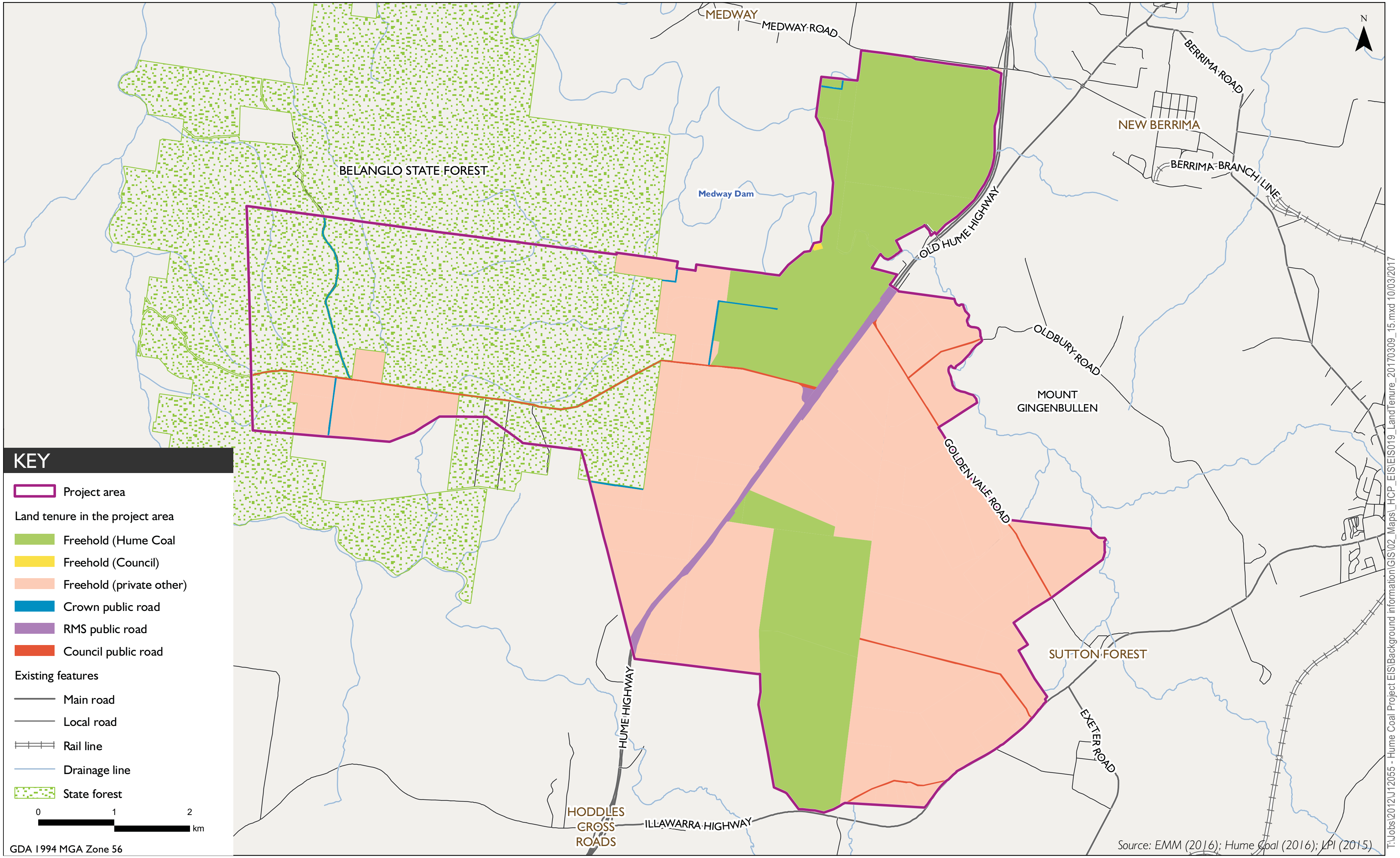


Land tenure

Hume Coal Project
Environmental Impact Statement
Figure 5.6

5.3.2 Existing land uses

The main land uses within and adjacent to the project area are currently agricultural, industrial, extractive, forestry, rural residential and residential.

i Agriculture

Over half of the project area comprises cleared land that is, and will continue to be, used for livestock grazing, cropping and small-scale farm businesses. There are a small number of vineyards present, principally Cherry Tree Hill and Eling Forest Wines adjacent to the Hume Highway. Associated with agricultural land uses within the project area are farm improvements such as outbuildings, dams, access tracks, fences, yards and gardens. The Southern Regional Livestock Exchange is also in the locality, positioned on Berrima Road around 2.5 km from the centre of Moss Vale. The saleyard turns over approximately 60,000 head of cattle per year.

ii Residential

The Wingecarribee LGA's main regional centres are Moss Vale, Bowral and Mittagong, which are between 3 km and 15 km east and north-east of the project area. The villages of Sutton Forest and Exeter are located within A349, but both have been excluded from the project area, although the project area includes part of the broader Sutton Forest area which extends to Medway Rivulet in the north. Medway, New Berrima and Berrima villages are also nearby, although again, are outside of the project area; noting that with the exception of New Berrima, the project area includes parts of their broader localities.

Within the project area, there are scattered homesteads, dwellings, and other built structures that are generally associated with agricultural production.

iii Mining

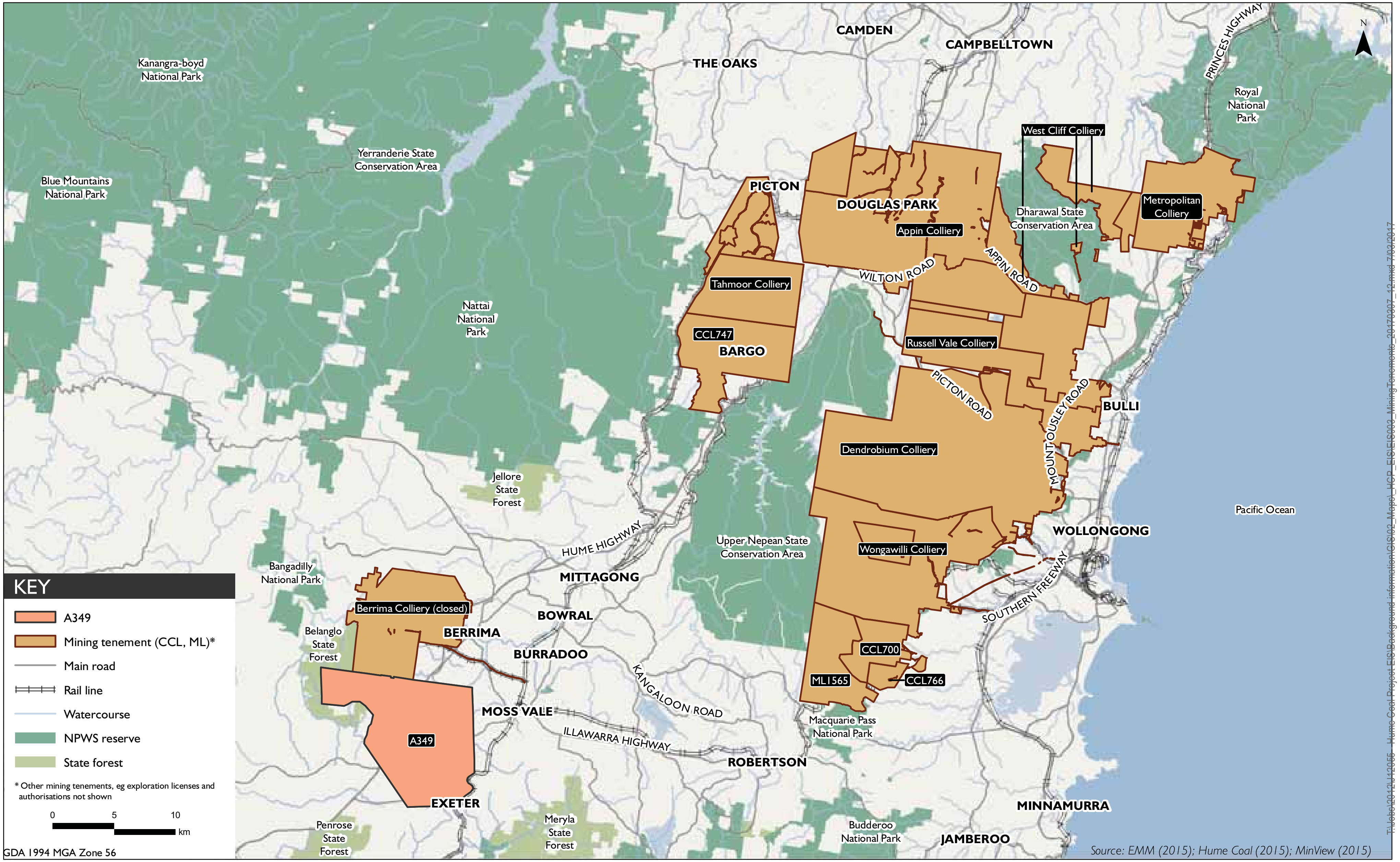
There is a long history of mining in the Southern Highlands as outlined in Section 1.1, with coal exploration and mining activities occurring since the 19th century. There are numerous mining tenements in the Southern Highlands, as illustrated in Figure 5.7.

Historical mines within and in close proximity to the project area are summarised below and illustrated in Figure 5.8.

- Berrima Colliery (closing) – this mine is located to the north of Wingecarribee River. Berrima Colliery's mining lease (CCL 748) adjoins the project area's northern boundary, and is currently undergoing closure having ceased operations in 2013. The workings are the most extensive of any mine in the area and comprise first workings and pillar extraction in the Wongawilli Seam. Mining operations commenced in 1926 and ceased in 2013, with mechanisation (and full extraction) commencing in 1968. Production varied between 0.13 and 0.46 Mt/year.

- The Loch Catherine Mine (abandoned) – this mine opened in 1924 with an anticipated maximum production of 200 t/day. The workings are underneath the former Berrima Colliery stockpile pad bounded by Medway Rivulet and the Wingecarribee River. The mine worked the Wongawilli Seam. Operations ceased at Loch Catherine Mine in the 1960s. The adits are still open, and iron staining is evident in the water pooled at the mine entries.

- Southern Colliery (abandoned) – this colliery is on Foxgrove Road, about 5 km south west from the project area. Mining appears to have occurred in the Tongarra Seam. This was a small scale mine which ceased operations many years ago.



Mining tenements in the Southern Coalfield
Hume Coal Project
Environmental Impact Statement
Figure 5.7

Historical mining activity in the region
Hume Coal Project
Environmental Impact Statement
Figure 5.8

- Numerous adits exist at coal seam outcrops along escarpments for pre-mechanisation (manual) abandoned workings. Typical examples of these adits are Black Bobs, Belanglo (abandoned in the 1950s), Belanglo Extended, and Flying Fox collieries to the west and the north of the project area, and Erith Colliery near Bundanoon. These operations were likely to be very small, probably mining less than 100,000 t in total. Most are not sealed and drain into local watercourses. They typically consist of two headings extending in from outcrop by a few hundred metres up to 1400 m. Belanglo was a small operation along Black Bobs Creek, presumed to be on the southern side of the creek to the west of the Hume Highway. Murrimba Colliery was on the eastern side of Black Bobs Creek in approximately the same location and was abandoned after hitting a full face of stone a few hundred metres from the creek. Belanglo Colliery is located in the Berrima Colliery lease in a tributary of Medway Rivulet.

- Two adits have also been located along Longacre Creek, in the far north-west of the project area. The workings are of unknown length and above one another in the Tongarra and Wongawilli Seams. Historical literature discusses a number of old mines in the area around the Loch Catherine mine, and it is likely that other small scale abandoned mine workings are present along the coal seam outcrop in this area.

Coal mining continues in the Wingecarribee LGA today as mentioned in Section 1.1, with CCL 747 of Tahmoor Colliery, an underground longwall mine operating in the Bulli Seam, extending into the northern end of the LGA. The mining leases associated with Dendrobium and Wongawilli Collieries also extend into the north-west of the LGA.

iv Industry

Industrial and manufacturing facilities in the region include cement works, brickworks, metal fabrication, mining equipment manufacture and quarries. Figure 3.2 in Chapter 3 shows the extent of land zoned for industrial uses to the east of the project area, around New Berrima, and between New Berrima and Moss Vale. A large portion of this area between the two townships is zoned IN1 General Industrial, and part of the Moss Vale Enterprise Corridor; a portion of land set aside for employment generating development under the Wingecarribee LEP. The importance of this corridor is reinforced in the DP& E's *Sydney-Canberra Corridor Regional Strategy 2006-31.*

Industrial facilities in the area are listed below.

- Berrima Cement Works – located on the fringe of New Berrima, the Boral Cement Limited (Boral) Berrima Cement Works have been operating since 1929 and produce cement products (cement and clinker) for sale in NSW, the ACT and for export. The cement works have approval to produce up to 1.56 Mtpa of cement products, which are dispatched by rail and road transport to domestic customers and to international customers via Port Kembla.

- Berrima Feed Mill – the Ingham poultry feed mill is located on Berrima Road on the fringe of New Berrima, and has been operating for approximately 15 years.

- Omya – Omya's Moss Vale plant was originally established in 1961, and is on Collins Road on the outskirts of Moss Vale. In recent years the incorporation of technology and high levels of automation have resulted in the plant being a high volume producer of bulk products for the glass, agriculture, mining and manufacturing industries.

- Dux – The Dux hot water plant is also located on Collins Road in Moss Vale, and produces both solar and electric hot water heaters.

- Resource recovery centre – The WSC resource recovery centre is off Berrima Road, Moss Vale and comprises a waste recycling, collection and transfer facility.

5.3.3 Community profile

As mentioned above in Section 5.3.2 the main regional centres in the area are Moss Vale, Bowral and Mittagong, where retail and community facilities, infrastructure and services are concentrated. Smaller nearby villages include Sutton Forest, Exeter, Medway, New Berrima and Berrima (refer to Figures 1.1 and 1.2).

The project's operational workforce will be required to reside within 45-minutes travel time of the mine. This 'workforce catchment area' encompasses most of the Wingecarribee LGA as well as parts of the surrounding LGAs.

The Wingecarribee LGA has experienced moderate population growth over the last decade with a total increase in population of 9.8% to an estimated 47,584 people in 2014. The population in the Wingecarribee LGA is older than the NSW average with approximately 37% of the population aged over 55 compared with 27% of the NSW population. Approximately 8% of the LGA's population is aged between 25 and 34. This is significantly lower than the NSW average of 14%. The disproportionate distribution of different age groups within the LGA is indicative of two trends – an ageing population and migration of working age people to larger centres because of limited local employment opportunities.

In general, there are higher or consistent levels of education, health, wellbeing and income within the Wingecarribee LGA compared with NSW.

There are relatively low unemployment rates in the Wingecarribee LGA, reported at 3.6% in March 2015 compared with 5.9% across NSW. The main industries of employment are health care and social assistance, retail trade and manufacturing. The most common occupations in the Wingecarribee LGA are professionals, technicians and trade workers.

Population forecasts for the Wingecarribee LGA predict that the area will continue to experience population growth to 2031. This is due to its high amenity, strategic location between Sydney and Canberra, and its diverse economy. Currently, there is a good supply of affordable housing with a number of additional release areas identified by WSC to accommodate future predicted population growth. In addition, there is a good supply of a range of community facilities and services available to the public including schools, recreation facilities and emergency services.

5.4 Cultural factors

5.4.1 Aboriginal heritage

Field investigations have identified a number of Aboriginal sites in the project area, comprising open artefact sites, grinding groove sites and rock shelters, with some containing archaeological deposit and/or art. Rock shelters are confined to the western portion of the project area and do not occur in the proposed surface infrastructure area. A number of potential archaeological deposits (PADs) have also been identified at rock shelters, open artefact sites and elevated landforms near watercourses. Test excavation has been carried out in these areas to confirm the presence or otherwise of archaeological deposits.

Most of the Aboriginal sites in the project area occur near watercourses, typically on landforms such as low hill spurs, which have gently inclined elevated topography and good outlook across the surrounding environment. Artefact scatters have also been recorded on ridgelines, but generally at lower densities than those adjacent to watercourses. Areas of moderate to high archaeological sensitivity occur on outcropping sandstone geology within the Belanglo State Forest. The sandstone escarpment and low hills with scarp landform features in this area support rock shelters and grinding grooves.

No places of specific cultural significance are known to occur in the project area.

Further information on Aboriginal cultural heritage in the project area and surrounds is provided in the cultural heritage assessment in Appendix S, and the key findings are summarised in Chapter 21.

5.4.2 Historic heritage

European settlement in the present-day Wingecarribee LGA began in the 1820s as members of the new colony searched for grazing and farming land. The area was developed for farming and in the latter part of the nineteenth century became a holiday destination because of its cooler climate and European style gardens. There are a number of historic heritage items and landscapes across the region, including buildings, streetscapes, gardens and tree plantings that date back to the nineteenth century.

The project area has been refined to exclude heritage items where possible and, as a result, it does not contain any items listed on the State Heritage Register as being of State significance though several are present nearby. In addition, numerous heritage items listed on the Wingecarribee LEP are present in the vicinity of the project area, but mainly in the neighbouring areas of Sutton Forest, Berrima and Moss Vale, and on Golden Vale Road. These are mostly houses, cottages, gardens, agricultural complexes including sheds and other outbuildings, and functional buildings such as post offices. There are some locally listed heritage items and their curtilages along the southern boundary of the project area, and one, 'Mereworth house and gardens' built circa 1965, within the project area near the proposed surface infrastructure area.

Scatters of bricks, glass fragments and other relics have been identified at two locations, both near Oldbury Creek and the proposed surface infrastructure area. These two sites are both considered to have archaeological potential.

Further information on historic heritage in and surrounding the project area is provided in the Statement of Heritage Impact in Appendix T, and the key findings are summarised in Chapter 22.

5.5 Other development

As described above in Section 5.3.2, a number of industrial, extractive and manufacturing facilities occur in the locality. The EIS has also considered proposed or recently approved developments in the region with respect to cumulative impacts, as listed below.

- Berrima Cement Works - A modification to the existing development consent was recently approved (modification 9) to allow the use of solid waste derived fuel as an energy source and construction and operation of a fuel storage and kiln feeding system. The modification will result in changes to air emission limits of particulate matter, nitrous oxides and volatile organic compounds.

- New Berrima Clay/Shale Quarry – The Austral Brick Company Pty Ltd (Austral) was granted Project Approval for the New Berrima Quarry in July 2012. This approval allowed the extraction of clay/shale from a resource within the Mandurama property, approximately 1.5 km east of New Berrima and 1.5 km north-east of the Berrima Cement Works, for transportation and use principally at the Bowral brick plant. No construction or extraction operations have been undertaken since Project Approval was granted, and Austral recently sought a modification to the original project approval to allow the relocation of the extraction area. The PAC recommended approval to the modification in November 2015. The quarry location is approximately 4 km from the eastern boundary of the project area.

- Green Valley Sand Quarry – Rocla Materials Pty Ltd (Rocla) received approval on 21 June 2013 for the construction and operation of a sand quarry in an area 28 km south-west of Berrima and 14 km north-east of Marulan. The approval allows the extraction of sandstone, dry and wet processing operations and despatch of sand products to markets on the South Coast, Southern Highlands and Sydney. The quarry is not yet operational.

- Sutton Forest Quarry – SEARs for the Sutton Forest Quarry were issued on 7 February 2014. The SSD proposal involves the establishment of a quarry approximately 20 km south-west of Moss Vale, to extract and process up to 1.15 Mtpa of sand from a total resource of approximately 25 Mt. A development application and accompanying EIS has not been submitted for the quarry.

A description of how other developments have been considered in the cumulative impact assessment of the project is presented in Table 5.4.

Table 5.4 Other developments considered in cumulative impact asessments

Study	Development considered in cumulative assessment
	Existing development
Water resources	Surface water - there are no existing developments in or around the project area that would contribute to cumulative impacts with the Hume Coal Project. The Berrima Rail Project, which is upstream of the Hume Coal Project area in the Oldbury Creek catchment, is the only relevant additional project to consider for cumulative impacts. Potential cumulative impacts on flooding, drainage and surface water quality of the two projects were therefore assessed. Groundwater - relevant existing groundwater works include landholder bore pumping and the Berrima Colliery. The groundwater model includes both in the baseline against which project effects are assessed. There are no water-related aspects of the proposed or recently approved projects listed above that would contribute to cumulative drawdown or water quality changes for the project.
Soils	The cumulative impacts on soil and land capability of the Hume Coal Project and the Berrima Rail Project were assessed.
Biodiversity	Potential cumulative impacts as a result of the following projects were considered: • Berrima Rail Project • Sutton Forest Quarry • Green Valley Sand Quarry • New Berrima Clay/Shale Quarry
Noise	The application of the Industrial Noise Policy (INP) and the derivation of criteria for all assessment locations take into account existing industrial noise levels, and therefore enables an assessment of the potential for cumulative noise impacts from all existing industrial noise sources. The Berrima Rail Project will include a rail maintenance facility located to the east of the Hume Highway. The construction and operation of this facility has been included in the assessment of cumulative industrial noise impacts, by conservatively combining 15-minute LAeq noise levels from the rail maintenance facility with predicted 15-minute LAeq noise from the Hume Coal Project.
Air	The air quality assessment included an assessment of the following with respect to cumulative air quality impacts: • Berrima Rail Project • Berrima Cement Works • New Berrima Shale Quarry • Dux Manufacturing Moss Vale • Ingham's Berrima Feed Mill • Omya Southern Limestone, Moss Vale • Southern Regional Livestock Exchange • Wingecarribee Resource Recovery Centre
Traffic	Cumulative impacts on current road users were considered through the use of historic RTA and RMS tube traffic counts from the years 2005 and 2012. The impact on the road network of combined traffic volumes associated with the Hume Coal Project and the Berrima Rail Project were also assessed.
Visual	The visual assessment considered the potential cumulative visual amenity impacts of the Berrima Cement Works, Omya and Inhgam's feed mill, which have visual significance in the locality due to their height. The potential for cumulative visual impacts with the Berrima Rail Project were also assessed.

6 Project evolution and alternatives

6.1 Introduction

This chapter describes the alternatives that were considered during the planning of the Hume Coal Project. The project design concept presented in Chapter 2 is the result of an iterative process undertaken to achieve a project design that represents leading practice in underground coal mining; one that provides efficient extraction of the resource, environmental protection and socio-economic benefits.

The design and location of elements of the project were evaluated and a number of fundamental aspects were given particular scrutiny. These were:

- the mining method;
- underground mine layout, including panel widths and mine footprint;
- surface infrastructure;
- surface and underground water management philosophy and infrastructure;
- site access;
- management of coal rejects; and
- accommodation for construction workers.

The alternatives considered for each of these aspects are discussed in the sub-sections below.

6.2 Mining method and mine plan

Hume Coal considered numerous mining methods and layouts, such as longwall, miniwalls, first workings, full and partial extraction bord and pillar methods, evaluating each against the objectives of technical, financial and environmental optimisation.

Due to the nature and location of the deposit, open cut mining methods were never considered to be appropriate. Aside from the increased surface disturbance related environmental impacts associated with an open cut mine when compared to an underground mine, the stripping ratio would exceed 20 bcm/tonne even in areas of the deposit with a relatively shallow depth of cover, quickly ruling this option out.

The project design phase was undertaken over a period of approximately five years, allowing extensive baseline data to be obtained to inform the project design. The key steps in this process are listed below.

1. Concept Study - a concept study was completed in 2011 and recommended a combination of longwall and bord and pillar mining methods. This recommendation was then investigated further in a pre-feasibility study.

2. Pre-feasibility study - this study was completed by consultants in March 2013, and recommended a combination of 300 m wide longwall panels and first workings across the entirety of A349.

3. Pre-feasibility study review - following the 2013 pre-feasibility study, Hume Coal commissioned a detailed review of the pre-feasibility study. The first stage of this review defined a more conservative set of constraints and mine design criteria. An environmental opportunities and constraints analysis was undertaken as part of this process. The constraints that have long been evaluated included resource quality, geotechnical, geology, engineering, logistical, land ownership, environmental and social considerations. Based on this analysis, potential constraints were mapped, including:

   - areas where the coal seam thickness or coal quality was likely to be unsuitable for mining or require special treatment;
   - areas with depths of cover less than 70 m;
   - major geological structures such as Mount Gingenbullen;
   - residential areas such as Sutton Forest and Exeter;
   - roads and other sensitive surface infrastructure;
   - watercourses (with stream order differentiated);
   - valuable ecological features;
   - areas of low resource confidence;
   - Aboriginal heritage items; and
   - State-listed heritage items.

   The resultant constraints plan informed the development and evaluation of alternative mining systems and mine plans. To develop a viable project that would have acceptable social and environmental impacts, a viable mining system needed to be identified that would meet the following objectives:

   - minimise groundwater impacts;
   - minimise subsidence impacts;
   - have the flexibility to deal with surface and geological constraints;
   - able to be mined in a safe and efficient manner; and
   - be able to accommodate underground reject emplacement.

The mining system alternatives that were considered against their ability to achieve these objectives and the results are described below.

6.2.1 Alternative 1 – Longwall

As mentioned above, the initial concept study recommended a combination of longwall and bord and pillar mining. These mining methods were investigated further in the pre-feasibility study, which recommended a mine plan comprising 300 m wide longwall panels and some first workings across the entirety of A349. This initial alternative involved the extraction of up to 4.5 Mtpa of ROM coal from the Wongawilli Seam, producing both coking and thermal coal products.

Longwall mining involves progressive extraction of large rectangular blocks of coal by a shearer in a series of passes, which run perpendicular to the direction of advancement. Modern Australian longwalls are up to 415 m wide, although the longwalls can be narrower to control subsidence. As the coal is cut the longwall face is supported by hydraulically operated supports, and as the face advances, the roof behind the face supports is allowed to collapse behind the line of supports forming the goaf. The relaxation of the overlying strata into the void results in surface subsidence and potential damage to surface features. After extraction of each block of coal, the equipment is relocated to a new pre-developed block of coal to re-commence production.

Generally, the advantage of longwall mining is that it maximises resource recovery compared with other underground mining methods. However, it also causes subsidence impacts with the potential to damage natural and built surface features, as well as potentially increasing water inflow to underground workings due to increased hydraulic conductivity in the rock strata above the goaf. Longwall mining is also less flexible in being able to avoid sensitive surface features and geological constraints. Further, the mine layout recommended in the concept study included mining under potentially sensitive structures such as State significant heritage properties. While this would have maximised resource recovery, it was considered by Hume Coal that the environmental impacts were unacceptable and this option was rejected.

6.2.2 Alternative 2 – Miniwalls and Wongawilli method

Hume Coal then commissioned a review of the pre-feasibility study, which examined the alternative of extracting coal by using miniwalls; a mining system which would reduce both subsidence and environmental impacts when compared with longwall mining.

Miniwalls are typically less than 100 m in width. The system is very similar to longwalls with the primary difference being the width of the face, although there are other differences in terms of equipment sizing and selection, capital cost and operating methods. Whilst extraction by miniwalls results in less subsidence than longwall mining, their use is uncommon in Australia as they are require high development rates to support miniwall extraction and provide only limited flexibility in avoiding geological anomalies.

Reduced panel sizes of varying widths were investigated, including, 50 m, and 100 m wide miniwall panels, as well as 150 m wide longwalls. The different panel widths were considered across the different areas of A349, depending on each area's sensitivity to subsidence impacts and groundwater inflow considerations. The principal recommendation from this investigation was a mine plan comprising a combination of 50 m and 100 m wide miniwalls, as well as a modified Wongawilli method of extraction using continuous miners, and some first workings in areas containing sensitive surface features.

The modified Wongawilli method is a bord and pillar method that has been used extensively in the Wongawilli Seam and in the Southern Coalfield. This method uses continuous miners and shuttle cars for all mining activities. The system can be established to commence pillar extraction in parallel with panel development. Whilst this system is less productive than miniwalls, it results in less subsidence than from an equivalent width miniwall and allows greater flexibility with respect to avoidance of adverse geology and subsidence management around sensitive surface features.

The multi-system mine plan considered in the pre-feasibility study review therefore comprised:

- 90 m wide miniwalls panels east of the Hume Highway and west of Golden Vale Road;
- modified Wongawilli panels east of Golden Vale Road; and
- 40 m wide miniwalls panels west of the Hume Highway.

Whilst this mine design alternative incorporated measures to protect sensitive surface features, the use of miniwalls would still result in some subsidence impacts across the project area. This mining method would also see heightened fracturing of the Hawkesbury Sandstone and therefore increased flow or permeability of water through the aquifer. This multi-system mine plan was ultimately rejected due to the desire to minimise groundwater and subsidence impacts and to provide a non-caving mine void for the underground emplacement of coal rejects.

6.2.3 Alternative 3 – Low impact mining methods

After considering longwall and miniwall mining systems, Hume Coal considered lower impact mining methods. Mining systems were evaluated that would enable economic resource recovery while eliminating 'caving', which is the process where the roof of the extracted area is allowed to collapse following mining, as is the case with longwall mining, resulting in surface and subsurface subsidence impacts. Eliminating caving has the added advantages of keeping void spaces open so that they can be used for underground reject emplacement, and of maintaining the integrity of the strata overlying the Wongawilli Seam which contains the aquifer. The mining systems investigated included:

- traditional first workings only (using square pillars);
- pillar 'pocketing' system, which involves first workings, followed by progressive extraction of additional coal from the pillars left during first workings development, such that the pillars are reduced in size in a 'non-caving' manner; and
- a modified first workings system, incorporating slender pillars and parallel drivages into the mine layout, as described in the following section and in detail in Chapter 2.

These systems were found to meet the goals established for the project, as listed in Section 6.2, and would provide better environmental outcomes than other alternatives considered (longwall mining, and a combination of miniwall and bord and pillar). The system incorporating slender pillars has the added advantage of lending itself to automation of the mining process, allowing personnel to work remotely from the face. Accordingly, this mining method was selected for more detailed investigation.

6.2.4 The proposal – first workings with slender pillar system

The key features of the innovative 'non-caving' coal extraction method adopted for the project, to address all of the constraints identified, are described below.

- The underground mine layout, described in detail in Chapter 2, enables economic resource recovery whilst leaving sufficient coal in place in the form of web and barrier pillars to keep the overlying strata supported and provides long-term geotechnical stability, thus meeting the goals of minimising and/or eliminating subsidence impacts and minimising groundwater impacts. The environmental, social and economic benefits of this option are discussed in detail in Chapter 23 (justification). Surface subsidence impacts will be negligible. The very minor levels of ground settlement above first-workings only mines are typically limited to pillar compression resulting from the combined effect of increased loading and depressurisation of a coal seam, and are typically imperceptible, as confirmed in the subsidence assessment undertaken of the project (refer to Chapter 14). The overburden remains intact, and so disturbance to overlying strata and aquifers, and associated groundwater impacts is minimised and allows rapid post-mining groundwater recovery (refer to Chapter 7 water resources).

- The void spaces will be kept open until each panel is sealed with bulkheads, thus allowing reject emplacement underground, and removing the need for surface reject emplacement, with associated potential for air quality, visual, and surface disturbance related impacts. Placing the rejects underground will also act to enhance underground pillar stability and benefit the overall system.

- Each mining panel will be separated from adjacent panels by 50 m wide solid coal barrier pillars. The mine workings in each panel will be partially backfilled with coal reject and then sealed with bulkheads following completion of mining. This will allow groundwater to recover more rapidly. Long-term pillar stability will be further enhanced once the mine workings fill with groundwater and a full hydrostatic pressure head has been re-established, albeit that the system is designed to be long-term stable with or without backfill and hydrostatic pressure. The bulkheads are designed to be water-retaining and thus also minimise inflows to the active mining area.

- The proposed mining system is flexible. It can be modified as required to avoid specific features, for instance geological structures such as faults and diatremes, including any which may not yet have been identified. This facilitates an adaptive management strategy. Notwithstanding, to avoid any perception that primary dwellings or the Hume Highway could be affected by long-term ground movements, no panels will be beneath these features, with only underground roadways required to access other parts of the mine.

In addition to the mining method and mine plan, alternatives in relation to other aspects of the project were considered; including surface infrastructure location and design, reject emplacement, water management and site access. These are discussed in the following sections.

6.3 Surface infrastructure and equipment

Numerous surface infrastructure locations and designs have been examined as the mine plan developed, each evaluated against the aforementioned criteria of technical, financial and environmental optimisation. This has broadly been by a two stage process, to firstly identify a suitable site and to then refine the surface infrastructure design within that site, as described below.

6.3.1 Locations considered

The primary requirements in identifying a suitable location for the project's surface infrastructure were:

- proximity to the underground mining area;

- proximity and access to important services and infrastructure, particularly the rail network;

- land availability, that is Hume Coal must already own or likely be able to purchase the land, or where landowner approval could be negotiated to gain access; and

- a suitably sized area, relatively free from environmental, urban and other constraints, specifically to enable:

  - avoidance of more densely populated areas and areas with fragmented land ownership;

  - avoidance of flood-prone land, defined as land that would be inundated by a 1% annual exceedance probability (AEP) rainfall event, that is, an event that on average occurs once every 100 years;

  - avoidance of large tracts of native vegetation;

  - integration with the existing topography and landform by selecting a relatively flat site where the need for cut and fill is minimised, and with the site surrounded by landforms and/or vegetation that would minimise exposure from the Hume Highway and other sensitive viewing points;

- minimisation of the number of watercourse and road crossings by new infrastructure; and
- concealing surface infrastructure from sensitive receptors as much as possible, to minimise the potential for visual, noise, dust and amenity impacts.

Hume Coal looked for options within and adjacent to A349 and identified several sites that met some or most of the above criteria. Numerous locations and variations to these were considered, which can all be summarised in four general areas shown indicatively on Figure 6.1. The preferred option described in this EIS is Option 4, which has the advantage of meeting each of the afore-mentioned criteria and is also viable in terms of functionality, cost and efficiency. The main reasons for rejecting the other three options are outlined in Table 6.1.

Table 6.1 Alternative surface infrastructure locations considered

Location		Main reasons rejected
1.	Between Exeter and the Illawarra Highway	Proximity to the village of Exeter and associated potential for visual, noise, dust and amenity impacts.
		Longer section of Main Southern Rail Line to traverse than other options, with limited train paths available.
		This option was close to the site of the previously proposed Austen and Butta rail spur and pit top, and was rejected by Hume Coal very early on.
2.	Central A349, east of Hume Highway	Distance from the rail line - extensive overland conveyors required over numerous properties, with substantial cost and increased disturbance footprint.
3.	North of A349, near Berrima Cement Works	Potential cumulative noise, visual and dust impacts at New Berrima, because of the site's proximity to other industrial facilities including the Berrima Cement Works and Austral Bricks shale quarry.
		Limited land available for purchase.
4.	Central northern A349, west of Hume Highway, and extending north of A349	Not applicable – selected as preferred option.

Surface infrastructure locations considered

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Figure 6.1

EMM HUMECOAL

6.3.2 Designs considered

Alternative designs were evaluated at each of the surface infrastructure locations under consideration. Once the preferred location was chosen, Hume Coal worked with engineering and environmental specialists to develop and refine the project components and their layout within that site. The design had to satisfy the same requirements listed in Section 6.3.1 for selecting a location. Hume Coal was also seeking to:

- minimise the disturbance footprint as much as practicable and avoid direct impacts on features like Mereworth House and Gardens, which is a locally listed heritage property owned by Hume Coal;
- position the drift portals (for mine access and egress) and associated mine infrastructure close to the underground mining area; and
- position the CPP and coal stockpiles outside Medway Dam's catchment area and close to rail. While the project's water and wastewater management system is designed to avoid unplanned off-site movement of contaminants and sediment, and Medway Dam is a third-tier water supply, which is currently not used (Beca 2010), it was considered that the community would be more confident with not having these in its catchment.

Conceptual layouts of the various options were prepared. These were then subject to environmental investigations and a series of workshops held to further optimise the design and mitigate potential impacts. This included consideration of air, noise, visual, heritage, and ecological factors. Examples of the refinements made to the initial concepts as a result of preliminary environmental investigations and baseline monitoring are provided in the following sections.

i Heritage and ecology considerations

Archaeologists and ecologists surveyed proposed surface infrastructure areas. They identified areas of potential sensitivity such as Aboriginal sites and threatened species habitat, as well as areas of 'low constraint', which represented opportunities for positioning surface infrastructure with minimal impact. In particular, a narrow corridor of native vegetation along Oldbury Creek (north of where the CPP is proposed) was found to provide potential habitat for threatened microbats and Koalas and some Aboriginal sites were found there. The original design extended much closer to Oldbury Creek than what is now proposed. Management and mitigation measures were recommended to address potential impacts. However, Hume Coal decided to move the proposed CPP site and associated stockpile areas south to avoid this area and the associated potential for Aboriginal heritage and ecological impacts. Also, the layout was reconfigured to fit within a smaller footprint to avoid Medway Dam's catchment area and a number of sites containing Aboriginal heritage items and endangered Paddy's River Box (*Eucalyptus macarthurii*) trees.

The resultant design completely avoids State-listed heritage items and direct impacts to locally-listed heritage items, and avoids most threatened fauna habitat, endangered tree species and Aboriginal heritage sites.

ii Air and noise considerations

a. Surface Infrastructure location modified

The surface infrastructure area, inclusive of the ventilation fans, administration building and workshops, was originally proposed to be on the southern side of Medway Rivulet, as shown on Figure 6.1. The administration and workshop area was shifted north to increase its set-back from receptors on the highway's eastern side, and the ventilation fans were moved westward. This assisted minimising the potential for adverse noise, dust and amenity impacts on nearby receptors. Further, careful consideration has been taken to design the infrastructure within the lay of the land and topography to avoid and/or reduce potential visual amenity related impacts.

b. Conveyors

Hume Coal initially committed to enclosing transfer points and drives for all major surface conveyors. Hume Coal then took this a step further by committing to install state-of-the-art low noise conveyor rollers (otherwise known as idlers). This technology is considered leading practice and has been demonstrated to significantly reduce noise compared to conventional conveyors (Brown 2004).

c. Dozers removed from stockpiles

Dozers were initially proposed to be used to manage coal at the stockpiles. Preliminary air and noise modelling showed that they would be a dominant emission source. Accordingly, it was decided to use stackers and reclaimers instead for both ROM coal and product coal stockpiles.

d. Other dust and noise mitigations

Other innovative and leading practices introduced as the project evolved included:

- enclosing drives, pump motors and processing equipment on-site to minimise noise and dust propagation;
- restricting certain activities such as shaping of the temporary reject stockpile by dozer to the daytime only;
- minimising use of surge bins (typically a significant source of dust and noise emissions) as much as possible; and
- covering all train wagons travelling to and from the mine, the first coal project in Australia to do so.

6.4 Reject emplacement

The first two alternative mining methods investigated for the project; longwall and miniwalls, as described in Section 6.2, included surface reject emplacement in the project design. The surface emplacement option included the use of belt press filters for dewatering of the ultrafine reject to a cake consistency and combining this material with coarse reject. The combined reject would then be disposed of by trucks to surface emplacement areas.

One of the advantages of the adopted first workings mining system (ie non-caving) is that the void spaces left from the extraction of coal will be kept open, thereby allowing reject emplacement underground and removing the need for permanent surface reject emplacement. This option has been incorporated into the final project design as it has many advantages, in particular reducing the surface disturbance footprint and removing the air quality, noise and visual impacts associated with traditional surface emplacement of reject material.

Both settling and non-settling styles of reject were investigated and a non-settling paste was ruled out due to higher capital and operating costs associated with milling plant.

6.5 Water management

Water management was recognised early in the initial project planning phase as a key design consideration. Management of groundwater inflows, groundwater recovery and surface water/groundwater connectivity have all been key inputs into the project design process.

In recognition of the importance of groundwater and surface water issues, Hume Coal established a WAG in 2011. The WAG generally met on a quarterly basis throughout the project planning and environmental assessment phases, acting as an advisory committee for the development of an effective an efficient water management system that would result in acceptable impacts.

The options for managing water evolved as the mining method and plan evolved. The main options considered are listed below.

- Recirculation / reinjection – this option involve collecting groundwater that flows into the mine workings and recirculating it back into the sealed up mined-out voids behind bulkheads. The principal benefit of this option is the reduction of the groundwater take, minimising the associated groundwater drawdown and recovery time.
- Managed aquifer recharge – this option involves injecting water extracted from the underground workings back into the Hawkesbury Sandstone. The particular application considered was reinjection prior to the availability of volume behind the bulkheads during the early stages of mining. Injection of surplus water into the Hawkesbury Sandstone would provide an excellent mitigation measure to minimise groundwater drawdown in landholder bores, and enhance recovery times following mining. However, a licence to trial this activity (ie injection into a water source) was not issued by DPI Water, and as such, this mitigation measure could not be properly investigated and included in the project.
- Water treatment and use (for example for irrigation).
- Water treatment and release to creeks.

The option adopted for managing surplus water involves a combination of reinjection to underground sealed panels, and treatment and release to Oldbury Creek for those years where the capacities of other strategies (reinjection and storage) are exceeded under a small percentage of potential climate scenarios modelled.

A detailed discussion on the adopted water management strategy is provided in Chapter 7.

6.6 Site access

During the site access investigations it was decided that no new access points would be created from the Hume Highway, in accordance with the preferences of the RMS.

Road access to the surface infrastructure area, as presented in this EIS, will therefore be principally from Mereworth Road, with secondary access only from existing intersections on the highway.

6.7 Workforce accommodation

Both the use of existing local accommodation or building a temporary accommodation village for construction workers were considered. A peak workforce of 414 full-time equivalent employees will be required during the construction phase. Given the highly specialised skills that will be required, it has conservatively been assumed that the majority of construction workers will be sourced from outside the local area, and therefore these workers will require accommodation whilst rostered on during construction. This meant there was potential for the project to be competing with the local tourism industry for beds during peak periods. On this basis, Hume Coal decided to house non-local workers in a temporary accommodation village within the project area. This arrangement will mean that the presence of non-local construction workers will not place excessive pressure on local short-term accommodation supply. In addition, the village will significantly reduce project-related effects on the general availability of rental accommodation, which generally has low vacancy rates in the area.

In relation to the operational workforce, for work health and safety reasons, Hume Coal will require all operations employees to live within 45 minutes travel time from the project area. This policy will reduce the risk of fatigue related travel accidents, given that some production employees will be working afternoon and night shifts. Given the utmost importance placed on safety, no other options were considered in this regard.

6.8 'Do nothing' alternative

The 'do nothing' alternative would result in the relinquishment of A349 to the NSW Government. The immediate effect would be the loss of approximately 15 local full-time equivalent positions, as well as up to 100 contractors and service providers, both local and located elsewhere. In subsequent years there would be a lost opportunity of up to 414 construction jobs and 300 operational jobs, as well as the indirect and induced employment flow on effects the project would create. Rates, royalties and other tax payments from this publicly owned coal resource to Local, NSW and Commonwealth Governments would be foregone. Coking coal used for steel manufacture would need to be sourced from another location quite likely outside Australia, resulting in a potential loss of market share for NSW and the country.

One of the objects of the EP&A Act is to encourage the proper development of natural resources, including minerals, for the purpose of promoting the social and economic welfare of the community. The do nothing alternative would result in 50 Mt of coal remaining unrecovered, and therefore the economic benefits that flow from the recovery of a coal resource would not be realised. The impact assessment provided in Part D of this EIS shows that the resource can be economically recovered in an environmentally and socially acceptable way, and as such this alternative would conflict with the objects of the EP&A Act.

The do nothing alternative would also result in significant financial inefficiency due to the loss of the large investment already made by Hume Coal in exploration activities, mine planning, land purchases, extensive environmental investigations and contributions already made to the local community.

The assessment documented in this EIS has found that the overall balance of environmental, social and economic impacts of the project is positive from both a public interest perspective and that of the applicant. Consequently, the do nothing option was not considered further. Further discussion on the justification of the project is provided in Chapter 23.

Part D

Impact assessment

Chapter 7: Water resources
Chapter 8: Soil and land resources
Chapter 9: Agricultural resources
Chapter 10: Biodiversity
Chapter 11: Noise and vibration
Chapter 12: Air quality
Chapter 13: Greenhouse gas
Chapter 14: Subsidence
Chapter 15: Traffic and transport
Chapter 16: Visual amenity
Chapter 17: Closure and rehabilitation
Chapter 18: Hazards and risk
Chapter 19: Economic assessment
Chapter 20: Social assessment
Chapter 21: Aboriginal heritage
Chapter 22: Historic heritage


MSA

7 Water resources

7.1 Introduction

A detailed assessment of the potential impacts on surface water and groundwater resources was conducted for the project. The water assessment was prepared with the input of a number of technical studies, including:

- Surface Water Quality Assessment (WSP PB 2016a);
- Surface Water Flow and Geomorphology Assessment (WSP PB 2016b);
- Flooding Assessment (WSP PB 2016c);
- Water Balance Report (WSP PB 2016d);
- Groundwater Assessment, Volume 1: Data Analysis (Coffey 2016a);
- Groundwater Assessment, Volume 2: Numerical modelling and Impact (Coffey 2016b); and
- Hydrogeochemical Assessment (Geosyntec 2016).

As described in Chapter 1, leading practice measures have been incorporated into the design of the project, including measures specifically related to avoiding, minimising and/or mitigating potential impacts to water resources including:

- adoption of a first workings mining method with negligible associated subsidence;
- underground emplacement of reject, which removes the need for permanent reject emplacement areas; and
- progressive sealing of mined panels, allowing for faster groundwater recovery.

The water management strategy for the project has been developed following a number of years of baseline data collection and an iterative design process, with results of initial surface and groundwater modelling informing the mine design, layout and reject disposal methods. The strategy is based on diverting clean water around the surface disturbance areas, retaining water that falls within disturbed areas on site for recycling and reuse, and injecting groundwater into sealed voids enabling an increased groundwater recovery rate and reduced drawdown impact. The water management strategy also minimises evaporation losses by storing excess water in underground voids to accelerate the groundwater recovery time and/or use in operations.

This chapter provides a summary of the water assessment report, which is attached in Appendix E. The technical studies prepared as input to the overarching water assessment (as listed above) are appended to that report.

7.1.1 Assessment requirements and guidelines

The SEARs require an assessment of the likely impacts of the project on the region's surface water and groundwater resources. The specific requirements relating to water are presented in Table 7.1.

Table 7.1 Water related SEARs

Requirement	Section where addressed in this document
As assessment of the likely impacts of the development on the quantity and quality of the region's surface and groundwater resources, having regard to the EPAs, DPIs and Water NSW requirements and recommendations.	Section 7.4 – surface water Section 7.5 - groundwater
An assessment of the likely impacts of the development on aquifers, watercourses, riparian land, water-related infrastructure, and other water users.	Section 7.4 – surface water Section 7.5 - groundwater
An assessment of the potential flooding impacts of the development.	Section 7.4.3
A water management strategy, having regard to the EPA's, DPI's and WaterNSW requirements.	Section 2.10

A number of agencies, including DPI Water, WaterNSW, the EPA, OEH, and the DoEE raised matters relevant to water resources in their assessment recommendations for the project. The agency recommendations and where they are addressed in the EIS are included in Appendix B along with the SEARs, and were taken into account in preparing the water assessment.

A number of government guidelines were also considered in preparing the water resource assessments. The Commonwealth Government released significant impact guidelines to assist any person who proposes to take an action which involves a coal seam gas development or a large coal mining development to decide whether the action will have or is likely to have a significant impact on a water resource (DoE 2013). These guidelines were consulted in preparing the referral documentation to the DoEE. As described in Chapter 3, after referral the project was deemed a controlled action by DoEE on the basis that it may impact a water resource (ie the 'water trigger', Sections 24D and 24E of the EPBC Act) and listed threatened species and communities (Sections 18 and 18A of the EPBC Act).

The surface water and groundwater assessments were also undertaken in accordance with the *Information Guidelines for Independent Expert Scientific Committee (IESC) advice on coal seam gas and large coal mining development* (IESC 2015). The IESC is a statutory body established under the EPBC Act and provides advice to the Commonwealth Government on water related matters for projects referred to the Commonwealth under the EPBC Act water trigger, and also on projects referred to them directly from state authorities.

The IESC published guidelines (IESC 2015) to outline their role in providing scientific water advice to the Commonwealth Government, and provide a checklist of information requirements to adequately assess impacts of a project. The water resources assessment considered these requirements and outlines that the information required and the impact assessment undertaken adequately addresses these guidelines. The IESC checklist is included in Appendix B of the water assessment report (refer to Appendix E) indicating where each requirement has been addressed.

7.1.2 Study area

Each technical water assessment focused on a particular study area that was relevant to the subject matter. The study area for each technical assessment is described in Table 7.2.

Table 7.2 Defined study areas for each technical assessment

Technical assessment	Study area
Water balance	The surface infrastructure area footprint and the underground mine footprint (Figure 2.1)
Surface water quality	The streams with potential to be impacted by the project within the groundwater model domain (Figure 7.6)
Surface water flow and geomorphology	Streams adjacent to and downstream of the surface infrastructure area within the Medway Rivulet and Oldbury Creek catchments, and streams affected by loss of baseflow due to aquifer depressurisation
Flooding	The surface infrastructure area (Figure 2.1) and the surrounding Medway Rivulet and Oldbury Creek catchments
Groundwater numerical model	The groundwater model domain (Figure 7.6)
Hydrogeochemical	The underground mine and portions of the groundwater systems down hydraulic gradient from the underground workings

7.2 Existing environment

7.2.1 Water sharing plans

Two WSPs are applicable to the project area and surrounds; one covering surface water resources and the other applicable to groundwater. These WSPs cover numerous water sources, which are then further subdivided into management zones. The WSPs and the applicable water sources and management zones are:

<u>Surface water</u>

Water Sharing Plan for the Greater Metropolitan Region, Unregulated River Water Sources 2011 (Metropolitan surface water WSP) (NOW 2011a):

- Upper Nepean and Upstream Warragamba Water Source
  - Medway Rivulet management zone
  - Lower Wollondilly River management zone
  - Upper Wingecarribee River management zone
  - Lower Wingecarribee River management zone
  - Nattai River management zone
- Shoalhaven River Water Source
  - Bundanoon Creek management zone

Groundwater

Water Sharing Plan for the Greater Metropolitan Region, Groundwater Sources 2011 (Metropolitan groundwater WSP) (NOW 2011b):

- Sydney Basin Nepean Groundwater Source;
  - Nepean Management Zone 1;
  - Nepean Management Zone 2; and
- Sydney Basin South Groundwater Source.

The surface water and groundwater WSP, including water source, and management zone boundaries, are shown in Figures 7.1 and 7.2 respectively. As evident on these figures, the project area is physically within and overlying the Sydney Basin Nepean Zone 1 Groundwater Source, and the Upstream Nepean and Upstream Warragamba Water Source Medway Rivulet and Lower Wingecarribee River Management Zones.

7.2.2 Baseline monitoring program

A dedicated surface water quality and flow monitoring network was established to investigate hydrologic conditions in the project area, providing over four years of baseline data (2012 – 2016, inclusive). The surface water monitoring network consists of 11 stream flow gauging locations and 24 water quality monitoring locations, as shown in Figure 5.2 (refer to Chapter 5). The surface water monitoring locations were developed in consultation with DPI Water in order to:

- achieve spatial representation across the project area, including upstream and downstream locations, and different land uses scenarios;
- characterise major drainages (ie larger stream orders) and streams that will be undermined;
- examine the potential for surface water-groundwater interaction; and
- target key potentially sensitive receptors, including Medway Dam and Long Swamp.

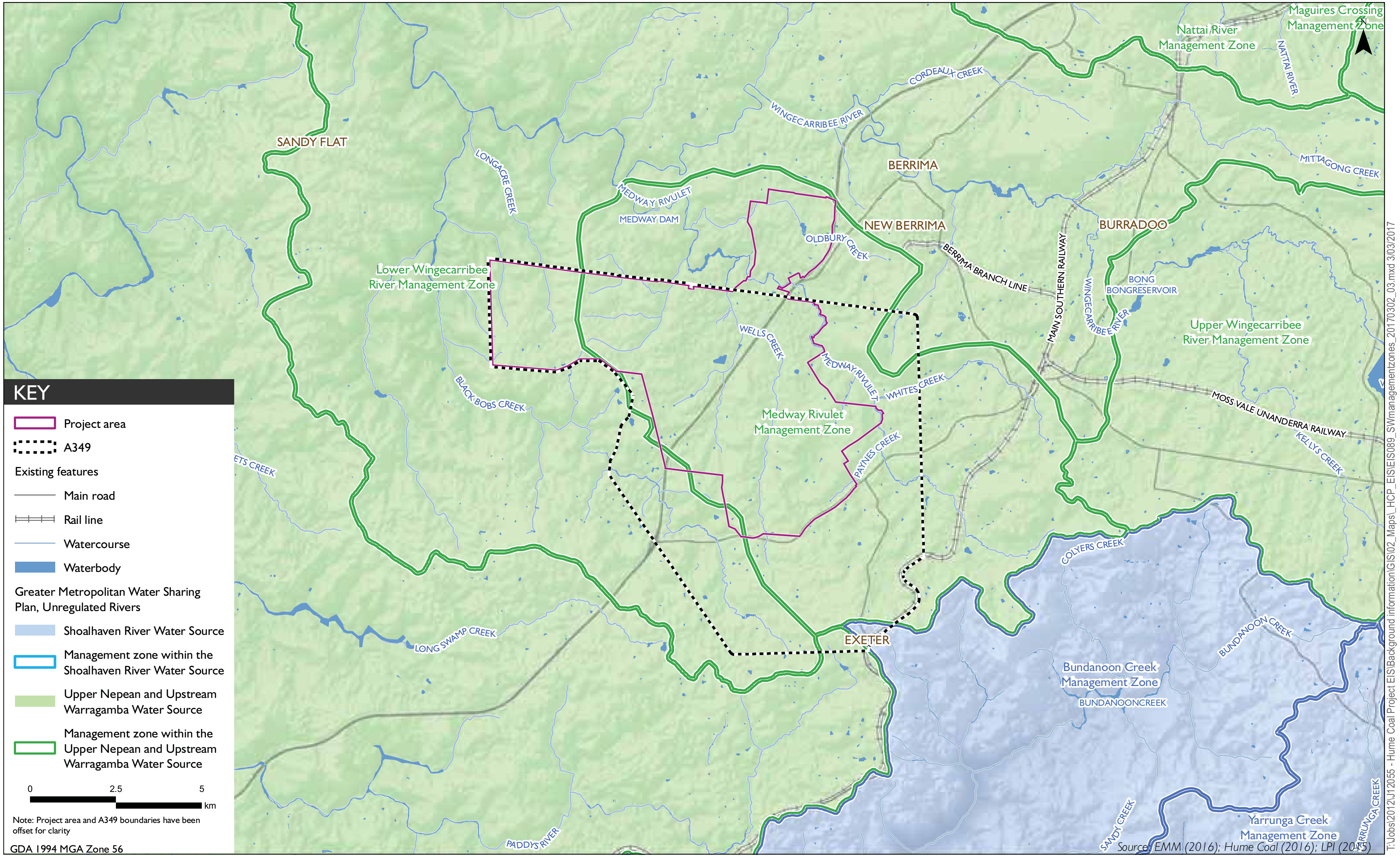
Installation of the groundwater monitoring network occurred between September 2011 and October 2014. The network includes:

- 54 groundwater monitoring bores at 22 locations (some sites have multiple bores at varying depths to provide information on the vertical hydraulic gradients and inferred connectivity at that location (ie nested bores)).
- 11 vibrating wire piezometer sensors within three bores. The sensors collect information on pore pressure within a geological formation which can infer groundwater pressure. Similar to nested bores, positioning the sensors at different depths provides an understanding of vertical hydraulic gradients; and
- Three landholder bores, two within the project area and one to the north. All target the Hawkesbury Sandstone.

The groundwater monitoring network was developed in consultation with DPI Water and was designed to:

- identify and characterise water bearing units and aquitards in the project area, with particular focus on characterising groundwater flow and quality within the main groundwater bearing unit, Hawkesbury Sandstone, and the mining target, Illawarra Coal Measures;
- provide spatial representation of pressure heads across the project area to investigate potential vertical hydraulic gradients and connectivity between water bearing units and the underlying target coal seam;
- investigate the potential for surface water-groundwater interaction; and
- monitor potential sensitive features, including Medway Dam, Long Swamp, landholder bores and potential groundwater dependent ecosystems.

An overview of the existing groundwater and surface water environment, as informed by the extensive monitoring program, is provided in the sub-sections below.



Surface water management zones

Hume Coal Project
Environmental Impact Statement
Figure 7.1

EMM HUMECOAL