underground Mine) and does not outcrop within the catchment areas that have been monitored. Access for mining in the West Borehole Seam occurred from areas further east.

Accordingly, there does not appear to be any connection between the observed metals concentrations and previous mining activities in the catchment of Blue Gum Creek (Appendix C).

Existing Water Users

No surface water licensed extractions have been identified on Surveyors Creek, Burkes Creek or the tributary of Wallis Creek that drains to the 'Colliery Dam' (Appendix C).

Existing Environmental Performance

Site water management and water quality monitoring for the existing Tasman Underground Mine is conducted in accordance with the requirements of the EPL 12483 and DA 274-9-2002.

Review of all AEMRs prepared for the Tasman Underground to date indicates two reportable surface water incidents.

One of these incidents (8 July 2007) involved an unmonitored discharge during a significant rainfall event that resulted in widespread flooding in the region (Trevor Brown and Associates, 2009). It was not considered that the rainfall runoff would have caused environmental harm due to the flooding in the local area and the minimal impact of the discharge volume on the receiving waters (Trevor Brown and Associates, 2009).

The other incident (15 July 2008) involved a minor unmonitored discharge from one of the pollution control dams (i.e. the flow was the equivalent of a moderately flowing household tap). There has been no reported reoccurrence of this incident.

A description of the existing environmental performance relating to groundwater is provided in Section 4.4.1.

4.6.2 Potential Impacts

The following potential impacts to surface water flow characteristics and water quality were identified (Appendix C):

- potential for subsidence induced cracking to create a pathway for loss of water from the catchment or creek channels, alternative subsurface flow paths or changes in the amount of water held in pools;
- potential changes in groundwater levels (e.g. due to mine water inflows) leading to changes to the interactions between the groundwater system and creeks in the Project area; and
- a reduction in the contributing catchment area as a result of the proposed stormwater retention for pollution control purposes at the new pit top facility.

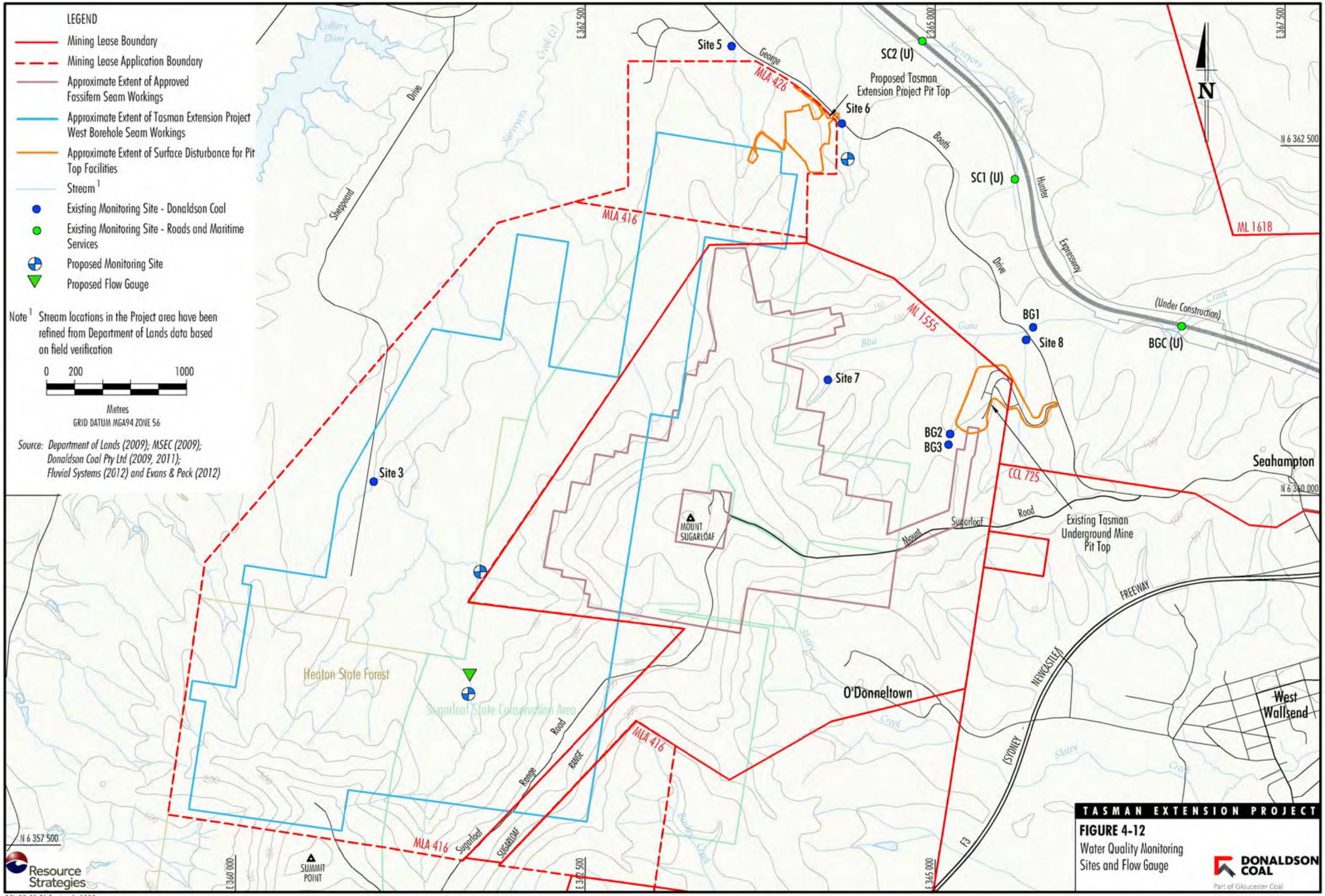


FIGURE 4-12
Water Quality Monitoring Sites and Flow Gauge

Surface Water Flow Characteristics

Subsidence Related Impacts

Potential subsidence impacts associated with the Project were predicted by DgS (2012), including the potential for surface cracking, changes in stream bed gradient and ponding and changes in stream alignment (Appendix A and Section 4.2.4). Potential subsidence impacts were predicted inclusive of the implementation of the SCZs described in Section 2.6.3 and summarised in Box 4-4.

Potential subsidence impacts were not predicted to have any significant effect on the surface water flow characteristics of the streams in the West Borehole seam mining area, and no significant change to the amount of water stored in pools (i.e. due to changes seepage and evaporation losses) (Appendix C).

Changes in Groundwater Levels

Potential changes to the contribution of baseflow from groundwater to/from the streams in the West Borehole Seam mining area, attributable to changes in groundwater levels associated with underground mining, were predicted by RPS Aquaterra (2012).

These predicted changes in baseflow to/from these streams are negligible in comparison with average runoff, and therefore, are predicted to have no measurable effect on the surface water flow characteristics of the streams in the West Borehole Seam mining area.

Reduction in Contributing Catchment

The only material surface development associated with the Project would be the construction of the new pit top facility and upcast ventilation shaft.

As described in Section 2.9, the site water management system at the new pit top facility would be designed such that runoff from areas where the handling of coal and/or hydrocarbons would occur (e.g. coal stockpile area) would be stored on-site and re-used for dust suppression, with no proposed discharge off-site to the surrounding creek system.

Stormwater runoff from areas where the handling of coal and/or hydrocarbons would not occur (e.g. administration office area) would drain off-site.

The net retention of surface runoff from disturbed areas would be negligible (i.e. approximately 0.1%) in comparison with annual median runoff from the catchment areas of Surveyors Creek within the Project area (Appendix C).

BOX 4-4
STREAMS
SUBSIDENCE MANAGEMENT

1st Order Stream*

Project subsidence performance measures:

- Negligible connective cracking to underground workings.
- Not more than minor environmental consequences for 1st and 2nd order streams.
- Negligible environmental consequences (that is, negligible diversion of flows and negligible change in the natural drainage behaviour of pools) for 3rd order streams or above.

Project subsidence control zone:

- Partial extraction with stable remnant pillars resulting in less than 300 mm of subsidence where the depth of cover to the stream is less than 80 m for 1st and 2nd order streams.
- First workings only within 26.5° angle of draw resulting in less than 20 mm subsidence at the edge of the bank for 3rd order streams or above.

Project subsidence control outcomes:

- Maintenance of stream water quality, geomorphic character, flows and ecological function.

Refer to Table 2-3 for details.
*Appendix D.

Post-mining surface water management is described in Section 5.3.6.

Surface Water Quality

Stormwater Runoff

As described in Section 2.9, the Project does not involve the discharge of mine water, however limited quantities of stormwater runoff (e.g. from the administration and car park areas) would drain from the pit top area. This water would be treated by oil/sediment traps and grass swales before discharge, to avoid downstream water quality effects.

Stormwater runoff would only be released subject to compliance with relevant EPLs and to the satisfaction of the EPA, and as such, no impacts to water quality are predicted (Appendix C).

Regular monitoring of water quality upstream and downstream of the pit top would be undertaken throughout the life of the Project (Section 4.6.3).

Subsidence Related Impacts

Existing water quality data has not indicated that there is evidence of changes to water quality (e.g. increased iron concentrations or decreased pH levels) associated with surface cracking due to subsidence from existing workings (Appendix C).

Notwithstanding, it is considered possible that surface cracking could occur in areas outside of the SCZs, which may lead to the creation of shallow subsurface flow pathways leading to changes in water quality.

Monitoring of water quality would be undertaken (Section 4.6.3) to detect any significant changes to water quality that may require remedial action (e.g. sealing of cracks), along with visual inspection of mined areas for evidence of cracking (Section 4.2.6).

Cumulative Impacts

Cumulative Impacts from Other Mining Operations

Potential subsidence impacts and changes in groundwater levels were predicted in consideration of proposed mining operations in the West Borehole Seam, cumulatively with other relevant approved and proposed mining operations (including approved operations in the Fassifern Seam).

On this basis, potential impacts (associated with subsidence and changes in groundwater levels) to the surface water flow characteristics and water quality of streams in the West Borehole Seam mining area have been predicted in consideration of the potential cumulative impacts from the other relevant approved and proposed mining operations.

No material impacts to surface water characteristics or water quality of streams in the West Borehole Seam mining area are predicted during the life of the Project (Appendix C).

Cumulative Impacts to Regional Surface Water

On the basis that no material impacts to surface water characteristics or water quality of streams in the West Borehole Seam mining area are predicted during the Project (Appendix C), no additional surface water impacts to water quality outside of the West Borehole Seam mining area were predicted due to the Project, when considered cumulatively with other relevant mining operations (Appendix C).

Climate Change and Surface Water

No additional surface water impacts associated with the Project were predicted when considered cumulatively with potential impacts associated with climate change (Appendix C).

The performance of the site water management system for the new pit top facility was assessed using 125 years of historical rainfall. This was considered to adequately account for projected changes to rainfall, rainfall intensity and evaporation associated with climate change in the region of the Project during the life of the Project (Appendix C).

4.6.3 Mitigation Measures, Management and Monitoring

Water Management Plans

Water Management Plans would be prepared for the Project as part of the Extraction Plan process (i.e. Extraction Plans would be prepared prior to the commencement of mining in each area).

Water Quality Monitoring

Water quality monitoring would continue at the locations (operated by Donaldson Coal) shown on Figure 4-12.

In addition, two water quality monitoring sites would be established on tributaries of Surveyors Creek within the West Borehole Seam underground mining area to monitor any potential changes to water quality during the life of the Project (Figure 4-12).

Water quality monitoring frequency and the parameters monitored would continue as per the existing water quality monitoring regime.

Should water quality monitoring show significant changes to water quality, an investigation of the cause would be conducted, and if required, appropriate remediation would be identified.

The details of additional water quality monitoring sites would be included in the Water Management Plans. The results of water quality monitoring would be reported in the AEMRs for the Project.

Surface Water Flow Monitoring

A flow gauging station would be established on Surveyors Creek (Figure 4-12) to calibrate the inferred surface water flow characteristics (Section 4.6.1) (once sufficient data has been collected) and monitor any potential changes to surface water flow characteristics due to the Project.

The Water Management Plans would include an investigation trigger (nominally a 10% deviation from the predicted annual flow from the catchment using pre-mining model parameters), which if triggered, would lead to an investigation, and if required, identification of appropriate remediation works.

The flow gauging station would preferentially be located where the existing stream bed provides natural hydraulic control, however, any additional works required to create hydraulic control would be designed to allow fish passage (Appendix C).

A pluviometer would also be established in an appropriate location in close proximity to the proposed flow gauging station.

The details of flow gauging station would be included in the Water Management Plans and results would be reported in the AEMRs for the Project.

Site Water Management Plan

As described in Section 2.9, the existing Site Water Management Plan would be revised to incorporate the construction and operation of the new pit top facility.

In addition to the water quality monitoring described above, a water quality monitoring site would be established upstream of the new pit top facility to supplement the existing monitoring downstream (Site 6) (Figure 4-12). The data from these two sites would be used to monitor any potential water quality changes associated with stormwater runoff from relatively undisturbed areas of the new pit top facility (e.g. from the administration and car park areas) being directed off-site.

The details of these water quality monitoring sites would be included in the revised Site Water Management Plan and results would be reported in the AEMRs for the Project.

4.7 AQUATIC ECOLOGY

An Aquatic Ecology Assessment has been prepared for the Project by frc environmental (2012) and is presented in Appendix E.

A description of the aquatic ecosystems of the Project area and surrounds is provided in Section 4.7.1. Section 4.7.2 describes the potential impacts of the Project on aquatic ecology, while Section 4.7.3 outlines relevant mitigation measures, management and monitoring.

4.7.1 Existing Environment

Regional and Local Setting

The Project is located in the Hunter River and Lake Macquarie catchments. The surface water drainage (including water quality) in the local area surrounding the Project is detailed in Sections 4.5 and 4.6 and shown on Figure 4-7.

Aquatic Ecology Monitoring

Robin Tuft & Associates Pty Ltd has undertaken spring and autumn aquatic ecology monitoring upstream and downstream of the current Tasman Underground Mine pit top facility since baseline data was collected prior to mining operations in 2000.

The aquatic ecology monitoring program has shown that water quality and macroinvertebrate communities vary between sites and surveys however there is no evidence of an obvious deterioration in water quality due to operation of Tasman Underground Mine (Appendix E). Changes at individual sites have been attributed to immediate environmental conditions (such as sunlight availability and turbidity), unaffected by the mine.

Project Aquatic Ecology Surveys

frc environmental undertook detailed aquatic ecology surveys at eight sites across the Project area from 9 to 11 June 2011 (Appendix E) (Figure 4-13).

Aquatic habitat condition (including water quality parameters), aquatic flora, aquatic macroinvertebrates, fish and other aquatic vertebrates were surveyed. Sampling of habitat condition was conducted according to the Australian River Assessment System (AUSRIVAS) (Turak and Waddell, 2002), and bioassessment scores were also measured in accordance with Queensland Department of Natural Resources and Mines (DNRM) (2001). AUSRIVAS and bioassessment scores provide an index of habitat condition, which enables a comparison of habitat quality between sites.

The potential for threatened aquatic biota listed, in the schedules of the NSW *Fisheries Management Act, 1994* (FM Act), NSW *Threatened Species Conservation Act, 1995* (TSC Act) and EPBC Act, to occur in the locality was evaluated.

Aquatic Habitats

The natural drainage systems in the Project area are generally limited to pooled water following medium to high rainfall events and do not provide significant habitat for aquatic fauna (Appendix E). This is particularly the case in the upper catchment and steeper sections of the Project area.

Plate 4-11 shows an area of pooled water along a tributary of Surveyors Creek following a high rainfall event. This section of the tributary is located on the flatter zones in the north-west of the Project area in privately-owned land. Plate 4-12 shows a typical section of tributary in the steeper parts of the Project area.

The riparian zone at all sites was generally diverse and included large trees, shrubs and grasses (Appendix E). It was noted that some riparian vegetation had historically been cleared for residential properties and transmission lines (Plate 4-13).

Source: Appendix E.

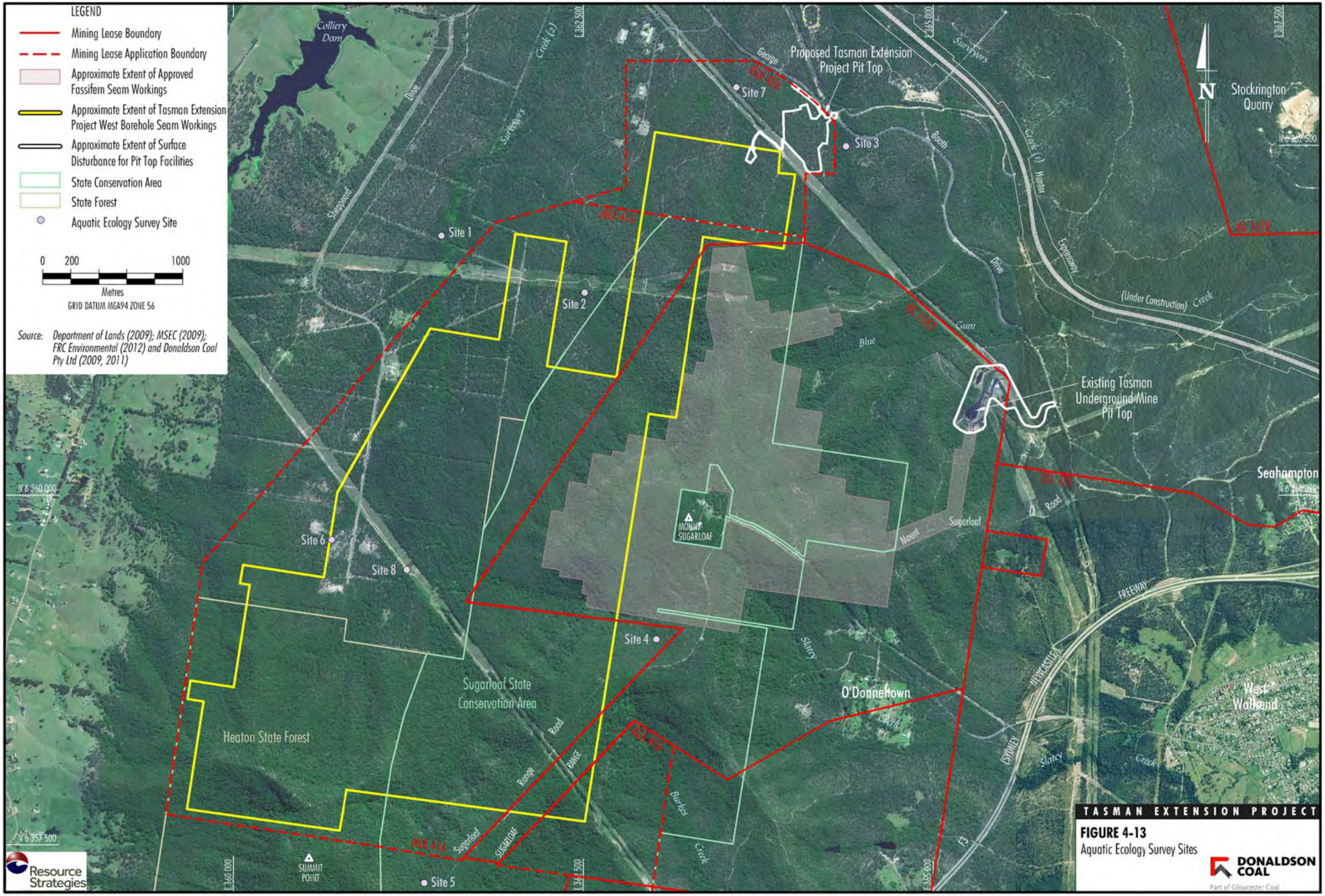
Plate 4-11 – Pooled Water Following Rain – Surveyors Creek 2 Downstream of West Borehole Seam Mining Area

Source: Appendix E.

Plate 4-12 – Native Vegetation in the Riparian Zone – First Order Portion of Surveyors Creek 2

Source: Appendix E.

Plate 4-13 – Cleared Section of Surveyors Creek Tributary S2G in Powerline Easement



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Most sites had either a moderate or good habitat bioassessment score. The moderate score (Site 6) was due to past channel alteration and subsequent scouring and deposition and, therefore, a lack of stable habitat (Appendix E). Bank stability at most sites was moderate to high and there was little evidence of recent erosion (Appendix E).

In-stream habitat such as woody debris and overhanging/trailing bank vegetation provided refuge and food for aquatic fauna at most sites (Appendix E, Plate 4-14). Boulders provided additional habitat at sites in the upstream sections.

Source: Appendix E.

Plate 4-14 – Riparian Vegetation – Downstream Section of Surveyors Creek Tributary S2E

Substrate sediment varied according to channel steepness and ranged from sand and silt/clay in the downstream sections to sandstone in the upper reaches.

Macroinvertebrates

The most common and abundant macroinvertebrates sampled by frc environmental were non-biting midge larvae (sub-families Chironominae and Tanypodinae), seed shrimp (family Ostracoda) and marsh beetle larvae (class Scirtidae) (Appendix E).

Vertebrate Fauna

Three species of fish were caught during the survey, all at one location, located on the lower reaches of a tributary of Surveyors Creek. The most abundant and widespread species caught was the Eastern Gambusia (*Gambusia holbrooki*) (an exotic and declared noxious species) (Appendix E). The Empire Gudgeon (*Hypseleotris compressa*) and Firetail Gudgeon (*Hypseleotris galii*) were also caught.

The natural drainage gullies in the Project area are generally limited to pooled water following medium to high rain events, and so do not provide significant habitat for aquatic fauna (Appendix E).

Threatened Aquatic Biota

No threatened aquatic biota listed in the schedules of the FM Act or EPBC Act were identified by the aquatic surveys or are considered likely to occur in the Project area or surrounds (Appendix E).

4.7.2 Potential Impacts

The Aquatic Ecology Assessment (Appendix E) provides an assessment of the potential impacts of the Project on aquatic ecology. Potential impacts on aquatic ecology were considered in terms of potential impacts of surface activities and potential consequence of subsidence impacts, as described below.

Potential Impacts of Project Surface Activities on Aquatic Fauna and their Habitat

Vegetation Clearance

The Project would require the removal of approximately 11.2 ha of dry forest/woodland for construction of the pit top facility and upcast ventilation shaft.

No streams, creeks, waterbodies or riparian vegetation would be removed by the Project. As such, vegetation clearance would not have a significant impact on aquatic fauna and their habitat (Appendix E).

Surface Water Quality

Potential surface water quality impacts due to Project surface activities are described in Section 4.6.2. No significant impacts to aquatic ecology in the receiving environment are expected (Appendix E).

Obstructions to Fish Passage

Stream crossings can create waterway barriers that prevent or impede movements of aquatic fauna (e.g. fish). Many of the fish native to ephemeral and intermittent systems in Australia migrate between different habitats at particular stages of their lifecycle (Appendix E). As discussed in Section 4.6.3, the Project may include the installation of a flow gauging station. The flow gauge would be designed to allow fish passage (Section 4.7.3 and Appendix C).

Potential Consequences of Subsidence Impacts on Aquatic Fauna and their Habitat

Surface Water Flow Regime

Changes to the flood regime, and the timing and magnitude of flows in watercourses, have the potential to impact on aquatic ecology.

Changes to flow may occur as a result of surface and sub-surface cracking that re-route surface flow. As described in Section 4.6.2, due to the implementation of SCZs to achieve the various subsidence performance measures, the Project is predicted to have negligible impacts on stream flow regimes, including baseflow. As such, no impacts to aquatic ecology are predicted due to a change in flow regime.

Surface Water Quality

Potential surface water quality impacts as a result of subsidence impacts are described in Section 4.6.2. frc environmental (2012) concluded that subsidence is unlikely to impact on key aquatic habitats in the Project area or have locally-significant impacts on aquatic flora and fauna (Appendix E).

4.7.3 Mitigation Measures, Management and Monitoring

The majority of mitigation measures and management relevant to aquatic biota are described under surface water (Section 4.6), groundwater (Section 4.4) and geomorphology (Section 4.5). The key additional measures relevant to aquatic ecology are appropriate design of any flow gauging structures and implementation of an appropriate monitoring program.

Flow Gauging Station

Where required, gauging stations would be designed and constructed in accordance with the *NSW Policy and Guidelines for Fish Friendly Waterway Crossings* (DPI, 2004) and *Policy and Guidelines for Aquatic Management and Fish Conservation* (DPI, 1999). Their design and installation would encourage fish movement, minimise cumulative effects of fish barriers and retain natural morphological features of the stream where possible.

Monitoring

As part of the Project, Donaldson Coal would develop and implement a monitoring program for aquatic ecology. The aquatic ecology monitoring program would be integrated with the surface water monitoring program as part of Water Management Plans prepared under the Extraction Plan process. The aquatic ecology monitoring program would include:

- monitoring of biological indicators such as macroinvertebrates and fish;
- appropriate timing to allow for seasonal considerations;
- monitoring upstream and downstream of mining areas and surface facilities;
- monitoring across the range of stream orders;
- triggers to implement further investigation and/or adaptive management; and
- mechanisms to allow for results to inform future practices/continual improvement.

4.8 FLORA

A Terrestrial Flora Assessment was conducted for the Project by Hunter Eco (2012a, 2012b) and is provided in Appendix F.

A description of the flora in the vicinity of the Project is provided in Section 4.8.1 and Section 4.8.2 describes the potential impacts of the Project on flora. Section 4.8.3 outlines relevant mitigation measures, management and monitoring and Section 4.8.4 summarises the proposed offset and compensatory measures.

4.8.1 Existing Environment

Regional Setting

The Project is located at the northern edge of the Wyong sub-region in the Sydney Basin Interim Biogeographic Regionalisation of Australia bioregion on the central east coast of NSW. The Project is also located at the southern end of the North Coast Botanical Division (Appendix F).

The majority of the Project area is well vegetated and includes open heath, dry sclerophyll forest, wet sclerophyll forest and mesic rainforest (Appendix F).

Baseline Flora Surveys

Baseline flora surveys were conducted in accordance with DEC's (2004b) *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities, Working Draft*. Field surveys across the proposed mining area and within the proposed pit top facilities area were conducted during periods when cryptic threatened species (considered potential occurrences) were in flower.

High resolution aerial photography was used to identify areas of potential groundwater dependant ecosystems and these areas were targeted during field surveys. A vegetation map was prepared from ground-truthed point data, floristic plot data and ground-truthed community boundary determination.

Vegetation community types were determined by matching floristic content to data from the NSW National Parks and Wildlife Service (NPWS) (2000) regional classification.

As a component of the baseline flora surveys, a number of reference sources were reviewed including database records (OEH BioNet and Commonwealth Protected Matters Search database records) and other relevant scientific literature. Where appropriate, these references sources were also included in the assessment of existing vegetation and evaluation of likelihood of threatened species.

Vegetation Communities

A total of 11 vegetation communities (including three variants) were mapped across the Project area and surrounds, as listed below:

- MU1a: Coastal Warm Temperate – Sub Tropical Rain Forest.
- MU5: Alluvial Tall Moist Forest.
- MU12: Hunter Valley Moist Forest.
- MU15: Coastal Foothills Spotted Gum – Ironbark Forest:
    - MU15(p): Sugarloaf Uplands Paperbark Thicket.
- MU17: Lower Hunter Spotted Gum – Ironbark Forest:
    - MU17(p): Paperbark variant.
    - MU17(iv): Honey Myrtle Scrub variant.
- MU18: Central Hunter Ironbark – Spotted Gum - Grey Box Woodland.
- MU19: Hunter Lowlands Redgum Forest.
- MU30: Coastal Plains Smooth-barked Apple Woodland.

Vegetation mapping is shown on Figure 4-14 and detailed community descriptions are provided in Appendix F.

Flora Species Composition

A total of 155 plant species were recorded during flora surveys within the new pit top facility area and surrounds including 150 native and five introduced species. A total of 230 plant species were recorded in the West Borehole Seam mining area and surrounds including 229 native and one introduced species (Appendix F).

Within the West Borehole Seam mining area and surrounds, 78 rainforest species were recorded. Several Red Cedar (*Toona ciliata*) were also recorded indicating that this area would likely have been logged in the past when part of the Heaton State Forest (Appendix F).

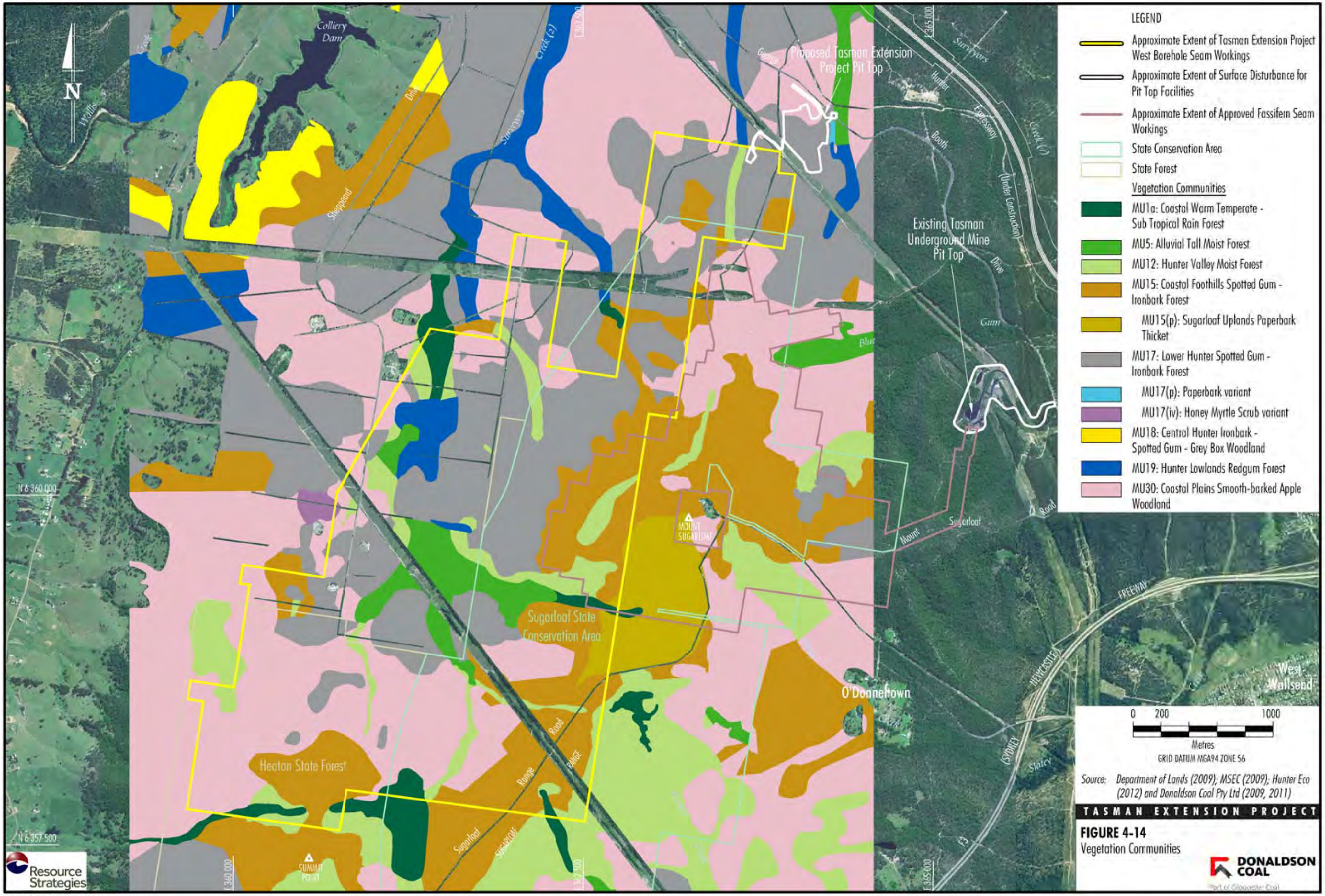
A full list of plant species recorded during flora surveys is provided in Appendix F.

Introduced Flora Species and Noxious Weeds

Five weed species were recorded at the new pit top facility area by the Project surveys including: Fireweed (*Senecio madagascariensis*); Dandelion (*Taraxacum officinale*); Lamb's Tongues (*Plantago lanceolata*); Parramatta Grass (*Sporobolus africanus*); and South African Pidgeon Grass (*Setaria sphacelata*). One weed species was recorded across the West Borehole Seam mining area and surrounds by the Project surveys (i.e. Lantana [*Lantana camara*]). Lantana and Fireweed are listed as noxious under the NSW *Noxious Weeds Act, 1993*.

Threatened Flora Species

The Project flora surveys identified three threatened flora species listed under the TSC Act. Two of these were recorded at the new pit top facility area and immediate vicinity, namely Heath Wrinklewort (*Rutidosis heterogama*) and Black-eyed Susan (*Tetratheca juncea*), both listed as Vulnerable under the TSC Act. These two threatened flora species were also recorded within the West Borehole Seam mining area and surrounds, in addition to the Small-flower Grevillea (*Grevillea parviflora* subsp. *parviflora*), also listed as Vulnerable under the TSC Act. Locations of Project threatened flora species records are shown on Figures 4-15 and 4-16.



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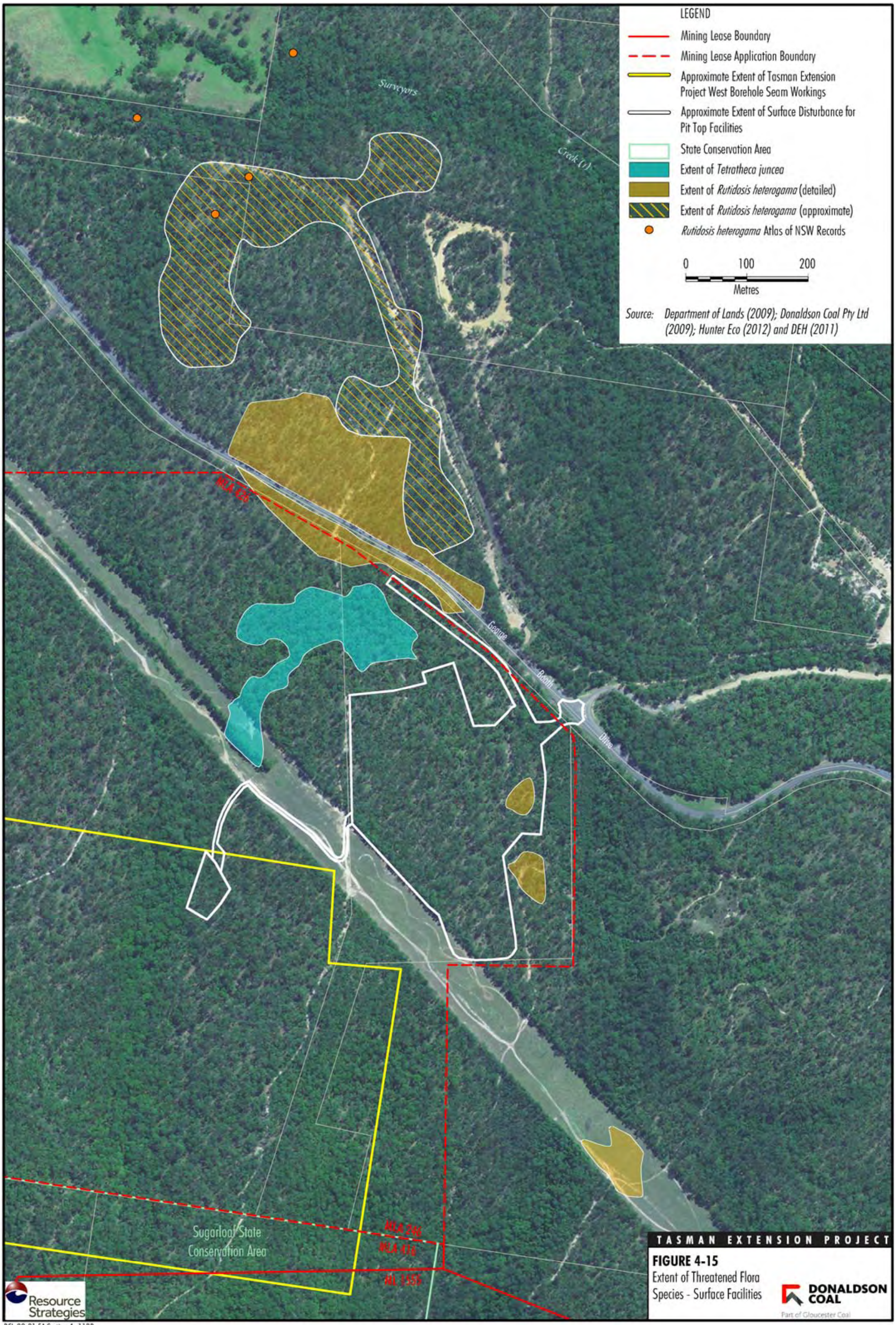
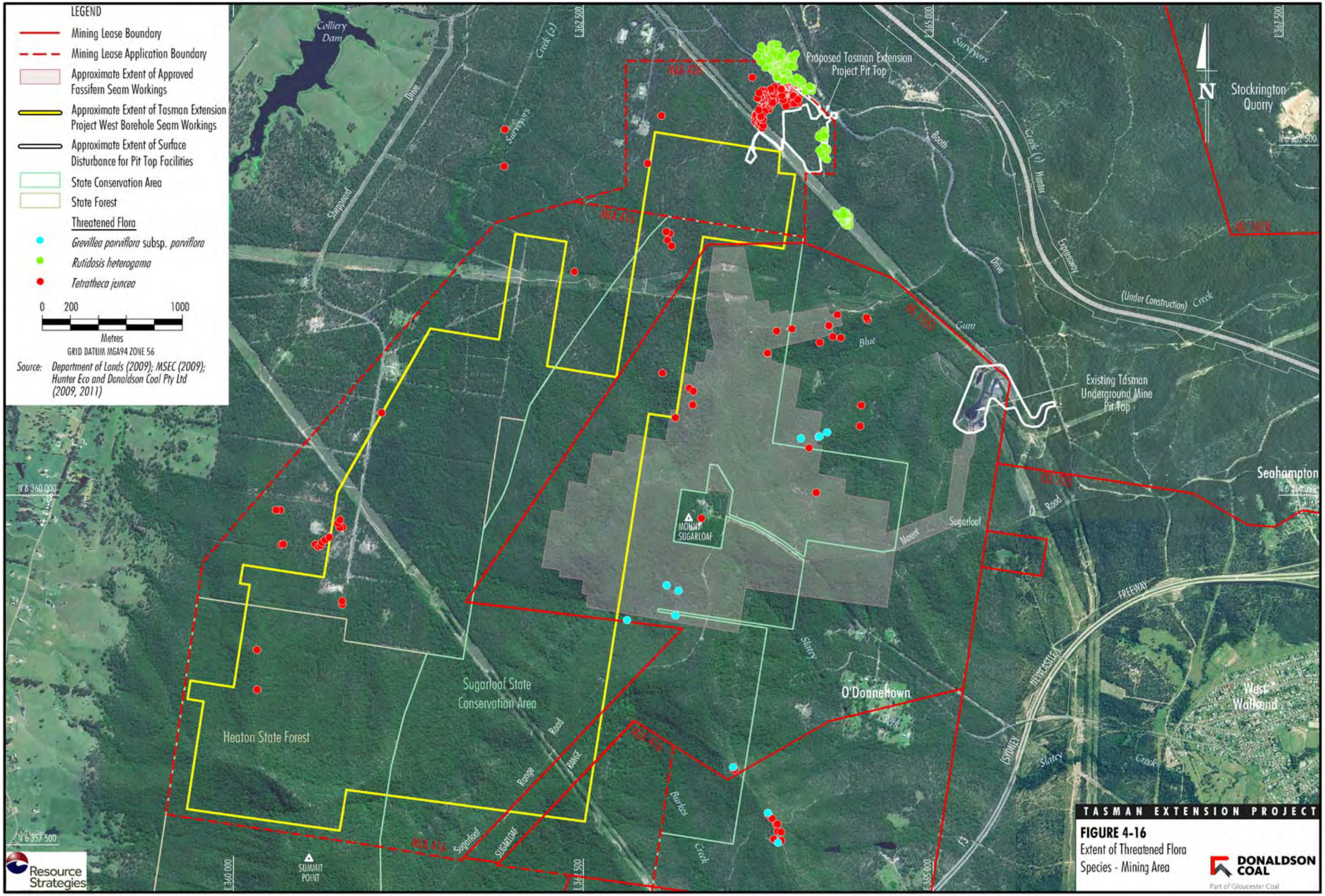


FIGURE 4-15
Extent of Threatened Flora Species - Surface Facilities



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Endangered Flora Populations

No endangered flora populations listed under the TSC Act are located in the Project extent or known to occur in the immediate surrounds (Appendix F).

Threatened Ecological Communities

Seven of the recorded vegetation communities are considered to represent EECs listed under the TSC Act. Three of these communities were recorded at the new pit top facility area and surrounds and six were recorded across the West Borehole Seam mining area and surrounds (Table 4-9) (Figure 4-14).

Groundwater Dependent Ecosystems

Groundwater dependent ecosystems are ecosystems which are dependent in whole or in part on water reserves held in the ground. Hunter Eco (2012b) considers that groundwater dependent ecosystems in the West Borehole Seam mining area include MU1a Coastal Warm Temperate – Sub Tropical Rainforest and MU5 Alluvial Tall Moist Forest. The vegetation community MU15(p) Sugarloaf Uplands Paperbark Thicket is considered a possible groundwater dependent ecosystem (Appendix F).

4.8.2 Potential Impacts

Key potential impacts of the Project on terrestrial flora and their habitats include vegetation clearing and subsidence. Other potential impacts associated with the Project include increased weed incursion and increased fire frequency.

Vegetation Clearance

The new pit top facility has been subject to various design iterations during development of the proposed Project. The design parameters relevant to flora include:

- Limiting vegetation clearance as far as practicable. The property boundary is approximately 24 ha and the disturbance for the new pit top facility and upcast ventilation shaft has been limited to 11.2 ha.
- Avoiding clearance of the *Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions* EEC (Plate 4-15).
- Avoidance of a known roost tree for the threatened fauna species Yellow-bellied Glider (*Petaurus australis*) recorded within the initial disturbance footprint of the new pit top facility.

Table 4-9
Endangered Ecological Communities Recorded across the West Borehole Seam Mining Area and Surrounds

Project Vegetation Communities	Endangered Ecological Community	Project Location	
		New Pit Top and Surrounds	West Borehole Mining Area and Surrounds
MU1a – Coastal Warm Temperate – Sub Tropical Rain Forest	Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions	-	•
MU5 – Alluvial Tall Moist Forest	River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	-	•
MU17 – Lower Hunter Spotted Gum – Ironbark Forest	Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion	•	•
MU17(p) – Paperbark variant		•	-
MU17(iv) – Honey Myrtle Scrub variant.		-	•
MU18 – Central Hunter Ironbark - Spotted Gum - Grey Box Woodland	Central Hunter Ironbark – Spotted Gum– Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions	-	•
MU19 – Hunter Lowlands Redgum Forest	Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions	•	•

Source: After Appendix F.

- Avoiding clearance of the threatened flora species Black-eyed Susan (*Tetratheca juncea*), including a 20 m buffer.
- Limiting clearance of the *Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion* EEC as far as practicable.
- Limiting clearance of the threatened flora species Heath Wrinklewort (*Rutidosis heterogama*) as far as practicable.

Source: Appendix F.

Plate 4-15 – Hunter Lowlands Redgum Forest

Apart from very minor clearing associated with ongoing exploration, management and monitoring activities, the Project would result in the clearance of approximately 11.2 ha for the new pit top facility and upcast ventilation shaft (Table 4-10).

Table 4-10
Vegetation Clearance for the New Pit Top Facility and Upcast Ventilation Shaft

Vegetation Community	Area (ha)
MU17 Lower Hunter Spotted Gum – Ironbark Forest (EEC)	8.9
MU 30 Coastal Plains Smooth-barked Apple Woodland	2.3
Total	**11.2**

Source: After Appendix F.

There would be no clearing in the underground mining areas that would lead to habitat fragmentation or isolation. Consequently, the corridor values of the Sugarloaf Range (including the Sugarloaf State Conservation Area) would be maintained (Appendix F).

Subsidence Impacts

The key potential impacts on flora species and vegetation communities in the underground mining area are from subsidence. Impacts to groundwater dependent ecosystems and riparian vegetation can occur if stream flow is altered. Subsidence can alter stream flow via streambed cracking (i.e. localised diversion of flows), changes to ponding (i.e. less or more ponding in streams) and connective cracking (i.e. diversion of surface waters into the mine workings). *Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands* is a key threatening process listed in Schedule 3 of the TSC Act. Localised impacts to vegetation are also possible where subsidence results in destabilisation of exposed rocky escarpments resulting in major rock falls.

Section 2.6.3 describes the subsidence performance measures and SCZs that have been developed for the Project to minimise impacts to significant surface features. Surface features relevant to flora with specific performance measures include:

- cliff lines and steep slopes (Box 4-3);
- streams (Box 4-4); and
- Coastal Warm Temperate – Sub Tropical Rainforest and Alluvial Tall Moist Forest (groundwater dependent) and Hunter Lowlands Redgum Forest on 3rd order streams (Box 4-5).

The performance measures developed for cliff lines and steep slopes are *minor impact resulting in negligible environmental consequence and no additional risk to public safety* (Appendix A). These measures substantially reduce the risk of subsidence induced impacts to cliff lines and steep slopes.

The magnitude of potential alteration to hydrology/stream flow has been assessed by DgS (2012) (Appendix A) and Evans & Peck (2012) (Appendix C). These potential impacts are summarised in Sections 4.2 and 4.6, respectively.

As stated in Section 4.6.2, the Project is predicted to have negligible impacts on stream flow regimes and the mine plan would be designed to achieve no more than negligible connective cracking to the underground workings below streams.

BOX 4-5
KEY ENDANGERED ECOLOGICAL COMMUNITIES
SUBSIDENCE MANAGEMENT

Alluvial Tall Moist Forest*

Project subsidence performance measures:

- Negligible environmental consequence.

Project subsidence control zone:

- Partial extraction with stable remnant pillars resulting in less than 300 mm of subsidence.

Project subsidence control outcomes:

- No more than negligible environmental consequence.

Refer to Table 2-3 for details.
*Appendix F.

Considering implementation of the various SCZs (Section 2.6.3), the majority of vegetation over the proposed full extraction panels (i.e. areas with greatest potential subsidence) is MU17 Lower Hunter Spotted Gum – Ironbark Forest and MU30 Coastal Plains Smooth-barked Apple Woodland (Appendix F). Empirical observation by Hunter Eco (2012b) suggests that both of these communities can tolerate a range of conditions as expressed in their varying composition. These communities present as dry open forest through to moist shrubby forest. These communities are not groundwater dependent and therefore, as with a lot of Australian vegetation, they have adapted to a wide range of water availability (Appendix F).

For a long-term detrimental impact to occur to flora species or communities, changes to habitat would need to be widespread and themselves long-term (Appendix F). There is no recorded experience of this occurring as a consequence of the mining methods relevant to the Project. Hunter Eco (2012b) reports that the worst case scenario would be localised loss of individual plants, an event that would be unlikely to place any local population at risk of extinction.

Numerous assessments and monitoring programs of the environmental consequence of mine subsidence have been conducted at the Tasman Underground Mine and Abel Underground Mine, other mines in the Newcastle Coalfield and also in other coalfields across Australia. Donaldson Coal has a subsidence monitoring program for the Tasman Underground Mine which includes visual inspections and photographic monitoring focusing on surface features such as cliffs. Apart from some recent observations of minor tensile cracking on an access track, there has been no observed and/or reported subsidence impacts on cliffs, rock outcrops or drainage lines (Section 4.2.1). Furthermore there have been no observed impacts to flora as a result of these minor surface effects.

Threatened Flora Species and Ecological Communities

Potential impacts on threatened flora species and ecological communities (susceptible to subsidence induced impacts) are substantially reduced by subsidence performance measures and associated SCZs, as described above.

Potential impacts on threatened flora species have been minimised by the various design parameters and constraints for the new pit top facility.

Formal impact assessments for threatened flora (known and considered potential occurrences) are provided in Appendix F. These assessments conclude that the Project is unlikely to have any lasting impacts on threatened flora or their habitats in the Project area, Sugarloaf State Conservation Area or the Heaton State Forest.

Weeds

The Project has some potential to increase the spread of weeds through vegetation clearing activities, dispersal of seed or soil material containing seed via continued movement of vehicles across the Project area and through rehabilitation or restoration activities (e.g. along streams).

Fire

High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition is listed as a key threatening process under the TSC Act. The potential for bushfires to occur may be increased due to various activities associated with the Project (e.g. vehicles traversing tracks in dense vegetation) (Section 4.3.2).

4.8.3 Mitigation Measures, Management and Monitoring

Although the Project would avoid or minimise the impacts on terrestrial flora and their habitats, several measures have been developed to mitigate, manage or offset unavoidable impacts of the Project on terrestrial flora, including:

- subsidence performance measures and SCZs;
- design of the pit top to minimise vegetation clearance;
- monitoring of vegetation;
- miscellaneous programs (i.e. weed and fire management, control of the spread of Myrtle Rust, erosion and sediment control and rehabilitation);
- rehabilitation of surface disturbance areas; and
- a biodiversity offset and compensatory package (Section 4.8.4).

Subsidence Performance Measures and Subsidence Control Zones

Subsidence performance measures and associated SCZs are described in Section 2.6.3. These measures greatly reduce the potential impacts of the Project on flora.

Biodiversity Management Plans would be developed as part of the Extraction Plan process to monitor and manage potential impacts on flora as a result of subsidence.

Vegetation Clearance

One of the key avoidance measures relevant to flora is the design of the new pit top facility to minimise vegetation clearance as far as practicable. This has resulted in the clearance required by the Project being limited to 11.2 ha (Section 4.8.2).

Donaldson Coal currently implements a Flora and Fauna Management Plan (Ecobiological, 2007) at the existing Tasman Underground Mine. The Flora and Fauna Management Plan includes a VCP to minimise and ameliorate any impact on flora and fauna, in particular threatened species, during the clearing process. The key components of the VCP relevant to flora include delineation of areas to be cleared of native remnant vegetation and vegetation clearance supervision.

The Flora and Fauna Management Plan would be reviewed and revised for the construction components of the Project (Section 7).

Management measures to limit vegetation clearance associated with management and monitoring outside the pit top would include:

- Restricting vegetation clearance to the slashing of vegetation where possible (i.e. leaving the lower stem and roots *in-situ* to maximise the potential for natural regrowth).
- Lopping of branches, rather than the removal of trees.
- The use of existing fire trails to access sites to minimise the disturbance of soils.
- Limiting the amount of soil disturbance to the minimum required for the mobilisation, placement and operation of equipment and for maintaining access to equipment.
- The use of rubber lattice matting or other measures to delineate work areas and to minimise disturbance to soils and vegetation.
- Measures to encourage natural regeneration (e.g. placing stockpiled vegetative material over cleared areas).
- Rehabilitation measures (e.g. the implementation of weed control measures, or active planting in the event natural regeneration is not considered to be progressing).

Threatened Flora Management Measures

The extent of surface disturbance for the new pit top facility has been designed to avoid the occurrence of Black-eyed Susan (*Tetratheca juncea*) (including a 20 m buffer), *Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions* EEC and the majority of the occurrence of the Heath Wrinklewort (*Rutidosis heterogama*). The new pit top facility has also been designed to limit clearing of the *Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion* EEC.

As part of the review and update of the existing Flora and Fauna Management Plan, measures specific to the protection of Black-eyed Susan and Heath Wrinklewort populations and the *Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions* EEC would be included. Such measures would include fencing around buffer areas, specific induction of plant (machinery) operators (and any other relevant personnel), and regular inspection of the patches being avoided.

The Biodiversity Management Plan would include a monitoring program for select vegetation communities located above the underground mining areas. The monitoring program would be focussed on riparian and/or groundwater dependent communities. The program would include monitoring of various vegetation condition/health parameters aimed at identifying changes due to subsidence impacts (e.g. effects on water availability).

Miscellaneous Programs

Weeds

Donaldson Coal would implement weed control measures to minimise seed transport across the Project, including inspection of vehicles and mechanical equipment (Appendix F).

Donaldson Coal would also implement specific weed management measures for the pit top area, including identification of weeds via regular site inspections, mechanical removal of identified weeds and/or the application of approved herbicides and follow-up site inspections to determine the effectiveness of eradication programs.

Bushfire

Donaldson Coal implements a Bushfire Management Plan for the existing Tasman Underground Mine, which would be reviewed and revised for the Project (Section 4.3.3).

Myrtle Rust

The Biodiversity Management Plan would include measures to limit the potential spread of Myrtle Rust. Donaldson Coal's induction program would also be reviewed to include employee awareness of Myrtle Rust.

Site Water Management Measures (including Erosion and Sediment Control)

Donaldson Coal currently implements a Site Water Management Plan for the existing Tasman Underground Mine, which would be reviewed and revised to include the Project. The Site Water Management Plan includes erosion and sediment control measures (Section 4.6.3).

Rehabilitation of Surface Disturbance Areas

Similar to the existing Tasman Underground Mine, the final land use of Project surface disturbance areas would be native vegetation conservation (except for areas within electricity transmission line easements). The Project rehabilitation program would include:

- progressive rehabilitation of minor Project surface disturbance areas; and
- rehabilitation of surface disturbance areas at the cessation of mining of the Fassifern Seam (i.e. the existing pit top facility) and the Project (i.e. the new pit top facility and ventilation shaft site).

At the completion of mining, the key Project components requiring rehabilitation would include:

- existing Tasman Underground Mine infrastructure;
- new pit top facility;
- upcast ventilation shaft site;
- mine access road and internal roads; and
- other service infrastructure areas.

The rehabilitation concepts and measures that would be implemented for these key Project components and other surface disturbance areas are detailed in Section 5.

4.8.4 Offset and Compensatory Measures

Compensatory measures and other ecological initiatives relating to terrestrial flora for the Project are described below. Other ecological initiatives for the Project (specifically relating to management works in the Sugarloaf State Conservation Area) are described in Section 7.

Compensatory Land Package and Contributions

Condition 25 of the Tasman Underground Mine Development Consent (DA 274-9-2002) (16 March 2004) stated:

> ***FLORA & FAUNA***
>
> ***Compensatory Habitat***
>
> *25. The Applicant shall establish at least 10 hectares of compensatory habitat on the surface colliery holding to the satisfaction of the Director-General, to offset the vegetation removed by the development.*

This condition was developed to offset the clearance of approximately 8 ha of native vegetation required for development of the Tasman Underground Mine pit top facility (Newcastle Coal Company Pty Limited, 2002).

As described in Section 4.8.2, the Project would include the clearance of approximately 11.2 ha of native vegetation for the new pit top facility and upcast ventilation shaft, including approximately 8.9 ha of Lower Hunter Spotted Gum – Ironbark Forest (an EEC listed under the TSC Act) and approximately 2.3 ha of Coastal Plains Smooth-barked Apple Woodland.

Consistent with the approved compensatory land package for the existing Tasman Underground Mine pit top facility, the Project biodiversity offset land may include the following:

- establishment of at least 22.5 ha of native bushland (ratio of 2:1) as compensatory habitat (including at least 18 ha of the *Lower Hunter Spotted Gum - Ironbark Forest in the Sydney Basin Bioregion EEC*);
- selection of suitable bushland for the compensatory habitat to the satisfaction of DP&I, in consideration of:
  - OEH's *Principles for the use of Biodiversity Offsets in NSW*; and
  - the Offsetting Principles outlined in the *Lower Hunter Regional Conservation Plan* (DECCW, 2009b);
- funding for costs associated with establishment of the compensatory habitat;
- suitable long-term protection of the compensatory habitat to the satisfaction of DP&I; and
- funding for minor site improvement works if required.

Donaldson Coal would develop a Biodiversity Offset Strategy to finalise the selection of the biodiversity offset land and facilitate management of the land, in consultation with OEH and to the satisfaction of DP&I. The Biodiversity Offset Strategy would be developed within 12 months of the Development Consent, if granted.

Alternatively, at the time the land was purchased by Newcastle Coal Company Pty Ltd, DEC (now OEH) indicated in a letter (dated 1 March 2007) that impacts associated with the new pit top would be offset in an appropriate manner should a set of actions relevant to the land and the new pit top be undertaken. These actions include:

- Designing the new pit top to avoid impact on the threatened flora species Black-eyed Susan (*Tetratheca juncea*), including a 20 m buffer.
- Designing the new pit top to avoiding clearance of the *Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions* EEC.
- Designing the new pit top to limit clearance of the *Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion* EEC.
- Transferring the land associated with the new pit top to OEH once mining and rehabilitation have been completed.
- Managing the existing Tasman Underground Mine compensatory habitat area to protect the area's biodiversity values in accordance with the existing Flora and Fauna Management Plan.
- Conserving a population of the threatened flora species Black-eyed Susan (*Tetratheca juncea*) located within the existing Tasman Underground Mine compensatory habitat area.
- Consideration of transferring the existing Tasman Underground Mine compensatory habitat area to OEH once mining and rehabilitation are complete.

In addition to either option, Donaldson Coal would contribute $25,000 per annum during mining in the Sugarloaf State Conservation Area for rehabilitation, revegetation and management works in the State Conservation Area (Section 7).

Heath Wrinklewort (Rutidosis heterogama)

The Project surface facilities require the clearance of approximately 417 individual *Rutidosis heterogama* plants from a local population of between approximately 4,198 and 11,273 individuals (Appendix F). Of the individuals outside the proposed disturbance area, approximately 2,209 individuals will be conserved in perpetuity by the RMS as part of the compensatory offset package for the Hunter Expressway. An additional 700 individuals located within Donaldson Coal owned land surrounding the proposed surface facilities would not be cleared as part of the Project and would be conserved in perpetuity. In addition, individuals within the George Booth Drive road reserve are afforded a level of protection from future development.

As part of the Project, Donaldson Coal would sponsor the following ecological initiatives aimed at better understanding and managing the local population of *Rutidosis heterogama*:

- A research program to determine the level of genetic exchange between patches of *Rutidosis heterogama* across George Booth Drive.
- A research program into translocation of the individuals located within the proposed disturbance area. The target area for translocation would be the closest existing patch on Donaldson Coal owned land (located approximately 70 m to the south). This area would be conserved in perpetuity. The program would include both translocation of as many of the plants as can readily be retrieved, and collection and planting of available seed. Any such program would be prepared for approval by the OEH prior to any work commencing and be prepared consistent with the principles in Vallee *et al*. (2004) (*Guidelines for the Translocation of Threatened Plants in Australia*).

4.9 TERRESTRIAL FAUNA

The Terrestrial Fauna Assessment report has been prepared for the Project by Biosphere Environment Consultants (2012) and is provided in Appendix G.

A description of the terrestrial fauna in the vicinity of the Project is provided in Section 4.9.1, while Section 4.9.2 describes the potential impacts of the Project on terrestrial fauna and Section 4.9.3 outlines mitigation and management measures that would be implemented to minimise the potential impacts of the Project on fauna.

4.9.1 Existing Environment

Regional and Local Setting

The Project occurs within the Sydney Basin Interim Biogeographic Regionalisation of Australia bioregion on the central east coast of NSW and within the Bassian zoogeographic region proposed by Spencer (1896) and modified by Schodde (1994) (cited in Date *et al*. [2000]).

Fauna Surveys

Terrestrial vertebrate fauna surveys were conducted across the Project area in three stages to account for seasonal variation and to allow subsequent surveys to consider findings of previous surveys and adapt accordingly. The initial fauna survey was conducted from 6 to 10 April 2011, inclusive. The second stage of the fauna survey was conducted from 12 to 16 October 2011 and the third stage of the survey was conducted during the period 5 to 9 December 2011. The surveys included systematic and targeted surveys for threatened fauna species listed under the TSC Act and EPBC Act considered possible occurrences in the Project area or surrounds.

The fauna survey design was developed in consideration of the numerous recent fauna surveys that have been undertaken across the Project area and surrounds, particularly within the Sugarloaf State Conservation Area.

In addition to the previous work, a total of 12 systematic survey sites and 26 targeted survey sites were surveyed for the Project using a variety of methods including Elliott traps, cage traps, bird surveys, spotlighting, herpetological searches, hair tubes, ANABAT™ detectors, call playback, frog surveys, identification of faunal traces and opportunistic observations.

The locations of the systematic and targeted fauna survey sites are provided in Appendix G. The fauna survey design was consistent with the *Threatened Species Survey and Assessment: Guidelines for Developments and Activities Working Draft* (DEC, 2004b).

As a component of the baseline terrestrial vertebrate fauna surveys, a number of reference sources were reviewed including database records (OEH BioNet, Australian Museum, Birds Australia and Commonwealth Protected Matters Search database records) and relevant local or regional fauna surveys and scientific literature (Appendix G). Where appropriate, these reference sources were included in the assessment of terrestrial fauna and the evaluation of likelihood of threatened species.

Broad Fauna Habitat Types

Two major fauna habitat types occur within the Project area, namely: Dry Forest/Woodland and Moist Forest. Water (including creeklines and dams) and associated riparian habitat and areas of cleared land associated with electricity transmission line easements are also fauna habitats present in the Project area.

A brief description of these habitat types is provided below with further detail provided in Appendix G:

- Dry Forest/Woodland Habitat – encompasses the majority of the Project area and is comprised of various vegetation communities. This habitat provides a variety of refuge and foraging resources for native fauna including hollow-bearing trees, peeling bark, trunk crevices and sandstone rock faces and scattered rock outcrops, particularly in the western portion of the Project area. Ground debris is abundant in many areas with fallen trees and tree limbs.
- Moist Forest Habitat – occurs sparsely across the proposed underground mining area and none occurs within the proposed pit top facility. Components of this habitat include open Eucalypt forest and provide refuge and foraging resources (e.g. logs, fallen branches and groundcover) for small terrestrial fauna. Other components of this habitat have a distinct closed rainforest canopy and typically surround gullies and creeklines.
- Water and Associated Riparian Habitat – includes the headwaters of several streams within the Project area and surrounds. Typically, the upper reaches have a sandy substrate with scattered sandstone boulders providing breeding and foraging habitat for amphibians, as well as foraging resources for birds, small mammals and reptiles. Some of the wetter areas and small pools in the lower reaches are degraded, with reduced water flow. These areas contain a variety of vegetation, shelter and foraging resources. Several small dams throughout the Project area may provide breeding habitat for forest-dwelling amphibians, however, limited vegetation surrounding the margins of the dams restricts shelter and foraging habitat.
- Cleared Land – includes cleared electricity transmission line easements which traverse the Project area. These easements typically consist of cleared grassy areas with some regenerating vegetation. These areas provide limited foraging resources for macropods, birds and reptiles. The absence of ground shelter and the presence of active access tracks limit the habitat value for small terrestrial fauna species.

Native Fauna Species Composition

A total of 119 vertebrate fauna species were recorded by Biosphere Environmental Consultants in the Project area and immediate surrounds. Species recorded include 112 native species (comprising 15 amphibian, 14 reptile, 62 bird and 21 mammal species), and seven introduced species (Appendix G).

Introduced Fauna

Seven introduced fauna species were recorded during the surveys (Appendix G). The species were all mammals and included the House Mouse (*Mus musculus*), Black Rat (*Rattus rattus*), Red Fox (*Vulpes vulpes*), Brown Hare (*Lepus capensis*), Rabbit (*Oryctolagus cuniculus*), Pig (*Sus scrofa*) and Goat (*Capra hircus*) (Appendix G).

Threatened Fauna Species under the TSC Act and EPBC Act

Six threatened fauna species were recorded across the Project area and its surrounds during the Project surveys (Figures 4-17a and 4-17b). Each of these species is listed as Vulnerable under the TSC Act. The threatened fauna species recorded include (Appendix G):

- Little Lorikeet (*Glossopsitta pusilla*);
- Glossy Black-cockatoo (*Calyptorhynchus lathami*);
- Yellow-bellied Glider (*Petaurus australis*);
- Grey-headed Flying-fox (*Pteropus poliocephalus*);
- Large-eared Pied-bat (*Chalinolobus dwyeri*); and
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*).

The Yellow-bellied Glider (*Petaurus australis*) is the only threatened fauna species that was recorded in the vicinity of the new pit top facility during the Project surveys. The roost tree in which the record was taken has resulted in a redesign of the new pit top facility to avoid disturbance of this tree (Section 4.8.2).

4.9.2 Potential Impacts

Key potential impacts of the Project on terrestrial fauna and their habitats include habitat removal/modification and subsidence. Other potential impacts associated with the Project include increased vehicular traffic, artificial lighting, noise, increased fire frequency and increased occurrence of introduced fauna.

Fauna Habitat Removal and Modification

Animals can use native vegetation for foraging, roosting, movement, shelter and breeding. Apart from minor disturbance associated with monitoring and management in the underground mining areas, the Project would involve the removal of approximately 11.2 ha of dry forest/woodland habitat for construction of the new pit top facility and upcast ventilation shaft.

The potential clearing impacts associated with the Project are comparable to other land uses in the vicinity of the Project which have resulted in small scale vegetation clearance.

As described in Appendix G and Section 4.8.2, the design of the pit top facility has been modified to avoid an area of Hunter Lowlands Redgum Forest (an EEC) and a habitat tree (with recorded usage) for the Yellow-bellied Glider.

The Project would involve progressive rehabilitation of minor Project surface disturbance areas and rehabilitation of surface disturbance areas at the cessation of the Project (i.e. the new pit top facility and upcast ventilation shaft site and any residual surface disturbance areas). Rehabilitation commitments are detailed in Section 5.

Mine Subsidence Effects

Potential environmental consequence for terrestrial fauna may occur due to mine subsidence impacts as a result of Project underground mining. Mine subsidence surface impacts may include:

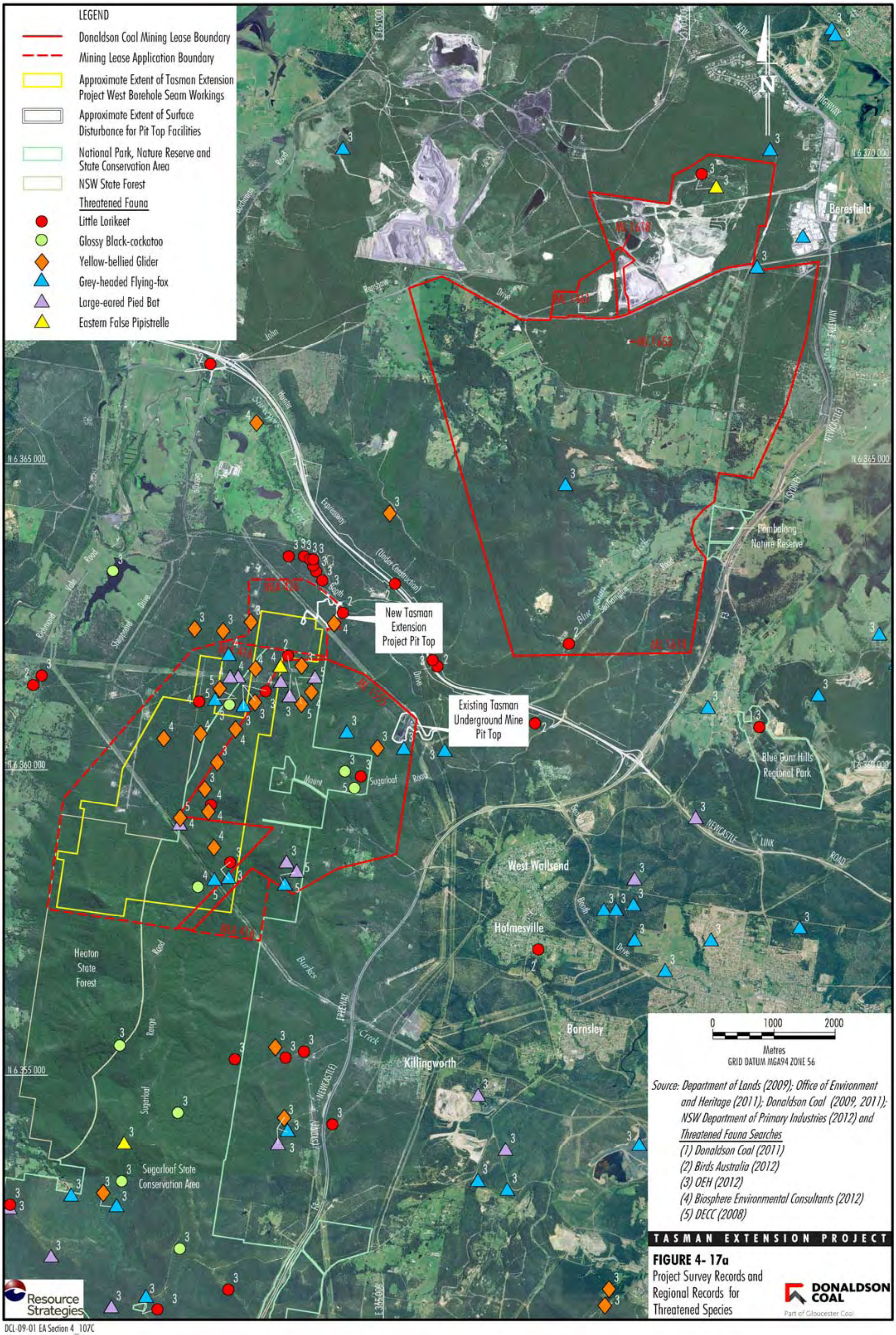
- potential surface cracking of soils or slope instability, including erosion and sedimentation effects;
- potential to impact on streams including changes to stream geomorphology and availability of water; and
- potential to increase the natural rate of erosion and rock falls with localised impacts on vegetation and minor impacts, if any, on potential shelter, retreat or roosting sites for fauna species.

The Project includes substantial commitments to limit consequences associated with subsidence. The commitments, in the form of proposed subsidence performance measures (Section 2.6.3), greatly reduce the risk of subsidence consequences on fauna or their habitats.

A description of the potential impacts of surface cracking, changes to hydrology/water availability and rock fall associated with cliff lines is provided in Sections 4.2.4 (Subsidence), 4.3.2 (Land Resources), 4.5.2 (Stream Geomorphology), 4.6.2 (Surface Water) and 4.8.2 (Flora).

Vehicular Traffic Movements

Vehicular traffic movements associated with exploration, construction and operation of the Project have the potential to increase the incidence of fauna mortality via vehicular strike. Traffic movements are expected to increase along existing public roads as a result of the Project. There is limited vehicle access in the underground mining area and therefore the Project is not expected to increase the risk of vehicle-fauna collisions in this area.



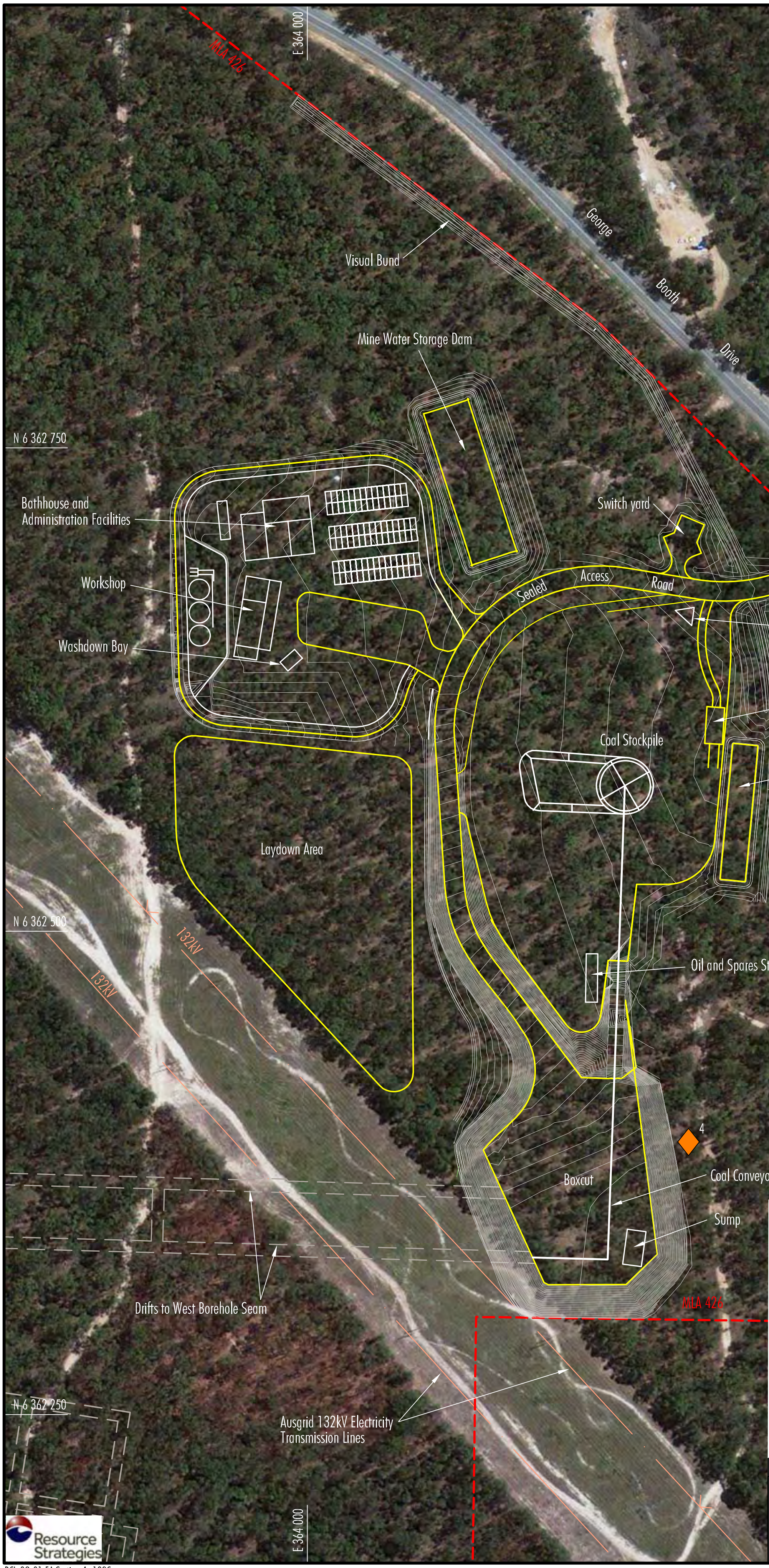
TASMAN EXTENSION PROJECT

FIGURE 4- 17a

Project Survey Records and Regional Records for Threatened Species

DONALDSON COAL
Part of Gloucester Coal

DCL-09-01 EA Section 4_107C



Threatened Fauna
Little Lorikeet
Yellow-bellied Glider

0 100
Metres
GRID DATUM MGA94 ZONE 56

Source: Donaldson Coal (2012) and Ardill Payne & Partners (2012)
Threatened Fauna Searches
(2) Birds Australia (2012)
(4) Biosphere Environmental Consultants (2012)

TASMAN EXTENSION PROJECT

FIGURE 4-17b
Project Surveys Records and Regional Records for Threatened Species

DONALDSON COAL
Part of Gloucester Coal

Resource Strategies

DCL-09-01 EA Section 4_108C

Artificial Lighting

It is considered that Project lighting associated with the new pit top facility and upcast ventilation shaft would have minimal impact on fauna.

Notwithstanding, night-lighting of Project surface facilities would be kept to a practicable minimum (Section 4.19.3) whilst maintaining the required levels for occupational health and safety for employees.

Noise

Numerous studies have been undertaken on the effects of noise on wildlife (Appendix G). The studies indicate that many species are well adapted to human activities and noise.

Notwithstanding, noise associated with the construction and operation of Project surface facilities has the potential to disrupt the routine activities of vertebrate fauna. Noise mitigation and management measures would be implemented at the surface facilities in accordance with the *NSW Industrial Noise Policy* (INP) (EPA, 2000). The potential for noise generation in the proposed underground mining area is expected to be low and have a minimal impact on fauna.

Bushfire

High frequency fire resulting in the disruption of life cycle processes in plants and animals, and loss of vegetation structure is listed as a key threatening process under the TSC Act. The potential for bushfires to occur may be increased due to various activities associated with the Project (e.g. vehicles traversing tracks in dense vegetation) (Section 4.3.2).

Introduced Fauna

Seven introduced fauna species were recorded during the Project surveys (Section 4.9.1).

Many animal pests pose a threat to native fauna through competition for habitat resources and direct predation. The provision of refuge or scavenging areas (e.g. discarded food scraps and other rubbish) also has the potential to increase populations of introduced fauna species in or around the Project area.

Management measures would be implemented to maintain a clean, rubbish-free environment in order to discourage scavenging and reduce the potential for colonisation by introduced fauna.

Koala Habitat

In response to a state-wide decline in Koala populations, the NSW Department of Urban Affairs and Planning (DUAP) (now DP&I) gazetted the *State Environmental Planning Policy No. 44 – Koala Habitat Protection* (SEPP 44) in January 2005. The applicability of SEPP 44 to the Project is discussed in Attachment 3.

An assessment of potential impacts of the Project on core and potential Koala habitat, as defined by SEPP 44 has been undertaken and is provided in Appendix G. Biosphere Environment Consultants (2012) concluded that while some areas of some vegetation communities constitute potential Koala habitat, core Koala habitat is absent from the Project area (Appendix G).

Notwithstanding, management measures to minimise impacts on Koala habitat would be implemented and are described in Section 4.9.3.

Threatened Fauna

Evaluations have been conducted to assess the potential impacts of the Project on threatened fauna species and their habitats. The evaluations were conducted in accordance with the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005) and are documented in Appendix G.

Given the limited area of proposed vegetation clearance and impacts associated with the Project (Appendix G):

- the Project is unlikely to significantly reduce the quality or availability of suitable habitat for the recorded threatened species or other local terrestrial fauna; and
- is unlikely to result in an area of habitat suitable for the recorded threatened species or other local terrestrial fauna becoming fragmented or isolated.

Cumulative Impacts

A cumulative impact assessment considers the impacts of the Project added to other existing impacts, as well as potential impacts from proposed (but not yet approved) developments in the local area.

A cumulative impact assessment in relation to fauna has been undertaken and is provided in Appendix G. In addition, an assessment of the cumulative subsidence impacts of the Project and the existing Tasman Underground Mine is provided in Appendix A. The cumulative subsidence assessment is the basis for the potential impacts described above.

4.9.3 Mitigation Measures, Management and Monitoring

Although the Project would avoid or minimise potential impacts on terrestrial fauna and their habitats, several specific measures have been developed to mitigate unavoidable impacts of the Project on terrestrial fauna. Impact avoidance and mitigation measures are addressed under the following categories (Appendix G):

- subsidence performance measures and SCZs;
- design of the pit top facilities to minimise vegetation clearance;
- land clearing strategies (i.e. timing of land clearance, pre-clearance surveys and salvage of habitat features);
- miscellaneous programs (i.e. bushfire management, erosion and sediment control, pest control and rehabilitation of surface disturbance areas); and
- implementation of biodiversity offset and compensatory measures.

Mitigation and management measures relevant to fauna would be detailed in Biodiversity Management Plans that would be developed as part of the Extraction Plan process (Section 7).

Subsidence Performance Measures and Subsidence Control Zones

As a component of the Project, Donaldson Coal has developed subsidence performance measures for significant surface features. These subsidence performance measures would be achieved by implementing SCZs to manage subsidence effects on the surface feature and achieve the performance measure.

A detailed description of the subsidence performance measures and SCZs is provided in Section 2.6.3. These measures greatly reduce the potential impacts of the Project on fauna.

Vegetation Clearance

Vegetation clearance minimisation is described in Section 4.8.3.

Land Clearing Strategies

Donaldson Coal currently implements a Flora and Fauna Management Plan (Ecobiological, 2007) at the existing Tasman Underground Mine. The Flora and Fauna Management Plan includes a VCP to minimise and ameliorate any impact on flora and fauna, in particular threatened species, during revegetation clearing activities (Appendix G).

Measures that would continue to be implemented as part of the Project to minimise the impacts on fauna include:

- minimisation and avoidance;
- demarcation to avoid accidental damage;
- timing of land clearance in consideration of breeding and hibernation periods;
- pre-clearance surveys; and
- salvage of habitat features for use in rehabilitation.

Miscellaneous Programs

Bushfire management measures, erosion and sediment control measures and rehabilitation of surface disturbance areas are summarised in Section 4.8.3 and described further in Sections 4.3.3, 4.6.3 and 5, respectively.

Pest Control

Waste management measures would be implemented to maintain a clean, rubbish-free environment to discourage scavenging and reduce the potential for colonisation by non-endemic fauna. Measures include confining surface lighting to the area around the pit top facility (Appendix G).

Offset and Compensatory Measures

Biodiversity offset and compensatory measures would be implemented to offset the impacts of the Project. The biodiversity offset and compensatory measures are described in Section 4.8.4.

4.10 ABORIGINAL HERITAGE

An Aboriginal Cultural Heritage Assessment was undertaken for the Project by South East Archaeology Pty Limited (2012) and is presented in Appendix K.

The Project Aboriginal Cultural Heritage Assessment has been undertaken in accordance with the following guidelines:

- *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (DECCW, 2010a);
- *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW* (DECCW, 2010b);
- *Draft Guidelines for Aboriginal Cultural Impact Assessment and Community Consultation* (DEC, 2005a);
- The Australian International Council on Monuments and Sites (ICOMOS) *Burra Charter* (Australia ICOMOS, 1999);
- *Aboriginal Cultural Heritage: Standards and Guidelines Kit* (NPWS, 1997);
- *Ask First: A Guide to Respecting Indigenous Heritage Places and Values* (Australian Heritage Commission, 2002); and
- *NSW Minerals Industry Due Diligence Code of Practice for the Protection of Aboriginal Objects* (NSW Minerals Council, 2010).

Surveys for the Aboriginal Cultural Heritage Assessment focussed on areas of additional Project surface disturbance and future proposed mining areas (i.e. West Borehole Seam mining area and future Fassifern Seam mining area).

A description of Aboriginal heritage (including cultural and archaeological values) in the vicinity of the Project is provided in Section 4.10.1. Section 4.10.2 describes the potential impacts of the Project and Section 4.10.3 outlines mitigation measures, management and monitoring.

4.10.1 Existing Environment

Aboriginal History

The nature of organisation of Aboriginal groups within the Central Coast and Lower Hunter regions is unclear, due to the limited ethnohistorical records and the disruption to traditional culture that had already occurred by the time observations were made.

The Project area is located within the territory of the Awabakal tribe, close to the boundary of the Wonnarua tribe (Tindale, 1974). The territory of the Awabakal tribe extended south from the Hunter River to Norah Head and Wyong, and west to Kurri Kurri and Maitland. The Wonnarua tribe occupied territory in the Upper Hunter River, from just north of Maitland and west to the Great Dividing Range. Both modern Awabakal and Wonnarua people identify strong contemporary, historical and traditional associations with the Project area (Appendix K).

There are a number of references within ethnohistorical literature to sites of cultural significance in the region. Mount Sugarloaf within the Project area is documented for its association with male initiation ceremonies and the presence of the supernatural spirit being ‘Puttikan’ and the supreme being ‘Koe-in’ (Boot, 2002; Knight, 2001; Threlkeld in Gunson, 1974). Umwelt (Australia) Pty Ltd (Umwelt) (2005) also reports that the Sugarloaf Range was an important pathway for Aboriginal people between Mount Sugarloaf, where ceremonial and spiritual activities occurred, and the central and coastal lowlands, where resources were procured and camp sites were located. Greater detail is provided in Appendix K.

Natural Resources

A variety of natural resources would have been available to the local Aboriginal population. Several ethnohistorical observations have documented the use of plants and animals in the lower Hunter region.

Enright (1914) recorded an abundance of fauna including wombat, grey kangaroo, wallaroo, red wallaby, flying foxes, lizards and goannas. Fish including bass, mullet and herring, as well as shellfish, mussels and oysters from the nearby Hunter Estuary and Lake Macquarie were also utilised by the local Aboriginal population (Enright, 1914).

Threlkeld (in Gunson, 1974) describes huts or “gunyahs” made of bark often from stringybark or swamp mahogany trees. Dawson (1830) observed Aborigines removing bark, by cutting toe hold notches in tree trunks for support, while stripping bark in lengths of 1 to 2 m. Threlkeld (in Gunson, 1974) also observed bark stripped from trees to make canoes.

Threlkeld (in Gunson, 1974) also documents a variety of other items used by the local Aboriginal people including wooden waddies and hunting spears, fish hooks made of shell and stone hatchets.

Within the Project area, a variety of plant and animal resources would have been available to the Aboriginal population. Much of the Project area is comprised of steep terrain with limited level ground suitable for campsites. Sandstone outcrops and overhangs in the eastern portion of the Project area may have provided suitable temporary shelter sites. Ephemeral water sources were available in the Project area with pools and ponded water remaining following rainfall events. The occupation of the Project area would have most likely been related to hunting and gathering activities and the transitory movement between locations. The spiritual and ceremonial use of Mount Sugarloaf would have also been a significant factor in the occupation of the area (Appendix K).

Sections 4.7, 4.8 and 4.9 and Appendices E, F and G provide information on the ecological attributes of the Project area and surrounds.

Previous Archaeological Investigations

An Aboriginal Heritage Information Management System (AHIMS) database search for a 10 km by 10 km search area centred on the Project area identified a total of 100 Aboriginal heritage sites and potential archaeological deposits (PADs). Twenty-two of these recorded Aboriginal heritage sites were reported to be located within the future mining and surface disturbance areas.

Prior to this study, there had been limited systematic archaeological surveys undertaken within the Project area. An amateur heritage site recorder, Mr Warren Bluff recorded the majority of sites within the Project area.

Two systematic archaeological surveys have previously been undertaken in the vicinity of the Project area, namely:

- In 2002, Umwelt conducted an archaeological survey and assessment of the Tasman Underground Mine pit top facility area. No Aboriginal heritage sites were identified during this survey.
- In 2008, an Aboriginal Cultural Heritage Assessment was undertaken by South East Archaeology Pty Limited for Panels 1 to 17 of the Tasman Underground Mine as part of an SMP application (Figure 2-1). Three grinding groove sites were identified during the survey.

A number of other investigations have been undertaken in the wider region, including South East Archaeology Pty Limited (2006) for the Abel Underground Mine, South East Archaeology (2008) for the Bloomfield Colliery, Umwelt (2010) for an extension of mining operations at the West Wallsend Colliery, Brayshaw (1994, 2001) and Umwelt (2003, 2004, 2005, 2006a, 2006b) for the construction of the Hunter Expressway.

Cultural Heritage Assessment

Assessment Program

The Aboriginal Cultural Heritage Assessment (Appendix K) used relevant information from previous assessments and the results of Project field surveys and associated consultation with the Aboriginal community throughout the consultation process.

Table 4-11 summarises the main stages of the Aboriginal heritage consultation/survey program undertaken as part of the Project. A detailed account of the consultation process, including copies of correspondence to and from registered stakeholders and a detailed consultation log, is provided in Appendix K.

As previously described, consultation for the Project has been undertaken in accordance with the *Aboriginal Cultural Heritage Consultation Requirements for Proponents, 2010* (DECCW, 2010a) and the *Draft Guidelines for Aboriginal Cultural Impact Assessment and Community Consultation* (DEC, 2005a).

The fifteen Aboriginal stakeholders who registered an interest in being consulted in relation to the Aboriginal Cultural Heritage Assessment process were (in alphabetical order):

- Awabakal Descendants Traditional Owners Aboriginal Corporation;
- Awabakal LALC;
- Awabakal Traditional Owners Aboriginal Corporation;
- Cacatua Culture Consultants;
- Gidwaa Walang Cultural Heritage;
- Gimbay Gatigaan Aboriginal Corporation;
- Keepa Keepa Elders Group;
- Lower Hunter Wonnarua Council;
- Mindaribba LALC;

Table 4-11
Summary of the Project Aboriginal Heritage Consultation/Survey Program

Date	Consultation/Survey Conducted
15 June 2011	Letters requesting the names of Aboriginal parties or groups that may have been interested in registering in the consultation process were sent to the Awabakal LALC, Mindaribba LALC, Office of the Registrar, NTSCORP, OEH Coffs Harbour Environment Protection and Regulation Group, the National Native Title Tribunal, Hunter – Central Rivers CMA, Cessnock City Council and Lake Macquarie City Council to identify Aboriginal parties.
28 June 2011	Letters seeking registrations of interest were sent to Aboriginal parties or groups identified by the above step.
29 June 2011	Public advertisements published in the Maitland Mercury and Cessnock Advertiser inviting interested Aboriginal parties or groups to register.
2 July 2011	Public advertisement published in The Newcastle Post inviting interested Aboriginal parties or groups to register.
25 July 2011	Provision of a proposed methodology for undertaking the Aboriginal Cultural Heritage Assessment distributed to registered stakeholders. A selection criteria for paid involvement in the field surveys was also provided to all registered stakeholders.
11 August 2011	Record of names of registered stakeholders provided to OEH, the Awabakal LALC and the Mindaribba LALC in accordance with DECCW (2010a) (except for the Aboriginal stakeholders who requested their names were not provided).
July/August 2011	Feedback from the registered stakeholders in regard to the proposed methodology received. Consideration was given to all comments received on the proposed methodology.
1 September 2011	Invitation to registered stakeholders to participate in the Aboriginal cultural heritage survey based on completion of selection criteria.
12 September – 27 October 2011	Aboriginal and cultural heritage survey and inspection conducted over a period of 24 days. Cultural significance of the area and Aboriginal heritage sites discussed with the Aboriginal participants.
27 January 2012	All registered stakeholders invited to attend a meeting to discuss the findings of the field surveys and cultural values of the Project area and an inspection of the Project area and representative sites within the Project area.
23 February 2012	Draft Aboriginal Cultural Heritage Assessment issued to the registered stakeholders for review, including survey results, archaeological and cultural significance assessment (based on feedback received during consultation and fieldwork), potential impacts and proposed management and mitigation measures.
22 March 2012	All registered stakeholders invited to attend meeting to discuss the draft Aboriginal Cultural Heritage Assessment and facilitate the provision of comments on the draft. Outcomes of the meeting included the extension of the review period by one week to a total of six weeks.
April 2012	Comments received from registered stakeholders on the draft Aboriginal Cultural Heritage Assessment (in relation to cultural heritage) were considered and/or addressed in the Aboriginal Cultural Heritage Assessment.

Source: After Appendix K.

- Widescope Indigenous Group Pty Ltd;
- Wonn 1 Contracting;
- Wonnarua Culture Heritage;
- Wonnarua Nation Aboriginal Corporation;
- Yarrawalk (a division of Tocomwall Pty Ltd); and
- Yinarr Cultural Services.

Archaeological Findings

A total of 100 Aboriginal heritage sites were identified within the Project mining areas and surrounds, consisting of:

- thirty-eight open artefact sites;
- thirty-five grinding groove sites;
- one grinding groove/open artefact site; and
- twenty-six rock shelters with PAD.

No Aboriginal heritage sites were identified within the new pit top facility and upcast ventilation shaft areas.

Each of the 100 Aboriginal heritage sites are described in detail in Appendix K. The locations of the Aboriginal heritage sites are shown on Figure 4-18.

Photographs of an open artefact site, grinding groove site and rock shelter with PAD observed in the Project area are provided in Plates 4-16 to 4-18.

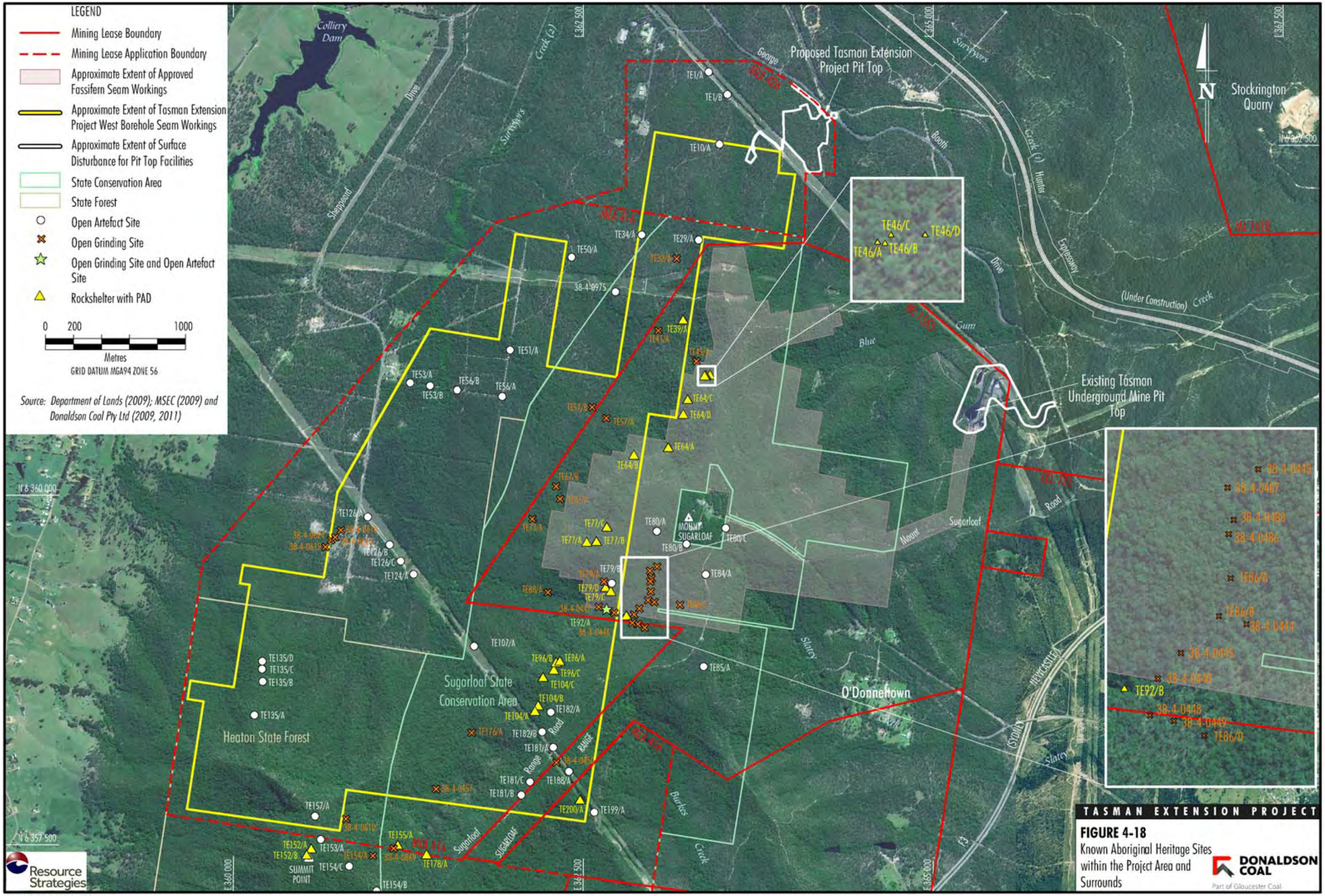
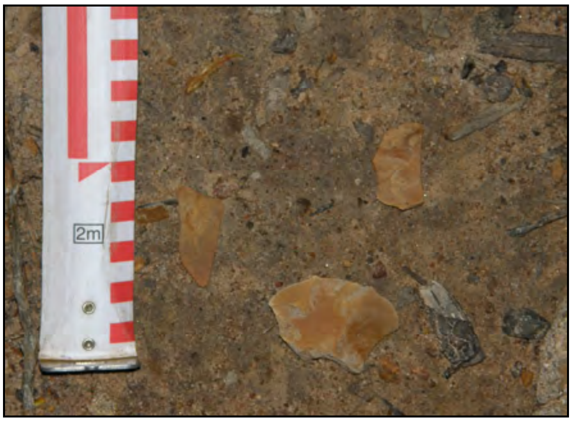


FIGURE 4-18
Known Aboriginal Heritage Sites within the Project Area and Surrounds

DCL-09-01 EA Section 4_105D



Source: Appendix K.

Plate 4-16 – Open Artefact Site (Site TE85/A)

Source: Appendix K.

Plate 4-17 – Grinding Groove Site (Site 38-4-0440)

Source: Appendix K.

Plate 4-18 – Rock Shelter with PAD Site (Site TE64/D)

In addition to the above, significant and widespread traditional, historical and contemporary cultural values and associations have been identified by the registered Aboriginal stakeholders (and are also known through ethnohistorical evidence) within the Project area. These do not necessarily involve Aboriginal objects or physical evidence and include (Appendix K):

- The entire Mount Sugarloaf area (including the Project area), including associations with the supreme being 'Koe-in' and the supernatural spirit 'Puttikan' and the connection or 'heirophany' of Mount Sugarloaf between the secular and sky-world.
- The Men's Area in the north-east of the Project area which is reported to be associated with male initiation ceremonies.
- The Grinding Groove Area in the central-eastern portion of the Project area which is reported to be associated with men's business, maintenance of hatchets and axes, preparation of medicine and other cultural uses.
- The Sugarloaf Pathways Area in the north-east portion of the Project area.
- The Keepa Keepa Pathways Area in the south-west portion of the Project area, which comprises a southern access route from the central lowlands to the Sugarloaf Range and the Watagan Mountains and Mount Vincent.

Further detail on the cultural significance of the Project area obtained from the Project surveys is provided in Appendix K.

Archaeological and Cultural Heritage Values

The local archaeological significance rankings for each of the 100 sites located within the Project area and surrounds are presented in Table 4-12. Three sites of high local archaeological significance were recorded (Appendix K).

The Aboriginal Cultural Heritage Assessment (including a specific assessment of cultural significance via consultation with the Aboriginal community) was undertaken in accordance with the relevant requirements of the various advisory documents and guidelines, as previously listed.

Table 4-12
Overall Local Archaeological Significance of Aboriginal Heritage Sites within the Future Mining and Surface Disturbance Areas and Surrounds[1]

Overall Local Archaeological Significance Ranking	Aboriginal Heritage Site Code	Number of Sites
High	38-4-0440, 38-4-0447, TE92/A.	3
Moderate to High	38-4-0445, TE64/C, TE157/A, TE200/A.	4
Moderate	38-4-0444, 38-4-0446, 38-4-0449, TE46/A, TE46/B, TE46/C, TE46/D, TE85/A, TE104/C.	9
Low to Moderate	38-4-0448, 38-4-0450, 38-4-0457, 38-4-0486, 38-4-0488, 38-4-0610, 38-4-619, 38-4-0869, TE32/A, TE39/A, TE57/A, TE57/B, TE64/D, TE67/A, TE67/B, TE79/A, TE86/A, TE86/B, TE88/A, TE135/A, TE176/A.	21
Low	38-4-0443, 38-4-0487, 38-4-618, 38-4-0623, 38-4-0624, 38-4-0975, TE1/A, TE1/B, TE10/A, TE29/A, TE34/A, TE41/A, TE45/A, TE50/A, TE51/A, TE53/A, TE53/B, TE56/A, TE56/B, TE64/A, TE64/B, TE71/A, TE77/A, TE77/B, TE77/C, TE79/B, TE79/C, TE79/D, TE80/A, TE80/B, TE80/C, TE84/A, TE86/C, TE86/D, TE92/B, TE96/A,TE96/B, TE96/C, TE104/A, TE104/B, TE107/A, TE124/A, TE126/A, TE126/B, TE126/C, TE135/B, TE135/C, TE135/D, TE152/A, TE152/B, TE153/A, TE154/A, TE154/B, TE154/C, TE155/A, TE178/A, TE181/A, TE181/B, TE181/C, TE182/A, TE182/B, TE188/A, TE199/A.	63

Source: After Appendix K.

1 Includes sites recorded by the Project surveys and sites previously recorded in the future mining and surface disturbance areas and surrounds.

Table 4-11 summarises the main stages of the Aboriginal heritage consultation/survey program undertaken as part of the Project, with further detail provided in Section 6 of Appendix K. The registered Aboriginal stakeholders were requested to contribute their cultural knowledge on the Project area, and the Aboriginal sites within it, at all stages during the consultation process (i.e. as part of the review of the proposed methodology, during the field survey, during the site inspection, as part of reviewing the draft Aboriginal Cultural Heritage Assessment and at meetings). Comments received from the registered Aboriginal stakeholders are provided in full and addressed in Appendix K (unless otherwise requested by the Aboriginal stakeholder).

Of note, several of the registered Aboriginal groups identified three stone features within the Men's Area as being the most culturally significant individual features within the Project area. Specific details regarding these features have been deemed culturally sensitive however Appendix A provides subsidence predictions and a risk of impact rating. Considering implementation of the SCZs, the risk of physical damage to these features is assessed as "very unlikely" (less than 5% probability) (DgS, 2012). This is the lowest risk category.

Notwithstanding, in consideration of their cultural significance, Donaldson Coal would undertake a detailed geotechnical assessment of these features prior to mining. This assessment would be undertaken as part of the relevant Extraction Plan by an appropriately qualified and experienced geotechnical engineer in consultation with the Aboriginal community. The final mine plan extent would be designed so as to avoid damage to these features.

4.10.2 Potential Impacts

Project Surface Development

Surface impacts would be largely confined to the proposed new pit top facility and upcast ventilation shaft. No Aboriginal heritage sites have been identified in this area. Surface impacts within the proposed underground mining areas would be limited to works such as the construction and maintenance of access tracks and the installation and operation of monitoring equipment.

Underground Mining Operations

Potential subsidence impacts from underground mining operations are summarised in Section 4.2 and discussed in detail in Appendix A. The potential impacts of subsidence effects on Aboriginal heritage is summarised below and described further in Appendices A and K.

Potential impacts from subsidence on Aboriginal heritage sites include the cracking of rock-based features such as rock shelters and grinding grooves, and (where cracking occurs at rock shelter sites) potential isolated rock falls. The potential impacts of the Project to Aboriginal sites and cultural areas have been significantly reduced by the implementation of SCZs, to achieve the various Project subsidence performance measures (Section 2.6.3).

Open artefact sites are not particularly susceptible to subsidence impacts (Appendices A and K). As provided in Appendix K, any effects to open artefacts sites due to subsidence are likely to be short-term, minimal and confined to the sediments within the site context rather than directly on the actual artefacts. Potential impacts to these sites are limited to surface disturbance associated with access tracks and environmental monitoring.

Subsidence impacts on rock-based sites have been defined in terms of cracking potential for grinding groove sites and cracking potential and toppling damage for rock shelters. The likelihood of perceptible subsidence impacts to Aboriginal heritage sites was assessed using the criteria in Table 4-13 developed by DgS (2012) (Appendix A).

The assessed likelihood of potential impacts to rock-based sites is summarised in Table 4-14.

Based on the above criteria:

- One rock shelter (TE39/A) and five grinding groove sites (TE41/A, TE57/A, TE71/A, 38-4-0623 and 38-4-0624) have a greater than 10% probability of perceptible impacts.
- Two rock shelters (TE46/A and TE46/B) and four grinding groove sites (TE67/A, TE67/B, TE88/A and 38-4-0447) have an unlikely (5 to 10% probability) of perceptible impacts.
- The remaining 23 rock shelters and 27 grinding groove sites would have a very unlikely (less than 5% probability) of perceptible impacts.

Many of the most significant cultural areas (i.e. the Men's Area, Grinding Groove Area, Sugarloaf Pathways and Keepa Keepa Pathways Areas) are located within the proposed SCZs and potential subsidence impacts would be minimised in these areas.

4.10.3 Mitigation Measures, Management and Monitoring

The mitigation, management and monitoring measures detailed below have been developed in consultation with the registered Aboriginal stakeholders and in consideration of the cultural and archaeological significance of the Aboriginal heritage sites to be impacted and the cultural significance of the area. The consultation process with registered Aboriginal stakeholders is described in Appendix K, including a description of how comments received have been considered.

A Heritage Management Plan (HMP) would be developed for the Project in consultation with the registered Aboriginal stakeholders and the OEH to detail management and mitigation measures relevant to the Project area.

The HMP would include:

- A protocol for the involvement of registered Aboriginal stakeholders in future investigations, salvage and monitoring.
- A protocol for registering site records with the OEH for any previously unrecorded sites identified within the Project area as well as updating and maintaining the existing record of Aboriginal heritage sites.
- A protocol for the management of any previously unrecorded sites identified within the Project area during future investigations or works.

Table 4-13
Likelihood of Perceptible Impacts to Rock-based Aboriginal Heritage Sites

Likelihood of Perceptible Impacts	Probability of Perceptible Impacts	Cracking Potential		Toppling Potential
		Tensile Strain (mm/m)	Compressive Strain (mm/m)	Tilt Increase (mm/m)
Moderate	>25%	>2.5	>5	>30
Possible	10-25%	1.5-2.5	3-5	10-30
Unlikely	5-10%	0.5-1.5	2-3	3-10
Very Unlikely	<5%	<0.5	<2	<3

Source: After Appendix A.

Table 4-14
Potential Impacts to Rock-based Aboriginal Heritage Sites

Likelihood of Perceptible Impacts	Local Archaeological Significance	Grinding Groove Sites	Rock Shelter Sites
Moderate (>25%)	Low	38-4-0623, 38-4-0624, TE41/A	-
	Low to Moderate	TE57/A	TE39/A
Possible (10-25%)	Low	TE71/A	-
Unlikely (5-10%)	Low to Moderate	TE67/A, TE67/B, TE88/A	-
	Moderate	-	TE46/A, TE46/B
	High	38-4-0447	-
Very Unlikely (<5%)	Low	38-4-0443, 38-4-0487, 38-4-0618, 38-4-0619, TE45/A, TE86/C, TE86/D, TE154/A	TE64/A, TE64/B, TE77/A, TE77/B, TE77/C, TE79/C, TE79/D, TE92/B, TE96/A, TE96/B, TE96/C, TE104/A, TE104/B, TE152/A, TE152/B, TE155/A, TE178/A
	Moderate to Low	38-4-0448, 38-4-0450, 38-4-0457, 38-4-0486, 38-4-0488, 38-4-0610, 38-4-0869, TE32/A, TE57/B, TE79/A, TE86/A, TE86/B, TE176/A	TE64/D
	Moderate	38-4-0444, 38-4-0446, 38-4-0449	TE46/C, TE46/D, TE104/C
	Moderate to High	38-4-0445	TE64/C, TE200/A
	High	38-4-0440, TE92/A	-

Source: After Appendix A.

- A cultural awareness program for employees and contract workers to assist in minimising impacts on Aboriginal heritage (e.g. through the augmentation of existing induction programs).
- An access protocol to allow registered Aboriginal stakeholders access to identified sites or specific areas within Donaldson Coal owned land, for cultural practices, in accordance with occupational health and safety requirements.
- A program for the further investigation of select grinding groove sites, including a residue and use-wear analysis.
- A program for undertaking an Aboriginal cultural heritage educational documentation program specific to the Mount Sugarloaf area and for use as an education tool/resource by the Aboriginal community.

Surface Disturbance

The following measures would be detailed in the HMP and undertaken to manage potential impacts to Aboriginal heritage from surface disturbance throughout the life of the Project:

- Re-inspection of ground surface at the proposed surface facilities area (i.e. the pit top facility and upcast ventilation shaft areas) after the initial removal of vegetation and/or mechanical surface scrapes. Localised hand excavation of features of significance identified during the scrapes may be undertaken.
- Where practicable, known Aboriginal heritage sites would be avoided during surface disturbance works in the underground mining areas (e.g. construction/maintenance of access tracks and installation/operation of monitoring equipment).
- Demarcation of known Aboriginal heritage sites where proximal surface disturbance works are required to avoid accidental disturbance.

- Where avoidance of known open artefact sites is not practicable, sites would be subject to baseline recording, in consultation with registered Aboriginal stakeholders and the OEH, prior to disturbance and sites would be subject to salvage for safekeeping in accordance with the wishes of the registered Aboriginal stakeholders.

Subsidence Impacts

The following measures would be detailed in the HMP and undertaken to manage potential impacts to Aboriginal heritage from subsidence throughout the life of the Project.

- Undertaking a detailed geotechnical assessment of the three culturally significant stone features within the Men's Area to further inform the mine layout design to avoid impacting these formations.
- Monitoring of subsidence impacts on select rock shelter sites, grinding groove sites and significant rock formations in the Men's Area and ridgelines which form the Sugarloaf Pathways and Keepa Keepa Pathways.
- Archaeological survey of privately owned land within the proposed underground mining area that could not be accessed during the surveys, subject to landowner agreement.
- Modification of the mine plan to ensure that the risk of perceptible subsidence impacts is lowered from "unlikely" to "very unlikely" for grinding groove site 38-4-0447.

4.11 NON-ABORIGINAL HERITAGE

A Non-Aboriginal Heritage Assessment for the Project was undertaken by Maxim Archaeology & Heritage (2012) and is presented in Appendix L. The Non-Aboriginal Heritage Assessment was undertaken broadly within the framework of the *NSW Heritage Manual* (NSW Heritage Office and DUAP, 1996) and in consideration of the *Burra Charter* (Australia ICOMOS, 1999).

Maxim Archaeology & Heritage (Appendix L) considered the archaeological and historical records of the Project area and the physical context of the Project area and determined that there is no evidence to suggest that the Project area possesses any elements of non-Aboriginal historical cultural heritage.

Having regard to the absence of any material evidence bearing cultural significance and/or historical cultural heritage values, Maxim Archaeology & Heritage (2012) determined that the Project would likely have no impact upon heritage values either in the Project area or surroundings.

4.12 ROAD TRANSPORT

A Road Transport Assessment for the Project was prepared by Halcrow (2012) and is presented in Appendix H. The Road Transport Assessment has been reviewed by the RMS. The RMS accepted the data and methodology used in the Road Transport Assessment (letter dated 11 May 2012) (Attachment 8).

The assessment was prepared in accordance with the *Guide to Traffic Generating Developments* (NSW Roads and Traffic Authority [RTA], 2002) and where relevant, makes reference to the *Road Design Guide* (RTA, 2006).

The Tasman Underground Mine is located in an area that is generally well serviced by major roads and the main road transport related concerns that have been raised during the Project consultation program have particularly related to the proposed increase in public road haulage of ROM coal between the Project and the Bloomfield CHPP. Hence the Road Transport Assessment is particularly focused on the existing and future performance of roads on the approved ROM coal haulage route (Figure 1-2).

Section 4.12.1 provides an overview of the existing road network and traffic flows in the vicinity of the Tasman Underground Mine. Section 4.12.2 provides an assessment of the potential impacts of the Project's additional traffic on road network capacity and safety. Section 4.12.3 describes relevant mitigation measures, management and monitoring.

4.12.1 Existing Environment

ROM Coal Haulage Route

ROM coal mined at the Tasman Underground Mine is reclaimed from the stockpiles at the pit top by front end loader and loaded onto trucks (up to 19 m long Stag B-Doubles) (Plate 4-19) for transport to the Bloomfield CHPP via approximately 16 km of public roads (i.e. George Booth Drive and John Renshaw Drive) (Figure 1-2), in accordance with a Road Transport Protocol (Donaldson Coal, 2009a).

Plate 4-19 – Loading of ROM Coal into a B-Double Truck at the Tasman Underground Mine

ROM coal dispatch from the Tasman Underground Mine to the Bloomfield CHPP is currently undertaken between 7.00 am to 10.00 pm Monday to Friday (up to 4,000 tonnes per day).

Road Hierarchy and Key Features

Major Arterial Roads

The Project site is located to the north-west of the Sydney-Newcastle (F3) Freeway (Figure 4-19), which links Sydney and Newcastle and forms part of the Pacific Highway.

The Hunter Expressway (currently under construction) is also located to the north-east of the Project, running approximately parallel to George Booth Drive between the F3 Freeway and John Renshaw Drive (Figure 4-19). When completed in late 2013 the Hunter Expressway will materially alter the local traffic conditions in the vicinity of the Project by providing an alternative connection between the F3 Freeway near Seahampton and New England Highway at Branxton, including an interchange with John Renshaw Drive at Buchannan.

George Booth Drive

George Booth Drive (Main Road 527) is a State Road which provides a link between Edgeworth and Buchanan and has an interchange with the F3 Freeway. To the west of the F3 Freeway, George Booth Drive typically has centre linemarking and a posted speed limit of 80 kilometres per hour (km/hr), with a reduced speed limit of 60 km/hr on the approach to the John Renshaw Drive intersection. George Booth Drive typically has a single travel lane in each direction, however, some overtaking lanes are provided on particular sections (Appendix H).

The existing intersection between the Tasman Underground Mine access road and George Booth Drive is a seagull intersection, with dedicated deceleration lanes for vehicles turning into the mine, and dedicated acceleration lanes for vehicles turning out of the mine (Figure 2-2).

The existing Daracon Buttai Quarry has an access off George Booth Drive located at the proposed intersection of the new pit top facility access road with George Booth Drive. This intersection is currently a T-intersection with acceleration and deceleration lanes (Figure 2-9).

John Renshaw Drive

John Renshaw Drive (Main Road 588) is a State Road which provides a link between Kurri Kurri and the F3 Freeway at Beresfield (Figure 4-19). Between Beresfield and George Booth Drive, John Renshaw Drive typically has a single travel lane in each direction, with centre linemarking and a posted speed limit of 100 km/hr. John Renshaw Drive has several long straight sections, with gentle grades and large radius bends.

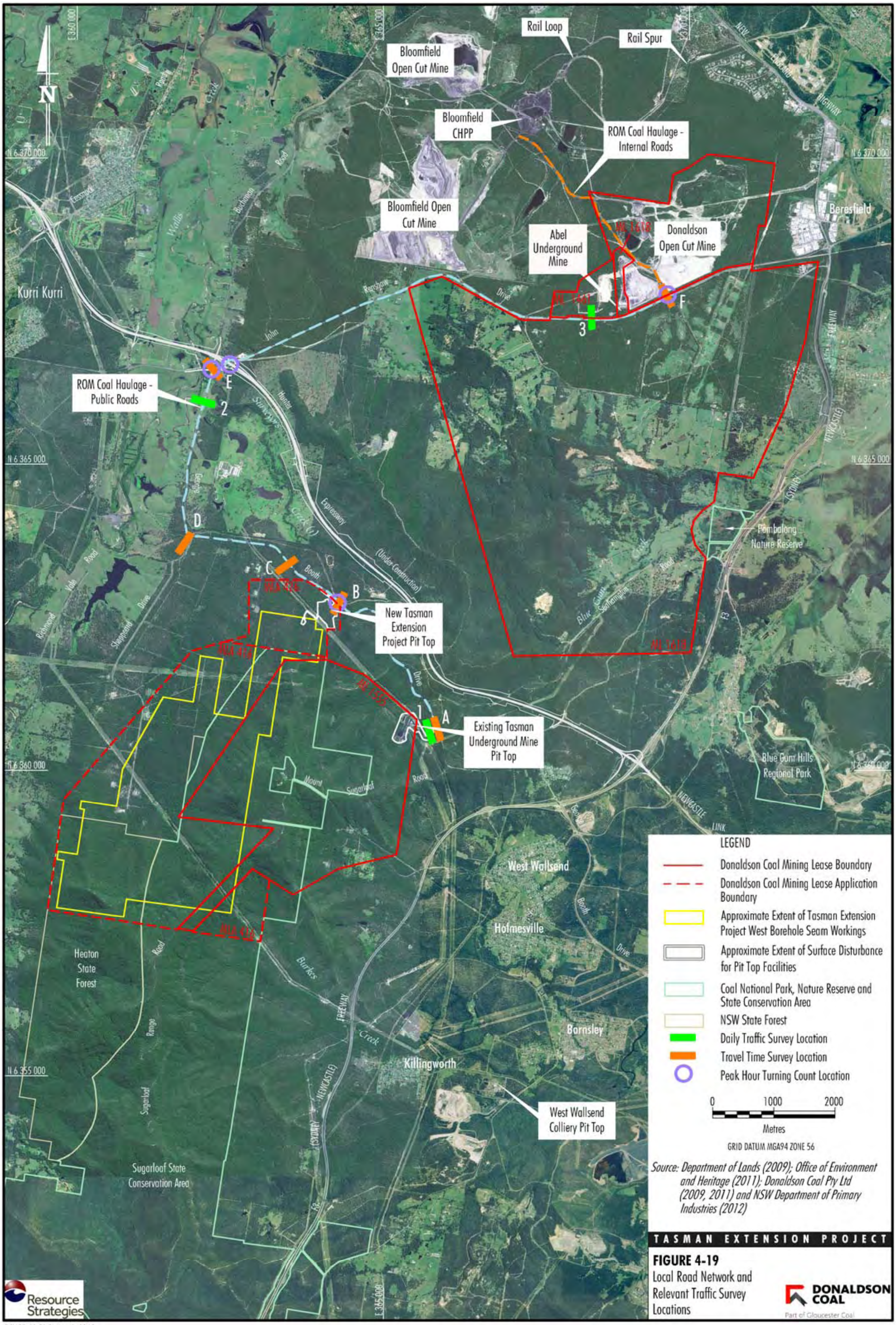
The intersection between George Booth Drive and John Renshaw Drive is a roundabout, with single approach and departure lanes on George Booth Drive and John Renshaw Drive west, and two approach and departure lanes on John Renshaw Drive east. Construction work is presently underway to construct the Hunter Expressway Buchanan interchange with John Renshaw Drive, to the east of the George Booth Drive intersection.

The intersection formed between the Donaldson access road[3] and John Renshaw Drive is a seagull intersection, with dedicated deceleration lanes for vehicles turning into the mine, and dedicated acceleration lanes for vehicles turning out of the mine. Vehicles turning right out of the Donaldson access road are not required to merge with the through traffic as there is a dedicated lane which merges with the through traffic lane over 1 km to the west of the intersection.

Local Roads

Richmond Vale Road is a local sealed road that links White Bridge Road and George Booth Drive (Figure 4-19).

[3] The Donaldson access road provides access to the Donaldson Open Cut Mine, the Abel Underground Mine and for ROM coal haulage trucks from the Tasman Underground Mine to the Bloomfield CHPP via internal roads.



Source: Department of Lands (2009); Office of Environment and Heritage (2011); Donaldson Coal Pty Ltd (2009, 2011) and NSW Department of Primary Industries (2012)

TASMAN EXTENSION PROJECT

FIGURE 4-19
Local Road Network and Relevant Traffic Survey Locations

DONALDSON COAL
Part of Gloucester Coal

Resource Strategies

DCL-09-01 EA Section 4_116C

Sheppeard Drive is a local sealed road that overlies part of the north-western Project underground mining area, running south from Richmond Vale Road before terminating at a rural residential subdivision (Figure 4-19).

Echidna Drive is a local road that provides access from George Booth Drive to the Orica Richmond Vale facilities.

Mount Sugarloaf Road is a local sealed road that provides access from George Booth Drive to the transmission towers located at Mount Sugarloaf and a public lookout area (Figure 4-19). Another local unsealed road, Sugarloaf Range Road, runs south west from Mount Sugarloaf to the Heaton State Forest (Figure 4-19).

Background Traffic Volumes

Available traffic flow data was reviewed and additional daily traffic counts were conducted in May and June 2011. Relevant traffic counter locations are shown on Figure 4-19 and the existing daily traffic volumes are summarised in Table 4-15.

In comparison to 2008 traffic surveys completed on George Booth Drive for the Orica Ammonium Nitrate Production Facility, Halcrow (2012) noted that the Project 2011 survey results at Site 2 indicate a significant growth in total traffic movements from late-2008 to mid-2011, and much of this growth is attributed to Hunter Expressway construction traffic.

Table 4-15 indicates that the Saturday and Sunday daily traffic volumes on the public roads are significantly less than the average weekday daily volumes. The traffic volumes generated by Tasman Underground Mine on the weekends are also significantly lower (Table 4-15).

Based on the estimated distribution of surveyed existing Tasman Underground Mine traffic on the local road network, Halcrow found that on George Booth Drive (Site 2) the mine contributed less than 3% of the surveyed total traffic, including approximately 18% of the surveyed heavy vehicle traffic. In comparison, on John Renshaw Drive (Site 3) the mine contributed less than 2% of the surveyed total traffic, including approximately 12% of the surveyed heavy vehicle traffic.

Halcrow (2012) concluded that on the surveyed average weekday the Tasman Underground Mine made only a small contribution to total traffic flows on George Booth Drive and John Renshaw Drive and that the coal haulage trucks were not the dominant source of heavy vehicles on these roads. Even with coal haulage at the maximum permitted rate, the contribution of the Tasman Underground Mine to heavy vehicle traffic would comprise approximately 25% of total heavy vehicles on George Booth Drive (Site 2) and 18% of total heavy vehicles on John Renshaw Drive (Site 3) (Appendix H).

Mid-Block Levels of Service

The Austroads (2009) *Guide to Traffic Management Part 3: Traffic Studies and Analysis* provides guidelines for the capacity of two lane, two-way rural roads and define levels of service as a qualitative measure describing operational conditions within a traffic stream (in terms of speed, travel time, room to manoeuvre, safety and convenience) and their perception by motorists and/or passengers. Level of service A corresponds to the highest level of service and level of service E corresponds to the roadway being at capacity (i.e. the lowest level of service).

The roads listed in Table 4-15 all operate with a satisfactory level of service (i.e. level of service C or better) (Appendix H).

Table 4-15
Surveyed Existing Daily Two Way Traffic Volumes – 2011

Day	Tasman Access Road (Site 1*)	George Booth Drive (Site 2*)	John Renshaw Drive (Site 3*)
Weekday Average	421	9,074	10,013
Saturday	94	6,135	6,835
Sunday	44	4,638	5,254

* Refer Figure 4-19.

Source: After Appendix H.

Peak Hour Intersection Performance

To examine the existing performance of key intersections of relevance to the ROM coal haulage route, surveys of vehicle turning movements were undertaken on Thursday 2 February 2012 between 6.00 am and 9.00 am, and between 3.00 pm and 6.00 pm including at the intersections of (Figure 4-19):

- George Booth Drive and the Daracon Buttai Quarry access road;
- George Booth Drive and John Renshaw Drive roundabout; and
- John Renshaw Drive with the Donaldson access road.

Halcrow (2012) noted that during the peak hour surveys, work was being undertaken on the Hunter Expressway and in particular the Buchanan interchange, which would be expected to result in increased traffic volumes and thus the surveyed conditions are considered to be busier than would otherwise be expected (Appendix H).

The operation of the intersections was analysed by Halcrow (2012) using SIDRA Intersection, an analysis program which determines characteristics of intersections operating conditions including the degree of saturation, average delays, and levels of service.

The SIDRA analysis results indicate that the relevant intersections currently operate at satisfactory levels of service, with the exception of the Daracon Quarry access road intersection with George Booth Drive, where the modelling suggests that vehicles turning right into or out of the access road can experience long delays (particularly in the morning peak period) (Appendix H).

Vehicle Travel Speeds/Times

A survey of vehicle travel speeds and time along the ROM coal haulage route was conducted in May 2011. The survey recorded travel times along the public road sections of the route in both directions between 7.00 am and 10.00 pm. Travel times were recorded at six locations along the route in order to calculate average travel speeds on individual sections of the ROM coal haulage route (Figure 4-19):

- Site A – Tasman Underground Mine access road/George Booth Drive intersection.
- Site B – Daracon Buttai Quarry/George Booth Drive intersection.
- Site C – Orica Richmond Vale Facilities access road/George Booth Drive intersection.
- Site D – Richmond Vale Road/George Booth Drive intersection.
- Site E – George Booth Drive/John Renshaw Drive roundabout.
- Site F – Donaldson access road/John Renshaw Drive intersection.

A summary of the average surveyed travel speeds of all vehicles, coal haulage trucks and general traffic excluding the coal haulage trucks is provided in Appendix H. Coal haulage truck average speeds were lower than the average speeds of other traffic on these segments.

Road Safety

Validated crash data was obtained from RMS for the period from 1 July 2005 to 30 June 2010 and is based on accidents reported to the Police, and included accidents on George Booth Drive between the F3 Freeway and John Renshaw Drive, and on John Renshaw Drive between the New England Highway at Beresfield and Kurri Kurri. There were some 186 reported crashes on these sections of road, which included four fatal crashes, 88 injury crashes, and 94 non-injury tow-away crashes over the five year period (Appendix H).

Review of George Booth Drive accident data indicates that speed is a significant factor in a large proportion of the crashes, which resulted in a significant number of single vehicle crashes where the driver lost control of the vehicle and left the carriageway (Appendix H). Review of the locations of the crashes indicated that crashes tended to occur in clusters, although there was not any one location where a significant grouping of accidents occurred (Appendix H).

The review of John Renshaw Drive accident data indicates that the most prevalent type of crash occurred between vehicles travelling in the same direction. A review of the locations of the crashes along John Renshaw Drive indicates that crashes tended to be spread along its length, however, there was a notable grouping of accidents at and near the roundabout at John Renshaw Drive/F3 Freeway/ Weakleys Drive (Appendix H). This intersection is located to the east of the Donaldson access road and is not on the ROM coal haulage route (Figure 4-19).

No crashes involving Tasman Underground Mine ROM coal haulage trucks have been reported prior to 2012 (Appendix H). One incident involving a Tasman Underground ROM coal haulage truck was reported on 11 May 2012. This incident involved a motorcyclist reportedly losing control and colliding with a ROM coal haulage truck on George Booth Drive.

Coal Haulage Complaints Records

Halcrow (2012) reviewed Donaldson Coal complaints data between June 2007 and February 2012, which included some 41 complaints which involved ROM coal haulage trucks on John Renshaw Drive or George Booth Drive. This review indicated (Appendix H):

- 31 complaints involved reported coal falling from trucks or small rocks being displaced by trucks and either hitting a following vehicle or landing on the carriageway;
- eight complaints involved the behaviour of a truck driver; and
- two complaints involved truck noise.

As described above there have been a number of complaints from members of the community regarding damage to private vehicles (e.g. windscreens) associated with Tasman Underground Mine coal haulage truck operations on the public road network. Donaldson Coal has a protocol for investigating and responding to such complaints and reimburses car owners for replacement/repairs of cracked windscreens where it is satisfied of the veracity of the claim.

Donaldson Coal commissioned an independent review of coal loading operations at the Tasman Underground Mine (Sinclair Knight Mertz, 2011) to identify areas of improvement, and these measures have been implemented.

Donaldson Coal is implementing additional procedures and upgrades to truck cleaning equipment to minimise future incidents.

School Buses

Hunter Valley Buses operates a school bus run in the vicinity of the Project. The bus travels along Richmond Vale Road from near Sheppeard Drive, George Booth Drive, John Renshaw Drive and Buchanan Road in the morning (around 8.00 am) and afternoon (around 4.00 pm), including one stop on George Booth Drive (Appendix H).

Tasman Underground Mine – Existing Traffic Management Measures

Material road and intersection upgrade works were undertaken by Donaldson Coal at a number of locations on the ROM coal haulage route (George Booth Drive and John Renshaw Drive) as a component of the development of the approved Tasman Underground Mine. These included (Appendix H):

- construction of the seagull type intersection at the George Booth Drive/Tasman Underground Mine access road intersection;
- construction of an auxiliary climbing lane on the westbound carriageway on George Booth Drive from Blue Gum Creek to the west for a distance of 1.2 km;
- construction of an auxiliary climbing lane on the eastbound carriageway of George Booth Drive over a distance of between 1.2 km to 2.8 km from the mine access;
- construction of an auxiliary climbing lane on the eastbound carriageway of John Renshaw Drive to the east of George Booth Drive for a distance of 1.2 km;
- construction of sealed passing lanes on George Booth Drive at each property access between Richmond Vale Road and John Renshaw Drive;
- widening of the road shoulders on George Booth Drive between the Tasman access road and John Renshaw Drive; and
- upgrading of the intersection of John Renshaw Drive and George Booth Drive to a roundabout.

Donaldson Coal has also established a wheel wash facility at the existing pit top facility that is utilised by all coal haulage trucks prior to departure, to reduce the probability of coal material being dislodged from trucks during transport on the public road network.

A Road Transport Protocol (Donaldson Coal, 2009a) sets out details of the coal haulage between the Tasman Underground Mine and the Bloomfield CHPP. The Protocol includes the following:

- haulage days, hours and maximum movements per hour;
- designated haulage routes, schedule and departure staggering;
- vehicle specifications and identification;

- drug and alcohol policies;
- fatigue management;
- incident reporting and complaints management; and
- a Drivers Code of Conduct that includes:
  - safety requirements;
  - driver behaviour requirements;
  - use of the pit top facility wheel wash and inspection of vehicles;
  - mandatory covering of loads;
  - driver training; and
  - general compliance requirements.

In addition to the above, in accordance with Condition 7 of Schedule 4 of the Tasman Underground Mine Development Consent, Donaldson Coal commissions independent traffic audits at six monthly intervals. These audits involve a review of the driving performance of the coal haulage contractor drivers, review of community complaints and accident records and provide any relevant recommendations for improvement of the management or mitigation of any potential adverse impacts associated with the mine road transport on the public road network.

4.12.2 Potential Impacts

Potential traffic impacts of the Project on traffic generation, roadway capacity and safety are assessed in Appendix H and summarised below.

Potential subsidence effects on local roads that are located in proximity to the Project underground mining area are discussed in Section 4.2 and Appendix A.

Project Haulage of ROM Coal

Total road haulage (including ROM coal transport and waste rock from the new pit top construction[4]) for the Project would be maintained at existing approved volumes up to 4,000 tonnes per day prior to commissioning of the Hunter Expressway (Section 2.7). Following commissioning of the Hunter Expressway, the Project would involve ROM coal transport of up to 6,200 tonnes per day along George Booth Drive and John Renshaw Drive.

Movement of ROM coal would be restricted to 7.00 am to 10.00 pm Monday to Friday and 7.00 am to 6.00 pm Saturday, except in the case of exceptional circumstances[5]. ROM coal transport would be limited to no more than 26 Saturdays in a financial year. ROM coal transport would not occur on Sundays or public holidays.

Halcrow (2012) noted that loaded coal haulage trucks took an average of 3.1 minutes to travel from the existing pit top (Site A) to the Daracon Buttai Quarry access (Site B) on George Booth Drive (Figure 4-19) and the return journey with empty trucks on this section took an average of 2.9 minutes. A saving of approximately 6 km in travel distance (Section 2.7) and approximately 6 minutes travel time on the public road network per haulage truck round trip could therefore be expected when coal haulage operations move from the existing pit top facility to the new pit top facility.

Cumulative Traffic Sources

Irrespective of the Project, changes to local traffic conditions are expected on both George Booth Drive and John Renshaw Drive over the life of the Project. These changes would be the result of growth in baseline traffic, changes to the physical traffic network and other cumulative traffic sources.

The opening of the Hunter Expressway is expected to result in a decrease in traffic of around 5% on John Renshaw Drive and a decrease of over 90% on George Booth Drive (Appendix H). The major reduction in the traffic on George Booth Drive is because the Hunter Expressway generally parallels George Booth Drive in the vicinity of the Project (Figure 4-19) and therefore will provide an alternative dual carriageway link for many motorists and heavy vehicles that currently use George Booth Drive as a through route to other destinations.

There are a number of potential cumulative traffic sources in the vicinity of the Project that may contribute to existing and/or future traffic volumes and have been considered in the Road Transport Assessment including (Appendix H):

- the recently completed Ammonium Nitrate Emulsion production facility at the Orica Richmond Vale facilities that accesses George Booth Drive via Echidna Drive;

[4] A description of the potential road transport benefits associated with trucking some Project waste rock to the Daracon Quarries is provided in Section 6.7.2 and Attachment 7.

[5] Exceptional circumstances include unexpected events such as a significant disruption to the haulage route. Hours would be extended in accordance with a contingency plan in the Road Transport Protocol with the agreement of the DP&I.

- the existing Daracon Buttai Quarry which can use access roads on either George Booth Drive or John Renshaw Drive;
- the Pace Farm ("Henholme") which has an access onto George Booth Drive between John Renshaw Drive and Richmond Vale Road; and
- the proposed Lower Hunter Lands Project (Black Hill Development) located to the south-west of the intersection of John Renshaw Drive and the F3 Freeway that could, if approved, become a major contributor to future traffic flows on John Renshaw Drive.

The construction of the Hunter Expressway is also contributing to current elevated traffic levels in the vicinity of the Project.

Counter to the reductions in traffic numbers that are expected to occur in the short-term with the opening of the Hunter Expressway, there would be medium to long-term growth in baseline traffic generation due to increased employment and population growth in the Lower Hunter Region. Published growth rates described in the *Lower Hunter Transport Needs Study Technical Paper 4 Traffic Analysis* (Hyder Consulting Pty Ltd, 2008) were used by Halcrow (2012) to estimate future traffic growth above existing levels that may occur on relevant sections of George Booth Drive and John Renshaw Drive over the medium to long-term.

The forecasts on which these growth rates are based included large employment generating developments off John Renshaw Drive to the east of the Bloomfield CHPP. Halcrow (2012) noted that the application of these future traffic growth rates in the long-term may be considered conservative, particularly on the section of John Renshaw Drive between George Booth Drive and the Donaldson access road, however, it may represent a traffic growth scenario that could eventuate with the development of the Black Hill site to the east of the Bloomfield CHPP, should it proceed.

Project Daily Traffic Generation

Table 4-16 summarises the estimated existing Tasman Underground Mine and predicted Project daily vehicle movements (weekday traffic in both directions), including ROM coal haulage, workforce movements, visitors and deliveries. Scenarios assessed included construction (2013), peak Project traffic generation (2017) and a 2029 scenario to examine the potential effect of long-term baseline traffic growth, late in the Project life.

Project estimated Saturday traffic generation is also described in Appendix H, however, as Saturday baseline traffic levels and Project traffic generation would be significantly lower than on weekdays, the following discussion focuses on weekday traffic flows.

With respect to assessment of Project traffic contributions on John Renshaw Drive east of the Donaldson access road, Halcrow (2012) concluded that further assessment was not warranted based on the small estimated traffic contributions (Table 4-16) in comparison to measured existing traffic flows on John Renshaw Drive (Table 4-15).

Table 4-16
Estimated Weekday Distribution of Two Way Tasman/Project Traffic

	Existing (2011)	Year 2013*+	Year 2017*	Year 2029*
Tasman Underground Mine				
Existing Pit Top Access	424	392	70	0
New Pit Top Access	0	223	748	748
George Booth Drive				
South of Existing Pit Top Access	200	275	338	287
North of Project Pit Top Access	224	340	480	461
John Renshaw Drive				
East of Donaldson Access	20	29	34	29
West of Donaldson Access	170	265	390	385

Source: Appendix H.

*Assumes Project coal haulage at maximum rates.

+ Prior to the opening of the Hunter Expressway.

Cumulative Daily Traffic Flows

Estimated traffic flows on George Booth Drive and John Renshaw Drive including cumulative traffic sources, the effects of the opening of the Hunter Expressway and estimated Project weekday traffic flows are presented in Table 4-17.

Halcrow (2012) concluded that background growth in traffic and the changes in traffic flows that result from the opening of the Hunter Expressway would be more significant than the traffic generated by the Project. The Project would contribute less than 3% to the total traffic on John Renshaw Drive (Appendix H).

With peak levels of ROM coal haulage in 2017, the Project contribution to total traffic on George Booth Drive north of the Project would be around 37% on weekdays (Appendix H), which is largely a function of the total traffic volumes on George Booth Drive declining by a very large margin due to the opening of the Hunter Expressway (Table 4-17).

In 2017 with Project maximum coal haulage, George Booth Drive north of the Project would be expected to carry some 439 heavy vehicles per day, of which 372 heavy vehicles would be associated with the Project, assuming that the proportion of non-Tasman heavy vehicles on George Booth Drive remains constant. The contribution of the Tasman Underground Mine to overall heavy vehicle volumes would increase, however the total number of heavy vehicles on this section of George Booth Drive would be less than half the existing daily number of heavy vehicles (972) (Appendix H).

Mid-Block Levels of Service

Halcrow (2012) assessed the future mid-block levels of service on George Booth Drive and John Renshaw Drive in the context of future traffic growth for 2013, 2017 and 2029. This assessment indicates that Project traffic would have no impact on the future levels of service of George Booth Drive and John Renshaw Drive (Appendix H).

Following the opening of the Hunter Expressway, the mid-block level of service on George Booth Drive would improve, as total traffic movements would fall (Table 4-17).

The Road Transport Assessment identifies that in the medium to long-term, if the growth in background traffic eventuates as predicted, measures would be required to address the capacity of John Renshaw Drive, with the mid-block level of service predicted to fall from the current level of C, to D in 2017 and E in 2029, regardless of whether or not the Project proceeds.

Peak Hour Intersection Performance

As the existing intersection turning movement surveys were conducted during the construction of the Hunter Expressway it is expected that the surveyed volumes were higher than would otherwise have been expected (Appendix H). A conservative peak hour analyses which assumes that the busiest hours for traffic generated by the Project would coincide with the busiest hours surveyed at the intersections in February 2012 was completed as a component of the Road Transport Assessment.

The existing roundabout at the intersection of George Booth Drive and John Renshaw Drive is planned to be altered with the construction and opening of the Hunter Expressway. Buchanan Road will be realigned to form a fourth northern leg to the roundabout. The upgraded roundabout has been designed to accommodate the longer term demands following completion of the Hunter Expressway, and the Project's contribution to those demands would be very low (Appendix H). The following discussion therefore focuses on the performance of the other two key intersections of particular relevance to the Project.

Table 4-17

Estimated Cumulative Two Way Weekday Traffic 2013, 2017 and 2029 - With Project

	Year 2011*+	Year 2013*+	Year 2017*	Year 2029*
George Booth Drive				
South of Existing Pit Top Access	9,052	10,200	1,148	1,308
North of New Pit Top Access	9,162	10,265	1,290	1,482
John Renshaw Drive				
West of Donaldson Access	10,099	11,632	13,799	19,945

Source: Appendix H.

*Assumes coal haulage at maximum rates.

+ Prior to the opening of the Hunter Expressway.

The results of the SIDRA modelling for the proposed roundabout at the intersection of George Booth Drive with the Daracon Buttai Quarry access road and the new pit top facility access road demonstrate that the new roundabout can be expected to operate at good levels of service during the morning and evening peak hours with the Project (Appendix H). In addition, the peak hour performance for vehicles turning right out of the Daracon Buttai Quarry would be improved and the roundabout would have spare capacity for additional traffic, should the Daracon Buttai Quarry alter their access arrangements in the future (Appendix H).

The existing layout of the intersection of John Renshaw Drive and the Donaldson access road would be retained. The operation of the intersection has been assessed using SIDRA, assuming that coal haulage from the Project to the Bloomfield CHPP occurs at the maximum hourly rate, matched by an equal number of empty trucks returning during the same hour. The SIDRA modelling results for this intersection indicates that the Project traffic would be readily accommodated in the short to medium term. However, should the high rate of predicted background traffic growth eventuate, excessive delays may result at the intersection in the long-term, with delays to vehicles turning right out of the Donaldson access road against heavy eastbound flows (Appendix H).

Road Safety

No significant impacts on the safety of the road network are expected to arise as a result of the Project (Appendix H). The implementation of existing road safety management measures would continue and would be augmented for the Project (Section 4.12.3).

Oversize Vehicles

A small number of overwidth, overheight, or overweight loads would be generated during the life of the Project. All such loads would be transported with the relevant permits, licences and escorts as required by the regulatory authorities. The proposed route would be negotiated with the relevant local councils on a case-by-case basis.

School Buses

The small traffic increases resulting from the Project are unlikely to have any measurable impact on the existing school bus services on George Booth Drive prior to opening of the Hunter Expressway (Appendix H). Following the opening of the Hunter Expressway, traffic volumes on George Booth Drive would decline, and thus there would a reduced probability of interaction between school buses and general traffic on George Booth Drive (Appendix H).

4.12.3 Mitigation Measures, Management and Monitoring

The Road Transport Assessment concluded that the Project's contribution to overall traffic conditions on George Booth Drive and John Renshaw Drive would be such that no significant impacts on the performance, capacity, efficiency and safety of the road network are expected to arise as a direct result of the Project (Appendix H). Notwithstanding, Donaldson Coal would implement the road transport management and mitigation measures described below.

Intersection Upgrades

As described in Section 2.5.1, Donaldson Coal would upgrade the existing Daracon Buttai Quarry access road intersection with George Booth Drive to a roundabout that incorporates the new pit top facility access road (Figure 2-9).

This new roundabout would be designed and constructed to the satisfaction of the RMS prior to major earthworks commencing at the new pit top facility.

ROM Coal Haulage Management

Donaldson Coal has already established a wheel wash facility at the existing pit top. A second wheel wash facility would be established at the new pit top facility during construction for use by all waste rock and coal haulage trucks prior to departure (Figure 2-9).

The existing Road Transport Protocol (Section 4.12.1) would be reviewed and updated as required to address the Project, including the extension of ROM coal haulage into the Saturday period (7.00 am to 6.00 pm). The Driver's Code of Conduct and other attachments to the Road Transport Protocol would also be updated as required to address the Project.

George Booth Drive – Private Driveway Safety Review

Donaldson Coal undertook upgrade works at a number of private driveways located on George Booth Drive between Richmond Vale Road and John Renshaw Drive including road shoulder widening and sealing as a component of the approved Tasman Underground Mine road upgrades (Section 4.12.1).

During recent consultation, a number of landholders who have private driveways on George Booth Drive expressed safety concerns regarding turning into and out of their private driveways on George Booth Drive with the continued presence of heavy vehicles (including ROM coal haulage trucks associated with the Project) on this section of road.

Donaldson Coal subsequently commissioned an inspection and safety review of some 16 access driveways on George Booth Drive between John Renshaw Drive and Richmond Vale Road by GHD in February 2012 (Figure 4-20). The *Tasman Extension Project Safety Review of George Booth Drive Shoulder Widenings* (GHD, 2012) is provided as Appendix Q of this EIS.

This review indicated a number of supplementary improvements could be made to further improve road safety for private vehicles turning onto and off George Booth Drive at, or in the vicinity, of the majority of these driveways.

Such improvement works that have been identified include (Appendix Q):

- provide additional or extended sealed shoulder widening for vehicles making left turns into private driveways;
- provide additional or extended widening of the shoulders for vehicles passing a propped vehicle making a right-hand turn into a private driveway;
- trimming or removing vegetation that obscures sight lines;
- relocation of guide posts;
- relocation of signage; and
- consideration of the relocation of some electricity transmission line poles that are located within the road verge.

The private driveways inspected, and the suggested treatments for each driveway (Appendix Q) are presented in Figures 4-21a to 4-21d.

Donaldson Coal would implement the identified private driveway/George Booth Drive safety improvement works within one year of obtaining Development Consent for the Project, should it be approved (subject to any required landholder consent and necessary environmental approvals being obtained). Donaldson Coal would also continue to consult with private landholders located on the ROM coal haulage route on George Booth Drive, and would consider on merit any further safety improvements at these driveways that may be requested by these landholders (e.g. funding the pruning of roadside vegetation on private land).

In addition, in the event that additional private residential access driveways are established on the ROM coal haulage section of George Booth Drive in accordance with Council approvals in the future, Donaldson Coal would commission a review of the driveway safety and implement any relevant road widening or upgrade works that may be determined to be required at the new driveway.

Independent Traffic Audits

Donaldson Coal would continue to commission independent traffic audits at intervals in accordance with the requirements of the DP&I and in consultation with the RMS and Cessnock City Council. The frequency of the independent audits may be reduced to annually once the Hunter Expressway is open as the potential for interaction of ROM coal haulage vehicles and private vehicles would be reduced on George Booth Drive.

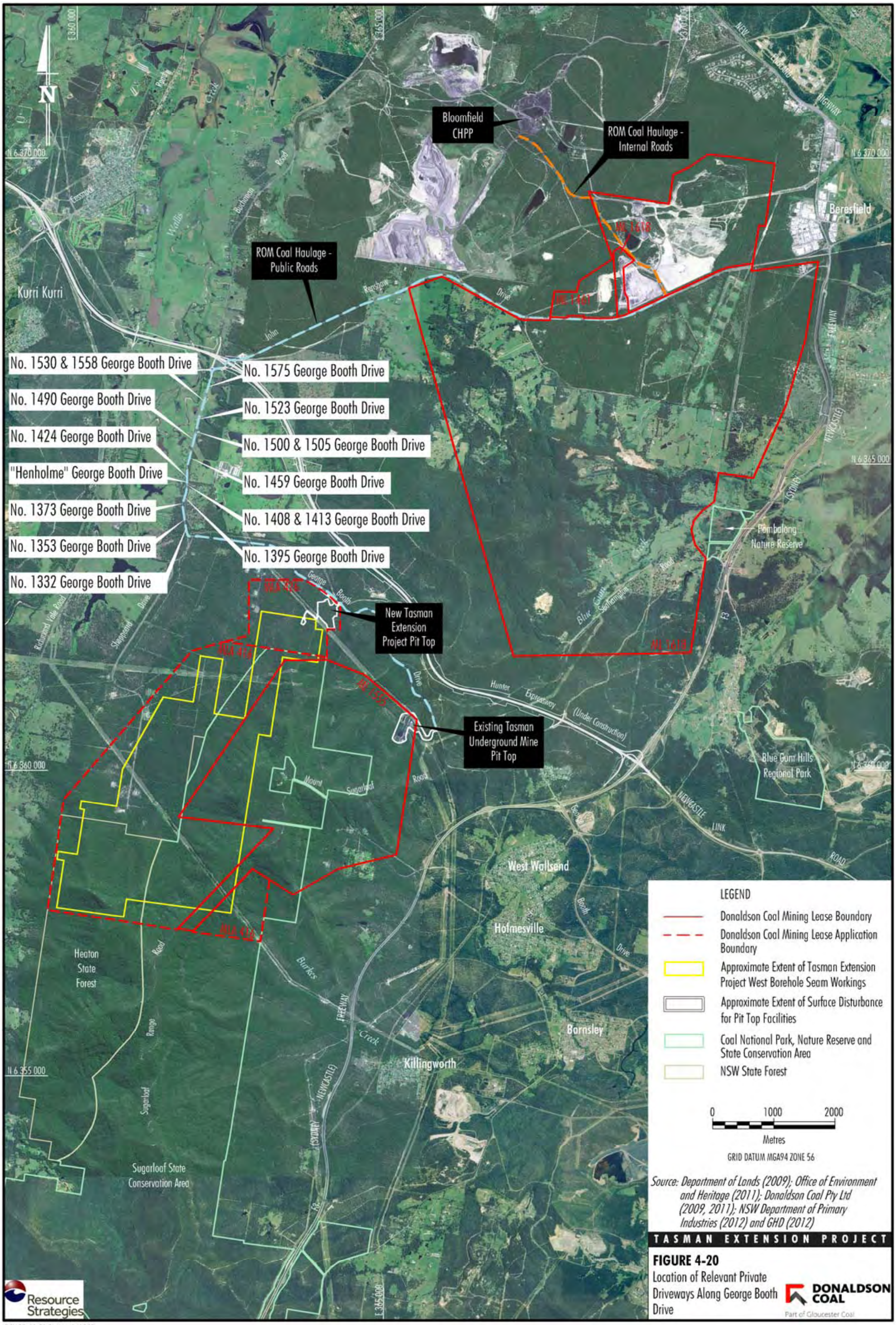
Oversize Vehicles

All Project oversized vehicles would have the relevant permits, licences and escorts, as required by the regulatory authorities and the proposed route would be negotiated with the relevant local councils.

All oversize vehicles loads would be appropriately secured and covered.

Peak Hour Intersection Performance Monitoring

The Road Transport Assessment has identified that in the long-term, the performance of the Donaldson access road intersection with John Renshaw Drive may deteriorate if the predicted levels of baseline traffic growth eventuate, and this baseline growth coincides with peak Project turning movements at this intersection.



TASMAN EXTENSION PROJECT

FIGURE 4-20
Location of Relevant Private Driveways Along George Booth Drive

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Address: No. 1575 George Booth Drive

Suggested Treatment: No improvements or modifications are proposed at this driveway.

Address: No. 1530 and 1558 George Booth Drive

Suggested Treatment: Extend the northbound shoulder widening to the south of property No. 1530 so that it will allow the safe overtaking of a vehicle propped to turn right into the property.
Provide sealed shoulder widening for the left turn into the property.

Address: No. 1523 George Booth Drive

Suggested Treatment: Provide sealed shoulder widening for the left turn into the property.

Address: No. 1500 and 1505 George Booth Drive

Suggested Treatment: No improvements or modifications are proposed at these driveways.

Note : Refer to Figure 4-20 for Locations
Source: GHD (2012)

TASMAN EXTENSION PROJECT

FIGURE 4-21a
Private Driveways Along George Booth Drive

Resource Strategies

DONALDSON COAL
Part of Gloucester Coal

DCL-09-01 EIS Sect 4_006D

  

Address:	No. 1490 George Booth Drive
Suggested Treatment:	Provide a sealed widened shoulder for the left turn into the property. Relocate Hunter Expressway sign to outside of the clear zone for the road. Provide additional widening for the right turn shoulder.

  

Address:	No. 1459 George Booth Drive
Suggested Treatment:	Provide sealed shoulder widening for the left turn into the property. Consider the relocation of the power pole to outside of the clear zone.

  

Address:	No. 1424 George Booth Drive
Suggested Treatment:	Provide a sealed widened shoulder for the left turn into the property. Extend the existing widened sealed shoulder to approximately 20m past the driveway prior to tapering back to the existing.

  

Address:	"Henholme" George Booth Drive
Suggested Treatment:	It is considered that the issues associated with this driveway are due to the commercial nature of the property. Provide sealed shoulder widening for the left turn into the property.

Note : Refer to Figure 4-20 for Locations
Source: GHD (2012)

TASMAN EXTENSION PROJECT

FIGURE 4-21b
Private Driveways Along George Booth Drive

Resource Strategies

DONALDSON COAL
Part of Gloucester Coal



Address: No. 1408 and 1413 George Booth Drive

Suggested Treatment: Consider the relocation of the power poles to outside of the clear zone for the road. These poles restrict the extents of the widened shoulders. It is also noted that should a vehicle overshoot the widened shoulder at this location they would travel straight into one of the poles.
Trim or remove vegetation on the southbound side of the road, north of the driveway into property No. 1408 to improve sightlines out of the driveway to approaching vehicles.



Address: No. 1395 George Booth Drive

Suggested Treatment: Provide additional widening for the right turn shoulder.
Guide posts to be relocated to outside the sealed pavement.



Address: No. 1373 George Booth Drive

Suggested Treatment: Provide additional shoulder widening for the property as required.



Address: No. 1353 George Booth Drive

Suggested Treatment: Provide sealed shoulder widening for the left turn into the property.

Resource Strategies

Note : Refer to Figure 4-20 for Locations
Source: GHD (2012)

TASMAN EXTENSION PROJECT

FIGURE 4-21c
Private Driveways Along George Booth Drive

DONALDSON COAL
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Address: No. 1332 George Booth Drive

Suggested Treatment: Provide sealed shoulder widening for the left turn into the property.
Replace the Telstra pit with a trafficable pit and lid.

Note : Refer to Figure 4-20 for Locations
Source: GHD (2012)

TASMAN EXTENSION PROJECT

FIGURE 4-21d
Private Driveways Along George Booth Drive

As the peak hour intersection assessment is based on conservative assumptions and the current and short to medium term performance of the intersection is predicted to be satisfactory, Donaldson Coal proposes to implement performance monitoring of the intersection, initially at 5 yearly intervals, with the monitoring interval to be reviewed based on measured intersection performance and in consultation with the RMS.

Complaints and Incident Response

Tasman Underground Mine complaint and incident response measures would continue to be implemented for the Project and any future claims regarding damage to windscreens that arise from the Project ROM coal haulage on the public road network would continue to be assessed and where relevant vehicle repairs would be funded by Donaldson Coal.

4.13 NOISE AND VIBRATION

A Noise and Blasting Impact Assessment for the Project was undertaken by SLR Consulting (2012) and is presented in Appendix I. It was conducted in accordance with the INP (EPA, 2000), *NSW Road Noise Policy* (DECCW, 2011), *Interim Construction Noise Guideline* (DECC, 2009b) and *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* (ANZECC, 1990).

Section 4.13.1 provides a description of the existing noise environment, including a description of the existing Tasman Underground Mine noise management and monitoring regime. Section 4.13.2 describes the potential noise and vibration impacts of the Project. Section 4.13.3 outlines mitigation measures, management and monitoring.

4.13.1 Existing Environment

Noise Monitoring Regime

Attended operational noise monitoring for the Tasman Underground Mine has been conducted since 2007, on a quarterly or annual basis, in accordance with the requirements of DA-274-9-2002. Noise monitoring has been conducted at locations in West Wallsend and Seahampton (Figures 4-22a and 4-22b), as described in the Abel Underground Coal (Integrated with Donaldson Open Cut, Tasman Underground and Bloomfield Open Cut Coal Mines) Integrated Environmental Monitoring Program and the Environmental Monitoring Program.

Compliance and Complaints

During all attended operational noise monitoring conducted to date, the Tasman Underground Mine was inaudible (Appendix I). Noise levels above the noise criteria detailed in DA-274-9-2002 have been recorded during the attended operational noise monitoring, however the dominant noise sources have been local and freeway traffic (Appendix I).

Since operations at the Tasman Underground Mine commenced in 2006, no operational noise complaints have been received (Appendix I). Two complaints in regard to traffic noise have been received. These complaints were made by the same person in June and August 2007, and were made in relation to brake noise from ROM coal haulage trucks. New B-Double ROM coal haulage trucks were subsequently sourced in 2007.

Noise Measurement and Description

The assessed noise levels presented in Appendix I, and summarised in this section, are expressed in A-weighted decibels (dBA). The logarithmic dBA scale simulates the response of the human ear, which is more sensitive to mid to high frequency sounds and relatively less sensitive to lower frequency sounds. Table 4-18 provides information on common noise sources in dBA for comparative reference.

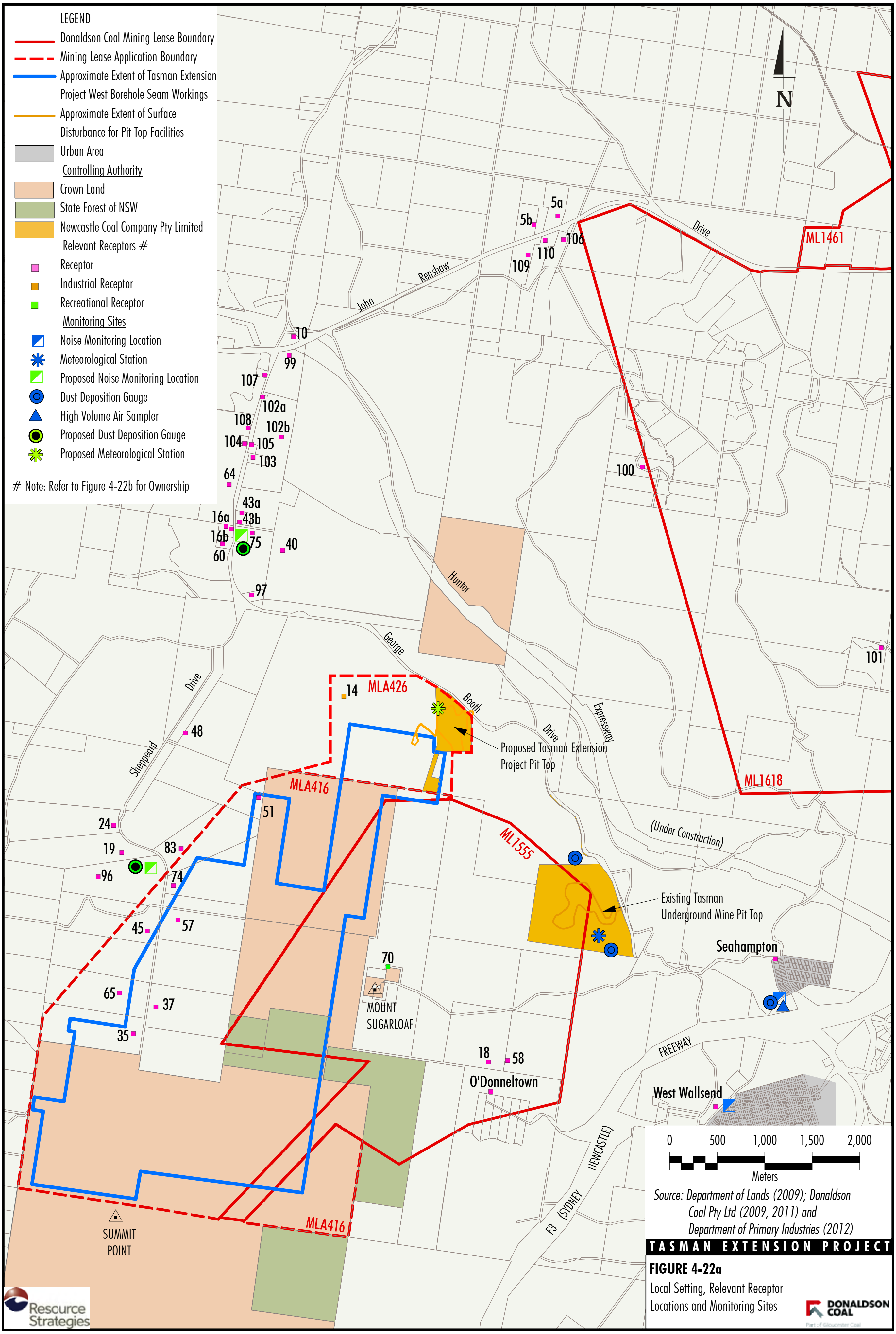
Hearing "nuisance" for most people begins at noise levels of about 70 dBA, while sustained (i.e. eight hours) noise levels of 85 dBA can cause hearing damage.

Measured or predicted noise levels are expressed as statistical noise exceedance levels (L_{AN}) which are the levels exceeded for a specified percentage (N) of the interval period. For example, L_{A10} is the noise level that is exceeded for 10% of the sampling period and is considered to be the average maximum noise level.

The equivalent continuous noise level (L_{Aeq}) refers to the steady sound level, which is equal in energy to the fluctuating levels recorded over the sampling period.

Background Noise Levels

The Rating Background Level is the background noise level determined without the subject premises in operation, in accordance with the INP (EPA, 2000).



TASMAN EXTENSION PROJECT

FIGURE 4-22a

Local Setting, Relevant Receptor Locations and Monitoring Sites

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O'Donneltown (represents receivers at O'Donneltown)	
Seahampton (represents receivers at Seahampton)	
West Wallsend (represents receivers at West Wallsend)	
5a	Four Mile Pty Limited
5b	Four Mile Pty Limited
10	Roads and Traffic Authority of New South Wales
14	Orica Australia Pty Limited
16a	ARM & C Roach
16b	ARM & C Roach
18	AR Sager
19	AS & KL Green
24	BG & M Smith
35	D & JA Hoey
37	GW & KM Cameron
40	GT, SD, JR & MA Holmes
43a	GG & CA Morris
43b	GG & CA Morris
45	GK Hooler
48	H Spruce & JW Rhind
51	JM Spruce
57	KH & DM Starr
58	KM & LJ Spruce
60	LD & KA Bradbery
64	ME Hooley
65	MA Honeysett
70	The Minister for Lands
74	PJ Crowhurst
75	PE Maytom
83	PW & DL Dryden
96	TransGrid
97	WC & LM Gibson
99	LJ & LM Jones
100	DR & KL Bishop
101	GR & RL Watts
103	DJ & SL Ayre
104	KP & J Mantle
105	LJ & C Fairhall
106	F Valicek
107	CR & L Parker
108	AM Williams
109	CR & ML Parnell
110	ME & KD Elliott
102a	IR & MMF Gee
102b	IR & MMF Gee

Source: Department of Lands (2011) and Donaldson Coal Pty Ltd (2009)

Note: Correct as of October 2011

TASMAN EXTENSION PROJECT

FIGURE 4-22b

Relevant Receptor Ownership List

DONALDSON COAL
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Resource Strategies

DCL-09-01 EIS Sect 4_011B

Table 4-18
Relative Scale of Various Noise Sources

Noise Level (dBA)	Relative Loudness	Common Indoor Noise Levels	Common Outdoor Noise Levels
110 to 130	Extremely noisy	Rock band	Jet flyover at 1,000 m
100	Very noisy	Internal demolition work (jackhammer)	Petrol engine lawn mower at 1 m
90	Very noisy	Food blender at 1 m	Diesel truck at 15 m
80	Loud	Garbage disposal at 1 m, shouting at 1 m	Urban daytime noise
70	Loud	Vacuum cleaner at 3 m, normal speech at 1 m	Commercial area heavy traffic at 100 m
60	Moderate to quiet	Large business office	-
50	Moderate to quiet	Dishwasher next room, wind in trees	Quiet urban daytime
40	Quiet to very quiet	Small theatre, large conference room (background), library	Quiet urban night-time
30	Quiet to very quiet	Bedroom at night, concert hall (background)	Quiet rural night-time
20	Almost silent	Broadcast and recording studio	-
0 to 10	Silent	Threshold of hearing	-

Source: After United States Department of the Interior (1994) and Richard Heggie Associates (1995).

SLR Consulting conducted background noise monitoring at three locations (i.e. West Wallsend, Seahampton and on George Booth Drive) to determine the Rating Background Level for these locations as part of the original noise impact assessment for the Tasman Underground Mine (Richard Heggie Associates, 2002). These noise levels were recorded prior to the establishment of the existing Tasman Underground Mine, and the Rating Background Levels are considered to be appropriate for the Project (Appendix I).

In addition, Umwelt (2009) conducted background noise monitoring to determine the Rating Background Level for a location on Sheppeard Drive.

A summary of Rating Background Levels for West Wallsend, Seahampton, George Booth Drive and Sheppeard Drive is provided in Table 4-19.

4.13.2 Potential Impacts

The Noise and Blasting Impact Assessment (Appendix I) included assessment of the following potential impacts:

- on-site operational and construction noise;
- off-site road traffic noise;
- vibration from construction and underground blasting; and
- vibration from coal haulage trucks.

Operational Noise

Operational Noise Criteria

The INP assessment procedure for industrial noise sources has two components (EPA, 2000):

- controlling potential intrusive noise impacts in the short-term for residences; and
- maintaining noise level amenity for particular land uses, for residences and other land uses.

The INP prescribes detailed calculation routines for establishing Project-specific $L_{Aeq(15minute)}$ intrusive criteria and $L_{Aeq(period)}$ amenity criteria. The Project-specific noise criteria are the most stringent of the intrusive and amenity assessment criteria.

The intrusiveness criterion essentially means that the L_{Aeq} of the source (e.g. the Project) should not be more than five decibels above the measured background level (L_{A90}) (Appendix I).

The amenity assessment is based on noise criteria specific to land use and associated activities, such that noise levels from new sources do not cumulatively (i.e. with other industrial noise sources) exceed the criterion (Appendix I). The criteria relate only to industrial-type noise and do not include road, rail or community noise.

Table 4-19
Summary of Ambient Background Noise Levels

Location	Rating Background Level (dBA)		
	Day	Evening	Night
West Wallsend	38	42	36
Seahampton	43	43	38
George Booth Drive	38	39	32
Sheppeard Drive	32	31	30

Source: After Appendix I.

Note: Day 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night 10.00 pm to 7.00 am.

SLR Consulting (2012) has assessed the Project-specific intrusive and amenity assessment criteria for the Project for relevant residential, recreational and industrial receivers, as detailed in Table 4-20. In accordance with the INP, Project-only noise levels at recreational and industrial receivers, and cumulative noise levels (i.e. from the Project as well as other industrial noise sources) have been assessed in Appendix I against the amenity criteria.

Operational Noise Modelling

An acoustic model was developed by SLR Consulting (2012) that simulated the Project components using noise source information (i.e. sound power levels and locations). The acoustic model predicted noise levels at relevant receiver locations. The model considered meteorological effects, surrounding terrain, the distance from source to receiver and noise attenuation.

To assess potential noise impacts representative of the life of the Project, noise modelling was conducted for two operational scenarios:

- Project Year 2 – which represents concurrent operations at the existing and new pit top facilities (Figure 2-8), with assumed ROM coal production rates of 460,000 tpa and 1,039,000 tpa from the existing and new pit top facilities, respectively[6]; and
- Project Year 7 – which represents operations at the new pit top facilities at the maximum ROM coal production rate of 1.5 Mtpa.

Assessment of Mitigation Measures

Preliminary modelling conducted by SLR Consulting (2012) indicated that the upcast ventilation fan was the largest contributor of noise at residential receivers. On this basis, to mitigate potential noise impacts, the ventilation fan would discharge horizontally and would be oriented away from the closest residential receivers, which are located to the north (i.e. the ventilation fan would be oriented to the south) (Appendix I).

This mitigation measure was included in the operational noise modelling conducted for the Project.

Assessment of Meteorological Conditions

The INP directs the use of a set of prevailing (i.e. occurring greater than 30% of the time) meteorological conditions in the assessment of noise impacts.

Details of meteorological analysis and modelled meteorological conditions are provided in Appendix J. The prevailing night-time meteorological conditions assessed for the Project include temperature inversions, as well as south to south-easterly winds (i.e. source to receiver winds for the closest residential receivers to the Project).

Potential Operational Noise Impacts

Based on the results of the operational noise modelling, the Project specific noise criteria (Table 4-20) were predicted to be met at all receiver locations for Project Years 2 and 7 during the day, evening and night under all meteorological conditions (Appendix I). In addition, no exceedance of the Project specific noise criteria was predicted on greater than 25% of any privately-owned vacant land.

6 It should be noted that ROM coal production from the existing pit top facilities is expected to be lower than the rate that has been conservatively assessed (Table 2-2).

Table 4-20
Project Specific Noise Criteria

Location[1]	Period	Intrusiveness Criteria $L_{Aeq(15minute)}$	OEH Acceptable Amenity Criteria $L_{Aeq(Period)}$	Project Specific Noise Criteria
West Wallsend and O'Donneltown Residential Areas	Day	43 dBA	55 dBA	43 dBA $L_{Aeq(15minute)}$
	Evening	43 dBA[2]	45 dBA	43 dBA $L_{Aeq(15minute)}$
	Night	41 dBA	40 dBA	40 dBA $L_{Aeq(Period)}$
Seahampton Residential Area	Day	48 dBA	55 dBA	48 dBA $L_{Aeq(15minute)}$
	Evening	48 dBA	45 dBA	45 dBA $L_{Aeq(Period)}$
	Night	43 dBA	40 dBA	40 dBA $L_{Aeq(Period)}$
Residences off George Booth Drive	Day	43 dBA	50 dBA	43 dBA $L_{Aeq(15minute)}$
	Evening	43 dBA[2]	45 dBA	43 dBA $L_{Aeq(15minute)}$
	Night	37 dBA	40 dBA	37 dBA $L_{Aeq(15minute)}$
Residences off Sheppeard Drive	Day	37 dBA	50 dBA	37 dBA $L_{Aeq(15minute)}$
	Evening	36 dBA	45 dBA	36 dBA $L_{Aeq(15minute)}$
	Night	35 dBA	40 dBA	35 dBA $L_{Aeq(15minute)}$
Mount Sugarloaf Public Lookout and Picnic Area	When in use	N/A	50 dBA	50 dBA $L_{Aeq(Period)}$
Orica Research Facility	When in use	N/A	70 dBA	70 dBA $L_{Aeq(Period)}$

Source: After Appendix I.

Note: Day 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night 10.00 pm to 7.00 am.

1 Refer to Figure 4-22a for locations.

2 Daytime criteria adopted with reference to the INP Application Notes (Appendix I).

Noise contour plots for Project Year 7 for the evening and night are shown in Figure 4-23. Results for all assessed receiver locations are provided in Appendix I.

Potential Cumulative Impacts

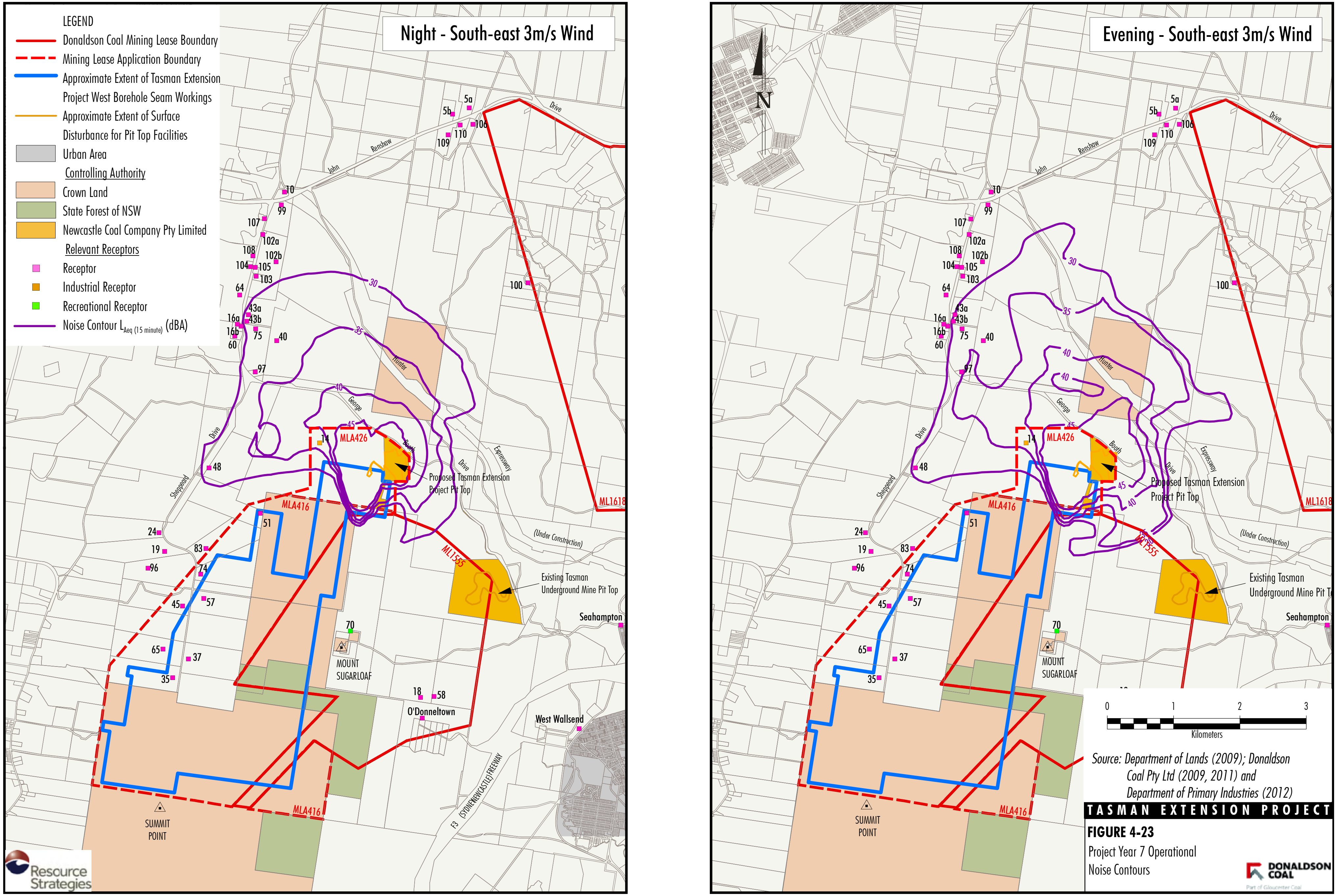
Potential cumulative noise impacts of the Project, existing industrial noise sources and the Orica Ammonium Nitrate Emulsion Project were assessed by SLR Consulting (2012) against the amenity noise criteria (Table 4-20). Cumulative noise levels were predicted to be below the amenity noise criteria at all receivers at all times (Appendix I).

Construction Noise

Potential noise impacts during construction were assessed against the construction noise goals provided in the *Interim Construction Noise Guideline* (DECC, 2009b) and the Project specific noise criteria for the following discrete construction activities:

- The bulk earthworks required for the construction of the new pit top facilities. Construction activities would occur between the hours of 7.00 am to 6.00 pm Monday to Friday, and 7.00 am to 1.00 pm Saturday, with no construction activities on Sundays or on public holidays.
- The development of the two drifts by two road headers. Development of the drifts would occur 24 hours per day, seven days per week, and for a short period (i.e. several weeks) the road headers would be close to the surface, before moving further underground (where they would be inaudible).
- Raise-bore drilling activities associated with the construction of the ventilation shaft for the new pit top facilities. Drilling would occur 24 hours per day, seven days per week. Construction of the ventilation shaft would occur simultaneously with the operation of the new pit top facilities (Figure 2-8).

Potential noise impacts associated with all construction activities were predicted to be below the *Interim Construction Noise Guideline* construction noise goals and Project specific noise criteria at all receivers at all times (Appendix I). In addition, the total noise levels associated with the simultaneous operation of the new pit top facility and the construction of the upcast ventilation shaft were predicted to be below the Project specific noise criteria at all residential receivers at all times (Appendix I).



Source: Department of Lands (2009); Donaldson Coal Pty Ltd (2009, 2011) and Department of Primary Industries (2012)

TASMAN EXTENSION PROJECT

FIGURE 4-23

Project Year 7 Operational Noise Contours

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Road Traffic Noise

Potential road traffic noise impacts were assessed against the criteria provided in the *NSW Road Noise Policy* (DECCW, 2011).

The assessment of road traffic noise focused on traffic generation along the coal haulage route (i.e. George Booth Drive north of the Project and John Renshaw Drive), as this route has the greatest potential for road traffic noise impacts, due to the trucks hauling coal to the Bloomfield CHPP during the day (7.00 am to 10:00 pm) only (Appendix I).

In addition, road traffic noise was assessed for George Booth Drive south of the Project, as this is the only transport route (i.e. for deliveries and employees) to the Project from the south.

Road traffic noise was assessed for the following scenarios:

- Project Year 1 (construction) – which represents road traffic movements during the Project, but prior to the commissioning of the Hunter Expressway (scheduled to occur at the end of 2013), with total haulage at the approved coal haulage rate of 4,000 tonnes per day (during the day only) and Project-related traffic associated with the construction of the new pit top facility. This existing approved coal haulage was considered to be non-Project related traffic, as these traffic movements could occur regardless of the approval of the Project.
- Project Year 5 – which represents peak Project-related traffic movements, with a rate of coal haulage of up to 6,200 tonnes per day (following the commissioning of the Hunter Expressway) during the day only, as per the existing coal haulage hours.

Potential Road Traffic Noise Impacts

No exceedance of the road traffic noise assessment criteria of 60 dBA $L_{Aeq(15\ hour)}$ and 55 dBA $L_{Aeq(9\ hour)}$ for the day and night, respectively, was predicted at the closest receivers along George Booth Drive or John Renshaw Drive for Project only road traffic noise (Appendix I).

Existing road traffic noise exceeds the relevant assessment criteria in the *NSW Road Noise Policy* at the closest receivers along George Booth Drive and John Renshaw Drive (Appendix I).

In Project Year 1, Project related construction traffic was predicted to result in increases to total road traffic noise at the closest receivers along George Booth Drive and John Renshaw of up to 0.4 dBA (Appendix I).

The *NSW Road Noise Policy* details that an increase of up to 2 dBA represents a minor impact that is considered barely perceptible for the average person (DECCW, 2011). As such, the increases to total road traffic noise associated with Project related construction traffic would be barely perceptible (Appendix I).

In Project Year 5, following the commissioning of the Hunter Expressway, there was predicted to be a significant reduction (i.e. greater than 6 dBA) in total road traffic noise experienced by receivers along George Booth Drive (Appendix I).

Notwithstanding, barely perceptible exceedances (i.e. up to 2.2 dBA) of the road traffic noise assessment criteria were predicted for the closest receivers (Appendix I):

- along George Booth Drive north of the Project during the day (2.2 dBA exceedance), with no exceedance predicted during the night; and
- along George Booth Drive south of the Project during the night (0.5 dBA exceedance), with no exceedance predicted during the day.

Although barely perceptible exceedances of the road traffic noise assessment criteria are predicted at the closest receivers, it should be noted that, as described above, a significant reduction in total road traffic noise is predicted following the commissioning of the Hunter Expressway.

In Project Year 5, Project related traffic was predicted to result in barely perceptible increases to total road traffic noise of up to 0.5 dBA at the closest receivers along John Renshaw Drive (Appendix I).

Construction Blasting

The maximum instantaneous charge of any blasts required during excavation of the box cut at the new pit top facility would be designed to achieve the relevant vibration damage criteria for all surface infrastructure and residences, in particular the Ausgrid 132 kV transmission line adjacent to the new pit top facility.

Underground Blasting

Igneous rock dykes have been identified to intersect some underground mining areas, and these dykes may require blasting to allow underground mining to continue (Section 2.2).

For all known dyke locations, the level of ground vibration associated with any required underground blasting was predicted to be significantly below the relevant vibration damage and annoyance risk criteria for all surface infrastructure (e.g. residences on Sheppeard Drive, transmission lines, buried FOCs and communication towers located on Mount Sugarloaf) (Appendix I).

It is possible that blasting may be required at other locations if further dykes and other geological features are discovered during mining. For all surface infrastructure, except residences, underground blasting was not predicted to exceed the relevant vibration damage and annoyance risk criteria for any location within the Project underground mining area (Appendix I). Underground blasting for the Project would not occur within the minimum offset distance (144 m) for residences identified by SLR Consulting (2012), or the blast size would be lowered such that vibration levels would comply with the relevant damage criteria.

Road Traffic Vibration

Trucks hauling coal from the Project to the Bloomfield CHPP were not expected to exceed the damage or annoyance vibration criteria at any receiver located along the coal haulage route (i.e. George Booth Drive north of the Project or John Renshaw Drive) (Appendix I).

4.13.3 Mitigation Measures, Management and Monitoring

Mitigation Measures

Operational Noise

Noise modelling conducted by SLR Consulting (2012) identified the ventilation fan as the largest contributor of noise at residential receivers. As described in Section 4.13.2, to mitigate potential noise impacts, the ventilation fan would discharge horizontally, and would be oriented away from the closest residential receivers (i.e. it would be oriented to the south) (Appendix I).

Construction Noise

The following mitigation measures would be implemented to minimise construction noise (Appendix I):

- Construction of the new pit top facility would generally adhere to daytime construction hours (with the exception of the construction of the drifts and drilling of the upcast ventilation shaft, as described above).
- Noisy plant operating simultaneously would be avoided wherever possible.
- Maintenance work on all construction plant would be carried out away from noise sensitive areas and confined to standard daytime construction hours.
- Noisy equipment would be situated behind structures that act as barriers, or at the greatest distance from the noise-sensitive areas, or oriented so that noise emissions are directed away from any sensitive areas.
- Equipment would be well maintained.
- Raise-bore drilling operations for the construction of the ventilation shaft would be partially enclosed in a shed.

In addition, community members and the Tasman Underground Mine Community Consultative Council would be informed of the timing of construction activities (i.e. commencement date, duration of construction and operating hours) prior to their commencement.

Road Traffic Noise

As described in the *NSW Road Noise Policy* (DECCW, 2011), projects that generate additional traffic on existing roads have limited potential for noise control, because these developments are not usually linked to road improvements.

The key road traffic noise mitigation measure for the Project is the restriction of coal haulage truck movements to the day (7.00 am to 10:00 pm) only on weekdays, 7.00 am to 6.00 pm on Saturdays (26 Saturdays per year) and no ROM coal haulage on Sundays or public holidays (Section 2.7).

In addition, the following noise mitigation measures and strategies would be implemented for the Project (Appendix I):

- Staff and drivers would be made aware of the potential for noise impact through site-specific inductions and staff education programs to reinforce quiet driving styles/attitudes.
- The number of vehicle trips to and from the site would be optimised by ensuring that haul trucks are loaded to their operating capacity.
- All loose and rattling truck body parts would be fixed or tightened to minimise noise emissions from ‘body rumble’ (i.e. when loose panels vibrate when the truck hits a bump, causing noise to emanate from the panel).

Noise Monitoring

The operational noise monitoring conducted for the Tasman Underground Mine would continue to be conducted for the Project. In addition to the noise monitoring locations at Seahampton and West Wallsend, noise monitoring locations would be established at proposed locations on George Booth Drive and Sheppeard Drive (subject to landowner agreement) (Figure 4-22a).

Road traffic noise monitoring would be conducted on George Booth Drive north of the Project, consistent with the timing and location of the operational noise monitoring at the proposed location on George Booth Drive.

The Abel Underground Coal (Integrated with Donaldson Open Cut, Tasman Underground and Bloomfield Open Cut Coal Mines) Integrated Environmental Monitoring Program and the Environmental Monitoring Program would be updated to reflect the additional operational noise and road traffic noise monitoring for the Project.

The results of noise monitoring would be reported in the AEMRs for the Project.

Blast Monitoring

Should underground blasting be required, blast monitoring would be conducted. The monitoring would be used to validate the predicted vibration levels detailed in Appendix I. The results of blast monitoring would be reported in the AEMRs for the Project.

4.14 AIR QUALITY

An Air Quality and Greenhouse Gas Assessment for the Project was undertaken by PAEHolmes (2012) and is presented as Appendix J. The assessment was conducted in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants* (Approved Methods) (DEC, 2005b).

A description of the existing environment relating to air quality is provided in Section 4.14.1. Section 4.14.2 describes the potential impacts of the Project to air quality, and Section 4.14.3 outlines air quality mitigation, management and monitoring measures.

Project greenhouse gas emissions are discussed in Section 4.15.

4.14.1 Existing Environment

Air Quality Criteria

Concentrations of Suspended Particulate Matter

Surface handling activities associated with the existing Tasman Underground Mine and the Project (as described in Section 2) have the potential to generate particulate matter (i.e. dust) in the form of:

- Total suspended particulate (TSP) matter, which refers to all suspended particles in the air and are typically less than 30 to 50 micrometres (μm) in aerodynamic diameter.
- Particulate matter with an equivalent aerodynamic diameter of 10 μm or less (PM_{10}) (a subset of TSP).
- Particulate matter with an equivalent aerodynamic diameter of 2.5 μm or less ($PM_{2.5}$) (a subset of TSP and PM_{10}). Often referred to as the fine particles.

Exposure to suspended particulate matter can result in adverse health impacts. The likely risk of these impacts to a person depends on a range of factors including the size, chemical composition and concentration of the particulate matter, and the existing health of the person (NSW Health and NSW Minerals Council, 2011).

For TSP and PM_{10}, the assessment criteria detailed in the Approved Methods (DEC, 2005b) are generally based on the thresholds relating to human health effects (i.e. they are set at levels to reduce the risk of adverse health effects). These criteria have been developed to a large extent in urban areas, where the primary pollutants are the products of combustion, which are more harmful than particulates of crustal origin, such as particulate matter from mining operations (Appendix J).

The Approved Methods (DEC, 2005b) does not specify criteria for $PM_{2.5}$. However, the DGRs for the Project require the assessment of $PM_{2.5}$. As such, PAEHolmes (2012) has assessed potential impacts associated with $PM_{2.5}$ emissions against the criteria specified in the *National Environment Protection (Ambient Air Quality) Measure* (Ambient Air-NEPM) (as amended) made under the Commonwealth *National Environment Protection Council Act, 1994* and NSW *National Environment Protection Council (New South Wales) Act, 1995*.

Relevant health based air quality criteria, as specified in the Approved Methods (DEC, 2005b) and Ambient Air-NEPM, are provided in Table 4-21.

Table 4-21
OEH and Ambient Air-NEPM Criteria for Particulate Matter Concentrations

Pollutant	Averaging Period	Criteria ($\mu g/m^3$)
TSP	Annual mean	90
PM_{10}	24-hour maximum	50
	Annual mean	30
$PM_{2.5}$	24-hour maximum	25
	Annual mean	8

Source: After Appendix J.
$\mu g/m^3$ = micrograms per cubic metre.

Dust Deposition

Particulate matter has the potential to cause nuisance (amenity) effects when it is deposited on surfaces.

The amenity criteria for the maximum increase in dust deposition and maximum total dust deposition, as specified by the Approved Methods (DEC, 2005b) are provided in Table 4-22.

Table 4-22
OEH Criteria for Dust (Insoluble Solids) Deposition

Pollutant	Averaging Period	Maximum Increase in Deposited Dust Level (g/m^2/month)	Maximum Total Deposited Dust Level (g/m^2/month)
Deposited Dust	Annual	2	4

Source: After Appendix J.
g/m^2/month = grams per square metre per month.

Existing Air Quality and Environmental Compliance

Air Quality Monitoring Regime

An air quality monitoring network for the Tasman Underground Mine was established in November 2006 to monitor dust deposition and dust concentrations (as PM_{10} and TSP) in the vicinity of the mine. The current monitoring network includes (Figure 4-22a):

- two HVASs located near Seahampton, measuring PM_{10} and TSP concentrations on a six day cycle; and
- three dust deposition gauges, located to the north and south of the Tasman Underground Mine, and at Seahampton, measuring dust deposition rates on a 30 day cycle.

PM_{10} and TSP Concentrations

Since monitoring began in 2006, the HVAS have not recorded annual average TSP and PM_{10} concentrations above the relevant criteria concentrations of 90 and 30 $\mu g/m^3$, respectively (Appendix J).

Recorded annual average TSP and PM_{10} concentrations for the period 2006 to 2011 are provided in Table 4-23.

During the monitoring period, the recorded 24-hour average PM_{10} exceeded the criteria level of 50 $\mu g/m^3$ on three occasions (5 May 2007, 31 December 2007 and 20 October 2008) (Appendix J). No significant events (e.g. bushfire or dust storm) were reported for these days, however the HVAS in the Air Quality Monitoring Network for the Donaldson Open Cut Mine also recorded elevated PM_{10} concentrations on 5 May 2007 and 20 October 2008, indicating that at least two of the three exceedances recorded at the Tasman HVAS were due to regional events (Appendix J).

Dust Deposition

There have been no exceedances of the dust deposition criterion of 4 g/m^2/month (annual average) for the monitoring period. Annual average dust deposition rates for the period 2006 to 2011 are provided in Table 4-23.

Air Quality for Assessment Purposes

The assessment of air quality impacts for the Project requires background particulate matter concentrations and dust deposition levels to be defined. It should be noted that the locations of the HVAS and dust gauges means that recorded air quality data includes any contributions resulting from surface operations at the Tasman Underground Mine (Appendix J). Therefore, use of this data to define background levels has the potential to result in double counting for predicted impacts from the Project plus background sources.

Notwithstanding the above, for assessment purposes, the following background levels have been adopted based on average recorded levels for all monitoring years (Table 4-23) (Appendix J):

- annual average TSP concentration of 31 $\mu g/m^3$;
- annual average PM_{10} concentration of 16 $\mu g/m^3$; and
- annual average dust deposition of 1.1 g/m^2/month.

An annual average $PM_{2.5}$ background level of 5 $\mu g/m^3$ was adopted for the assessment, based on an average ratio of $PM_{2.5}$ to PM_{10} of approximately 0.3, as recorded by co-located monitors for PM_{10} and $PM_{2.5}$ operated by the EPA at Beresfield and Wallsend.

Mitigation Measures

Emissions associated with the handling of ROM coal, ROM coal haulage on unsealed roads and wind erosion from the active ROM coal stockpile are managed and mitigated through the use of a water cart at the existing pit top facility. In addition, a wheel wash is located at the existing pit top facility, reducing the potential for dirt track out from the ROM coal haulage trucks on to public roads.

Complaints

No complaints associated with air quality have been received for the Tasman Underground Mine to date.

Table 4-23
Annual Average Air Quality Monitoring Results

Year	HVAS		Dust Deposition Gauges		
	PM_{10} ($\mu g/m^3$)	TSP ($\mu g/m^3$)	D01 (g/m^2)	D02 (g/m^2)	D03 (g/m^2)
2006	14	31	1.3	1.3	1.3
2007	19	35	0.6	0.8	0.7
2008	16	31	0.7	1.1	0.9
2009	16	32	1.3	1.3	1.8
2010	12	26	0.6	1.3	0.8
2011	15	32	0.6	2.0	1.2
Average	**16**	**31**	**0.8**	**1.3**	**1.1**

Source: After Appendix J.

Note: Refer Figure 4-22a for air quality monitoring locations.

4.14.2 Potential Impacts

Assessment Methodology

Modelling Scenarios

Air quality impacts for the Project were assessed for two operational scenarios:

- Project Year 2 – which represents concurrent operations at the existing and new pit top facilities (Figure 2-8), with assumed ROM coal production rates of 460,000 tpa and 1,039,000 tpa from the existing and new pit top facilities, respectively[7]; and
- Project Year 7 – which represents operations at the new pit top facilities at the maximum ROM coal production rate of 1.5 Mtpa.

Emission Inventories

Emission inventories were prepared for Years 2 and 7 in consideration of the expected ROM coal production rates from the underground mining operations. Sources of emissions were limited to ROM coal handling, loading and transport at the existing and new pit top facilities. The largest source of emissions was predicted to be the loading of ROM coal to and from the ROM coal stockpiles (Appendix J).

Dispersion Modelling

The CALMET/CALPUFF modelling system was used by PAEHolmes (2012) to assess potential air quality impacts associated with the Project. The modelling methodology is described in detail in Appendix J.

Potential Impacts

Potential air quality impacts resulting from the Project only were predicted to be well below the relevant air quality criteria listed in Tables 4-21 and 4-22 at all privately owned residences (Appendix J). In addition, no exceedance of the relevant air quality criteria was predicted on greater than 25% of privately-owned vacant land.

Figure 4-24 shows the predicted maximum Project only 24-hour PM_{10} contours for Years 2 and 7. Additional air quality contour plots are provided in Appendix J.

No exceedances of the relevant annual average criteria (Tables 4-21 and 4-22) were predicted when accounting for background concentrations and levels listed in Section 4.14.1 (Appendix J).

The maximum predicted increment in 24-hour PM_{10} and $PM_{2.5}$ concentrations from the Project at any residential receptor were predicted to be well below the relevant criteria. As such, any potential exceedance of the relevant criteria would be largely due to non-mine sources (Appendix J).

Cumulative Impacts

The adopted background levels used for the assessment of potential impacts associated with the Project were developed based on monitoring data in the region of the Project, and therefore, are inclusive of any dust generated by existing industrial operations. However, recently approved (but not operational) projects, and proposed projects, are not included in the adopted background levels.

Air quality contour plots for Years 2 and 7 of the Project are shown in Figure 4-24. Results for all assessed receiver locations are provided in Appendix J.

An assessment of cumulative impacts for the Project and recently approved or proposed projects was conducted for the Orica Ammonium Nitrate Emulsion Project, West Wallsend Colliery Continued Operations Project, Abel Underground Mine Modification and Hunter Expressway (Appendix J). Based on the predicted air quality impacts for these projects (as detailed in their respective environmental assessments) and the air quality impacts predicted for the Project by PAEHolmes (2012) (and detailed above), no cumulative exceedance of the relevant air quality criteria was predicted (Appendix J).

Potential Construction Impacts

An estimate of potential particulate matter emissions for the construction of the Project (i.e. the bulk earthworks required for the construction of the new pit top facility) was conducted (Appendix J). The total emissions were estimated to be less than 40% of the emissions estimated for the operational scenarios (i.e. Project Years 2 and 7). On the basis that compliance with the relevant criteria was predicted for the operation of the Project, compliance with the relevant criteria was also predicted for the construction period (Appendix J).

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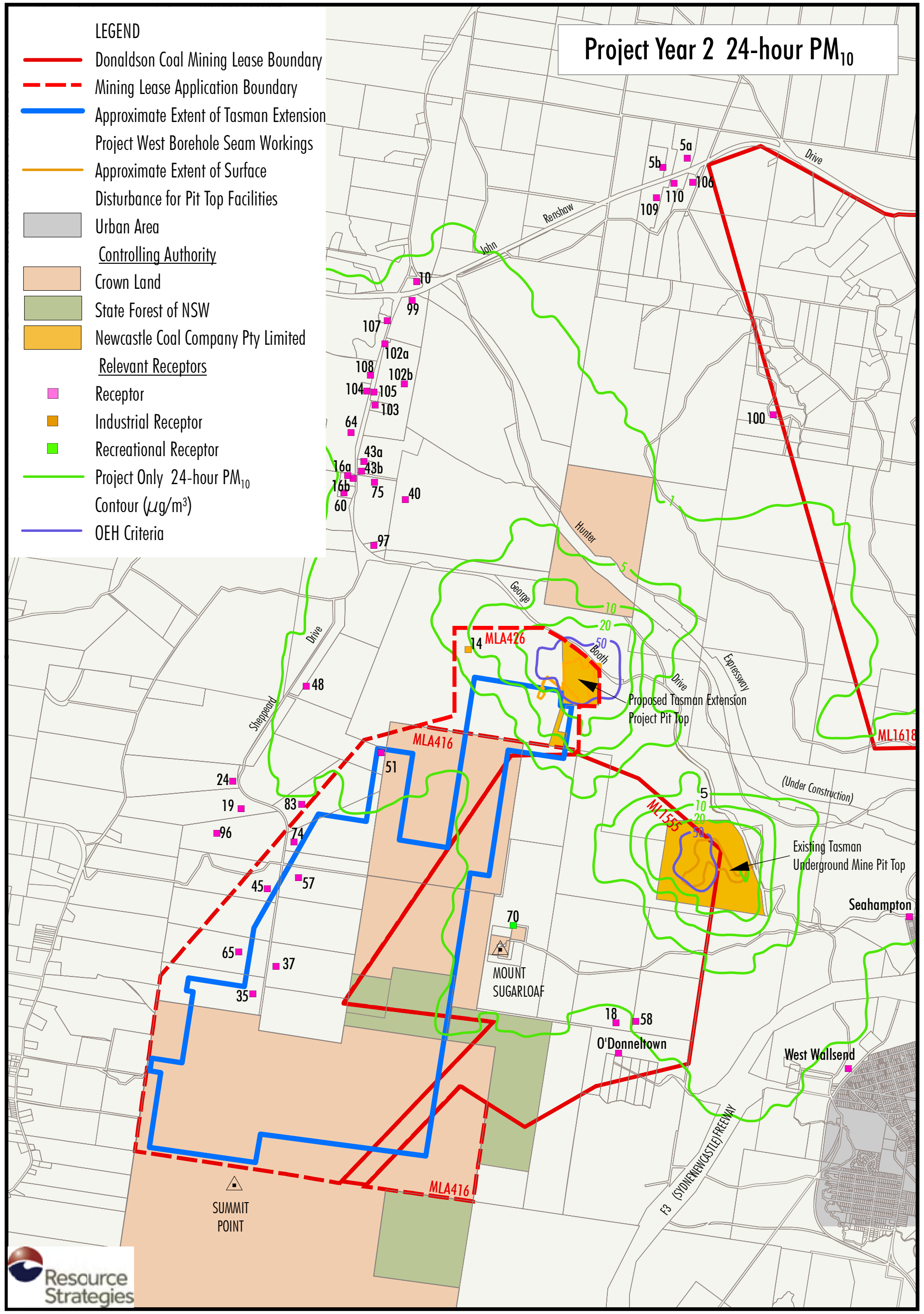
7 It should be noted that ROM coal production from the existing pit top facilities is expected to be lower than the rate that has been conservatively assessed (Table 2-2).



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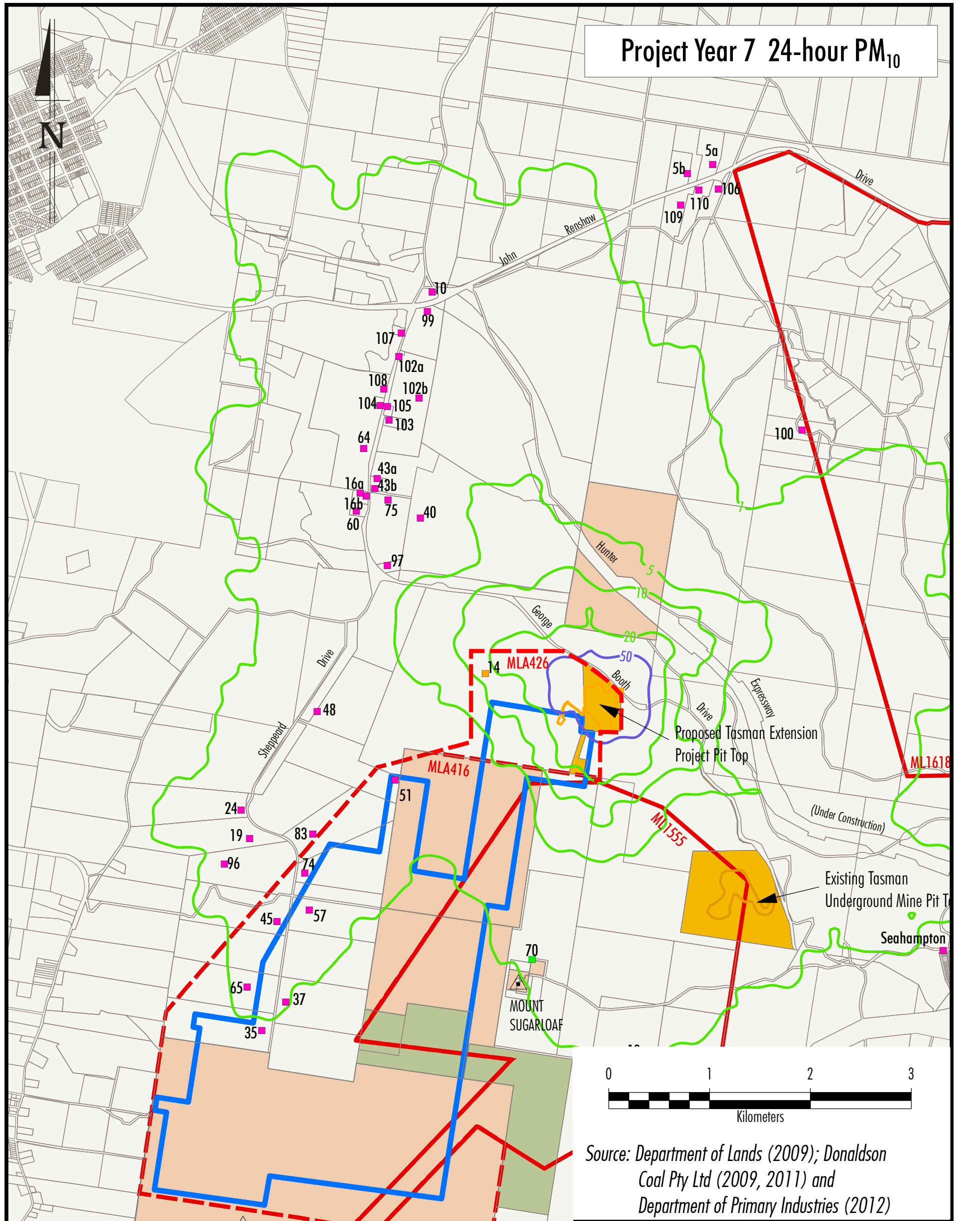

TASMAN EXTENSION PROJECT

FIGURE 4-24

Project 24-Hour PM_{10} Air Qualiy Contours

Road Transport

In comparison to all other road transport vehicles, coal haulage trucks have the potential to generate fugitive coal dust emissions (e.g. from wind erosion of the coal surface if the coal load is uncovered).

All haulage trucks transporting ROM coal from the Project to the Bloomfield CHPP would have their loads covered, as per the existing coal haulage operations at the Tasman Underground Mine, and in accordance with the Road Transport Protocol.

Covering the loads of haul trucks would effectively prevent fugitive coal dust emissions (Appendix J).

All road transport vehicles have the potential to generate particulate matter emissions through wheel generated dust and exhaust emissions. To prevent dirt track out onto public roads, and therefore prevent additional wheel generated dust from all road transport vehicles, a wheel wash is installed at the existing Tasman Underground Mine pit top facility, and a wheel wash would be installed at the new pit top facility for the Project.

4.14.3 Mitigation Measures, Management and Monitoring

Mitigation Measures

Emissions associated with the handling of ROM coal, ROM coal haulage on unsealed roads at the pit top facilities and wind erosion from the active ROM coal stockpile would continue to be managed and mitigated through the use of water carts at both the existing and the new pit top facilities.

Based on the existing air quality monitoring results and predicted impacts from the Project, the use of water carts would control emissions to an acceptable level, and as such are considered to be best practice, in accordance with the EPA best practice document *NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining* (Katestone Environmental Pty Ltd, 2011).

Monitoring

The existing monitoring network would be reviewed and augmented for the Project. This would include additional dust deposition gauges at the proposed locations shown on Figure 4-22a (i.e. on George Booth Drive and Sheppeard Drive) (note that these locations would be subject to landowner agreement).

The Abel Underground Coal (Integrated with Donaldson Open Cut, Tasman Underground and Bloomfield Open Cut Coal Mines) Integrated Environmental Monitoring Program and Environmental Monitoring Program would be updated to reflect the review of the existing monitoring regime that would be conducted for the Project.

The results of air quality monitoring would be reported in the AEMRs for the Project.

4.15 GREENHOUSE GAS EMISSIONS

4.15.1 Quantitative Assessment of Potential Scope 1, 2 and 3 Greenhouse Gas Emissions

A quantitative assessment of Project greenhouse gas emissions was undertaken by PAEHolmes (2012) and is provided in Appendix J. A summary of the assessment is provided below.

Greenhouse Gas Protocol Emission Scopes

The Greenhouse Gas Protocol (GHG Protocol) (World Business Council for Sustainable Development [WBCSD] and World Resources Institute [WRI], 2004) defines three ‘scopes’ of emissions (scope 1, scope 2 and scope 3).

Scopes 1 and 2 have been defined such that two or more entities would not account for emissions in the same scope, as follows (WBCSD and WRI, 2004):

- Scope 1 (Direct Greenhouse Gas Emissions) – defined as those emissions that occur from sources that are owned or controlled by the entity.
- Scope 2 (Electricity Indirect Greenhouse Gas Emissions) – indirect emissions that account for greenhouse gas emissions from the generation of purchased electricity consumed by the entity.

In addition, scope 3 emissions are defined as those emissions that are a consequence of the activities of an entity, but which arise from sources not owned or controlled by that entity. Examples of scope 3 activities provided in the GHG Protocol are extraction and production of purchased materials, transportation of purchased fuels, and use of sold products and services (WBCSD and WRI, 2004).

The GHG Protocol provides that reporting scope 3 emissions is optional (WBCSD and WRI, 2004). If an organisation believes that scope 3 emissions are a significant component of the total emissions inventory, these can be reported along with scope 1 and 2. However, the GHG Protocol notes that reporting scope 3 emissions can result in double counting of emissions and can also make comparisons between organisations and/or projects difficult because reporting is voluntary.

Greenhouse Gas Emissions Estimation

Scope 1 and 2 greenhouse gas emissions and key scope 3 greenhouse gas emissions have been estimated by PAEHolmes (2012) using published emission factors from the *National Greenhouse Accounts Factors July 2011* (NGA Factors) (Commonwealth Department of Climate Change and Energy Efficiency [DCCEE], 2011a), where possible. Where NGA emission factors were not available (e.g. for rail transport of product coal) other published emissions factors have been used.

The NGA Factors gives greenhouse gas emission factors for carbon dioxide, methane and nitrous oxide. Emission factors are standardised for each of these greenhouse gases by being expressed as a carbon dioxide equivalent (CO_2-e) based on their Global Warming Potential. This is determined by the differing times greenhouse gases remain in the atmosphere and their relative effectiveness in absorbing outgoing infrared radiation (e.g. methane has a Global Warming Potential 21 times that of carbon dioxide) (DCCEE, 2011b).

Emissions of carbon dioxide and methane would be the most significant greenhouse gases for the Project (Appendix J).

Project Greenhouse Gas Emissions

The Project would generate greenhouse gas emissions associated with the following:

- fuel consumption (diesel) during underground mining operations, ROM coal transport and construction (scope 1);
- release of fugitive methane during underground mining (scope 1);
- indirect emissions associated with on-site electricity use (scope 2);
- indirect emissions associated with the production and transport of fuels (scope 3);
- emissions from electricity consumed for the processing of Project ROM coal at the Bloomfield CHPP (scope 3);
- emissions from the transport of Project product coal by rail (scope 3); and
- emissions from the use of the product coal (scope 3).

The total direct (i.e. scope 1) emissions over the life of the Project are estimated to be approximately 0.3 Mt CO_2-e (or 300 kt CO_2-e), which is an average of approximately 20 kt CO_2-e per annum over the life of the Project (Appendix J).

Annual average scope 1 emissions would represent approximately 0.003% of Australia's Kyoto Protocol commitment (an average of 591.5 Mt CO_2-e per annum for the period 2008 to 2012) and a very small portion of global greenhouse emissions.

Project Greenhouse Gas Emissions Intensity

Using the annual emission calculations, the estimated greenhouse gas emissions intensity of the Project is approximately 0.02 t CO_2-e per tonne of ROM coal (this includes all scope 1) (Appendix J).

The estimated emissions intensity of the Project product coal is less than the average scope 1 emissions intensity of existing open cut and underground coal mines in Australia (0.05 t CO_2-e/t saleable coal) (Deslandes, 1999) (Appendix J).

Potential Impacts of Greenhouse Gas Emissions on the Environment

The Project's contribution to projected climate change, and the associated environmental impacts, would be in proportion with its contribution to global greenhouse gas emissions (Appendix J).

The Project's contribution to Australian and global emissions would be relatively small. Estimated average annual scope 1 emissions from the Project (20 kt CO_2-e) represent approximately 0.003% of Australia's commitment under the Kyoto Protocol (591.5 Mt CO_2-e) (Appendix J), and a very small portion of global greenhouse emissions, given Australia contributed approximately 1.5% of global greenhouse gas emissions in 2005 (Commonwealth of Australia, 2011).

Increased greenhouse gas levels have the potential to alter climate variables such as temperature, rainfall and evaporation. Projected changes to climate variables would have associated impacts, including to land, settlements and ecosystems, as described in Section 6.7.3.

4.15.2 Australian Greenhouse Gas Emission Reduction Targets and Proposed Carbon Pricing Mechanism

The potential impacts of greenhouse gas emissions from all Australian sources will be collectively managed at a national level, through initiatives implemented by the Commonwealth Government. The Commonwealth Government has committed to reduce greenhouse gas emissions by between 5 to 25% below 2000 levels by 2020, with the level of reduction dependent on the extent of reduction actions undertaken internationally (Commonwealth of Australia, 2011).

The Federal Opposition has committed to a 5% reduction below 1990 levels by 2020 (Liberal Party of Australia, 2010).

Greenhouse gas emissions from the Project would contribute to Australia's greenhouse gas emissions inventory, and would be considered in these emission reduction targets.

The commitment from the Australian Government to reduce greenhouse gas emissions is proposed to be achieved through the introduction of the Australian Government's proposed carbon pricing mechanisms. From 1 July 2012, this will involve a fixed price on greenhouse gas emissions, with no cap on Australia's greenhouse gas emissions, or emissions from individual facilities (Commonwealth of Australia, 2011).

From 1 July 2015 an emissions trading scheme is proposed to be implemented. As such, Australia's greenhouse gas emissions, inclusive of emissions associated with the Project, would be capped at a level specified by the Australian Government. Under the emissions trading scheme, there will specifically be no limit on the level of greenhouse gas emissions from individual facilities, with the incentive for facilities to reduce their greenhouse gas emissions driven by the carbon pricing mechanism (Commonwealth of Australia, 2011).

The Project may exceed the facility threshold of 25,000 t CO_2-e per annum for participation in the carbon pricing mechanisms during the Project, and as such scope 1 greenhouse gas emissions from the Project would be subject to the carbon pricing mechanism.

As such, the Project may directly contribute to the revenue generated by the carbon pricing mechanism, which is to be used to fund the following initiatives designed to reduce Australia's greenhouse gas emissions (Commonwealth of Australia, 2011):

- $1.2 billion Clean Technology Program to improve energy efficiency in manufacturing industries and support research and development in low-pollution technologies.
- $10 billion Clean Energy Finance Corporation to invest in renewable energy, low-pollution and energy efficiency technologies.
- $946M Biodiversity Fund (over the first six years) to protect biodiverse carbon stores and secure environmental outcomes from carbon farming.

4.15.3 Project Greenhouse Gas Mitigation Measures, Management and Monitoring

The potential for reducing greenhouse gas emissions from the Project is related predominantly to consumption of diesel by plant and equipment. Minimising diesel and electricity consumption (and therefore greenhouse gas emissions) is an integral part of mine and financial planning at the Tasman Underground Mine, and this would continue for the Project. Energy reduction measures implemented for the Project would include:

- Employees would conduct awareness training to reinforce energy efficient operation of equipment (e.g. shutting down equipment that is not in use).
- Appropriately size power factor correction equipment would be installed to achieve a power factor of greater than 0.9.
- Equipment would be regularly maintained, minimising energy consumption requirements.
- High efficiency lighting would be installed.

Ongoing monitoring and management of greenhouse gas emissions and energy consumption for the Project would be achieved through Donaldson Coal's (as a subsidiary of GCL) participation in the Commonwealth Government's National Greenhouse and Energy Reporting System (NGERS). Under NGERS requirements, relevant sources of greenhouse gas emissions and energy consumption must be measured and reported on an annual basis, allowing major sources and trends in emissions/energy consumption to be identified.

4.16 REGIONAL AND NSW ECONOMIES

A Socio-Economic Assessment (including a regional economic impact assessment) was undertaken for the Project by Gillespie Economics (2012) and is presented in Appendix M.

The regional economic assessment was conducted at two different scales to assess the potential impact of the Project on the region and in NSW. The local region adopted for the Project was the Newcastle Statistical Subdivision (SSD), which includes the Cessnock, Lake Macquarie, Maitland, Port Stephens and Newcastle Statistical Local Areas.

Regional economic assessment is primarily concerned with the effect of a proposal on an economy in terms of specific indicators, such as gross regional output (business turnover), value-added, income and employment. The regional economic assessment is based on analysis of a 2005 to 2006 input-output table (i.e. Newcastle SSD) and NSW economies.

A summary of the existing regional and NSW economy is provided in Section 4.16.1. The potential impacts of the Project on the regional and NSW economies are described in Section 4.16.2, while mitigation measures are provided in Section 4.16.3.

4.16.1 Existing Environment

The gross regional product for the regional economy (i.e. Newcastle SSD) is estimated at $19,303M, comprising $11,450M to households as wages and salaries (including payments to self employed persons and employers) and $7,854M in other value-added contributions (Appendix M).

The total employment in the region was estimated to be 181,688 people.

The regional and NSW economies are similar, with the main difference being the greater relative importance of the manufacturing sectors to the regional economy as well as the greater relative importance of gross regional product (value-added) and output in the mining and utilities sectors to the regional economy (Table 4-24).

In terms of gross output in the regional economy, the business services sectors and metal manufacturing sectors are the most significant (Appendix M). The business services sectors is the most significant in terms of value-added and income (Appendix M). The most significant sectors in terms of exports and imports are the metal manufacturing sectors (Appendix M).

The retail sector is the most significant sector to the regional economy in terms of employment (Appendix M).

4.16.2 Potential Impacts

The regional economic impact assessment in Appendix M included consideration of the impacts of the Project (including construction) on both the regional (i.e. Newcastle SSD) and NSW economies, and also potential impacts at the cessation of the Project.

Table 4-24
Contributions to Employment, Gross Regional Product and Output by Industry Sector – Regional and NSW Economies (2005 to 2006)

Sector	Total Employment (%)		Contribution to GRP (%)		Contribution to Output (%)	
	Regional	NSW	Regional	NSW	Regional	NSW
Agriculture, Forestry and Fishing	1	3	1	2	1	2
Mining	1	1	4	2	3	2
Manufacturing	13	11	15	11	25	19
Utilities	1	1	3	2	5	3
Building	6	7	6	6	8	9
Services	78	77	66	71	58	65

Source: After Appendix M.
Note: Rows may not sum to 100% due to rounding.

Construction

During the construction phase of the Project, an additional 20 people would be required in the short-term (12 to 18 months). The construction of the Project is predicted to have up to the following impacts on the regional economy (Appendix M):

- $12M in annual direct and indirect output;
- $5M in annual direct and indirect regional value added;
- $3M in annual direct and indirect household income; and
- 43 direct and indirect jobs.

The impact of construction on the NSW economy would be greater than at the regional level as the larger NSW economy is able to capture more of the expenditure associated with construction and the level of intersectoral linkages (as reflected by the multipliers) are larger.

Operation

The operation of the Project is predicted to have up to the following impacts on the regional economy at peak production (Appendix M):

- $193M in annual direct and indirect regional output or business turnover;
- $97M in annual direct and indirect regional value-added;
- $37M in annual household income; and
- 404 direct and indirect jobs.

Businesses that can provide the inputs to the production process required by the Project and/or the products and services required by employees would directly benefit by way of an increase in economic activity. However, because of the inter-linkages between sectors, many indirect businesses would also benefit (Appendix M).

Flow-on impacts from the Project are likely to affect a number of different sectors of the regional economy. The sectors most impacted by output, value-added and income flow-on are likely to be services to mining; services to transport; scientific research, technical and computer services; coal mining services; other business services; and the retail trade sector (Appendix M).

The Project would provide additional direct employment for over 40 people during operations (i.e. Donaldson Coal staff and on-site contractors). Of the approximately 150 direct jobs provided by the Project, 140 employees are assumed to reside in the region, based on existing distribution of employees (Appendix M).

In total, the operation of the Project is predicted to have up to the following impacts on the NSW economy at peak production (Appendix M):

- $281M in annual direct and indirect output or business turnover;
- $141M in annual direct and indirect value-added;
- $65M in annual household income; and
- 736 direct and indirect jobs.

The potential impacts of the Project on the NSW economy are expected to be substantially greater than for the regional economy alone, as more Project and household expenditure would be captured, and there is a greater level of inter-sectoral linkages in the larger NSW economy (Appendix M).

End of Project Life

The continuation and extension of the Tasman Underground Mine (i.e. the Project) would stimulate demand in the regional and NSW economy leading to increased business turnover in a range of sectors and increased employment opportunities. Cessation of the mining operations would result in a contraction in regional economic activity.

The magnitude of the regional economic impacts of cessation of the Project would depend on a number of interrelated factors, including the movements of workers and their families, alternative development opportunities and economic structure and trends in the regional economy at the time (Appendix M).

Continued and new mining resource developments in the region would help broaden the region's economic base and buffer against impacts of the cessation of individual activities (Appendix M). The Hunter Valley is a prospective location with a range of coal and coal seam methane resources (Appendix M).

4.16.3 Mitigation Measures, Management and Monitoring

Donaldson Coal would develop a Mine Closure Plan for the Project which would include details of the mine closure strategy (Section 5). The Mine Closure Plan would be developed in consultation with the Cessnock and Lake Macquarie City Councils, DP&I and the local community, and would include consideration of amelioration of potential adverse socio-economic effects due to the reduction in employment at Project closure.

4.17 EMPLOYMENT, POPULATION AND COMMUNITY INFRASTRUCTURE

Gillespie Economics (2012) assessed the potential impacts of the Project on existing regional community infrastructure as a result of employment and population change (Appendix M).

For the purposes of the employment, population and community infrastructure assessment, the Newcastle SSD was considered to be the local region.

Potential impacts of the Project on cumulative employment, population and community infrastructure demands are described in Section 4.17.1. Proposed Project mitigation measures are provided in Section 4.17.2.

4.17.1 Potential Impacts

Construction

It is anticipated that during the construction phase of the Project an additional 20 people would be required in the short-term (12 to 18 months).

It is envisaged that most of the required construction workforce would be contractor labour sourced from existing contractor firms located within the region. Any construction workforce unable to be sourced locally is expected to be sourced from Sydney and would commute to the region daily. Consequently, little, if any, population change as a result of the construction workforce is envisaged (Appendix M).

Operation

Employment in the Newcastle region in mining, construction, transport, professional/scientific/ technical services has been growing considerably over time and unemployment levels have been increasing since 2008 (Appendix M).

GCL, as the parent company of Donaldson Coal, operates a number of programs to aid in the local recruitment of its workforce including:

- offering apprenticeship opportunities (in conjunction with Hunter-V-Tec) within electrical and mechanical trades;
- the ‘Cleanskin’ program to introduce people to the mining industry who haven’t worked in the mining industry before; and
- a graduate development program.

It is therefore highly likely that all of the additional workforce required for the Project would already reside in the Newcastle region (Appendix M).

Notwithstanding, if it were conservatively assumed that all of the workforce migrated into the region, the maximum potential population influx is inconsequential in the context of the Lower Hunter Regional Strategy (DoP, 2006) which plans for an additional 160,000 residents and 115,000 new dwellings between 2006 and 2031.

Consequently, no additional impact on community infrastructure and no requirement for additional investment in community services and facilities are anticipated to result from the Project (Appendix M).

4.17.2 Mitigation Measures, Management and Monitoring

As described in Section 4.17.1, no additional impact on community infrastructure is anticipated as a result of the Project. Therefore, no specific mitigation measures or management are required for the Project.

Notwithstanding, Donaldson Coal and GCL would continue to develop and run programs that help in the recruitment of local labour and would work in partnership with Councils and the local community so that the benefits of the projected economic growth in the region are maximised and impacts minimised, as far as possible.

In this respect, a range of impact mitigation and management measures are proposed including:

- Continuation of the current community contributions policy which supports education, health and community causes.
- Continuation of current programs to aid in the local recruitment of its workforce, including offering apprenticeship opportunities, the 'Cleanskin' program and graduate development programs.
- Employment of local residents preferentially (where they have the required skills and experience and demonstrate a cultural fit with the organisation).
- Purchase local non-labour inputs to production preferentially where local producers can be cost and quality competitive.

4.18 HAZARD AND RISK

Potential incidents and hazards identified for the Project are described in Section 4.18.1. Proposed preventative and control measures to address the potential hazards identified are discussed in Section 4.18.2.

4.18.1 Hazard Identification and Risk Assessment

A Preliminary Hazard Analysis (PHA) (Appendix N) was conducted to evaluate the potential hazards associated with the Project in accordance with the general principles of risk evaluation and assessment outlined in *Multi-Level Risk Assessment* (DP&I, 2011). The results of the PHA are summarised below.

In addition to the offsite risks identified in the PHA, risks associated with the interaction of the Project with the historic Stockrington No. 2 Colliery workings are described below.

Preliminary Hazard Analysis

The PHA also addresses the requirements of *State Environmental Planning Policy No. 33 – Hazardous and Offensive Development* (SEPP 33) and has been assessed in general accordance with *Hazardous Industry Planning Advisory Paper No. 6: Hazard Analysis* (DoP, 2011).

This PHA considers off-site risks to people, property and the environment (in the presence of controls) arising from atypical and abnormal hazardous events and conditions (i.e. equipment failure, operator error and external events), with a specific focus on fixed installations on-site. As such, the main focus of the assessment was the on-site storage of the potentially hazardous materials (Appendix N).

The major potentially hazardous materials required for the Project include hydrocarbons (petrol, diesel, oils, greases, degreasers and kerosene), explosives and chemicals (Appendix N).

The following generic classes of incident associated with on-site storage were identified:

- leaks/spills;
- fire;
- explosion; and
- theft.

Following identification of the potential hazards associated with the Project, a qualitative assessment of the risks to the public, property and the environment associated with the Project was undertaken (Appendix N).

An assessment of the combination of the consequence and probability rankings concluded that the overall risk rankings for the identified hazards would be low, and therefore tolerable (Appendix N).

Interaction with Historic Stockrington No. 2 Colliery West Borehole Seam Workings

The new pit top facility is located above an area previously mined by the Stockrington No. 2 Colliery in the West Borehole Seam (Figure 4-25). Mine Advice Pty Ltd (2012) conducted an assessment of the long-term stability of the mine workings below the pit top facility.

Mine Advice Pty Ltd (2012) determined that mine workings beneath the new pit top facility are likely to be long-term stable, based on the level of confidence in the accuracy of the record tracings for the Stockrington No. 2 Colliery workings and the very low probability of pillar failure as calculated by the UNSW Pillar Design Procedure (Galvin *et al.*, 1998). As a result, any risk of mine subsidence affecting the new pit top facility can be provided for by structural design.

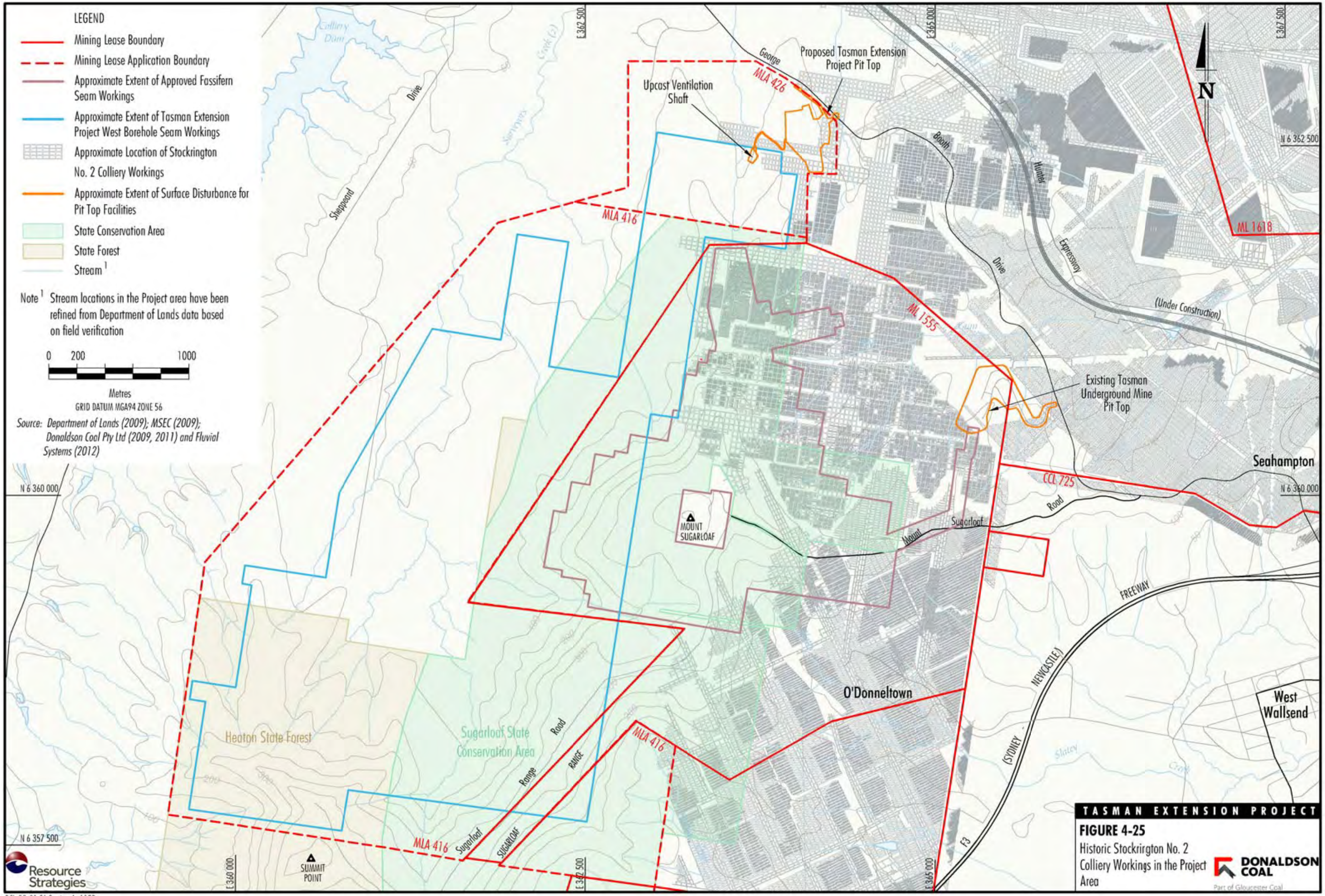

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FIGURE 4-25

Historic Stockrirgton No. 2 Colliery Workings in the Project Area

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The proposed West Borehole Seam workings for the Project are adjacent to the historic Stockrington No. 2 Colliery workings (Figure 4-25). A minimum 50 m barrier would be maintained between the new workings and the worst case position of the Stockrington No. 2 Colliery workings to avoid activities within an inrush control zone defined under the NSW *Coal Mine Health and Safety Regulation, 2006*.

4.18.2 Hazard Prevention and Mitigation Measures

Donaldson Coal implements a Health and Safety Management System at the Tasman Underground Mine for the management of hazards and associated risks of all activities that have the potential to cause harm to people or damage property (Donaldson Coal, 2009b).

The Health and Safety Management System includes the following components (Donaldson Coal, 2009b):

- System Elements (e.g. Health and Management System Overview, Occupational Health and Safety Policy, Drug & Alcohol Policy and Fatigue Management Policy).
- Major Hazard Management Plans (e.g. Underground Transport Management Plan, Strata Failure Management Plan, Inrush Management Plan, Pillar Extraction Management Plan, Fire and Explosion Management Plan, Dust Explosion Management Plan, Explosives Management Plan, Spontaneous Combustion Management Plan and Outburst Management Plan).
- Management Structure.
- Contractor Management Plan.
- Electrical Engineering Management Plan.
- Mechanical Engineering Management Plan.
- Emergency Management System (including Withdrawal Conditions and Bushfire Management Plan).
- Other Components (e.g. Inspection Program, Supervision Arrangements, Gas Monitoring Arrangements and Ventilation Arrangements).

In addition, hazard control and mitigation measures are also described in the following existing Tasman Underground Mine management documents and systems:

- Site Water Management Plan.
- Surface and Groundwater Response Plan.
- RFS Fire Management Plan.

Additional hazard control and mitigation measures would be incorporated into existing management plans or new management plans where required for the Project. The Inrush Management Plan would be revised to include provision of a minimum 50 m barrier between the West Borehole Seam workings for the Project and the worst case position of the Stockrington No. 2 Colliery workings.

In addition, the following hazard treatment measures would be adopted for the Project (Appendix N):

- Engineering Structures – Mining and civil engineering structures would be constructed in accordance with applicable codes, guidelines and Australian Standards. Where applicable, Donaldson Coal would obtain the necessary licences and permits for engineering structures.
- Contractor Management – All contractors employed by Donaldson Coal would be required to operate in accordance with the relevant Australian Standards, NSW and Commonwealth legislation, Health and Safety Management System and the Contractor Management Plan.
- Storage Facilities – Storage and usage procedures for potentially hazardous materials (i.e. fuels and lubricants) would be developed in accordance with Australian Standards and relevant legislation.
- Emergency Response – Emergency response procedures manuals and systems would continue to be implemented, including the Emergency Management System.

4.19 VISUAL CHARACTER

The visual character of the Project area from a regional, sub-regional and local setting is described in Section 4.19.1. Potential impacts on visual character as a result of the Project are assessed in Section 4.19.2, with proposed mitigation measures and management outlined in Section 4.19.3.

4.19.1 Existing Environment

The following discussion makes reference to visual settings that are based on distance as follows:

- Regional setting – greater than 5 km;
- Sub-regional setting – 1 to 5 km; and
- Local setting – up to 1 km.

Regional Setting

The visual character of the Project area is dominated by the undulating to steep forested slopes of the Sugarloaf Range. The Sugarloaf Range extends from the Watagan Mountains (in the south) to Mount Sugarloaf (in the north), before descending north towards Black Hill and the flatter landscape south of the Maitland area. When viewed from the east, the Sugarloaf Range is the first major landscape elevation west of Newcastle and Lake Macquarie, and can therefore be viewed from many locations around the Lower Hunter Valley.

Mount Vincent at 426 m AHD, is the highest point on Sugarloaf Range, and is located to the south of the Project. Mount Sugarloaf has an elevation of 412 m AHD, but is more readily identifiable from various viewpoints due to the high communication towers located at the summit. The Sugarloaf Range is dominated by open forest, with areas of disturbance associated with the picnic area and transmission towers on the summit of Mount Sugarloaf, transmission line easements and access roads.

To the east of the Project and the Sugarloaf Range, is the F3 Freeway and urban and industrial development associated with West Wallsend, Holmesville and Killingworth. Cleared, undulating topography associated with rural land uses is located to the west of the Project and Sugarloaf Range.

Sub-Regional Setting

The Project area, including the underground mining areas, includes part of the Sugarloaf Range and Mount Sugarloaf. The western section of the Project area extends beneath the lower elevated areas leading towards the Surveyors Creek and Wallis Creek floodplain. The south-eastern section of the Project area includes the lower elevated Slatey Creek area, and the north-eastern section includes the vegetated catchment of Blue Gum Creek.

The area within the Surveyors Creek and Wallis Creek catchment includes disturbance associated with rural residential lots along Sheppeard Drive and the Orica Richmond Vale facilities. The area towards Slatey Creek has been previously disturbed by mining associated with Seaham No. 2 and 3 Collieries, and includes the village of O'Donneltown.

It has been established through previous studies that scenic quality increases as topographic ruggedness and relative relief increase (Leonard and Hammond, 1984; Anderson *et al.*, 1976; Burns and Rundell, 1969).

Using these factors, the wider Project area could be given a medium to high scenic quality compared to the surrounding areas, as the area has high relief, ruggedness and a natural landscape, with some degree of disturbance associated with the transmission towers on the top of Mount Sugarloaf. The scenic quality is also increased as the Sugarloaf Range is a highly visible natural landform in the Lower Hunter Valley.

Local Setting

Existing Pit Top Facility

The existing pit top facility is located below 100 m AHD on the north-eastern descent of the Sugarloaf Range.

Views of the existing pit top facility are restricted by the local undulating terrain and vegetation cover. Views of the access road at the existing pit top facility are available from George Booth Drive and Mount Sugarloaf Road where the roads cross electricity transmission line easements.

The visibility of night-lighting at the existing pit top is minimised by vegetation and the use of directional lighting away from George Booth Drive and Mount Sugarloaf Road.

New Pit Top Facility and Upcast Ventilation Shaft

The new pit top facility and upcast ventilation shaft are located below approximately 80 m AHD on the northern descent of the Sugarloaf Range.

The area is generally covered by mature vegetation, with some disturbance associated with various access tracks, unauthorised dumping of rubbish and the Ausgrid easement with transmission pylons and wires crossing the landscape.

The new pit top facility and upcast ventilation shaft areas could be allocated a low to moderate scenic quality as the area has local areas of disturbance and does not have the topographic ruggedness provided by the higher sections of the Sugarloaf Range.

Aesthetic Value of Streams

Streams in the Project area have the potential to provide aesthetic values to the public. The aesthetic value of streams is influenced by various existing land uses (e.g. private residential, industrial, forestry and state conservation area) and disturbances (such as channel modification and erosion). As there is little permanent water within the Project areas, the streams provide little recreational value (e.g. fishing).

The streams within the Sugarloaf State Conservation Area and Heaton State Forest would be publicly accessible from access roads and tracks that generally follow the ridgelines. Access to streams on the private properties on Sheppeard Drive and the Orica Richmond Vale facilities would be more limited.

The streams within the Project area are generally vegetated, have little channel modification and have a variety of bed materials and form that would provide aesthetic value to bushwalkers and other members of the public.

Aesthetic Value of Cliffs, Other Rock Features and Steep Slopes

The slopes along the Sugarloaf Range within the Project area include a variety of forms including continuous cliff lines, overhangs, cliff terraces, discontinuous rock outcrops, talus slopes and other vegetated steep slopes (Section 4.3.1). These areas provide aesthetic and recreational values to users within the Sugarloaf State Conservation Area.

The slopes along Sugarloaf Range are densely vegetated, which restricts the visibility of cliff lines at distance. Plate 4-20 shows the screening of the cliff lines along Sugarloaf Range at a distance of approximately 2 km from the cliff lines on Sheppeard Drive.

Source: Appendix A.

Plate 4-20 – View of Cliff Lines near Summit Point from Sheppeard Drive (facing south)

4.19.2 Potential Impacts

The visual character of the local area would not be significantly altered by the Project, as the Project involves underground mining with minimal surface disturbance.

Elements of the Project considered to have the potential to impact the visual landscape include:

- the continuation and eventual decommissioning of the existing Tasman Underground Mine pit top facility;
- development of the new pit top facility and upcast ventilation shaft;
- night-lighting;
- exploration works and other short-term surface activities;
- subsidence related impacts on watercourses; and
- subsidence related impacts on cliffs, other rock features and steep slopes.

The methods used to assess the potential visual impacts as a result of the Project are described below.

Assessment Methods

The potential visual impacts of the Project were qualitatively assessed using the techniques developed by EDAW Australia Pty Ltd (EDAW) (2006) which are largely based on those developed by the United States Department of Agriculture – Forestry Service (1974). The potential visual impacts of the Project were assessed by evaluating the level of visual modification of the development in the context of the visual sensitivity of relevant surrounding land use areas from which the Project may be visible.

The level of visual modification of a development can be measured as an expression of the visual interaction, or the level of visual contrast between the development and the existing visual environment (EDAW, 2006). Visual (viewer) sensitivity is a measure of how critically a change to the existing landscape is viewed from various use areas, and is a function of both land use and duration of exposure (i.e. individuals generally view changes to the visual setting of their dwelling more critically than changes to the visual setting of the broader setting in which they travel or work) (EDAW, 2006).

The visual impact resulting from the combination of visual modification and viewer sensitivity is shown in Table 4-25.

Table 4-25
Visual Impact Matrix

Viewer Sensitivity

Visual Modification		H	M	L
	H	H	H	M
	M	H	M	L
	L	M	L	L
	VL	L	VL	VL

VL = Very Low

L = Low

M = Moderate

H = High

Source: EDAW (2006).

For the purposes of the visual assessment, land use areas in the vicinity of the Project were characterised in terms of low, moderate or high visual sensitivity as shown in Table 4-26.

The extent to which the viewer may have become accustomed to visual modifications as a result of the existing pit top facility was also considered.

Table 4-26
Visual Sensitivity Levels

Land Use	Local Setting		Sub-regional Setting		Regional Setting
	0 to 0.5 km	0.5 to 1 km	1 to 2.5 km	2.5 to 5 km	>5km
Natural/Recreation Area	High	High	High	Moderate	Low
Residential	High	High	High	Moderate	Low
Tourist Roads	High	Moderate	Moderate	Low	Low
Other Major Roads	Moderate	Low	Low	Low	Low
Local Roads	Low	Low	Low	Low	Low
Industrial Areas	Low	Low	Low	Low	Low

Source: EDAW (2006).

Visual Impact Assessment

Existing Pit Top Facility

Minimal changes to the existing pit top facility would occur prior to placement in care and maintenance or decommissioning (Section 5).

Given the mass and scale of the existing buildings and structures, the potential visual modification as a result of any minor alterations to the pit top facility is considered to be very low.

Given the low visibility of the existing pit top facility, there would be minimal improvement in the visual modification following decommissioning of the existing pit top facility.

New Pit Top Facility and Upcast Ventilation Shaft

The presence of extensive mature native vegetation and undulating topography would limit the potential impacts of the new pit top facility and the upcast ventilation shaft. For example, views of the new pit top facility and the upcast ventilation shaft would be screened from Sheppeard Drive.

Potentially sensitive visual settings in the vicinity of the new pit top facility and upcast ventilation shaft include George Booth Drive, the Daracon Buttai Quarry access road, the Orica Richmond Vale facilities and access roads and tracks within the Sugarloaf State Conservation Area.

Vehicles travelling along George Booth Drive would have moderate viewer sensitivity to any visual modification (Table 4-26). Two viewpoints along George Booth Drive are shown on Figure 4-26 and on Plates 4-21 and 4-22.

Vehicles travelling westbound using the new roundabout would have a limited view of the access road to the new pit top facility, however further view would be restricted by the dense vegetation along George Booth Drive (Plate 4-21). Vehicles travelling eastbound on George Booth Drive would have limited views of the pit top facility due to the dense vegetation (Plate 4-22) and would not easily see down the access road as the vehicle passes through the roundabout.

Overall, the visual modification to users along George Booth Drive would be low with a low potential visual impact. This would be reduced by the development of a visual bund adjacent to the George Booth Drive road easement.

The proposed roundabout on George Booth Drive would have very low visual modification as this is an expected component of a road.

Vehicles turning onto George Booth Drive from the access road to the Daracon Buttai Quarry would use the roundabout proposed for the new pit top access road intersection. These vehicles would have direct view down the pit top access road, however would have limited views of the coal stockpile and other infrastructure due to the curve in the access road and the visual bund (Figure 4-26 and Plate 4-23). This is anticipated to result in moderate to high visual modification. Given the industrial use of this road, the viewer sensitivity is considered to be low (Table 4-26) and the overall potential visual impact is low to moderate.

Views of the pit top facility and the upcast ventilation shaft may be possible from the access road to the Orica Richmond Vale facilities (Echidna Drive) along the Ausgrid easement, resulting in low to moderate visual modification. Given the industrial use of this road, the viewer sensitivity is considered to be low (Table 4-26) and the overall potential visual impact is also low.

Views of the pit top facility and the upcast ventilation shaft from the Sugarloaf State Conservation Area are expected to be limited due to intervening topography and the presence of extensive mature native vegetation. Notwithstanding, it is anticipated that there would potentially be some views of the facility from exposed and elevated positions along access tracks in the Sugarloaf State Conservation Area. Given the distance of these views, the viewer sensitivity is considered to be moderate to high (Table 4-26). The likely visual modification is anticipated to be low or very low given the potential for intervening vegetation, the small area of disturbance in the overall landscape and the location of the new pit top facility in proximity to the existing Orica Richmond Vale facilities. Therefore, the potential visual impact is low.

The visual impact from the Project on areas beyond the sub-regional setting are considered to be very low given the reduction in clarity of viewing that occurs with distance and the level of visual modification compared to the overall view.

FIGURE 4-26
New Pit Top - Locaton of Viewpoints 1 to 3

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Plate 4-21 Viewpoint 1 - George Booth Drive Travelling West

Plate 4-22 Viewpoint 2 - George Booth Drive Travelling East

Plate 4-23 Viewpoint 3 - Daracon Buttai Quarry Access Road

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Plates 4-21 to 4-23
Viewpoint Locations

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Night-Lighting

Night-lighting would continue to be used at the existing pit top facility and would be installed at the new pit top facility and upcast ventilation shaft as part of the Project. Night-lighting would be directed on the horizontal and would not be directed towards George Booth Drive. Potential impacts of night-lighting are expected to be minimal given the distance to private residences, intervening topography and vegetation and the implementation of the mitigation measures described in Section 4.19.3.

Exploration Works and Other Short-term Surface Activities

Exploration works, environmental monitoring, subsidence remediation and other short-term surface activities may be visible at times from public viewpoints and any minor land disturbance associated with these activities may be visible if located close to public vantage points.

Disturbance associated with short-term surface activities would be rehabilitated progressively and any visual impacts would therefore be limited in extent and temporary in nature.

Subsidence Related Impacts on Streams

Potential subsidence related impacts on watercourses are discussed in Sections 4.5 and 4.6, and may result in the following aesthetic impacts:

- visible surface cracking of stream bed material;
- reduced water levels in some pools or increased ponding in other areas; and
- increased levels of erosion due to increased tilt and/or knickpoint migration.

There would be higher viewer sensitivity to any potential impacts in the Sugarloaf State Conservation Area and Heaton State Forest as these areas are publicly accessible. Any visual modification to streams would generally not be visible unless the viewer is in close proximity to the stream.

SCZs for streams would be implemented for the Project (Section 2.6.3) including limiting potential environmental consequences for third order streams (i.e. Surveyors Creek 2) to negligible environmental consequences and limiting potential environmental consequences on other streams to no more than minor consequences.

Subsidence Related Impacts on Cliffs, Other Rock Features and Steep Slopes

Rock falls occur naturally as a result of natural weathering and tree-rooting processes. Subsidence has the potential to further reduce the stability of features (e.g. cliffs and overhangs) and increase the incidence of rock fall (Appendix A).

SCZs for cliff lines and steep slopes would be implemented for the Project (Section 2.6.3) to have no more than minor impact on the topographic feature, and negligible environmental consequence.

Due to the difficulties in distinguishing between natural and mining induced instabilities, any impacts on cliff lines and steep slopes are predicted to represent in the order of 3 to 5% of the cliff face and steep slope areas (Section 4.3.2). Visible exposure of fresh rock and debris around the bases of cliffs may therefore occur in these areas.

Given the natural occurrence of cliff and steep slope instabilities, the temporary nature of the visual impact and the proposed subsidence performance measures, the visual modification of any impacts to cliffs, overhangs and steep slopes is expected to be low to very low. Given the high viewer sensitivity in the Sugarloaf State Conservation Area, this would have a potential low to moderate visual impact.

As the visibility of cliff lines at distance are restricted by dense vegetation (Section 4.19.1), the visual modification at a sub-regional setting would be very low.

4.19.3 Mitigation Measures, Management and Monitoring

New Pit Top Facility

Building materials for the new pit top facility and at the upcast ventilation shaft would be non-reflective and appropriately coloured in shades such as green and beige to merge with the natural landscape. A visual bund would be constructed adjacent to the George Booth Drive road easement (Figure 2-9) to further minimise potential visual impacts.

Attention would be given to restrict lighting so that lights are not directed towards George Booth Drive, including the use of directional lighting where possible.

Exploration Works and Other Short-term Surface Activities

Disturbance areas associated with any short-term surface activities would be rehabilitated progressively (Section 5).

Subsidence Related Impacts

Subsidence Impacts on Streams

The Project mine layout would be designed to achieve subsidence performance measures for streams (Section 2.6.3).

Mitigation measures and management for potential impacts to streams are described in Sections 4.5 and 4.6. Remediation measures are described in Section 5.3.6.

Subsidence Impacts on Cliffs, Other Rock Features and Steep Slopes

The Project mine layout would be designed to achieve subsidence performance measures for cliff lines and steep slopes (Section 2.6.3).

No specific visual remediation measures are proposed for isolated rock falls that may occur as a result of the Project. Such events occur naturally in the sandstone landscape along the Sugarloaf Range, and exposed rock surfaces weather over time and any disturbed vegetation re-establishes naturally.