SECTION 6.0

Environmental Assessment

6.0 Environmental Assessment

6.1 Preliminary environmental risk analysis

A preliminary environmental risk analysis was undertaken for the Southern Extension Project to identify, from a technical perspective, the key environmental and social issues that are relevant to the Southern Extension Project and the level of further assessment that is required as part of the EA process.

The method used for the environmental risk assessment encompassed the following key steps:

- identify each element of the Southern Extension Project
- identify the environmental and community aspects and potential impacts/risks associated with each element of the Southern Extension Project
- assess the potential scope of the impact/risk to determine the key issues requiring further assessment and the level of assessment required.

The outcomes of the preliminary environmental risk analysis are detailed in **Table 6.1**.

Table 6.1 Potential Environmental Impacts Associated with the Southern Extension Project

Environmental Aspect	Preliminary Environmental Risk Analysis	Further Assessment Required for Project?
Pagodas	The area to the north and east of the Southern Extension Area contains sandstone and conglomerate rock features known as pagodas. The larger pagoda formations form prominent features in the landscape. These features and their immediate surroundings have been identified as having significant conservation value due to their uniqueness, visual character and ecological value. Indirect impacts on identified pagoda structures in the vicinity of the Southern Extension Area will be avoided through the incorporation of appropriate setbacks and detailed controls on blasting. An assessment of the potential impacts on pagodas and associated biodiversity values has been undertaken as part of the Blasting Impact Assessment and the Ecological Impact Assessment.	Yes, refer to: **Section 6.4** **Section 6.5** **Section 6.8** **Appendix 6** **Appendix 7** **Appendix 9**

Environmental Aspect	Preliminary Environmental Risk Analysis	Further Assessment Required for Project?
Ecology	**Section 3.7** provides an overview of detailed consideration of ecological features, and avoidance, through the design of the Southern Extension Project. The Southern Extension Project will include the removal of approximately 50 ha of vegetation. An ecological impact assessment has been undertaken to assess the potential impacts of the Southern Extension Project. Key areas of focus include: • threatened fauna species • threatened flora species • vegetation communities • biodiversity features associated with the pagoda formations and associated terrain. The Southern Extension Project has been assessed in accordance with the NSW Framework for Biodiversity Assessment (FBA) and a Biodiversity Assessment Report (BAR) has been prepared.	Yes, refer to: **Section 3.7** **Section 6.4** **Appendix 6**
Land Resources	The Southern Extension Project will disturb the ground surface. Soil resources from the Southern Extension Area will be used for the rehabilitation of the Southern Extension Area and other areas at Invincible. Poor rehabilitation outcomes and soil erosion can occur if not appropriately managed. A site verification certificate was issued in 2014 that confirmed that there is no BSAL present in the Southern Extension Area. The Southern Extension Area is located in Ben Bullen State Forest and is not used for agricultural purposes. The Southern Extension Area will have negligible to no impact on agricultural productivity. The forestry resources in the Southern Extension Area are largely limited to firewood and the removal of vegetation in this area will have negligible impact on the forestry value of the land as most of the easily accessible firewood resources have already been removed from this area due to its close proximity to the Castlereagh Highway. The Southern Extension Area is also occasionally used for trail bike riding and is located near tracks providing access to Ben Bullen State Forest to the east of the Southern Extension Area. The Southern Extension Area is located within the area proposed as a State Conservation Area as part of the Gardens of Stone Stage 2 proposal. It is noted that mining can be undertaken in an State Conservation Area under the provisions of the NPW Act	Yes, refer to: **Section 6.2** **Section 6.18**

Environmental Aspect	Preliminary Environmental Risk Analysis	Further Assessment Required for Project?
Surface water impacts	Runoff from disturbed areas and potentially acid forming material has the potential to adversely impact water quality downstream of the Southern Extension Project. Diversion of surface water flows has potential to impact on stream flows downstream of the Southern Extension Project and changes in catchment area can impact on flooding downstream. Water removed from the former Ivanhoe underground workings will be transferred into the former Invincible underground working and void space associated with the existing Invincible open cut. Any water in excess of storage space may need to be discharged to the downstream environment in accordance with relevant approvals and licences. Water will be required for coal washery processes, dust suppression and other operational purposes. A surface water impact assessment has been completed to determine the potential impact of the Southern Extension Project on surface water.	Yes, refer to: **Section 6.3** **Appendix 4**
Groundwater impacts	Aquifers in the region are largely limited to the coal seams (the Lithgow Seam in particular). The previous assessment of potential impacts identified that the Illawarra Coal Measures in the area, including the Lithgow Seam, are largely depressurised as a result of past mining activities in the area. The Southern Extension Project is therefore unlikely to result in any further depressurisation of these aquifers. Water stored in the former Ivanhoe and Invincible underground workings has saturated areas of the Lithgow Seam 'down dip' of these workings. The Southern Extension Project may involve the transfer of water between former underground working areas and this may impact upon the transfer of water between storages and coal seams. A groundwater impact assessment has been completed to determine the potential impact of the Southern Extension Project on groundwater systems in the area.	Yes, refer to: **Section 6.3** **Appendix 5**
Aboriginal Cultural Heritage	The Southern Extension Project has the potential to impact on Aboriginal archaeology and cultural heritage. An assessment has been undertaken to assess the potential impacts of the Southern Extension Project in consultation with registered Aboriginal parties.	Yes, refer to: **Section 6.5** **Appendix 7**
Historic Heritage	The Southern Extension Project is not expected to result in any impacts to historical heritage however an assessment of potential impacts has been undertaken.	Yes, refer to: **Section 6.6**
Air Quality	The Southern Extension Project has the potential to impact on the existing air quality environment. An air quality impact assessment has been completed to determine the potential impact of the Southern Extension Project on air quality.	Yes, refer to: **Section 6.7** **Appendix 8**

Environmental Aspect	Preliminary Environmental Risk Analysis	Further Assessment Required for Project?
Blasting	The Southern Extension Project has the potential to impact on blast sensitive locations including non-mining related structures such as the Castlereagh Highway and an 11 kV power line, nearby private residences and heritage items. Vibration from blasting also has potential to impact on cliff lines and pagoda formations to the east and north of the Southern Extension Area. A geotechnical assessment of the closest pagoda formations has been undertaken to understand the tolerances of these features to potential blast impacts. A detailed blast impact assessment has been undertaken to assess the potential impacts from blasting associated with the Southern Extension Project on nearby structures and heritage items and identify the management measures required to meet acceptable impact criteria for these items.	Yes, refer to: **Section 6.8** **Appendix 9**
Noise	The Southern Extension Project has the potential to impact on the existing noise environment. A detailed noise impact assessment has been prepared to determine the potential impact of the Southern Extension Project on noise amenity.	Yes, refer to: **Section 6.9** **Appendix 10**
Social Impacts	Socio-economic assessment is concerned with assessing and predicting the likely consequences of a project in both social and economic terms. A detailed community consultation program has been undertaken to understand stakeholders' views and attitudes towards the Southern Extension Project. A detailed assessment of the likely social impacts of the Southern Extension Project has been prepared.	Yes, refer to: **Section 5** **Section 6.10** **Appendix 11**
Traffic	Traffic associated with the Southern Extension Project is consistent with the existing approved Invincible operations and is unlikely to significantly affect the existing road network. A detailed traffic impact assessment has been undertaken to assess the potential impacts on the capacity, condition, efficiency and safety of the local and State road network to take account of any changes to traffic flows on these networks since previous traffic assessment for the existing approved development was undertaken.	Yes, refer to: **Section 6.11** **Appendix 12**
Economics	All new coal mining projects in NSW, including modifications to existing projects, are required to assess the economic benefits of the Southern Extension Project. The integration of Invincible with Manildra's existing operations necessitates the consideration of economic benefits associated with both the Proposed Modification and broader impacts on Manildra's operations should the Southern Extension Project not proceed. An economic impact assessment has been undertaken to assess the costs and benefits of the Southern Extension Project.	Yes, refer to: **Section 6.12** **Appendix 13**
Greenhouse Gas Emissions	The Southern Extension Project will result in greenhouse gas (GHG) emissions generated as part of the proposed operations and the downstream use of coal produced. A Greenhouse Gas Assessment has been completed for the Southern Extension Project to quantify the likely GHG emissions associated with the Southern Extension Project.	Yes, refer to: **Section 6.13**

Environmental Aspect	Preliminary Environmental Risk Analysis	Further Assessment Required for Project?
Bushfire	The Southern Extension Area is identified as bushfire prone land, the most significant potential bushfire threat being from within the Ben Bullen State Forest; however, no new infrastructure is proposed as part of the Southern Extension Project. Existing and emergency bushfire procedures, as well as mitigation measures have been summarised for the Southern Extension Project.	Yes, refer to: **Section 6.14**
Visual	The Southern Extension Project has the potential to be visible from the surrounding area including the Castlereagh Highway, elevated areas within Ben Bullen State Forest and other areas in the Cullen Bullen area. A visual impact assessment has been undertaken for the Southern Extension Project to assess the likely visual impacts of the development on surrounding private landowners and key vantage points in the public domain.	Yes, refer to: **Section 6.15**
Waste	The Southern Extension Project is not expected to generate any additional waste streams or increase waste volumes relative to approved mining operations. Existing waste management measures are outlined for the Southern Extension Project.	Yes, refer to: **Section 6.16**
Hazard and Risk	The Southern Extension Project will include the use of explosives and on-site storage of diesel. The Southern Extension Project will not change the location or size of existing approved diesel storages and explosives will be transported to the site for use from existing approved off-site storages. The EA includes a discussion of the hazards posed by these substances and the management measures that will be applied to managing any risks.	Yes, refer to: **Section 6.17**
Rehabilitation and mine closure	Rehabilitation of areas previously disturbed by mining at Invincible as well as the Southern Extension Area form part of the Southern Extension Project. The Environmental assessment includes details of the existing and proposed rehabilitation methods that will be applied to the Southern Extension Area and existing disturbed areas at Invincible. The assessment includes details of progressive rehabilitation timeframes and commitments.	Yes, refer to: **Section 6.18**

The key environmental assessment aspects identified in **Section 5.0** as an outcome of the consultation process for the Southern Extension Project are also addressed in the sections as indicated above. In addition, there are a number of additional matters that are contained in the Indicative Secretary's Environmental Assessment Requirements (Indicative SEARs) that are not considered to be key risks but have been assessed for completeness. These include:

- Feral Animals and Weeds (refer to **Section 6.4**)
- Public Safety (refer to **Section 6.17.2**).

6.2 Land resources, agriculture and land use

A Soil and Land Capability Assessment has been previously undertaken for Invincible and includes the Southern Extension Area (Ecobiological, 2011). The following section describes the soils and land capability and land suitability of the Southern Extension Area.

In March 2014, a BSAL Site Verification Certificate was issued confirming that the land within MLA 431 in the Southern Extension Area is not BSAL. In addition, the Southern Extension Area is located within a State Forest and no agriculture is undertaken in this area. The Southern Extension Project and ongoing rehabilitation at Invincible are considered unlikely to significantly impact on agricultural activities undertaken on land outside the Southern Extension Area. Accordingly further detailed assessment of agricultural impacts is not required for the Southern Extension Project.

6.2.1 Soil resources

Three soil units have been mapped within the Southern Extension Area, deep orange clay loam, shallow brown sandy loam and skeletal sandy loam (Ecobiological, 2011). The location of these soil units is mapped on **Figure 6.1**. The following sections describe the soil units in the Southern Extension Area.

6.2.1.1 Deep orange clay loam

This soil type occurs in a residual soil landscape and primarily on lower gradual slopes. The topsoil associated with the soil is approximately 20 cm in depth, and is non-saline, slightly dispersive and slightly acidic (pH 5-5.5). The subsoil extends to a depth of up to 240 cm and is non-saline, moderately dispersive and acidic (pH 4.9-6.1).

The topsoil is suitable for stripping to a depth of 15 to 20 cm and reuse as topdressing in rehabilitation. The subsoil however is texturally and structurally unsuitable for stripping, due to high clay content and massive structure, and should not be retained for topsoil respreading. Salinity levels and acidity are not suitable for supporting vegetation growth (Ecobiological, 2011).

The deep orange clay loam covers approximately 42 ha (85 per cent) of the Southern Extension Area (refer to **Figure 6.1**).

6.2.1.2 Shallow brown sandy loam

This soil type occurs in residual soil landscapes located primarily on the upper gradual slopes.

The topsoil associated with the soil is approximately 15 cm in depth and is non-saline, slightly dispersive and slightly acidic (pH 4.6-6.1). The subsoil extends to a depth of up to 114 cm and is non-saline, moderately dispersive and acidic (pH 4.6-6.2).

The topsoil is suitable for stripping to a depth of 10 – 15 cm and reuse as topdressing in rehabilitation. The subsoil however is texturally and structurally unsuitable for stripping, due to high clay content, and should not be retained for topsoil respreading.

The salinity levels and acidity of the soil material is not suitable for supporting vegetation growth (Ecobiological, 2011).

The shallow brown sandy loam is found on mid slope areas in the east of the Southern Extension area and covers approximately 5 ha (10per cent) of the Southern Extension Area (refer to **Figure 6.1**).

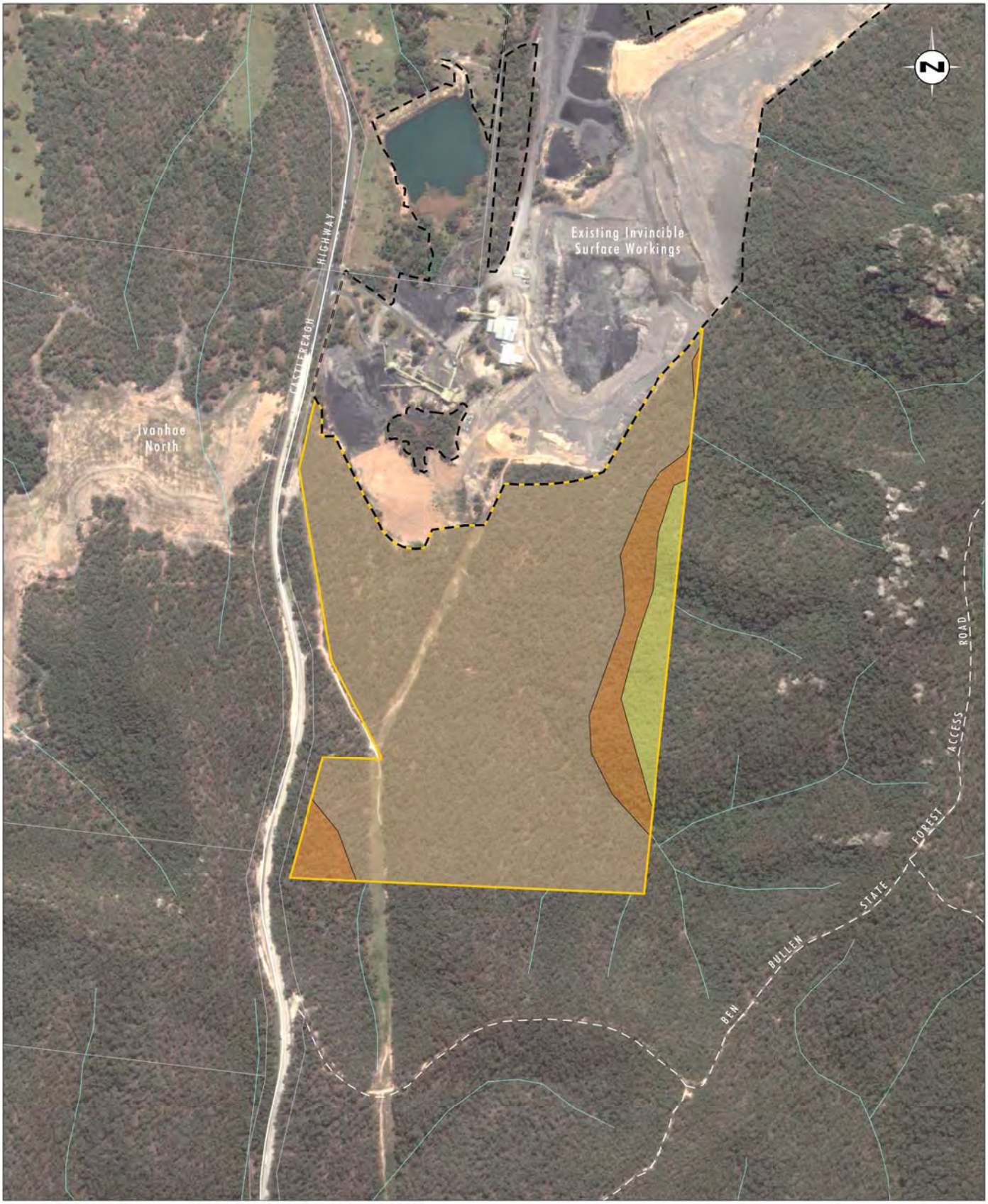


Image Source: Google Earth - CNES/Astrium (Mar 2015)
Data Source: LPI (2016), EcoBiological (2011)

0 100 250 500m

Legend

- Existing Approved Mining Disturbance Area
- Proposed Southern Extension Area
- Deep Orange Clay Loam
- Shallow Brown Sandy Loam
- Skeletal Sandy Loam

FIGURE 6.1

Soil Types within Southern Extension Area

6.2.1.1 Skeletal sandy loam

This soil type occurs in residual soil landscapes located primarily on crests and upper steep slopes. The occurrence of this soil landscape in the Southern Extension Area is limited to the upper crests of the Southern Extension Area (refer to **Figure 6.1**)

The topsoil associated with the soil is approximately 2 cm in depth and is non-saline, slightly dispersive and slightly acidic (pH 5.1). The subsoil is limited to a depth of only 2 cm and is non-saline, moderately dispersive and generally slightly acidic (pH 5.1).

Given that the topsoil is extremely shallow and the subsoil contains high density of parent rock material, the soil is texturally and structurally unsuitable for stripping and neither the topsoil nor subsoil should be retained for respreading.

The skeletal sandy loam covers approximately 3 ha (6 per cent) of the Southern Extension Area (refer to **Figure 6.1**).

6.2.2 Land capability and land suitability classifications

As identified above, the Southern Extension Area is located in the Ben Bullen State Forest and will remain part of Ben Bullen State Forest following completion of mining. The Southern Extension Area will be rehabilitated to woodland vegetation communities consistent with those currently present in the Southern Extension Area. The constraints on the land identified in the land capability and land suitability classifications are relevant to the methods used to establish the final landform following mining and the rehabilitation techniques applied (refer to **Section 6.18**). Details on the assessed land capability and suitability classifications for the Southern Extension Area are provided in the following sections.

6.2.2.1 Land capability

The land and soil capability mapping undertaken by Ecobiological (2011) indicate the majority of the Southern Extension Area is mapped as Land Capability Class V. A small area of land on the eastern edge of the Southern Extension Area was identified as being Class VIll land. The Class VIII land aligns with the more elevated crests where skeletal sandy loam was identified (refer to **Section 6.2.1**).

The definition of the Land Capability Classes identified as occurring in the Southern Extension Area and implications for agriculture and land uses are provided in **Table 6.2**.

Table 6.2 Land Capability Classes

Class	Description	Implication
Not suitable for Cultivation		
V	Suitable soil and topography for crops but economically not viable. High quality grazing land.	Structural soil conservation works such as absorption banks, diversion banks and contour ripping, together with conservation practices such as pasture improvement, stock control, application of fertilizer and minimal cultivation for the establishment or reestablishment of permanent pasture.
VIll	Wildlife reserves, bushland, recreation or water supply catchments.	Cliffs, lakes or swamps and other lands incapable of sustaining agricultural or pastoral production.

Source: Ecobiological 2011

6.2.2.2 Land suitability

Land suitability classes for the Southern Extension Area were also identified by Ecobiological (2011). The Southern Extension Area was identified primarily as Class 5 cropping land. The majority of the Southern Extension Area was mapped as being Class 4 grazing land, however the more elevated crests where skeletal sandy loam was identified and mapped as Land Capability Class VIII (refer to **Section 6.2.2.1**) were identified as being Class 5 grazing land. This finding also indicates that the land is unsuitable for cropping, mainly due to the inaccessibility of the terrain and lack of available topsoil.

6.2.3 Compatibility with surrounding land use

As discussed in **Section 1.4**, Invincible is located in a rural environment and is surrounded by vegetated parcels of Crown Land, State Forest and Castlereagh Coal owned land (refer to **Figure 6.2**).

The Southern Extension Area is located primarily in vegetated parcels of Ben Bullen State Forest (refer to **Figure 6.2**). The proposed activities in the Southern Extension Area are consistent with historical open cut mining operations at Invincible which have been undertaken in Ben Bullen State Forest. Parts of the Southern Extension Area are significantly impacted by subsidence from past underground mining in the area and would require disturbance for rehabilitation purposes, irrespective of the Southern Extension Project (refer to **Figure 1.4**).

The southern extent of Gardens of Stone National Park is located approximately 9 km to the north of the Southern Extension Area (refer to **Figure 6.3**). The eastern extent of Wollemi National Park is located approximately 13 km north-east of the Southern Extension Area. In 2005, the area of Ben Bullen State Forest in which the Southern Extension Area is located was proposed as a State Conservation Area by three environmental groups as part of the Gardens of Stone Stage 2 Proposal (refer to **Figure 6.3**). It is noted that mining is permissible within State Conservation Areas in accordance with the Mining SEPP and NPW Act. As outlined in **Section 4.0,** the Southern Extension Area is located in existing mining leases and MLA 431.

As detailed in **Section 3.7**, the Southern Extension Project is located in an area of Ben Bullen State Forest which has been selected in consideration of a range of potential environmental impacts and the economic need for accessing the speciality nut coal resource. The areas to the east and north of Invincible within Ben Bullen State Forest contain significant landforms and geological and biodiversity features and are primarily managed for recreation and conservation.

The Southern Extension Area and surrounding land is currently used primarily for firewood collection, and recreational use such as trail bike riding. Access to the Southern Extension Area for these uses is generally from the south via the power line easement. Located to the south and east of the Southern Extension Area are tracks providing access into areas of Ben Bullen State Forest located to the east and north of Invincible (refer to **Figure 2.1**). These tracks are utilised for a variety of uses including recreation (i.e. bush walking, trail bike riding) and are accessed off the Castlereagh Highway to the south of the Southern Extension Area.

The Southern Extension Project will result in the exclusion of public access to the Southern Extension Area and immediate surrounds being restricted for safety reasons. This exclusion will limit firewood collection and trail bike riding in the exclusion area which will extend up to 50 m from the edge of the pit. This exclusion area will not apply to the main access road through Ben Bullen State Forest which runs along the ridgeline to the south and east of the Southern Extension Area. Parts of this access road will be closed temporarily during blasts to prevent access within 500 m of blast areas. These closures will last approximately 15 minutes and will be managed in accordance with the exclusion protocols contained in the Blast Management Plan (refer to **Section 6.8.4**).

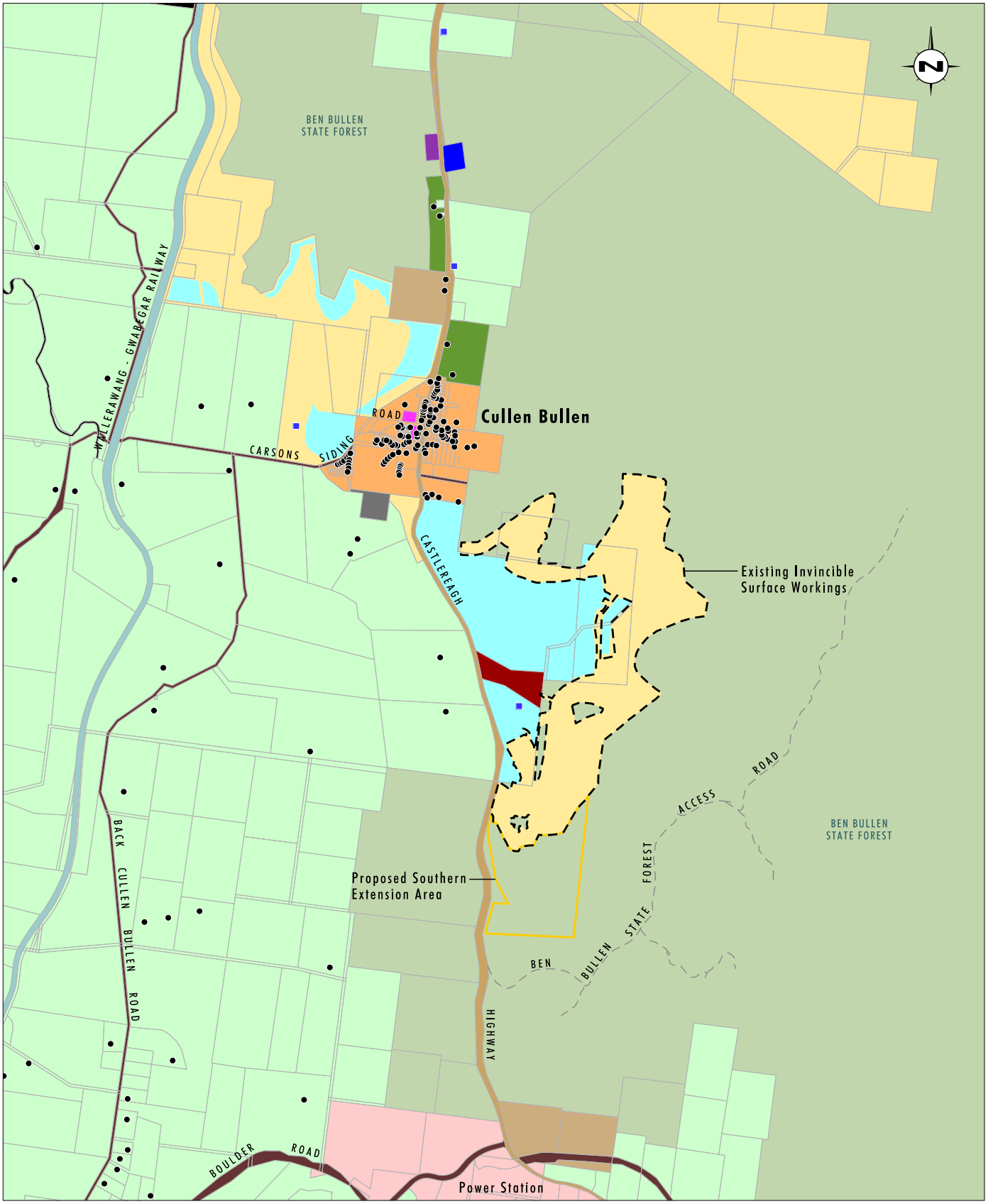


Image Source: Google Earth - CNES / Astrium (2015)
Data Source: Sedgman (2016), LPI (2016)

0 0.5 1.0 2.0km

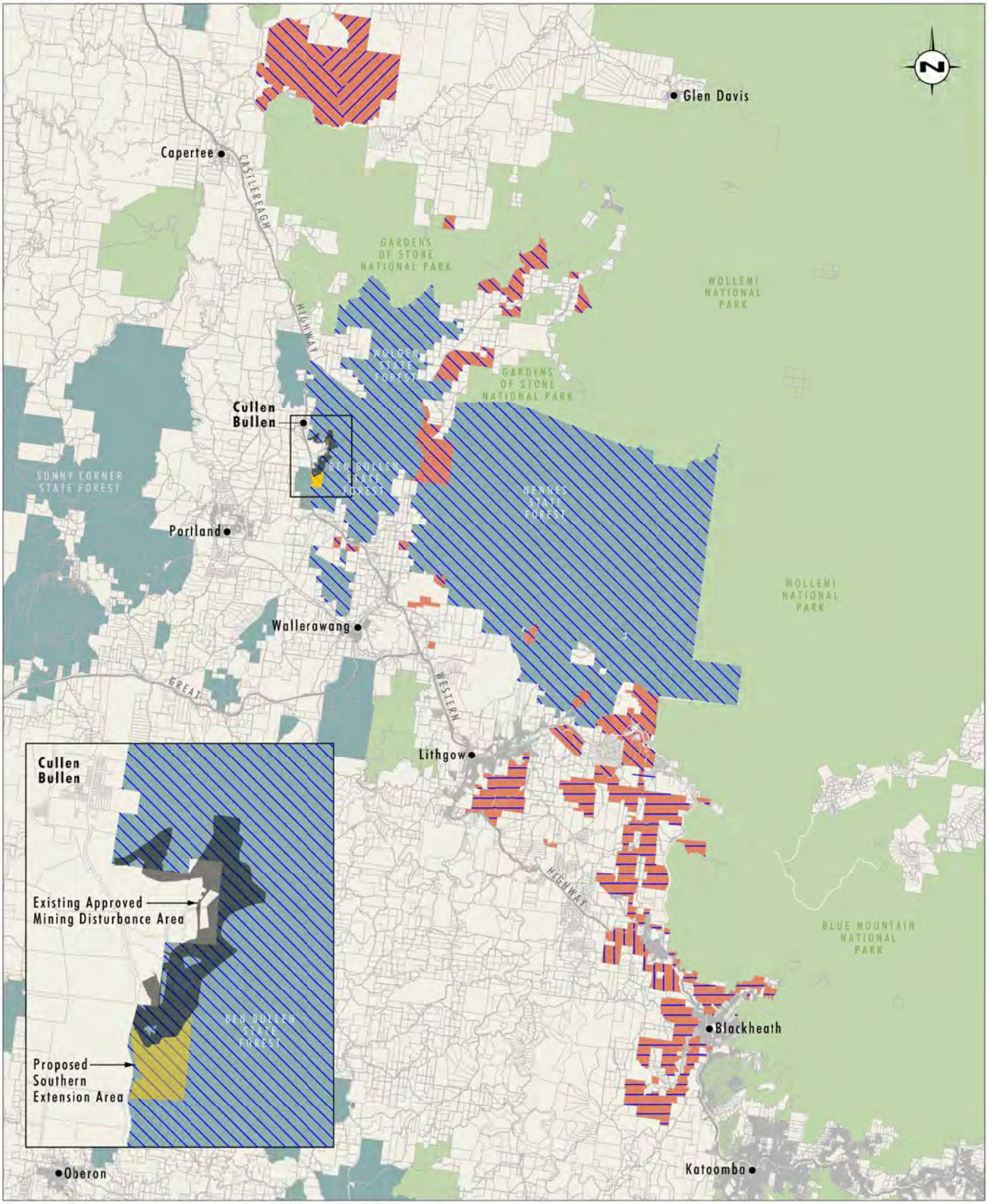
Legend

- Existing Approved Mining Disturbance Area
- Proposed Southern Extension Area
- Castlereagh Highway
- Cemetery
- Conservation/Biodiversity Offset
- Grazing/Farming/Rural Residential
- Mining/Mine Owned
- Mining Services
- Power Station
- Race Track
- Railway
- Road
- School
- State Forest
- Town
- Waste Facility
- Woodland (Crown)
- Woodland (Private)
- Private Residence
- Mine Owned Building

FIGURE 6.2

Land Use

File Name (A4): R02/3622_017.dgn
20160915 17.19



Legend

- Existing Approved Mining Disturbance Area
- Proposed Southern Extension Area
- State Forest
- National Park
- Crown Land
- Proposed Extension to Gardens of Stone National Park
- Proposed Extension to Blue Mountain National Park
- Proposed Gardens of Stone State Conservation Area
- Proposed Western Escarpment State Conservation Area

FIGURE 6.3

Conservation Areas and Gardens of Stone Stage 2 Proposal

The area to the immediate north of the Southern Extension Area is the existing Invincible open cut workings and mine infrastructure area. A mining services business known as Big Rim was located north of the Invincible mine infrastructure area between the Castlereagh Highway and the Invincible open cut mining area. This business previously serviced the Invincible operations, however it is currently in liquidation and the future use and ownership of this land is not known. The current approved use of the Big Rim land is for mining services industries. The Big Rim property is located more than 500 m from the nearest point that blasting will occur as part of the Southern Extension Project and therefore the blast management exclusion zone will not extend to this property. Blasts will be managed to ensure there is no structural damage to structures on the Big Rim property (refer to **Section 6.8**).

The dominant land use surrounding the Southern Extension Project west of the Castlereagh Highway is low intensity grazing, with some rural residential use. Parts of the privately owned Hillview property (refer to **Figure 6.2**) will be within 500 m of blasts in the north-western corner of the Southern Extension Area. The exclusion zone would not extend to the residence located on the property nor the access road for the property; the closest blasts will affect less than 1 hectare of the cleared land on the property. The management of potential blast impacts on this property is discussed further in **Section 6.8**.

The village of Cullen Bullen is located approximately 3 km north-west of the Invincible mine infrastructure area and Southern Extension Area. Cullen Bullen is a historic mining town and the surrounding area has a long history of mining, including the Cullen Valley Mine, the Old Invincible Colliery, the Baal Bone Colliery, Ivanhoe Colliery and Angus Place Colliery.

Invincible has coexisted with existing and previous land uses and the Southern Extension Project is considered compatible with existing surrounding land uses. An assessment of the potential off-site impacts of the Southern Extension Project has been prepared including water resources (**Sections 6.3**), ecological impacts (refer to **Section 6.4**), archaeological and cultural impacts (refer to **Sections 6.5** and **6.6**), air quality (**Section 6.7**), blasting (**Section 6.8**), noise (**Section 6.9**), and visual impacts (refer to **Section 6.15**). Specific measures have been incorporated in the detailed design of the Southern Extension Project to minimise potential impacts of the project on surrounding land uses, including areas of Ben Bullen State Forest; these measures are discussed in the relevant impact assessment sections of this EA. These assessments indicate that the Southern Extension Project will not have a significant impact on surrounding areas, and accordingly, adverse impacts on the current land uses surrounding Invincible are considered unlikely.

6.3 Water Resources

This section provides an overview of the water resources and management associated with the Southern Extension Project in relation to both surface and groundwater resources. As a result of the history of mining at Invincible the existing surface and groundwater (which is consists primarily of water stored in former underground mine workings) are interconnected across Invincible. Accordingly the management of water resources, and the potential impacts associated with the Southern Extension Project, is integrated.

Umwelt completed a Surface Water Impact Assessment (refer to **Appendix 4**) and Australasian Groundwater and Environment Consultants Pty Ltd (AGE) completed a Groundwater Assessment (refer to **Appendix 5**) for the Southern Extension Project. This section provides a summary of these assessments along with presenting the integrated water resources management commitments for the Southern Extension Project.

6.3.1 Local hydrology context

The following section describes the hydrological regime in which the Southern Extension Project is located.

6.3.1.1 Rainfall and climate

Invincible lies within a cool-temperate climatic zone and is characterised by mild summers and cold winters. The local climate is largely influenced by factors such as topography, altitude, aspect and exposure.

Three Bureau of Meteorology (BoM) rainfall stations lie within close proximity to Invincible: Station 63132 Lidsale (9 kilometres south-east); Station 63071 Portland (6 kilometres south); and Station 63226 Lithgow (21 kilometres south-east). Of these three BoM rainfall stations Lidsdale is considered most representative of rainfall conditions at Invincible due to its topographical location and also the completeness of the data set.

Daily rainfall has been recorded at Lidsdale (Station 63132) since 1960. Rainfall is generally spread evenly across the year, with slightly higher falls in late spring and summer and lower falls in autumn. For use in the water balance, periods of incomplete rainfall data at the Lidsdale gauge have been infilled with data sourced from Lithgow (Station 63226). **Table 6.3** presents the rainfall statistics for the data set used in the water balance (Lidsdale data with infilled Lithgow data).

Table 6.3 Water Balance Rainfall Data

Statistic	Rainfall (mm)
Minimum	329.8
10th %ile	505.5
50th %ile	758.6
90th %ile	927.9
Maximum	1171.0

Source: Bureau of Meteorology, 2016

Castlereagh Coal operates a meteorological monitoring station at Invincible (refer to **Figure 2.3**). In 2014, the site received 695 millimetres of rainfall over 141 rainfall days, which is consistent with a slightly below average rainfall year for the Lidsdale station.

Evaporation of about 1,351 mm/year exceeds rainfall throughout most of the year except for the winter months of June, July, and August (BOM Station No. 063005 – Bathurst agricultural station).

6.3.1.2 Surface water context

The Invincible open cut workings, existing mine infrastructure area and Southern Extension Area are located on the western fall of the Great Dividing Range within the Murray Darling Basin. The topography of the area surrounding the Southern Extension Area mainly consists of high Blue Mountains plateau terrain, with the western boundary running roughly parallel to, and west of, the outcrop of the Lithgow seam. The Southern Extension Area is located just within the outcrop of the seam and is characterised by flat undulating land adjacent to the outcrop rising to steeper land in the east.

On a regional scale, Invincible open cut and Southern Extension Area are located in the headwaters of the Turon River catchment within the broader Burrendong Catchment Area. This catchment drains to the west and is not in Sydney's drinking water catchment. Burrendong Dam is located near Wellington, approximately 100 kilometres north-west of Invincible. Regional drainage flows in a northerly direction along the Turon River, then westerly into the Macquarie River (and Burrendong Dam).

On a local scale, both the existing Invincible open cut and the Southern Extension Area lie entirely within the upper catchment of Cullen Creek. Cullen Creek, and its tributaries are ephemeral watercourses (refer to **Figure 6.4**). Cullen Creek is a fourth order (Schedule 3) watercourse (based on the Strahler stream ordering system). Cullen Creek flows in a north-westerly direction before joining Delhuntys Creek approximately 4 kilometres downstream of Invincible, which in turn joins Williwa Creek before flowing into the Turon River. Williwa Creek's confluence with the Turon River is approximately 25 kilometres downstream of Invincible. The nearest downstream flow gauging station is NSW Office of Water's site number 421026 that records flow data for the Turon River at Sofala. This site is approximately 45 kilometres downstream of Invincible.

Under the existing Invincible EPL, the site is authorised for wet weather discharges into the tributary of Cullen Creek from the Main Water Storage Dam (refer to **Figure 2.1)**. This discharge point is referred to as LD002.

The former Invincible underground workings in the Lithgow Seam extend to the east of the open cut workings below land that is located in the upper reaches of the Coxs Creek catchment, part of the Sydney drinking water catchment. There is no current discharge from these underground workings into the Coxs River catchment. Licensed discharges into Coxs River ceased in 2008 and this discharge point (LD001) was removed from the Invincible EPL in 2012.

The existing Invincible open cut workings intersect a number of 1st, 2nd and 3rd order tributaries of Cullen Creek with runoff from the catchment areas of these tributaries captured within the Invincible Water Management System (WMS). In addition, significant portions of the Southern Extension Area are affected by pre-existing surface cracking from underground bord and pillar mining in the abandoned Ivanhoe No.2 underground workings. Much of the surface water runoff from the Southern Extension Area does not report to downstream surface water management structures, instead entering a large sinkhole and fractures in the drainage lines and reporting directly to the abandoned underground workings.

Table 6.4 shows the pre-mining and current catchment areas of Cullen Creek, as well as the catchment area with the current approved final landform. The existing Invincible Project Approval allows for water management dams to be either rehabilitated or left in place, depending on their environmental value at the end of the life of the approved development. There are no final voids in the approved final landform.

Table 6.4 Cullen Creek Catchment Summary (Existing Approved Operations)

Scenario	Area (ha)
Pre-mining	1,725
Current	1,020
Currently Approved Final Landform	1,725

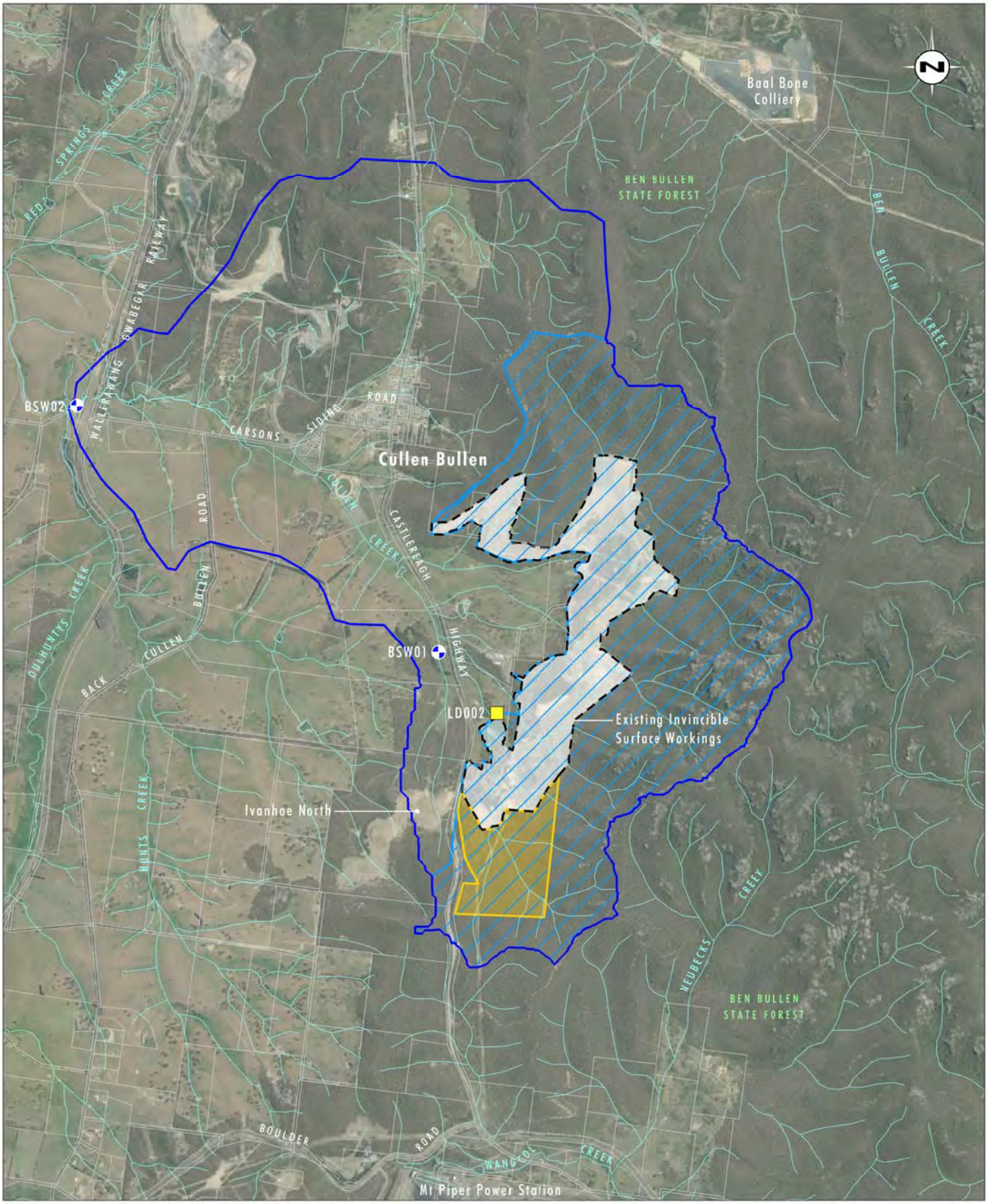


Image Source: Google Earth - CNES/Astrium (Nov 2014)
Data Source: LPI (2016)

0 0.5 1.0 2.0km

Legend

- Existing Mining Disturbance Area
- Proposed Southern Extension Area
- Catchment Area
- Existing Water Management System Area
- Licensed Discharge Point
- Water Monitoring Location

FIGURE 6.4

Surface Water Context

File Name (A4): R02/3622_116.dgn
20160916 8.32

6.3.1.3 Groundwater context

The majority of the Illawarra Coal Measures comprise very low yielding, to essentially dry interbedded strata of sandstone, siltstone, and mudstone. The sandstones, siltstones and mudstones are typically of significantly lower permeability than the coal seams (by one or more orders of magnitude) and they generally act as aquitards that confine the coal seams.

Groundwater within the Southern Extension Area and Invincible workings is found within the:

- Lithgow Seam (largely depressurised from historical mining operations targeting this seam including within the Southern Extension Area)
- historical underground mine workings in the Lithgow Seam
- saturated areas of spoil in the Invincible open cut workings
- Marrangaroo (sandstone / conglomerate) Formation.

The Lithgow Seam typically has low permeability but is the prime water bearing strata within the Illawarra Coal Measures. Groundwater within the Lithgow Coal Seam is typically associated with secondary permeability features such as cleat fractures, joints, and major bedding structures. The Lithgow Seam crops out near the Southern Extension Area and also at the Wolgan Valley escarpment located approximately 6.5 km north east of the Southern Extension Area. The Lithgow Coal Seam has been mined extensively in the vicinity of Invincible by historic underground and open cut workings in addition to current approved operations. This past mining has largely removed the coal seam aquifer in the Lithgow Seam (being the main aquifer within the proposed mining area), and depressurised the remaining un-mined coal. The former Ivanhoe No.2 underground workings in the Southern Extension Area are possibly wholly or partly flooded. However, this partial recharge of the aquifer does not represent a repressurisation of the aquifer to pre-mining conditions. Hence, the coal seam aquifer has been largely replaced by underground open voids that are wholly or partly flooded.

Historical underground mining at the Old Tyldesley Colliery, Old Invincible Colliery, the Invincible Colliery, Ivanhoe No. 2 Colliery, Wallerawang Colliery, and Baal Bone Colliery have all targeted the Lithgow Coal Seam because it is the deepest, thickest, and most continuous coal seam within the region. Parts of these historical mine workings have flooded with water that has accumulated since active dewatering ceased. Baal Bone Colliery is the only mine operation nearby that is currently dewatering significant areas of its underground workings.

The underground collieries are separated by coal seam barriers which in some cases are coincident with structural lineaments and in other cases by buffer zones around mining lease boundaries. The coal seam barrier between the Wallerawang No. 1 and No. 2 Collieries, and Invincible underground workings (refer to **Figure 2.1**) has previously been considered by Aquaterra (2010) to have been intentionally left intact to provide a barrier between these voids. Groundwater from the Wallerawang Colliery has previously been assessed to flow into the Invincible Colliery through the coal seam barrier (Bish, 1999) (refer to **Figure 6.5**).

Similarly, the coal seam barriers between the Ivanhoe No. 2 Colliery (incorporating the Southern Extension Area) and the adjacent Invincible and Wallerawang underground workings (refer to **Figure 2.1**) are also assumed to have been intentionally left intact to provide a barrier between these voids. The westernmost parts of Invincible and those immediately adjacent to the Southern Extension Area are dry (AGE, 2012 and 2014). As the Invincible underground workings dip to the northeast they become saturated. **Figure 6.5** shows the inferred extent of flooding in the Invincible underground workings based on previously provided data from observed water levels within the former Invincible underground workings.

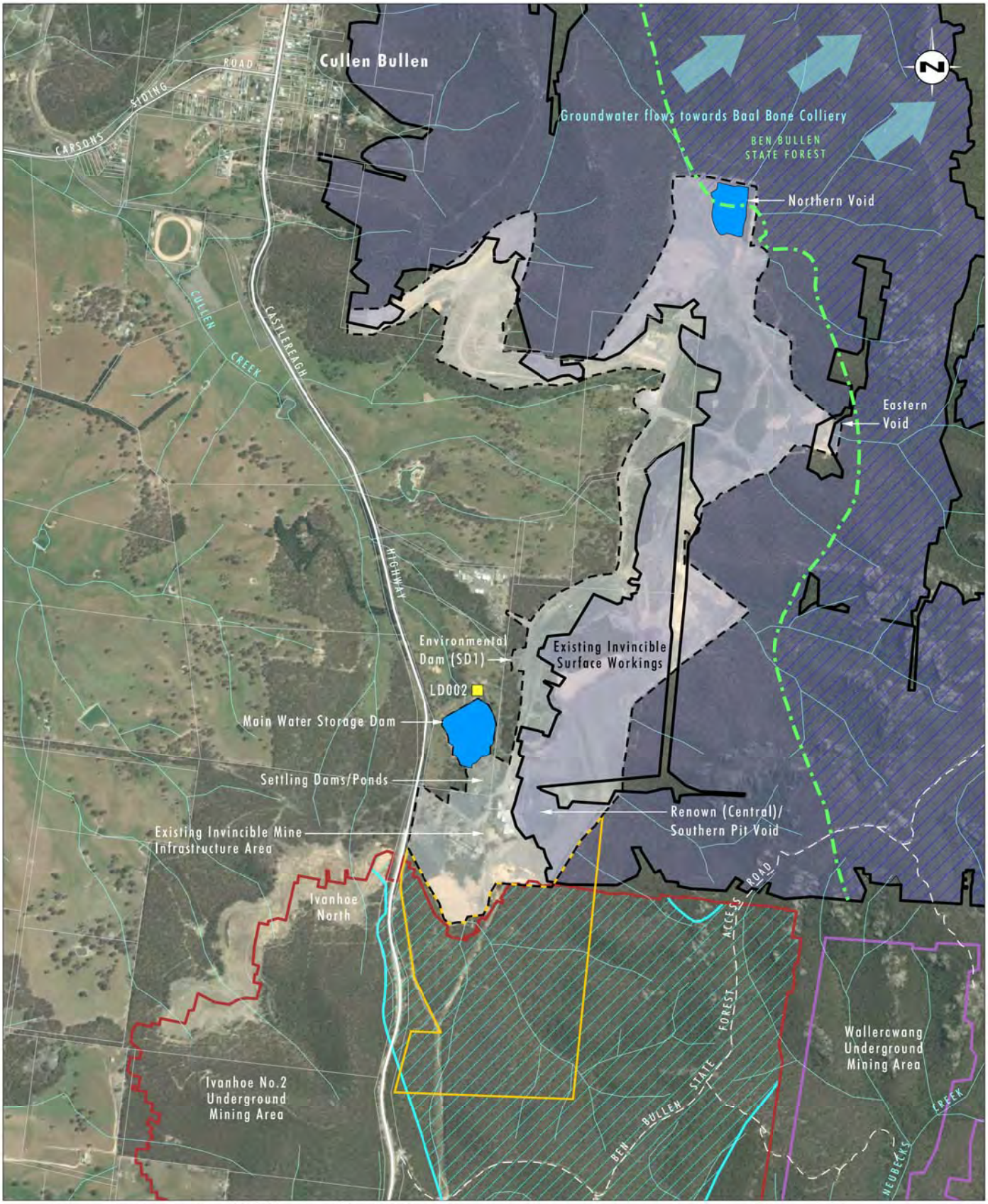


Image Source: Google Earth - CNES/Astrium (Nov 2014)
Data Source: LPI (2016), Coalpac (2014), AGE (2016)

Legend

- Existing Mining Disturbance Area
- Proposed Southern Extension Area
- Licensed Discharge Point
- Former Invincible Underground Workings
- Ivanhoe No.2 Underground Mining Area
- Wallerawang Underground Mining Area
- Inferred Water Level in Invincible Underground Workings
- Flooded Invincible Workings
- Potential Extent of water in Ivanhoe No.2 Underground Workings to be detwatered
- Dam

FIGURE 6.5

Inferred Water Level in Underground Working (Lithgow Seam)

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The water in the saturated areas of the Invincible workings are understood to be a combination of groundwater inflows from parts of the Lithgow seam to the east of the Invincible open cut which has not been depressurised, from surface inflows from subsidence impact and also from water accumulating within the Invincible open cut areas where the seam is at outcrop or buried within the spoil. Surface water captured in the Invincible water management system has also been historically pumped into the Northern Void which is hydraulically connected with the Invincible underground workings (refer to **Figure 6.5**).

The Ivanhoe No. 2 underground workings are believed to be flooded however there is limited information available to accurately determine the extent of flooding or the head of water in these workings. Water in the Ivanhoe No. 2 Colliery will have largely (if not totally) come from surface inflows from subsidence cracking. A large percentage of the runoff from the Southern Extension Area and upstream catchment is likely to be intercepted by subsidence cracking, located in drainage lines, associated with the previous Ivanhoe No. 2 Colliery. These surface flows would have otherwise flown into Cullen Creek. The maximum water level in the Ivanhoe UG workings is to 908m AHD, at which point the UG workings would decant from the former mine portal located at the Ivanhoe North site located west of the Castlereagh Highway (refer to **Figure 6.4**). The potential extent of flooding in the former Ivanhoe No. 2 workings is shown in **Figure 6.5**. A portion of recharge of the Ivanhoe No. 2 workings is also likely to be from water accumulating within the open cut areas where the seam is at outcrop or buried within the spoil and to a lesser degree via natural recharge processes.

The spoil material from the Southern Extension Project's open cut workings is proposed to be emplaced in-pit and in the existing open cut voids of Invincible, and then rehabilitated. Spoil material has already been emplaced in most of the northern areas of the void however three open voids currently remain (Northern Void, Eastern Void and Southern Void) (refer to **Figure 2.1**). In the northern areas of the open cut mining area, this spoil material is likely to become saturated and act as a water storage body and some of the spoil material adjacent to the Northern Void is already likely to be saturated. The Northern Void and former Invincible underground workings are interconnected through the Lithgow Seam (refer to **Section 6.3.1.4**).

The Marrangaroo Formation of sandstone and conglomerate, that underlies the Lithgow Coal Seam, crops out persistently throughout the Western Coalfield. The permeability of the formation is regionally variable and in some locations will be high enough to form a productive aquifer. Groundwater recharge to the Marrangaroo Formation, similar to the Permian coal seam aquifers, is likely to occur by direct rainfall infiltration and local runoff into the outcrop in low-lying areas. Similar to the Permian coal seam aquifers, groundwater within the Marrangaroo Formation is expected to flow towards the north-east (down-gradient) and discharge at outcrop areas (i.e. hillsides and gullies including the escarpment of the Wolgan Valley).

6.3.1.4 Existing water management

The approved Water Management Plan (Coalpac, 2009) describes the current water management systems for Invincible. The existing Water Management System allows for two categories of water: clean, comprising runoff from undisturbed and fully rehabilitated areas; and dirty, comprising runoff from any area disturbed by mining operations.

The water management strategy at Invincible is focused, where possible, on the separation of clean and dirty water streams by interception and diversion of stormwater runoff from operational and non-operational areas. In this context clean water comprises runoff from undisturbed parts of the WMS, while dirty water comprises stormwater runoff from disturbed areas of the site (including stockpiles, reject storage areas, coal handling and processing areas, mine infrastructure and overburden emplacement areas). This water has the potential for contamination from coal fines and/or oil and grease.

The water management system was been designed (as far as possible) as a closed loop system, with all water which enters the site via rainfall or runoff being managed in a series of dams within the WMS. A number of pit sumps (voids) located in the open cut areas collect dirty runoff from the active mining areas and overburden emplacement areas. However, clean runoff from undisturbed catchment areas upstream of the active mining area also drains into these sumps as it is not practical to divert runoff from the upstream catchments due to the steep nature of the topography in the area.

The existing Invincible WMS is shown in **Figure 6.6**.

The Northern Void (refer to **Figure 6.6**) is hydraulically connected to the former Invincible underground workings. The floor of the Invincible open cut workings slopes down toward the north-east. Water collected in the Eastern and Southern Voids (refer to **Figure 6.6**) seeps through the spoil in a north-easterly direction to the Northern Void where it drains into the former Invincible underground workings or is reused for dust suppression or other operational purposes. Stored water in the former Invincible underground workings seeps into the Lithgow seam and this seepage is estimated to range between 111 ML per year to 317 ML per year (AGE 2016).

As discussed in **Section 2.2**, the licensed discharge point for Invincible is located at the Invincible Main Water Storage Dam (LD002) (refer to **Figure 3.1** and **Section 3.3**). This discharge point is used for wet weather discharges in accordance with the requirements of the EPL.

6.3.2 Regulatory framework

Extraction of water in NSW is managed under two legislative acts: *Water Act 1912* and *Water Management Act 2000*. Impacts on water quality are regulated under the POEO Act.

6.3.2.1 Water extraction

The objective of the *Water Management Act 2000* is the sustainable and integrated management of water in NSW and is based on the concept of ecologically sustainable development by defining water access and water sharing strategies within NSW. The *Water Management Act 2000* supersedes the provisions of the *Water Act 1912* in regard to water take when a Water Sharing Plan (WSP) is in place and in regards to works adjacent to or within watercourses. Where WSPs have not commenced the provisions of the *Water Act 1912* continue to apply.

WSPs have been developed across NSW to protect the fundamental environmental health of water sources, whilst at the same time securing sustainable access to water for all users in the long-term. The WSPs specify maximum water extractions and allocations and provide water users with a clear picture of when and how water will be available for extraction.

Surface water sharing plans

Invincible lies within the area regulated by the WSP for the Macquarie Bogan Unregulated and Alluvial Water Sources 2012 and is located in the Turon Crudine River water source. Water take from surface and alluvial waters in and adjacent to the Invincible (including the Southern Extension Area) is therefore governed by the *Water Management Act 2000*.

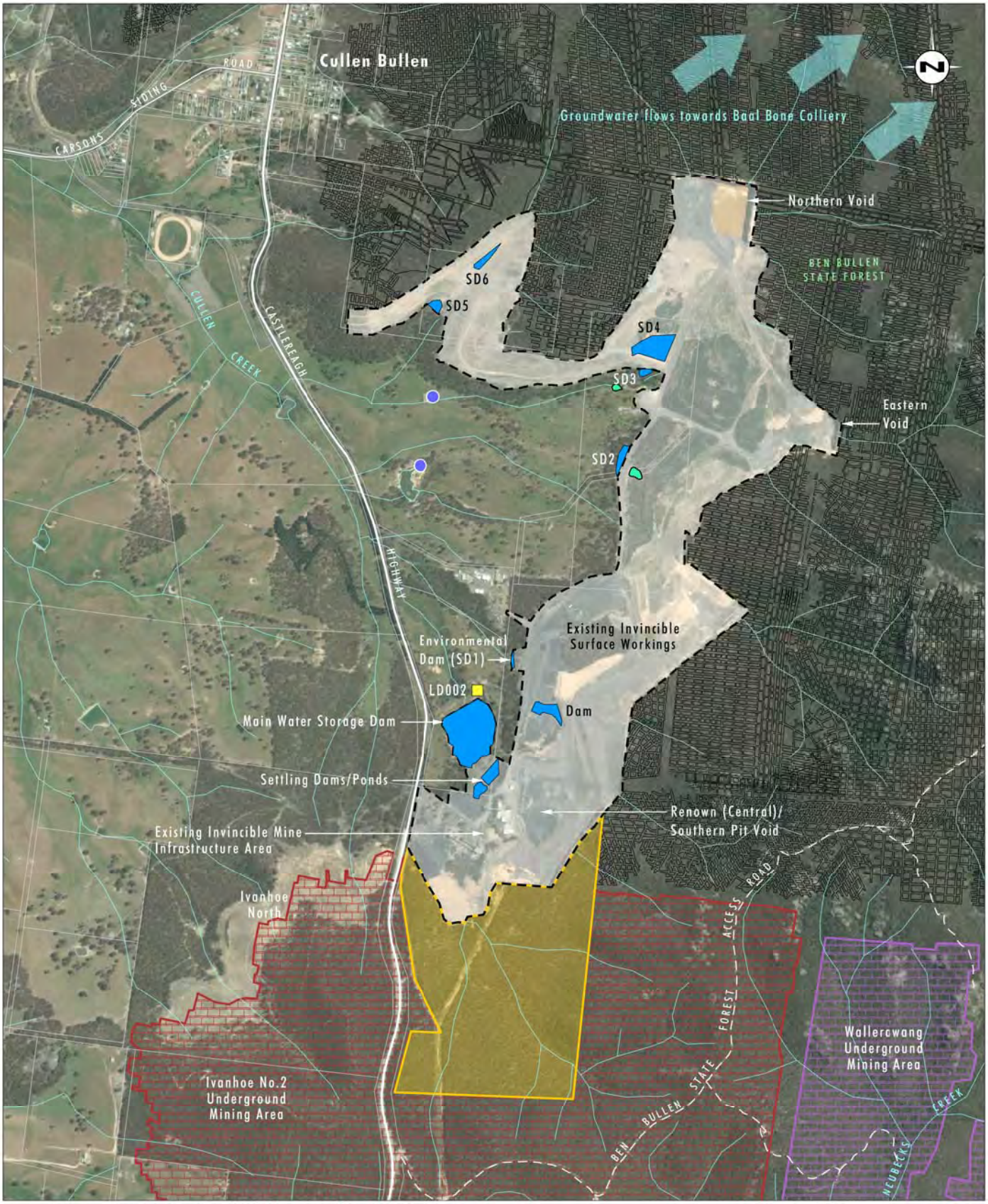

Image Source: Google Earth - CNES/Astrium (Nov 2014)
Data Source: LPI (2016)

0 0.25 0.5 1.0km

Legend

- Existing Mining Disturbance Area
- Proposed Southern Extension Area
- Licensed Discharge Point
- Former Invincible Underground Workings
- Ivanhoe No.2 Underground Mining Area
- Wallerawang Underground Mining Area

FIGURE 6.6

Existing Invincible Water Management System

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Groundwater water sharing plans

The Southern Extension Project is located within the WSP for the Murray-Darling Porous Rock Groundwater Sources (Sydney Basin). Immediate adjacent areas of the existing Invincible mining areas are also located within this Water Sharing Plan area.

The Murray Darling Basin Porous Rock Groundwater Water Sharing Plan is divided into four groundwater sources. Of these, the Southern Extension Project is located in the Sydney Basin Murray Darling Basin (MDB) Groundwater Source. The Sydney Basin MDB Groundwater Source includes all water contained in:

- all rocks of Permian, Triassic, Jurassic, Cretaceous, and Tertiary age within the outcropped and buried areas
- all alluvial sediments within the outcropped areas.

The Sydney Basin MDB is further subdivided into two management zones. Of which, the Southern Extension Project is located in the Sydney Basin MDB (Other) Management Zone.

Castlereagh Coal currently holds two aquifer access licences for water sourced from the NSW Murray-Darling Porous Rock Groundwater Sources Water Sharing Plan. The currently held licences entitle Castlereagh Coal to take 106 ML/year from the NSW Murray-Darling Porous Rock Groundwater Sources, comprising 26ML for Invincible and 80ML for Cullen Valley.

6.3.2.2 Water quality

The POEO Act is the key piece of environment protection legislation in NSW. Scheduled activities or other activities that do or may lead to pollution of waters in NSW are required to be licensed under the POEO Act and are regulated by the NSW Environment Protection Authority EPA. Where discharge of waters is permitted, it is strictly controlled by licence conditions such that discharges do not result in significant impacts on water resources.

Under Section 120 of the POEO Act, it is an offence to pollute waters or cause harm unless licensed to do so. Pollution in NSW is regulated by the POEO Act with discharges from mine water management systems requiring licensing by an Environment Protection Licence (EPL) if the discharge would otherwise constitute a pollution of waters (Section 120 of the POEO Act).

Coal mining and coal works are scheduled activities and Castlereagh Coal holds an EPL which licenses these activities at Invincible, including an existing water discharge point. Further details regarding the Invincible EPL are included in **Section 2.3.3**.

6.3.3 Key project features which interact with water resources

The following are the key aspects of the Southern Extension Project that have the potential to impact on water resources:

- landform changes as a result of the operations, including:
    - open cut mining
    - overburden emplacement areas.
- management of water removed from the Ivanhoe No.2 underground workings to enable mining of the remnant coal in the Lithgow Seam in the Southern Extension Area

- changes to the water balance associated with the Southern Extension Project
- ongoing rehabilitation of mine areas.

The key aspects listed above have the potential to impact on the following water characteristics:

- catchment areas and flow volumes in downstream watercourses
- flooding, including flow rates, velocities and depths
- water quality in downstream watercourses
- geomorphological and hydrological values of watercourses, including environmental flows
- riparian and ecological values of watercourses
- water users, both in the vicinity and downstream of Invincible.

Detailed assessments of potential impacts on surface water resources (refer to **Appendix 4**) and groundwater resources (refer to **Appendix 5**) have been undertaken for the Southern Extension Project.

6.3.4 Proposed water management system

The Southern Extension Project will not involve any increase in the area of catchment managed by the existing Invincible surface water management system (WMS), as the existing system already captures the catchment in which the Southern Extension Project will be located. The key changes associated with the Southern Extension Project relate to the areas of disturbance associated with mining in the Southern Extension Area and the management of water dewatered from the former Ivanhoe No.2 workings.

6.3.4.1 Management of dewatering of the Old Ivanhoe underground workings

The Ivanhoe No. 2 underground workings within the Southern Extension Area will need to be dewatered prior to open cut mining in the Lithgow seam. The Groundwater Assessment (AGE, 2016) has determined that up to approximately 2,121 ML of water contained in the Ivanhoe No.2 underground workings may need to be removed to enable the mining of the Lithgow seam in the Southern Extension Area. As noted in the Groundwater Assessment this volume is based on an inferred maximum storage within these workings in absence of water monitoring confirming current water levels within these former workings (refer to **Appendix 5**).

This water is expected to be of similar or better water quality to that in the Baal Bone Colliery to the north east due to being sourced almost entirely from surface flow through subsidence cracking and not from groundwater inflow from the coal seam.

As outlined in the **Section 6.3.7**, Castlereagh Coal have committed to the establishment of groundwater monitoring to confirm the findings of the groundwater assessment in relation to the volume and quality of water located in the former Ivanhoe and Invincible underground workings. This will be used to confirm the specific management of this water. Notwithstanding the assessment of water stored in former underground workings has been undertaken based on a number of conservative assumptions in order to identify appropriate options to effectively manage this water.

Calculations in the Groundwater Assessment have conservatively identified that that the former Invincible underground workings (i.e. those hydraulically connected to the Northern Void) have current free volume of approximately 1,585 ML in the underground workings and Invincible open cut spoil with outflows to Baal

Bone workings of between 111 ML per year and 317 ML per year (refer to **Appendix 5**). As discussed above, the potential volume of water that would need to be removed from the former Ivanhoe workings to enable mining of the Lithgow seam is up to 2121 ML, which exceeds the storage available in the former Invincible underground workings and Invincible open cut spoil.

To enable mining of the Lithgow Seam and avoid potential decant from the Invincible open cut associated with the filling of the Invincible underground workings, the discharge of surplus water from the dewatering the Ivanhoe No.2 underground workings, in accordance with requirements of the EPL. The dewatering of the Ivanhoe workings would occur prior to mining accessing the flooded extent of the Lithgow Seam in the Southern Extension Area.

An assessment of the receiving watercourses, i.e. Cullen Creek and its tributaries, indicates that the flow capacity of the channel immediately downstream of the Main Water Storage Dam is approximately 1.0 m^3 per second (i.e. 86 ML per day) which increases to a capacity of approximately 15 m^3 per second (i.e. 1,296 ML per day) immediately downstream of the Castlereagh Highway.

Based on the analysis completed in **Appendix 5**, maintaining the existing EPL discharge limits and restricting discharges to wet weather days only and taking account of existing flows in the receiving catchment, in excess of 2121 ML could be discharged from via the overflow in the Main Water Storage Dam in the first year of operations without exceeding the downstream channel capacity. Based on an a analysis of climatic data and channel capacity, discharges from the site associated with dewatering activities would be limited to 260 l/s (22.8ML/day) on wet weather days only. This volume represents 26% of bank full flows.

In order to progressively dewater the Ivanhoe No. 2 workings, it may be necessary to temporarily store some of the Ivanhoe No. 2 water in the Invincible underground workings, pending suitable days for discharge. This can be managed through pumping from the Ivanhoe No 2 workings to the Eastern or Northern Voids or by direct drainage from the Ivanhoe No.2 workings into the Southern/Renown Pit void and allowing for percolation through spoil into the former Invincible Underground Workings. Water levels in the spoil of the former Invincible open cut workings would be monitored to ensure the volume stored does not exceed storage capacity.

Should groundwater monitoring indicate additional storage available within the former Invincible underground workings is available and/or the volume of water in the Ivanhoe No. 2 underground workings is less than assumed, some or all of the water from Ivanhoe No. 2 underground workings may be transferred to these workings. Should this additional storage be confirmed through monitoring, the volumes of water requiring to be discharged would be reduced. The period over which discharges associated with the dewatering would occur would also be reduced if there is less water than assumed in the Ivanhoe No. 2 workings or there is additional storage available in the Invincible underground workings.

As noted above, the quality of the water in the Ivanhoe No. 2 workings is expected to be consistent with or better than the quality of water dewatered from the nearby Baal Bone operations. The water taken from the Baal Bone underground workings is discharged into the tributary of Jews Creek, together with surplus water from the Water Management System (Glencore 2016a). The groundwater discharged at Baal Bone Colliery (of which approximately 80% is from dewatering of workings) typically has the following concentrations of key analytes dissolved iron of 0.07 mg/L, pH between 6.5 to 8.5, TSS of 5 mg/L, EC of 1,125 µS/cm and Sulphate of 288 mg/L (based on 12 month rolling average data published 2016 (Glencore 2016b).

Discharge rates may be increased to meet operational requirements and any increase in discharges would be assessed as part of an application, if required, to vary the EPL. The EPL will also need to be varied to cover limits on EC, iron and sulfate levels similar to those applying to discharges for other mining operations in the area. It is noted that any discharges associated with the dewatering of the former

Ivanhoe underground workings will only be required in the short term. Ongoing discharges during the operation of the Southern Extension Project to manage operational water surpluses will be in accordance with relevant EPL requirements.

6.3.4.2 Changes to water management system

In addition to the dewatering of the Ivanhoe No. 2 underground workings, the Water Management System will need to be updated to reflect the additional catchment from disturbed areas.

For the Southern Extension Project, three categories of water will be managed, each with different potential for water quality impacts, namely:

- Clean water - Runoff from undisturbed areas or rehabilitated areas where vegetation is fully established, and where the water quality is suitable for release/discharge.
- Dirty water - Runoff from disturbed areas, such as active overburden emplacement areas or overburden emplacement areas where vegetation is not fully established. These areas have the potential for elevated TSS.
- Mine water - Mine water, being water exposed to coal or used in coal processing and runoff within mining areas. This water quality typically displays a higher level of salinity.

The target design criteria for the three categories of water are summarised in **Table 6.5**.

Table 6.5 Design Criteria for Components of the WMS

Water Category	Water Description	Target Design Criteria
Clean	Runoff from undisturbed or established rehabilitated areas	Intercept, convey and/or release, where practicable, to downstream environment.
Dirty	Runoff from disturbed areas	Managed in line with the Blue Book (Managing Urban Stormwater: Soils and Construction Volumes 1 and 2E).
Mine	Runoff from areas exposed to coal, or water used in coal processing or from coal stockpile areas	Sumps and associated systems located within the CPP area are sufficient to manage runoff for events up to and including the 1 per cent 24 hour AEP (Annual Exceedance Probability) storm event.

Dirty water and mine water will be utilised preferentially to meet the water needs for the Southern Extension Project – i.e. for coal processing and dust suppression. Water removed from the Ivanhoe No. 2 or water stored in the Invincible underground workings can be also be used for operational purposes. Given the volume of water stored in the underground workings, there will not be any need to import water onto the site other than potable supplies. Excess water captured on site that cannot be utilised will be discharged in accordance with the EPL.

Potable water supply and wastewater treatment and disposal practices for the Southern Extension Project will be the same as for the existing operations. Potable water is currently sourced from the Fish River Dam Water Supply main pipeline system. Wastewater is managed on site using a septic tank system which is periodically maintained by licensed contractors.

The conceptual layout of the key components of the WMS for Stage 1 and Stage 2 of the Southern Extension Project (refer to **Section 3.5.1**) are shown on **Figures 6.7** and **6.8**. **Figure 6.9** shows the proposed drainage systems for the proposed conceptual final landform. The operation of the proposed WMS for the Southern Extension Project during these stages is discussed in detail in **Appendix 4**.

6.3.4.3 Water balance

The WMS for the Southern Extension Project will be integrated with the existing Invincible WMS. As such, the water balance for the Southern Extension Project has been modelled as an integrated system including both the Southern Extension Area and the existing Invincible WMS.

The predicted average net site water balance is detailed in **Appendix 4**. On average, the modelling predicts that the operation will have a positive gross site water balance. The water make associated with the water balance will either be stored in the former Invincible Underground Workings or discharged off site in accordance will the EPL.

An analysis of the modelled discharges assuming no available storage volume within the former Invincible Underground Workings (i.e. the worst case scenario) is included in **Table 5.2**.

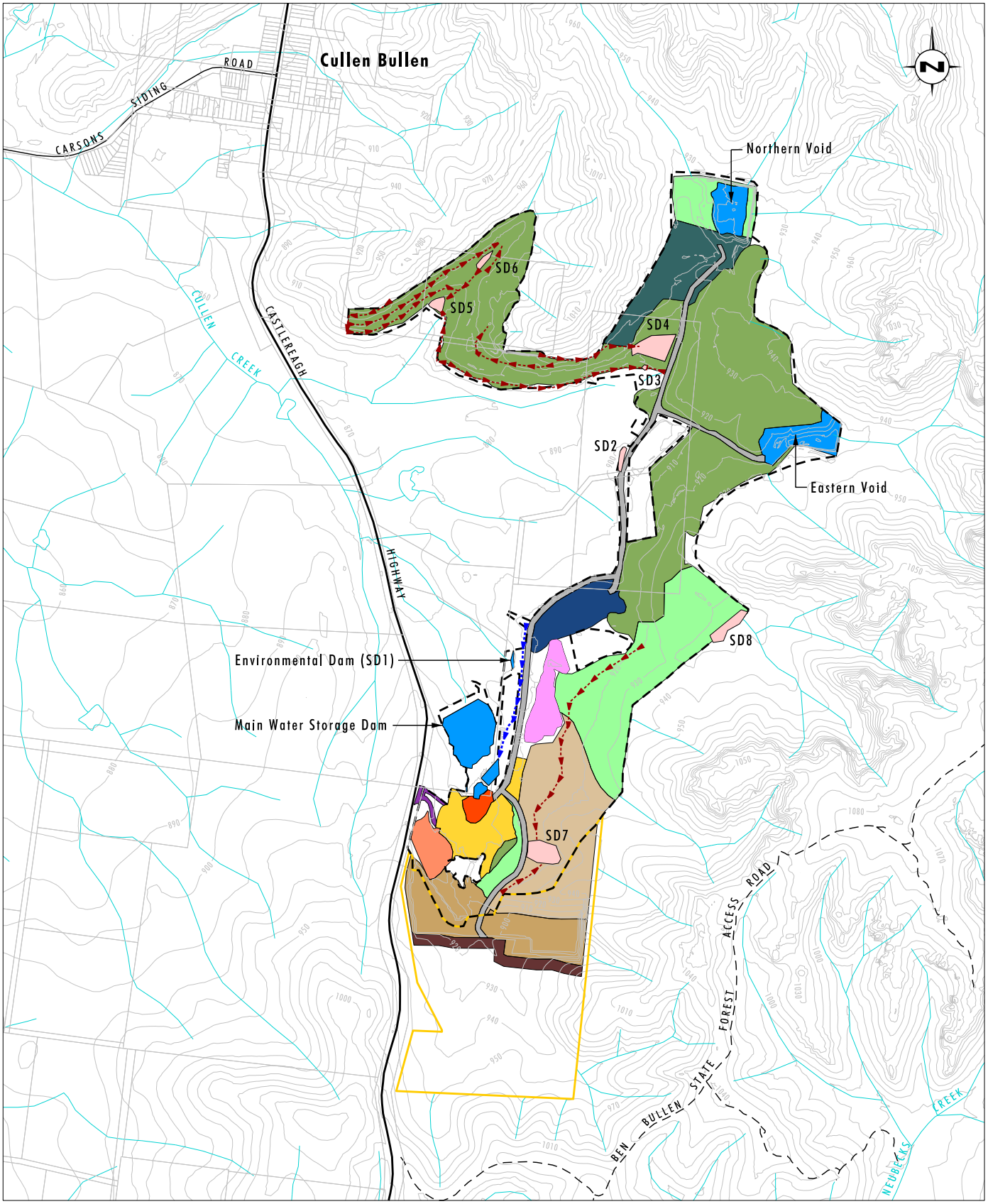
Table 6.6 Main Water Storage Dam Modelled Discharges

Percentile	Discharge (ML)
10th %ile	21
50th %ile	206
90th %ile	785

The modelled maximum number of days that discharges would occur from the Main Water Storage Dam is 78 days based on historical climate data and predicted site water demands.

As discussed in **Section 6.3.1** Castlereagh Coal is able to either discharge surplus water during wet weather to Cullen Creek (via EPL 1095) or pump surplus water to the underground voids. The modelled average daily discharge volume from the Main Water Storage Dam for the climatic period modelled is 0.94 ML per day.

Sediment dams for the Southern Extension Project are proposed to be designed in accordance with Blue Book requirements to contain the 95th percentile 5 day runoff. Consistent with the design criteria, the water balance model predicts that on average the Southern Extension Project sediment dams will spill during prolonged or unusually intense periods of rainfall. The average number of spills from sediment dams that spill off site for the climatic period modelled is estimated to be less than one spill per year.



Data Source: LPI (2016)
Note: Contour Interval 10m

Legend

- Existing Approved Mining Disturbance Area
- Proposed Southern Extension Area
- Active Mining
- Active Overburden Emplacement Area
- Pre Strip
- Rehabilitation - Vegetated
- Shaped Not Seeded
- Coal Stockpile - Product
- Coal Stockpile - ROM
- Haul Road / Access Road
- Sealed Access Road
- Infrastructure / Laydown Area
- MIA / Administration
- Water Management Area
- Tailings Drying Area
- Temporary Stabilisation Area
- Sediment Dam
- Mine Water Drain
- Dirty Water Drain

FIGURE 6.7

Conceptual Water Management System Stage 1

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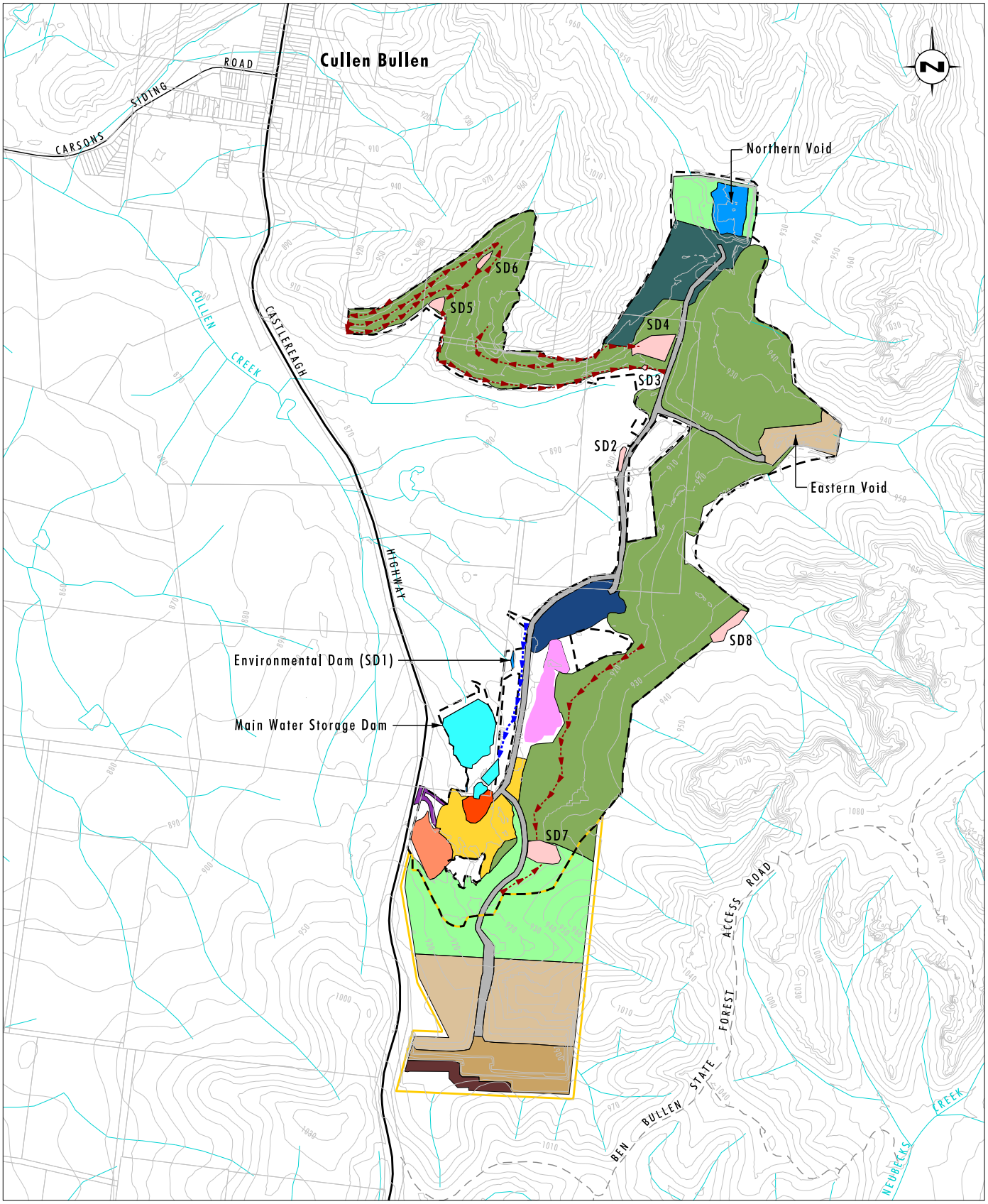

Data Source: LPI (2016)
Note: Contour Interval 10m

Legend

- Existing Approved Mining Disturbance Area
- Proposed Southern Extension Area
- Active Mining
- Active Overburden Emplacement Area
- Pre Strip
- Rehabilitation - Vegetated
- Shaped Not Seeded
- Coal Stockpile - Product
- Coal Stockpile - ROM
- Haul Road / Access Road
- Sealed Access Road
- Infrastructure / Laydown Area
- MIA / Administration
- Water Management Area
- Tailings Drying Area
- Temporary Stabilisation Area
- Sediment Dam
- Mine Water Drain
- Dirty Water Drain

FIGURE 6.8

Conceptual Water Management System Stage 2

File Name (A4): R02/3622_120.dgn
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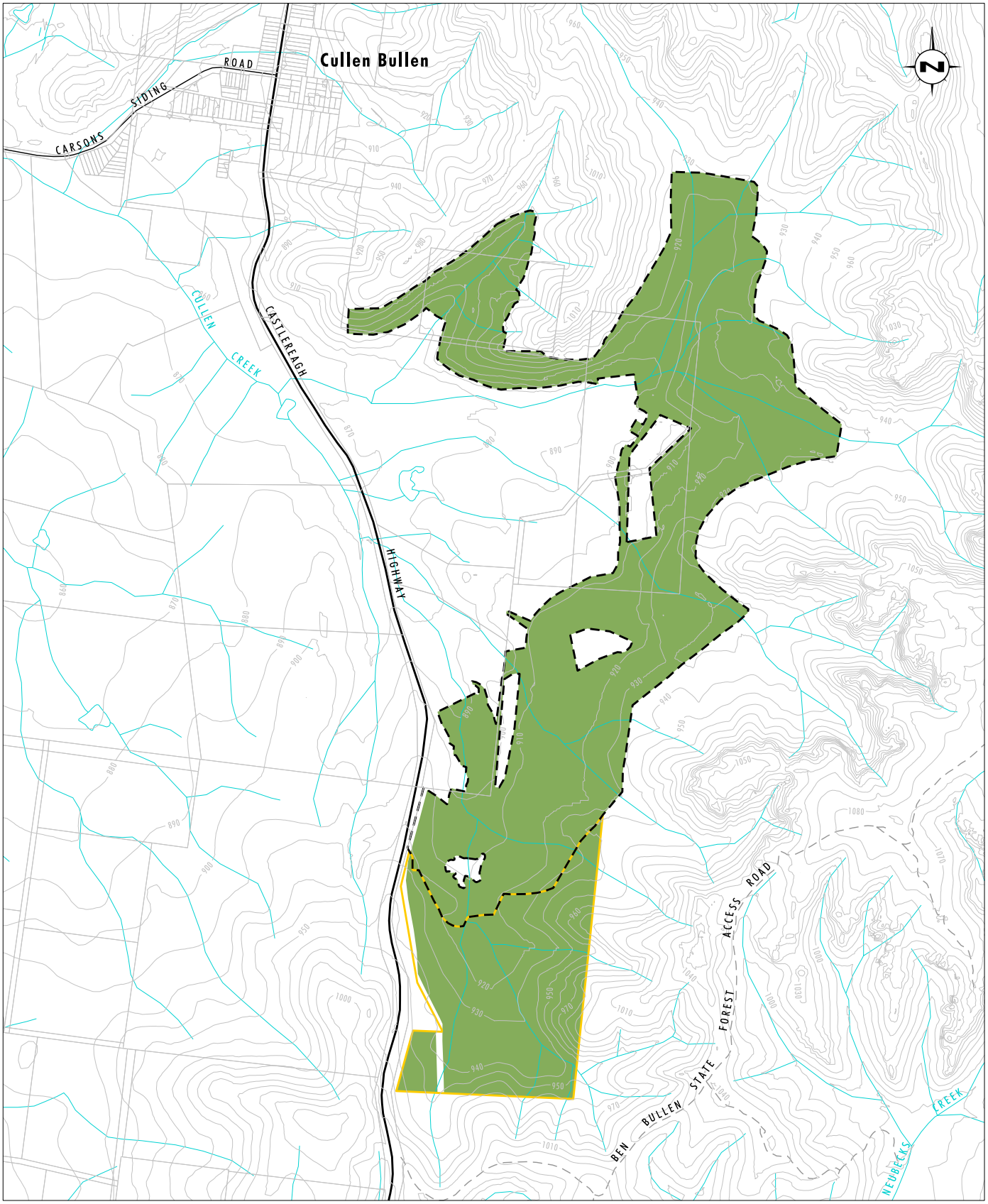

Data Source: LPI (2016)
Note: Contour Interval 10m

Legend

- Existing Approved Mining Disturbance Area
- Proposed Southern Extension Area
- Rehabilitation - Vegetated

FIGURE 6.9

Conceptual Drainage Systems in Final Landform

6.3.5 Surface Water Impacts

The Southern Extension Project and the associated WMS has the potential to impact on surface water systems including:

- Impacts to catchment areas and downstream watercourses
- Impacts to flooding, including flow rates, velocities and depths
- Impacts to water quality in downstream watercourses.

6.3.5.1 Catchment areas and annual flow volumes

Invincible with the Southern Extension Project will continue to capture runoff from upslope of the operational mining areas and manage runoff from disturbed areas during the operational and rehabilitation phases of the Southern Extension Project. The existing approved mining operations include capture of runoff from upslope of the operational areas and management of runoff from disturbed areas. The overburden emplacement areas will be rehabilitated as soon as practicable when final landform is achieved. By implication, some areas will be rehabilitated concurrently with overburden placement in others. The strategy of progressive rehabilitation will minimise the duration for which catchment is lost during the operational phase. Where practical, once rehabilitation is established, areas will be designed to externally drain to return water to the surrounding environment.

Table 6.7 summarises the predicted impacts on the catchment areas of Cullen Creek for the following scenarios:

- Prior to any mining
- Current landform
- Currently Approved Final Landform
- Maximum extent of mining under Southern Extension Project
- Proposed conceptual final landform.

For the assessment, the Southern Extension Project conceptual final landform has been compared to the currently approved final landform (refer to **Table 6.7**) unless stated otherwise.

Table 6.7 Cullen Creek Catchment Summary

Scenario	Area (ha)
Pre-mining	1,725
Current	1,020
Currently Approved Final Landform	1,725
End of Mining	1,020
Proposed Conceptual Final Landform	1,725

As shown in **Table 6.7**, substantial changes have occurred to date to the catchment area of Cullen Creek (i.e. when comparing pre-mining to the current area) as a result of approved mining operations within this catchment area.

During the life of the Southern Extension Project there will be no changes to the catchment area of Cullen Creek compared to the current impacts with the existing WMS. The Southern Extension Project will return by rehabilitation, existing catchment area as soon as possible to the downstream catchments. The Southern Extension Project final landform will not result in any final voids or changes to catchment boundaries as such there is no impact on the final catchment area compared to pre mining or the currently approved final landform.

As the Southern Extension Project will not result in changes to the current catchment area of Cullen Creek relative to the existing WMS or with the Southern Extension Project Final Landform compared to the currently approved Final Landform it is considered that there will be no reduction in annual flow volumes, relative to the currently approved impacts, in Cullen Creek. If required, the discharge of water from the site will increase flows in the Cullen Creek catchment relative to the current approved operations. As outlined in **Section 6.3.4.1**, this discharge would be managed in accordance with the relevant EPL requirements and in consultation with the EPA.

6.3.5.2 Flooding

The Surface Water Assessment includes dynamic flood modelling of Cullen Creek for the pre mining landform, the existing site, and the Southern Extension Project final landform. Flood events that were simulated included the 100 per cent, 5 per cent, 2 per cent and 1 per cent AEP flood events (refer to **Appendix 4**).

For the assessment, flood modelling results for the Southern Extension Project final landform have been compared to the pre mining landform. As no change occurs to the current catchment area during the operational life of the Southern Extension Project it is considered that there will be no impacts on downstream flooding during the life of the Southern Extension Project. While the overall catchment of Cullen Creek does not change as a result of the proposed final landform, the drainage network and landform does change which will affect flood patterns in drainage network downstream of the Invincible.

The modelling indicates that the Southern Extension Project results in decreases to peak flood depths, flows and velocities downstream in Cullen Creek.

The modelling indicates that the Southern Extension Project will range between negligible to improved flood access at the three of the culvert creek crossings over the Castlereagh Highway with the Southern Extension Project final landform. There is one culvert crossing, Culvert ID 2 that increases in flood hazard category between the pre-mining and Southern Extension Project final landform scenarios. However, it is considered that although the modelling predicts an increase this will not impact on the accessibility of the Castlereagh Highway at this location as the flood hazard categories are the same as the northern adjacent culvert (ID 3) and less than at the most northerly culvert (ID 4). Overall the flood accessibility of the Castlereagh Highway is improved with a reduction of the maximum flood hazard category from Damage to Light Structures to Wading Unsafe.

The changes in flood characteristics between the pre-mining and final landform scenarios are considered minor and would not be expected to impact on erosion/scour or sediment deposition within Cullen Creek.

6.3.5.3 Geomorphological and hydrological values

The Southern Extension Project is not expected to result in impacts to the geomorphological or hydrological values of local surface water systems. Potential impacts on geomorphological stability and changes to potential erodibility and scour as a result of the Southern Extension Project are discussed below.

The bed and banks of Cullen Creek have undergone little modification from existing operations. Upstream of the crossing with the Castlereagh Highway, Cullen Creek has a generally poorly defined channel and a sparsely vegetated riparian zone. The lower reaches of Cullen Creek prior to joining Delhuntys Creek are better defined, but remain sparsely vegetated.

Throughout the operational life of the Southern Extension Project, the Southern Extension Project will not influence the contributing catchment of Cullen Creek and all discharges will be managed to ensure that flows remain in-bank.

The Southern Extension Project final landform will result in a slight decrease in modelled flood flows and velocities compared to the pre-mining case. This slight decrease would likely be associated a reduction in potential impacts on stability, such as scour, are therefore predicted to be reduced in comparison with the pre-mining case.

6.3.5.4 Water quality

As set out in **Section 6.3.4.2**, it is proposed to integrate water management for the Southern Extension Project with the existing WMS to limit the potential impacts of the Southern Extension Project on downstream water quality by managing water that has the potential to cause environmental harm. In conjunction with the proposed WMS, a series of erosion and sediment control measures will be utilised during construction, operation and rehabilitation phases of the Southern Extension Project to manage water quality (refer to **Section 6.3.7**).

Through management of dirty water and mine water within the WMS over the life of the Southern Extension Project, and based on the outcomes of the assessment of changes to flood behaviour and flows in downstream watercourses, it is not anticipated that water quality in downstream watercourses will be adversely impacted by the Southern Extension Project. As such the Southern Extension Project is considered to have a low potential for adverse cumulative impacts to water quality on downstream watercourses. Additional management and monitoring measures for the Southern Extension Project are summarised in **Section 6.3.7**.

6.3.5.5 Water users

The Macquarie Bogan Unregulated and Alluvial Water Sources WSP applies to all land affected by surface operations at Invincible. The WSP includes rules for protecting the environment, water extractions, managing licence holders' water accounts and water trading in the plan area.

The majority of land adjacent to Cullen Creek immediately downstream of Invincible is owned by private landholders that retain basic landholder rights for domestic and stock use. There are no known licensed water users on waterways directly downstream of Invincible along Cullen Creek.

While the Southern Extension Project does not extract water from Cullen Creek directly, the WMS does intercept runoff from part of the upstream catchment area. Capture of water from Cullen Creek is managed under *Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Sources (Turon Crudine River Water Source)* and is discussed in **Section 6.3.2**. Capture of quantities beyond those allowed under

basic landholder rights (10 per cent of the average regional runoff from a landholding) require a WAL which Invincible will obtain as part of its permitting process.

Following rehabilitation, the Southern Extension Project will have minimal impact on annual flow volumes in Cullen Creek compared to the pre-mining conditions. During the four year life of the Southern Extension Project, impacts will be commensurate with those associated with the currently approved existing site. Water take associated with any dams remaining in the Southern Extension Project final landform will be managed within the harvestable rights provisions for the final landholdings.

The predicted impacts on flows in the downstream receiving waters, including Cullen Creek and it is considered there will be no negative impacts on downstream water users in the Turon River system.

6.3.5.6 Cumulative impacts

Both the Southern Extension Area and the surrounding areas have been subject to open cut and underground mining operations for many decades. Recent and existing mining at the site include underground workings and open cut pits. In the local region other mining operations include open cut and underground operations at Cullen Valley, Ivanhoe and Baal Bone Collieries, which are on care and maintenance or in the case of Ivanhoe being rehabilitated.

The surface water assessment indicates that the Southern Extension Project is expected to have negligible impacts on flows, water quality and water users relative to the current approved impacts immediately downstream of Invincible on Cullen Creek and the Turon River system.

6.3.6 Ground water impacts

6.3.6.1 Assessment methodology

The groundwater assessment (refer to **Appendix 5**) was based on a conceptual hydrogeological model to assess potential groundwater flow pathways, the potential volume of groundwater stored within the Southern Extension Area, and the potential impacts on the groundwater system resulting from the Southern Extension Project.

As outlined above, the Lithgow Seam has been mined extensively in the vicinity of Invincible by historic underground and open cut workings in addition to the current approved operations. This past mining has largely removed the coal seam aquifer (being the main aquifer within the proposed mining area), and depressurised the remaining un-mined coal. The former underground workings are possibly wholly or partly flooded. However, this partial recharge of the aquifer does not represent a repressurisation of the aquifer to pre-mining conditions. Hence, as the main body of the aquifer within the Southern Extension Project area has largely been replaced by underground open voids the key water related issue for the Southern Extension Project is managing the water stored within flooded former underground workings.

6.3.6.2 Potential Impact on flooded underground workings

The flooded underground workings are considered to be an aquifer for the purposes of the *Water Management Act 2000*.

The predominant groundwater recharge pathway for the Lithgow Seam aquifer in the Southern Extension Project area is likely to be infiltration from the surface at the seam subcrop and via subsidence cracking which extends to the surface. The Southern Extension Project area is located adjacent to the seam subcrop, therefore dewatering of the underground workings of the Ivanhoe No. 2 Colliery within the Southern

Extension Project area will not likely have a measurable impact on the water levels within adjacent workings.

During the life of mining during the Southern Extension Project there may be a slight increase in the amount of surface water flows captured and diverted into former Ivanhoe No. 2 workings in the Lithgow seam relative to existing conditions. However, pit dewatering activities and the slope of the Lithgow Seam bedding plane north towards the existing Invincible open cut void will minimise the extent of any inflows.

All water falling into disturbed areas of the open cut (with the exception of rainfall events which exceed the design criteria of sediment dams) as either rainfall of inflows from upstream catchment will be diverted first into the open cut and then ultimately into the former Invincible underground workings. Water will be extracted from the Northern Void for operational purposes (e.g. washery use and dust suppression) which will remove water from the underground workings.

Rehabilitation of the former open cut areas and Southern Extension Project area will ultimately reduce inflows into the former Invincible and Ivanhoe underground workings as increased amounts of runoff are diverted into Cullen Creek.

The Southern Extension Project and the Invincible underground is located up-gradient of Baal Bone Colliery. The Invincible underground are likely to contribute groundwater to Baal Bone Colliery by way of seepage from the workings. This volume of seepage to the Baal Bone Colliery has previously been estimated to range between approximately 111 ML/year and approximately 317 ML/year. The potential transfer of water from the Ivanhoe underground workings to the Invincible underground will increase the pressure head and potentially increase the seepage rate into the Baal Bone, by as much as 30%. Given that Baal Bone is currently on care and maintenance, dewatering at Baal Bone Colliery is likely to cease at some stage in the future. The water level within the Invincible underground will likely rise if the Baal Bone Colliery ceases to dewater their underground workings. However, this increase would not occur until the Baal Bone workings and associated goaf had filled and the remnant coal in the Lithgow Seam becomes saturated. This process will take many years and recharge into the Invincible underground workings will be significantly reduced relative to existing levels as a result of the rehabilitation of the Invincible open cut. As a result, any increase in water levels in the Invincible underground workings is expected to be extremely slow.

6.3.6.3 Groundwater seepage to open cut

Currently, there is the potential to store a volume of groundwater within the Invincible underground workings. However, if the Ivanhoe No. 2 workings are flooded and the Invincible underground workings are flooded to the tidemark used in calculation of available storage, there is potential for water to discharge into the corner of the Invincible open cut area to the north of the Southern Extension Project. Castlereagh Coal will commit to establishment of monitoring of the water level within the northern areas of spoil to monitor an increase that may give rise to decant. Discharges from the Invincible water management system will be managed in accordance with the Invincible EPL to remove any risk of decant.

6.3.6.4 Potential aquifer depressurisation

The Southern Extension Project area is located close to the Lithgow Seam subcrop and recharge zone. Depressurisation of the Lithgow Seam due to dewatering within the Southern Extension Area will likely be minimal and is assumed to generate a localised zone of depressurisation. The Lithgow Seam has been extensively mined down-dip of the Southern Extension Area, so this aquifer has already been highly modified from its natural state and has already experienced significant regional dewatering and then subsequent re-wetting. The extent of any localised depressurisation would be limited to the barrier coal between the Ivanhoe and Invincible workings and the Ivanhoe and Wallerawang workings.

Most of the surrounding historical underground mine workings are currently flooded. With the exception of the Ivanhoe No. 2 workings, these are all located down dip from the Southern Extension Area. The groundwater head in nearby underground workings is unlikely to be measurably lowered because these workings are located down dip and the coal seam barriers that separate the underground workings will partially restrict the zone of depressurisation. The very large storage capacity of the underground workings will also buffer any potential water level changes.

6.3.6.5 Potential impact on groundwater users

The only registered bore in close proximity to the Southern Extension Area is a bore associated with Invincible. The closest registered bore (a monitoring bore at the Pine Dale Coal Mine) is located approximately 1.2 km to the south of the Southern Extension Area. The closest bore potentially used for productive (i.e. non mine related) purposes is located approximately 3.5 km to the west of the Southern Extension Area. Dewatering of the Southern Extension Project area is not anticipated to impact the water levels in this bore.

6.3.6.6 Potential impact on groundwater dependent ecosystems

No high priority GDEs are located within the footprint of the Southern Extension Project area. The absence of any groundwater seepage and aquifer depressurisation will ensure that no GDEs will be impacted.

6.3.6.7 Assessment against Aquifer Interference Policy

An assessment that compares the predicted impacts of the Southern Extension Project against the Aquifer Interference Policy Level 1 minimal impact considerations for the less productive groundwater of the Permian coal measures is provided in **Appendix 5**. This assessment confirms that the predicted groundwater impacts are within the minimal impact considerations under the Aquifer Interference Policy.

6.3.7 Water licensing

Water licensing for the Southern Extension Project is governed by the *Water Management Act 2000* and applicable WSPs. Whilst technically classified as 'groundwater' for the purposes of the *Water Management Act 2000*, the water in the Ivanhoe No. 2 workings is largely stored surface water which was historically intercepted by subsidence cracks. The historical take of this water has been considered in the development of the WSP applicable to these surface flows and the extraction of this water is not considered to be take for the purposes of the Water Management Act. Surface flows from upstream catchments intercepted by the open cut workings is considered licensable take. The net take from surface flows (i.e. intercepted flow less water returned to the catchment via discharges) over basic landholder rights will need to be licensed.

A detailed site water balance will be developed, based on confirmed water volumes in Ivanhoe No. 2 workings, to confirm net take and outflows into both groundwater and surface water systems. Net take from these systems in excess of basic landholder rights will be licenced in accordance with the rules under the relevant WSP. Castlereagh Coal has consulted with DPI Water in relation to the relevant licensing requirements for the Southern Extension Project and will continue to engage with DPI Water to confirm the specific water licensing requirements for the Southern Extension Project.

6.3.8 Management and monitoring commitments

The key management measures for the Southern Extension Project in regard to surface water are the Invincible WMS and associated erosion and sediment control measures. The existing Invincible Water Management Plan will be updated to reflect the changes to the WMS and recommendations described in **Appendix 4** and **Appendix 5**.

The existing monitoring programs at Invincible will be updated as part of the Water Management Plan for the Southern Extension Project, including development of specific triggers around water quality and water levels in former underground workings and open cut spoil. These programs will be documented in the Invincible Water Management Plan as detailed in the commitments below.

The Water Management Plan will be updated to guide the overall management of water as part of the Southern Extension Project.

- Castlereagh Coal will monitor the water level in the former Ivanhoe No. 2 Underground workings and estimate the volume of water that will need to be removed to safely mine the Lithgow Seam in the Southern Extension Area prior to any dewatering of these workings.

- Castlereagh Coal will ensure any water discharged from discharge point (LDP002) meets the relevant requirements of EPL 1095.

- Castlereagh Coal will obtain appropriate water licences for all take from surface and groundwater systems as required for the Southern Extension Project. The Water Management Plan will outline a licensing strategy developed in consultation with DPI-Water to ensure that water access licences are obtained to account for take through the life of the Southern Extension Project.

- Castlereagh Coal will inspect the settlement ponds and sediment basins on a regular basis, or following rainfall of >25mm/24 hours, and clean out the sediment basins of consolidated sediment once capacity reduced by 20per cent.

- Castlereagh Coal will excavate temporary sumps within the open cut area to capture rainfall and runoff within the open cut.

- Castlereagh Coal will monitor water quality and volume of water released from licensed discharge point LDP002 within 24 hours of commencement of discharge and / or as specified on EPL 1095.

- Castlereagh Coal will monitor water quality within the Main Water Storage Dam at least monthly.

- Castlereagh Coal will monitor the quality of any water in the former Ivanhoe No. 2 Underground workings that may need to be dewatered to enable mining in the Southern Extension Area prior to dewatering.

- Castlereagh Coal will install standpipe monitoring bores into the former Invincible Underground workings for the purposes of monitoring water levels and water quality in the former workings.

- Castlereagh Coal will install a standpipe monitoring bore into the spoil near the potential decant point at the northern end of the open cut workings.

- Castlereagh Coal will monitor the water level and water quality in the Northern Void, monitoring bore in spoil near potential decant point and the monitoring bores in the former Invincible underground workings at least monthly.

- The WMS will be updated to include Trigger Action Response Plans related to the management of water levels in the underground workings and open cut spoil and the risk of decant.

- Castlereagh Coal will locate the dewatering discharge point to the Main Water Storage Dam from the Northern Void/Invincible Underground workings and Ivanhoe No. 2 workings on a float towards the middle of the dam to assist mixing.

- Castlereagh Coal will cease pumping and dewatering from Northern Void or underground workings to the Main Water Storage Dam in the event of observed ferrous iron oxidation or signs of other contamination. Pumping may recommence if monitoring of water quality in the underground workings indicates that the water is unlikely to exceed water quality criteria specified in the EPL.

6.4 Ecology

A detailed Biodiversity Assessment Report (BAR) has been prepared to assess the potential ecological impacts of the Southern Extension Project using the Framework for Biodiversity Assessment – NSW Biodiversity Offsets Policy for Major Projects (FBA). The FBA was released in October 2014 and is the required approach for ecological assessments for major projects in NSW. The FBA process is a credit driven system where calculators provided by the NSW Government are input with ecological data about the site to generate 'impact credits'. The project is then required to offset these credits through a biodiversity offset strategy. The BAR report is provided in **Appendix 6** with a summary included in this section.

Following the FBA methodology, the BioBanking Credit Calculator (BBCC) was applied following extensive literature reviews, the identification of relevant landscape features and detailed flora and fauna field surveys (refer to **Figure 6.10**) in accordance with BioBanking Assessment Methodology (BBAM) (DECC, 2008). A full outline of the methodology of the BAR is provided in **Appendix 6**.

A summary of the BAR is provided in this section of the report which also includes a description of the project design changes to avoid ecological impacts, as well as details of the key ecological values of the Southern Extension Area and the outcomes of the FBA process.

6.4.1 Project design changes to avoid ecological impacts

As detailed in **Section 3.7**, Castlereagh Coal has sited and designed the Southern Extension Project to avoid and minimise potential impacts on biodiversity values. Key site selection and planning phase avoidance measures included:

- The Southern Extension Project does not include any highwall mining or other underground mining and will not have any subsidence impacts that may affect the pagodas and associate habitat values.

- Locating the mining area to the south of Invincible, which avoids direct impacts on the steep valleys between pagoda formations located to the northeast of the Southern Extension Area, previously identified as providing a diverse range of vegetation communities and rocky habitat features in close proximity to pagoda structures for key species, including the broad headed snake.

- The pagodas located directly to the east of the Southern Extension Area are typically smaller in scale and are associated with much drier vegetation communities than the more significant terrain features associated with the more northerly pagodas.

- The area to the south of Invincible represents an area of relatively homogenous vegetation types and relatively low threatened species diversity and habitats compared to other areas of vegetation in proximity to Invincible.

- The limit of disturbance associated with mining was initially set back at least 300 m from all pagoda formations. The setback from the nearest pagoda was reduced to approximately 210 m following further investigations which identified that the appropriate microhabitat requirements, exfoliated slabs and crevices, required by the species were generally absent or sparse at this and other pagodas located in proximity to the Southern Extension Area.

- The setback has resulted in an area of potentially mineable resources in the north-east of the Southern Extension Area not being mined. Future extraction of the coal in this area is unlikely once the disturbed areas to the west of it are rehabilitated as part of the Southern Extension Project.

The Southern Extension Project has been assessed in accordance with the FBA which allows for the quantification of impacts and the identification of clear offset requirements and the mechanisms by which these offsets can be achieved. This is detailed in **Appendix 6**.

6.4.2 Key ecological values of the Southern Extension Area

The FBA process requires the identification and characterisation of a range of ecological values of a project area in order to inform the calculation of impacts and mitigation requirements. These values have been identified in terms of broad landscape features, native vegetation and threatened species features of the Southern Extension Area, as detailed in **Appendix 6**.

6.4.2.1 Landscape features

Landscape features and classifications within the Southern Extension Area and surrounds are summarised in **Table 6.8**.

Table 6.8 Landscape Features in the Southern Extension Area

Landscape Features	
IBRA Bioregion	South Eastern Highlands
IBRA Subregion	Capertee
Mitchell Landscape	Newnes Plateau
Rivers, Streams, Estuaries	1st, 2nd and 3rd order streams
Wetlands	None identified
Native Vegetation	80 ha in the inner assessment circle
State or Regional Biodiversity Links	739 ha in the outer assessment circle

No state or regional significant biodiversity links were identified within a plan approved by the Chief Executive of OEH in the South Eastern Highlands. Although a number of tributaries run through the Southern Extension Area, including first, second and third order streams, these are not defined as state or regional significant biodiversity links under the FBA (OEH 2014).

The site is completely covered in moderate to good condition native vegetation and joins with much larger areas on moderate to good condition native vegetation to the north, east and south associated with Ben Bullen State Forest and the Newnes Plateau State Forest. Therefore, the narrowest point of linkages to these areas of vegetation before and after the impact is greater than 500 m (refer to **Appendix 6**).

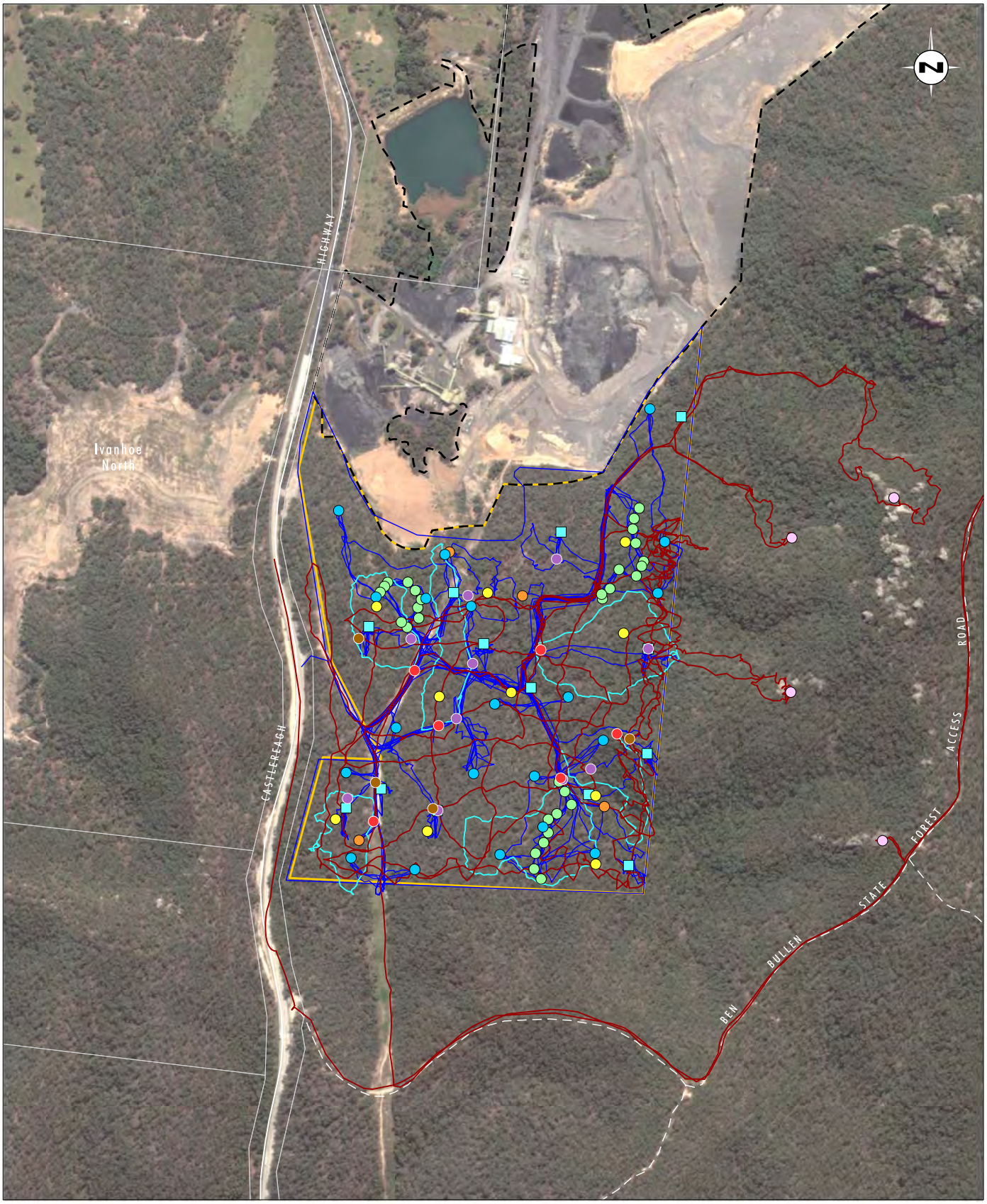

Image Source: Google Earth - DigitalGlobe (March 2015)
Data Source: LPI (2016)

0 100 250 500m

Legend

- Existing Approved Mining Disturbance Area
- Proposed Southern Extension Area
- Broad-headed Snake Survey Track
- Spotlighting Transect
- Flora Survey Tracks
- Flora Survey Locations
- Anabat
- Bird, Reptile and Amphibian Point
- Broad-headed Snake Habitat Assessment Point
- Call Playback
- Habitat Assessment
- Remote Camera
- Trapping Point
- Winter Bird Survey Point

FIGURE 6.10

Ecology Survey Effort

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6.4.2.2 Native vegetation

Surveys of the Southern Extension Area identified two Biometric Vegetation Types (BVTs) (excluding disturbed land) (refer to **Figure 6.11**) being:

- CW263 - Inland Scribbly Gum grassy open forest on hills in the Mudgee Region, NSW central western slopes
- CW117 - Brittle Gum - Broad-leaved Peppermint - Red Stringybark open forest in the north-western part (Yass to Orange) of the South Eastern Highlands Bioregion.

Refer to **Appendix 6** for detailed descriptions of these communities.

No threatened ecological communities were recorded within the Southern Extension Area. A review of the OEH Bionet website for Threatened Ecological Communities (TECs) within the Capertee sub-region identified two potentially occurring TECs listed under the TSC Act, being:

- Fuzzy Box Woodland on alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions
- White Box Yellow Box Blakely's Red Gum Woodland.

A thorough review of the biometric plot data collected from within the Southern Extension Area and the Scientific Determination for these communities confirmed that the vegetation present in the Southern Extension Area was not classified as these TECs.

6.4.2.3 Threatened Species

The FBA methodology categorises fauna species as either ecosystem-credit species or species-credit species which are defined as:

- Ecosystem-credit species – species that can be reliably predicted to occur in Plant Community Types (PCTs) and have a high likelihood of occurring on the site. Therefore, targeted surveys for ecosystem-credit species are not required
- Species-credit Species – species that cannot be reliably predicted based on a PCT, distribution or habitat criteria. These species require targeted survey effort to determine their presence or otherwise on the site.

Six ecosystem credit species were recorded in the Southern Extension Area during the surveys undertaken for this assessment (refer to **Figure 6.12**). These were:

- brown treecreeper (eastern subspecies) (*Climacteris picumnus subsp. victoriae*) – vulnerable under the TSC Act
- gang-gang cockatoo (*Callocephalon fimbriatum*) – vulnerable under the TSC Act
- scarlet robin (*Petroica boodang*) – vulnerable under the TSC Act
- large-eared pied bat (*Chalinolobus dwyeri*) (foraging habitat only) – vulnerable under the TSC and EPBC Acts

- eastern bentwing-bat (*Miniopterus schreibersii oceanensis*) (foraging habitat only) – vulnerable under the TSC Act

- yellow-bellied sheathtail-bat (*Saccolaimus flaviventis*) – vulnerable under the TSC Act.

No other records of ecosystem-credit species are known to occur within the Southern Extension Area. A discussion on these records and a full fauna species list from the surveys undertaken by Umwelt as part of this assessment are provided in **Appendix 6**.

Three species-credit species were recorded in the Southern Extension Area during the surveys undertaken for this assessment (refer to **Figure 6.12**). These were:

- Capertee stringybark (*Eucalyptus cannoni*) – vulnerable under the TSC Act

- large-eared pied bat (*Chalinolobus dwyeri*) – vulnerable under the TSC and EPBC Acts

- squirrel glider (*Petaurus norfolcensis*) – vulnerable under the TSC Act.

It is noted that the Southern Extension Area is considered to contain an area of woodland foraging habitat for the large-eared pied bat. The large-eared pied bat is only listed as a species-credit species when there is potential breeding habitat for the species likely to be impacted. This species breeds in caves, rock crevices and disused mineshafts, none of which occur within the Southern Extension Area or will be impacted by the Southern Extension Project. Further assessment of the large-eared pied bat has not been undertaken as part of this Southern Extension Project as the foraging component of the species habitat is considered as part of the ecosystem credit requirements of the Southern Extension Project.

Further discussion on these species-credit species and a full fauna species list from the surveys undertaken in 2015/2016 is included in **Appendix 6**.

In addition to species-credit species recorded in the Southern Extension Area, the broad-headed snake is a species-credit species that has a habitat qualifier. Although this species was not recorded during the targeted surveys within the Southern Extension Area, there is a recent (2010) record of this species 1.5 km to the north-east of the Southern Extension Area. In accordance with FBA considerations, the Southern Extension Area is considered to contain appropriate summer habitat for this species as the Southern Extension Area is land within 500 m of sandstone escarpments with hollow-bearing trees, rock crevices or flat sandstone rocks on exposed cliff edges and sandstone outcropping. The portion of the Southern Extension Area within 500 m of sandstone escarpment and containing tree hollows has been mapped as potential habitat for this species and it has been discussed below and included in the FBA calculator assessment.

As part of the BAR, a range of threatened species recorded (refer to **Figure 6.12**) or with potential to occur within the Southern Extension Area have been identified and where relevant have been included in the calculation of ecosystem credits for the Southern Extension Project (refer to **Section 6.4.5**).

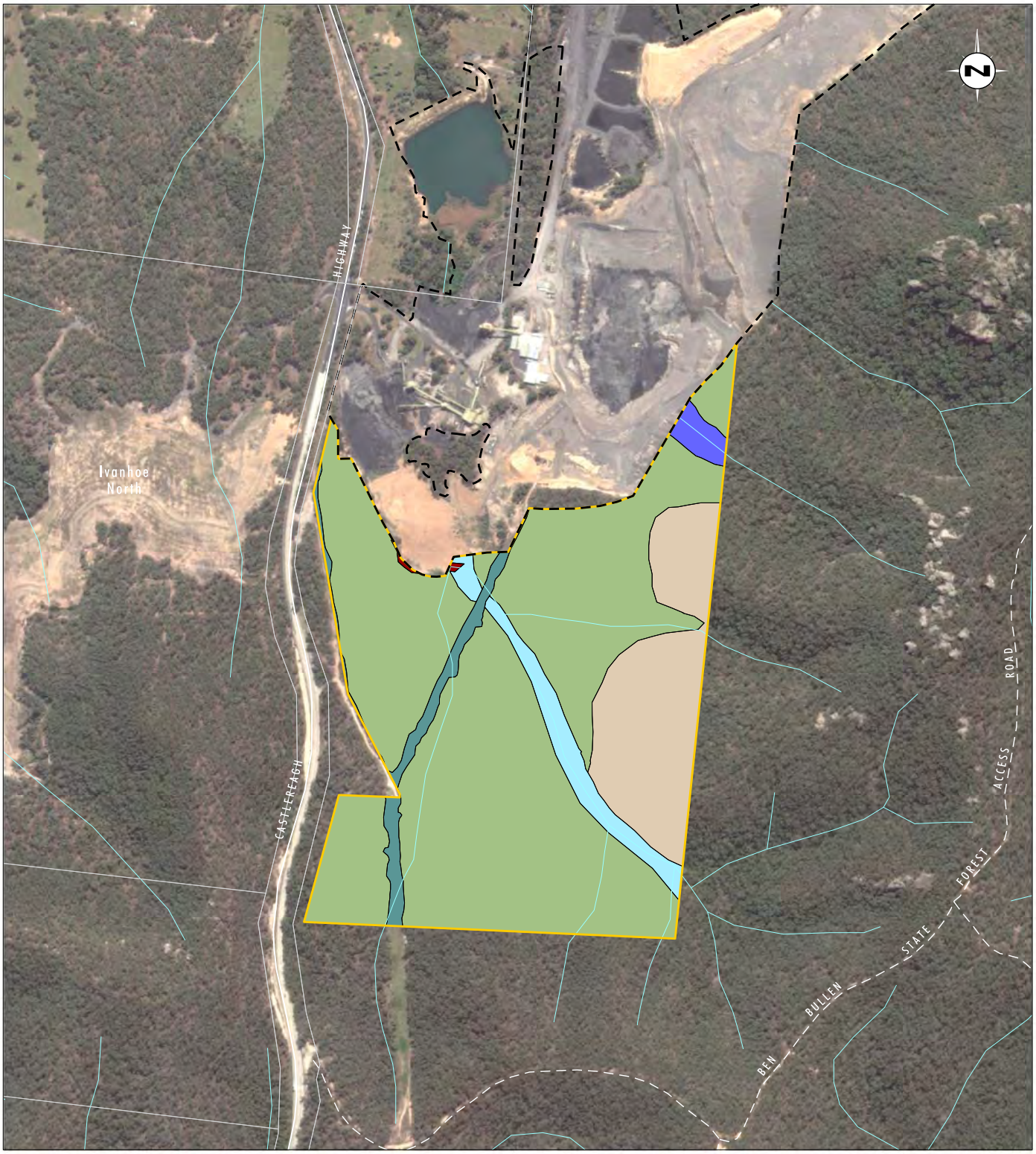

Image Source: DigitalGlobe (March 2015)
Data Source: LPI (2016)

0 100 250 500m

Legend

- Existing Approved Mining Disturbance Area
- Proposed Southern Extension Area
- Cleared Area
- Zone 1 - CW117 - Brittle Gum - Broad-leaved Peppermint - Red Stringybark open forest in the north-western part (Yass to Orange) of the South Eastern Highlands Bioregion (Modertae to Good)
- Zone 2 - CW263 - Inland Scribbly Gum grassy open forest on hills in the Mudgee Region, NSW central western slopes (Moderate to Good)
- Zone 3 - CW263 - Inland Scribbly Gum grassy open forest on hills in the Mudgee Region, NSW central western slopes (Moderate to Good/High)
- Zone 4 - CW263 - Inland Scribbly Gum grassy open forest on hills in the Mudgee Region, NSW central western slopes (Moderate to Good/Moderate)
- Zone 5 - CW263 - Inland Scribbly Gum grassy open forest on hills in the Mudgee Region, NSW central western slopes (Moderate to Good/Other)

FIGURE 6.11

Biometric Vegetation Type Communities in the Southern Extension Area

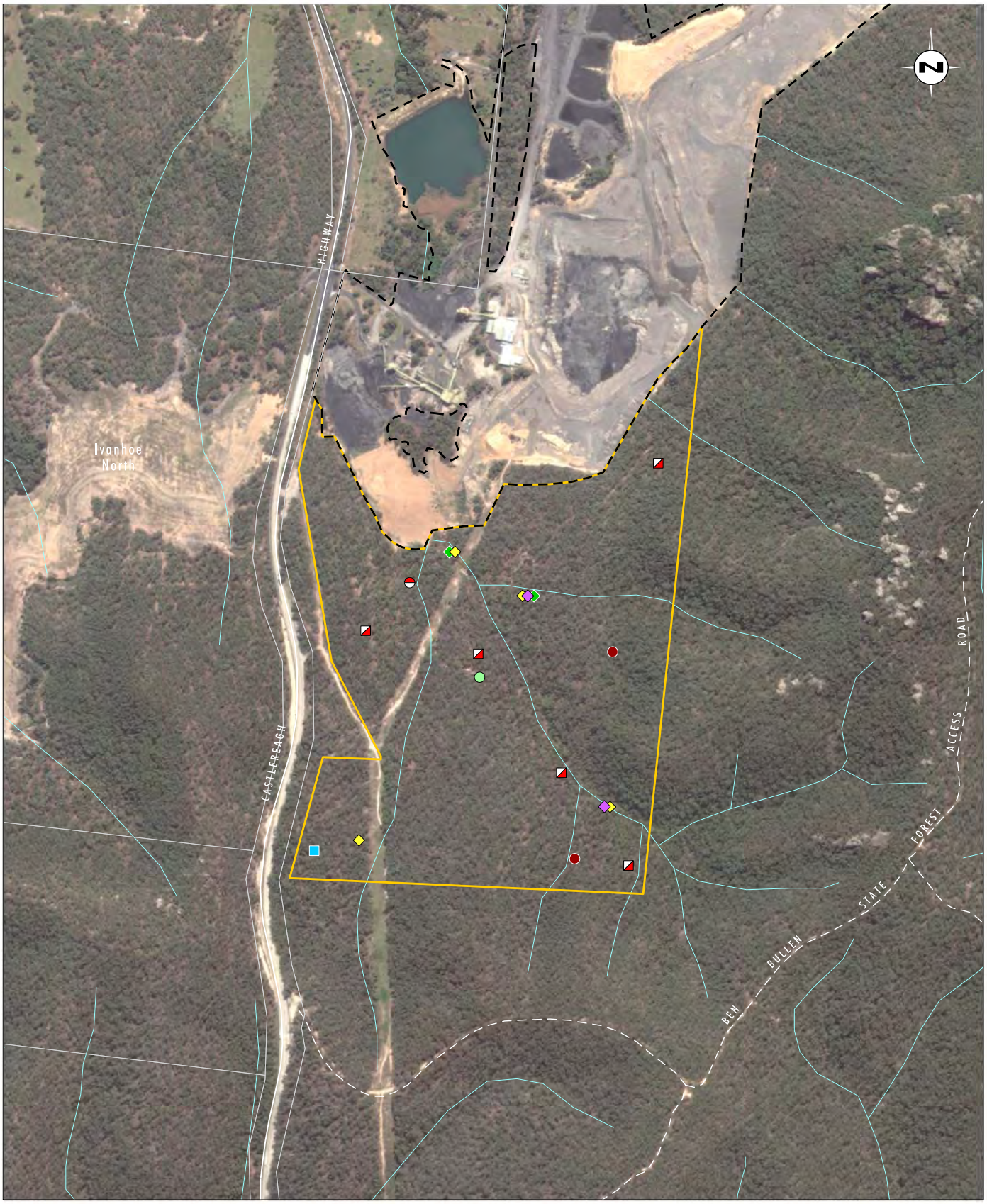

Image Source: DigitalGlobe (March 2015)
Data Source: LPI (2016)

0 100 250 500m

Legend

- Existing Approved Mining Disturbance Area
- Proposed Southern Extension Area
- Brown treecreeper (eastern subspecies)
- Eastern bentwing-bat
- Gang-gang cockatoo
- Large-eared pied bat
- Scarlet robin
- Squirrel glider
- Yellow-bellied sheathtail-bat
- *Eucalyptus cannonii*

FIGURE 6.12

Threatened Species Records in Southern Extension Area

File Name (A4): R02/3622_083.dgn
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6.4.3 Mitigation measures

In addition to the impact avoidance measures incorporated into the design of the Southern Extension Project (refer to **Section 6.4.1**), Castlereagh Coal have committed to implementing a broad range of management and mitigation measures designed to reduce the unavoidable impacts of the Southern Extension Project.

- Castlereagh Coal is committed to the design and implementation of a comprehensive strategy to mitigate adverse impacts during the Southern Extension Project. This includes specific measures to manage potential impacts on fauna species in the Southern Extension Area during vegetation clearing activities including:
    - update the existing Landscape Management Plan in accordance with the requirements of the modified Invincible Project Approval to minimise impacts on biodiversity values
    - surveying and marking the boundaries of the areas of disturbance on the ground prior to any vegetation clearing
    - a robust tree felling procedure will be implemented to minimise the potential for impacts on native fauna species (focusing on threatened species) as a result of the clearing of hollow-bearing trees. The tree felling procedure is designed to minimise impacts to hollow-dependent fauna, particularly the squirrel glider and hollow-dependent micro-bats (refer to **Appendix 6**)
    - tree hollows felled during clearing will either be stockpiled for use as habitat in rehabilitation areas or relocated to areas within the biodiversity offset areas which will not be disturbed by the project
    - felled trees and branches will be stockpiled for use in stabilising slopes and for habitat in the rehabilitated landform. Some trees and branches may be mulched for use in soil amelioration and stabilisation
    - targeted weed management measures including regular weed inspections and weed control and eradication techniques such as herbicides, physical removal and prompt revegetation of bare areas
    - erosion and sedimentation control in accordance with management procedures for the Southern Extension Project as defined in the SWMP
    - employee education and training including inductions for staff, contractors and visitors to the site will be conducted to inform personnel of the biodiversity issues present at the site and so they know their role and responsibilities in relation to the protection and/or minimisation of impacts to native biodiversity
    - areas of biodiversity value outside the Southern Extension Area will be fenced or signposted, where appropriate, to prevent any unnecessary disturbance during mining.

Appendix 6 provides further details on the committed mitigation measures for the Southern Extension Project.

6.4.3.1 Other land management measures

Weed species could be inadvertently brought into the Southern Extension Area with imported materials, or could invade naturally through removal of native vegetation. The increased presence of weed species within the Southern Extension Area has the potential to decrease the value of adjacent vegetation to native species:

- Castlereagh Coal will undertake the following management measures to minimise the potential impacts and spread of weeds during the Southern Extension Project:
    - the limits of ground disturbance will be clearly demarcated and no unnecessary disturbance will be undertaken outside of these areas
    - rehabilitation will be undertaken on disturbed areas as soon as practical following disturbance. This may include respreading of topsoil, seeding and/or planting of natives
    - regular inspections will be undertaken in the Southern Extension Area and adjacent areas to monitor the spread of weed species
    - training of environmental personnel on the identification of target weed species.
- Castlereagh Coal will control and eradicate any outbreak of noxious weeds as required under the *Noxious Weeds Act 1993*, and as required by the Local Land Services and other relevant authorities. Weed control and eradication techniques may include:
    - spraying with herbicides
    - physical removal, e.g. chipping
    - minimisation of area available for weed infestation, through prompt revegetation of bare areas.

Feral animal species may increase within the Southern Extension Area due to altered landforms and land use. Clearing vegetation and the creation of tracks through existing vegetation has the potential to allow penetration of introduced feral animal species into disturbed areas.

- Castlereagh Coal will monitor the presence of pest species and additional pest control measures will be implemented in consultation with the appropriate government agency or controlling authority as required
- Castlereagh Coal will update the existing Landscape Management Plan, the overarching plan to guide future rehabilitation. The Landscape Management Plan will also include details regarding the management of noxious weeds and feral animals.

6.4.4 Impact assessment

Direct impacts

The Southern Extension Project will result in a range of direct impacts on biodiversity values within the Southern Extension Area. Direct impact includes loss of native vegetation and fauna habitats as a result of direct clearance works and construction of the mine.

Table 6.9 below outlines these impacts as they were entered into the BBCC (Major Project Assessment Type). Avoidance and mitigation measures associated with minimising the impacts of these direct impacts are discussed in **Sections 6.4.3** and **Appendix 6**.

Table 6.9 Direct Impacts of the Southern Extension Project

Ecological Feature	Area within the Southern Extension Area Impact (ha)
Biometric Vegetation Types	
CW117 - Brittle Gum - Broad-leaved Peppermint - Red Stringybark open forest in the north-western part (Yass to Orange) of the South Eastern Highlands Bioregion (Moderate/Good)	8.24
CW263 - Inland Scribbly Gum grassy open forest on hills in the Mudgee Region, NSW central western slopes (Moderate/Good)	36.50
CW263 - Inland Scribbly Gum grassy open forest on hills in the Mudgee Region, NSW central western slopes (Moderate/Good_High)	0.62
CW263 - Inland Scribbly Gum grassy open forest on hills in the Mudgee Region, NSW central western slopes (Moderate/Good_Medium)	2.25
CW263 - Inland Scribbly Gum grassy open forest on hills in the Mudgee Region, NSW central western slopes (Moderate/Good_Other)	1.65
Threatened Flora Species	
Capertee stringybark (*Eucalyptus cannonii*)	24 Individuals
Threatened Fauna Habitats	
Land within 500 m of sandstone escarpments with hollow-bearing trees, rock crevices or flat sandstone rocks on exposed cliff edges and sandstone outcropping – broad headed snake	11.76
Native woodland vegetation within 75 m of high quality woodlands for squirrel glider	47.61

Impacts that require further consideration

Under the FBA, certain impacts on biodiversity values may require further consideration by the consent authority. These are impacts that are considered to be complicated or severe and include:

- impacts on landscape features, being:
    - impacts that will reduce the width of vegetation in the riparian buffer zone bordering significant streams and rivers, important wetlands or estuarine areas
    - impacts that will prevent species movement along corridors that have been identified as providing significant biodiversity linkages across the state.

- impacts on native vegetation that are likely to cause the extinction of an EEC/CEEC from an IBRA subregion or significantly reduce its viability

- impacts on critical habitat or on threatened species or populations that are likely to cause the extinction of a species or population from an IBRA subregion or significantly reduce its viability.

The Southern Extension Project will not have an impact on any biodiversity features that would result in one or more of the above severe impacts. Therefore there are no impacts that require further consideration by the consent authority.

Seven part tests of significance

Threatened species impact assessment is an integral part of environmental impact assessment. The objective of section 5A of the EP&A Act, the assessment of significance, is to improve the standard of consideration afforded to threatened species, populations and ecological communities, and their habitats through the planning and assessment process, and to ensure that the consideration is transparent.

Although it is understood that the preparation of a BioBanking Assessment under the FBA supersedes the requirement to prepare Seven Part Tests, DP&E has advised that the requirements of Section 5A of the EP&A Act are required to be considered in the BAR. The preparation of a BAR under the FBA addresses the components of the Seven Part Tests by use of the BBCC. A summary of the requirements of the Seven Part Tests of Significance and where they are addressed in the BAR is outlined in **Appendix 6**.

Impacts on aquatic species

No *Fisheries Management Act 1994* (FM Act) listed threatened aquatic flora or fauna species were recorded or are expected to occur within the Southern Extension Area.

Impacts on Matters of National Environmental Significance under the EPBC Act

Under the Commonwealth EPBC Act, the approval of the Commonwealth Minister for the Environment is required for any action that may have a significant impact on matters of national environmental significance (MNES).

The 2014 Modification Project was referred to the Minister for Environment on 3 March 2014 (EPBC Act referral 2014/147), which included land within the Southern Extension Area. The referral concluded that the proposed action described in the referral was unlikely to significantly impact any MNES. The referred action was declared to not be a controlled action for the purposes of the EPBC Act on 31 March 2014. Approval under the EPBC Act for the referred action was therefore not required.

The Southern Extension Project is a subset of the earlier 2014 Modification Project design and was largely included in the area previously referred and declared to not be a controlled action in 2014. The proposed open cut mining area for the Invincible component of the referral was 88 ha. The Southern Extension Project does not include open cut mining to the north of the existing Invincible open cut mining area and an area to the immediate north-west of the Southern Extension Area which formed part of the previously referred project (refer to **Figure 6.13**). The Southern Extension Project does not include any highwall mining.

The Southern Extension Project will remove approximately 38 ha less vegetation than the previously referred project, much of which was located within 500 m of pagoda formations. A small area of the Southern Extension Area (less than 0.5 ha) lies outside both the approved disturbance area under the Invincible Project Approval and the area that was referred in EPBC Act referral 2014/147 (refer to **Appendix 6**).

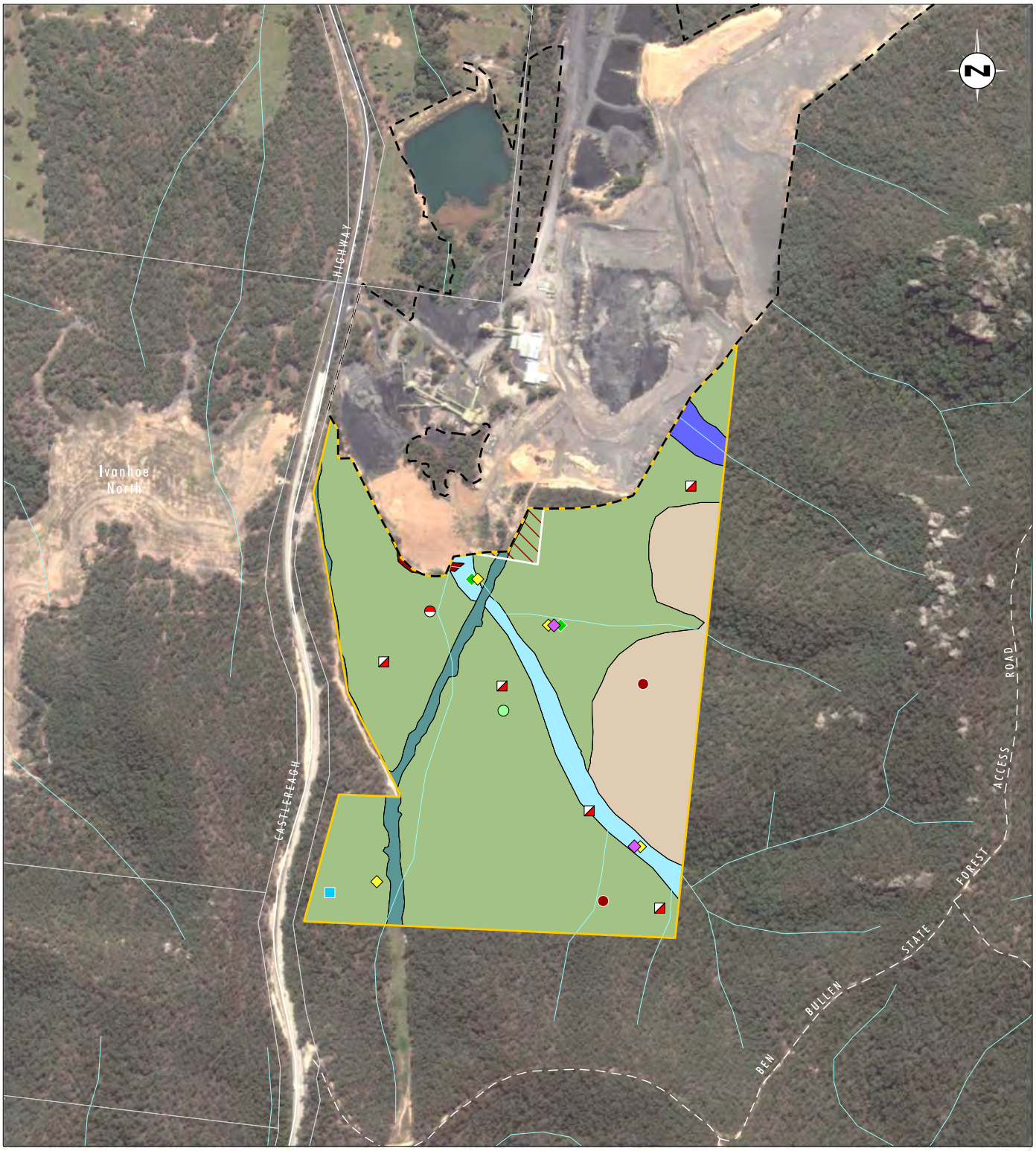


Image Source: DigitalGlobe (March 2015)
Data Source: LPI (2016)

0 100 250 500m

Legend

- Existing Approved Mining Disturbance Area
- Proposed Southern Extension Area
- Brown treecreeper (eastern subspecies)
- Eastern bentwing-bat
- Gang-gang cockatoo
- Large-eared pied bat
- Scarlet robin
- Squirrel glider
- Yellow-bellied sheathtail-bat
- *Eucalyptus cannonii*
- Part of Southern Extension Area not in 2014 EPBC Act Referral Area
- Cleared Area
- Zone 1 - CW117 - Brittle Gum - Broad-leaved Peppermint - Red Stringybark open forest in the north-western part (Yass to Orange) of the South Eastern Highlands Bioregion (Modertae to Good)
- Zone 2 - CW263 - Inland Scribbly Gum grassy open forest on hills in the Mudgee Region, NSW central western slopes (Moderate to Good)
- Zone 3 - CW263 - Inland Scribbly Gum grassy open forest on hills in the Mudgee Region, NSW central western slopes (Moderate to Good/High)
- Zone 4 - CW263 - Inland Scribbly Gum grassy open forest on hills in the Mudgee Region, NSW central western slopes (Moderate to Good/Moderate)
- Zone 5 - CW263 - Inland Scribbly Gum grassy open forest on hills in the Mudgee Region, NSW central western slopes (Moderate to Good/Other)

FIGURE 6.13

Part of Southern Extension Area not in 2014 EPBC Act Referral Area

There are no records of flora species listed as MNES under the EPBC Act within the Southern Extension Area and the vegetation does not conform to any threatened or endangered ecological communities listed under the EPBC Act. Whilst there is potential habitat for some threatened fauna species listed under the EPBC Act in this area, the potential impact of the Southern Extension Project will be less than that considered in the referral due to the overall reduced scale of impact associated with the Southern Extension Project relative to the previously referred action. As the referred action was considered unlikely to have a significant impact on any biodiversity related MNES (a conclusion supported by the decision by the Minister that the referred action was not a controlled action), the much smaller Southern Extension Project is similarly considered to be unlikely to have a significant impact on any biodiversity related MNES and approval under the EPBC Act is therefore not required.

State Environmental Planning Policy 44 – Koala Habitat Protection (SEPP 44)

SEPP 44 restricts the granting of development consent for proposals on land identified as core koala habitat without preparation of a plan of management. Greater Lithgow Local Government Area (LGA) is listed in Schedule 1 of SEPP 44 and therefore SEPP 44 is relevant to the Southern Extension Project. Assessment under SEPP 44 is based on an initial determination of whether the land constitutes potential koala (*Phascolarctos cinereus*) habitat. This is determined by assessing whether the eucalypt species present in Schedule 2 of the policy constitute 15 per cent or more of the total number of trees in the upper or lower strata of the tree component.

If potential koala habitat is present, the area must be further assessed to determine if the land is core koala habitat.

No potential koala habitat was recorded within the Southern Extension Area as defined by SEPP 44 as Schedule 2 species listed under the policy were either not recorded or recorded in densities less than 15 per cent of all overstorey species within each community. Furthermore, no koalas were identified during extensive spotlight searches, no koalas responded to call playback and no evidence of koala use was detected during the habitat assessment using the SAT. The Southern Extension Area does not contain any potential koala habitat. Consequently, the requirement for preparation of a koala plan of management does not apply.

6.4.5 Biodiversity offset strategy

- Castlereagh Coal is committed to delivering a Biodiversity Offset Strategy that appropriately compensates for the unavoidable loss of ecological values as a result of the Southern Extension Project. Fulfilling offset requirements under the NSW *Biodiversity Offset Policy for Major Projects* will be undertaken using one or a combination of the following offset strategies:
    - securing required credits through the open credit market, off site
    - offsetting through a land-based offset site secured by a BioBanking Agreement
    - if suitable offsets are unavailable, contributing funds to supplementary measures in accordance with relevant conservation or recovery actions relevant to the species
    - contributing to the Offsets Fund.

Castlereagh Coal will investigate a range of available properties in the locality that contain the appropriate biodiversity features to offset the impacts of the Southern Extension Project. The application of the FBA Variation Rules may be required if it is demonstrated that the appropriate ecosystem or credit-species credits are unavailable for use in the Invincible Biodiversity Offset Strategy. It is noted that, through

investigations undertaken to date, it is likely that a land based offset site located within proximity to Invincible will be adopted.

Table 6.10 provides a summary of the ecosystem and species credits that require offsetting as a result of the Southern Extension Project.

Table 6.10 Ecosystem and Species Credits Required for the Southern Extension Project

Name	Credits Required
Ecosystem Credits	
CW117 - Brittle Gum - Broad-leaved Peppermint - Red Stringybark open forest in the north-western part (Yass to Orange) of the South Eastern Highlands Bioregion (Moderate/Good)	542
CW263 - Inland Scribbly Gum grassy open forest on hills in the Mudgee Region, NSW central western slopes (Moderate/Good)	2714
CW263 - Inland Scribbly Gum grassy open forest on hills in the Mudgee Region, NSW central western slopes (Moderate/Good_High)	30
CW263 - Inland Scribbly Gum grassy open forest on hills in the Mudgee Region, NSW central western slopes (Moderate/Good_Medium)	99
CW263 - Inland Scribbly Gum grassy open forest on hills in the Mudgee Region, NSW central western slopes (Moderate/Good_Other)	50
Total	**3435**
Species Credits	
Broad-headed snake (*Hoplocephalus bungaroides*)	388
Capertee stringybark (*Eucalyptus cannonii*)	312
Squirrel glider (*Petaurus norfolcensis*)	1047
Total	**1747**

Castlereagh Coal will develop and implement an appropriate Biodiversity Offset Strategy for the Southern Extension Project to meet the requirements in **Table 6.10**, in consultation with OEH and DP&E.

6.5 Aboriginal cultural heritage

An Aboriginal Cultural Heritage and Archaeological Assessment (ACHAA) has been prepared for the Southern Extension Area by Umwelt in consultation with the registered Aboriginal parties. The assessment is included as **Appendix 7** with a summary of the findings provided below.

6.5.1 Consultation process

Consultation with Aboriginal parties regarding the Southern Extension Project has been undertaken in accordance with the *National Parks and Wildlife Regulation 2009* and relevant guidelines. A full consultation log and consultation records are attached in **Appendix 7**. As a result of this process, six Aboriginal parties registered an interest in ongoing consultation regarding the Southern Extension Project.

The registered Aboriginal parties are:

- Ann Glassenbury
- Bathurst Local Aboriginal Land Council (BLALC)
- Mingaan Aboriginal Corporation
- Wellington Valley Wiradjuri Aboriginal Corporation (WVWAC)
- Wiray-duraa Maing-gu
- Warrabinga Native Title Claimants Aboriginal Corporation (WNTCAC).

Local media advertising was also conducted to identify additional interested Aboriginal parties. An advertisement was placed in the Lithgow Mercury on 15 December 2015 requesting parties register for consultation relating to the proposal by 12 January 2016.

A search of the National Native Title Tribunal (NNTT) register was undertaken on 10 March 2016. No Native Title claims and no Indigenous Land Use Agreements (ILUAs) have been registered or notified by the NNTT as being in place over the Southern Extension Area.

Further to their identification as a registered party, WNTCAC are joint signatories to an ancillary deed of agreement with Gundungurra Tribal Council Aboriginal Corporation and Coalpac. Under this deed, the Southern Extension Area is designated as 'other areas to which the agreement applies' and is located outside the Gundungurra Tribal Council Aboriginal Corporation Native Title Application area and in proximity to the Warrabinga – Wiradjuri Claim Group Native Title Application area. A meeting was held with representatives of WNTCAC, Castlereagh Coal and Umwelt on 22 April 2016 to discuss the ancillary deed and its requirements as it related to the ACHAA process. At this time, it was agreed that the proposed methodology for the assessment met the requirements of the deed and that the assessment report should address all relevant aspects of the deed. This ACHAA has been prepared in accordance with this understanding.

All registered Aboriginal parties were provided with the opportunity to be involved in the pedestrian survey of the survey area. The inspection of the survey area was conducted by Amy Armstrong (BLALC), Brad Bliss (WVWAC), Coral Williams (WNTCAC) and Shaen Morgan (WNTCAC).

A draft version of the ACHAA report was supplied to all the registered Aboriginal parties in July 2016 with an invitation to review all aspects of this document, particularly those related to mitigation and management. Registered Aboriginal parties were asked specifically to provide any cultural information they deemed appropriate to the preferred management of the Southern Extension Area. Cultural information received during this review period has been incorporated into the ACHAA report for consideration as part of the EA.

6.5.2 Location context

A search of the OEH Aboriginal Heritage Information Management System (AHIMS) database for the area surrounding the Southern Extension Area was undertaken on 2 September 2015. This resulted in the identification of 22 Aboriginal sites (refer to **Figure 6.14**). **Table 6.11** summarises the registered sites found within and in the vicinity of the Southern Extension Area.

Table 6.11 AHIMS Registered Sites within and in vicinity of the Southern Extension Area

Site Type	Site Feature	Number of Sites
Artefact Scatter	Multiple stone artefacts in proximity to each other with no other associated features.	10 (3 within the Southern Extension Area)
Isolated Find	A single stone artefact without other associated site features.	3 (1 within the Southern Extension Area)
PAD	Potential archaeological deposit.	1 (none within Southern Extension Area)
Artefact Scatter and PAD	Multiple stone artefacts in proximity to each other and potential archaeological deposit.	6 (none within the Southern Extension Area)
Art and Artefact Scatter	Art created by Aboriginal People and multiple stone artefacts in proximity to each other.	1 (none within the Southern Extension Area)
Rock shelter, PAD and Artefact Scatter	A sheltered area created by a rock overhang within a cliff line possibly used for habitation by Aboriginal people with potential archaeological deposit and stone artefacts.	1 (none within the Southern Extension Area)
Total	**22**	

Artefact scatter sites and Artefact Scatter and PAD sites are the most common site types in the vicinity of the Southern Extension Area. As outlined in **Table 6.11**, there are only three artefact scatters and one isolated find previously identified within the Southern Extension Area with all other sites located outside of this area. These previously identified sites within the Southern Extension Area are described further in **Section 6.5.2.1**.

6.5.2.1 Previous Assessments

AECOM (2011) completed a detailed assessment as part of an Environmental Assessment for the Coalpac Consolidation Project. The area assessed included the current Southern Extension Area and a considerable area to the north of the current approved disturbance area. The majority of sites identified consisted of artefact scatters and isolated finds. Other site types included rock shelters (including rock shelters with art or PAD), PAD and grinding grooves.

As part of the AECOM (2011) assessment, fifteen sites, including six previously recorded sites, were identified as a part of the survey, of which four are located within the Southern Extension Area. The sites located within the Southern Extension Area are listed in **Table 6.12.** The previous assessment recommended the surface collection of these sites prior to impact. Subsurface investigations were not deemed necessary due to the small size and disturbed nature of these sites.

Table 6.12 Previously Registered Sites within the Southern Extension Area

AHIMS#	Site Name	Type	Description
45-1-0069	Invincible Colliery 1	Artefact Scatter	Sparse artefact scatter containing 16 artefacts within a 100 square metre area partially within a 66 kV power line easement parallel to the Castlereagh Highway. Quartz was the dominant raw material with a minor quartzite and chert / tuff component. Recorded artefact types include mainly flakes and cores. The site condition is disturbed as a result of the construction of the power line and drain. The site was recorded by Linda Haglund in 1982 with only 1 artefact identified by AECOM in the 2010 survey for the Coalpac Consolidation Project. AECOM assessed the site as having low significance and low subsurface archaeological potential.
45-1-0070	Invincible Colliery 2	Artefact Scatter	Sparse artefact scatter within a 220 square metre area within a 66 kV power line easement parallel to the Castlereagh Highway. Quartz was the dominant raw material with a minor quartzite and chert/ tuff component. Recorded artefact types include mainly flakes and cores. The site condition is disturbed as a result of the construction of the power line. The site was recorded by Linda Haglund in 1982 and 7 artefacts were identified by AECOM in the 2010 survey for the Coalpac Consolidation Project. AECOM assessed the site as having low significance and low subsurface archaeological potential.
45-1-2708	CV-AS1-10	Artefact Scatter	An artefact scatter consisting of a quartz core and broken chert flake 170 m southeast of Invincible Colliery on a vehicle track within an area of 6 square m. The site was assessed as highly disturbed with low subsurface archaeological potential. The site was recorded by AECOM in 2010.
45-1-2714	CV-IF1-10	Isolated find	An isolated complete chert / tuff flake within an unsealed vehicle track within the 66 kV power line easement parallel to the Castlereagh Highway. The site was assessed as highly disturbed with low subsurface archaeological potential. The site was recorded by AECOM in 2010.

In addition, a rock shelter site was identified approximately 1.1 km from the Southern Extension Area (refer to **Figure 6.14**), and as noted in **Table 6.13**. This is the only previously identified site that is of a type that is more vulnerable to indirect impacts such as vibration as a result of mining activity.

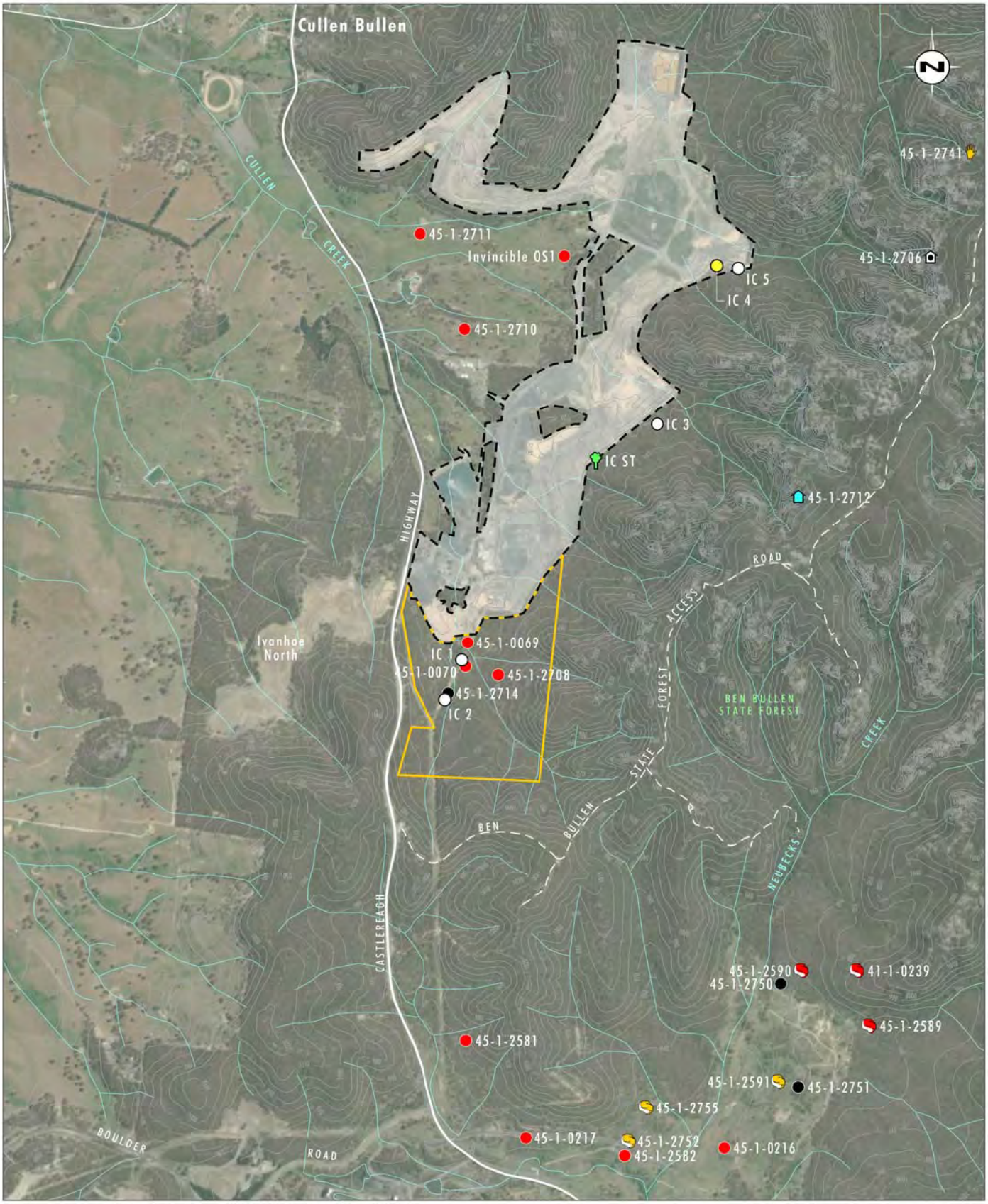


Image Source: Google Earth - CNES/Astrium (Nov 2014)
Data Source: AHIMS (2015)
Note: Contour Interval 10m

0 0.25 0.5 1.0km
1:25 000

Legend

- Existing Approved Mining Disturbance Area
- Proposed Southern Extension Area
- Art Site / Isolated find
- Artefact Scatter
- Artefact and Potential Archaeological Deposit
- Isolated Find
- Isolated Find / Potential Archaeological Deposit
- Rockshelter / Potential Archaeological Deposit
- Rockshelter / Artefact Scatter
- Artefact Scatter (Umwelt)
- Isolated Find (Umwelt)
- Scarred Tree (Umwelt)

FIGURE 6.14

Aboriginal Archaeological Sites in Proximity to Proposed Southern Extension Area

File Name (A4): R02/3622_085.dgn
20160916 9.49

Table 6.13 Previously Registered Sites in Proximity to the Southern Extension Area

AHIMS#	Site Name	Type	Description
45-1-2712	CV-RCK1-10	Rock Shelter, PAD and Artefact Scatter	A rock shelter with large overhang approximately 36 x 25 x 20 m with a westerly aspect. Five artefacts were identified within the shelter, three flakes (two quartz, one chert / tuff), one broken quartz flake and a chert / tuff scraper. The Deposit within the shelter was assessed as moderate potential to contain further subsurface deposits. Quartz is available within the shelter and immediately adjacent where it is eroding out of the parent sandstone. An intermittent waterfall on the northern edge of the shelter is a source of fresh water. The site was assessed to have moderate subsurface archaeological potential and moderate scientific significance. It was noted that ongoing natural erosion was occurring within the shelter and impacting the condition of the deposit. The site was recorded by AECOM in 2010.

Appendix 7 provides a detailed review of the Aboriginal sites identified in previous assessments in the region surrounding Invincible.

6.5.3 Survey methodology

A draft assessment methodology (including a survey strategy) was provided to all registered Aboriginal parties on 15 December 2015 for comment in accordance with consultation guidelines (refer to **Section 6.5.1**).

Pedestrian survey of the area was conducted in accordance with the requirements of the OEH Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW. The survey area is shown in **Figure 6.15**. A total of four representatives from the registered Aboriginal parties participated in the survey conducted on 26, 27, 28 and 29 April 2016, accompanied by Umwelt archaeologists.

A survey of all landforms within the Southern Extension Area and targeted survey within the additional survey area was undertaken to assess the potential impacts of the Southern Extension Project, including identification of sites that may be at risk of indirect impacts (refer to **Figure 6.14**). The additional survey area included accessible areas within 500 m of the Southern Extension Area in order to identify any sites that may potentially be susceptible to indirect impacts from mining.

All sites and artefacts located were recorded to OEH standards. The archaeological and Aboriginal and cultural significance of the sites / artefacts was discussed with the registered Aboriginal parties participating in the survey and any requirements for subsurface testing of sites and PADs as part of the assessment process /or post approval was also specifically discussed.

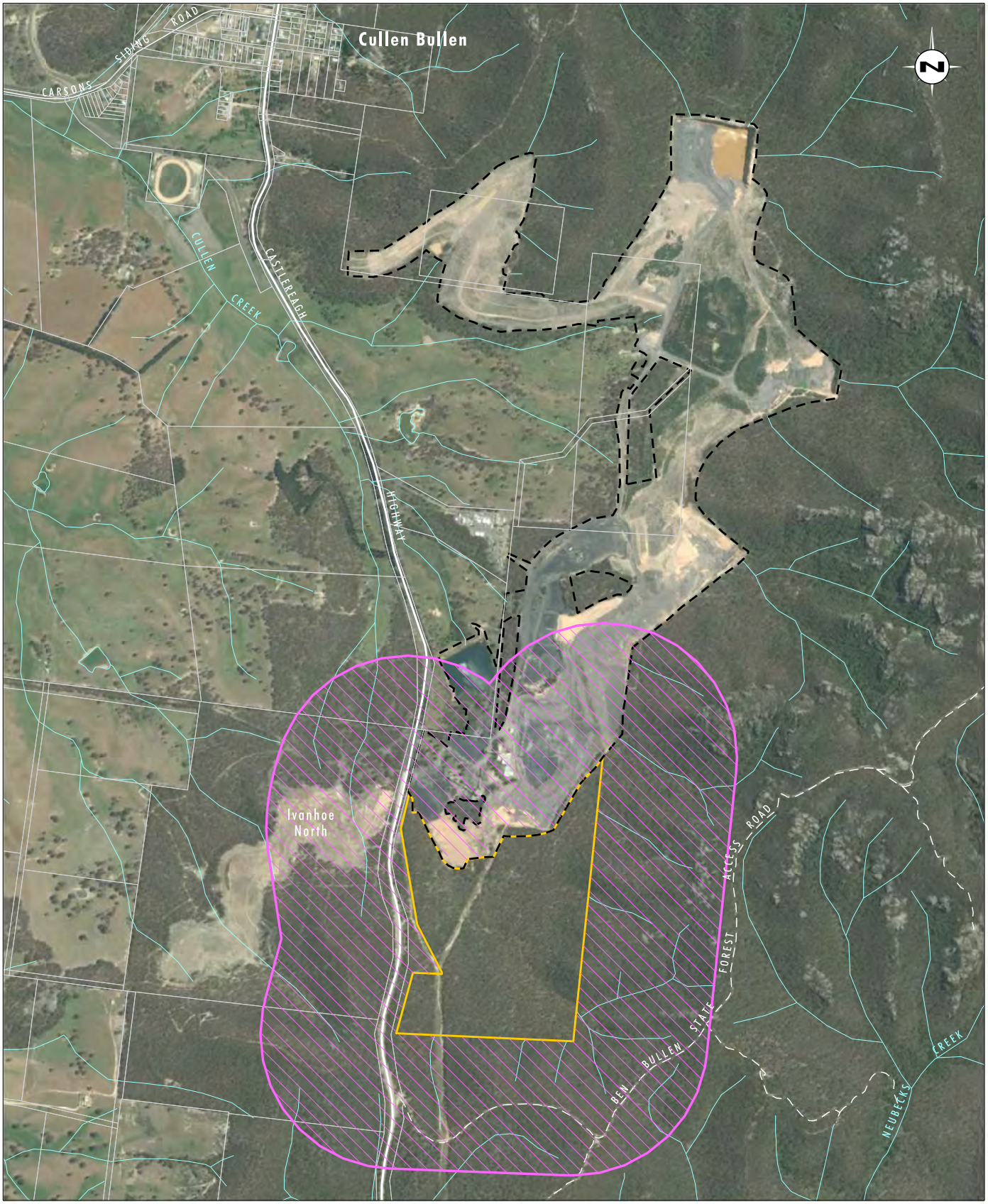


Image Source: Google Earth - CNES/Astrium (Nov 2014)
Data Source: LPI (2016)

0 0.25 0.5 1.0km

Legend

- Existing Approved Mining Disturbance Area
- Proposed Southern Extension Area
- Additional Survey Area

FIGURE 6.15

Aboriginal Cultural Heritage Survey Area

6.5.4 Survey results

6.5.4.1 Newly recorded sites within the Southern Extension Area

Two new sites were identified within the Southern Extension Area during the survey and are detailed in **Table 6.14** and **Figure 6.14.**

Table 6.14 Newly recorded sites within the Southern Extension Area

Site Name	Type	Description
IC1	Isolated find	An isolated find located on a gentle slope within the cleared power line easement (refer to **Figure 6.14**). The area is assessed to have low subsurface archaeological potential due to the shallow soil depth and its position on the slope. The crest also has low subsurface archaeological potential as it is eroded to clay.
IC2	Isolated find	An isolated find located on the mid slope of a gently inclined spur within a cleared power line easement, adjacent to a vehicle track (**Figure 6.14**). The site and surrounding area have been subject to significant sheetwash erosion, resulting in the loss of the majority of topsoil. The artefact was present within an area of gravel lag left after topsoil had been eroded. The area is assessed as having low subsurface potential based on the extent of erosion and loss of topsoil.

6.5.4.2 Newly recorded sites outside the Southern Extension Area

Four new sites were identified during due diligence inspections associated with currently approved mining activities (refer to **Table 6.15**) and are reported here for completeness.

Table 6.15 Newly recorded sites outside the Southern Extension Area

Site Name	Type	Description
IC 3	Isolated find	An isolated find located within the eroded tyre rut of previously graded vehicle track (refer to **Figure 6.14**) on a lower slope, gently inclined to the north. The area is assessed as having low subsurface potential as a result of the erosion and previous disturbance of the area.
IC 4	Artefact scatter	An artefact scatter located within a highly modified drainage ditch and adjacent windrow at the edge of the current open cut pit (refer to **Figure 6.14**). The site condition was poor, within a highly modified area subject to vegetation clearance and grading to create the drainage ditch and the artefacts were no longer *in situ*. The area was assessed as having low subsurface potential as it has been severely disturbed as a result of the earthworks and the artefacts were not located *in situ*. The artefacts could have been subject to significant movement within the drainage ditch.
IC 5	Isolated find	An isolated find located on the windrow on the edge of the current open cut pit (refer to **Figure 6.14**). The area was assessed as having low subsurface potential as the area was disturbed as a result of the earthworks and the artefact was not located *in situ*. The artefact has possibly been subject to movement within the drainage ditch.

Site Name	Type	Description
IC ST	Scarred tree	A scarred tree located within a pile of pushed over trees, next to the windrow, at the edge of the current open cut pit. The tree is not *in situ* and is in poor condition; being dead lying on its side. The bark is gone and there is evidence of damage from insect borers.

As outlined on **Figure 6.15**, an additional survey area, which consisted of accessible areas within 500 m of the Southern Extension Area was surveyed, which did not identify any additional archaeological sites that may be susceptible to indirect impacts from mining. It is noted that a number of pagodas and a cliff line structure are present in this area. Whilst these sites have been identified as being of cultural significance (refer to **Section 6.5.5**), they have not been assessed as having any archaeological features or significance. Potential indirect impacts on the pagodas and cliff line in proximity to the Southern Extension Project have been assessed in **Section 6.8**.

As the overall visibility of the Southern Extension Area and additional survey area was low, there is a possibility for further sites within the Southern Extension Area that were not identified during the survey. However due to the sloping nature of the landforms and level of previous disturbance, it is likely any further sites would be small in number and of a similar nature to the currently identified sites. That is, small artefact scatters and isolated finds with low potential for subsurface archaeological deposits as a result of the erosion and subsidence within the Southern Extension Area.

6.5.5 Significance Assessment

The Burra Charter defines cultural significance in terms of aesthetic, scientific, historic and social values. Aboriginal cultural heritage is typically assessed according to its social and scientific significance; however other values may also be of importance. The assessment of cultural significance is critical in establishing mitigation and management strategies for cultural heritage (refer to Pearson and Sullivan, 1995:21).

The assessment of significance provides a guideline for determining appropriate mitigation and management strategies. The relationship between levels of significance and management strategies can be summarised as follows:

- High significance – the site should be conserved and protected from the impacts of development, where possible
- Moderate significance – the site should be protected if possible, however, if impacts to the site are unavoidable, appropriate mitigation strategies should be implemented prior to impact
- Low significance – the site should be protected if possible, however, if impacts to the site are unavoidable, the presence of the site should not impede the proposed development.

6.5.5.1 Aboriginal Cultural Significance

As Aboriginal cultural significance relates to the values of a site, place or landscape to Aboriginal people, it must be determined by Aboriginal people. The assessment of Aboriginal cultural significance will therefore be undertaken by the registered Aboriginal parties for the Southern Extension Project. In assessing this significance, a range of factors may be considered and this can extend beyond the physical presence of a site and its contents to intangible aspects of the cultural landscapes. Archaeological material, cultural knowledge, natural resources and landscape attributes may all be considered.

Representatives of the registered Aboriginal parties indicated high cultural significance for the pagoda formations located to the east of the Southern Extension Area which will not be subject to direct impact by the Southern Extension Project. Representatives relayed that the pagodas feature in songlines and that the pagodas are significant components of creation stories.

6.5.5.2 Archaeological (scientific) significance

The criteria applied to the assessment of archaeological significance are listed in **Appendix 7**. All but one site identified within and in the vicinity of the Southern Extension Area was found to have a low overall archaeological significance.

Rock shelter (45-1-2712), located approximately 1.1 km from the Southern Extension Area, was found to have high overall archaeological significance. This site is in overall good condition with some slope wash occurring. A small number of artefacts were identified on the surface of the deposit in the vicinity of the drip line. Some graffiti is present on the back wall of the shelter and the shelter is currently being accessed as boot prints were observed in the back of the shelter when visited for the survey, demonstrating current access to the site by members of the public.

6.5.6 Impact assessment

It is noted that the proposed activities associated with the Southern Extension Project have the potential to harm Aboriginal objects within the Southern Extension Area and surrounds. The locations of these identified sites that have potential to be impacted by the Southern Extension Project are listed in **Table 6.16** and are shown in **Figure 6.14**.

Table 6.16 Aboriginal Sites impacted and potentially impacted by the Southern Extension Project

Harm	Site
Located within the Southern Extension Area subject to impacts as a result of proposed works	IC 1
	IC 2
	45-1-0069
	45-1-0070
	45-1-2708
	45-1-2714
Located within areas that are subject to currently approved mining activities associated with the current open cut pit.	IC 3
	IC 4
	IC 5
	IC ST
Outside any area of impact, including indirect impacts such as blasting	45-1-2712

An assessment of the cliff line and pagodas in the vicinity of the Southern Extension Area has been completed (refer to **Section 6.8**). As outlined in **Section 6.8** a conservative vibration limit for the pagodas and the cliff line has been established and all blasting will be below these limits. It is noted that the rock shelter (45-1-2712) site is located at greater distance from the Southern Extension Area (approximately 1.1 km) relative to the assessed pagoda and cliff line structures. Therefore the rock shelter (45-1-2712) and the pagodas and cliff line (although they do not contain any archaeological features they are identified as being of cultural value) are not subject to any direct or indirect impacts that will result in harm to these features.

A potential birthing tree was identified by a RAP and is located within the Southern Extension Area. This feature is discussed in further detail in **Appendix 7** and will be removed as a result of the proposed works.

6.5.7 Management and mitigation commitments

It is recognised that recommendations provided from an Aboriginal cultural perspective may differ to those based on an archaeological perspective. Both sets of recommendations are detailed in the following sections.

6.5.7.1 Aboriginal parties recommendations

The recommendations presented below were provided by registered Aboriginal party representatives participating in the survey of the Southern Extension Project and through comments on the draft ACHAA (refer to **Appendix 7**).

- The scarred tree (IC ST) needs to be recovered from the pile at the windrow and stored in a weather sheltered location, elevated off the ground. The tree could be trimmed either side of the scarred section as part of this process. WVWAC further recommended that IC ST be recovered and moved to a safe storage location on site and stored under cover on reinforced steel racking support not on the ground or on concrete to minimise any future damage.

- The artefact scatters and isolated finds (IC 1, IC 2, IC 3, IC 4, IC 5, 45-1-0069, 45-1-0070, 45-1-2708 and 45-1-2714) need to be collected, if they are to be impacted

- Any salvaged artefacts need to be returned to a secure keeping place on country, potentially a shipping container within the Southern Extension Area / Invincible site that can be accessed by the registered Aboriginal parties

The recommendations above will be adopted for the Southern Extension Project as detailed in **Appendix 7**, and will be incorporated in the revised Aboriginal Cultural Heritage Management Plan (ACHMP). Castlereagh Coal will continue to engage with the registered Aboriginal parties through the preparation of the revised ACHMP for Invincible.

6.5.7.2 Archaeological Management Measures

The following management measures have been developed in light of the archaeological context of the region, the findings of the survey, the archaeological assessment of the Southern Extension Area, the cultural assessment of the area by Aboriginal parties; the potential impacts of the Southern Extension Project and current cultural heritage legislation:

- The ACHMP for the Invincible Project Approval will be revised in consultation with the registered Aboriginal parties. The revised ACHMP will be updated, in consultation with registered Aboriginal parties to reflect the outcomes of the current assessment and will include the management activities listed below. Consideration will also be given in the ACHMP to ongoing consultation mechanisms such as regular consultation meetings with Aboriginal parties, as requested by WVWAC.

- Prior to any impacts, surface collection of sites IC 1, IC 2, IC 3, IC 4**,** IC 5, 45-1-0069, 45-1-0070, 45-1-2708 and 45-1-2714 will be undertaken in accordance with the methodology provided in **Appendix 7**

- Prior to any further impacts, the scarred tree (IC ST) will be salvaged in accordance with the methodology recommended by the registered Aboriginal parties (refer to **Section 6.5.7.1**) and detailed in **Appendix 7**

- Rock shelter 45-1-2712 is located outside the Southern Extension Area, and outside any predicted areas of blasting impacts. Baseline recording and ongoing periodic monitoring of the shelter will be undertaken to ensure that there are no incidental impacts to the site. The methodology and requirements for monitoring will form part of the revised ACHMP and will be subject to consultation with the registered Aboriginal parties

- The rock formations known as pagodas are outside the Southern Extension Area and will not be subject to direct or indirect impacts from the Southern Extension Project. However, given that these formations have been identified as having high Aboriginal cultural value, registered Aboriginal parties will be provided with an opportunity to be part of monitoring at these locations (refer to **Section 6.8**). This monitoring will form part of the revised ACHMP and will be subject to consultation with the registered Aboriginal parties

- Should any Aboriginal objects be identified during works (other than the sites referenced above), all works in the immediate vicinity of the objects will cease until such time as an appropriate strategy for their management has been developed in consultation with the registered Aboriginal parties and OEH.

- In the unlikely event that a potential burial site or potential human skeletal material is exposed within the Proposed Disturbance Area, the following procedure will be followed in accordance with the Policy Directive – Exhumation of Human Remains (NSW Department of Health 2008), Skeletal Remains – Guidelines for the Management of Human Skeletal Remains under the Heritage Act 1977 (NSW Heritage Office 1998) and the Aboriginal Cultural Heritage Standards and Guidelines Kit (NPWS 1997):

    - as soon as remains are exposed, work in the immediate area is to halt immediately to allow assessment and management

    - contact local police, OEH and the Heritage Division

    - a physical or forensic anthropologist will inspect the remains *in situ*, and make a determination of ancestry (Aboriginal or non-Aboriginal) and antiquity (pre-contact, historic or forensic)

    - if the remains are identified as forensic the area is deemed as a crime scene

    - if the remains are identified as Aboriginal, the site is to be secured and OEH and all registered Aboriginal parties are to be notified in writing

    - if the remains are non-Aboriginal (historical) remains, the site is to be secured and the Heritage Division is to be contacted.

    The above process functions only to appropriately identify the remains and secure a site. From this time, the management of the remains is to be determined through liaison with the appropriate stakeholders (NSW Police Force, forensic anthropologist, OEH, Heritage Division, registered Aboriginal parties etc) and in accordance with the *Public Health Act 1991*.

- Castlereagh Coal will maintain existing controls and protection of site "Invincible 0S1" in accordance with existing requirements of the Invincible Project Approval

- Castlereagh Coal will inform all site personnel and provide training to relevant employees on the presence of all known Aboriginal sites potentially affected by operations at the site and their obligations under the NPW Act and the Invincible Project Approval

- Castlereagh Coal will conduct a Cultural Heritage Awareness Induction Course for all staff on site and any contractors who will be working at Invincible and may be undertaking surface disturbance works, blasting or tree felling activities.

Measures to manage potential blast impacts on heritage items are identified in the **Section 6.8**.

6.6 Historic heritage

A detailed Historic Heritage Assessment has been previously undertaken for Invincible and includes the Southern Extension Area (AECOM, 2011). This study included a detailed description and review of the non-indigenous cultural history of the area in the vicinity of the Southern Extension Project, and in particular the history of land uses and settlement including the township of Cullen Bullen, along with identification of historic heritage sites across the Invincible and Cullen Valley mines and surrounding areas. Given that the Southern Extension Area was included as part of this assessment, a review of existing information has been undertaken. The survey of the Southern Extension Area associated with the Aboriginal cultural heritage survey (refer to **Section 6.6**) included observation of any other heritage values in the survey area. The results of the desktop studies and survey are summarised below.

6.6.1 Identification of historic heritage sites

The identification of historic heritage sites within and in the vicinity of the Southern Extension Area was undertaken through a review of relevant heritage databases including:

- State Heritage Inventory

- Australian Heritage Database (including Commonwealth and National Heritage lists and the Register of the National Estate)

- Lithgow Local Environment Plan 2014.

The database review identified no listed sites within the Southern Extension Area. Two listed heritage sites were identified in the vicinity of the Southern Extension Area and are shown on **Figure 6.16**, and presented in **Table 6.17**.

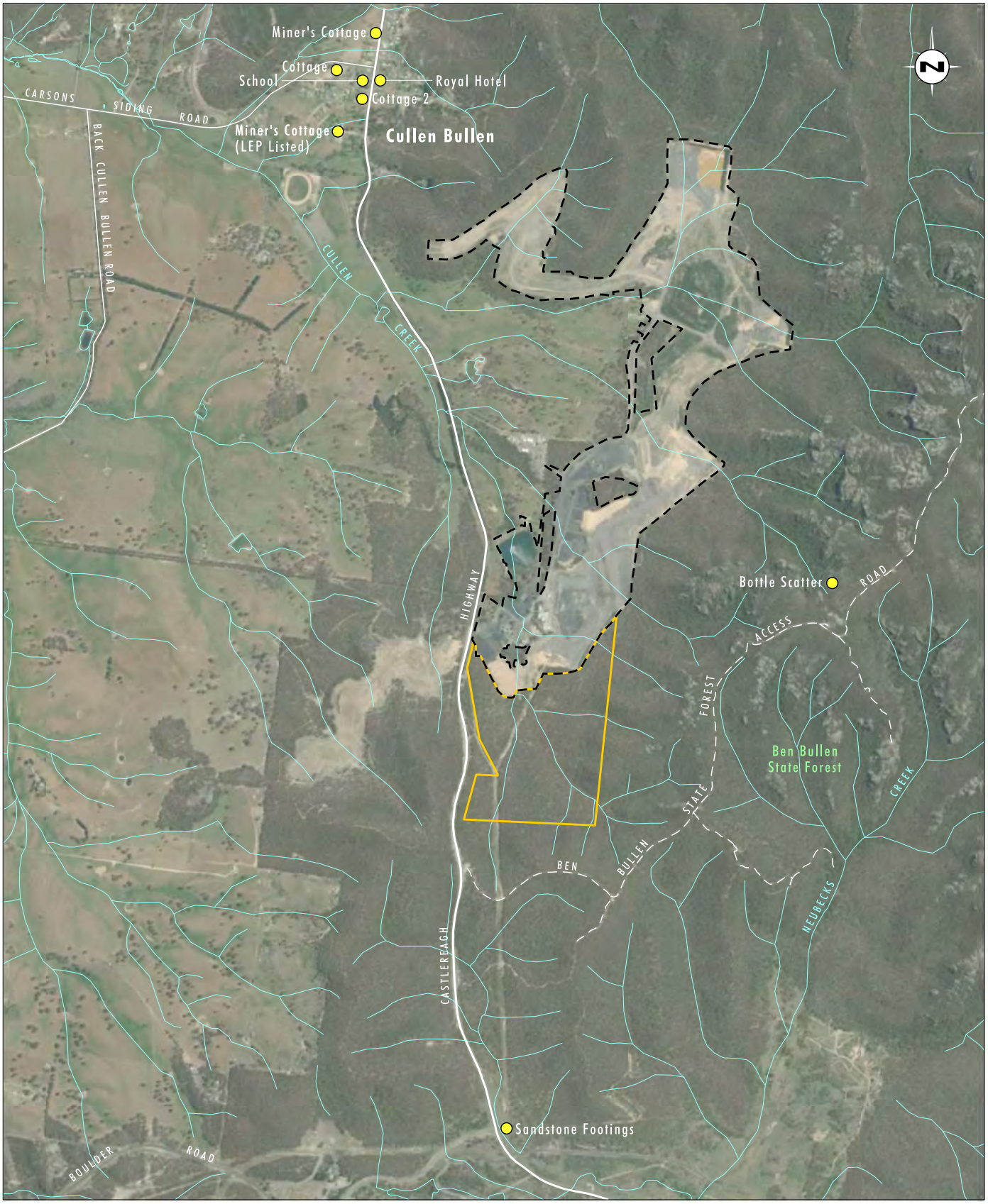
Table 6.17 Listed Heritage Sites located within the vicinity of the Southern Extension Area

Site	Location	Listing	Significance	Distance to Southern Extension Area
Cullen Bullen School	15–23 Castlereagh Highway, Cullen Bullen	Lithgow Local Environment Plan 2014	Local historical significance	Approximately 2.9 km north of the Southern Extension Area.
Miners cottages (listed)	1 Old Company Cottages Road, Cullen Bullen	Lithgow Local Environment Plan 2014	Local historical significance	Approximately 2.7 km north of the Southern Extension Area.

In addition to the listed historical sites identified in **Table 6.18**, other potential historical heritage sites were identified in the previous Historic Heritage Assessment undertaken (AECOM, 2011). The location of the sites are shown in **Figure 6.16** and presented in **Table 6.18**.

Table 6.18 Previously Identified Heritage Sites

Site	Location	Identified	Significance	Distance to Southern Extension Area
Bottle Scatter CV-RCK1-10	Located north-east of the Southern Extension Area in the Ben Bullen State Forest	Identified during AECOM field survey (AECOM 2011).	Local historical research significance.	Approximately 1.2 km north-east of the Southern Extension Area.
Sandstone Building Footings	Located south of the Southern Extension Area	Identified during AECOM field survey (AECOM 2011).	No assessment of significance has been carried out due to limited available information.	Approximately 1.7 km south of the Southern Extension Area.
Royal Hotel	22 Castlereagh Highway, Cullen Bullen.	Identified in the City of Lithgow Heritage Study (2000).	Local historical significance	Approximately 2.9 km north of the Southern Extension Area.
Cottage	Carson Siding Road, Cullen Bullen.	Identified in the City of Lithgow Heritage Study (2000).	Local historical significance	Approximately 3 km north of the Southern Extension Area.
Cottage 2	33 Castlereagh Highway, Cullen Bullen	Identified in the City of Lithgow Heritage Study (2000).	Local historical significance	Approximately 2.8 km north of the Southern Extension Area.
Miners Cottage	45 Castlereagh Highway, Cullen Bullen.	Identified in the City of Lithgow Heritage Study (2000).	Local historical significance	Approximately 3.1 km north of the Southern Extension Area.



Legend

- Existing Approved Mining Disturbance Area
- Proposed Southern Extension Area
- Historic Heritage Site

FIGURE 6.16

Historic Heritage Sites

Targeted inspection of the Southern Extension Area and surrounds were undertaken as part of the Aboriginal cultural heritage survey (refer to **Section 6.5**). No additional potential historic heritage sites or items were identified during these surveys within the Southern Extension Area or accessible areas within 500 m of the Southern Extension Area.

6.6.2 Historic heritage impacts and management commitments

The potential impacts of the Southern Extension Project are considered in terms of direct impacts and indirect impacts. Direct impacts are considered to be physical impacts to a site, including removal / destruction. No heritage sites are located within the Southern Extension Area (refer to **Figure 6.16**) and therefore no heritage sites will be directly impacted as a result of the Southern Extension Project.

Indirect impacts are considered to include vibration from blasting to structures; which has the theoretical potential to damage / destroy / disturb historical heritage items. The potential impact of blasting on the identified historic heritage sites has been considered in the detailed Blasting impact assessment for the Southern Extension Project (refer to **Section 6.8**).

As detailed further in **Section 6.8**, no heritage sites assessed in the Blasting impact assessment have a predicted ground vibration level that exceeds 5 mm/s, which is below the nominated criterion for historical sites. Cottage and Cottage 2 were not specifically assessed as part of the Blasting impact assessment, however both sites are located a greater distance from the Southern Extension Area than the closest Miners Cottage (listed) which has a predicted ground vibration level of no greater than 0.8 mm/s, which is well below the relevant ground vibration criteria for these heritage structures.

It is not expected the Southern Extension Project will result in any direct or indirect impacts to heritage sites / items.

6.6.2.1 Mitigation measures

Historical heritage management measures to be implemented for the Southern Extension Project include:

- Castlereagh Coal will implement historical heritage management measures for the Southern Extension Project including:
    - In the unlikely event that unexpected archaeological remains or potential heritage items not identified as part of this assessment are discovered during the Southern Extension Project, all works in the immediate area will cease, the remains and potential impacts will be assessed by a qualified archaeologist or heritage consultant and, if necessary, the Heritage Division, Office of Environment and Heritage (OEH) notified in accordance with Section 146 of the *Heritage Act 1977* (NSW)
    - In the unlikely event that a potential burial site or potential human skeletal material is exposed within the Southern Extension Area, the process detailed in **Section 7.5** will be implemented.

Measures to manage potential blast impacts on heritage items are identified in **Section 7.8**.

6.7 Air quality

A comprehensive assessment of the potential air quality impacts for the Southern Extension Project has been prepared by Jacobs (refer to **Appendix 8**). This detailed assessment has been undertaken in accordance with the EPA's *Approved Methods of the Modelling and Assessment of Air Pollutants in New South Wales* (DEC, 2005).

The Southern Extension Project design and planning process included identifying air quality mitigation and management measures and incorporating them into the Southern Extension Project design to minimise air quality impacts. The location of the Southern Extension Project at the southern extent of Invincible is the furthest practicable distance from private residences, and Cullen Bullen which is located approximately 3 km to the north-west of the Invincible Mine Infrastructure Area.

The Air Quality Impact Assessment has focussed on the assessment of impacts from the early stages of the Southern Extension Project (mine plan stage 1) as this area is located in closest proximity to surrounding receiver locations to provide a prediction of the potential worst case air quality impacts associated with the Southern Extension Project.

A summary of the key findings of the Air Quality Impact Assessment is provided in this section and the full report is provided in **Appendix 8**.

6.7.1 Potential air quality issues

The Southern Extension Project will result in emissions to air from a variety of activities including material handling, material transport, processing, wind erosion and blasting. These emissions will mainly comprise of particulate matter (dust) from general mining activities, and to a lesser extent, diesel exhaust emissions from the use of machinery and plant as part of the Southern Extension Project.

Castlereagh Coal understands that air quality is an important issue for the community and has designed the Southern Extension Project to minimise air quality impacts with a range of mitigation and management measures incorporated into the Southern Extension Project design. These measures include:

- development of a mine plan that allows for progressive rehabilitation of the Southern Extension Area and the existing Invincible site
- minimising the length of haul roads (where practicable) and adopting controls for haul road dust emissions
- minimising the area of disturbed land at any one time as much as practicable
- using temporary rehabilitation and stabilisation measures on disturbed land
- implementation of the dust controls discussed in **Section 6.7.6**.

6.7.2 Air quality criteria

A range of different categories of dust are relevant to the assessment process. Dust concentration refers to airborne dust (or particulate matter (PM)) and is measured in micrograms per cubic metre (µg/m^3). There are various classifications of dust and relevant criteria are typically prescribed for total suspended particulates (TSP), PM_{10}, $PM_{2.5}$ and deposited levels. TSP relates to all suspended particles which are usually in the size range of zero to 50 micrometres (µm). PM_{10} refers to particulate matter with a diameter less than 10 micrometres (µm) and $PM_{2.5}$ refers to particulate matter with a diameter less than 2.5 µm. Dust deposition levels refer to the quantity of all dust particles that settle out of the air as measured in grams per square metre per month (g/m^2/month).

The air quality assessment criteria adopted for the Southern Extension Project are those recommended by the EPA and specified in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (DEC 2005) (Approved Methods) and the relevant criteria specified as a non-discretionary development standard in the Mining SEPP. With the exception of the criterion for annual average PM_{10}, these criteria are consistent with the national standards set by the National Environmental Protection Council under the National Environment Protection Measures (NEPM) for Ambient Air Quality (NEPC 1998a and 1998b). In December 2015 the Australian Government announced a National Clean Air Agreement (Clean Air Agreement). The Clean Air Agreement aims to reduce air pollution and improve air quality with the relevant key action including:

> *Strengthened ambient air quality reporting standards for particle pollution. Specifically, "Taking into account the latest scientific evidence of health impacts, Ministers agreed to strengthen national ambient air quality reporting standards for airborne fine particles. Ministers agreed to adopt reporting standards for annual average and 24-hour $PM_{2.5}$ particles of 8 µg/m3 and 25 µg/m^3 respectively, aiming to move to 7 µg/m^3 and 20 µg/m^3 respectively by 2025.*
>
> *Ministers also agreed to establish an annual average standard for PM10 particles of 25 µg/m^3. Victoria and the Australian Capital Territory will set, and South Australia will consider setting, a more stringent annual average PM_{10} standard of 20 µg/m^3 in the state, while ensuring nationally consistent monitoring and reporting against the agreed National Environment Protection Measure standards. The decision was also taken to review PM10 standards in 2018. The review will be co-led by the NSW and Victorian governments, in discussion with other jurisdictions."*

On 25 February 2016 an amendment to the NEPM entered into force and introduced the new national air quality standards for PM_{10} and $PM_{2.5}$. While all jurisdictions have agreed to this action, no States (including the NSW EPA or D&E) have prescribed a change to the air quality criteria to be used for the assessment of specific projects. The Clean Air Agreement indicates an initial work plan of two years to progress the actions. The potential effect of the Air Quality Agreement on the assessment criteria is considered in **Section 6.7.5**.

The assessment criteria used for the Air Quality Impact Assessment are outlined in **Table 6.19**. These criteria apply to existing and potential sensitive receptors such as residences, schools and hospitals. Criteria for nitrogen dioxide (NO_2) are also included as there would be sources of this substance associated with the Southern Extension Project such as vehicle exhausts.

Table 6.19 Air Quality Assessment Criteria

Substance	Averaging time	Criterion	Agency
Particulate matter (PM_{10})	24-hour	50 µg/m^3	EPA
	Annual	30 µg/m^3	EPA
Particulate matter ($PM_{2.5}$)	24-hour	25 µg/m^3	NEPM
	Annual	8 µg/m^3	NEPM
Particulate matter (TSP)	Annual	90 µg/m^3	EPA
Deposited dust	Annual (maximum increase)	2 g/m^2/month	EPA
	Annual (maximum total)	4 g/m^2/month	EPA
Nitrogen dioxide (NO_2)	1-hour	246 µg/m^3	EPA
	Annual	62 µg/m^3	EPA

The air quality assessment criteria set out in **Table 6.19** relate to the total concentration of air pollutant in the air (that is, cumulative) and not just the contribution from project-specific sources. Therefore, consideration of background levels needs to be made when using these criteria to assess impacts. Further discussion of background levels in the area surrounding the Southern Extension Area is provided in **Section 6.7.3**.

6.7.3 Existing air quality environment

6.7.3.1 Sensitive receiver locations

As discussed in **Section 6.2**, the Southern Extension Area is located within the Ben Bullen State Forest to the east of the Castlereagh Highway and is surrounded by existing mining operations to the north, state forest to the east and west and rural land to the north-west. The closest privately owned residence is located approximately 820 m to the north-west of the Southern Extension Area.

Other sensitive receiver locations include scattered privately owned rural residences to the west of the Southern Extension Area and those within the township of Cullen Bullen, which is located approximately 3 km to the north-west of the Invincible mine infrastructure area (refer to **Figure 1.5**).

6.7.3.2 Meteorological conditions

The Air Quality Impact Assessment (refer to **Appendix 8**) analysed data from two meteorological stations to determine the meteorological conditions within and surrounding the Southern Extension Area. This included data from stations located at Invincible and Cullen Valley Mine from 2009 to 2015 (refer to **Figure 2.3**). Hourly records of temperature, wind speed and wind direction were analysed in order to identify a representative year for air dispersion modelling.

Analysis of annual wind patterns from the Invincible meteorological station indicate the most common winds in the area are from the northeast and southwest (refer to **Figure 6.17** and **Figure 6.18**). At the Cullen Valley Mine meteorological station this north-east / south-west pattern is also evident but to a lesser degree with some winds from other sectors also measured, and generally of lighter strength.

The 2014 calendar year was identified as being representative of the meteorological conditions observed in the data and was selected as the meteorological year used in the modelling for the air quality impact assessment.

6.7.3.3 Existing monitoring

The EPA air quality criteria identifies acceptable levels of particulates and substances. These criteria, and the criteria included in the VLAMP apply to cumulative impacts. The assessment has therefore considered the impact of the Southern Extension Project and existing sources, which has included contributions from mining operations located within the area surrounding the Southern Extension Project. In general, the background concentration may contain emissions from many sources such as from mining activities, construction works, bushfires and 'burning off', industry, vehicles, roads, wind-blown dust from nearby and remote areas, fragments of pollens, moulds, etc. To fully assess impacts against all the relevant air quality criteria it is necessary to have information or estimates of the existing air quality conditions in the vicinity of the Southern Extension Project.

Dust deposition and dust concentration (TSP and PM_{10}) are monitored in the vicinity of the Southern Extension Area by high volume air samplers and dust deposition by dust deposition gauges. The locations of these monitoring sites are shown in **Figure 2.3**. Concentrations of $PM_{2.5}$, TSP and NO_2 have not been measured in the region surrounding the Southern Extension Area, however the OEH measures these substances as part of its Upper Hunter Air Quality Monitoring Network and so regionally relevant data are available and have been used to determine an indicative regional background level to inform the Air Quality Impact Assessment (refer to **Appendix 8**).

Particulate Matter - PM_{10}

A summary of the measured PM_{10} concentrations for each of monitoring sites surrounding the Southern Extension Project from 2009 to 2015 is provided in **Table 6.20**.

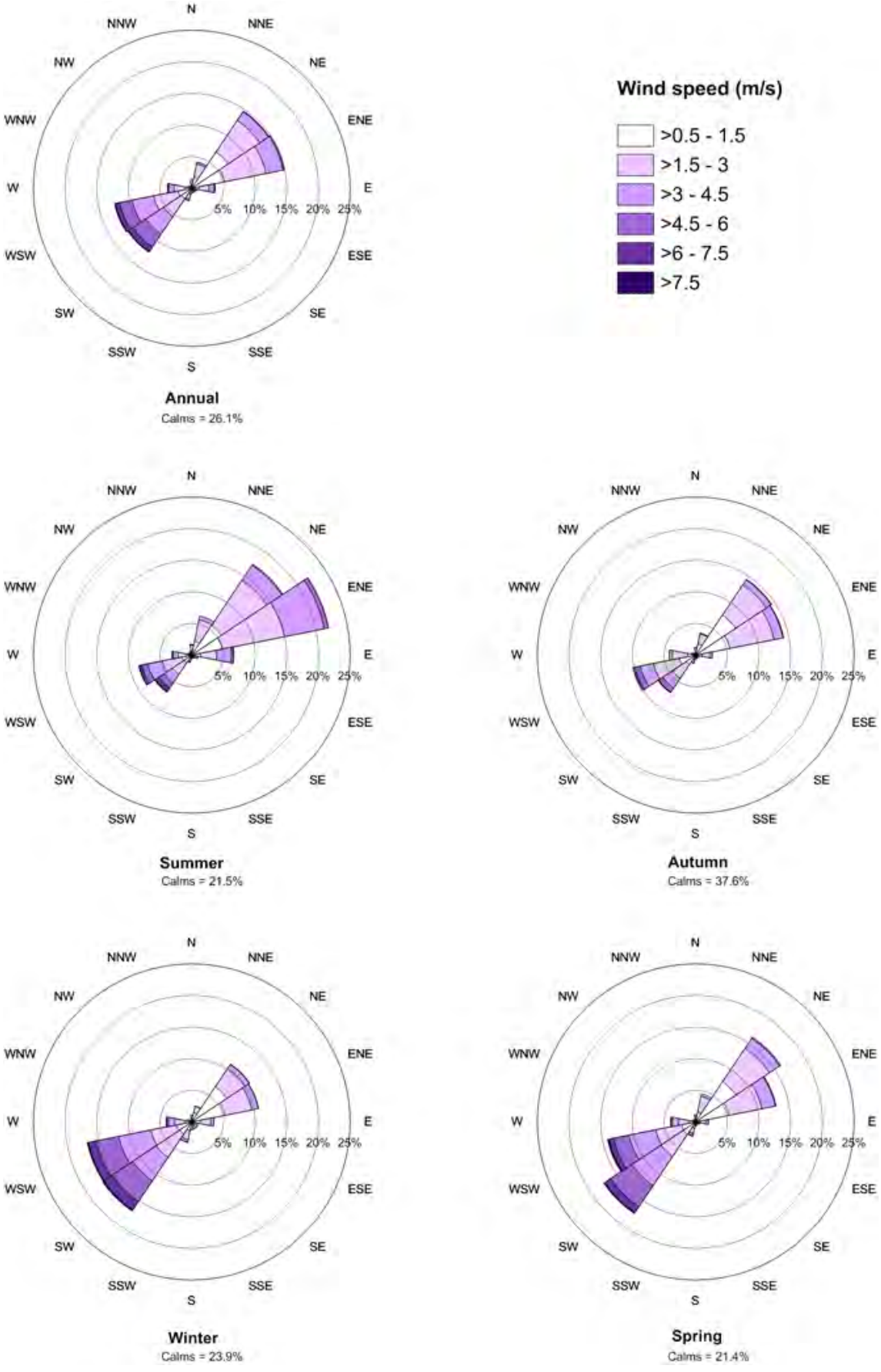


FIGURE 6.17

Wind Rose Data
Invincible
Meteorological Station (2014 data)

FIGURE 6.18

Wind Rose Data
Cullen Valley Mine
Meteorological Station (2014 data)

Table 6.20 Measured PM_{10} Concentrations

Year	Invincible Colliery HVAS	Cullen Valley Mine HVAS	Criterion
Maximum 24-hour average in µg/m^3			
2009	1330*	44	50
2010	46	23	
2011	40	20	
2012	36	20	
2013	48	44	
2014	18	61	
2015	18	37	
Number of days above 24-hour average criteria. Note: high volume samplers collect data up to around 60 days per year			
2009	4	0	5 (NEPM)
2010	0	0	
2011	0	0	
2012	0	0	
2013	0	0	
2014	0	1	
2015	0	0	
Annual average in µg/m^3			
2009	41 (18 without dust storm record)*	14	30
2010	11	8	
2011	13	9	
2012	9	6	
2013	5	7	
2014	4	5	
2015	5	7	

Note: *There has been five days in the past seven years where PM_{10} concentrations exceeded the EPA's 50 µg/m^3 24-hour criterion. Annual average PM_{10} concentrations have been below the 30 µg/m^3 criterion when excluding the September 2009 dust storm influence.

Particulate Matter – $PM_{2.5}$

The closest air quality monitoring stations which recorded concentrations of $PM_{2.5}$ with publicly available data are located at Singleton, Camberwell and Muswellbrook. The Camberwell, Singleton and Muswellbrook monitoring sites are located closer to more sources of $PM_{2.5}$ than found in the vicinity of the Southern Extension Project and are detailed in **Appendix 8**. The $PM_{2.5}$ concentrations in the vicinity of the Southern Extension Project would therefore be expected to be lower than those measured in the Hunter Valley. For the Southern Extension Project area, Pacific Environment has previously (PEL 2014) estimated an annual average $PM_{2.5}$ concentration of 5 µg/m^3, based on established $PM_{2.5}$ to PM_{10} ratios. This approach has been adopted for the air quality impact assessment (refer to **Appendix 8**).

Particulate Matter - TSP

TSP concentrations have not been measured in the vicinity of the Southern Extension Project. Annual average TSP concentrations have been estimated from the PM_{10} measurements by assuming that 40 per cent of the TSP is PM_{10}. This relationship was obtained from data collected by co-located TSP and PM_{10} monitors operated for long periods of time in the Hunter Valley (NSW Minerals Council, 2000). Use of this relationship indicates that the annual average TSP concentration is approximately 26 µg/m^3 which is well below the EPA annual average assessment criterion of 90 µg/m^3.

Deposited dust

Dust deposition monitoring data is collected from five locations surrounding the Southern Extension Area. **Table 6.21** shows the annual average deposited dust levels for each gauge from data collected in the past eight years.

Table 6.21 Summary of measured deposited dust levels

Year	DM1	DM2	DM3	DM4	DM5	Criterion
Annual average expressed as g/m^2/month						
2008	1.2	0.6	0.7	0.7	0.8	4
2009	1.5	1.1	1.4	1.2	1.5	
2010	1.7	0.7	0.7	0.4	1.1	
2011	1.1	0.7	0.4	0.4	0.7	
2012	1.0	1.1	0.5	0.4	0.9	
2013	0.6	0.5	0.4	0.3	0.5	
2014	0.5	0.6	0.9	0.5	17.6	
2015	0.5	0.5	0.4	0.5	1.0	

Monitoring data for the period 2008 to 2015 indicates that one location (DM5) experienced a deposition level above the EPA's 4 g/m^2/month criterion in 2014. No other monitors have measured deposition levels above 4 g/m^2/month. The average from all years of data and from all sites was 1.2 g/m^2/month.

Nitrogen Dioxide (NO_2)

The closest known air quality monitoring sites that record NO_2 concentrations are located in the Hunter Valley at Singleton and Muswellbrook. **Table 6.22** provides a summary of the measured NO_2 concentrations from these two OEH monitoring sites.

Table 6.22 Summary of measured NO_2 concentrations

Year	Singleton (OEH)	Muswellbrook (OEH)	Criterion
Maximum 1-hour average in µg/m^3			
2012	82	90	246
2013	84	86	
2014	74	80	
2015	66	86	
Annual average in µg/m^3			
2012	18	21	62
2013	18	18	
2014	16	21	
2015	16	18	

6.7.3.4 Assumed background levels

One of the objectives for reviewing the air quality monitoring data was to determine appropriate background levels to be added to model predictions for the assessment of potential cumulative impacts, that is, mining contribution plus non-mining contribution. The estimated background levels that apply at sensitive receptors are shown below in **Table 6.25**. These levels (or approach adopted) have been added to model predictions to determine the potential cumulative impacts.

Table 6.23 Assumed non-modelled background levels that apply at sensitive receptors

Substance	Averaging time	Assumed background level that applies at sensitive receptors	Notes
Particulate matter (PM_{10})	24-hour	23 µg/m^3	95th percentile of Invincible and Cullen Valley PM_{10} monitoring data for 2009 to 2015.
Particulate matter (PM_{10})	Annual	10 µg/m^3	Average of Invincible and Cullen Valley PM_{10} monitoring data for 2009 to 2015.
Particulate matter ($PM_{2.5}$)	24-hour	11 µg/m^3	Estimated from 24-hour PM_{10}.
	Annual	5 µg/m^3	Estimated from annual PM_{10}.

Substance	Averaging time	Assumed background level that applies at sensitive receptors	Notes
Particulate matter (TSP)	Annual	26 µg/m^3	Estimated from PM_{10}, assuming 40per cent of TSP is PM_{10}.
Deposited dust	Annual	1.2 g/m^2/month	Average of Invincible dust deposition monitoring data for 2008 to 2015.
Nitrogen dioxide (NO_2)	1-hour	90 µg/m^3	Maximum measured value from Singleton and Muswellbrook.
	Annual	21 µg/m^3	Maximum measured value from Singleton and Muswellbrook.

6.7.4 Assessment methodology

The Air Quality Impact Assessment has followed the EPA's *Approved Methods of the Modelling and Assessment of Air Pollutants in New South Wales* (DEC, 2005), which specifies how assessments based on the use of air dispersion models should be undertaken in NSW.

Background air quality and meteorology data collated for the site and described in **Section 6.7.3.2**, were used in conjunction with comprehensive emissions inventories to model the potential air quality impacts of the Southern Extension Project.

The CALMET/CALPUFF modelling system was used to predict off-site dust concentration and dust deposition levels due to the Southern Extension Project. CALPUFF is an air dispersion model which has been approved by the EPA for these types of assessments.

The stage 1 mine plan where hauling distances are near their longest has been combined with the maximum proposed production of 1.2 Mt ROM coal, and overburden handling volume of 4.2 million bank cubic metres (Mbcm) and used for CALPUFF dispersion modelling. This scenario has been developed to simulate the potential worst-case air quality impacts at nearest sensitive receptors.

The potential cumulative effects of emissions were also considered in the modelling process by assessing the combined effects of other mining and non-mining contributions. The estimated background levels that apply at sensitive receivers are shown in **Appendix 8**. These levels (or approach adopted) have been added to model predictions to determine the potential cumulative impacts.

6.7.5 Impact assessment

6.7.5.1 Particulate emissions

Air quality impacts due to the Southern Extension Project were predicted, and potential changes in air quality over existing levels were identified. Dust contours have been generated to approximate air quality impacts for the area surrounding the Southern Extension Project and are discussed below.

PM_{10}

Representative dust contours for predicted maximum 24-hour average and annual average PM_{10} concentrations are shown on **Figure 6.19**.

Figure 6.19 shows the predicted maximum 24-hour average PM_{10} concentrations due to the Southern Extension Project. The relevant criterion is 50 µg/m^3. This criterion is represented in **Figure 6.19** by the 27 µg/m^3 contour which takes into consideration the assumed maximum background levels of 23 µg/m^3. It can be seen from these results that the Southern Extension Project is not predicted to cause exceedances of the EPA's criterion at any private residence surrounding the Southern Extension Project.

Figure 6.19 shows the predicted annual average PM_{10} concentrations due to the Southern Extension Project. The relevant criterion is 30 µg/m^3. This criterion is represented in **Figure 6.19** by the 20 µg/m^3 contour which takes into consideration the assumed background levels of 10 µg/m^3. These results show that the Southern Extension Project will not cause exceedances of the EPA's criterion at any private residence surrounding the Southern Extension Project.

Based on the model results, no privately owned residences are expected to experience PM_{10} concentrations above EPA criteria. This conclusion will not change as a result of the National Clean Air Agreement which proposes the establishment of an annual average standard for PM_{10} of 25 µg/m^3, which may replace the EPA's current criterion of 30 µg/m^3 (refer to **Section 6.7.2**).

$PM_{2.5}$

The results for $PM_{2.5}$ are shown in **Figure 6.19**, for maximum 24-hour and annual averages. **Figure 6.19** shows that maximum 24-hour average $PM_{2.5}$ concentrations, due to the Southern Extension Project, will not exceed the NEPM criteria of 25 µg/m^3 at any private residence surrounding Invincible. Similarly, annual average $PM_{2.5}$ concentrations are predicted to be below the NEPM criteria of 8 µg/m^3 (refer to **Figure 6.19**) at all private residences surrounding the Southern Extension Project.

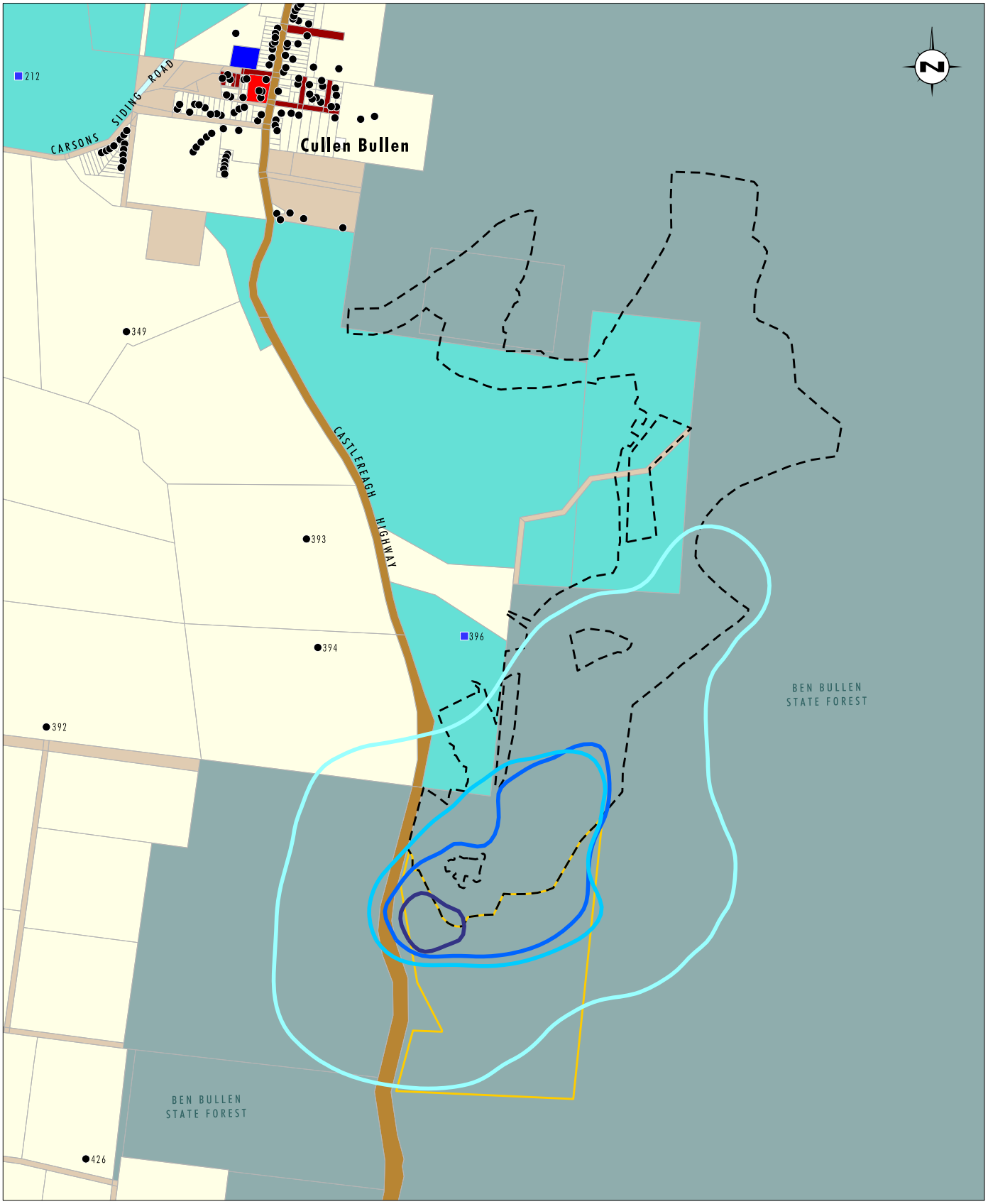
The conclusions of the Air Quality Impact Assessment with regard to $PM_{2.5}$ impacts will not change as a result of the National Clean Air Agreement.

TSP and dust deposition

There are no private residences that are predicted to experience annual average TSP or dust deposition levels above the air quality assessment criteria, either from the Southern Extension Project alone or from the cumulative impacts of the Southern Extension Project and all other sources. The predicted extent of TSP and Dust Deposition is located within the extent of the modelled PM_{10}, 24 hr emissions from the Southern Extension Project. Full results for these classes of dust are provided in the in the air quality impact assessment in **Appendix 8**.

6.7.5.2 Diesel emissions

Emissions from diesel exhausts associated with off-road vehicles and mining equipment have been assessed as part of the Air Quality Impact Assessment for the Southern Extension Project (refer to **Appendix 8**). The most significant emissions from diesel exhausts are products of combustion including carbon monoxide (CO), oxides of nitrogen (NO_x) and particulate matter (PM_{10} including $PM_{2.5}$). The NO_x, or more specifically NO_2, and PM_{10} (including $PM_{2.5}$) have been considered as part of this assessment.



Data Source: Sedgman (2016), LPI (2016)

0 0.25 0.5 1.0km

Legend

- Existing Approved Mining Disturbance Area
- Proposed Southern Extension Area
- Cumulative 24-hour PM10 (50 $\mu g/m^3$)
- Cumulative Annual Average PM10 (30 $\mu g/m^3$)
- Cumulative 24-hour PM2.5 (25 $\mu g/m^3$)
- Cumulative Annual Average PM2.5 (8 $\mu g/m^3$)
- Castlereagh Highway
- Council
- Crown
- Cullen Bullen Primary School
- Minister for Education
- Private
- Rail Corporation NSW
- Shoalhaven Coal Owned
- State Forest
- State Government
- Private Residence
- Mine Owned Building

FIGURE 6.19

Predicted Air Quality Impacts Southern Extension Project

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The NO_x emission estimates have been modelled to provide an indication of the off-site NO_2 concentrations due to diesel exhaust emissions. **Appendix 8** details the predicted maximum 1-hour average NO_2 concentrations, which assumes that 20 per cent of the NO_x is NO_2 at the locations of maximum ground-level concentrations.

With the addition of maximum background levels of 90 µg/m^3, the results indicate compliance with the EPA criteria of 246 µg/m^3 for 1 hr average NO_2 concentrations. With the addition of conservative background levels of 21 µg/m^3, the results indicate compliance with the EPA criteria of 62 µg/m^3 for the annual average NO_2 concentrations.

6.7.6 Management and Monitoring Commitments

Castlereagh Coal is committed to effectively managing the air quality impacts associated with the Southern Extension Project and will implement a range of dust management measures for the key dust generating activities. These measures are described in **Table 6.24** and have been incorporated into the modelling of dust impacts of the Southern Extension Project.

Table 6.24 Dust Management Measures

Activity / Dust Source	Dust Management Measures
Stripping topsoil by scraper	Watering of haul routes
Drilling overburden and coal	Water injection, dust curtains
Hauling overburden and coal on unsealed roads	Watering of haul routes
Coal processing	Enclosure
Dozers on ROM and product coal stockpiles	Watering / moist travel routes
Conveyors to stockpiles	Water sprays
Wind erosion from partially rehabilitated dumps	Partial rehabilitation / stabilisation
Wind erosion from ROM and product coal stockpiles	Water sprays
Grading roads	Watering of haul routes

Air Quality Management Plan

Air Quality Management Plan

- Castlereagh Coal will prepare and implement an Air Quality Management Plan for the Southern Extension Project. The plan will incorporate a range of proactive and reactive dust control strategies. The controls to be implemented include the following key measures:
    - Proactive air quality management will involve the planning of activities in advance of potentially adverse conditions. Specifically, the proactive air quality management approach will include:
        - implementation of a system to provide environmental personnel with a daily forecast of expected dust conditions in the vicinity of the operation
        - discussion of the dust forecast at daily pre-shift meetings

        - modifying the planned mining activities, as appropriate, to minimise or avoid the potential dust impacts.

    - Reactive air quality management will including modification or suspension of activities in response to identified triggers including:

        - visual conditions, such as visible dust from trucks above wheel height

        - meteorological conditions, such as dry, windy conditions, with winds blowing towards sensitive receptors.

Dust Management Measures

- Castlereagh Coal will implement a range of dust management measures for the key dust generating activities including:

    - watering of haul routes

    - water injection, dust curtains

    - enclosure

    - watering / moist travel routes

    - water sprays

    - partial rehabilitation / stabilisation.

- Castlereagh Coal will minimise clearing ahead of construction and operational activities.

Air Quality Monitoring

- Castlereagh Coal will review and consolidate the air quality monitoring currently operating to meet the needs of the Southern Extension Project. Specifically, the locations and types of monitoring will consider the location of sensitive receptors, prevailing meteorological conditions, and location of mining activities. The air quality monitoring program will form part of the Air Quality Management Plan to be developed for the Southern Extension Project.

6.8 Blasting assessment

To assess the potential blasting impacts associated with the Southern Extension Project, a detailed Blasting Impact Assessment was undertaken by Enviro Strata Consulting Pty Ltd (ESC) (refer to **Appendix 9**). As outlined in **Section 6.1**, a key issue for the Southern Extension Project is the risk of potential impacts to pagodas located in proximity to the Southern Extension Area associated with blasting. A detailed assessment of the current condition and structural characteristics of the closest pagodas to the Southern Extension Area has been undertaken (refer to **Appendix 9**) to assess the potential risk of blast impact and define appropriate criteria for these locations to minimise potential impacts from the Southern Extension Project.

Blasting will be undertaken in accordance with the current Invincible Project Approval, which is limited to between 9.00 am and 5.00 pm (EST) Monday to Saturday, not more than 2 blast per day, or 5 blasts per week averaged over any 12 month period. Castlereagh Coal will design blasts to meet all relevant criteria at a range of blast sensitive locations in proximity to the Southern Extension Area, including private residences, infrastructure, historic heritage sites and sandstone, as detailed in **Section 6.8.2**.

The existing Blast Management Plan will be updated to provide for the detailed design of each blast to minimise dust, fumes, ground vibration and airblast overpressure, to maximise blast efficiency and ensure compliance with site specific blasting conditions. This will include detailing the proposed blast monitoring program to be implemented over the life the Southern Extension Project. The Blast Management Plan and associated monitoring program is detailed in **Section 6.8.4**.

6.8.1 Conceptual blast design

A mixture of emulsion blends (wet holes) and ANFO (dry holes) explosives will be used for the Southern Extension Project. Blast designs and sizes will vary and will depend on numerous factors including the depth of coal seams and the design of open cut benches.

Standard conceptual blast sizes will typically be up to a maximum instantaneous charge mass (MIC) of 466 Kilograms. As detailed in **Appendix 9**, a range of standard blast designs have been assessed as part of the Blasting impact assessment to determine potential impacts from blasting. As outlined further in **Section 6.8.3**, where relevant criteria could be exceeded under standard blast design parameters, Castlereagh Coal will specifically design the blasts to meet the relevant criteria at blast sensitive locations. Castlereagh Coal has committed to the management of blasts to meet all relevant criteria for the life of the Southern Extension Project.

Blasts will be managed to minimise vibration, airblast overpressure, potential flyrock impacts and other impacts on the surrounding environment. In practice, Castlereagh Coal will undertake blasting in accordance with a detailed design process that considers operational, geological and environmental constraints.

Detailed design will be undertaken for each blast in order to maximise the blast efficiency, minimise potential dust, vibration and overpressure impacts, and to ensure compliance with site specific blast conditions. The detailed blast design process, including consideration of environmental conditions that may propagate potential blast impacts, will be specified in the Blast Management Plan.

6.8.2 Blast assessment methodology

The blast assessment was completed through identifying blast sensitive locations in proximity to the Southern Extension Area, and defining appropriate criteria to protect these locations. These criteria will inform detailed design of blasts so that relevant criteria are met. The blast locations assessed by the Blasting impact assessment and the criteria adopted are described below. Further details on the methodology adopted in the blast assessment are set out in **Appendix 9**.

6.8.2.1 Blast sensitive locations

The identification of blast sensitive locations was based on:

- the location of known structures (including public and private infrastructure) and residences in proximity to the Southern Extension Area that may be impacted by blasting
- detailed outcomes of relevant impact assessment studies that identified potentially blast sensitive structures, including the detailed assessment of pagodas (refer to **Appendix 9**), and Aboriginal heritage assessments (refer to **Section 6.5**) and historic heritage assessment (refer to **Section 6.6**).

The location of structures, nearby residences, natural features and heritage items assessed as part of the Blasting Impact Assessment are shown in **Figure 6.20** and include:

- pagodas / cliff line in proximity to the Southern Extension Area
- surrounding private residences
- identified infrastructure including:
    - Castlereagh Highway
    - Boulder Road
    - Overpass bridge
    - 11 kV power line infrastructure within and to the west of the Southern Extension Area
    - Structures at Big Rim Property.
- historical items including:
    - The Royal Hotel
    - Cullen Bullen School
    - Sandstone footings
    - Miners cottages.

It is noted that a number of potentially sensitive Aboriginal archaeological sites (rock shelters) have been previously identified to the north and east of the Southern Extension Area, however they are located at a greater distance (approximately 1.1 km) from the Southern Extension Area than the closest sandstone pagoda structures as assessed in detail in **Section 6.8.2** and **Appendix 9**.

6.8.2.2 Blast assessment criteria

Assessment criteria used in the Blasting Impact Assessment are detailed in **Appendix 9**. The following is a summary of the criteria used in the assessment.

Blast emissions criteria for human comfort

Human annoyance criteria for blasting for any privately-owned residence or other sensitive locations was assessed against the criteria identified in Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration prepared by the Australian and New Zealand Environment Council (1990):

- the maximum airblast should not exceed 115 dB for more than 5 per cent of blasts in any year, and should not exceed 120 dB for any blast
- the maximum peak particle ground velocity should not exceed 5 mm/s for more than 5 per cent of blasts in any one year, and should not exceed 10 mm/s for any blast.

The above criteria are detailed in the existing Invincible Project Approval (PA070127).

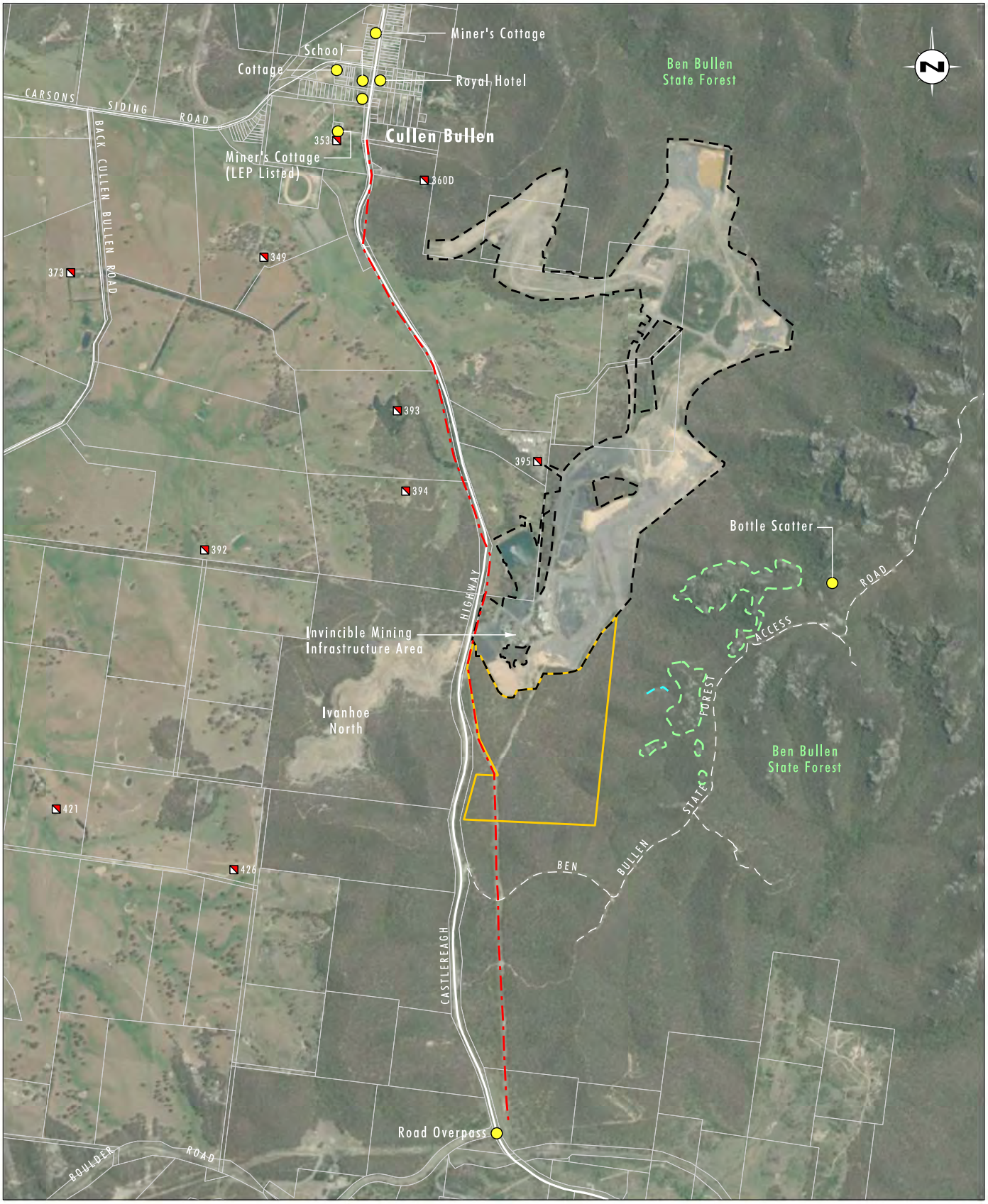

Image Source: Google Earth - CNES/Astrium (Nov 2014)
Data Source: Sedgman (2016), LPI (2016)

0 0.5 1.0 1.5km

Legend

- Existing Approved Mining Disturbance Area
- Proposed Southern Extension Area
- 11kV Powerline
- Pagodas assessed for Blast Impact Assessment
- Cliffline
- Heritage Site
- Blast Sensitive Structure Location

FIGURE 6.20

Blast Sensitive Locations

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20160915 16.55

Blast damage criteria for ground vibration

For blast damage criteria for residential structures the Australian Standard AS 2187-2:2006, refers to other available standards, such as British Standard BS 7385-2:1993 and American (USBM) RI8507.

The blast damage criteria are frequency dependent; based on the British Standard BS 7385-2:1993 these range from 15 mm/s for low frequencies up to 50 mm/s for high frequencies. It is noted that the lowest transient vibration value for cosmetic damage is estimated as 15 mm/s at 4 Hz. The cited range is well above the blast emission criteria for human comfort (i.e. 5 mm/s and 10 mm/s) as discussed above. It therefore follows that when vibration limits for human comfort are met, compliance with blast damage criteria for residential structures will be achieved.

Blast damage criteria for airblast

The Australian Standard AS 2187-2:2006, specifies a conservative limit of 133 dBL as a safe level, implying no damage to the structure. AS 2187-2:2006 also specifies that damage to windows (regarded as the most fragile / sensitive material) is considered improbable for airblast exposures below 140 dBL.

Therefore, when vibration limits for human comfort are met (i.e. 115 and 120 dBL), the possibility of structural damage for the surrounding residential structures is eliminated.

Criteria for infrastructure and historical sites

The proposed ground vibration and airblast emission criteria for the identified infrastructure and relevant historical sites are 5mm/s and 133dBL. Further information regarding blast emission criteria used in the assessment is contained within the Blast Impact Assessment (refer to **Appendix 9**).

Pagodas

The assessment of pagodas (refer to **Appendix 9**) specifically detailed the structural integrity of pagodas closest to the Southern Extension Area, and an identified cliff line. The methodology included detailed in-field rock strength testing as detailed in **Appendix 9**.

The structural integrity of the sandstone formations was inspected and assessed in detail. The sandstone pagodas are of substantial size located on a significant sub-base and are affected in places by ongoing rock weathering. The sandstone material was determined to be of an acceptable strength in terms of potential vibration impact. The assessment revealed a limited number of cracks and geological intrusions / weaknesses within the sandstone pagoda structures, which have been detailed in **Appendix 9** to form a baseline for ongoing monitoring (refer to **Section 6.8.4**).

The vibration limit for the sandstone pagodas (including the Northern, Central and Southern Pagodas) was identified as 50 mm/s and 25mm/s for the cliff line. As discussed in the **Appendix 9**, the specified level is conservative when considering minimum vibration levels that could induce damage to the assessed strength of the rock strata layers at each of the pagoda sites. The proposed limit is also well below the damage criteria for the assessed sandstone material that forms a large substantive mass of these structures. The recommended allowable vibration limits are in agreement with established studies of comparable rock strata materials as well as other published studies of a similar nature as presented in **Appendix 9**.

There are no airblast overpressure criteria for the pagodas and cliff line as airblast overpressure would have negligible impact on these structures.

Table 6.25 provides a summary of the relevant blast impact assessment criteria for the Southern Extension Project.

Table 6.25 Summary of Blast Emission Assessment Criteria

Location	Vibration Criteria (mm/s)	Airblast Criteria (dBL)
Private residences(1)	5 / 10	115 / 120
Public roads	100	n/a
Concrete bridges	100	n/a
Power lines(2)	50 / 100	n/a
Surface infrastructure - occupied	25	133
Surface infrastructure - unoccupied	100	133
Historical sites (Miners Cottages, Cullen Bullen Public School, Royal Hotel, Sandstone Building Footings)	5	133
Pagodas	50	n/a
Cliff line	25	n/a

(1) Specified in the existing Invincible Project Approval PA 07_0127
(2) 50 mm/s applies to tension towers, 100 mm/s applies to free standing towers.

6.8.3 Predicted blast impacts

6.8.3.1 Surrounding private residences

The predicted ground vibration levels that will be experienced at the private residences have been modelled for residences located in proximity to the Southern Extension Area and also on the southern extent of Cullen Bullen, and are generally located within 3 km of the Southern Extension Project.

The predicted ground vibration levels for private residences using variable standard MICs are in the order of 0.1 to 4.6 mm/s for all residential receivers within a 3 km radius. These levels are below the applicable ground vibration criteria of 5 mm/s (for 95 percent of blasts) as outlined in **Table 6.25**.

The predicted airblast levels for the closest private residence (ID 394), located 820 m from the Southern Extension Project, for the variable MICs assessed were 106 to 116 dBL. These overpressure levels apply only when blasting at the assessed MICs is undertaken in the northern-most corners of the Southern Extension Area. The modelling demonstrated that the airblast impact can be managed effectively via the application of lower MICs, including compliance with relevant criteria at Residence 394, which will be implemented by Castlereagh Coal when undertaking blasting in this area.

The predicted airblast levels for all private residential receivers within 1 to 3 km from the Southern Extension Project, for the variable MICs will be in the order of 89 to 112 dBL. Predicted airblast levels indicate that no exceedance of the required limit of 115 dBL (for 95 per cent of blasts) and 120 dBL (not to be exceeded) is predicted at surrounding private residences. It is noted that predicted ground vibration of less than 1 mm/s and airblast of approximately 100 dBL is predicted for private residences on the southern extent of Cullen Bullen, which is well below the applicable criteria as outlined in **Table 6.25**.

The Blasting impact assessment (refer to **Appendix 9**) also states that as mining progresses to greater depths, some topographical shielding will be created due to a change in the contours of the area. This will assist with controlling potential impacts associated with airblast and subsequently lessen the impact on the surrounding private residences.

6.8.3.2 Existing infrastructure

The potential impacts of blasting activities have been assessed in relation to the infrastructure identified in **Section 6.8.2.1** and shown on **Figure 6.20**. The ground vibration modelling undertaken included three different simulations involving the application of standard MICs which are representative of the design for blasting activities.

Public Infrastructure

The Castlereagh Highway is located a minimum of approximately 30 m from the pit boundary. At the critical distance of 30 m, lower MICs will be required to meet the vibration limit criteria. When blasting at further distances, i.e. in excess of 100 m, criteria can be met with the use of standard MICs. Through applying these blast design controls, the vibration impact can be managed effectively below the applicable vibration limit of 100 mm/s.

Boulder Road and the concrete overpass bridge located at 1.6 km and 1.7 km respectively from the pit will be exposed to vibrations below 2 mm/s. This is well below the vibration criteria for roadways and bridges of 100 mm/s.

Ground vibration modelling for the 11 kV powerline, indicates that the ground vibration impact can be managed effectively to a level below the applicable vibration limit criteria (i.e. 50 and 100 mm/s for tension and transmission towers respectively) via the application of lower MIC. This includes were blasting may be undertaken within 20 m of the power line.

Private infrastructure

The privately owned industrial storage sheds located approximately 820 m to the north of the Southern Extension Project on the Big Rim land will be exposed to vibrations no higher than 5 mm/s. This is well below the applicable criteria of 25 and 100 mm/s (for occupied and unoccupied respectively) industrial structures. Blasts will need to be designed to avoid impacts to Castlereagh Coal buildings and structures located at the Invincible Mine Infrastructure Area. These structures are located much closer to potential blast locations than the Big Rim infrastructure. Accordingly, the management of blasting to avoid impacts at the Invincible Mine Infrastructure Area will mean that impacts at Big Rim are likely to be significantly lower than predicted.

It is noted that a 66 kV power line is located within the Southern Extension Area, which is owned by Castlereagh Coal. Similarly, to the publicly owned 11 kV power line, blasting in proximity to this line will be managed to minimise impacts to this infrastructure.

Heritage sites

The vibration exposures for non-Indigenous heritage sites located within Cullen Bullen village (including Miners Cottages, the Royal Hotel and Cullen Bullen Public School) will be exposed to ground vibrations no higher than 0.8 mm/s. These sites are located at variable distances ranging from 2.7 km to 3.1 km from the Southern Extension Area.

Previously identified Sandstone Building Footings are approximately 1.7 km south of the Southern Extension Project and the maximum predicted exposure is 1.8 mm/s. All estimates are below the applicable criteria of 5 mm/s.

Pagodas

The closest sandstone pagoda is the Southern Pagoda located approximately 210 m from the mining area of the Southern Extension Project. It will be exposed to ground vibration levels no higher than 36 mm/s based on the maximum standard MIC. This is below the assessment criteria for pagodas of 50 mm/s. The Northern and Central Pagodas (located 320 m and 370 m distant from the Southern Extension Project respectively) will be exposed to vibration levels no higher than 18 and 15 mm/s respectively.

Based on the blast modelling, the vibration exposure for the cliff line can be managed effectively to below the applicable assessment criteria of 25 mm/s via the application of lower MIC. As outlined in the Blasting impact assessment (refer to **Appendix 9**) implementing an MIC of 175 kg fired at the edge of the pit is expected to generate no more than 22 mm/s at this location.

Notwithstanding these predicted results, Castlereagh Coal will commit to the ongoing monitoring of blast vibration levels at the closest pagoda sites and regular inspections to provide an ongoing assessment of structural integrity and condition over the life of the Southern Extension Project.

6.8.3.3 Flyrock

The Southern Extension Project will operate using a standard 500 m exclusion zone, which is considered appropriate for managing the risk of flyrock and is used widely across the mining and quarry industries. This will include the development and implementation of a road closure protocol for blasts undertaken within 500 m of the Castlereagh Highway. It is noted that blasting at Invincible has been previously undertaken within 500 m of the Castlereagh Highway and was effectively managed through a standard protocol and system of notices and signage.

In addition the exclusion zone will apply to a number of areas along established access paths to the Ben Bullen State Forest located within 500 m of the Southern Extension Area to the south and east. Public access to these tracks will also be managed in accordance with the Blast Management Plan and exclusion protocols.

The closest private residence (residence ID 394) is located approximately 820 m from the Southern Extension Project and all parts of the access road to this property are located in excess of 500 m. The issue of flyrock impact on adjacent residences is therefore considered to be fully managed and potential risks are considered negligible. As detailed in **Section 6.2**, a small area of cleared land on the southern extent of the Hillview property (residence ID 394) is located within 500 m of the Southern Extension Area. This will be managed through consultation with the landholder including the implementation of temporary restriction of access to this area and relocation of stock (as required) during times of blasting within 500 m of this property. This will be detailed in the updated Blast Management Plan (refer to **Section 6.8.4**).

6.8.3.4 Pagodas

In consideration of the distances and estimated vibration exposures, the detailed assessment (refer to **Appendix 9**) did not identify any major risks related to structural damage to the pagodas as a result of blasting associated with the Southern Extension Project. This included taking into consideration the current state of these structures, their substantial base and limited number of weaknesses. Based on the assessments and using recommended vibration limits, the risks are classified as negligible / low for the pagodas, and low / moderate for the cliff line (refer to **Appendix 9**).

6.8.4 Management and monitoring commitments

- As a result of the detailed Blasting impact assessment undertaken for the Southern Extension Project, Castlereagh Coal will update the existing Blast Management Plan to include the following management and monitoring:
    - blasting will be undertaken between 9.00 am and 5.00 pm (EST) Monday to Saturday
    - no more than 2 blasts per day or 5 blasts a week averaged over any 12 month period will be undertaken
    - Castlereagh Coal will offer structural inspections of any residence within 2 km of the Southern Extension Area to provide baseline assessment of the condition of these structures prior to blasting occurring
    - Castlereagh Coal will continue to notify landowner / occupier of all residences (who register to be notified) within a 3 km radius of the Southern Extension Project of the blasting schedule
    - Castlereagh Coal will publish the planned blast schedule and associated road closures on the Castlereagh Coal website at least a week in advance of the planned blasts
    - Castlereagh Coal will provide emergency services with details of planned road closures
    - Castlereagh Coal will provide emergency services with the contact details for relevant people at the mine site to enable blasts to be delayed or rescheduled in the event that emergency access along the Castlereagh Highway is required during a planned closure period
    - Castlereagh Coal will continue to undertake blasting activities in accordance with the Blast Management Plan which includes controls to ensure safety to people and property, control vibration and airblast emissions, minimise dust and fume emissions and minimise the cumulative effects of blasting
    - Castlereagh Coal will provide relevant environment groups and recreation groups with regular updates regarding proposed mining activities that may impact on access to parts of Ben Bullen State Forest. This engagement would include information about accessing details of the proposed blast schedule and associated exclusion zones and periods.
- Castlereagh Coal will update the existing Blast Management Plan to include the following controls relating to the Pagodas:
    - Castlereagh Coal will undertake a detailed structural integrity assessment of pagoda structures prior to undertaking any blasting within 500 m of a pagoda. This is to provide a baseline reference for ongoing monitoring and inspection of these sites over the life of the Southern Extension Project
    - Castlereagh Coal will commit to the ongoing monitoring of blast vibration levels at the closest pagoda sites and regular inspections to provide an ongoing assessment of structural integrity and condition over the life of the Southern Extension Project
    - An appropriate system of flyrock monitoring will be developed as part of the Blast Management Plan, including strict quality control measures during blast design and loading stages and adequate procedural requirements.

- Castlereagh Coal will update the existing Blast Management Plan to include the following controls relating to ground vibration:
    - Use of appropriate MIC design, i.e. avoid overcharging holes
    - Use of an appropriate initiation sequence to minimise the possibility of hole interactions thus avoiding a build-up in wavefront reinforcement.
- Castlereagh Coal will update the existing Blast Management Plan to include the following controls relating to airblast:
    - Use of appropriate MIC design, i.e. avoid overcharging holes, and the use of insufficient stemming column
    - Use of an appropriate initiation sequence to minimise the possibility of hole interactions thus avoiding a build-up in wavefront reinforcement
    - Ensure appropriate blast design around identified geological features to avoid face burst
    - Application of an appropriate quality stemming material and stemming height to enable correct confinement of explosives to minimise airblast emission
    - Maintain appropriate burden specification for the front row holes (to avoid face burst)
    - Use pre-blast procedure (including meteorological conditions review) to avoid blasting in unfavourable weather conditions.
- Castlereagh Coal will update the existing Blast Management Plan to include the following controls relating to flyrock:
    - Ensure appropriate blast design around identified geological features to avoid face bursts and potential flyrock incidents
    - Application of an appropriate quality stemming material and stemming height to enable correct confinement of explosives to minimise the possibility of stemming ejection / flyrock incidents
    - Maintain appropriate burden specifications for the front row holes (to avoid face bursts and related flyrock incidents).
- Castlereagh Coal will implement a Blast Monitoring System including:
    - Monitoring system for private residences will consist of two permanent monitoring stations:
        - The first station will be located at the closest residence to the north-west (i.e. ID 394) to represent the Cullen Bullen community
        - An additional monitoring station will be installed to provide adequate and representative coverage for the area. The recommended location for the monitor is either of the residences ID 392 or ID 426
        - The existing blast monitor located at BO1 in the south of Cullen Bullen village will be maintained during the early stages of proposed mining and removed if it is demonstrated that monitoring at ID 394 is effective in monitoring impacts at further locations.

- Periodic vibration monitoring of the pagodas and cliff line, including crack behaviour monitoring and surveys of the area, in particular of the damaged section of the cliff line (caused by inferred surface subsidence) will be required when blasting is within a 500 m metre radius of these sites

- Periodic monitoring of infrastructure, including the power line poles and Castlereagh Highway, will be required when blasting within 250 m with a MIC in excess of 130 kg, that is when vibrations are expected to be 10 mm/s or above, or when blasting within 100 m irrespective of the MIC.

- Castlereagh Coal will develop a pre-blast assessment protocol as part of the Blast Management Plan that minimises the impacts on the surrounding area

- Castlereagh Coal will incorporate the existing Invincible weather monitoring station into the pre-blast assessment protocol

- Castlereagh Coal will prepare a Road Closure Protocol in consultation with the relevant road authorities.

- Consult with Endeavour Energy in relation to the specific management measures relating to the 11kV power line.

6.9 Noise impact assessment

A comprehensive assessment of the potential noise impacts of the Southern Extension Project has been prepared by Umwelt. In addition to the operational noise from the Southern Extension Project, the Noise Impact Assessment (NIA) also takes into consideration construction and road impacts associated with the Southern Extension Project. The NIA also assesses the cumulative impact of all industrial noise sources in the area, considering the combined impacts of the Southern Extension Project and the surrounding approved mining operations. The NIA for the Southern Extension Project is included as **Appendix 10**. A summary of the key findings of the assessment is provided in this section.

The NIA has been undertaken in accordance with the NSW EPA *Draft Industrial Noise Guideline* (Draft ING) and other current and relevant guidelines and policies relating to environmental noise resulting from the Southern Extension Project, including:

- *NSW Road Noise Policy (DECCW 2011)*

- *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) (NSW) (2007)*

- *Voluntary Land Acquisition and Mitigation Policy for State Significant Mining, Petroleum and Extractive Industry Developments (NSW Department of Planning and Environment 2014).*

Given that the Southern Extension Project is a modification of the existing Invincible Project Approval, the existing approval requirements in relation to relevant noise criteria have been adopted for this assessment (refer to **Section 6.9.1**), which were determined in accordance with the existing Industrial Noise Policy (INP). The Draft ING has been used for the purpose of undertaking the NIA as it is expected that this will be the applicable policy for the management of noise over the life of the Southern Extension Project. As the assessment criteria determined under the methodology in the Draft ING and the existing Invincible Project Approval are the same for the day and evening periods in which the Southern Extension Project will be operational, the modification application does not seek and change to the existing noise criteria.

6.9.1 Existing Noise Criteria

The existing Invincible Project Approval contains various environmental performance conditions, including conditions 2 and 3 in Schedule 3 which are reproduced below as they relate to noise considerations.

Impact Assessment Criteria

2. *The Proponent shall ensure that the noise generated by the project does not exceed the noise impact assessment criteria set out in Table 2 at any residence on privately owned land, or on more than 25 percent of any privately owned land.*

Table 2: Impact assessment criteria dBA

Residence / Location	*Day*	*Evening*	*Night*
All privately owned land	*LAeq,15 minute*	*LAeq,15 minute*	*LAeq,15 minute*
	40	*35*	*35*

However, if the Proponent has a written negotiated noise agreement with any landowner and a copy of this agreement has been forwarded to the Department and DECC, then the Proponent may exceed the noise limits in Table 2 on that land in accordance with the negotiated noise agreement.
Notes:

- *To determine compliance with the LAeq,15minute noise limits, noise from the project is to be measured at the most affected point within the residential boundary, or at the most affected point within 30 m of the dwelling (rural situations) where the dwelling is more than 30 metres from the boundary. Where it can be demonstrated that direct measurement of noise from the project is impractical, the Department and DECC may accept alternative means of determining compliance (see Chapter 11 of the NSW Industrial Noise Policy). The modification factors in Section 4 of the NSW Industrial Noise Policy shall also be applied to the measured noise levels where applicable.*

- *These limits apply under meteorological conditions of:*
  - *wind speeds of 3 m/s at 10 metres above ground level; or*
  - *up to 3ºC/100 m temperature inversion strength for all receivers, plus a 2m/s source to receiver component drainage flow wind at 10 metres above the ground level for those receivers where applicable.*

Land Acquisition Criteria

3. *If the noise generated by the project exceeds the criteria in Table 3 at any residence on*

privately owned land, or on more than 25per cent of any privately owned land, the Proponent shall, upon receiving a written request for acquisition from the landowner, acquire the land in accordance with the procedures in the conditions 6-8 of schedule 4.

Table 3: Acquisition criteria dBA

Residence / Location	*Day*	*Evening*
All privately owned land	*LAeq,15 minute*	*LAeq,15 minute*
	45	*40*

There are two properties, (Hillview (Receiver ID 394) and Billabong (Receiver ID 393), which are currently identified as having acquisition rights under the Invincible Project Approval due to predicted exceedances of the acquisition criteria under the Invincible Project Approval. The development which was predicted to have noise impacts at these residences above criteria has now been completed in accordance with the existing Invincible Project Approval.

6.9.2 Project design process

Potential noise impacts were a key consideration in the design of the Southern Extension Project. Comprehensive noise modelling was completed on an iterative basis throughout the project design phase to develop a mine plan that would minimise noise impacts associated with the Southern Extension Project as far as practicable. Accordingly, through an early iterative modelling process, noise associated with the CAT 785 trucks, which were originally proposed to haul overburden, was identified as being a dominant noise source. Therefore, alternative CAT 777 (or acoustically similar) haul trucks have been incorporated into the design as a reasonable and feasible measure to minimise a key emission source. The CAT 777 truck (or similar) is approximately 10 dB(A) quieter than the CAT 785 and would therefore result in significantly reduced overall noise emission. An optimised rate of haulage to the northernmost emplacement area was also incorporated into the design.

Prior to the finalisation of the project design, production schedule and fleet requirements, a range of additional options were investigated to minimise, control or manage the noise impacts from the Southern Extension Project. In establishing the feasible and reasonable noise control measures that could be incorporated into the project design, a broad range of specific noise control measures were considered as part of the NIA (refer to **Appendix 10**).

Those controls that were found to be reasonable and feasible in relation to providing an effective control of potential impacts have been incorporated into the Southern Extension Project and included as part of the noise model for the Southern Extension Project.

6.9.3 Existing environment

6.9.3.1 Existing acoustic environment

A number of noise surveys have been carried out in the general area including noise surveys associated with Cullen Valley Mine, Invincible and Baal Bone Colliery. Given that there has not been any significant changes in the industrial noise environment in the locality in recent times (as most mining operations are on care and maintenance) the NIA has relied on previous noise monitoring and assessments to define the existing acoustic environment surrounding the Southern Extension Project.

The latest acoustic report prepared by Bridges Acoustics in 2014 represents the most recent study associated with Invincible prior to it entering onto care and maintenance. Within the report, background noise levels from the various surveys were collated and reviewed. Background noise levels tended not to lie below 30 dB(A) during the daytime but tend to be lower than 30 dB(A) during the evening and night-time periods. The assessment therefore adopted background noise levels of 30 dB(A) and 32 dB(A) daytime, dependent on the offset from Castlereagh Highway, and 30 dB(A) during the evening periods.

6.9.3.2 Existing meteorological conditions

Meteorological data has been assessed as part of the Air Quality Impact Assessment (refer to **Appendix 8**) which was analysed to establish the prevailing wind directions for the relevant daytime and evening periods, for each season.

Based on analysis of the wind data in accordance with Draft ING procedures, **Table 6.26** presents the prevailing wind directions and meteorological conditions used in the noise modelling (excluding identified prevailing west-south-west winds that blow away from the receivers and reduce noise). These are consistent with the day and evening modelled prevailing wind directions determined in the previous acoustic assessments (Acoustic Impact Assessment, Modifications to Cullen Valley Mine and Invincible Project Approvals, Environmental Impact Statement (Bridges Acoustics 2014)), based on analysis of site specific meteorological data derived from site monitoring undertaken in that study.

Table 6.26 Modelled Meteorological Conditions

Parameter	Day and Evening Periods	
	Calm	North-east Wind
Temperature (°C)	20	20
Relative Humidity (per cent)	70	70
Wind Speed (m/s)	0	3
Temperature Gradient (°C/100m)	0	0

Moderate and strong temperature inversions, particularly during the night-time period in winter, also have the potential to significantly enhance noise propagation, however no night-time operations are proposed for the Southern Extension Project, and therefore no further analysis in relation to this has been undertaken.

6.9.4 Operational noise assessment

6.9.4.1 Methodology and approvals

As part of the NIA, noise levels were predicted using RTA Technology's Environmental Noise Model (ENM) to determine the acoustic impact of mining operations. The indicative mine stage plan 1 is considered representative of potential worst case mining operations in closest proximity to private residences located to the north-west of the Southern Extension Area, and forms the basis of the modelling.

Two daytime operational scenarios have been modelled to represent the indicative mine plan stage 1 with overburden emplacement scenarios including:

- haulage of waste for emplacement to the area just north of the extraction area, which will occur as part of the progression of mining

- haulage of waste for emplacement to the area approximately 2 km north-east of the extraction area, adjacent to the eastern boundary of the site – it is noted that this will likely only occur in the later stages of mining where the mining activity is located a further 500 m away from private residences, however has been included as part of stage 1 mining to provide a potential worst case operational scenario with regards to potential noise impacts.

In accordance with the Draft ING procedures, reasonable and feasible noise mitigation measures including an optimised rate of haulage to the northernmost emplacement site have been incorporated into the mining process in combination with alternative and quieter haul trucks (i.e. CAT 777 fleet, or similar, in lieu of CAT 785).

In addition to the above scenarios, an operational scenario was modelled during the evening period, representing transportation of product from site, which is proposed to occur up to 9.30 pm.

The ENM includes predicted noise levels at each of the residences surrounding the Southern Extension Area to assess the noise impacts from operational components of the Southern Extension Project, the proposed equipment fleets and the relevant meteorological conditions for the area.

6.9.4.2 Modelling scenarios

The ENM noise models were run for daytime and evening operational scenarios of the Southern Extension Project, under calm and a prevailing noise enhancing northeast wind at 3 m/s.

The assumptions used in modelling the operational phase of the Southern Extension Project include the following:

- all acoustically significant plant and equipment operating simultaneously in accordance with the conceptual mining and maximum production schedule of up to 1.2 Mtpa
- mobile noise sources, such as front-end loaders, excavators and haul trucks modelled at typical locations and assumed to operate in repetitive cycles.

6.9.4.3 Noise criteria

The Project Noise Trigger Levels (PNTL), noise management level and noise affectation level have been determined in accordance with the requirements of the Draft ING.

With reference to the Draft ING, a daytime Rating Background Level of 35 dB(A) and evening and night Rating Background Levels of 30 dB(A) have been adopted for this project. This is based on the Draft ING requirement to set the Rating Background Level at 35 dB(A) during the day, and 30 dB(A) during the evening and night where background levels are below these levels. These represent the minimum Rating Background Levels that can be used for assessment of a development based on the Draft ING and are considered to be appropriate given the rural character of the area and low level of ambient noise.

Accordingly, the appropriate day and evening intrusiveness criteria are LAeq,15minute 40 dB(A), and 35 dB(A), respectively. These criteria are consistent with the noise criteria established under the existing Invincible Project Approval (refer to **Section 6.9.1**).

Table 6.27 outlines the PNTLs established for the Southern Extension Project.

Table 6.27 Project Noise Trigger Levels

Noise Parameter	Day	Evening
Intrusive Noise Level, LAeq(15min) – impact assessment	40	35
Intrusive Noise Level, LAeq(15min) – significant impact	45	40

Noise management zones

The Noise Management Zone in this NIA is applicable where the predicted noise levels exceed the PNTL by up to 5 dB. The noise impacts in this zone range from minor (up to 2 dB above) to marginal or moderate (greater than 2 dB up to 5 dB), dependent on the existing levels of industrial noise contributing to a receiver as defined in the VLAMP and as detailed in the NIA (refer to **Appendix 10**).

Management procedures that can be implemented in the Noise Management Zone include:

- prompt response to any issues of concern raised by community
- noise monitoring on-site and within the community
- refinement of on-site noise mitigation measures and plant operating procedures where practical
- consideration of acoustic mitigation at receivers (taking into consideration the guidance provided in the Draft ING on mitigation measures dependent on level of exceedance of PNTLs)the negotiation of private agreements with property holders.

Noise affectation zone

The Noise Affectation Zone in this NIA is applicable where the predicted noise levels are more than 5 dB above the PNTL. Noise emissions at this level are considered likely to be unacceptable by some property owners and implementation of the following measures may be required:

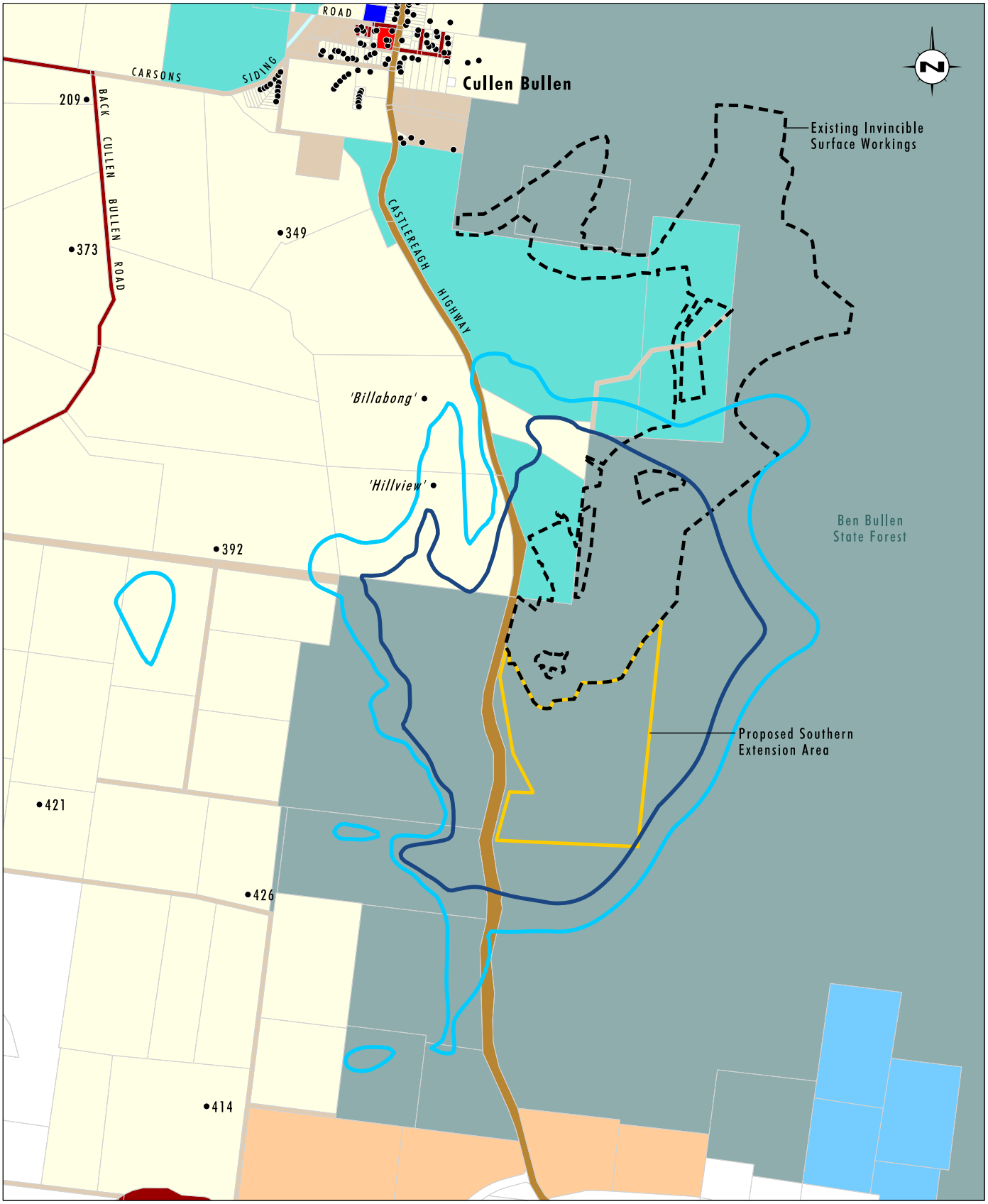
- discussions with relevant property holders to assess concerns and provide solutions
- implementation of acoustic mitigation at receivers or other negotiated agreement
- up front advice to property owners that they have the right to request acquisition in accordance with terms of any development consent.

Setting the Noise Affectation Zone based on exceedances of greater than 5 db(A) of the PNTL provided in **Table 6.28** is consistent with the relevant noise land acquisition criteria provided in the existing Invincible Project Approval (refer to **Section 6.10.1**).

As the development which gave rise to the noise impacts at Hillview (Receiver ID 394) and Billabong (Receiver ID 393) has been completed, the NIA has reassessed the predicted impacts at these properties associated with the Southern Extension Project, including the application of the voluntary acquisition or management rights under the VLAMP

6.9.4.4 Noise assessment findings

The NIA includes the prediction of noise levels from the Southern Extension Project at the nearest residential receiver locations identified on **Figure 6.21** under the meteorological conditions described in **Appendix 8** and **Appendix 10**. The predicted operational noise levels for the operational years modelled are presented in detail in **Appendix 10**.



Data Source: Sedgman (2016), LPI (2016)

0 0.25 0.5 1.0km

Legend

- Existing Approved Mining Disturbance Area
- Proposed Southern Extension Area
- Castlereigh Highway
- Centennial Pty Ltd
- Council
- Crown
- Crown/Council
- Cullen Bullen Primary School
- Delta Energy
- Minister for Education
- Private
- Rail Corporation NSW
- Shoalhaven Coal Owned
- State Forest
- State Government
- Wallerawang Collieries
- Not searched
- Private Residence
- 40dB LAeq 15mins
- 45dB LAeq 15mins

FIGURE 6.21

Predicted Worst Case Noise Impacts Southern Extension Project

File Name (A4): R02/3622_057.dgn
20160915 17.01

The predicted operational noise levels for the various daytime and evening scenarios are presented in **Table 6.28.**

Table 6.28 Predicted Site Noise Emissions

Residence ID	Daytime, Stage 1 Mine Plan , LAeq,15min, dB(A)		Daytime, Stage 1 Mine Plan (includes Overburden Haulage to North-east Void Area) LAeq,15min, dB(A)		Evening, Product Transportation LAeq,15min, dB(A)	
	Calm	3m/s NE Wind	Calm	3m/s NE Wind	Calm	3m/s NE Wind
349	33	32	33	33	20	19
393	35	34	36	39	25	23
394	**43**	**42**	**44**	**44**	35	32
392	30	37	30	38	20	27
373	30	33	29	33	15	17
388	25	36	25	36	13	22
391	26	37	26	37	14	25
412	26	38	26	37	13	27
404	22	34	23	33	8	21
419	21	32	21	31	10	19
421	21	31	21	30	10	19
426	27	32	27	33	18	24
Criterion (Draft ING)	**40**	**40**	**40**	**40**	**35**	**35**
Criterion (PA070127)	**40**	**40**	**40**	**40**	**35**	**35**

Note: Noise levels above the noise criterion shown in bold text.

During the daytime period, the Southern Extension Project will achieve the daytime target PNTL at all residential receiver locations except Receiver 394 (Hillview). Under the VLAMP 2014, Receiver 394 (Hillview) will qualify for voluntary mitigation measures if requested by the landowner. The mitigation measures would be implemented in accordance with the procedure set out in the VLAMP 2014. Castlereagh Coal may negotiate an alternative agreement with the property owner.

The Southern Extension Project will not trigger voluntary property acquisition in accordance with requirements of the VLAMP at any property. As outlined **Appendix 10**, this includes consideration of the extent of noise contours over private land, with the NIA identifying that no private land will have greater than 25 per cent of it affected by significant noise impacts as defined in the VLAMP.

This is a reduction in noise impacts associated with the existing approved (but completed) Invincible operations under the existing Invincible Project Approval. Neither Residences 393 (Billabong) nor 394 (Hillview) are predicted to have noise impacts associated with the Southern Extension Project which would qualify the properties for voluntary acquisition rights under the VLAMP. On the basis of the lower predicted noise impacts associated with the Southern Extension Project, it is proposed that the acquisition rights for these residences be removed from the Invincible Project Approval as part of this modification. Mitigation Rights would be retained for the owners of Residence 394 (Hillview) but not Residence 393 (Billabong).

During the evening period the Southern Extension Project will achieve the evening target PNTL at all residential receiver locations. It is acknowledged from engagement with the community, that there have been concerns expressed with regards to potential noise from maintenance activities completed during the evening period (i.e. up to 10.00 pm). As such, Castlereagh Coal has committed to a number of controls to specifically mitigate this issue and will continue to monitor the noise impacts in accordance with the Noise Management Plan (refer to **Section 6.9.9**).

Some limited activities may occur on the site outside the proposed operating periods of 7.00am and 10.00pm Monday to Saturday. These activities include some pre-start checks and environmental management activities such as pumping from sedimentation dams to storage areas during wet weather. These activities will be managed to ensure compliance with night-time criteria of 35 dB(A).

6.9.5 Low frequency noise

As part of the NIA an assessment of the potential effect of low frequency noise has been undertaken in accordance with the requirements of the Draft ING, which determined that LFN is not expected to contribute significantly to noise emissions from the Southern Extension Project.

6.9.6 Construction noise

Construction noise activities on site are expected to be minimal given that the infrastructure for the Southern Extension Project is already in place. For the purposes of assessment, a small construction period of up to three months has been identified, which would consist of upgrade and maintenance works on existing site infrastructure, including the Invincible CPP. This activity would require additional construction related employee traffic (up to 10 vehicles a day) and a number of equipment deliveries such as truck delivery of materials and equipment (expected to be up to 24 in total over this period). Noise emissions associated with such activities is relatively minimal, particularly when compared with the operational phase, which would be occurring concurrently with this construction period. All construction activities associated with the Southern Extension Project will be managed to ensure compliance with operational noise criteria applicable at the time the construction and maintenance activities are being undertaken. In addition, the traffic assessment (refer to **Section 6.11**) indicates that construction related traffic would involve a minimal increase in traffic during this short term period.

6.9.7 Road noise

The Department of Environment, Climate Change and Water (DECCW) (now EPA's) NSW Road Noise Policy (DECCW 2011) sets out criteria for road traffic noise through the provision of a framework that addresses traffic noise issues associated with new developments, new or upgraded road developments or planned building developments. The predicted road traffic noise impacts at closest receivers and the relevant assessment criteria are presented in **Table 6.29**.

The primary access route to Invincible will be from the south along Castlereagh Highway. Castlereagh Highway is defined as an arterial road. The relevant road noise impact assessment criteria are outlined in **Table 6.29**.

Table 6.29 Road Noise Criteria, dB(A)

Road Category	Type of Project/Land Use	Assessment Criteria, dB(A)	
		Day (7.00 am – 10.00 pm)	Night (10.00 pm – 7.00 am)
Freeway/arterial/ sub-arterial roads	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	LAeq, 15 hour 60 (external)	LAeq, 9 hour 55 (external)

The potential traffic related noise impacts are associated with employee traffic and heavy vehicle traffic associated with product coal transportation to Mt Piper Power Station and to Shoalhaven Starches Plant. As outlined in **Section 3.0**, as part of the Southern Extension Project the proposed employee levels and product coal transportation will be in accordance with existing approved levels. Accordingly, traffic related noise impacts associated with the Southern Extension Project will be consistent with existing approved operations.

The transport route for coal transported to Mt Piper Power Station does not pass any residences or sensitive receivers. The Southern Extension Project will also include the transportation of nut coal to the Shoalhaven Starches Plant located at Bombaderry, approximately 300 km from Invincible. Based on maximum nut coal production levels, transport will be in the order of up to 10 additional heavy vehicle movements each way per day along the Castlereagh Highway and Great Western Highway between Invincible and Mount Victoria (from Mount Victoria to Bomaderry, the transport route for coal will be identical to that currently used for the transport of nut coal from Clarence and the Southern Extension Project will therefore not result in any change in traffic noise impacts along this section of the transport route). As outlined in **Section 6.11** this will not be a significant increase in heavy vehicle traffic along the Castlereagh Highway, and will be an insignificant continuation to traffic to the major arterial roads between Invincible and Mount Victoria along the Castlereagh Highway and Great Western Highway. Based on this assessment, it is considered that the potential impacts associated with additional coal transportation on road traffic noise levels will not be significant.

6.9.8 Cumulative noise assessment

Cumulative noise impacts that may arise from the Southern Extension Project operating in conjunction with other existing developments in the area have been considered as part of the NIA, in accordance with the Draft ING. The cumulative noise assessment considered noise generated by the simultaneous operation of other nearby approved mines including Cullen Valley Mine (currently on care and maintenance), Baal Bone Colliery (currently on care and maintenance), along with Mt Piper Power Station, including the Mt Piper Extension Project.

In accordance with the Draft ING, whilst an individual operation should not exceed its respective project amenity noise level, the cumulative LAeq, period noise levels from multiple industrial noise sources should not exceed the recommended amenity noise levels appropriate for the locality and land use. Within the rural area, the cumulative daytime and evening noise levels should not exceed 50 dB(A) and 45 dB(A) respectively (refer to **Table 6.30**).

The estimated cumulative noise levels are presented in **Table 6.30** are based on worst-case noise levels under prevailing wind conditions from the Southern Extension Project. These levels are considered to be conservative as they are based only on attenuation due to geometric spreading of the noise energy and do not account for the additional attenuation from ground effect, any acoustic shielding from intervening terrain or atmospheric absorption over the additional distance. Furthermore, the cumulative noise levels are generally based on worst-case meteorological conditions, which cannot occur at the same time at all locations, but for the purpose of this assessment has been conservatively assumed.

Table 6.30 Cumulative Noise Levels

Receiver	Daytime Noise Contribution Contribution, LAeq, 11hour, dB(A)				
	Invincible	Mt Piper Power Station and Extension	Baal Bone	Cullen Valley	Total Cumulative Level
349	31	24	29	11	34
393	39	27	25	8	39
394	42	27	27	8	42
392	36	27	27	8	37
391	35	26	26	9	36
412	36	27	25	8	37
404	22	25	25	7	29
426	31	30	25	6	34

Note 1- In accordance with Draft ING, the LAeq,11hour daytime amenity noise levels have been estimated by subtracting 2 dB(A) from the LAeq,15minute noise levels. 2- Cullen Valley and Baal Bone are both on care and maintenance.

Table 6.30 shows that the cumulative noise levels are well within the relevant 50 dB(A) daytime cumulative amenity noise level recommended in the Draft ING for rural receivers.

6.9.9 Management and monitoring commitments

The Draft ING requires that, when predicted noise levels exceed the PNTLs, a range of strategies should be considered where feasible and reasonable to reduce the noise impact on off-site receivers. The three main strategies that may be used to identify reasonable and feasible noise control and mitigation strategies have been outlined in **Section 6.9.2**.

6.9.9.1 Noise management measures

The identification and assessment of reasonable and feasible noise controls have been considered throughout the project design process and incorporated into detailed noise modelling (refer to **Section 6.9.2**). The incorporation of these reasonable and feasible controls has reduced the predicted noise impacts of the Southern Extension Project as far as practicable.

- Castlereagh Coal will consider implementing the following general noise management measures where feasible and reasonable:
    - consideration of noise minimisation when selecting new plant and equipment
    - the maintenance of product stockpiles in strategic locations, where practicable, shielding product trucks and product loading equipment
    - the use of broad band reversing alarms instead of beeper style alarms on all mobile equipment
    - the management of mobile machines during adverse weather conditions when wind conditions enhance the noise propagation towards sensitive receiver locations. In order to minimise noise impacts, this would likely include:
        - where possible, not operating a dozer for shaping during rehabilitation at the northernmost emplacement site under adverse weather conditions
        - moving extraction activities to locations deeper in the pit during adverse weather conditions
        - shut down of some equipment and activities during adverse weather conditions, if required, in particular haulage of overburden to the emplacement areas.
- Castlereagh Coal is committed to ensure the ongoing effective operation of these noise control measures through:
    - regular inspection and maintenance of noise management processes (as informed by ongoing regular noise monitoring (refer to **Section 6. 10.9.3**)
    - implementation of a process for periodic review of noise performance of equipment. This process will be outlined in a Noise Management Plan to be prepared for the Southern Extension Project (refer to **Section 6.10.9.2**).
- If during the course of operations, individual residential receivers are found to exceed relevant noise criteria, in addition to the management of operational noise levels outlined above, additional management procedures that can be implemented include:
    - prompt response to any issues of concern raised by community
    - additional targeted noise monitoring on-site and within the community
    - Castlereagh Coal will refine on-site noise mitigation measures and plant operating procedures where practical, specific to the transmission of noise to the affected receiver.

- Castlereagh Coal will develop and implement an updated Noise Management Plan (NMP) for the Southern Extension Project. The NMP will detail the implementation of environmental management controls to be utilised to manage potential noise impacts associated with site operations. The NMP will, at a minimum, include:

    - noise objectives and targets consistent with the Invincible Project Approval and EPL

    - noise mitigation measures, referencing relevant operating procedures with documented controls. The suitability of the noise management controls is to be assessed on an annual basis as part of ongoing review of operational risks to the Southern Extension Project

    - provision of general noise awareness training for operational staff, which identifies site specific objectives and targets for noise management, potential noise impacts, environmental commitments for the colliery and obligations in respect of noise management

    - noise monitoring processes to be implemented over the life of the Southern Extension Project to provide for ongoing noise performance monitoring and determination of compliance with relevant noise criteria provided in the Invincible Project Approval and EPL (refer to **Section 6.10.1**)

    - mechanisms for stakeholder consultation

    - complaint handling processes including maintenance of a 24 hr Community Contact Line which will be in operation during operating hours

    - a roles and responsibilities matrix, with responsibilities being clearly defined through all levels within the operation as this relates to the control and management of noise.

6.9.9.2 Noise monitoring

- Castlereagh Coal will develop and implement a noise monitoring program on a quarterly basis comprising of day time operations and if/when undertaken, evening operations. Noise monitoring locations will be developed based on suitability and available land access, however, would ideally assess noise impacts at a number of the nearest sensitive receivers (for example, 393, 394 and 392). The monitoring program will include:

    - attended noise monitoring to measure ambient noise levels in the surrounding region and determination of the Southern Extension Project's contribution to measured noise levels

    - comparison of the attended noise monitoring results with predicted noise levels from the Southern Extension Project under similar meteorological conditions, and relevant Invincible Project Approval and EPL noise limits

    - assessment of performance of noise control measures and recommendations for additional measures if required.

6.10 Social

A Social Impact and Opportunity Assessment (SIOA) was undertaken for the Southern Extension Project to identify and assess potential social impacts and opportunities (refer to **Appendix 11**). The SIOA integrates assessment of project details, data relating to the existing community, and issues and concerns of local landholders and other key stakeholders to develop a layered picture of the potential social risks, impacts and opportunities that arise as the result of the Southern Extension Project and to identify management and enhancement strategies to address these. The full SIOA report is included as **Appendix 11,** with a summary of the key findings included in this section. Further detailed information regarding stakeholder engagement is included in **Section 5.0**.

6.10.1 Methodology

The SIOA adopted a risk-based framework that assessed the impacts that may arise as a result of the Southern Extension Project. The framework assessed each potential impact, taking into consideration:

- the importance of each theme for stakeholders as identified through the engagement program, with the level of perceived stakeholder concern rated according to the following categories:
    - high (red) - high level of current or potential for future concern
    - moderate (amber)– moderate level of current or potential for future concern
    - low (green) – low level of current or potential for future concern.
- the assessment of social risks and impacts, including review and analysis of relevant secondary data, and identification of any opportunities that arise within each theme
- the outcomes of specialist environmental studies that have implications for the SIOA
- current and proposed mitigation and management measures to improve project design and operation and also social/community impact outcomes.

6.10.2 Assessment of social impacts and opportunities and management approaches

Impact themes have been separated into two broad categories (refer to **Table 6.31**):

- social amenity impacts - impacts that relate primarily to the change in land use within the immediate locality, such as dust, noise, blasting, land management, etc. These impacts are largely localised and nearby residents are usually the most significantly impacted
- impacts to community sustainability, values and place - impacts felt more widely, such as population movements or changes to the economy, as well as less tangible psychosocial aspects of change, ranging from the stress of change, to how people value their homes and surroundings through to the sustainability of communities as a whole.

Table 6.31 Assessed Impact Themes

Community Sustainability, Values and Place Impacts	Social Amenity Impacts
Population change	Land management and future land use
Impacts on housing availability and community infrastructure	Blasting
Economic impacts	Traffic
Sense of community	Air quality (dust)
Recreational and environmental values	Noise
Community sustainability	Visual impacts
	Other environmental impacts, such as those to water, biodiversity and GHGs

Table 6.32 provides a summary of the results of the SIOA, with impact themes colour coded in relation to the level of anticipated risk identified by stakeholders.

Table 6.32 Summary of Mitigated Impacts of the Southern Extension Project

Project Aspect	Perceived Stakeholder Risk	Mitigated Technical Risk	Mitigation and Management Measures
Community Sustainability, Values and Place Impacts			
Population Change	High (positive)	Low	Castlereagh Coal will endeavour to source all employees from the local area. Recognising that some skilled roles may not be available from within the local area, Castlereagh Coal anticipate that approximately 80% of employees will be able to be sourced from the local area To assist in achieving this level of employment from the local area, the following strategies will be implemented: • a mechanism for locals to register their interest in employment opportunities will be developed and advertised. • Where possible, roles which do not require specific qualifications or prior mining experience will be made available to persons who can be trained 'on the job'. • apprenticeship opportunities for both mining, maintenance and processing roles will be investigated In addition to the above, employees recruited from outside the local area will be encouraged to reside locally via an Employee Recruitment Policy.

Project Aspect	Perceived Stakeholder Risk	Mitigated Technical Risk	Mitigation and Management Measures
Housing and Infrastructure	Low	Low	No further management approaches are recommended from a social perspective.
Economic Impacts	High (positive)	Low	Where possible Castlereagh Coal will support local business by: • Identifying local suppliers and services providers • Hosting an information session to outline company needs and procurement processes • Where possible using local and regional suppliers.
Sense of Community	High (positive)	Medium (positive)	Castlereagh Coal will: • Focus and invest in local employment • Maximise local and regional spend. Engage regularly with the CCC and community to ensure sense of community is maintained e.g. quiet and peaceful integration with the surrounding land uses.
Recreational and Environmental Values	Medium	Low	The design of the Southern Extension Project has taken into account issues raised in previous applications including: • site selection and mine planning to avoid areas of higher biodiversity value • minimising potential impacts on threatened species habitat through set backs from pagodas • size of blasts designed to avoid impacts on pagodas • offsetting residual biodiversity impacts in accordance with the FBA. In addition to these considerations Castlereagh Coal provide environment and recreation groups with regular updates regarding proposed mining activities that may impact on access to parts of Ben Bullen State Forest. This engagement would include advice regarding how to obtain details of proposed blast times and associated exclusion zones and periods.

Project Aspect	Perceived Stakeholder Risk	Mitigated Technical Risk	Mitigation and Management Measures
Community sustainability – Cullen Bullen	High (positive)	Medium (Positive)	Castlereagh Coal will not only contribute locally via employment, but become involved in the community where possible via: • Volunteering in local improvement initiatives e.g. Tidy Towns • Participating in local events e.g. Speedway, Progress Association • Using local facilities e.g. Cullen Bullen Community Hall, Cullen Bullen Primary School, Cullen Bullen Hotel.
Community sustainability – Lithgow LGA	Low	Low	Given the local impacts of the Southern Extension Project, management measures will be focused on the Cullen Bullen community
Social Amenity Impacts			
Land management and future land use	High	Low	A number of plans apply including the Landscape Management Plan and the Rehabilitation Strategy (refer to **Section 6.19**). In addition there will be: • no final voids • disturbed areas will be revegetated using local endemic species • ongoing review of planting mixes including consideration of percentages of acacia species or increased percentages of other potential pioneer species which can be used in the rehabilitation seed mix. In addition site visits will be undertaken regularly by the CCC to track progress of rehabilitation activities across the site.

Project Aspect	Perceived Stakeholder Risk	Mitigated Technical Risk	Mitigation and Management Measures
Blasting - impact on Pagodas	Medium	Low	A series of on-site and other management protocols will be observed as per **Appendix 9**. In addition to these, management practices that may impact the general community will include periodic road closures as discussed within **Section 6.8**. Blasting will be limited to 9.00 am - 5.00 pm. Monday to Saturday. There will be no more than 2 blasts per day and 5 per week averaged over 12 months. Castlereagh Coal will offer all private landholders located within 2 km of the Southern Extension Area a property inspection prior to the commencement of blasting in order to establish the baseline condition of private structures. Castlereagh Coal has also committed to implement a blast notification procedure so that the community, including emergency services, are informed of upcoming blasts (refer to **Section 6.8**). Road closure signage will be placed at locations on Castlereagh Highway that enable traffic to detour around road closures.
Blasting - impact on Local Residences	Medium	Low	
Traffic	Medium	Low	A series of management protocols will be observed as per **Appendix 12** in conjunction with Public Safety commitments refer to **Section 6.17.2**. In addition to these, in accordance with existing Invincible Project Approval requirements, Castlereagh Coal will maintain the use of a wheel wash for trucks to reduce mud on the highway. Employee traffic will be dependent upon their place of residence, however driver education will be included as part of a broader safety program.
Dust emissions	Low	Low	No further air quality management measures are required from a social perspective. See proposed air quality controls in **Section 7.7**.
Visual changes	Low	Low	No further visual management measures are required from a social perspective. See proposed visual controls in **Section 7.15**.
Noise emissions	Low	Low	No further noise management measures are required from a social perspective. See proposed noise controls in **Section 7.9**.
Impact on Ecological values	Low	Low	No further ecological management measures are required from a social perspective. See proposed controls in **Section 7.4**.

Project Aspect	Perceived Stakeholder Risk	Mitigated Technical Risk	Mitigation and Management Measures
Impact on Water (ground and surface)	Low	Low	No further water management measures are required from a social perspective. See proposed water controls in **Section 7.2** and **7.3**.
Greenhouse gases	Low	Low	No further GHG management measures are required from a social perspective. See proposed GHG controls in **Section 7.13**.

6.10.2.1 Voluntary planning agreement

As part of the modification application Castlereagh Coal recognises the opportunity to contribute to the future development of the local area through entering into a Voluntary Planning Agreement (VPA) for the Southern Extension Project. Based on the assessed low levels of impact on the population and community infrastructure, this contribution will focus on local level infrastructure provision. Castlereagh Coal will enter into discussions with Lithgow City Council to determine the form and content of the VPA for the Southern Extension Project.

6.10.3 Monitoring and evaluation

- Castlereagh Coal will undertake the following monitoring commitments in relation to the SIOA, including:
    - key areas of predicted impact, including perceived and experienced social impacts, through consultation with neighbouring and other nearby landowners, to monitor if experienced impacts are in line with predicted impacts
    - evaluation of actions and investments to assess the outcomes of key projects and programs arising from:
        - commitments made within the SIOA
        - any wider community development or partnership programs at an operational or corporate level
        - voluntary Planning Agreement (VPA) for the Southern Extension Project.
    - Development of a program for monitoring any other social impacts predicted in the current assessment and identification of any unforeseen social impacts, should they occur
    - Consideration of SIOA outcomes in the preparation of the site specific engagement strategy so that relevant stakeholders, including neighbouring and nearby landholders, are properly informed regarding current and future operations.

6.11 Traffic impact assessment

A comprehensive Traffic Impact Assessment (TIA) has been prepared by Transport and Urban Planning Pty Ltd (TAUP) (refer to **Appendix 12**). The traffic to be generated by the Southern Extension Project will be consistent with existing approved operations at Invincible with employee numbers and total product coal not exceeding the current approved levels. As such the TIA has reassessed the traffic associated with the Southern Extension Project against current and projected traffic conditions on the surrounding road network. The TIA has been undertaken in accordance with the requirements of relevant guidelines including the Roads and Traffic Authority's (now RMS) Guide to Traffic Generating Developments October 2002.

Castlereagh Coal has undertaken an extensive community engagement program as part of the Southern Extension Project (refer to **Section 5.0**). This program identified that transport planning was perceived as an important issue/impact for both neighbouring landholders and the local community more broadly. Key issues raised by the community were impacts on travel time due to road closures associated with blasting and concerns about mud on the road from trucks leaving Invincible. These concerns were informed by past experiences in relation to the operation of the site under former mine ownership.

Castlereagh Coal has designed the Southern Extension Project to minimise impacts associated with traffic and transport, with a range of mitigation and management measures incorporated into the Southern Extension Project design. These measures are outlined in **Section 6.11.3**.

6.11.1 Existing traffic conditions

The existing road network surrounding the Southern Extension Project includes the Castlereagh Highway, Invincible Mine Access Road, Boulder Road and Mt Piper Power Station Access Road off Castlereagh Highway (refer to **Figure 6.22**). The transport routes between Invincible Mine and Bomaderry involve the State road and highway road network including Castlereagh Highway, Great Western Highway, State roads and Motorways in the Sydney metropolitan area and the Princes Highway.

Traffic related to the Southern Extension Project will access Invincible via the existing Invincible Mine Access Road, however, due to height restriction at the main access, oversize equipment and deliveries will enter the site via the Big Rim access road located approximately 1 km to the north of the main mine access point (refer to **Figure 6.22**). A detailed description of the existing local road network is provided in **Appendix 12**.

As part of the TIA for the Southern Extension Project, traffic count data was analysed to characterise existing traffic generation patterns in the vicinity of Invincible. This included the analysis of traffic count data collected from three sites (refer to **Figure 6.22**), including the key intersections relevant to the Southern Extension Project. The existing traffic volumes obtained from these traffic count surveys are summarised in **Appendix 12**. In addition road traffic levels associated with the approved, but not operating, Cullen Valley Mine, have been incorporated into the TIA (refer to **Appendix 12**).

The existing local road network experiences peak hour flows in the morning between 8.00 am and 9.00 am. The afternoon peak hour for Castlereagh Highway/Invincible intersection occurs between 3.15pm and 4.15pm and at the Castlereagh Highway/Boulder Road intersection between 3.00 pm and 4.00 pm.

6.11.1.1 Principal intersections and current performance

The principal intersections associated with the Southern Extension Project are:

- Castlereagh Highway/Invincible Mine Access Road/Ivanhoe Mine Access

- Castlereagh Highway/Boulder Road
- Boulder Road/Access Road to Mt Piper Power Station's Coal Area.

The locations of these principal intersections are illustrated on **Figure 6.22** and are discussed in more detail below.

Castlereagh highway/Invincible mine access road/Ivanhoe mine access

The Castlereagh Highway between the Invincible Mine Access Road and Boulder Road has significant traffic management including sections of two lanes provided in each direction, to cater for truck movements travelling between Invincible and Boulder Road. In the two lane sections, Castlereagh Highway has two travel lanes (one in each direction), wide sealed shoulders with marked centreline and edgelines, together with guideposts and reflectors. Guardrail and wire fencing is provided in those sections where required, together with advisory warning signs and directional signposting. Existing signage is in place on this section of Castlereagh Highway to notify of temporary road closures associated with blasting at Invincible.

The Invincible Mine Access Road intersects Castlereagh Highway on its eastern side and forms a channelised intersection. The Invincible Mine Access Road provides vehicle access to the mine's infrastructure and has separate road carriageways for inbound and outbound vehicles. Very small numbers of vehicles are currently entering and exiting the Invincible Mine at the present time, reflective of the care and maintenance status of the operation. Ivanhoe Mine Access Road also intersects Castlereagh Highway on the western side at this location. Ivanhoe Mine is closed and currently undergoing rehabilitation. As such, the Ivanhoe Mine Access Road is not currently used and is unlikely to be used by large volumes of traffic during the life of the Southern Extension Project.

Due to the low levels of existing traffic turning at this intersection at the present time, the intersection is currently considered to operate at a very good level of service (LOS).

Castlereagh highway/Boulder road

Boulder Road forms a channelised T junction intersection with Castlereagh Highway on its western side. Boulder Road provides a road link to Portland and also vehicle access to Mt Piper Power Station. In the section adjacent to Mt Piper Power Station, Boulder Road is a two lane road (single lane in each direction) and has a posted speed limit of 60 km/h.

This intersection currently operates at LOS A with low vehicle delays to the minor traffic movements that are subject to priority control.

Boulder road/Access road to Mt Piper power station's coal area

The access road to the coal storage area for the Mt Piper Power Station is located approximately 280 m west of the Castlereagh Highway (refer to **Figure 6.22**). This access road forms a T junction with Boulder Road. At the time of surveys, there was no receipt of coal at Mt Piper by truck and the intersection was not being used. At present, all coal received by Mt Piper Power Station is via conveyor from Springvale Mine. Angus Place Colliery is currently on care and maintenance. There is a private haul road between Angus Place Colliery and Mt Piper. Should operations recommence at Angus Place Colliery, any coal supplied to Mt Piper by Angus Place would be via the private haul road. Cullen Valley and Invincible are the only approved suppliers of coal to Mt Piper which would use the Castlereagh Highway and the Boulder Road intersection to transport coal to Mt Piper.

Due to the low levels of existing traffic turning at this intersection at the present time, the intersection is currently considered to operate at a very good level of service.

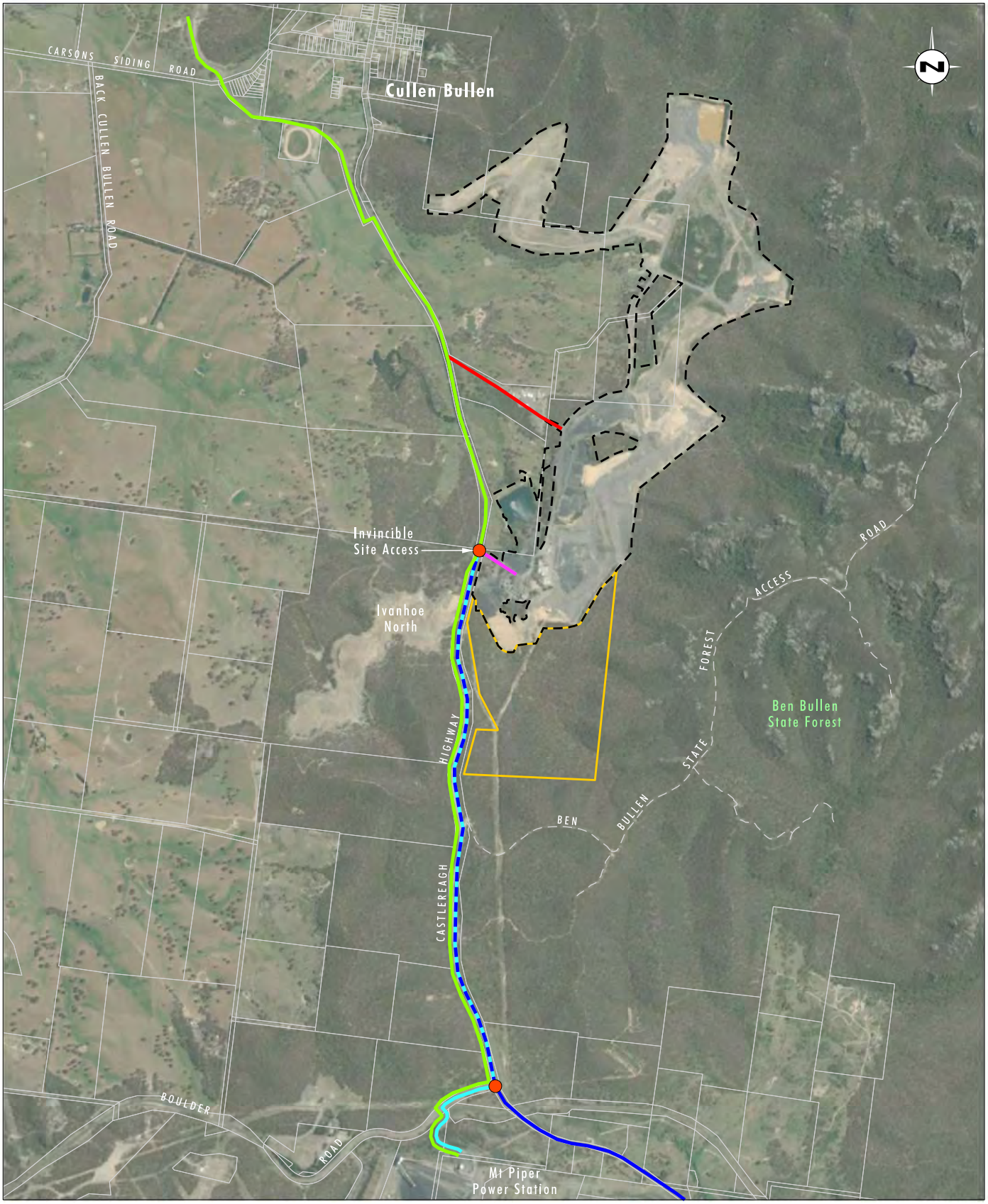


Image Source: Google Earth - CNES/Astrium (Nov 2014)
Data Source: LPI (2009)

0 0.5 1.0 1.5km

Legend

- Existing Approved Mining Disturbance Area
- Proposed Southern Extension Area
- Mine Access
- Access Through Big Rim (Oversize)
- Transport Route to Mt Piper Power Station
- Transport Route to Bomaderry
- Transport Route from Cullen Valley Mine
- Traffic Count Location

FIGURE 6.22

Local and Regional Road Network

File Name (A4): R02/3622_092.dgn
20160915 17.04

6.11.2 Potential transport impacts

The Southern Extension Project will require a peak operational workforce of up to 35 full time staff and up to an additional 4 contractors will be employed on a part time basis. Visitors to the mine are expected to average approximately 5 per day. The mine will operate on a single production shift commencing at 7.00 am and finishing at 6.00 pm Monday to Saturday.

The Southern Extension Project may require an additional construction workforce of approximately 10 employees associated with minor upgrade and maintenance works to existing infrastructure. The construction period is unlikely to be more than three months in duration.

Transport hours for coal haulage will be 7.00 am –to 9.30 pm Monday to Saturday, excluding Sundays and public holidays.

On weekdays and Saturdays, the Southern Extension Project is expected to generate up to:

- 39 employee trips at shift time changes with a total of 78 two way trips per day (i.e. 39 in / 39 out). These will be light vehicle trips

- Up to 5 visitor trips per day which will also be light vehicle trips (i.e. 5 in / 5 out)

- 146 coal haulage loads per day from the site (i.e. 146 in / 146 out) which will be heavy vehicles (i.e. 19 metre long semi trailer vehicles)

- potentially 7 heavy vehicle loads per day entering the Southern Extension Area from Cullen Valley Mine (ie. total of 14 truck trips per day with return trips (unladen) based on 7 in / 7 out (refer to **Section 2.2.1**) and

- Up to 5 heavy vehicles (i.e. Austroad Class 3-12) associated with maintenance and deliveries (i.e. 5 in / 5 out).

For the purposes of this assessment a maximum production scenario has been assumed and average traffic in order to identify the potential worse case traffic impacts that may occur over the life of the Southern Extension Project.

6.11.2.1 Operational traffic impacts

During the operational phase of the Southern Extension Project, the greatest potential for impact is associated with coal haulage from Invincible and other heavy vehicle movements. It is estimated that on an average weekday 138 laden truck movements will be generated from the Southern Extension Project and a further 12 laden trucks will enter the site comprising (on average). Average daily heavy vehicle movements are summarised below:

- 136 loads travelling between the Southern Extension Area and Mt Piper Power Station (i.e. total of 272 truck trips per day with return trips based on 136 inbound and 136 outbound movements) with no more than 146 coal laden outbound trips per day and no more than 16 coal laden outbound trips per hour.

- 10 loads per day travelling between the Southern Extension Area and the Shoalhaven Starches Plant at Bomaderry (i.e. total of 20 truck trips per day with return trips based on 10 in / 10 out).

- Potentially 7 loads per day entering Invincible Mine from Cullen Valley Mine (i.e. total of 14 truck trips per day with return trips (unladen) based on 7 in / 7 out) (refer to **Section 2.2.1**).

- Up to 5 heavy vehicles (i.e. Austroad Class 3-12) associated with maintenance and deliveries (i.e. 5 in / 5 out).

The majority of the coal truck trips (approximately 93 per cent) assessed in the traffic assessment will occur on the adjacent road network to Invincible using Castlereagh Highway and a short section of Boulder Road to Mt Piper Power Station. The TIA has also conservatively considered the impact associated with approved truck movements from Cullen Valley Mine along the Castlereagh Highway between the Cullen Valley private haul road and Mt Piper Power Station. These truck movements are unlikely to eventuate in practice as Castlereagh Coal do not have existing plans to concurrently mine both operations and wash Cullen Valley coal at Invincible.

Castlereagh Highway is constructed to a high standard with a high level of traffic management including the intersection treatments at principal intersections. The impacts of the coal trucks using these roads will be the same as what has previously occurred on the road network and is assessed as satisfactory.

Impacts on key intersections

The TIA utilised a SIDRA model analysis to assess the performance of the key intersections during operation of the Southern Extension Project. SIDRA is preferred by the RMS for intersection modelling and was used to provide key indicators for delay, queuing and average speed of the key intersection associated with the Southern Extension Project, based on morning and afternoon peak periods. RMS Guidelines indicate that a Level of Service D operation or better (i.e. A, B, C or D) is desirable design criteria for intersections.

SIDRA traffic modelling was undertaken for peak periods being between 3.00 pm and 4.00 pm at Boulder Road intersection and between 3.15 pm and 4.15 pm at the Invincible Mine Access Road intersection. Refer to **Appendix 12** for the full SIDRA traffic modelling for the Southern Extension Project. To account for predicted traffic growth on the road network, the assessment has conservatively assumed that production does not commence until year 5 of the 8 year period for which approval is being sought. The SIDRA assessment has therefore assessed a traffic scenario associated with maximum production (1.2 Mtpa production) in the last year of production (year 8). As noted in **Section 6.11.1.1**, at the time the traffic counts were undertaken, there was no coal being transported from Cullen Valley to Mt Piper. Whilst Castlereagh Coal have no immediate plans to recommence mining at Cullen Valley, the traffic assessment has assumed a worst case traffic scenario which includes approved coal haulage from Cullen Valley to Mt Piper via the Castlereagh Highway and Boulder Road in addition to the 5,000 t per month between Cullen Valley and Invincible (a total of 1 Mtpa product coal from Cullen Valley).

The results of the traffic modelling for both intersections show they will continue to operate at a very good or good LOS (A or B) with the additional truck movements associated with the Southern Extension Project, during a busy hour.

On the basis of the analysis presented in TIA, the principal intersections on the road network adjacent to Invincible will continue to operate at good levels of service with the Southern Extension Project in place. The TIA found that no traffic impact mitigation measures are considered necessary to accommodate the additional traffic associated with the Southern Extension Project.

Impacts on the Wider road network

The impact on the wider road network is expected to be very minor. Ten loads of coal per day (i.e. 20 truck trips with return trips) will travel from Invincible to Bomaderry via Castlereagh Highway and Great Western Highway and other State roads and highways. The State highway and road network is provided to facilitate road trips by all classes of vehicles including heavy vehicles within NSW.

The additional 10 truck trips in each direction using the highway network will comprise a very small proportion of trips including heavy vehicle trips using these State highways on a daily basis, for example the additional trucks from the Southern Extension Project represent around 0.2 per cent of the total existing traffic using the Great Western Highway.

Construction employee traffic impacts

The peak construction period is anticipated to occur when upgrade and maintenance activities coincide with the full operational workforce (i.e. 39 operational personnel plus 10 additional maintenance employees). The assessment has conservatively assumed that all personnel will arrive on site prior to the production shift (i.e. 49 light vehicle trips entering Invincible between 6.00 am and 7.00 am). This period represents the potentially highest number of employment related vehicle movements associated with the Southern Extension Project.

The SIDRA intersection model was used to predict intersection performance during peak construction periods at key local intersections. The SIDRA assessment has assumed 75 per cent of the employee traffic movements would arrive at the Castlereagh Highway / Invincible Assess Road intersection from the south and 25 per cent from the north. This is broadly consistent with the predicted employment split in the local area (refer to **Section 6.10**). As with the assessment of operational traffic impacts, the SIDRA assessment also conservatively considered the impact associated with traffic growth over the entire period for which approval is sought. For the purposes of assessing potential worst case impacts associated with construction employee traffic, the assessment assumed the construction period would occur in year 5 (notionally 2021) of the Southern Extension Project (i.e. allowing for a four year period ending in the final year of which approval is being sought). The results of the SIDRA modelling are provided in **Appendix 12**.

This modelling indicated that the intersection of Castlereagh Highway / Invincible Access Road would operate at a very good LOS (A), in relation to modelled intersection delay and traffic queuing with regard to peak traffic movements during the modelled construction period.

The modelling also determined that the intersection of Castlereagh Highway/Boulder Road would operate at a very good LOS (A), in relation to modelled intersection delay and traffic queuing with regard to peak traffic movements during the modelled construction period.

On the basis of the TIA, peak employee related traffic impacts are not predicted to significantly impact the performance of the road network and key intersections in the vicinity of the Southern Extension Project.

6.11.2.2 Road closures due to blasting

As discussed in **Section 6.8**, blasting as part of the Southern Extension Project will be managed to comply with the relevant criteria so that no damage occurs to the Castlereagh Highway or other public roads. As also discussed in **Section 6.8**, the Southern Extension Project will require periodic closures of the Castlereagh Highway due to blasting near the road. Road closure periods are typically in the order of 15 minutes in duration.

Blasting at Invincible is restricted to 9.00 am to 5.00 pm Monday to Saturday. Accordingly, road closures associated with blasting do not coincide with the morning (8.00 am to 9.00 am) traffic peak and will not impact on commuters travelling home after 5.00 pm.

The existing Road Closure Management Plan will be updated for the Southern Extension Project in consultation with the RMS and Lithgow Council. Planned road closure times will be notified on the existing blast notification signs on Castlereagh Highway. The blast schedule will also be provided to local emergency services and contact details will be provided to these services to enable blasts to be delayed or rescheduled if emergency access along the Castlereagh Highway is required during a scheduled blast. The blast schedule will also be published on the Castlereagh Coal website to enable road users to plan trips to avoid delays associated with road closures.

Castlereagh Coal will manage truck haulage times to minimise traffic impacts associated with truck queuing following road closures.

6.11.2.3 Road safety

Accident history on local road network

The TIA examined the road safety of the current sub-regional traffic network, specifically by referring to the RMS crash data for the key roads and intersections. The principal intersections that will be used by the coal trucks are constructed to a high standard, as is the section of Castlereagh Highway adjacent to Invincible. The analysis of crash history does not indicate that road or intersection design is a contributing factor to any recent accidents in the local road network in the vicinity of the Southern Extension Project.

The small number of trucks that will travel between the mine and Bomaderry will use the State highway and State road network, which is constructed and maintained to a standard to accommodate heavy vehicles.

Fatigue was identified as a factor in some of the accidents on the local road network. The proposed shift arrangements at Invincible are unlikely to result in significant fatigue issues for employees. Truck operators will be required to comply with relevant State and Commonwealth requirements regarding fatigue management.

Mud on Castlereagh highway

Previous operations at Invincible included the loading of road trucks near the tailings drying facilities. Access to this area was along an unsealed haul road. Trucks leaving the site had potential to track mud onto the road which posed a safety risk and presented a nuisance value for other road users in terms of their vehicles becoming muddy when driving affected sections of the road. All trucks will be loaded at the Invincible Mine Infrastructure Area and there will be limited opportunities for road trucks to drive on unsealed or muddy roads. A truck wash procedure will be implemented for all trucks leaving the site that may have mud on their wheels to avoid mud being tracked onto the Castlereagh Highway. This is consistent with the current requirements of the Invincible Project Approval.

6.11.3 Road traffic management commitments

As outlined above, there are not predicted to be any significant impacts on traffic flows or traffic infrastructure performance as a result of the construction or operation of the Southern Extension Project. Regardless, Castlereagh Coal proposes to implement the following mitigation measures to maximise the safety and efficiency of the sub-regional traffic network and to address community concerns:

- Castlereagh Coal will require truck loading to occur in the Invincible Mine Infrastructure Area, with a wheel wash operated to wash tyres, where required, prior to leaving the site
- Castlereagh Coal will educate staff regarding the need to travel in a safe manner through the regional road network as an extension of the broader safety programs in place at Invincible
- Castlereagh Coal will undertake all transport activities strictly in accordance with the project approval
- Castlereagh Coal will minimise truck movements during periods when buses carrying school children are travelling on the section of road between the Invincible Colliery and Mt Piper Power Station
- Castlereagh Coal will undertake all deliveries of "oversize" loads in accordance with RMS and Council restrictions on transport hours and safety / warning requirements
- Castlereagh Coal will ensure all truck drivers operate in accordance with a Transport Policy and Code of Conduct
- Castlereagh Coal will obtain a Workplace Health and Safety Management Plan and a "Code of Conduct" for all drivers from each transport contractor
- Castlereagh Coal will enforce a covered load policy to all trucks transporting coal from the Invincible Colliery
- Commitments in relation to the management of road closure impacts are detailed in **Section 7.7**.

6.12 Economics

A detailed Economic Impact Analysis (EIA) was undertaken by Cadence Economics and is included as **Appendix 13**. The EIA uses the economic assessment framework set out in the *Guidelines for the economic assessment of mining and coal seam gas proposals* (the Guidelines) released by the NSW Government in December 2015. The Guidelines provide that economic assessments must outline the net present value of the project to the NSW community and provide a Local Effects Analysis (LEA) using the Cost Benefit Analysis (CBA) framework set out in the Guidelines.

The key findings of the economic assessment are discussed in the following sections.

6.12.1 Cost benefit analysis scenarios

A CBA is a method of obtaining a consolidated estimate of the net economic value of the Southern Extension Project by identifying the incremental costs and benefits of the project relative to the base case (i.e. no project), and placing a quantitative value on these items wherever possible. To carry out this economic assessment, a ‘base case’ representing business as usual has been compared to a ‘project case’. The ‘base case’ in the CBA is the scenario of the Invincible mine remaining in care and maintenance and being rehabilitated over a 5 year period.

The 'project case' essentially involves undertaking additional capital investment and operating expenditure associated with the Southern Extension Project at maximum production scenario. There is some overlap between both the 'project case' and the 'base case' in that both involve the rehabilitation of areas of Invincible that have previously been disturbed by mining activities.

6.12.1.1 'Base case' scenario

Under the 'base case' scenario Castlereagh Coal has an obligation to rehabilitate the land at a cost of $2.32 million (in NPV terms). In addition the residual value of the land is worth $0.07 million, generating an overall loss to NSW of $2.25 million.

6.12.1.2 'Project case' scenario

As noted above the assumptions for the project case are based on the maximum production scenario (i.e. where all nut coal is sourced from Invincible over a 4 year period operating up to maximum production).

For the purposes of the EIA, the Southern Extension Project will involve the extraction and sale of approximately 2,624 kts of product coal, over the 4 year period from 2017 to 2020. Under the central case assumptions (as outlined in **Appendix 13**) it is expected Castlereagh Coal will install $5.5 million of capital and generate revenue of $139 million in NPV terms (using a discount rate of 7%).

6.12.2 Benefits to the State

Directly the Southern Extension Project will generate $55.0 million of benefit, through the net producer surplus, royalties and payroll tax paid directly to the NSW Government and the company tax apportioned to NSW. The Southern Extension Project is also expected to generate total indirect benefits of $26.8 million, composed of $6.1 million of benefits to workers residing in NSW and $20.8 million of supplier benefits (i.e. profits for NSW based Castlereagh Coal).

The Southern Extension Project is expected to generate modest indirect costs on the NSW community of $2.2 million, including $1.9 million of Greenhouse gas emissions and $0.2 million associated with the cost of delay caused from road closures associated with blasting. Other potential externalities such as biodiversity, noise and air quality impacts have either been assessed qualitatively in the assessment or are included as operational costs to the Southern Extension Project.

Overall, the Southern Extension Project will generate a benefit to the NSW community of $79.7 million and a benefit to cost ratio (BCR) of 38relative to the 'base case'.

Table 6.33 outlines the overall economic benefits of the 'project case' against that of the 'base case.

Table 6.33 Net Benefits of the Project Case to NSW

Benefits	Total NPV ($M)	Costs	Total NPV ($M)
Direct benefits		**Direct costs**	
1. Net producer surplus attributed to NSW	$37.6		
2. Royalties, payroll tax and Council rates	$11.8		
3. Company income tax apportioned to NSW	$5.7		
Total direct benefits	$55.0	Total direct costs	-
Indirect benefits		**Indirect costs**	
1. Net economic benefit to existing landholders	$0.0	1. Air quality	
2. Net economic benefit to NSW workers	$6.1	2. Greenhouse gas emissions	-$1.9
3. Net economic benefit to NSW suppliers	$20.8	3. Visual amenity	
		4. Transport impact	-$0.2
		5. Net public infrastructure cost	
		6. Residual value of land	-$0.1
		7. Biodiversity impact	-$3.1*
		8. Noise impact	-$0.018*
		9. Loss of surplus to other industries	
		10. Water	
		11. Aboriginal cultural heritage	
		12 Historical heritage	
Total indirect benefits	$26.8	Total indirect costs	-$2.2
Total economic benefit of project	$81.8	Total economic cost of project	-$2.2
NPV of project - ($'M)	**$79.7**		
BCR (benefit cost ratio)	**38.0**		

Note: * Biodiversity impacts and Noise impacts have been assessed at the expense to mitigate these impacts. These are costs are included in the operational costs for the mine and netted off the Direct benefits.

6.12.2.1 State CBA – Sensitivity analysis

The EIA relies on a number of modelling assumptions. **Table 6.34** provides a summary of the net benefits of the Southern Extension Project to NSW under various scenarios and discount rates.

The Low Case scenario reduces the revenue (i.e. the coal price) from the Project Case by 25% and increases operational, labour and environmental costs by 25%, while the High Case scenario increases revenue by 25% and reduces costs by 25%. The capital cost requirement has not been changed for the purposes of the sensitivity analysis, some of these cost have already been incurred, with additional capital expenditures taking place prior to commencement of the Southern Extension Project.

Table 6.34 Net Benefits of the Project Case – Sensitivity analysis

Scenario	Net benefit of the Southern Extension Project – NPV ($M)		
Discount rate	7%	4%	10%
Central Case	79.7	85.6	74.4
Low Case – higher costs and lower revenue	47.9	51.7	44.4
High Case – lower costs and higher revenue	110.6	118.4	103.6

As can be seen from **Table 6.34**, the Southern Extension Project will deliver a net benefit to NSW under all considered scenarios.

From the sensitivity analysis, it is possible to determine how large the non-quantified negative externalities would need to be before the Southern Extension Project is no longer a net benefit to the NSW community. Using the most conservative estimate, the Low Case with a 10% discount rate, these externalities would need to be $44.4 million before the Southern Extension Project would return a net negative return to NSW.

6.12.3 Economic benefits to the region

The EIA includes a local effects analysis to assess the net benefit of the Southern Extension Project on the local region. For the purposes of the EIA, the region has been assessed as being the Lithgow –Mudgee Region.

The Southern Extension Project will have limited direct benefits as Council rates and other taxes will be largely the same under both the Base Case and the Project Case scenarios. The money paid under the Voluntary Planning Agreement is not considered to be a benefit for the purposes of the Economic Assessment as the underlying purpose of the VPA under the EP&A Act is to compensate Council for additional infrastructure and community costs incurred by Council as a result of the approved development. The Southern Extension Project is also expected to generate total indirect benefits of $8.77 million in NPV terms, composed of $4.85 million in benefits to workers residing in the area and $4.15 million of benefits to suppliers in the region.

The Southern Extension Project is expected to generate modest indirect costs on the Lithgow-Mudgee community of $0.23 million.

Table 6.35 summarise the inputs to the local effect analysis.

Table 6.35 Project Case Local Effects Analysis

Benefits	Total NPV ($M)	Costs	Total NPV ($M)
Direct benefits		**Direct costs**	
1. Net producer surplus attributed locally	$0.00		
2. Royalties, payroll tax and Council rates	$0.00		
3. Company income tax apportioned locally	$0.00		
Total direct benefits	$0.00	Total direct costs	-
Indirect benefits		**Indirect costs**	
1. Net economic benefit to existing landholders	$0.00	1. Air quality	
2. Net economic benefit to local workers	$4.85	2. Greenhouse gas emissions	$0.0
3. Net economic benefit to local suppliers	$4.15	3. Visual amenity	
		4. Transport impact	-$0.16
		5. Net public infrastructure cost	
		6. Surface water impact	
		8. Residual value of land	-$0.07
		7. Biodiversity impact	
		8. Noise impact	-$0.018*
		9. Loss of surplus to other industries	
		10. Water	
		11. Aboriginal cultural heritage	
		12 Historical heritage	
Total indirect benefits	$9.0	Total indirect costs	-$0.25
Total economic benefit of project	$9.0	Total economic cost of project	-$0.23
NPV of project - ($'M)	**$8.77**		
BCR (benefit cost ratio)	**38.71**		

Note: * Biodiversity impacts and Noise impacts have been assessed at the expense to mitigate these impacts. These are costs are included in the operational costs for the mine and netted off the direct benefits.

6.12.3.1 Local Effects Analysis – Sensitivity analysis

The EIA relies on a number of modelling assumptions. **Table 6.36** provides a summary of the net benefits of the region under the same scenarios and discount rates applied to the State CBA sensitivity analysis (refer to **Section 6.12.2.1**).

Table 6.36 Net Benefits of the Project Case – Sensitivity analysis

Scenario	Net benefit of the Southern Extension Project – NPV ($M)		
Discount rate	7%	4%	10%
Central Case	8.77	9.50	8.17
Low Case – higher costs and lower revenue	11.72	12.56	10.98
High Case – lower costs and higher revenue	6.11	6.62	5.69

As can be seen from **Table 6.36,** the Southern Extension Project will deliver a net benefit to the region under all considered scenarios.

Using the most conservative estimate, the Low Case with a 10% discount rate, the regional cost of externalities not quantitatively considered in the assessment would need to be $5.69 million before the Southern Extension Project would return a net negative return to the Region.

6.13 Greenhouse gas and energy assessment

The following Greenhouse Gas and Energy Assessment (GHGEA), includes a quantitative assessment of the potential Scope 1, 2 and 3 emissions associated with the Southern Extension Project; a qualitative assessment of the potential impacts of these emissions on the environment; and an assessment of reasonable and feasible measures to minimise Greenhouse Gas (GHG) emissions and energy use.

6.13.1 Greenhouse assessment policy context

The United Nations Framework Convention on Climate Change (UNFCCC) is the leading international forum for setting climate change targets and objectives. In 2015 the UNFCCC successfully negotiated an international climate change agreement between 195 countries (the Paris Agreement). The Paris Agreement aims to:

- hold the increase in the global average temperature to well below 2°C above pre-industrial levels, and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels
- increase the ability [of nations] to adapt to the adverse impacts of climate change and foster climate resilience and low GHG emissions development, in a manner that does not threaten food production
- make finance flows consistent with a pathway towards low GHG emissions and climate-resilient development.

The Paris Agreement seeks to meet its objectives by developing programs and mechanisms that:

- require participating Parties to prepare and communicate GHG mitigation contributions. Parties are expected to set mitigation targets for 2020, and then develop new targets every five years. Each successive target is expected to represent a larger mitigation effort than the previous target
- promote climate change resilience and adaptation
- provide mitigation and adaptation funding to developing countries
- foster mitigation and adaptation technology transfer between Parties
- require participating Parties to report progress towards their mitigation contributions on an annual basis.

Australia's commitment to the Paris Agreement includes reducing GHG emissions by 26 – 28 per cent, on 2005 levels, by 2030 (Commonwealth of Australia, 2015). To meet the requirements of the Paris Agreement, Australia will also have to develop interim targets for 2020 and 2025.

6.13.2 Methodology

The GHGEA has considered the potential impacts of the operational and closure stages of the Southern Extension Project. The GHGEA also evaluated potential mitigation and energy efficiency measures for the Southern Extension Project's operational activities.

The GHGEA was prepared with regard to the following key guidelines:

- National Greenhouse Accounts (NGA) Factors (2015) (DoE 2015)
- World Business Council for Sustainable Development and World Resources Institute Greenhouse Gas Protocol 2004 (GHG Protocol 2004).

The GHG Protocol provides an internationally accepted approach to the accounting and reporting of GHG emissions by entities. Under the GHG Protocol the establishment of operational boundaries involves identifying emissions associated with an entity's operations, categorising them as direct or indirect emissions, and identifying the scope of accounting and reporting for emissions.

Three 'Scopes' of emissions (Scope 1, Scope 2 and Scope 3) are defined for GHG accounting and reporting purposes. These scopes are outlined below:

- Scope 1 emissions are direct emissions which occur from sources owned or controlled by the reporting entity, over which they have a high level of control (such as fuel use)
- Scope 2 emissions are those generated from purchased electricity consumed by the reporting entity, which can be easily measured and can be influenced through energy efficiency measures. Scope 2 emissions physically occur at the facility where electricity is generated, that is, the power station
- Scope 3 emissions are indirect emissions that are a consequence of the activities of the reporting entity, but occur at sources owned or controlled by another reporting entity (e.g. outsourced services).

Scope 1 and 2 emissions were calculated based on the methodologies and emission factors contained in the National Greenhouse Accounts Factors 2015 (DoE 2015).

Scope 3 emissions associated with product transport were calculated based on emission factors contained in the National Greenhouse Gas Inventory: Analysis of Recent Trends and Greenhouse Gas Indicators (AGO 2007). Other Scope 3 emissions were calculated using methodologies and emission factors contained in the National Greenhouse Accounts Factors 2015 (DoE 2015).

The assessment boundary for the GHGEA incorporates all significant scope 1, 2 and 3 emissions. **Figure 6.23** demonstrates how the assessment boundary interacts with the potential emission sources under Castlereagh Coal's operational control and other emission sources associated with the Southern Extension Project.

6.13.3 Data and assumptions

The assumptions detailed this section have been used for calculation purposes only, and are not meant to describe the exact specifications of the Southern Extension Project. The following data and assumptions were used to prepare the GHGEA:

- The Southern Extension Project will recover approximately 2,336,000 ROM tonnes of thermal coal
- The Southern Extension Project will recover approximately 403,000 ROM tonnes of coal from the Lithgow Seam
- Only coal from the Lithgow Seam will be washed for nut coal production
- Energy use estimates were calculated from historical National Greenhouse and Energy Reporting data
- Explosive use will average 3 kg/ROM tonne
- Diesel use for final rehabilitation will approximate 50 per cent of operational diesel use for the final year of production
- The energy content of nut coal is 29 GJ/tonne
- Thermal coal will be transported 10 km by road
- Nut coal will be transported 300 km by road
- Explosives will be transported from Newcastle
- Diesel will be transported from Bathurst.

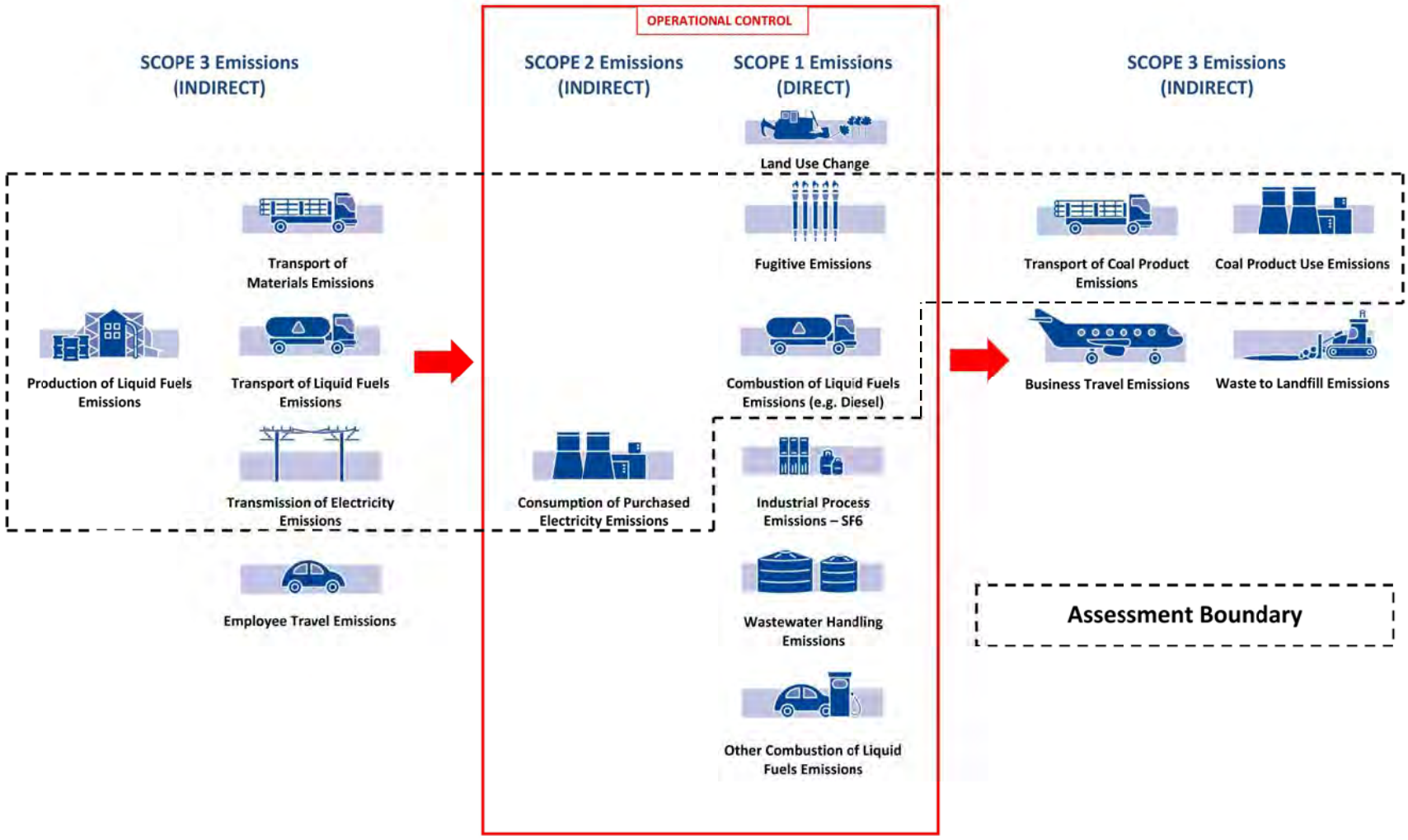


FIGURE 6.23

Greenhouse Gas Assessment Boundary

6.13.4 Results

6.13.4.1 Predicted energy consumption

The Southern Extension Project's energy requirements will primarily be met through diesel and electricity consumption. Outlined below is a summary of the predicted energy consumption for the Southern Extension Project:

- the operational phase of the Southern Extension Project is forecast to require approximately 506,000 GJ of energy from diesel and grid electricity
- during the closure phase, the Southern Extension Project is forecast to consume approximately 29,000 GJ of energy, all of which will be sourced from diesel.

The industry average energy use for operational open cut coal mines in Australia ranges between 430 and 660 Megajoules (MJ)/product tonne (AGSO 2000). The Southern Extension Project is forecast to operate with an average energy use intensity of approximately 193 MJ/product tonne. The energy use efficiency of the Southern Extension Project is likely to be low, given that a large proportion of ROM coal bypasses the Invincible CPP.

6.13.4.2 Predicted GHG emissions

Operational Stage

The Southern Extension Project is forecast to generate, or be associated with, the following GHG emissions over the life of the Southern Extension Project:

- approximately 183,000 t CO_2-e of Scope 1 emissions, primarily from the combustion of diesel and release of fugitive emissions. Fugitive emissions result from the release of gas (primarily carbon dioxide and methane) stored in the materials mined
- approximately 3,000 t CO_2-e of Scope 2 emissions from consuming electricity
- approximately 6,470,000 tonnes CO_2-e Scope 3 emissions. Scope 3 emissions will be generated by third parties during product transport and consumption activities.

The Southern Extension Project's GHG inventory is dominated by Scope 3 emissions, with approximately 97 per cent of emissions occurring either upstream or downstream of the Southern Extension Project. Approximately 3 per cent of the GHGs associated with the Southern Extension Project are related to on-site energy use and fugitive emissions (Scope 1 and 2 emissions).

Scope 2 and 3 emissions have been included in the GHGEA to demonstrate the potential upstream and downstream impacts of the Southern Extension Project. All Scope 2 and 3 emissions identified in the GHGEA are attributable to, and may be reported by, other sectors.

Closure and rehabilitation phase

The Southern Extension Project is forecast to generate approximately 2,000 tonnes CO_2-e Scope 1 emissions from combusting diesel during the closure phase. The closure phase is also expected to be associated with approximately 100 tonnes CO_2-e Scope 3 emissions. Scope 3 emissions will be generated by third parties undertaking activities such as extracting, refining and transporting diesel.

6.13.4.3 Impact assessment

The GHG emissions generated by the Southern Extension Project have the potential to impact the physical environment and the GHG reduction objectives of national and international governing bodies. The following assessment makes the distinction between environmental impacts and impacts on policy objectives.

6.13.4.4 Impact on the environment

The Southern Extension Project's GHG emissions will have a dispersing impact as they are highly mobile and are generated up and down the supply chain. The accumulation of GHGs or carbon in 'carbon sinks' is the primary impact of GHG emissions. Since the industrial revolution, anthropogenic GHG emissions have accumulated in three major carbon sinks - the ocean (30 per cent), terrestrial plants (30 per cent) and the atmosphere (40 per cent) (BOM and CSIRO, 2014).

The accumulation of GHG in the atmosphere is an important driver of global warming, sea level rise and climate change (IPCC 2013). Sea level rise and climate change may have many ramifications for the natural and built environment. The accumulation of GHGs in the ocean is an important driver of ocean acidification (IPCC 2013).

The Southern Extension Project's direct emissions are forecast to be approximately 46,000 t CO_2–e per annum based on a maximum production scenario over a four year period.

To put the Southern Extension Project's emissions into perspective, global GHG emissions are forecast to be 46,000,000,000 t CO_2-e by 2020 (Sheehan *et al*. 2008). During operation, the Southern Extension Project will contribute approximately 0.000046 per cent to global emissions per annum (based on its projected Scope 1 emissions). The Scope 2 and 3 emissions associated with the Southern Extension Project will be generated by GHG sources outside the Southern Extension Project boundary and are attributable to other projects / facilities.

6.13.4.5 Impact on climate change

The Intergovernmental Panel on Climate Change (IPCC) define climate change as a change in the state of the climate that can be identified by changes in the mean and/or variability of its properties, and persists for an extended period, typically decades or longer (IPCC 2007).

Climate change is caused by changes in the energy balance of the climate system. The energy balance of the climate system is driven by atmospheric concentrations of GHGs and aerosols, land cover and solar radiation (IPCC 2007).

Climate change models forecast many different climate change impacts, which are influenced by future GHG emission scenarios. Climate change forecasts also vary significantly from region to region.

A qualitative assessment of climate change requires a regional reference and future emission trajectory assumptions. The Southern Extension Project, in isolation, is unlikely to influence global emission trajectories. Future emission trajectories will largely be influenced by global scale issues such as; technology, population growth and GHG mitigation policy. NSW climate change projections have been modelled by the NARCliM project. NARCliM has modelled climate change projections for 2030 and 2070, using the IPCC high emissions A2 emission trajectory scenario. The A2 scenario assumes (IPCC 2000):

- Relatively slow demographic transition and relatively slow convergence in regional fertility patterns
- Relatively slow convergence in inter-regional GDP per capita differences

- Relatively slow end-use and supply-side energy efficiency improvements (compared to other storylines)
- Delayed development of renewable energy
- No barriers to the use of nuclear energy.

The Southern Extension Project is consistent with the A2 emissions trajectory scenario, therefore the climate change projections developed by NARCliM are a reasonable basis for a qualitative climate change impact assessment. NARCliM makes the following climate change projections for NSW (Adapt NSW 2016):

- Maximum temperatures are projected to increase
- Minimum temperatures are projected to increase
- The number of hot days will increase
- The number of cold nights will decrease
- Rainfall is projected to decrease in spring and winter
- Rainfall is projected to increase in summer and autumn
- Average fire weather is projected to increase in summer and spring
- Number of days with severe fire danger is projected to increase in summer and spring.

The extent to which global emissions and atmospheric concentrations of GHGs have a demonstrable impact on climate change will be largely driven by the global response to reducing total global emissions that includes all major emission sources and sinks.

6.13.4.6 Impact on policy objectives

As discussed in **Section 6.13.1**, the Australian Government has committed to reduce Australia's GHG emissions by 26 to28 per cent on 2005 levels by 2030 (Commonwealth of Australia, 2015). To meet the requirements of the Paris Agreement, Australia will also have to develop interim targets for 2020 and 2025.

While the Southern Extension Project is likely to increase the mitigation effort required to reach the 2020 target, the Southern Extension Project itself is unlikely to prevent the Australian Government achieving its national GHG targets.

The Southern Extension Project's Scope 2 and 3 emissions will be generated by facilities and activities with environmental approval to generate GHG emissions in Australia.

6.13.5 Greenhouse gas and energy management commitments

- Castlereagh Coal will implement a range of measures found to be both technically feasible and financially reasonable to minimise GHG emissions. Other than fugitive emissions, Scope 1 emissions are primarily associated with diesel consumption. Accordingly, there are financial drivers for undertaking operations in a manner which reduces diesel consumption. Matters implemented in the mine design consideration which contribute to lower diesel consumption (and Scope 1 emissions) include:
    - limiting the length of material haulage routes
    - optimising ramp gradients
    - improving rolling resistance of haul roads
    - optimising payload size
    - reducing idling times (dependent on weather conditions)
    - scheduling activities so that equipment and vehicle operation is optimised
    - utilising fuel efficient equipment
    - working machines to their upper design performance.
- Castlereagh Coal will continue to investigate options for improving the efficiency of operations through the life of the Southern Extension Project. Castlereagh Coal will also investigate options for use of alternative fuels such as biodiesel, where reasonable and feasible.

6.14 Bushfire

This section provides a summary of the proposed bushfire management and emergency response to bushfires for the Southern Extension Project. No new infrastructure is proposed as part of the Southern Extension Project and as such the bushfire threat will remain the same as the existing approved operations (refer to **Section 2.0**).

The Southern Extension Area is identified as bushfire prone land on available mapping (Lithgow City Council 2016) (refer to **Figure 6.24**). The Southern Extension Project is located within the Ben Bullen State Forest which is dominated by dry sclerophyll forest communities. The most significant potential bushfire threat to the Southern Extension Area is from within the Ben Bullen State Forest, which supports forest / woodland vegetation and a potentially significant fuel load capable of sustaining and spreading bushfire.

Bushfire prone land within the Southern Extension Area will be disturbed as part of the Southern Extension Project and vegetation within this area will be progressively removed as mining progresses. This will remove this area of bushfire prone land (refer to **Figure 6.24**) in proximity to the existing infrastructure area over the life of the Southern Extension Project. The progressive rehabilitation of Invincible and the Southern Extension Area aims to restore areas of native vegetation which will introduce potential bushfire fuel loads. This will be managed as part of the Southern Extension Project as detailed further in **Section 6.18.1** below.

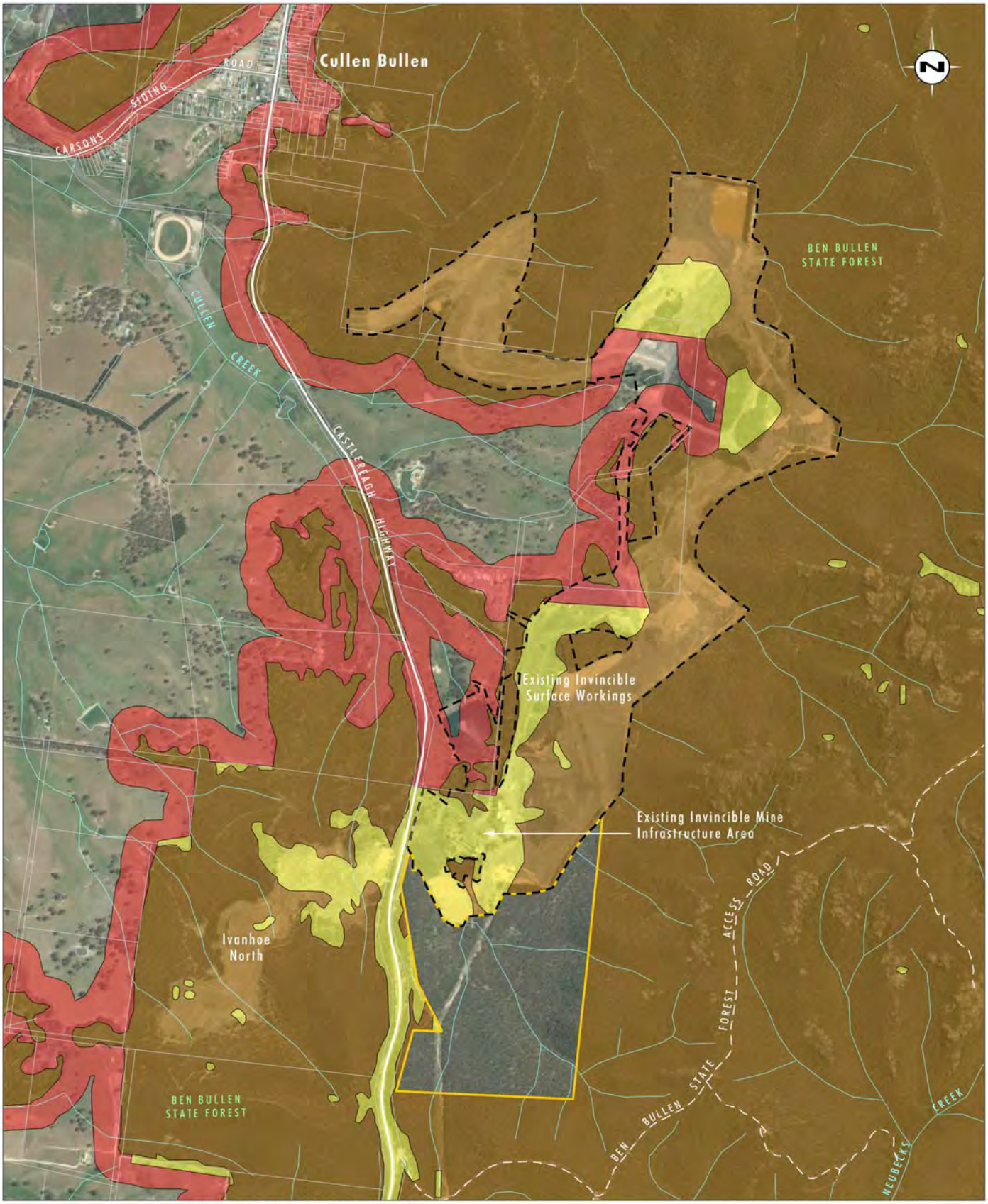


Image Source: Google Earth - CNES/Astrium (Nov 2014)
Data Source: LPI (2016), Lithgow Council (2016)

0 0.25 0.5 1.0km

Legend

- Existing Approved Mining Disturbance Area
- Proposed Southern Extension Area
- Bush Fire Vegetation - Category 1
- Bush Fire Vegetation - Category 2
- Bush Fire Vegetation Buffer (100m and 30m)

FIGURE 6.24

Mapped Bushfire Prone Land

6.14.1 Bushfire management

A Bushfire Management Plan will be developed for the Southern Extension Project in consultation with the Rural Fire Service (RFS), neighbouring landholders and the community and Lithgow City Council.

The Bushfire Management Plan will be developed with the aim of assessing the bushfire risk across the entire Invincible Site (which includes the Southern Extension Area) and to identify practical management strategies to reduce the risk of fire to life, property and the environment.

The objectives of the Bushfire Management Plan are to:

- reduce fire ignition potential across areas of Invincible
- prevent the spread of fire within and beyond Invincible
- protect the flora and fauna within Invincible from unplanned fire events.

The Bushfire Management Plan will be developed to be consistent with the relevant requirements of the *Rural Fires Act 1997* and the RFS guideline *Planning for Bushfire Protection 2006* (PBP 2006) (NSW RFS 2006). It will define the applicable management zones based on the location of assets, topography, land use and potential bushfire hazard. Management zones are separated into the following three categories:

- Asset Protection Zones (APZ)
- Strategic Fire Advantage Zones (SFAZ)
- Land Management Zones (LMZ).

The progressive rehabilitation of the site will consider the relevant provisions of the Bushfire Management Plan.

6.14.2 Access

All existing infrastructure areas are accessible by all weather access roads. Invincible is inspected regularly to determine the requirement of maintenance for existing roads. Access across the Southern Extension Area will be maintained as the Southern Extension Project progresses, in accordance with the Bushfire Management Plan.

As specified in the existing Care and Maintenance MOP, fire trails or access roads at the extremities of the lease area, which serve as access for fire fighting services as well as establishing a fire break to the limits of operations at the open cut will continue to be maintained.

6.14.3 Water supply

Detail regarding the existing water supply system and proposed water management works as part of the Southern Extension Project is provided in **Section 3.0**. The water management network supplies water for the mining operations with the dams accessible by water carts provided with fill points. The existing infrastructure areas within Invincible are supplied with adequate water supply, fire fighting facilities and equipment in accordance with the Building Code of Australia and all relevant Australian Standards.

6.14.4 Emergency response

The Bushfire Management Plan will detail the emergency response procedure, responsibility for fire management and the monitoring review and reporting of fire incidents. The RFS has Fire Control Centres at Lithgow where the response time to the Southern Extension Area would be approximately 20 to 25 minutes.

With the implementation of the bushfire management controls, it is considered that bushfire risk associated with the Southern Extension Project can continue to be managed in an appropriate and effective manner.

6.14.5 Management and mitigation commitments

- Castlereagh Coal will update the Landscape Management Plan to incorporate the following bushfire management controls for the Southern Extension Project in consultation with the RFS, neighbouring landholders and the community and Lithgow City Council:
    - Fitting fire extinguishers to all earthmoving and mining equipment
    - Advising NSW Rural Fire Service, regulatory authorities and neighbours of any burning-off operations
    - Ensuring that vehicles with low level exhaust systems do not leave defined tracks in locations and conditions likely to lead to ignition of combustible plant material
    - Maintaining, at the request of NSW Forestry Corporation, existing fire trails or access roads at the extremities of the mine disturbance area, which serve as access for fire fighting services as well as establishing a fire break to the limits of operations at the open cut.

6.15 Visual

An assessment of the likely visual impacts of the development on surrounding private landowners and key vantage points in the public domain has been undertaken for the Southern Extension Project, paying particular attention to the creation of any new landforms and minimising the impacts of the Southern Extension Project on surrounding areas.

Minimising visual impacts was one of the key considerations for the design of Southern Extension Project. Visual amenity was raised by a number of landholders, and largely related to concerns about the effect of open cut mining on the landscape, with references to the legacy issues associated with the Cullen Valley and Invincible sites. This has been considered through the commitment to the progressive rehabilitation process over the life of the Southern Extension Project which includes rehabilitation to areas of existing disturbance as well as the Southern Extension Area. It is noted that whilst community issues have been raised in relation to Cullen Valley mine, this is addressed through the approved rehabilitation commitments for this operation and is separate to the Southern Extension Project.

The visual amenity assessment findings for the Southern Extension Project are provided in the following sections.

6.15.1 Existing visual character

The region surrounding the Southern Extension Project has a diversity of landforms, vegetation patterns and land uses resulting in considerable variation in scenic quality. In general terms, scenic quality is considered to improve with increasing diversity of topographic ruggedness, vegetation patterns, natural and agricultural landscapes and water bodies (Andrews Neil 1999).

The Southern Extension Project is located on the western edge of the Ben Bullen State Forest, bounded to the west by Castlereagh Highway and to the east by Ben Bullen State Forest. Pagodas and rock formations are a key visual feature of the area and occur within the Ben Bullen State Forest. The most visually prominent formations in the area around Invincible (viewed from the west) are the prominent pagoda formations which are located to the east of the existing open cut operations (north-east of the Southern Extension Area).

The industrial land uses within the region, including mining and power generation, are visible from a range of locations including along sections of the Castlereagh Highway. In the vicinity of Invincible, mined surfaces, coal related infrastructure (conveyors, mining surface facilities) and other built infrastructure such as power lines contribute to the visual environment. To the south of Invincible, along the Castlereagh Highway, the Mt Piper and Wallerawang power stations dominate the visual landscape.

As identified in **Section 6.2**, the predominant land uses in the immediate vicinity of the Southern Extension Project include state forest, coal mining, agricultural and rural/rural-residential holdings. The largely cleared area to the west of the Southern Extension Area has significant contrast with the vegetated elevated slopes and ridges of the Ben Bullen State Forest east of the Southern Extension Area. The vegetated State Forest areas contrast to the mining areas of the existing Invincible site. It is noted that views of open cut mining areas associated with Invincible are limited to a few vantage points due to both intervening topography and screening from vegetation located between the Castlereagh Highway (and other potential vantage points), and limited accessibility of elevated locations to the east of Invincible.

These various landscape elements provide significant contrast in visual amenity from areas with a largely natural or agricultural character which are generally considered of high visual amenity, to areas with significant mining or industrial landscape features. The mining and industrial landscape features, where visible, are typically considered to have a low visual amenity, but are consistent with the historical development of mining and industry in this area, and form substantial features in the landscape

6.15.2 Impact of existing Invincible operations on visual character

Views of mining activities at the existing Invincible site are the most prominent from high vantage points on pagoda formations within the Ben Bullen State Forest, looking west. These vantage points can only be accessed by foot, generally by the existing tracks located to the south and east of the Southern Extension Area. There is limited or no views of Invincible open cut workings or mine infrastructure area from the main access road through the State Forest except from the road immediately south of the Southern Extension Area where there are views down the cleared powerline easement to the mine. It should be noted that views to the south from this location are of the Mt Piper power station and the clearing associated with the easement itself, which is in stark contrast to the surrounding woodland and forest vegetation in Ben Bullen State Forest (refer to **Plate 6.1**).

The majority of the existing mining infrastructure and disturbance areas are screened from views from the north, south and west of the site by the existing topography and vegetation. Parts of the existing Invincible open cut workings and the mine infrastructure area are visible from a number of locations along the Castlereagh Highway (refer to **Plate 6.2**) and vantage points to the west (refer to **Plate 6.3**). The former West Pit mining area (refer to **Figure 2**.**1**) is prominent from the Castlereagh Highway for vehicles travelling north. This area is in the process of ongoing rehabilitation and vegetation is becoming established which has reduced visual impacts relative to the historical active mining of this area. These impacts will be further reduced as vegetation in this area becomes more established through the continued progressive rehabilitation of this area over the life of the Southern Extension Project.

During the stakeholder consultation program undertaken for the Southern Extension Project, a number of local community representatives noted the visual impacts associated with mining at Invincible and also drew attention to concerns about the visual prominence of flowering acacias in rehabilitation areas; typically this was raised as a negative impact. This has been considered through the commitment to the progressive rehabilitation process over the life of the Southern Extension Project which includes areas of existing disturbance as well as the Southern Extension Area. The requirement for acacias in the rehabilitation strategy is discussed further in **Section 6.18**.

6.15.3 Southern extension project visual character design features

Castlereagh Coal has considered the amenity impacts of the ongoing surface operations during the mine planning process for the Southern Extension Project. The Southern Extension Area is located in an area with relatively few vantage points from the west, east and south due to screening provided by vegetation and landform features. Mining of this area was therefore considered less visually intrusive than some of the other options considered for mining at Invincible (refer to **Section 3.7**). The locations with a potential view of the Southern Extension Area were identified as being a short section of the Castlereagh Highway on the southern side of Cullen Bullen, high vantage points within Ben Bullen State Forest (such as the tops of pagodas), down the electricity line easement from the road into the State Forest to the south of the Southern Extension Area and glimpses through trees for traffic travelling along Castlereagh Highway adjacent to the Southern Extension Area. The potential visual impacts from these and other potential vantage points have been assessed as detailed below.

6.15.4 Visual amenity assessment methodology

To assess the visual impacts of the Southern Extension Project a series of radial analyses and a visual montage have been completed for a number of surrounding locations where it was considered there may be views of the Southern Extension Area. The locations selected for the radial analysis assessment were chosen based on field observations and a review of topographical information.

Radial analyses are developed using 3D topographic information and electronic data files relating to the Southern Extension Project to identify what can theoretically be seen from particular vantage points. The radial analysis illustrates what is visible from a height of 1.7 m at that location (i.e. from average eye height). It should be noted that the radial analyses are topography based only and do not include vegetation which may in fact screen a portion of a viewshed.

PLATE 6.1

View south from powerline easement

PLATE 6.2

View from Castlereagh Highway looking
East across the Main Water Storage Dam

PLATE 6.3

View to the south east from Carsons Siding Road

Radial analyses were completed using the Stage 2 Mine Plan (refer to **Section 3.5**) as a representation of the maximum extent of potential impacts associated with the Southern Extension Project in terms of both height and extent of disturbance to gauge the potential visual impact from targeted viewpoints. Four visual locations were selected from areas surrounding the Southern Extension Project as shown on **Figure 6.25** and described below.

From the east:

- **VP1** – provides a representative view looking west from the top of a pagoda (publicly accessible trig station) within Ben Bullen State Forest.

From the north-west:

- **VP2** – represents views looking south-east from Portland Cullen Bullen Road.

From the north-north-west:

- **VP3** – represents views looking south-south-west from Carson Siding Road.

- **VP4** – provides a representative view from the Castlereagh Highway travelling south where there is potential for view of the Southern Extension Area.

In addition, the closest private residences, Hillview (residence ID 394) and Billabong (residence ID 393) were inspected to assess their potential views of the Southern Extension Area. Both residences are located to maximise views to the west and north-west; with views to the east (i.e. towards Invincible and the Southern Extension Area) from these residences is screened by vegetation and neither residence will have views of the Southern Extension Area.

Where the radial analysis from a viewpoint identified the potential for views of the Southern Extension Area, a panoramic photograph (made using a series of individual photos), 3D topographic information, and electronic data files pertaining to the Southern Extension Project were analysed to determine whether non-topographical features such as vegetation or man-made structure obstruct views of the Southern Extension Area. Where the analysis determined there would be views of the Southern Extension Area, a visual montage was prepared to illustrate the likely worst case visual impact of the Southern Extension Project. Constructing visual montages of 'before and after' scenarios illustrates the existing landscape and provides a comparison landscape, including the Southern Extension Project and its visual amenity management measures, to enable the visual impact for that location to be assessed.

A visual montage was completed at VP4 as this assessment location has potential visual amenity impacts and is accessible to the general public. The views from VP1 located in an elevated location in Ben Bullen State Forest include significant areas of the existing Invincible site and the Southern Extension Area. Given that the existing mining operations are visible from this location, and the location can only be accessed on foot, the visual impacts from this viewing location and other elevated areas to the east of Invincible have therefore been assessed in the context of the visual impacts associated with existing Invincible operations. The visual impacts from these and the other locations assessed are discussed in **Section 6.15.5**

Night time impacts from the Southern Extension Project related to lighting are considered to be minimal due to the day time operating hours of mining operations. Potential impacts from loading and maintenance operations which may occur during the evening and mining operations in dusk / early evening during winter months are considered in **Section 6.15.5.3**.

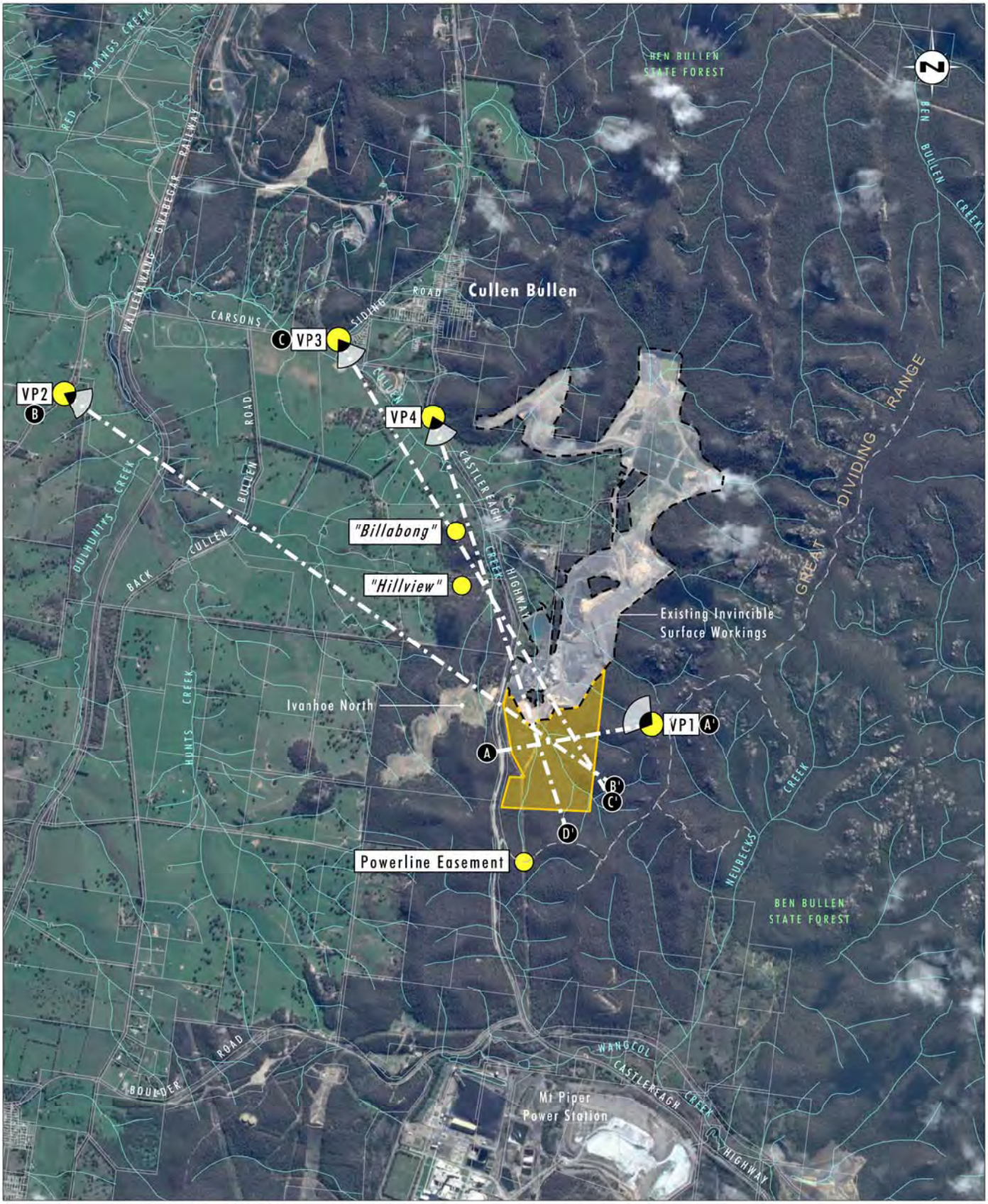


Image Source: Google Earth - CNES/Astrium (May 2014)
Data Source: LPI (2016)

Legend

- Existing Approved Mining Disturbance Area
- Proposed Southern Extension Area
- Viewpoint Location
- Visual Transect Location

FIGURE 6.25

Viewpoint and Visual Transect Locations