

VICKERY EXTENSION PROJECT

ENVIRONMENTAL IMPACT STATEMENT

SECTION 4

ENVIRONMENTAL ASSESSMENT

TABLE OF CONTENTS

4	ENVIRONMENTAL ASSESSMENT	4-1		
4.1	ENVIRONMENTAL RISK ASSESSMENT	4-1		
4.2	CLIMATE AND TOPOGRAPHY	4-1		
4.2.1	Climate	4-1		
4.2.2	Topography	4-4		
4.3	LAND RESOURCES AND AGRICULTURAL PRODUCTION	4-5		
4.3.1	Existing Environment	4-5		
4.3.2	Potential Impacts	4-12		
4.3.3	Mitigation Measures, Management and Monitoring	4-15		
4.4	GROUNDWATER	4-16		
4.4.1	Existing Environment	4-17		
4.4.2	Potential Impacts	4-25		
4.4.3	Mitigation Measures, Management and Monitoring	4-28		
4.5	SURFACE WATER	4-30		
4.5.1	Existing Environment	4-30		
4.5.2	Potential Impacts	4-36		
4.5.3	Mitigation Measures, Management and Monitoring	4-40		
4.6	FLOOD BEHAVIOUR	4-42		
4.6.1	Existing Environment	4-42		
4.6.2	Potential Impacts	4-44		
4.6.3	Mitigation Measures, Management and Monitoring	4-48		
4.7	OPERATIONAL AND CONSTRUCTION NOISE	4-48		
4.7.1	Existing Environment	4-48		
4.7.2	Potential Impacts	4-49		
4.7.3	Mitigation Measures, Management and Monitoring	4-57		
4.8	BLASTING	4-58		
4.8.1	Blast Measurement and Description	4-58		
4.8.2	Predicted Blasting Emission Effects	4-59		
4.8.3	Mitigation Measures, Management and Monitoring	4-59		
4.9	AIR QUALITY	4-60		
4.9.1	Existing Environment	4-60		
4.9.2	Potential Impacts	4-63		
4.9.3	Mitigation Measures, Management and Monitoring	4-69		
4.10	GREENHOUSE GAS EMISSIONS	4-70		
4.10.1	Quantitative Assessment of Potential Scope 1, 2 and 3 Greenhouse Gas Emissions	4-70		
4.10.2	Australian Greenhouse Gas Emissions Reduction Targets	4-72		
4.10.3	Project Greenhouse Gas Mitigation Measures, Management and Monitoring	4-72		
4.11	BIODIVERSITY	4-73		
4.11.1	Existing Environment	4-73		
4.11.2	Potential Impacts	4-85		
4.11.3	Mitigation Measures and Management	4-88		
4.11.4	Project Biodiversity Offset Strategy	4-92		
4.12	ROAD TRANSPORT	4-96		
4.12.1	Existing Environment	4-98		
4.12.2	Potential Impacts	4-101		
4.12.3	Mitigation Measures, Management and Monitoring	4-104		
4.13	ROAD AND RAIL TRANSPORT NOISE	4-104		
4.13.1	Potential Impacts	4-104		
4.13.2	Mitigation Measures, Management and Monitoring	4-106		
4.14	VISUAL CHARACTER	4-106		
4.14.1	Existing Environment	4-106		
4.14.2	Potential Impacts	4-108		
4.14.3	Mitigation Measures, Management and Monitoring	4-122		
4.15	ABORIGINAL CULTURAL HERITAGE	4-123		
4.15.1	Existing Environment	4-123		
4.15.2	Potential Impacts	4-129		
4.15.3	Mitigation Measures, Management and Monitoring	4-130		
4.16	HISTORIC HERITAGE	4-131		
4.16.1	Existing Environment	4-132		
4.16.2	Potential Impacts	4-134		
4.16.3	Mitigation Measures, Management and Monitoring	4-135		
4.17	ECONOMIC EFFECTS	4-135		
4.17.1	Existing Environment	4-135		
4.17.2	Potential Impacts	4-136		
4.17.3	Mitigation Measures, Management and Monitoring	4-137		
4.18	SOCIAL AND COMMUNITY INFRASTRUCTURE	4-137		
4.18.1	Existing Environment	4-137		
4.18.2	Potential Social Impacts and Opportunities	4-138		
4.18.3	Mitigation Measures, Management and Monitoring	4-140		
4.19	HAZARD AND RISK	4-141		
4.19.1	Hazard Identification and Risk Assessment	4-141		
4.19.2	Hazard Prevention and Mitigation Measures	4-141		

TABLE OF CONTENTS (Continued)

LIST OF TABLES

Table 4-1	Meteorological Data Summary – Rainfall and Evaporation
Table 4-2	Meteorological Data Summary – Temperature and Humidity
Table 4-3	Overview of Land and Soil Capability Assessment Scheme
Table 4-4	Summary of Agricultural Suitability Classification/Land Uses
Table 4-5	Potential Impacts of the Project on Regional and State Agricultural Land Area
Table 4-6	Available Whitehaven WALs
Table 4-7	Estimated Water Licensing Requirements for the Project
Table 4-8	Local Sub-Catchment Area Summary
Table 4-9	Summary of Regional Average Water Quality Data
Table 4-10	Summary of Local Average Water Quality Data
Table 4-11	Progressive and Maximum Changes to Contributing Catchment of Stratford Creek, Driggle Draggie Creek and the Namoi River
Table 4-12	Historic and Design Event Peak Flood Discharges for the Namoi River
Table 4-13	Predicted Design Event Peak Flood Discharges for the Local Drainages
Table 4-14	Relative Scale of Various Noise Sources
Table 4-15	NPfI Project-specific Intrusive and Amenity Assessment Criteria for Operational Noise (dBA)
Table 4-16	Significance of Residual Noise Impacts and Potential Treatments
Table 4-17	Proposed Project Noise Mitigation Measures
Table 4-18	Summary of Potential Operational Noise Exceedances at Privately-owned Receivers under Adverse Meteorological Conditions
Table 4-19	Criteria for Particulate Matter Concentrations
Table 4-20	Criteria for Dust Deposition (Insoluble Solids)
Table 4-21	Annual Average PM ₁₀ and PM _{2.5} Concentrations
Table 4-22	Estimated Background Dust Levels
Table 4-23	Summary of Key Potential Project Greenhouse Gas Emissions
Table 4-24	Project Ecosystem Credit Requirements
Table 4-25	Project Species Credit Requirements
Table 4-26	Existing Impact Avoidance and Mitigation Measures
Table 4-27	Existing Biodiversity Offset Strategy
Table 4-28	Project – Additional Biodiversity Offset Strategy
Table 4-29	NSW Summary of Credit Requirements and Proposed Offset Methods
Table 4-30	Surveyed Average Weekday Traffic Volumes

LIST OF TABLES (Continued)

Table 4-31	Average Weekday Project Traffic Distribution (vehicle trips/day)
Table 4-32	NSW Road Noise Policy Criteria for Residential Land Uses
Table 4-33	Network Rail Line Rail Infrastructure Noise Guideline Rail Noise Assessment Trigger Levels
Table 4-34	Non-network Rail Noise Assessment Criteria Adopted
Table 4-35	Visual Impact Matrix
Table 4-36	Visual Simulation Locations
Table 4-37	Summary of Visual Assessment
Table 4-38	Summary of Aboriginal Heritage Consultation Undertaken for the Project
Table 4-39	Aboriginal Heritage Sites within Project Area and Immediate Surrounds and Level of Proposed Impact
Table 4-40	Historic Heritage Sites of Significance within Project Area and Immediate Surrounds
Table 4-41	Management Measures for Relevant Historic Heritage Items
Table 4-42	Summary of Social Impact Assessment Stakeholder Engagement and Consultation undertaken by Elliott Whiteing

LIST OF FIGURES

Figure 4-1	Agricultural Suitability Mapping in the Project Mining Area
Figure 4-2	Current Agricultural Enterprises in the Project Mining Area and Surrounds
Figure 4-3	Current Agricultural Enterprises along the Rail Spur Area and Surrounds
Figure 4-4	Groundwater Monitoring Locations and Regional Geology
Figure 4-5	Upper Namoi Alluvium Extent
Figure 4-6	Upper Namoi Alluvium Cross-Section
Figure 4-7	Relevant Groundwater Sources
Figure 4-8	Bore Census
Figure 4-9	Regional Surface Water and Weather Monitoring Sites
Figure 4-10	Namoi Catchment and Liverpool Plains Sub-catchment
Figure 4-11	Existing Hydrology – Project Mining Area
Figure 4-12	Predicted Existing Flood Depths and Extents Along Namoi River Floodplain for the 1% AEP Event
Figure 4-13	Maximum Predicted Noise Level – Year 7
Figure 4-14	Maximum Predicted Noise Level – Year 21

TABLE OF CONTENTS (Continued)**LIST OF FIGURES (Continued)**

- Figure 4-15 Air Quality Monitoring Sites
- Figure 4-16 Project 24-hour average PM₁₀ Air Quality Contours – Year 3
- Figure 4-17 Project 24-hour average PM₁₀ Air Quality Contours – Year 7
- Figure 4-18 Project 24-hour average PM₁₀ Air Quality Contours – Year 21
- Figure 4-19a Project Assessment Area – Mining Area
- Figure 4-19b Project Assessment Area – Project Rail Spur
- Figure 4-20a Vegetation Communities and Threatened Flora Species – Mining Area
- Figure 4-20b Vegetation Communities – Project Rail Spur
- Figure 4-21 Threatened Fauna Records – Wider Locality
- Figure 4-22a Threatened Fauna Records – Mining Area
- Figure 4-22b Threatened Fauna Records – Project Rail Spur
- Figure 4-23 Local Biodiversity Enhancement Measures
- Figure 4-24a Existing Approved and Proposed Biodiversity Offset Areas - North
- Figure 4-24b Existing Approved and Proposed Biodiversity Offset Areas - South
- Figure 4-25 Local Road Network and Traffic Survey Locations
- Figure 4-26 Viewpoints and Visual Simulation Locations
- Figure 4-27a Existing View and Visual Simulation Outline (Year 21) – Brolga Residence (VP4)
- Figure 4-27b Visual Simulation (Year 21 and Post Mining) – Brolga Residence (VP4)
- Figure 4-28a Existing View and Visual Simulation Outline (Year 21) – Blue Vale Road (VP6)
- Figure 4-28b Visual Simulation (Year 21 and Post Mining) – Blue Vale Road (VP6)
- Figure 4-29a Existing View and Visual Simulation Outline (Year 7) – Braymont Road (VP7)
- Figure 4-29b Visual Simulation (Year 7 and Post Mining) – Braymont Road (VP7)
- Figure 4-30a Existing View and Visual Simulation Outline (Year 7) – Kamilaroi Highway (VP8)
- Figure 4-30b Visual Simulation (Year 7 and Post Mining) – Kamilaroi Highway (VP8)
- Figure 4-31 Visual Simulation – Kamilaroi Highway Rail Overpass (VP14)
- Figure 4-32 Heritage Sites Within and in Proximity to the Project Area

4 ENVIRONMENTAL ASSESSMENT

4.1 ENVIRONMENTAL RISK ASSESSMENT

As a component of the environmental assessment of the Project, an Environmental Risk Assessment (ERA) was undertaken to identify key potential environmental issues for further assessment in the EIS. ERA workshops were conducted in July 2012 and again in March 2016, facilitated by a risk assessment specialist (Operational Risk Mentoring, 2018).

The 2012 and 2016 risk assessment teams consisted of representatives from:

- Operational Risk Mentoring (2012 and 2016);
- Whitehaven (2012 and 2016);
- HydroSimulations (2012 and 2016);
- Advisian (2012 and 2016);
- Fluvial Systems (2012);
- McKenzie Soil Management (2012);
- Niche Environment and Heritage (Niche) (2012); and
- Resource Strategies (2012 and 2016).

The key potential environmental issues identified during the ERA workshops were associated with (Appendix O):

- Soil and Land Resources (Section 4.3);
- Groundwater (Section 4.4);
- Surface Water and Flooding (Sections 4.5 and 4.6);
- Noise and Blasting (Sections 4.7, 4.8 and 4.13);
- Air Quality (Sections 4.9 and 4.10);
- Biodiversity (Section 4.11);
- Road Transport (Section 4.12);
- Visual (Section 4.14);
- Aboriginal Cultural Heritage (Section 4.15);
- Historic Heritage (Section 4.16); and
- Socio-Economic (Sections 4.17 and 4.18).

The risks associated with the potential environmental issues identified were ranked in accordance with the frameworks detailed in Australian Standard/New Zealand Standard (AS/NZS) International Standards Organisation (ISO) 31000:2009 *Risk Management – Principles and Guidelines*, Handbook 203:2012 *Managing Environment-Related Risk* (note also conforms with ISO 31000:2018 *Risk Management – Guidelines*) and MDG1010 *Minerals Industry Safety and Health Risk Management Guideline* (Mine Safety Operations Branch, 2011).

All of the potential issues were ranked within the ‘As Low as Reasonably Practicable’ or ‘Tolerable’ range by the risk assessment team. The ERA is provided in full as Appendix O.

4.2 CLIMATE AND TOPOGRAPHY

Long-term meteorological data for the region are available from nearby Commonwealth Bureau of Meteorology (BoM) meteorological stations (Tables 4-1 and 4-2).

Short-term local meteorological data (from January 2013 onwards) are available from the on-site weather station, which is owned and operated by Whitehaven.

The on-site weather station monitors a number of meteorological parameters, including temperature, humidity, rainfall, wind speed and wind direction.

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

4.2.1 Climate

Rainfall Data and Statistics

Table 4-1 provides a summary of long-term rainfall data from regional BoM stations. The long-term average annual rainfall ranges from approximately 583 to 612 mm, with the driest month being April (as well as August for the Keepit Dam station) and the wettest month being January.

Table 4-1 also provides a summary of short-term rainfall data from the on-site weather station. The short-term average annual rainfall recorded on-site for the period January 2013 to August 2017 is approximately 847 mm.

Table 4-1
Meteorological Data Summary – Rainfall and Evaporation

Period of Record	Long-term Average Monthly Rainfall (mm)			Short-term Average Monthly Rainfall (mm)	Average Monthly Pan Evaporation (mm)
	Boggabri Post Office (55007) 1884 to May 2018	Boggabri (Retreat) (55044) 1899 to May 2018	Keepit Dam (55276) 1955 to May 2018	On-site Weather Station ¹ 2013 to August 2017	Gunnedah Resource Centre (55024) 1948 to May 2018
January	71.6	71.3	83.1	59.8	238.7
February	63.1	61.4	63.5	20.9	190.0
March	45.7	43	43.7	65.1	182.9
April	33.5	34.8	34.9	34.4	129.0
May	41.2	38	42.2	50.6	83.7
June	44.1	44.6	37.2	91.5	57.0
July	41	42	38.5	27.7	58.9
August	38	37.8	34.7	54.4	86.8
September	38.2	40	38.8	53.9	120.0
October	50	49.3	53	26.6	167.4
November	59.6	58.5	66.3	26.5	201.0
December	62.9	61.2	73.8	36.8	241.8
Annual Average	591.6 [588.9]	583.4 [581.9]	612.4 [609.7]	548.1 [548.2]	1,752 [1,757.2]

Source: BoM, 2018; Whitehaven, 2017.

¹ Monitoring undertaken from 1 January 2013.

[] Sum of average monthly records. Discrepancy with annual averages is based on BoM historical records.

Table 4-2
Meteorological Data Summary – Temperature and Humidity

Period of Record	Long-term Average Daily Temperature (°C)				Short-term Average Daily Temperature (°C)		Average Humidity (%)	
	Gunnedah Pool Station (55023)		Gunnedah Resource Centre (55024)		On-site Weather Station ¹		Gunnedah Pool (055023) ²	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	9.00 am	3.00 pm
	1876 to 2011		1948 to May 2018		2013 to August 2017		1876 to 2010	
January	18.4	34.0	19.0	32.1	20.6	33.7	61	43
February	18.1	32.9	18.7	31.2	19.1	31.2	65	45
March	15.8	30.7	16.7	29.2	17.3	29.1	65	44
April	11.4	26.4	12.8	25.2	12.7	24.7	67	46
May	7.1	21.3	8.7	20.4	9.2	20.4	73	51
June	4.3	17.6	6.1	16.9	6.7	16.9	79	55
July	3.0	16.9	4.8	16.2	4.9	16.4	77	53
August	4.2	18.9	5.8	18.0	5.8	18.5	71	48
September	7.0	22.8	8.6	21.6	8.5	23.5	65	44
October	10.8	26.7	12.2	25.3	12.9	29.1	61	43
November	14.2	30.3	15.1	28.6	16.3	31.8	59	40
December	16.8	32.9	17.6	31.1	17.7	32.8	58	40
Annual Average	10.9	25.9	12.2	24.6	12.6	25.7	67	46

Source: BoM, 2018; Whitehaven, 2017.

¹ Monitoring undertaken from 1 January 2013.

² Humidity measured from 1876–2010 for 9.00 am readings, measured from 1940–2010 for 3.00 pm readings.

Evaporation Data and Statistics

Table 4-1 shows long-term pan evaporation data from the Gunnedah Resource Centre. When compared to long-term average rainfall, the rate of evaporation exceeds rainfall on an annual average basis, as well as for all months.

Temperature Data and Statistics

Table 4-2 shows long-term average temperature data from two nearby BoM stations. The long-term daily temperature ranges from a minimum of 3 degrees Celsius (°C) in July to a maximum of 34°C in January.

Table 4-2 also shows the temperature range recorded at the on-site weather station between 2013 and 2017. The short-term daily temperature recorded by this station ranges from a minimum of 4.9°C in July to a maximum of 33.7°C in January.

Humidity Data and Statistics

Table 4-2 shows long-term humidity data from the Gunnedah Pool BoM station. The long-term annual average humidity is 67% at 9.00 am and 46% at 3.00 pm.

Wind Direction and Speed

As part of the Air Quality and Greenhouse Gas Assessment (Appendix E), windroses were developed using wind direction and wind speed data from several meteorological stations in the region. The prevailing wind direction for the on-site weather station is from the south-east quadrant with annual average wind speeds of approximately 3 metres per second (m/s) (Appendix E). Winds from the west north-west are prevalent in spring (Appendix E). Lighter winds from the north-east quadrant are prevalent in winter (Appendix E).

Temperature Inversions

Temperature inversions occur in the wider Project area, particularly during the night-time in winter months. The frequency of temperature inversions is described in Section 4.7.2 and the Noise and Blasting Assessment (Appendix D).

4.2.2 Topography

Existing Environment

The natural topography in the Project mining area consists of undulating hills and slopes, with the elevation ranging from approximately 255 m AHD to approximately 325 m AHD. The topography is more dissected and steeper within the Vickery State Forest to the east of the Project where it rises to approximately 479 m AHD. To the north, south and west of the Project mining area the topography is gently sloping to almost flat, and generally drains towards the Namoi River. These floodplains typically have elevations of between 250 to 260 m AHD.

The Project mining area is situated within the Namoi catchment. The Namoi River is located to the west of the Project mining area and generally flows in a north-westerly direction from its headwaters in the Great Dividing Range.

The headwaters of Driggle Draggie Creek and a number of other un-named ephemeral streams originate in the slopes of the Vickery State Forest. As they descend onto the flatter areas they become less defined drainage paths, which become expansive, ponded, overland flow areas during and following heavy rainfall. These flows slowly move down gradient and merge with the Namoi River.

The development of the Approved Mine and associated open cut mining and waste rock emplacements would result in alteration to the site's pre-mining topography. Modified landforms would include open cut pits (including two approved final voids in addition to the existing Blue Vale final void), elevated waste rock emplacements, stockpiles, water management infrastructure and other infrastructure areas.

Potential Impacts

The Project would alter the landforms and topography within the Project mining area. Some topographic changes would be temporary (e.g. temporary bund/drains) and some would be permanent (e.g. final mine landforms).

The Project would increase the extent of the open cut mining area for the Approved Mine. At the cessation of mining one final void would remain (in addition to the existing Blue Vale final void) (Section 5).

Waste rock mined during the development of the Project would be placed within the footprint of the open cut void, behind the advancing open cut operations, as well as being disposed of in an elevated waste rock emplacement up to approximately 370 m AHD (i.e. the Western Emplacement).

These changes, while altering the layout and extent of the Approved Mine, would generally be consistent with the nature and form of the Approved Mine landforms with the following improvements (Section 5):

- Reduction in the number of final voids from five to two within the Project area (noting that three final voids would be retained for the Approved Mine).
- Removing the requirement for the Eastern Emplacement as a waste rock emplacement (i.e. creating a permanent change to the final landform), with its approved footprint to be used as a temporary secondary infrastructure area for the Project.
- Introduction of micro-relief (i.e. gently undulating surface typically ranging in elevation by 1 to 2 m) to the waste rock emplacement to assist in drainage design that replicates natural drainage systems.
- Introduction of macro-relief (i.e. 10 to 20 m hills similar to those found in the Vickery State Forest) to the top surface of the waste rock emplacements to improve the integration of the landform with the surrounding environment and mitigate potential visual impacts.
- Increased areas of woodland/forest revegetation to enhance the biodiversity value of the rehabilitated Project mining area and improve the connectivity of woodland between the Vickery State Forest and the Namoi River.

A range of lesser topographic changes would be associated with the construction of temporary infrastructure areas, roads, hardstands and water management, erosion and sediment control features over the life of the Project.

Further description of the proposed post-mining final landform for the Project is provided in Section 5.

An assessment of the likely visual impacts of the changes to landforms and topography associated with the Project is provided in Section 4.14 and Appendix L.

4.3 LAND RESOURCES AND AGRICULTURAL PRODUCTION

A description of the existing environment relating to land resources and agricultural production is provided in Section 4.3.1. Section 4.3.2 describes the potential impacts of the Project on land resources and agricultural production, and Section 4.3.3 describes applicable management, mitigation and monitoring measures.

4.3.1 Existing Environment

Land Use

The Project area was part of the tribal lands of the Kamilaroi Aboriginal people who inhabited the Gunnedah Basin (Appendix G). European settlement of the area began in 1835 with the establishment of a sheep run called Namoi Hut at the confluence of the Namoi River and Cox's Creek (Heritage Management Consultants, 2012).

Historical research conducted as part of the Non-Aboriginal Heritage Assessment for the Approved Mine (Heritage Management Consultants, 2012), combined with interviews with local landholders, indicate that the initial agricultural land use in the Project mining area was sheep grazing on native pastures in the 1830s and 1840s, which was gradually combined with small scale dryland cropping of barley and some wheat using horse-drawn ploughs and harvesters. Anecdotal information from local landholders indicates that the dryland cropping was low yielding and was largely abandoned in the early to mid 1900s when tractors were introduced to the region and the cropping potential of the black soils on the region's floodplains was discovered.

Over the past 50 years the Project mining area has been mostly used for grazing purposes (currently cattle only), with intermittent small scale dryland cropping on areas with higher soil fertility.

Aerial photographs of the Project mining area sourced from the Department of Lands, the oldest of which was taken in the 1950s, were obtained as part of the Agricultural Impact Statement (AIS) (Appendix H). The photographs show the Project mining area and the land along the Project rail spur as having been predominately cleared for at least 55 years, with numerous small paddocks, some of which appear to have been sown to crops.

The majority of the Project mining area is currently cleared and is dominated by grassland areas with occasional re-growth trees. Scattered remnants of woodland, semi-cleared woodland and White Cypress Pine (*Callitris glaucophylla*) re-growth occur in the Project mining area. In addition, the Project mining area includes small areas of land that have been previously disturbed by mining activities and are now rehabilitated.

The entire Project mining area is currently owned by Whitehaven (Figure 1-5a). The Project mining area is primarily used for cattle grazing under licence agreements with Whitehaven.

The eastern part of the Project rail spur would be located on land owned by Whitehaven (Figure 1-5a). Whitehaven has entered into access agreements for the western part of the Project rail spur.

The Vickery State Forest is located to the east of the Project and is used for forestry and limited recreational purposes.

A detailed description of the existing and historical agricultural practices conducted within the Project mining area is provided in the AIS (Appendix H).

Soils

A number of soils surveys of the Project mining area have been undertaken, including:

- *Vickery Coal Project Agricultural Resource Assessment* (McKenzie Soil Management, 2012);
- *Vickery Coal Project BSAL Assessment Report*; (SESL, 2015); and
- *Vickery Extension Project Soil Resource Assessment* (SESL, 2018a) (Project Soil Resource Assessment).

The Project Soil Resource Assessment (SESL, 2018a) consolidates the soil survey data, and is included as an attachment to the AIS (Appendix H).

The main soil types mapped in the Project mining area are Dermosols and Sodosols, with smaller areas of Anthrosols, Vertosols, Stratic Rudosols, Chromosols, Ferrosols, Tenosols and Kandosols also observed.

Topsoil Condition

The Project Soil Resource Assessment concluded the following with respect to the condition of soil for use in rehabilitation (SESL, 2018a):

- The topsoil is neither saline nor sodic, and is not strongly acidic. The topsoil is slightly acidic to moderately alkaline, and generally within an ideal range for plants.
- Where pH is elevated, it could be lowered through applications of iron sulphate, however this is unnecessary if vegetation tolerant of alkaline soils is used.
- Organic carbon levels are variable and can be maintained and improved by pasture management.

Further discussion of the soil conditions is provided in the AIS (Appendix H).

Land and Soil Capability

SESL (2018a) has determined the land and soil capability (LSC) of the Project mining area in accordance with the *Land and Soil Capability Assessment Scheme* (LSC Scheme) (OEH, 2012).

The LSC Scheme builds on *the Rural Land Capability Classification System* (Emery, 1986), which is used to delineate the various classes of rural land on the basis of the capability of the land to remain stable under particular uses.

The LSC Scheme uses biophysical land features including position, slope, drainage, climate, soil type and soil characteristics to derive rating tables for land and soil hazards.

An overview of the LSC Scheme is provided in Table 4-3.

SESL (2018a) assessed the LSC of the Project mining area as ranging from Class II to Class VI (Appendix H). Wind erosion hazard and acidification (buffering capacity) in the topsoil are the primary determinants of land class in this area.

An assessment of the LSC along the Project rail spur indicates the land is likely to be Class II to III west of the Namoi River and Class III to IV east of the Namoi River (Appendix H).

Table 4-3
Overview of Land and Soil Capability Assessment Scheme

Class	LSC Scheme
Land Suitable for Regular Cultivation/Cropping	
I	No special soil conservation works or practices necessary.
II	Soil conservation practices such as strip cropping, conservation tillage and adequate crop rotations are necessary.
III	Soil conservation practices such as graded banks and waterways are necessary, together with all the soil conservation practices as in Class II.
Land Suitable Mainly for Grazing	
IV	Soil conservation practices such as pasture improvement, stock control, application of fertiliser, minimal cultivation for the establishment or re-establishment of permanent pasture and maintenance of good ground cover.
V	Soil conservation works such as diversion banks and contour ripping, in addition to the practices in Class IV.
Land Suitable for Grazing	
VI	Not capable of cultivation. Soil conservation practices include limitation of stock, broadcasting of seed and fertiliser, promotion of native pasture regeneration, prevention of fire, destruction of vermin, maintenance of good ground cover and possibly some structural works.
Land Suitable for Tree Cover	
VII	Land best protected by trees. Land unsuitable for agriculture.
VIII	Cliffs, lakes or swamps where it is impractical to grow crops or graze pasture.

Source: OEH, 2012.

Agricultural Suitability

The Agricultural Suitability system is used to classify land in terms of its suitability for general agricultural use. Land is classified by evaluating biophysical, social and economic factors that may constrain the use of land for agriculture.

SESL (2018a) assessed the Agricultural Suitability of the Project mining area as predominantly Class 4 and Class 3, with small patches of Class 2 in the north and south of the Project mining area (Figure 4-1).

An assessment of the Agricultural Suitability along the Project rail spur estimates the land to be Class 3 or 4 east of The Kamilaroi Highway, and Class 2 or 3 west of the Kamilaroi Highway (Appendix H).

These classes are defined as:

Class 2: Arable land suitable for regular cultivation for crops, but not suited to continuous cultivation. It has a moderate to high suitability for agriculture but soil factors or environmental constraints reduce the overall level of production and may limit the cropping phase to a rotation with sown pastures.

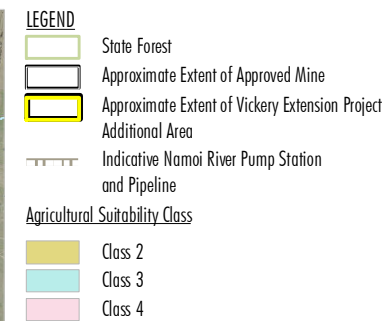
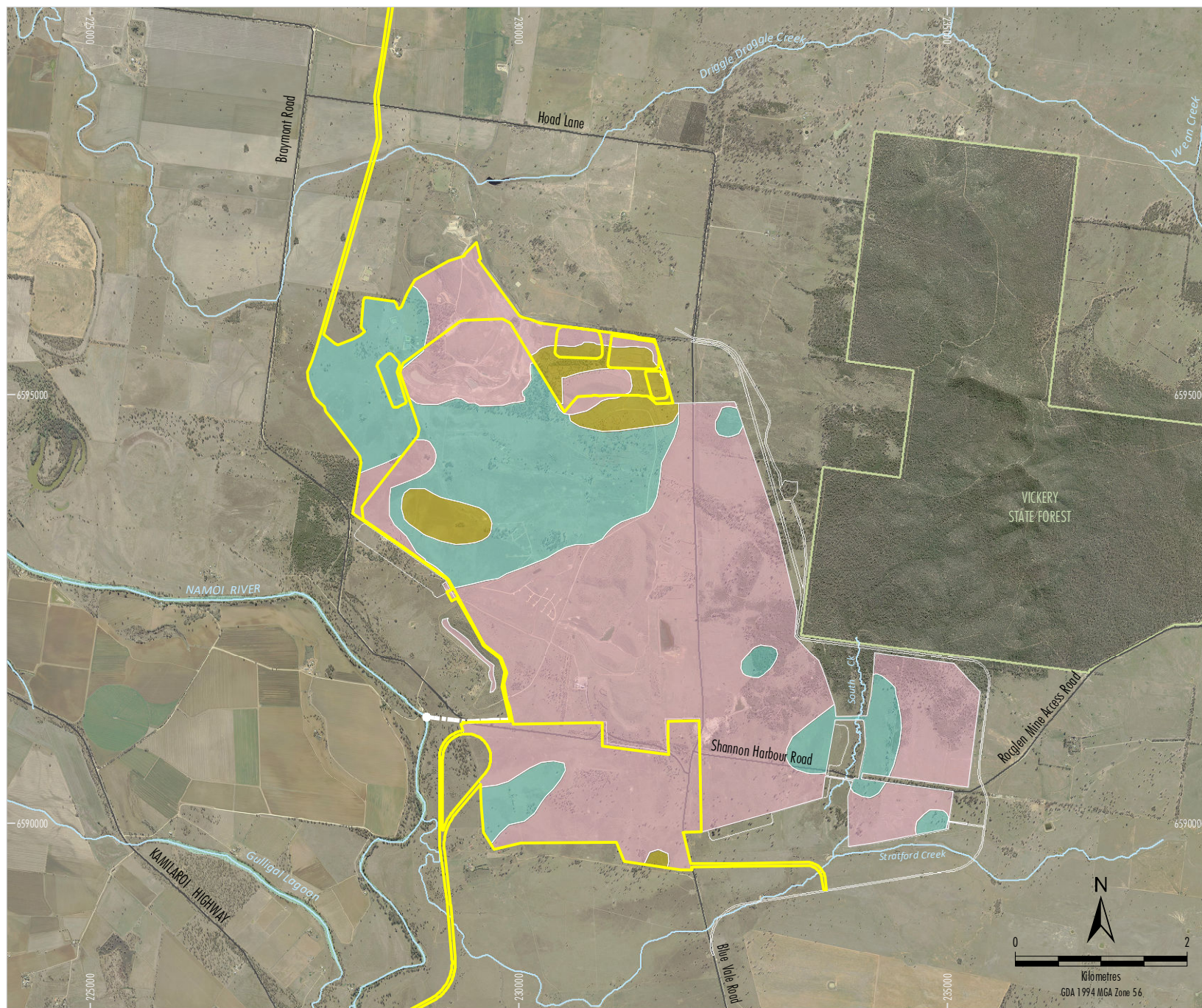
Class 3: Grazing land or land well suited to pasture improvement. It may be cultivated or cropped in rotation with sown pasture. The overall production level is moderate because of soil or environmental constraints. Erosion hazard, soil structural breakdown or other factors, including climate, may limit the capacity for cultivation and soil conservation or drainage works may be required.

Class 4: Land suitable for grazing but not for cultivation. Agriculture is based on native pastures and improved pastures established using minimum tillage techniques. Production may be seasonally high but the overall production level is low as a result of major environmental constraints.

Agricultural Activities, Productivity and Services

The Project is located within broad areas of known agricultural significance, including the New England North West Region, as defined in the *New England North West Strategic Regional Land Use Plan* (the New England North West SRLUP) (DPI, 2012).

The New England North West Region is an area of 9.9 million ha, including the LGAs of Armidale Dumaresq, Glen Innes Severn, Gunnedah, Guyra, Gwydir, Inverell, Liverpool Plains, Moree Plains, Narrabri, Tamworth Regional, Tenterfield, Uralla and Walcha (DPI, 2012).



Source: Orthophoto - Department of Land and Property Information, Aerial Photography (July 2011); Department of Industry (2015); McKenzie Soil Management (2012); SESL (2015; 2018)


VICKERY EXTENSION PROJECT
Agricultural Suitability Mapping
in the Project Mining Area

Figure 4-1

The region accounts for approximately \$1.8 billion per annum of agricultural production. Sheep and cattle grazing, broad acre cereal crops, irrigated cotton, intensive livestock and poultry production are the main contributors to the agricultural production of the region (DPI, 2012).

The New England North West Region is split into four agricultural-geographical sub-regions in the New England North West SRLUP (DPI, 2012):

- Southern Plains (Liverpool Plains and Gunnedah LGAs).
- Northern Plains (Moree Plains and Narrabri LGAs).
- Slopes (Tamworth, Gwydir and Inverell LGAs).
- Tablelands (Walcha, Uralla, Armidale, Guyra, Glen Innes and Tenterfield LGAs).

The Project is located on the border of the Northern and Southern Plains sub-regions.

A variety of specialist agricultural suppliers and services (e.g. agricultural supplies, irrigation supplies, harvest contractors and machinery service centres) are located in Gunnedah, Narrabri, Boggabri and other towns in the Narrabri and Gunnedah LGAs.

Infrastructure to allow for the transport, temporary storage and dispatch of crops (e.g. cotton and wheat) is located throughout the Narrabri and Gunnedah LGAs. This infrastructure includes silos, storage warehouses and rail and truck loading facilities. Cotton gins are operated in Boggabri and Narrabri. In addition, livestock saleyards are located in Narrabri and Gunnedah.

The Narrabri and Gunnedah LGAs are well located to use existing road and rail transport networks to access domestic and export markets. The key road transport routes servicing the area are the Kamilaroi and Newell Highways. The Newell Highway provides access to markets/ports in Brisbane and Melbourne, and the Kamilaroi Highway provides access to markets/ports in Newcastle and Sydney. The Werris Creek Mungindi Railway provides access to markets/ports in Newcastle, Sydney and Brisbane.

Gunnedah and Boggabri are the closest towns to the Project area (Figure 1-2), and provide a wide range of service and infrastructure facilities to support local agricultural industries (e.g. regional rail and road links, livestock saleyards, grain storage and loading facilities, agricultural equipment sales and servicing businesses, and various agriculture-related consultancy and service firms).

The Project mining area is located on Whitehaven-owned land, which is predominantly used for cattle grazing under licence agreements with Whitehaven (Figure 4-2). The carrying capacity of the Project mining area is generally considered to be relatively low (Appendix H).

Land adjacent to the Project rail spur is used for grazing and cropping (Figure 4-3).

Whitehaven conducted a comprehensive consultation program with Federal, State and local government agencies, local community and other interested stakeholders as part of the preparation of the EIS for the Approved Mine. This included consultation with local landholders in September and October 2012 to gather information about the existing and historical agricultural practices within the Project mining area and at some of the adjoining properties.

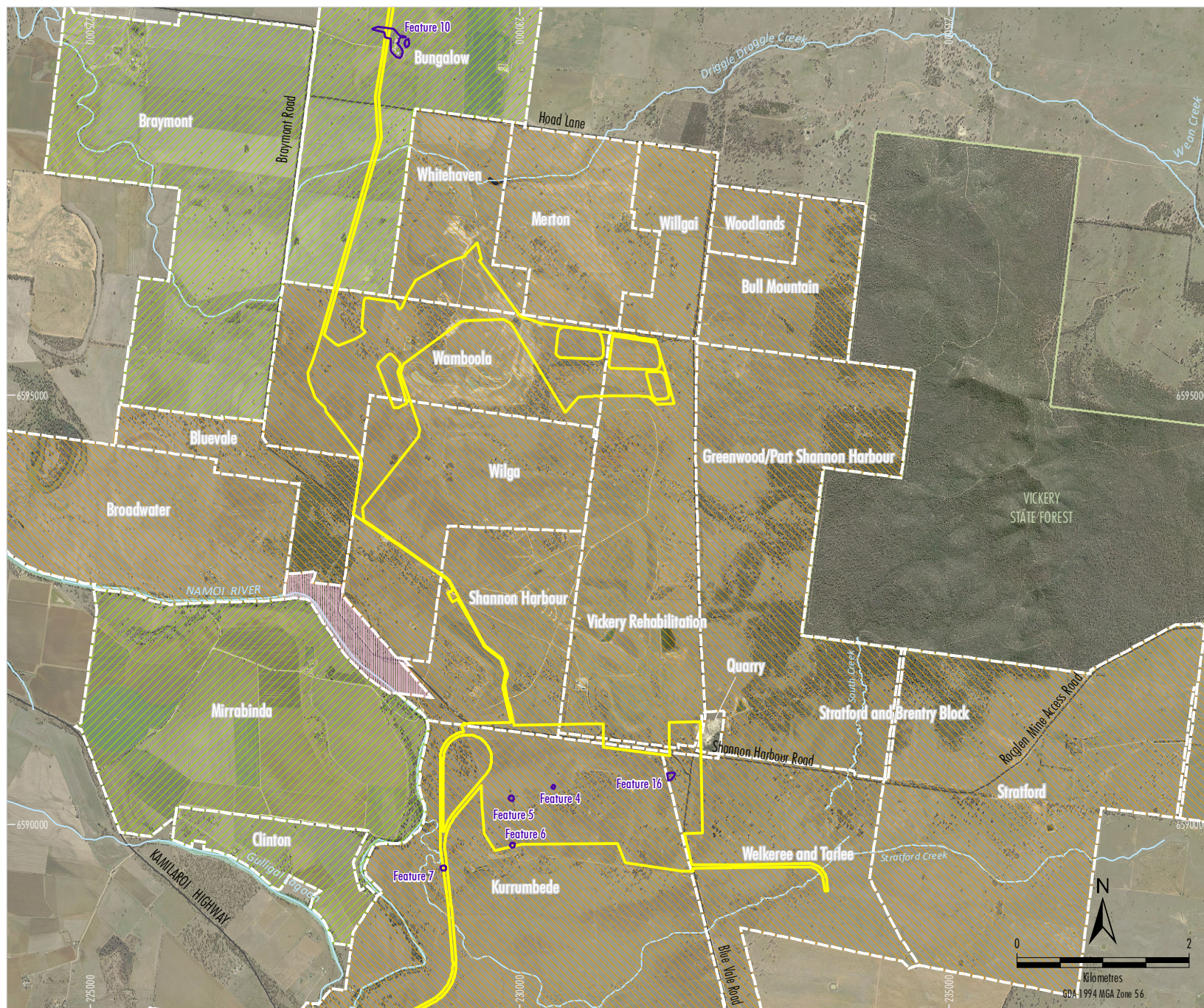
Whitehaven consulted again with some local landholders and licensees between 2016 and 2018 to confirm contemporary agricultural practices within the Project mining area along the Project rail spur and at some of the adjoining properties.

The outcomes of this consultation and details regarding the current agricultural practices undertaken on these lands are provided in Appendix H.

Biophysical Strategic Agricultural Land

Biophysical strategic agricultural land (BSAL) is land considered to be highly suitable for agriculture, having the best quality landforms, soil and water resources which are naturally capable of sustaining high levels of productivity and require minimal management practices to maintain this high quality (NSW Government, 2013).

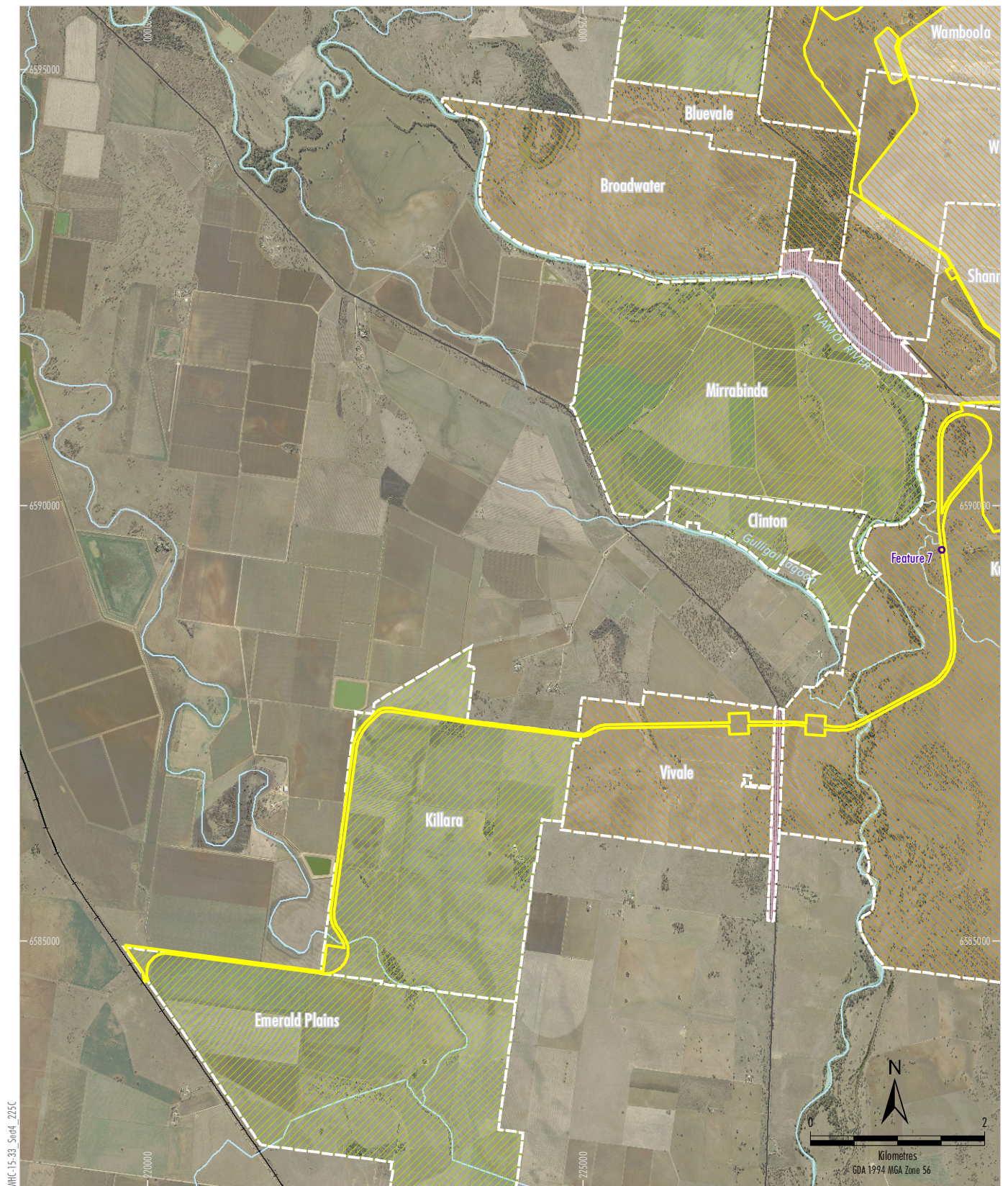
The New England North West SRLUP (DPI, 2012) identifies BSAL at a regional scale.



Source: Department of Industry (2015);
 Orthophoto - Department of Land and Property Information,
 Aerial Photography (July 2011); Whitehaven (2016);
 SESL (2018)


VICKERY EXTENSION PROJECT
 Current Agricultural Enterprises in the
 Project Mining Area and Surrounds

Figure 4-2



LEGEND

- Approximate Extent of Vickers Extension Project
- Additional Area
- Predominantly Cropping Area
- Predominantly Grazing Area
- Crown Land
- Relevant Feature of Interest for Land Contamination Assessment

Source: Department of Industry (2015);
 Orthophoto - Department of Land and Property Information,
 Aerial Photography (July 2011); Whitehaven (2016);
 SESL (2018)



VICKERY EXTENSION PROJECT Current Agricultural Enterprises along the Rail Spur Area and Surrounds

Figure 4-3

Clause 50A of the EP&A Regulation requires that for ‘mining and petroleum development’ (within the meaning of Part 4AA of the Mining SEPP) that is on land shown on the Strategic Agricultural Land Map (or on any other land that is the subject of an SVC and not located on mapped critical industry cluster land), the Development Application must be accompanied by either a current Gateway Certificate or an SVC.

The Project is not located on mapped critical industry cluster land under the Mining SEPP. An SVC was issued by the Secretary of the DP&E on 8 February 2016 verifying that MLA 1 is not located on BSAL. The SVC is provided as Attachment 9.

The *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land* (NSW Government, 2013) states that the Gateway Process does not apply to any associated development, such as linear infrastructure, outside the area of a proposed mining or production lease.

Bushfire Regime

The Project is located partially on land mapped as Bush Fire Prone by the NSW RFS. Potential bushfire hazards and management measures are described in Section 4.3.2 and 4.3.3.

Existing Potential for Land Contamination

A Land Contamination Assessment was undertaken in accordance with *Managing Land Contamination – Planning Guidelines SEPP 55 – Remediation of Land* (Department of Urban Affairs and Planning and Environment Protection Agency, 1998) by SESL (2018b) and is presented in Appendix Q. The Land Contamination Assessment included a desktop review and site inspection of the MLA 1 area, Project rail spur area and water supply borefield.

Potential sources of land contamination in these areas included sites associated with old farm building structures (asbestos material and lead paints), former pesticide and chemical storage sites and potential for soil contamination from former farm sheds (storing machinery).

4.3.2 Potential Impacts

Soils

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

- disturbance of *in-situ* soil resources within the disturbance areas;
- alteration of soil structure beneath infrastructure items, hardstand areas, roads and water management structures;
- possible soil contamination resulting from spillage of fuels, lubricants and other chemicals;
- increased erosion and sediment movement due to exposure of soils during construction (e.g. road realignments); and
- alteration of physical and chemical soil properties (e.g. structure, fertility, permeability and microbial activity) due to soil stripping and stockpiling operations.

The assessment of the physical and chemical properties of the soils within the Project area has established that there are soil resources present that would be suitable as a rehabilitation medium for native plant revegetation and for agricultural land uses (i.e. grazing) on the Project area post-mining (Section 5 and Appendix H).

Land Use - Agricultural Activities and Productivity

An assessment of the potential impacts of the Project on agricultural resources and enterprises of the local area has been conducted and is contained in the AIS (Appendix H). The AIS has been prepared consistent with the *Agricultural Impact Statement Technical Notes* (DPI, 2013).

The Project would result in the long-term disturbance or alteration of existing agricultural lands. A summary of the area of agricultural lands, before and after the Project life is provided in Table 4-4.

The Project mining area would impact on approximately 2,541 ha of agricultural land in the long-term (i.e. due to areas to be rehabilitated to woodland/forest and the final void pit lake and highwall) (Table 4-4). The majority of this land consists of Class 4 Agricultural Suitability land. The areas of Class 3 and 2 Agricultural Suitability land that would be lost are currently only used for cattle grazing and are not considered to be highly productive or of strategic agricultural importance within the region.

Table 4-4
Summary of Agricultural Suitability Classification/Land Uses

Area	Existing Agricultural Suitability Classification (ha)			Post Mining Agricultural Suitability Classification/Land Use (ha)					
	Class 2	Class 3	Class 4	Class 2	Class 3	Class 4	Woodland/ Forest Rehabilitation	Final Void Pit Lake and Highwall	Sediment Dams
Project Mining Area [^]	148	774	1,875	0	78	178	2,385	135	21
Project Borefield	3	0	0	3	0	0	0	N/A	N/A
Project Rail Spur	51	32	0	51	32	0	0	N/A	N/A

[^] As per Figure 4-1, this includes the mining area for the Approved Mine.

The construction of the Project rail spur and associated laydown areas would result in the disturbance of approximately 83 ha of agricultural land. The indicative alignment of the rail spur has been selected to minimise impacts to existing cropping paddocks and water management infrastructure located on the agricultural enterprises west of the Namoi River. The construction of the Project rail spur is not expected to result in a material impact to the existing agricultural productivity of these enterprises.

The construction of the Project borefield would result in disturbance of approximately 3 ha of Class 2 Agricultural Suitability Land.

Following mine closure and subject to no further ongoing use for the infrastructure being identified, the Project rail spur and borefield would be decommissioned and the disturbed land would be rehabilitated to a condition of comparable Agricultural Suitability to the surrounding land, unless otherwise agreed with the relevant government agencies and landholders.

The area of agricultural lands that would be impacted by the Project mining area, borefield and Project rail spur can be considered in the context of the area of land under agricultural production in NSW and the Gunnedah/Narrabri region (Table 4-5).

As shown in Table 4-5, the potential impact of the Project on the area of land that is subject to agricultural use in NSW and in the Gunnedah/Narrabri region would be very small.

Establishment of land-based offset areas has the potential to affect agricultural activities. However, land-based offset areas have not yet been established for the Project and may not be required if Whitehaven satisfies its biodiversity offset requirements through other measures. The final extent and location of land-based offset areas would be confirmed with State and Federal regulators and the required offset areas would be located to avoid areas of mapped BSAL wherever possible.

Whitehaven-owned land surrounding the Project area would continue to be used for agriculture under licence.

There would be no change to the existing land use of the Vickery State Forest.

Other Potential Impacts to Agricultural Productivity

The Agricultural Impact Statement (Appendix H) has also considered the following potential impacts to agricultural productivity of private properties surrounding the Project:

- Predicted groundwater drawdown from Project mining is predicted to be within the 'Level 1' minimal impact criteria of 2 m, as defined in the AIP, at any privately-owned groundwater bore (Appendix A).
- The Project Water Management System would prevent the release of poorer quality water to the receiving environment. The minor reduction in surface catchment reporting to the Namoi River due to the Project Water Management System is 0.01%, and is predicted to result in negligible reductions in flows in the Namoi River (Appendix B). As such, negligible impact to downstream surface water users is predicted.

Table 4-5
Potential Impacts of the Project on Regional and State Agricultural Land Area

Region	Approximate Area under Agricultural Use (ha) ¹	Project Maximum Impact (incorporating the Approved Mine)*		Residual Impact of Project Final Landform (incorporating the Approved Mine)*		Residual Impact of Approved Mine Final Landform (no Project)*	
		(ha)	(%)	(ha)	(%)	(ha)	(%)
NSW	60,900,000	2,883	0.0047%	2,541	0.0042%	1,462	0.0024%
Gunnedah/Narrabri	1,255,000		0.23%		0.20%		0.12%

¹ Source: Gillespie Economics (2012b).

* Does not include agricultural land lost in biodiversity offset areas as these are yet to be finalised.

- Any external water required to meet operational demands is predicted to be within licensed allocations currently held by Whitehaven (Appendix B).
- Any changes to flood behaviour (velocities and afflux) due to the Project rail spur would be within the criteria specified in the Draft FMP.
- Other potential indirect impacts (e.g. road transport, visual, dust and noise) are not expected to result in any significant impacts to agricultural productivity (Appendix H).

Agricultural Production and Critical Mass Thresholds

An evaluation of the economic value of lost agricultural production due to potential direct and indirect impacts of the Project has been conducted by AnalytEcon (2018) and is included in Appendix J.

In summary, based on conservative assumptions, the Project is projected to result in a loss of agricultural gross margins of \$17.9 million in net present value (NPV) terms (\$1.6 million annually) (Appendix J).

The agricultural flow-on impacts effectively represent an offset to the broader flow-on benefits of the Project to the local region. While this effect is insignificant at the state level, it is material at the level of the local region, corresponding to (Appendix J):

- a reduction in disposable income of \$15.5 million in NPV terms (\$0.7 million per annum); and
- a reduction in employment of approximately 0.5 full-time equivalent jobs per annum.

The potential change in regional agricultural value is not expected to cause significant losses to related services. As such, agricultural production values in the region are not expected to drop below critical mass thresholds (Appendix J).

Bushfire Hazard

Any uncontrolled fires originating from Project activities may present potentially serious impacts to nearby rural properties and the Vickery State Forest.

Similarly, fires originating in nearby rural areas could pose a significant risk to Project infrastructure and Whitehaven staff, contractors and equipment. The degree of potential impacts of a bushfire would vary with climatic conditions (e.g. temperature and wind) and the quantity of available fuel.

The development of the Project could increase the potential for fire generation, however, given the range of management measures that would be put in place, the overall risk of increased bush fire frequency due to the Project is likely to be low.

Land Contamination Potential

Potential land contamination risks from the Project were identified as part of the Preliminary Hazard Analysis (PHA) (Appendix P) and include leaks/spills, fires and explosions associated with the transport, storage and use of hydrocarbons and chemicals.

In addition, the Project could result in the migration of existing contamination, in the absence of appropriate mitigation measures. SESL (Appendix Q) concluded that the site is suitable for the land use change as proposed by the Project, with the implementation of the recommendations outlined in Section 4.3.3.

4.3.3 Mitigation Measures, Management and Monitoring

Soils

General soil resource management practices would include the stripping and stockpiling of soil resources for use in rehabilitation. The objectives of soil resource management for the Project site would be to:

- identify and quantify potential soil resources for rehabilitation;
- optimise the recovery of useable soil reserves during soil stripping operations;
- manage soil reserves so as not to degrade the resource when stockpiled; and
- establish effective soil amelioration procedures to maximise the availability of soil reserves for future rehabilitation works.

The following management measures would be implemented during the stripping of soils at the Project:

- Areas of disturbance would be stripped progressively, as required, to reduce the potential for erosion and sediment generation, and to minimise the extent of stockpiles and the period of soil storage.
- Areas of disturbance requiring soil stripping would be clearly defined following vegetation clearing.
- Soil stripping during periods of high soil moisture content (i.e. following heavy rain) would be avoided, whenever practicable, to reduce the likelihood of damage to soil structure.
- In preference to stockpiling, stripped soil would be directly replaced on completed sections of the final landforms wherever practicable.

Any long-term soil stockpiles would be managed to maintain long-term soil viability through the implementation of relevant management practices as listed below:

- Soil stockpiles would be retained at a height up to 3 m, with slopes no greater than 1:2 (vertical to horizontal [V:H]) and a slightly roughened surface to minimise erosion.
- Soil stockpiles would be constructed to minimise erosion, encourage drainage, and promote revegetation.

- Ameliorants such as lime, gypsum and fertiliser would be applied to stockpiles where needed to improve the condition of stripped soil.
- Wherever practicable, soil would not be trafficked, deep ripped or removed in wet conditions to avoid breakdown in soil structure.
- All soil stockpiles would be seeded with a non-persistent cover crop to reduce erosion potential as soon as practicable after completion of stockpiling. Where seasonal conditions preclude adequate development of a cover crop, stockpiles would be treated with a straw/vegetative mulch to improve stability.
- Soil stockpiles would be located in positions to avoid surface water flows. Silt stop fencing would be placed immediately down-slope of stockpiles until stable vegetation cover is established.
- An inventory of soil resources (available and stripped) on the Project site would be maintained and reconciled annually with rehabilitation requirements.
- Weed control programs would be implemented on soil stockpiles if required.

The MOP would describe soil management measures relevant to the various stages of mine development (i.e. stripping, stockpiling and rehabilitation). The management measures would include identification of soil constraints and use of appropriate amelioration measures, as per the recommendations of SESL (2018a).

Land Use - Agricultural Activities and Productivity

Agricultural land resource management at the Project would include the following key components:

- minimisation of disturbance to agricultural lands, where practicable;
- continued use of adjoining Whitehaven-owned land for agricultural uses;
- management of soil resources at the Project site so that they can be used for rehabilitation; and
- inclusion of approximately 342 ha of agricultural land in the Project rehabilitation strategy (Table 4-4 and Section 5).

Continued Use of Existing Agricultural Areas

Land owned by Whitehaven outside of the Project area would continue to be used for agricultural uses, where practicable. Whitehaven would continue to manage agricultural land in the Project area and surrounding Whitehaven-owned land, including the implementation of property, grazing and cropping management measures, as well as erosion, weed and pest controls.

Management measures would be implemented on properties under licence agreement with Whitehaven, consistent with the terms of the licence and in consultation with the licensee.

Bushfire Hazard

Whitehaven would develop and implement appropriate bushfire management measures in accordance with the 'plan and prepare' materials available on the NSW RFS website and the aims and objectives of *Planning for Bushfire Protection* (NSW RFS, 2006).

Bushfire management measures for the Project may include clearing restrictions, controlled grazing, restricted vehicle movements, fire breaks, the use of diesel vehicles, prohibition of smoking in fire-prone areas and rapid response to any outbreak of fire.

Whitehaven would continue to consult with the NSW RFS and provide assistance to the organisation as required.

Land Contamination

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

- Contractors that transport dangerous goods to and from site would be appropriately licensed in accordance with the provisions of the *Australian Code for the Transport of Dangerous Goods by Road and Rail* (National Transport Commission, 2014) (or its latest version).
- On-site consumable storage areas would be designed with appropriate bunding.
- Fuel and explosive storage areas would be regularly inspected and maintained.

Prior to commencing any demolition of the structures on site, a hazardous material survey would be undertaken to assess the potential for lead paints and asbestos-containing material within building structures to allow management/removal actions to be appropriately implemented (Appendix Q).

A detailed site inspection of Features of Interest 4, 5, 6, 7, 10 and 16 (as identified in Appendix Q, and shown on Figures 4-2 and 4-3) would be conducted prior to disturbance in the area to determine if there is any land contamination requiring remediation, as recommended by SESL (Appendix Q).

4.4 GROUNDWATER

A Groundwater Assessment for the Project was undertaken by HydroSimulations (2018) and is presented in Appendix A. The Groundwater Assessment was peer reviewed by Kalf and Associates (Dr Frans Kalf) and the review report is presented in Attachment 4.

The Groundwater Assessment for the Project builds upon the assessment conducted by Heritage Computing (2013) for the Approved Mine, with improvements including:

- drilling investigation and surveys to confirm the additional open cut areas for the Project do not extend into the alluvium associated with the Namoi River;
- upgrade to the latest groundwater modelling software; and
- incorporation of additional calibration data (up to 2017).

A description of the existing groundwater resources in the Project area and surrounds, including the existing monitoring regime, baseline data and existing groundwater use, is provided in Section 4.4.1. Section 4.4.2 describes the potential impacts of the Project on groundwater resources including cumulative impacts, while Section 4.4.3 outlines mitigation measures, management (including licensing considerations) and monitoring.

The Project groundwater and surface water studies have been undertaken in an integrated manner. For example, the recovery of groundwater includes the predicted post-mining water level of the final void determined by the Surface Water Assessment (Appendix B).

The Groundwater Assessment has considered the requirements of the SEARs as well as potential impacts of the Action to MNES under the EPBC Act (Attachment 2), and concludes the Project would not have a significant impact on groundwater resources.

4.4.1 Existing Environment

Baseline Groundwater Data

Baseline geological and groundwater data were reviewed and compiled from a number of sources as part of the Groundwater Assessment including:

- results of drilling and electromagnetic surveys conducted in the vicinity of the open cut to assist in delineating the extent and depth of alluvium in the vicinity of the Project;
- results of a bore census of privately-owned bores/wells in the vicinity of the Project mining area undertaken in March 2012;
- geological and geophysical data and logs from the Vickery Coal Mine exploration programs and previous mining operations;
- hydrogeological information from investigations conducted for the Approved Mine and the Project (described further below);
- monitoring information from groundwater monitoring locations for the Approved Mine and the nearby former Canyon Coal Mine and approved Rocglen and Tarrawonga Coal Mines (Figure 4-4);
- results of searches of the PINNEENA Groundwater Works Database including registered bores and continuous groundwater monitoring data;
- previous groundwater assessments for the Vickery Coal Mine and Approved Mine;
- groundwater modelling, monitoring, and assessments undertaken at the mining operations surrounding the Project, including the former Canyon Coal Mine and Rocglen and Tarrawonga Coal Mines;
- extents of water sources as defined in the relevant water sharing plans;
- DPI regional geology mapping;
- DI Water (then NSW Department of Natural Resources) *Upper Namoi Groundwater Flow Model: Model Development and Calibration* (McNeilage, 2006);

- Regional groundwater dependent ecosystem (GDE) mapping (BoM, 2015);
- stygofauna sampling (Appendix N); and
- other additional geological and regional topographic mapping data.

Overview of the Groundwater Regime in the Project Area and Surrounds

The Project mining area is located within an area of surface expression of the Permian-aged sedimentary rocks of the Maules Creek Formation (Figure 4-4). The Upper Namoi Alluvium associated with the floodplains of the Namoi River is located to the north, west and south of the Project mining area (Figures 4-4 and 4-5).

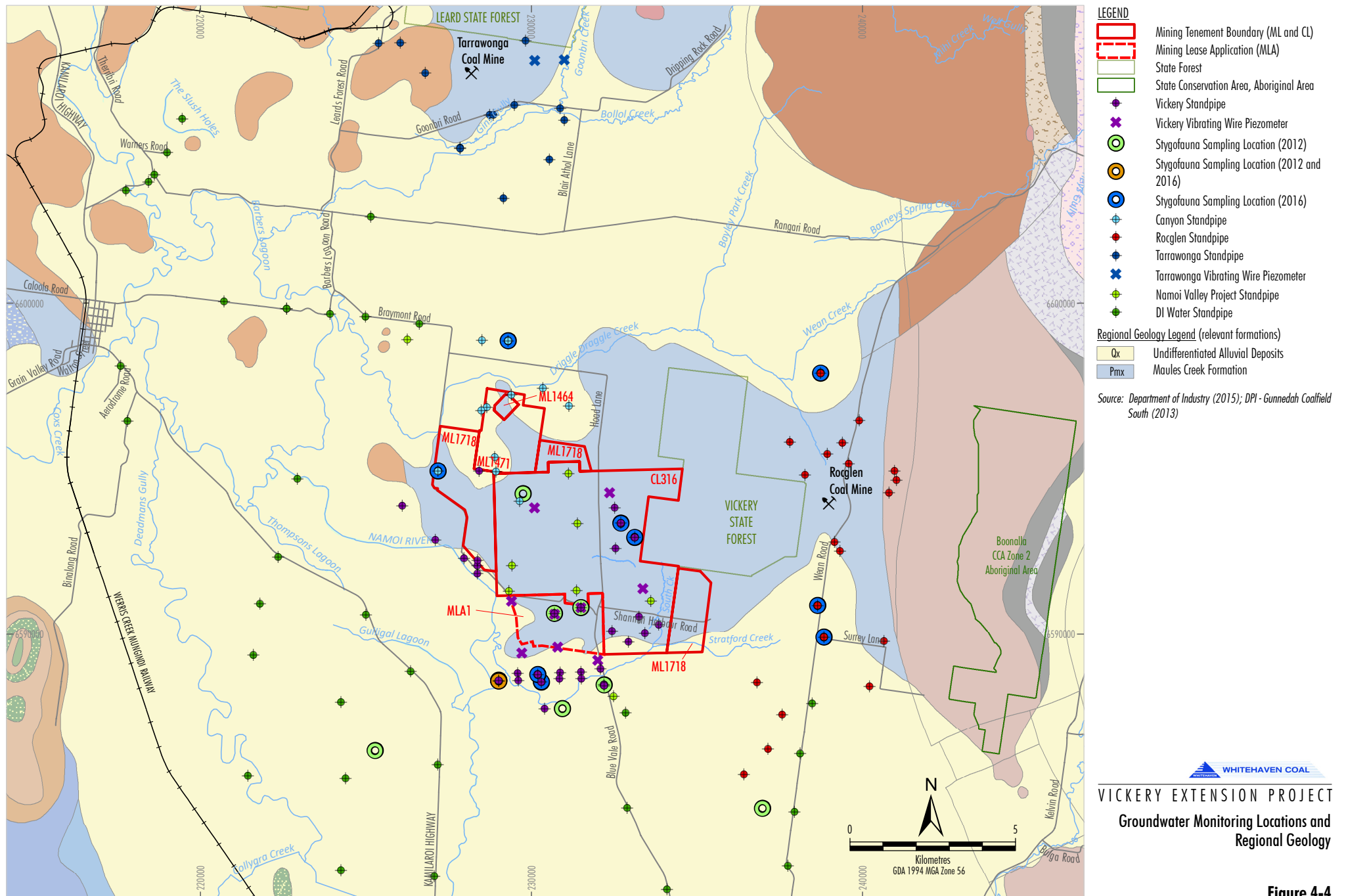
A conceptual geological model of the existing groundwater regime was developed by HydroSimulations (2018), based on a review of the available baseline groundwater data and relevant water sharing plans (Appendix A). The two groundwater systems identified in the relevant water sharing plans, within the Project mining area and surrounds, are:

- **Alluvial groundwater system** – associated with the unconsolidated alluvial sediments of the Namoi River floodplains.
- **Porous rock groundwater system** – including coal measures of the Maules Creek Formation.

Alluvial Groundwater System

The Project mining area is bordered by alluvial sediments deposited by the Namoi River, Driggle Draggie Creek and Stratford Creek (Figures 4-4 and 4-5). These alluvial sediments are subdivided into two formations, although they are not always distinguishable. The uppermost Narrabri Formation consists predominantly of clays with minor sand and gravel beds. Underlying the Narrabri Formation is the Gunnedah Formation, which consists predominantly of gravel and sand with minor clay beds.

The alluvium grades into colluvium material at the lower break of slope on the western boundary of the Project mining area. Colluvium is distinct from alluvium as it is derived from loose, unconsolidated sediments that are deposited at the base of slopes by rain-wash, sheet-wash, slow continuous downslope creep, or a combination of these processes. Colluvium in the Project mining area consists predominantly of clays and is typically unsaturated.



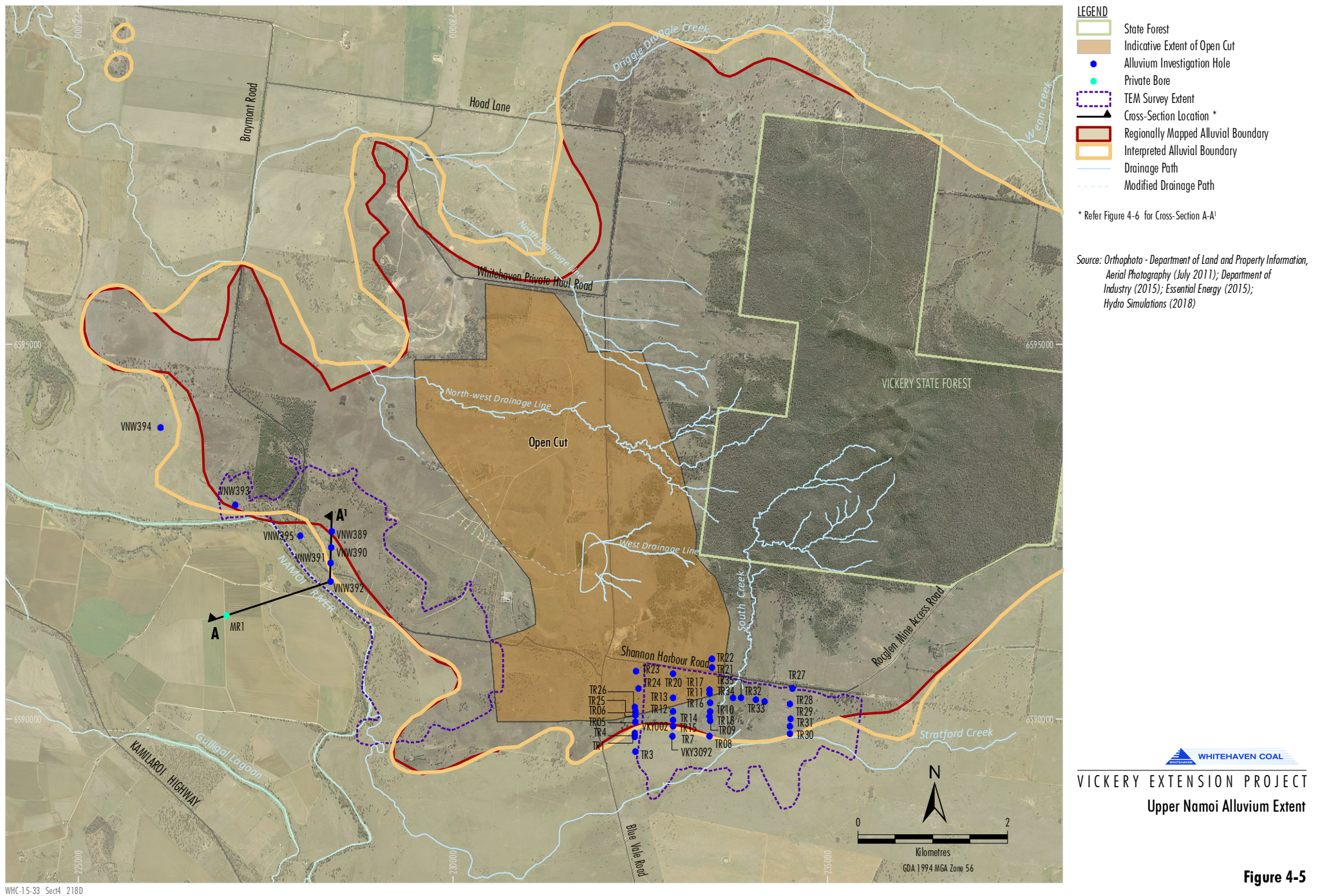


Figure 4-5

Extent of the Upper Namoi Alluvium

A number of targeted studies have been undertaken in order to better define the geometry and properties of the alluvium surrounding the Project mining area. These studies confirm the open cut would not extend into the surrounding Upper Namoi Alluvium (Appendix A).

The first study, undertaken in 2012 for the Approved Mine, involved the installation of five transects consisting of 33 shallow boreholes (Figure 4-5). The aim of the investigation was to delineate the extent of the Upper Namoi Alluvium near the southern extent of the open cut (i.e. in the vicinity of the final void), and to determine the surface profile of the underlying Maules Creek Formation. Extensions to the open cut for the Project remain outside the extent of the alluvium delineated in 2012.

Another study, undertaken in 2015, focused on the extent and nature of unconsolidated alluvial and colluvial deposits in the vicinity of the Project, adjacent to (east of) the Namoi River (i.e. between the Project and the Namoi River). The study involved a TEM survey as well as drilling at six locations, including a transect of four drill holes on the northern side of the Namoi River on Braymont Road (Figures 4-5 and 4-6).

The study confirmed that the alluvium between the Project and the Namoi River is:

- located further west than indicated on the regional geology mapping (i.e. further away from the open cut extent) (Figure 4-5);
- relatively thin (e.g. less than 6 m thick);
- dominated by silt and clay of relatively low hydraulic conductivity (consistent with the Narrabri Formation); and
- unsaturated (the regional water table is below the base of the alluvium).

Review of the *Upper Namoi Groundwater Flow Model: Model Development and Calibration* (McNeilage, 2006) and regional geology mapping indicates the Project extension of the open cut into MLA 1 does not extend into the Upper Namoi Alluvium (Figure 4-5).

Upper Namoi Alluvium Productivity

The Gunnedah Formation is the most productive aquifer in the region (i.e. used extensively to support irrigation). The overlying Narrabri Formation has a much lower yield potential, and its use for irrigation is therefore restricted. Use of the Narrabri Formation is also typically limited by the brackish to saline groundwater of the unit (Appendix A).

The Upper Namoi Alluvium between Driggle Draggie Creek and Bollol Creek to the north of the Project is typically 40 to 70 m thick, and to the south of the Project is up to approximately 140 m thick. The Upper Namoi Alluvium in the immediate vicinity of the Project (i.e. to the east of the Namoi River) is relatively thin and historically has not been used to support irrigated cropping.

Maules Creek Formation Groundwater System

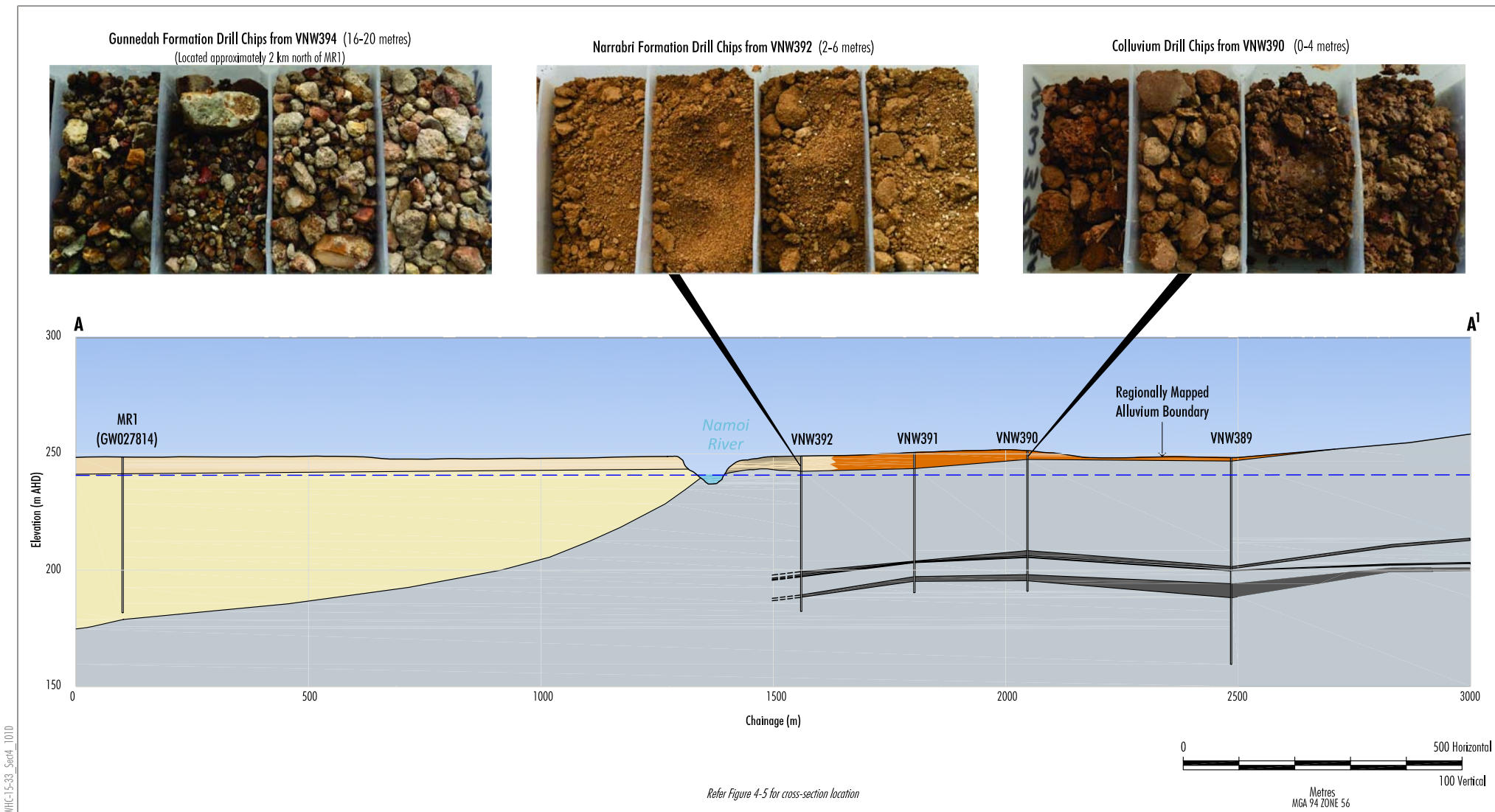
Contour maps of recent measured and inferred watertable levels at regional and local scales were prepared as part of the Groundwater Assessment, based on long-term average groundwater levels at DI Water and mine-owned monitoring sites in the vicinity of the Project mining area (Appendix A).

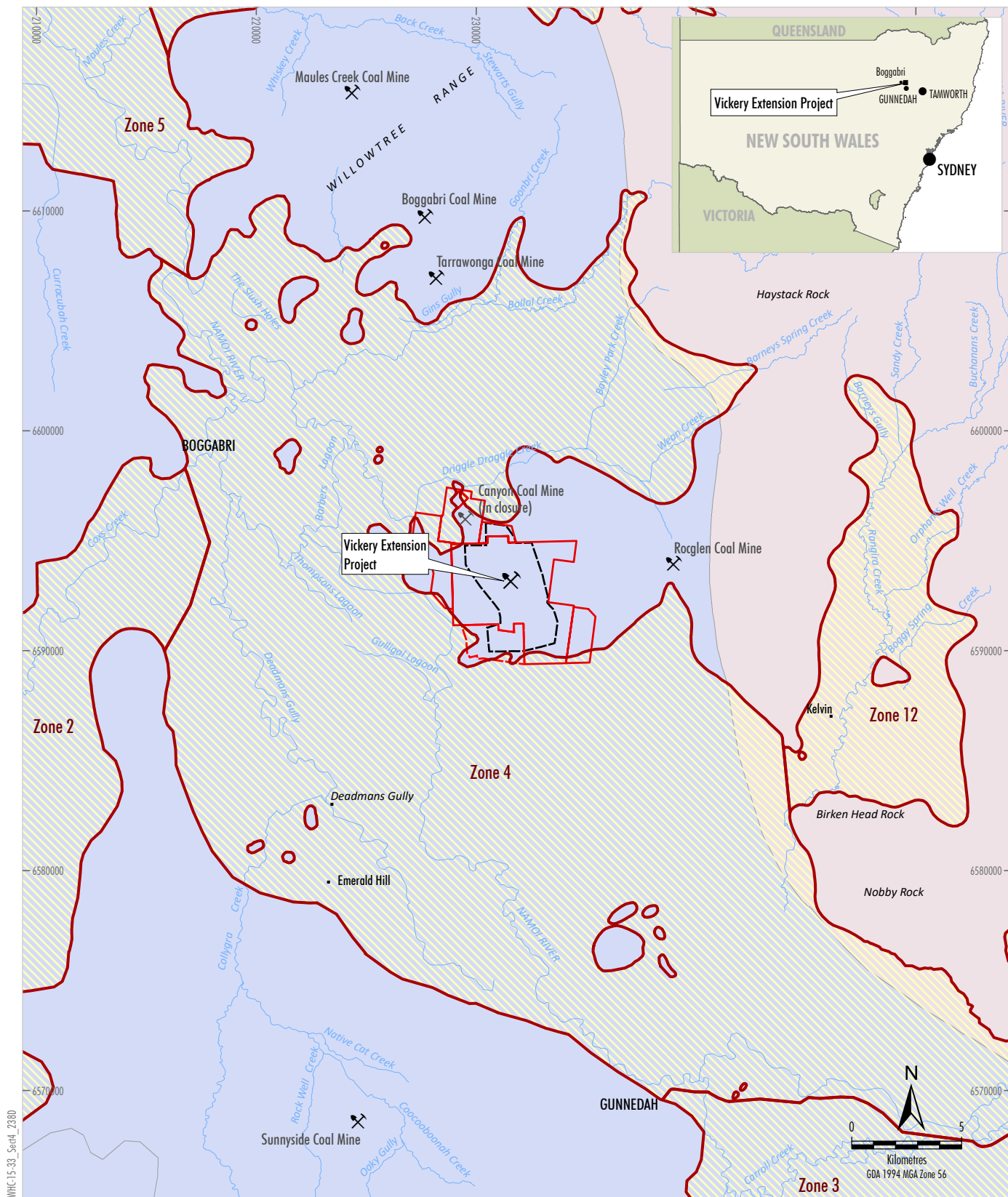
The data indicate groundwater levels follow topography, with a groundwater mound corresponding with the higher elevations in the Vickery State Forest and decreasing groundwater levels as elevations decrease towards the Namoi River. This results in an overall direction of groundwater flow towards the west, south-west and north-west (i.e. from the hills of the Vickery State Forest towards the adjoining floodplains).

The groundwater level data indicate the watertable within the Project mining area typically occurs approximately 20 m to 50 m below ground level (Appendix A).

Water Sharing Plans

The open cut would be located entirely within the Maules Creek Formation, which is within the porous rock (i.e. sedimentary rock) groundwater systems of the Gunnedah Basin, and lies within the boundary defined in the *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Water Sources 2011* (Figure 4-7). The Project coal resource is wholly located within the 'less productive' Gunnedah-Oxley Basin MDB Groundwater Source of the porous rock groundwater.





LEGEND

- Mining Tenement Boundary (ML and CL)
- Mining Lease Application (MLA)
- Extent of Project Open Cut

Water Sharing Plan for the Upper and Lower Namoi Groundwater Sources 2003

 Alluvial Groundwater Source

Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2011

 Gunnedah-Oxley Basin MDB Groundwater Source

Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources 2011

 New England Fold Belt MDB Groundwater Source

Source: Geoscience Australia Topographic Base (2006);
NSW Department of Industry (2015); NOW (2011)

WHITEHAVEN COAL

VICKERY EXTENSION PROJECT

Relevant Groundwater Sources

Figure 4-7

The alluvial groundwater system associated with the floodplains of the Namoi River to the north, south and west of the Project mining area falls within the Upper Namoi Zone 4, Namoi Valley (Keepit Dam to Gin's Leap) Groundwater Source (Zone 4) of the *Water Sharing Plan for the Upper and Lower Namoi Groundwater Sources 2003* (Figure 4-7). Zone 4 is defined as 'highly productive' under the *NSW Aquifer Interference Policy* (NSW Government, 2012) (AIP) although in reality, yields and water quality can vary considerably (Appendix A).

Bore Census

Whitehaven conducted a census of privately-owned bores and wells in the vicinity of the Project mining area in March 2012 (including some that are now owned by Whitehaven).

The closest privately-owned bores to the Project on the eastern side of the Namoi River were confirmed to be used for domestic purposes (as opposed to irrigation), with no associated licensed allocation under the relevant water sharing plans.

The results of the bore census were used to confirm the number and type of groundwater users in the vicinity of the Project, as well as assisting in the development of the regional numerical groundwater model and impact assessment.

The bores identified during the census are shown on Figure 4-8.

Groundwater Use

In addition to the bore census, Whitehaven has undertaken Water Access Licence (WAL) title searches to identify the distribution of licensed allocations in the 'highly productive' Zone 4 groundwater source.

The results of the WAL title search show (Appendix H):

- There are no WALs licensed to extract water from the alluvium between the Namoi River and the Project mining area.
- The nearest WAL licensed to extract water from the alluvium on the eastern side of the Namoi River is approximately 3.5 km west of the open cut extent.

This is consistent with the outcomes of the drilling programs to date that indicate the area in the vicinity of the Project, adjacent to (east of) the Namoi River, and the area to the immediate south of the open cut, do not contain high yielding alluvium.

Groundwater Dependent Ecosystems

There are no high priority GDEs identified in the Upper Namoi Groundwater Sources or Porous Rock Groundwater Sources in the vicinity of the Project (Appendix A).

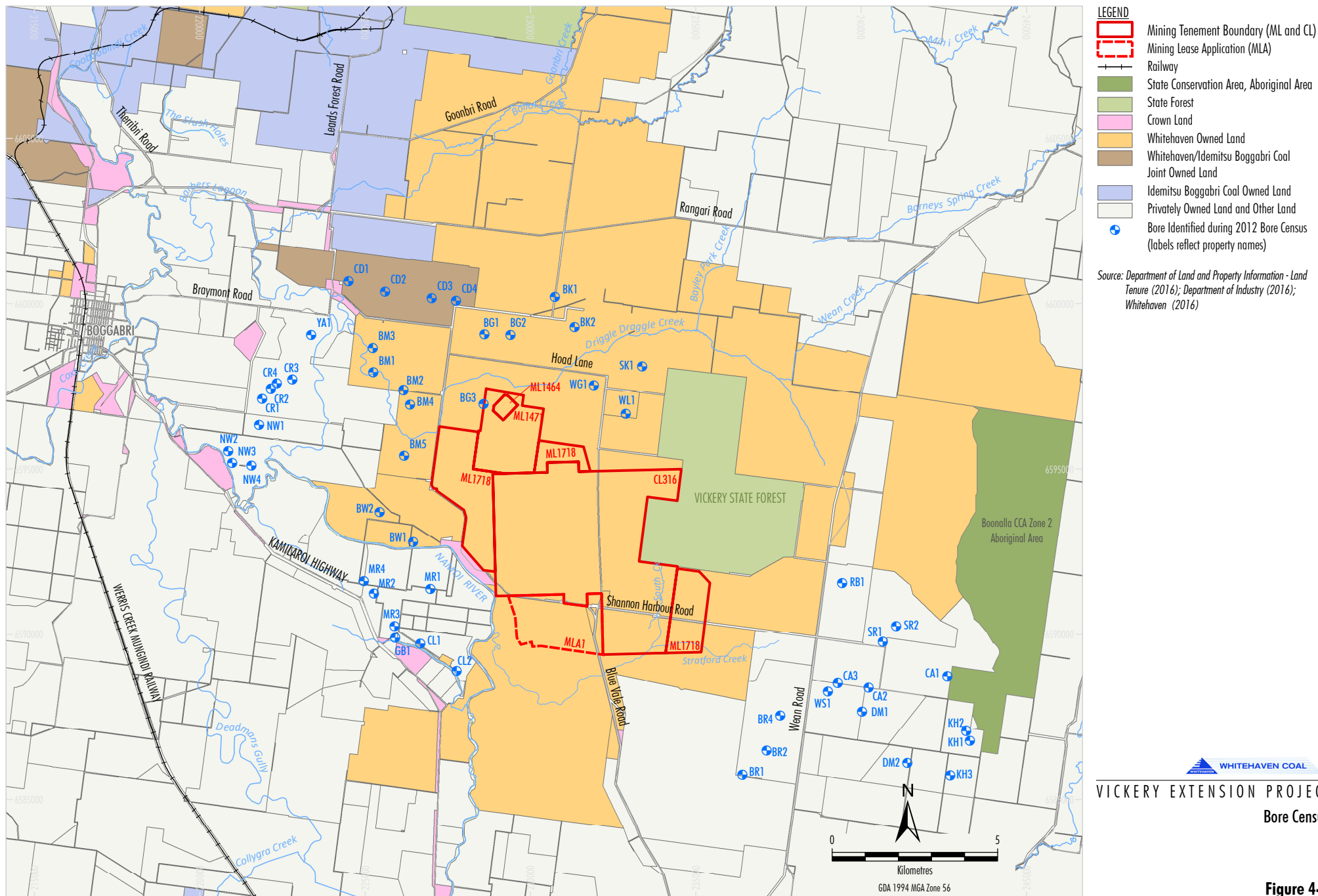
No stygofauna were recorded in the eight bores sampled in August 2012, however four stygofauna taxa were collected from three of the ten bores sampled in the Namoi River alluvial aquifer during a survey undertaken for the Project in February to March 2016 (Figure 4-4). The stygofauna collected during the survey were all widespread taxa and, consequently, have low conservation value. They are likely to occur throughout large sections of the Namoi River alluvial aquifer (Appendix N).

The *Groundwater Dependent Ecosystems Atlas* (BoM, 2015) identifies some areas of vegetation in the vicinity of the Project (e.g. Vickery State Forest) as having a low or moderate potential for groundwater interaction. However, recent flora surveys have identified no woodland/forest vegetation communities in the Project locality that exhibit characteristics of groundwater dependency (Appendix F).

The Vickery State Forest consists of Dry Sclerophyll Forests that are not considered to be groundwater dependent (Appendix F). This is consistent with the Groundwater Assessment, which determined that the water table is typically deeper than 50 m below ground level in the Vickery State Forest area (Appendix A).

The *NSW State Groundwater Dependent Ecosystems Policy* (NSW Department of Land and Water Conservation, 2002) recognises the four Australian GDE types that can be found in NSW, namely (Hatton and Evans, 1998):

- terrestrial vegetation;
- baseflows in streams;
- aquifer and cave ecosystems; and
- wetlands.



The *Risk Assessment Guidelines for Groundwater Dependent Ecosystems* (GDE guideline) (NOW, 2012) also identifies four above ground ecosystems that are considered GDEs, as follows:

- groundwater dependent wetlands;
- baseflow streams (surface water ecosystems);
- estuarine and near shore marine ecosystems; and
- phreatophytes – groundwater dependent terrestrial ecosystems.

The Namoi River is considered a GDE (i.e. the river and associated riparian vegetation) because riparian vegetation and baseflows in the main channel are partially sustained by inputs from alluvial groundwater. Interaction between the Namoi River and the underlying alluvium varies based on rainfall conditions (Appendix N).

In accordance with the GDE guideline (NOW, 2012), the Namoi River is not considered to be a high value GDE given (Appendix N):

- it is not reserved as a National Estate, listed wetland or mapped under the *NSW State Environment Planning Policy No 26 – Littoral Rainforests*;
- several exotic species occur in large populations;
- it has undergone major changes in physical structure and species composition due to historical agriculture in the region; and
- flow regime in the main channel is largely determined by releases from Keepit Dam.

Groundwater Quality

An analysis of water quality attributes of groundwater in the Project area and surrounds is provided in Appendix A, including analysis of groundwater salinity (i.e. measured EC), total dissolved solids (TDS), major anions and metals.

Groundwater quality within and surrounding the Project mining area (i.e. on the eastern side of the Namoi River) is highly variable but generally poor, with most groundwater suitable only for livestock and irrigation of some salt tolerant crops. The highest groundwater salinity is associated with the Maules Creek Formation, but is also apparent in the shallow alluvium and colluvium in the vicinity of the northern extent of the Project (Appendix A).

4.4.2 Potential Impacts

The Groundwater Assessment prepared by HydroSimulations (2018) has evaluated the potential impacts of the Project on groundwater resources using a numerical regional groundwater model.

Geological, groundwater and mine planning information published for the Rocglen Coal Mine (i.e. Rocglen Coal Extension Project) and Tarrawonga Coal Mine (i.e. Tarrawonga Coal Project) has been considered in the Groundwater Assessment.

Numerical Regional Groundwater Model

The numerical model for the Approved Mine has been improved by converting it to the latest, best practice software (MODFLOW-USG).

The numerical regional groundwater model covers an area of approximately 957 square kilometres (km²) (29 km east-west and 33 km north-south of the Project) and incorporates the Rocglen and Tarrawonga Coal Mines (Appendix A).

Groundwater modelling undertaken for the Tarrawonga Coal Project (Heritage Computing, 2012) indicated that cumulative effects are not expected at the Tarrawonga Coal Mine from the Maules Creek Mine and Boggabri Coal Mine. As the Project is located a further 9 km south of the Tarrawonga Coal Mine, inclusion of the Boggabri and Maules Creek Coal Mines in the regional model was not required (Appendix A).

The model also incorporates extraction from the Upper Namoi Alluvium groundwater system by other landholders for agricultural purposes (Appendix A).

Model Simulations

Five model simulations were conducted as follows:

- **Initial calibration simulation (pre-mining and pre-pumping):** Initial calibration of hydraulic properties in order to replicate regional groundwater levels, using data unaffected by historical groundwater extraction, including for agriculture and mining. The groundwater levels from this calibration simulation were used to provide the initial heads for the transient calibration simulation.

- **Transient calibration simulation (2006 to 2011):** Calibration of hydraulic properties against time varying groundwater levels at monitoring bores. Rainfall recharge, historical pumping from the Upper Namoi Alluvium groundwater system, and historical mining (e.g. Rocglen Coal Mine) were included in the transient calibration simulation.
- **Verification (2012 to 2017):** Verification of hydraulic properties against time varying groundwater levels at monitoring bores. Rainfall recharge, historical pumping from the Upper Namoi Alluvium groundwater system, and historical mining have been included in the verification simulation.
- **Transient prediction simulation:** Simulation of the annual progression of open cut mining, allowing for time-varying properties for mine waste rock (hydraulic conductivity, specific yield and rainfall recharge), with prediction of potential impacts of the Project on the groundwater regime, GDEs and prediction of mine inflow rates. Three prediction scenarios were simulated:
 - Baseline scenario – Rocglen and Tarrawonga Coal Mines operating without the Project.
 - Cumulative scenario – the Project and Rocglen and Tarrawonga Coal Mines operating at the same time.
 - Cumulative with Blue Vale void water storage – the Cumulative scenario operating, with the use of the Blue Vale void as a water storage.
- **Transient recovery simulation:** Simulation of groundwater level recovery close to equilibrium for the final landform and open cut void.

Groundwater Inflows

The numerical model indicates average groundwater inflows from the Maules Creek Formation to the advancing open cut would be up to approximately 1.42 ML/day (Appendix A).

There would be no direct groundwater inflow from the Upper Namoi Alluvium.

Mine-affected water captured in the open cut, comprising runoff and infiltration from active mining and emplacement areas and groundwater inflows, would be collected in in-pit collection sumps. Where the potential for higher open cut groundwater inflows is identified during the life of the Project, advanced dewatering may also be conducted using appropriately licensed temporary bores ahead of the open cut mining operation.

Following closure of the Project the final void would remain as a groundwater “sink”. Groundwater inflow to the final void is predicted to equilibrate at approximately 0.3 ML/day to 0.5 ML/day. The inflow would be sustained primarily by rainfall infiltration through the Western Emplacement (Appendix A).

Maules Creek Formation

As mining operations progress, the open cut would act as a localised groundwater sink. This would cause a change in groundwater flow direction and, in some places, a localised reversal of flow direction. There would also be a change in hydraulic properties where waste rock is subsequently placed within the footprint of the open cut void. As waste rock would have a higher permeability than natural rock material, there would be associated reductions in localised hydraulic gradients (Appendix A).

Numerical modelling conducted as part of the Groundwater Assessment predicts a substantial reduction in potentiometric head in the deeper Maules Creek Formation in the near vicinity of the open cut. However, drawdown of greater than 1 m would not extend beyond the immediate Project mining area and into the surrounding alluvium (Appendix A).

Recovery of the groundwater water table and pressures within the Maules Creek Formation groundwater system is predicted to occur over many decades following the cessation of mining (Appendix A).

Upper Namoi Alluvium

Potential impacts of the Project on the Upper Namoi Alluvium groundwater system are predicted to be negligible given (Appendix A):

- Incidental losses through enhanced leakage (i.e. vertical loss) from the Upper Namoi Alluvium to the underlying Maules Creek Formation are predicted to be less than 0.1 ML/day.

- Predicted groundwater drawdowns in the ‘highly productive’ aquifers associated with the Upper Namoi Alluvium are within the AIP minimal impact criterion of less than 2 m.
- Water within the final void would not migrate out of the void and therefore would not adversely affect surrounding groundwater resources (i.e. as the final void would act as a groundwater sink).
- Although the north-western extent of the Western Emplacement overlaps the alluvium, potential seepage from the Western Emplacement into the alluvium embayment is predicted to be minimal, the salinity of the seepage is anticipated to be significantly lower than the existing salinity of the groundwater currently within the shallow alluvium embayment, and would cause no adverse water quality impacts to the alluvium.

Groundwater Borefield Extraction

Water would be extracted from the groundwater supply borefield during periods when required (e.g. when supply from the mine storages is insufficient to meet the Project water demand, and sufficient allocation from the Namoi River is unavailable). Groundwater would be extracted through a series of up to 10 bores (Section 2.4.5) constructed within the Zone 4 groundwater source of the *Water Sharing Plan for the Upper and Lower Namoi Groundwater Sources 2003*, to the north of the Project mining area.

Whitehaven holds a number of WALs for extraction from the Zone 4. Water would be extracted in accordance with the WALs and the rules prescribed in the relevant water sharing plan (i.e. the *Water Sharing Plan for the Upper Namoi and Lower Namoi Groundwater Sources 2003*).

As all extraction from the Zone 4 groundwater source would be conducted in accordance with the licensed entitlements issued by DI Water, and in accordance with the rules in the relevant water sharing plan, minimal impacts to the Zone 4 groundwater source and other users are predicted as a result of the use of the Project groundwater supply borefield (Appendix A).

Stream Flow

The existing surface water resources and their characteristics (i.e. hydrology, water quality and physical characteristics) are described in Section 4.5.1 and Appendix B.

The Namoi River and the headwaters of Driggle Draggie Creek (to the north and north-east of the Project) are the closest watercourses to the Project with some groundwater interaction. In the vicinity of the Project there is limited water exchange with almost negligible baseflow lost from the Namoi River to the surrounding groundwater (Appendix A). Driggle Draggie Creek is a slight ‘gaining’ stream (i.e. the creek regains some baseflow from the surrounding alluvium).

The Project is predicted to have negligible influence on baseflow to/from the Namoi River and Driggle Draggie Creek during operations or post-mining (Appendix A).

Groundwater Users

No privately-owned bores, as identified by the bore census (Figure 4-8), are predicted to have greater than 2 m drawdown (i.e. impacts are within the ‘Level 1’ minimal impact criteria in the AIP).

Given no more than 1 m of drawdown is predicted in the alluvium, any bores in the alluvium not identified in the bore census or constructed after the census was undertaken would also be within the ‘Level 1’ minimal impact criteria in the AIP.

Groundwater Dependent Ecosystems

The Namoi River is considered a GDE however, in accordance with the GDE guideline, it is not considered to be a high value GDE.

The Project would present a low risk to the Namoi River (as defined in the GDE guideline) (NOW, 2012) because (Appendices A and B):

- the predicted baseflow reduction in the Namoi River due to the Project is negligible; and
- the Project is predicted to have negligible impact on water quality in the Namoi River.

Cumulative Impacts

The impacts described above (i.e. negligible impact to privately-owned bores, the Upper Namoi Alluvium and the Namoi River) are based on predictions from the Groundwater Assessment that include the cumulative impacts of the Project, the approved Rocglen and Tarrawonga Coal Mines and regional agricultural groundwater extraction.

Cumulative groundwater drawdown contours showing the magnitude and water table pattern caused by coincident mining at the approved Rocglen and Tarrawonga Coal Mines and the Project are presented in Appendix A.

The drawdown contours indicate there would be no interaction between groundwater effects from mining at the Tarrawonga Coal Mine and the Project (Appendix A).

Cumulative effects with the Rocglen Coal Mine are limited to the Maules Creek Formation and are largely restricted to the area in the immediate vicinity of the two mines (Appendix A).

Sensitivity Analysis

Two additional model simulations were conducted for sensitivity analysis as follows (Appendix A):

- **Climate Change:** A climate change scenario was run using decreased rainfall recharge in line with Climate Change in Australia Model (Commonwealth Scientific and Industrial Research Organisation [CSIRO], 2015a and 2015b) predictions.
- **Hydraulic Conductivities:** Two scenarios were conducted using higher and lower vertical hydraulic conductivities for all model layers, respectively.

Climate change projections for Australia and NSW are discussed in Section 6.1.3 and Appendix A. The climate change model scenario resulted in a less than 1% reduction in pit inflows. Therefore, the sensitivity of the groundwater model results to climate change is not considered to be significant (Appendix A).

Changing the vertical hydraulic conductivity of all model layers by one order of magnitude results in an estimated change of pit inflows ranging from -8% to +16% (compared to the base case), and therefore the model results are considered to have negligible uncertainty (Appendix A).

4.4.3 Mitigation Measures, Management and Monitoring

Groundwater Licensing

Available WALs held by Whitehaven are summarised in Table 4-6.

Project groundwater licensing requirements are described in Attachment 6 including consideration of the Project against the water management and access licence dealing principles under the NSW *Water Management Act, 2000*.

The predicted annual groundwater volumes required to be licensed over the life of the Project and post-mining are summarised in Table 4-7.

Based on the groundwater modelling, Whitehaven currently hold licences sufficient to cover the modelled groundwater inflows from the porous rock groundwater sources and associated losses from the alluvium and Namoi River due to enhanced leakage to the Maules Creek Formation (Table 4-7). Sufficient licence allocations could be retired at the completion of the Project to account for groundwater inflows to the void post-mining.

Water Management Plan

A Water Management Plan would be developed for the Project. As the Project impacts are similar in magnitude to those for the Approved Mine, it is expected the Water Management Plan would be consistent with the requirements of Development Consent (SSD-5000), however, it would ultimately be prepared in consideration of the requirements of any relevant Development Consent conditions for the Project.

Groundwater Monitoring

The existing groundwater monitoring network is described in Appendix A and shown on Figure 4-4 and provides comprehensive baseline data for the Project. The existing groundwater monitoring network would be reviewed as part of the Water Management Plan with consolidation of the network as required. Two additional monitoring bores would be installed in the waste rock emplacement areas once it is sufficiently developed.

Numerical Model Review

The numerical model developed and used for the Groundwater Assessment (Appendix A) would be used as a management tool for the periodic review and calibration of predicted groundwater impacts through the life of the Project.

Table 4-6
Available Whitehaven WALs

Water Sharing Plan	Water Source	Licence Category	Water Access Licence Number	Allocation (Shares)
<i>Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2011</i>	Gunnedah-Oxley Basin MDB Groundwater Source	Aquifer	36576	600
<i>Water Sharing Plan for the Upper and Lower Namoi Groundwater Sources 2003</i>	Upper Namoi Zone 4, Namoi Valley (Keepit Dam to Gin's Leap)	Aquifer ¹	12653	166
		Aquifer ¹	12651	52
		Aquifer ¹	12645	35
		Aquifer ¹	12724	45
		Aquifer ¹	12715	75
		Aquifer ¹	12701	20
		Aquifer ¹	12731	3
		<i>Subtotal</i>	-	396
<i>Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016</i>	Lower Namoi Regulated River Water Source	General Security River	14936	1,056
		General Security River	13051	96
		General Security River	2682	486
		Supplementary River	13052	10.5
		Supplementary River	2683	53
		High Security River	16034	50
		<i>Subtotal</i>	-	1,751.5

¹ With the exception of the Upper and Lower Namoi Groundwater Zone 1, all Namoi aquifer access licences and unregulated river licences received an allocation of 1 ML per unit share of entitlement in the 2018/2019 water year (DI Water, 2018).

Table 4-7
Estimated Water Licensing Requirements for the Project

Water Sharing Plan	Water Source	Approximate Whitehaven Entitlement (Shares)	Maximum Project Licensing Requirement (ML/year)	
			Groundwater Inflows During Mining	Groundwater Inflows Post-Mining
<i>Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2011</i>	Gunnedah-Oxley Basin MDB Groundwater Source	600	517	< 500
<i>Water Sharing Plan for the Upper and Lower Namoi Groundwater Sources 2003</i>	Upper Namoi Zone 4, Namoi Valley (Keepit Dam to Gin's Leap)	396	5	9
<i>Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016</i>	Lower Namoi Regulated River Water Source	1,751.5	11	27

The results of the groundwater monitoring program would inform progressive refinement of the numerical model as the open cut mining area is developed. Revised outputs from the numerical model would be reported in the Annual Review, as relevant over the life of the Project, and used to inform site water balance reviews (Section 4.5.3).

Make Good Provisions

No privately-owned bores are predicted to experience greater than 2 m drawdown.

Notwithstanding, should monitoring or an investigation show greater than 2 m drawdown at a privately-owned bore, and the drawdown is attributable to the Project, 'make good' provisions for the affected groundwater user would be implemented, and may include:

- deepening the affected groundwater bore;
- construction of a new groundwater bore; and/or
- provision of an alternative water supply of appropriate quality and quantity.

4.5 SURFACE WATER

A Surface Water Assessment for the Project was undertaken by Advisian (2018) and is presented in Appendix B. The Surface Water Assessment was peer reviewed by Emeritus Professor Tom McMahon (University of Melbourne) and the review report is presented in Attachment 4.

A description of the existing surface water resources in the Project area and surrounds, including the existing monitoring regime, baseline data and existing surface water use, is provided in Section 4.5.1. Section 4.5.2 describes the potential impacts of the Project on surface water resources including cumulative impacts, while Section 4.5.3 outlines mitigation measures, management (including licensing considerations) and monitoring.

The Project groundwater and surface water studies have been undertaken in an integrated manner. For example, the assessment of potential surface water impacts includes baseflow reductions predicted by the Groundwater Assessment (Appendix A).

The Surface Water Assessment has considered the requirements of the SEARs as well as the potential impact of the Action to MNES under the EPBC Act (Attachment 2) and concludes the Project would not have a significant impact on surface water resources.

4.5.1 Existing Environment

With the exception of the Vickery State Forest, the majority of land within and adjacent to the Project has been cleared for agricultural purposes. The surface water quality and flow regimes in the Project area reflect the influences of the historical clearing and the elevated catchments within the Vickery State Forest.

The discussion below presents a summary description of baseline surface water data and the regional and local hydrology. Further detail is provided in Appendix B.

Baseline Surface Water Data

Advisian (2018) analysed data made available by Commonwealth and State government agencies, Whitehaven and surface water reports from surrounding mining operations. This included BoM climate data, DI Water gauging station flow data, local surface water quality data, the *Namoi Catchment Water Study Phase 2 Report* (Schlumberger Water Services, 2011) and geological and regional topographic mapping data.

In addition, the Surface Water Assessment (Appendix B) has considered the requirements of the *Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016* and the *Water Sharing Plan for the Namoi Unregulated and Alluvial Water Sources 2012*.

Relevant surface water and weather monitoring locations are shown on Figure 4-9.

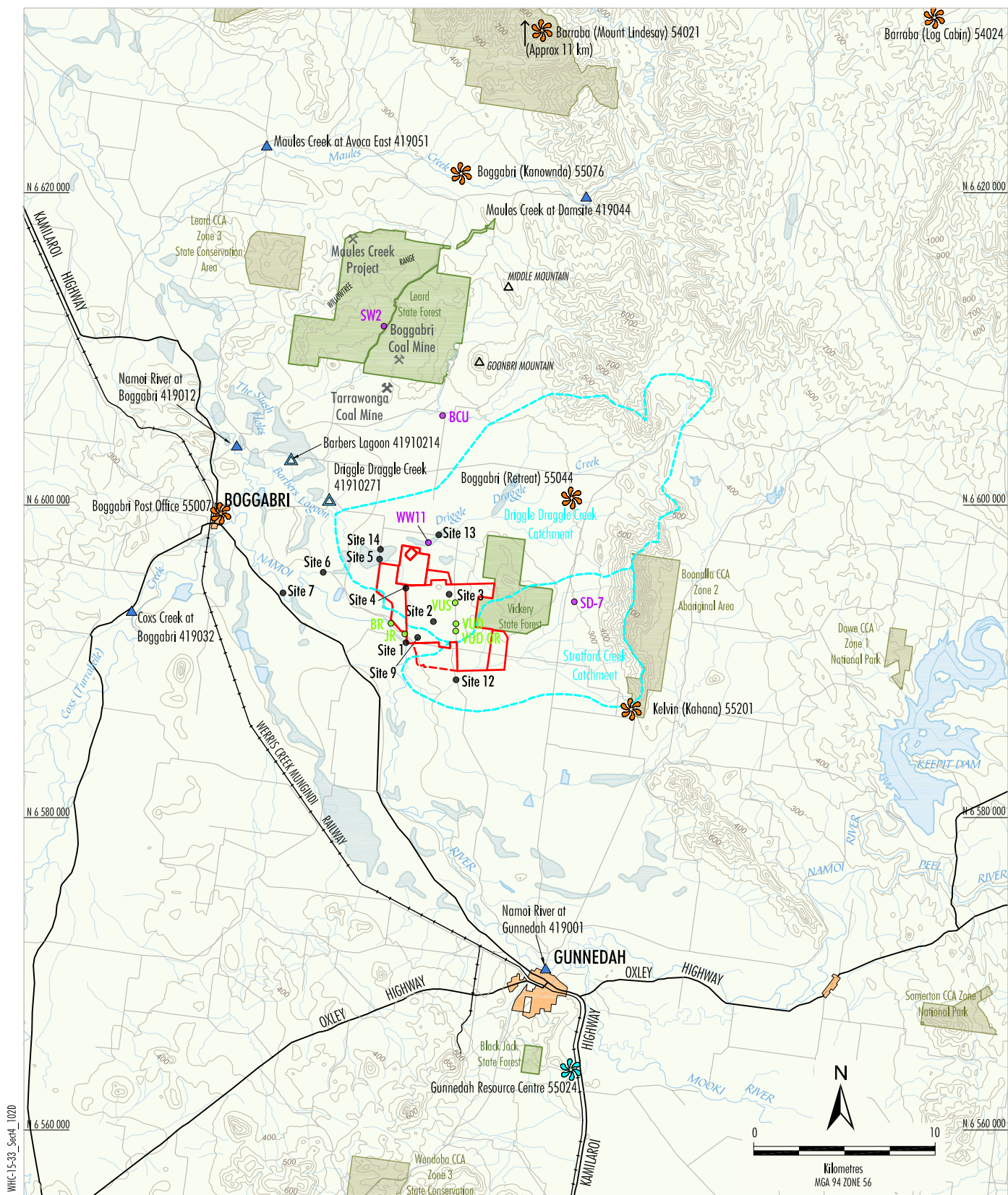
Regional Hydrology

The Namoi catchment (Figure 4-10) is part of the Murray-Darling System and covers an area of approximately 4.2 million ha.

The catchment is bordered by the Great Dividing Range east of Tamworth, the Liverpool Ranges and Warrumbungle Ranges in the south, and the Nandewar Ranges and Mount Kaputar to the north.

The Project area is situated within the Lower Namoi Regulated River Water Source under the *Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016*.

The Namoi River is a tributary of the Barwon River that ultimately flows to the Murray-Darling System.

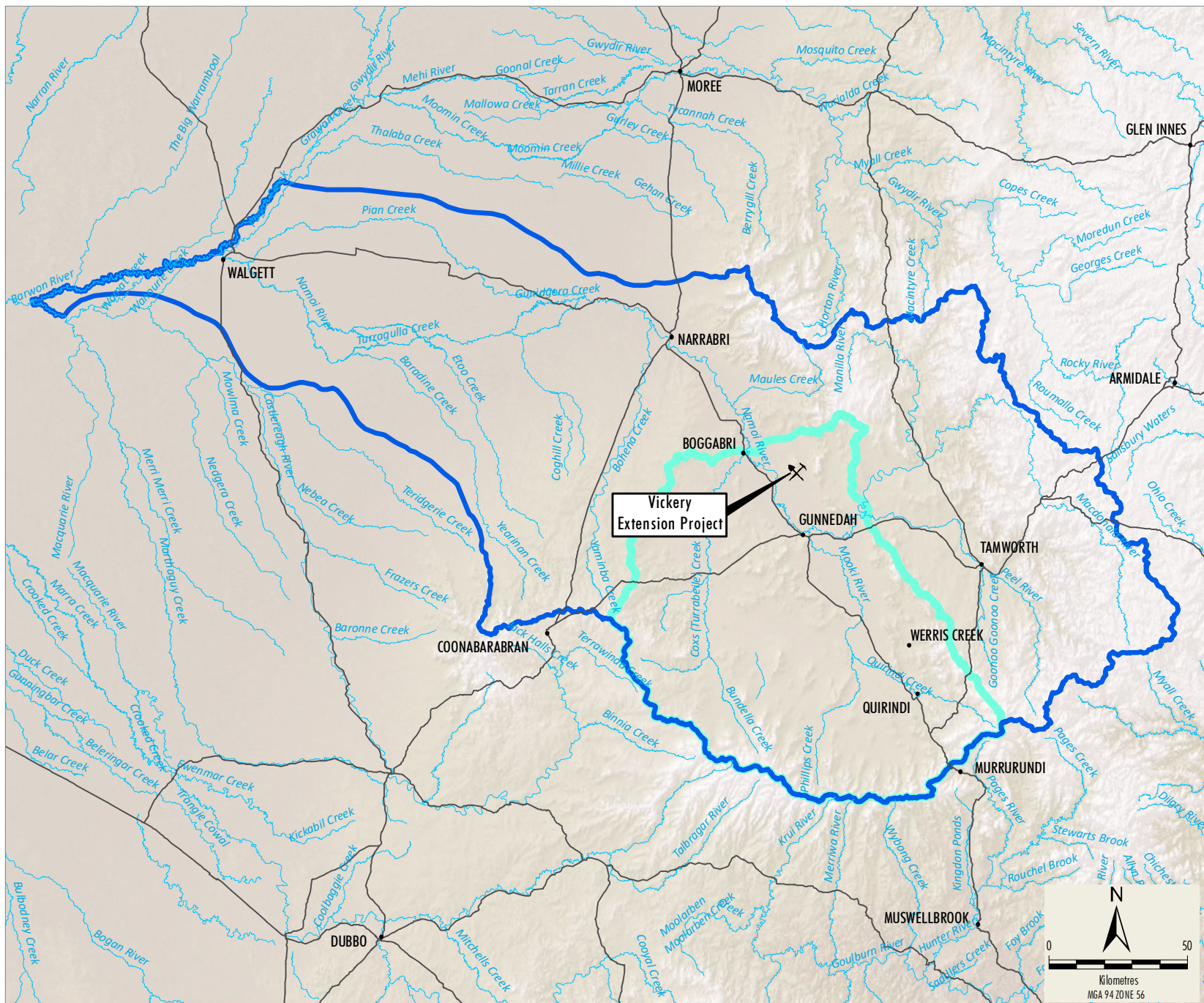


WHITEHAVEN COAL

VICKERY EXTENSION PROJECT

Regional Surface Water and Weather Monitoring Sites

Figure 4-9



LEGEND

- Namoi Catchment
- Liverpool Plains Sub-catchment

Source: Geoscience Australia (2006); LPI (2014); OEH (2014);
NSW Department of Industry (2016); Whitehaven (2016)

WHITEHAVEN COAL

VICKERY EXTENSION PROJECT

Namoi Catchment and
Liverpool Plains Sub-catchment

Figure 4-10

Flow in the Namoi River is regulated by three major water storages:

- Keepit Dam – constructed on the Namoi River upstream of the Peel River confluence in 1960 with a storage capacity of 427,000 ML.
- Chaffey Dam – constructed on the Peel River upstream of Woolomin in 1979 with a storage capacity of 62,000 ML.
- Split Rock Dam – constructed on the Manilla River in 1988 with a storage capacity of 397,000 ML.

Water is released from these major water storages for irrigation, industrial and domestic/urban requirements in the Namoi catchment and as environmental flows.

The closest gauging station to the Project mining area on the Namoi River is located at Boggabri (419012), just upstream of the Bollol Creek confluence with the Namoi River (Figure 4-9). At the Boggabri gauging station there is a catchment area of 22,600 km² (Appendix B).

Streamflow in the Namoi River at Boggabri is characterised by strong flow persistence with flows exceeding 1.6 ML/day on 95% of days. Zero flow is recorded on 1.4% of days. Over the full period of available data, streamflow in the Namoi River at Boggabri has a median of 403 ML/day and an average of 1,695 ML/day (Appendix B).

Local Hydrology

The Project mining area is largely located within the Stratford Creek and Driggle Draggie Creek sub-catchments, which ultimately flow into the Namoi River south of Boggabri (Figure 4-9). The south-western extent of the Project mining area is within the Namoi catchment.

The Project rail spur traverses the flatter land south-west of the Project mining area associated with the Namoi River floodplain, including Stratford Creek and Deadmans Gully (Figure 2-3).

Driggle Draggie Creek

Driggle Draggie Creek flows in a westerly direction to the north of the Project mining area and is an ephemeral watercourse that receives baseflow recharge in its headwaters (to the north-east of the Project).

Unnamed ephemeral drainage paths that flow through the Project mining area (referred to as the north drainage line, the north-west drainage line and west drainage line) ultimately join Driggle Draggie Creek to the north of the Project (Figure 4-11).

Driggle Draggie Creek enters Barbers Lagoon to the north-west of the Project, which eventually flows into the Namoi River (Figure 4-9). Driggle Draggie Creek is a seventh order stream at its confluence with Barbers Lagoon.

Stratford Creek

Stratford Creek is an ephemeral watercourse that flows in a westerly direction before flowing into the Namoi River. The watercourse runs in an east-west direction parallel to the southern extent of the Project mining area (Figure 4-11). At the confluence with South Creek, Stratford Creek is a fourth order stream.

South Creek

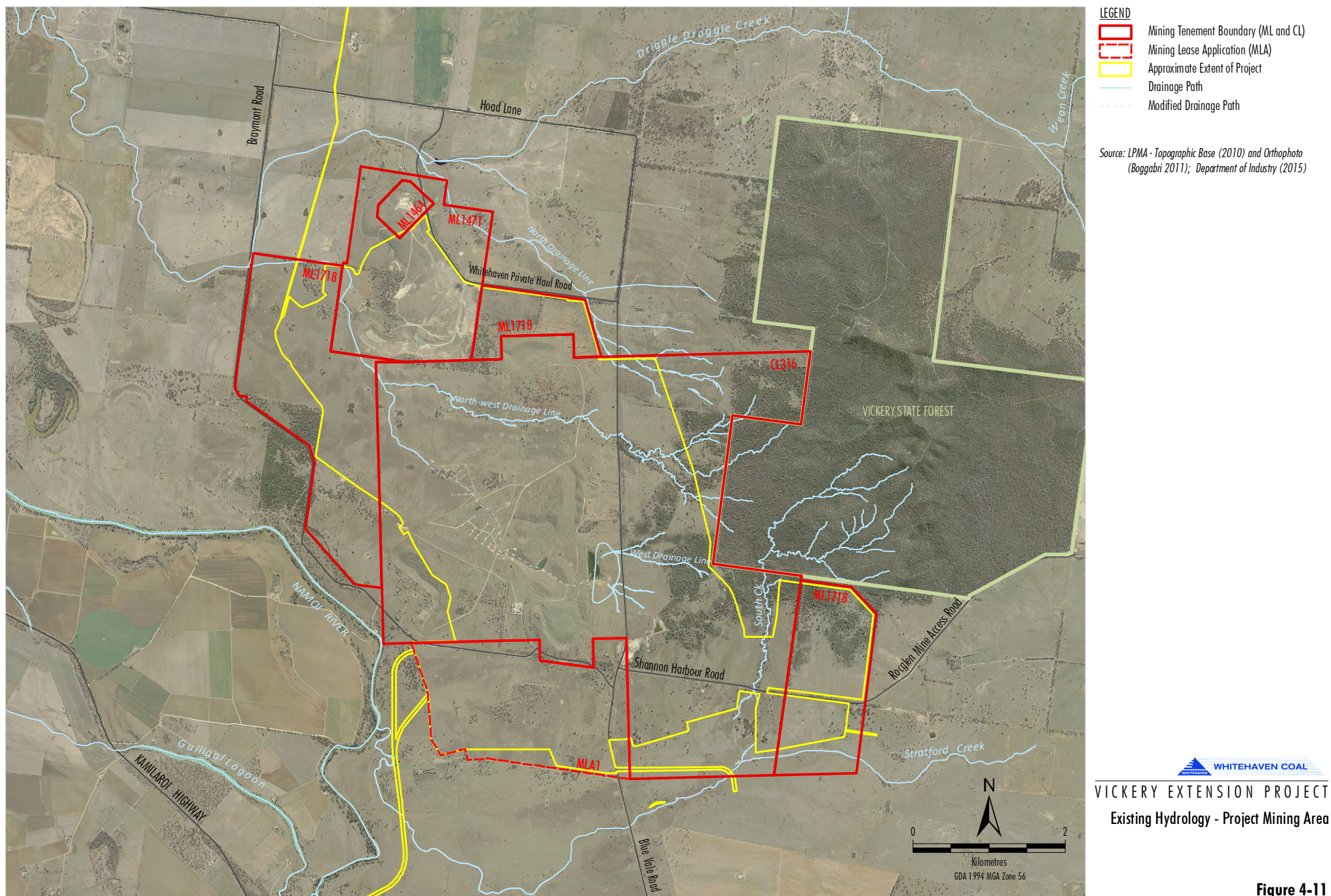
South Creek is an ephemeral watercourse that drains the southern portion of the Vickery State Forest and flows in a southerly direction between the proposed open cut extent and the secondary infrastructure area (Figure 4-11). South Creek joins Stratford Creek south-west of the secondary infrastructure area and is a fourth order stream.

North-West Drainage Line

The north-west drainage line is an ephemeral watercourse that drains the western part of the Vickery State Forest in a north-westerly direction across the Project mining area (Figure 4-11). The north-west drainage line receives flow from the west drainage line before joining Driggle Draggie Creek to the north-west of the Project. After the confluence with the west drainage line the watercourse becomes a fourth order stream.

West Drainage Line

The west drainage line drains from the central portion of the Project mining area in a north-westerly direction before joining the north-west drainage line (Figure 4-11). Immediately prior to this confluence, the west drainage line is a third order stream.



North Drainage Line

The north drainage line drains from the north-eastern portion of the Project mining area in a north-westerly direction (Figure 4-11). The north drainage line joins Driggle Draggie Creek to the north of the Project and is a third order stream.

Project Mining Area Sub-catchments

A summary of the sub-catchments within the Project mining area and the properties of these catchments are provided in Table 4-8.

Table 4-8
Local Sub-Catchment Area Summary

Sub-Catchment	Location	Catchment Area ¹ (km ²)
Driggle Draggie Creek	Drains towards the Namoi River to the north of the Project.	203
Stratford Creek	Drains towards the Namoi River to the south of the Project.	65

¹ Catchment area at the edge of the Project mining area.

No flow gauges are located on the ephemeral watercourses described above. The Surface Water Assessment (Appendix B) therefore characterised the flow regime of the north-west drainage line and South Creek using the Australian Water Balance Model.

The modelling indicated that the average runoff from the north-west drainage line and South Creek is 21 megalitres per annum (ML/annum) and 79 ML/annum respectively with predicted 90th percentile flows of 36 ML/annum and 141 ML/annum respectively (Appendix B).

Surface Water Quality

Regional Surface Water Resources

The Namoi River, and its associated floodplains and fringing lagoons, are the regional surface water resources of relevance to the Project.

Figure 4-9 shows the existing regional surface water quality monitoring sites and sample locations in the vicinity of the Project.

Water quality of the Namoi River is generally characterised by moderate alkalinity and elevated EC relative to Australian and New Zealand Environmental and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000) guideline trigger values for aquatic ecosystems (Table 4-9).

The *Current water accounts and water quality for the Namoi subregion (Product 1.5 for the Namoi subregion from the Northern Inland Catchments Bioregional Assessment)* (Pena-Arancibia *et al.*, 2016) concludes the following with respect to surface water quality in the Namoi River:

- The ANZECC/ARMCANZ default trigger value for EC for the protection of aquatic ecosystems is frequently exceeded.
- The mean daily turbidity in the Namoi River (according to DI Water gauging station records) of 141 NTU exceeds the ANZECC and ARMCANZ (2000) trigger value for aquatic ecosystems.
- There is a lack of data on the presence of heavy metals, trace elements and hydrocarbons.

EC values in the Namoi River at Gunnedah (419001) ranged between 200 microSiemens per centimetre (µS/cm) and 900 µS/cm every year between 2001 and 2011 and there is no significant trend to the data (Schlumberger Water Services, 2011).

Average total nitrogen and total phosphorous concentrations have also been elevated relative to ANZECC and ARMCANZ guideline trigger values for aquatic ecosystems. Phosphorous and nitrogen are sourced from effluent, agricultural runoff and in-stream processes (Schlumberger Water Services, 2011).

Highest turbidities are recorded in the lower sections of the Namoi River (Schlumberger Water Services, 2011). Most sediment is derived from disturbance within catchments, stream bed and bank erosion, or direct access by livestock (Thoms *et al.*, 1999). As stated in Schlumberger Water Services (2011):

In summary the early studies, including Nancarrow (1998), concluded that prior to 2000, the chemical water quality of the Namoi River system was generally moderate to poor, with high levels of nutrients, areas contaminated by agricultural chemicals, and areas with on-going salinity problems. While trends for parameters such as salinity, turbidity and nutrients varied in the short term, longer term trends showed little signs of a decline through time.

Table 4-9
Summary of Regional Average Water Quality Data

Location (refer Figure 4-9)	Parameter [^]					
	pH	EC (µS/cm)	Alkalinity (mg/L)	Turbidity (NTU)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
Namoi River (and Lagoons)						
• Gunnedah (419001)	8.06	497	204	67.3	0.72	0.14
• Barbers Lagoon (downstream of Bollol Creek) (41910214)	7.70	348	-	304	-	-
• Driggle Draggie Creek at Boggabri (41910271)	6.99	117	-	-	-	-
ANZECC/ARMCANZ (2000) Guideline Trigger Values						
• Aquatic Ecosystems [Default]	6.5 – 7.5	30 – 350	-	2 – 25	0.25	0.02
• Primary Industries [Default]	5.0 – 9.0	-	-	-	-	-
• Livestock Drinking Water [Default]	-	3,125 [~]	-	-	-	-

Source: Appendix B.

NTU = nephelometric turbidity unit.

[^] Sample counts for each parameter varies for each location.

[~] Equivalent to 2,000 mg/L TDS with a conversion factor of 1.5625 applied.

Surface water quality data between 2002 and 2007 has been analysed in a study carried out by the NOW (now DI Water) in the Namoi catchment (Mawhinney, 2011), with the following relevant conclusions:

- EC values typically exceeded default trigger levels for the protection of aquatic ecosystems but were suitable for irrigation;
- turbidity levels increased with distance down the catchment and are predicted to fall as beds and banks are stabilised; and
- high total phosphorous and nitrogen were detected, although there was no corresponding significant growth of blue/green algae.

Local Surface Water Resources

Local water quality data for the Project are available from the following sources:

- Approved Mine and Project surface water quality monitoring conducted by Whitehaven in the immediate vicinity of the Project;
- the original Vickery Coal Mine EIS (Vickery Joint Venture, 1986); and
- publicly available documentation containing details of water quality monitoring conducted at nearby mine sites.

The results of 75 surface water quality samples collected by Whitehaven for the Project mining area are presented in Appendix B. Opportunities to sample have been limited because the watercourses in the vicinity of the Project (with the exception of the Namoi River) are ephemeral.

Figure 4-9 shows existing local surface water monitoring sites and sample locations in the vicinity of the Project.

A summary of the water quality monitoring conducted for the Project, for upstream monitoring locations at other mine sites in the region, as well as the original Vickery Coal Mine EIS (Vickery Joint Venture, 1986) is presented in Table 4-10.

The surface water quality results for local surface water resources are described further in Appendix B.

4.5.2 Potential Impacts

The following sub-sections describe the potential operational and post-mining impacts of the Project on surface water flow regimes and surface water quality.

The objectives and design criteria of the Project Water Management System are described in Section 2.10.1.

Table 4-10
Summary of Local Average Water Quality Data

Location (refer Figure 4-9)	Parameter [^]		
	pH	EC (µS/cm)	TSS (mg/L)
Average of all Water Quality Monitoring Results			
• Project monitoring sites (BR, JR, VUS, VUD and VUD OR)	7.0	73	42
• 1986 EIS monitoring sites (Sites 1 to 7, 9 and 12 to 14)	8.1	456	77
• Site WW11 (upstream of the former Canyon Coal Mine)	7.1	96	109
• Site BCU (upstream of Tarrawonga Coal Mine)	7.0	169	164
• Site SW2 (upstream of Boggabri Coal Mine)	7.1	98	95
ANZECC/ARMCANZ (2000) Guideline Trigger Values – Aquatic Ecosystems	6.5 – 7.5*	30 – 350	-

Source: After Appendix B.

TSS = Total Suspended Solids

[^] Sample counts for each parameter varies for each location and are provided in Appendix B.

* Value for NSW Upland Rivers (>150 m AHD altitude).

Surface Water Flow Regimes

The Project would result in changes to flows in local watercourses and drainage lines due to the progressive development of the Project Water Management System and associated capture and re-use of drainage from operational disturbance areas.

Table 4-11 summarises the progressive change in catchment area reporting to Driggle Draggie Creek and the Namoi River, as a result of the Project (Appendix B).

The potential maximum cumulative impact, including the Project, would reduce the contributing catchment to Driggle Draggie Creek during operations by up to 11.9% (an additional 4.0% when compared to the Approved Mine). The minor changes in flows in Driggle Draggie Creek as a result of the Project are unlikely to have any effect on the geomorphologic characteristics or riparian values of the creek itself or the downstream receiving waters in Barbers Lagoon (Appendix B).

The maximum predicted change in catchment of the Namoi River over the life of the Project when compared to the total catchment of the Namoi River is approximately 0.07% (an increase of 0.02% when compared to the Approved Mine). This change would not lead to any perceptible or measurable change in the flow regime of the river (Appendix B).

Post-mining, only the catchment area of the final void would remain excised from the Namoi catchment (approximately 250 ha or 0.01% of the total catchment of the river). This is approximately half of the catchment that would be captured by the two final voids approved to be developed as part of the Approved Mine (i.e. 490 ha).

The *Tarrawonga Coal Project Surface Water Assessment* (Gilbert & Associates, 2011) considered the potential cumulative impacts of the Tarrawonga Coal Mine, the Boggabri Coal Mine and the Maules Creek Coal Project in the context of potential reduction in catchment area of the Namoi River. Based on this estimate, it is considered that the maximum cumulative reduction in contributing catchments to the Namoi River during the life of the Project would be approximately 0.18% (an increase of approximately 0.02% from the Approved Mine). This conservatively assumes that the maximum reduction in contributing catchments for each individual mine would occur at the same time (Table 4-11).

Namoi River Surface Water Extraction

Consistent with the approach for the Approved Mine, water would be extracted from the Namoi River when supply from the mine storages (e.g. the mine water dams and sediment dams) is insufficient to meet the demand. This water would be extracted using a pump station located to the south-west of the Western Emplacement (Section 2.4.5), and would be pumped for storage in the mine water dams.

Water would be extracted from the Namoi River in accordance with licences held by Whitehaven and the rules prescribed in the relevant water sharing plan (i.e. the *Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016*).

The site water balance modelling conducted for the Project demonstrates that external water demands could be met with surface water (and groundwater) licenses currently held by Whitehaven (Appendix B).

Table 4-11
Progressive and Maximum Changes to Contributing Catchment of Driggle Draggie Creek and the Namoi River

Scenario	Percentage Reduction in Contributing Catchment	
	Driggle Draggie Creek	Namoi River
Project (Incorporating the Approved Mine)		
Project – Year 3	6.2%	0.02%
Project – Year 7	9.1%	0.05%
Project – Year 13	10.8%	0.05%
Project – Year 21	10.8%	0.07%
Other Mining Projects		
Tarrawonga Coal Mine	N/A	0.02%
Boggabri Coal Mine	N/A	0.04%
Maules Creek Coal Project	N/A	0.04%
Rocglen Coal Mine	1.1%	0.01%
Potential Maximum Cumulative Impact	11.9%	0.18%
<i>Approved Mine Maximum Cumulative Impact</i>	<i>7.9%</i>	<i>0.16%</i>
Incremental Change Due to the Project	4.0%	0.02%

Source: After Appendix B; Gilbert & Associates (2011); and GSS Environmental (2011).

As all extraction from the Namoi River would be conducted in accordance with the licensed entitlements issued by DI Water and the rules in the relevant water sharing plan, impacts to the Namoi River water source are not anticipated to be significant.

Surface Water Quality

Runoff and Contaminants

The Project Water Management System is designed to contain water collected in the open cut as well as runoff from the active waste rock emplacement areas and the mine infrastructure areas for re-use on-site (Section 2.10.1). The site water balance model results indicate that there would be no uncontrolled releases of this water from the Project Water Management System (Appendix B).

Discharge from sediment dams would only occur under the following circumstances (Appendix B):

- Overflow in the event of rainfall in excess of the design criteria specified in DECCW (2008) for the Project region (38.4 mm over five days) and when there is insufficient capacity for water to be transferred to mine water dams.

- Controlled discharge to restore the capacity of sediment dams, which would only occur if the water had a suspended solids concentration of less than 50 mg/L. Prior to controlled discharge the water would be sampled and analysed to check its suitability for discharge.

With these controls in place, the Project is predicted to have negligible impact on water quality in the receiving watercourses (Appendix B).

Potential Impacts from the Waste Rock Emplacement

A Geochemistry Assessment was conducted by GEM (2018) and is presented in Appendix M. A summary of the outcomes of the Geochemistry Assessment is provided in Sections 2.8 and 2.9 including characterisation of waste rock and coal reject material and management and mitigation measures for PAF and sodic materials.

Relevant to surface water, the Geochemistry Assessment found (Appendix M):

- The majority of the overburden and interburden generated from the Project would generally be expected to have a low sulfur content and be NAF.

- A small quantity of overburden was identified as containing increased sulfur concentrations but with low acid generating capacity. These materials are anticipated to produce acid conditions only if left exposed to the atmosphere for a number of years.
- Some interburden material (typically mudstone) was identified as containing increased sulfur concentrations and higher acid generating capacity. Blending of this material during excavation, transport and dumping is expected to produce an overall NAF material.
- The rejects material is typically expected to be NAF. A small proportion of the rejects are likely to have a very low ANC and as such there is a risk that some of these materials will be PAF. However, due to the low total sulfur content, any PAF coal rejects are expected to only have a low capacity to generate acid.
- The overburden, interburden and coal rejects material contain metal enrichment compared to average crustal abundance, with Arsenic, Molybdenum and Selenium relatively soluble in waste rock and coal reject samples.

Overburden and interburden would be emplaced in the waste rock emplacement, which would be progressively rehabilitated (Section 5). Water that has been in contact with the open cut or coal stockpiles would be captured in mine water dams and coal contact water dams, contained and re-used on-site (Section 2.10.1).

No reject material would be placed within 30 m of the edge of the Western Emplacement, and reject material would be covered with at least 5 m of inert material on the outer surfaces of the waste rock emplacement. Dewatered reject material would be co-disposed in locations such that any runoff or infiltration would report to the mine water management system.

Given the management of overburden, interburden, rejects and mine water proposed for the Project, the risk of contaminants in water released from sediment dams impacting downstream waters is considered to be low (Appendix B). In addition (Appendix B):

- water would only overflow from sediment dams following heavy rainfall (i.e. concentrations of these metals would be heavily diluted by fresh rainwater);
- water that overflows following heavy rainfall would represent a very small portion of the flow in receiving watercourses (e.g. Namoi River, Driggle Draggie Creek, north drainage line and Stratford Creek);
- under median climatic conditions, overflows from one of the sediment dams (i.e. when rainfall exceeds sediment basin design criteria) would only occur on average one day in every 3 years, with less frequent overflows from other sediment dams; and
- under median climatic conditions, controlled releases from sediment dams (i.e. to restore their design storage capacity) would only occur on average two days per year and in accordance with an EPL.

Alteration of Groundwater Quality

No measurable changes in the quality of groundwater (alluvial and porous rock) are predicted to occur as a consequence of mining (Appendix A).

As a result, there would be negligible impact on surface water quality in local creeks through baseflow.

Post-Mining Surface Water Impacts

The potential post-mining surface water impacts primarily relate to the design of the final void and performance of the permanent and rehabilitated mine landforms in the long-term and are discussed below.

Final Void

At the cessation of mining, one final void would remain in the south-eastern corner of the open cut (in addition to the existing Blue Vale final void). The Project would therefore reduce the number of final voids in comparison to the five final voids in the current landscape and three voids proposed for the Approved Mine.

A perimeter bund would be constructed around the final void to prevent runoff or floodwater draining into the void (Appendix B). The catchment area of the final void within the perimeter bund would be approximately 250 ha.

Post-mining inflows to the final void would come from the following sources:

- incident rainfall;
- surface water runoff (albeit from a minimised reporting catchment); and
- groundwater inflows from the Maules Creek Formation groundwater system as it recovers and adjacent mine and waste rock emplacement infiltration (reducing with time).

A void water recovery analysis, including predicted groundwater inflows, has been conducted as part of the Surface Water Assessment and is presented in Appendix B. A pit lake is predicted to form with a maximum equilibrium level of approximately 110 to 120 m AHD under higher rainfall scenarios, or approximately 80 m AHD under reduced rainfall scenarios.

Water would only be lost from the final void through evaporation. The water level in the final void would remain at least 140 m below the crest of the void and would not overflow to downstream watercourses (Appendix B).

The salinity of the pit lake is predicted to increase slowly with time, with the salinity varying depending on the climate (e.g. rainfall and evaporation). Salinity is predicted to increase to approximately 10,000 mg/L under higher rainfall scenarios and significantly greater than 10,000 mg/L under lower rainfall scenarios (Appendix B).

Rehabilitated Mine Landforms

Storage dams and sediment dams would be retained until the revegetated surface of the waste rock emplacement is stable and runoff water quality reflects runoff water quality from similar unmined areas. At this time these drainage controls may be removed and the rehabilitated areas would be free-draining, or report to unmanaged sediment dams.

Cumulative Impacts

The maximum cumulative reduction in contributing catchments to the Namoi River during the life of the Project would be 0.18% (an increase of 0.02% relative to the Approved Mine) (Table 4-11).

The negligible changes in baseflow to/from watercourses predicted include the cumulative contribution of other nearby mining operations (Appendix A).

The Project's incremental contribution to any potential cumulative impacts on surface water flows are expected to be negligible (Appendices A and B).

Climate Change and Surface Water

Potential effects of climate change on the predicted Project surface water impacts, including consideration of alternative climate scenarios within the water balance and in the final void water level and salinity predictions (i.e. sensitivity analysis) are considered in Appendix B.

4.5.3 Mitigation Measures, Management and Monitoring

Water Quality Management Measures

The Project Water Management System would be used to protect the integrity of local and regional water sources and separate runoff from undisturbed, rehabilitated and mining affected areas (Section 2.10.1).

The Project Water Management System would be operated throughout the life of the mine to provide sufficient water to meet the Project demand. It would also be designed to provide sufficient water storage capacity.

Water quality monitoring sites would be installed at sediment dams and other water storages as required by an EPL for the Project.

Waste Rock Emplacement Areas

Consistent with the recommendations of the Geochemistry Assessment (Appendix M), the following parameters would be included in the surface water monitoring program for the Project (the frequency of monitoring would be reviewed during operations):

- pH;
- Aluminium;
- Arsenic;
- Molybdenum; and
- Selenium.

In the event that low pH conditions or high metal concentrations are identified through surface water monitoring, an investigation would be undertaken and remedial measures would be implemented, if required.

Irrigation and Evaporation

Excess water held within the Project Water Management System may be used to irrigate land catchments that report to the Project Water Management System for mine water. Evaporation cannons may also be used in these areas to remove excess water from the Project Water Management System. Irrigation and evaporation activities would be undertaken to maximise evaporation and evapotranspiration but avoid surface runoff directly off-site.

Water Management Plan

A Water Management Plan would be developed for the Project in consideration of the requirements of an EPL and relevant Development Consent conditions for the Project.

Site Water Balance

The site water balance for the Project is provided in Appendix B, and a summary of the key findings is provided in Section 2.10.

The site water balance modelling demonstrates Whitehaven holds sufficient groundwater and surface water licences to meet the predicted external water demands.

Periodic review and revision of the site water balance would be undertaken over the life of the Project to record and document the status of inflows (water capture), storage and consumption (e.g. dust suppression and CHPP water supply) and to optimise water management performance. The reviews would also evaluate actual external make-up water requirements, climatic conditions and long-term predictions (including consideration of Available Water Determinations [AWD] for the Lower Namoi Regulated River Water Source of the *Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016*).

Monitoring would be undertaken over the life of the Project to provide data for refinement of the site water balance, including:

- records of pumped water volumes;
- storage levels in mine water dams and other containment storages;
- dust suppression water usage rates; and
- CHPP water usage rates.

Surface Water Management Measures

In relation to surface water, the Water Management Plan would include:

- a detailed description of the Project Water Management System including detailed plans, design objectives and performance criteria;
- trigger levels for investigating any potentially adverse impacts associated with the Project;
- contingency mitigation/compensation/offset measures that would be implemented in the event that downstream surface water users or riparian vegetation are adversely affected by the Project; and
- a surface water monitoring program.

Surface water monitoring would include the following:

- water quality monitoring at points upstream and downstream on watercourses closest to the Project mining area (monitoring locations would be selected during development of the Water Management Plan); and
- sampling of parameters described in the Geochemistry Assessment (Appendix M) and Surface Water Assessment (Appendix B).

Surface Water Licensing

The Project area falls within the Lower Namoi Regulated River Water Source for the purpose of the *Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016*.

The extraction of water from the Namoi River to meet the Project water demand would be conducted as per the relevant licence conditions.

The *Water Sharing Plan for the Namoi Unregulated and Alluvial Water Sources 2012* provides sharing of water between the environment, town water supplier, basic landholder rights and commercial uses, and applies to unregulated water sources in the Namoi Basin.

The NSW *Water Management Act, 2000* gives landholders the right to capture 10% of the average regional rainwater runoff on the land by means of harvestable rights. The landholding owned by Whitehaven which is attributable to the Project provides a maximum harvestable right capacity (i.e. maximum dam capacity) of 175 ML (Appendix B).

Further discussion regarding licences required for each water source associated with the Project is provided in Attachment 6.

Post-Mining Surface Water Management

The management of surface water resources post-mining, including drainage across the final mine landform and final void management, are discussed in Section 5.

4.6 FLOOD BEHAVIOUR

A Flood Assessment for the Project was undertaken by WRM Water & Environment (WRM) (2018) and is presented in Appendix C (Flood Assessment).

A description of the existing flood environment, including consideration of past flood studies, is provided in Section 4.6.1. Section 4.6.2 describes the potential flooding impacts of the Project, while Section 4.6.3 outlines the proposed mitigation measures, management and monitoring to be undertaken.

The Flood Assessment has been prepared to address the flooding related requirements of the SEARs for the Project, having regard to the recommendations and requirements of relevant agencies (Attachment 1).

4.6.1 Existing Environment

The Project involves construction of infrastructure on the Namoi River floodplain, as well as on the floodplains of local drainages of the Namoi River including Driggle Draggie Creek and Stratford Creek. Local drainages in the vicinity of the Project are described in Section 4.5.1 and shown of Figure 4-11.

Namoi River Floodplain

The Namoi catchment (Figure 4-10) is bounded by the Great Dividing Range in the east, the Liverpool Ranges and Warrumbungle Ranges in the south, and the Nandewar Ranges and Mount Kaputar to the north. Major tributaries of the Namoi River include Cox's Creek and the Mooki, Peel, Cockburn, Manilla and Macdonald Rivers, all of which join the Namoi River upstream of Boggabri. The catchment area of the Namoi River to Boggabri is approximately 22,600 km² (Appendix C).

The Namoi River adjacent to the Project is characterised by a 50 m to 70 m wide main channel meandering along a lower terrace floodplain approximately 500 m to 1,200 m wide. The lower terrace floodplain cuts through the greater Namoi River floodplain that varies in width from 6 km to 11 km (Appendix C).

Rural floodplain management is currently in transition from rural floodplain management planning under Part 8 of the *NSW Water Act, 1912* to the *NSW Water Management Act, 2000*.

The Project is partially located within the extent of the gazetted *Carroll to Boggabri Floodplain Management Plan September 2006* (Carroll to Boggabri FMP) area. The Carroll to Boggabri FMP was prepared under the *NSW Water Act, 1912* using the *Floodplain Development Manual* (NSW Government, 2005).

OEH and DPI Water (now DI Water) have developed a Draft FMP pursuant to section 50 of the *NSW Water Management Act, 2000*. The Draft FMP contains rules to coordinate the approval of new flood works or amendments to existing flood works in a similar manner to the existing Carroll to Boggabri FMP (noting that the Project would not require a flood work approval under the *NSW Water Management Act, 2000* due to section 4.41 of the EP&A Act). Rules are defined in the Draft FMP for a number of management zones that represent different hydraulic and ecological regions across the floodplain. The management zones have been defined in accordance with clause 41A of the *NSW Water Management (General) Regulation, 2011*.

The management rules given in the Draft FMP have been used as the basis for assessing the infrastructure proposed as part of the Project.

Floodplains of Local Drainages

The catchments of local drainages (e.g. Driggle Draggie Creek and Stratford Creek) generally flood independently of the greater Namoi River floodplain and are potentially affected by backwater flows from the Namoi River at their downstream ends.

Past Flood Studies

Flood records for the Namoi River extend back to 1864 when a large flood was observed (recording of 9.85 m at Gunnedah), with other significant flood events occurring in 1908 and 1955 (9.65 m and 9.60 m at Gunnedah, respectively) (SMEC, 2003; Worley Parsons Services Pty Ltd, 2013).

Flooding along the reaches of the Namoi River nearest to Boggabri is characterised by outbreaks from the main river channel, and associated inundation of the extensive floodplain areas on both sides of the river. Floodplain flow is dominated by flow in flood runners (i.e. overland preferential flow paths). Flow patterns are affected by a series of relic channels that form semi-permanent lagoons between floods (SMEC, 2003).

The results of past flood studies and assessments have been considered in the Flood Assessment (Appendix C) including:

- *Gunnedah and Carroll Floodplain Management Study* (SMEC, 1999); and
- *Carroll to Boggabri Flood Study* (SMEC, 2003).

Flood Characterisation and Modelling

Characterisation of the existing flood behaviour of the Namoi River and local drainages was undertaken by WRM (2018) based on analysis of historic flood events and development of flood models to estimate the 20%, 5% and 1% AEP design flood events, and an extreme flood event to represent a Probable Maximum Flood (PMF) event (Appendix C).

Namoi River Design Flood Discharges

A flood frequency analysis was undertaken of the 48 years (1968 to 2015) of recorded stream flow data from the Namoi River stream gauge at Gunnedah (gauge number 419001) to estimate the 20%, 5% and 1% AEP design discharges (Appendix C).

The estimated peak discharge for the 1955 flood event, which was one of the largest historical events on record, was also included in the flood frequency analysis. While recorded stream gauge data was not available for 1955, the peak flow for the 1955 flood event was derived by WRM (2018) by converting the recorded peak water level to a stream discharge using the currently available rating curve for the gauge.

Table 4-12 shows the predicted peak discharges for the 20%, 5% and 1% AEP and the extreme design flood events, as well as the peak discharges for two historical flood events (1955 and 1998).

Table 4-12
Historic and Design Event Peak Flood Discharges for the Namoi River

Event		Peak Discharge (m ³ /s)
20% AEP	Design	828
1998	Historic	2,617
5% AEP	Design	2,975
1% AEP	Design	9,141
1955	Historic	9,260
Extreme (3 x 1% AEP)	Design	27,423

Source: After Appendix C.

The results in Table 4-12 indicate the 1955 flood had an AEP of approximately 1%. This is consistent with the *Gunnedah and Carroll Floodplain Management Study* (SMEC, 1999) adopted by the Gunnedah Shire Council that concluded the 1955 flood event had an AEP of between 1.4% and 1.0% and the *Carroll to Boggabri Flood Study* (SMEC, 2003) that concluded the 1955 flood event had an AEP of 1% at the Gunnedah stream gauge (Appendix C).

A PMF event was not able to be determined by WRM (2018) using the flood frequency analysis methodology for the Namoi River, as the PMF is beyond the limit of extrapolation from the 48 years of available data for the Namoi River stream gauge at Gunnedah (Appendix C). Therefore, the estimate of a peak discharge for an 'extreme' flood (Table 4-12) has been made by using three times the 1% AEP discharge estimate (Appendix C).

Namoi River Modelled Peak Flood Levels

For the Namoi River, historical discharge flood hydrographs (i.e. flood levels) for the 1955 and 1998 events were obtained from the hydraulic model developed as part of the *Carroll to Boggabri Flood Study* (SMEC, 2003). This model extends upstream of Gunnedah and provides estimates of the distribution of flow between the river channel and the overbank floodplains.

The 1955 and 1998 peak flood levels were modelled as the Carroll to Boggabri FMP uses these flood events to assess proposed infrastructure against the complying works assessment criteria.

Namoi River Tributaries Design Flood Discharges

An XP-RAFTS runoff-routing model was used to estimate the 20%, 5% and 1% AEP and PMF design discharges in Driggle Draggie Creek and Bollol Creek.

In the absence of recorded stream flow data for the local drainages, the XP-RAFTS design discharges were validated through comparison with the design discharges estimated using the Draft Australian Rainfall and Runoff Regional Flood Frequency Estimation (RFFE) (Appendix C).

The results indicated the XP-RAFTS predicted peak design discharges are generally in good agreement with the RFFE estimates (to within 14%).

A summary of the predicted XP-RAFTS model design peak discharges at key locations on the local drainages is provided in Table 4-13.

Flood Levels and Velocities

TUFLOW two-dimensional hydraulic models were used by WRM (2018) to estimate flood levels and velocities for the Namoi River floodplain in the vicinity of the Project mining area and along the Project rail spur.

The TUFLOW model was split into two separate hydraulic models. The 'Namoi River' model was used to estimate flood levels for the Namoi River and extends approximately 19 km upstream and 23 km downstream of the Project. The 'Namoi Tributaries' model covers the Driggle Draggie Creek and Bollol Creek floodplain to the north of the Project mining area.

The 'Namoi River' hydraulic model was calibrated to the available data for the 1998 and 1955 flood events and was verified against peak flood levels predicted by the hydraulic model developed as part of the *Carroll to Boggabri Flood Study* (SMEC, 2003).

Data available for the 1998 flood consisted of aerial photography as well as surveys of peak flood levels at four locations. Surveys of peak flood levels for the 1955 event at six locations were also available and used for calibration. Comparison of the TUFLOW model results to aerial photography and surveyed peak flood levels indicates the model provides a good representation of the extent of flooding and provides conservatively high estimates of design flood levels (Appendix C).

Flood Extents

The predicted flood depths and extents along the Namoi River floodplain for the 1% AEP event are shown on Figure 4-12.

Based on the extents and depths of flooding (i.e. as predicted by the calibrated TUFLOW model):

- The Project mining area is located outside of the predicted Namoi River peak flood extents for all events including the extreme (three times the 1% AEP) flood event. Therefore the Project mining area is not located on the Namoi River floodplain or Namoi River flood prone land.
- The secondary infrastructure area and the south-eastern corner of the open cut are within the extent of flooding from Stratford Creek.
- The Project rail spur traverses the Namoi River floodplain.

4.6.2 Potential Impacts

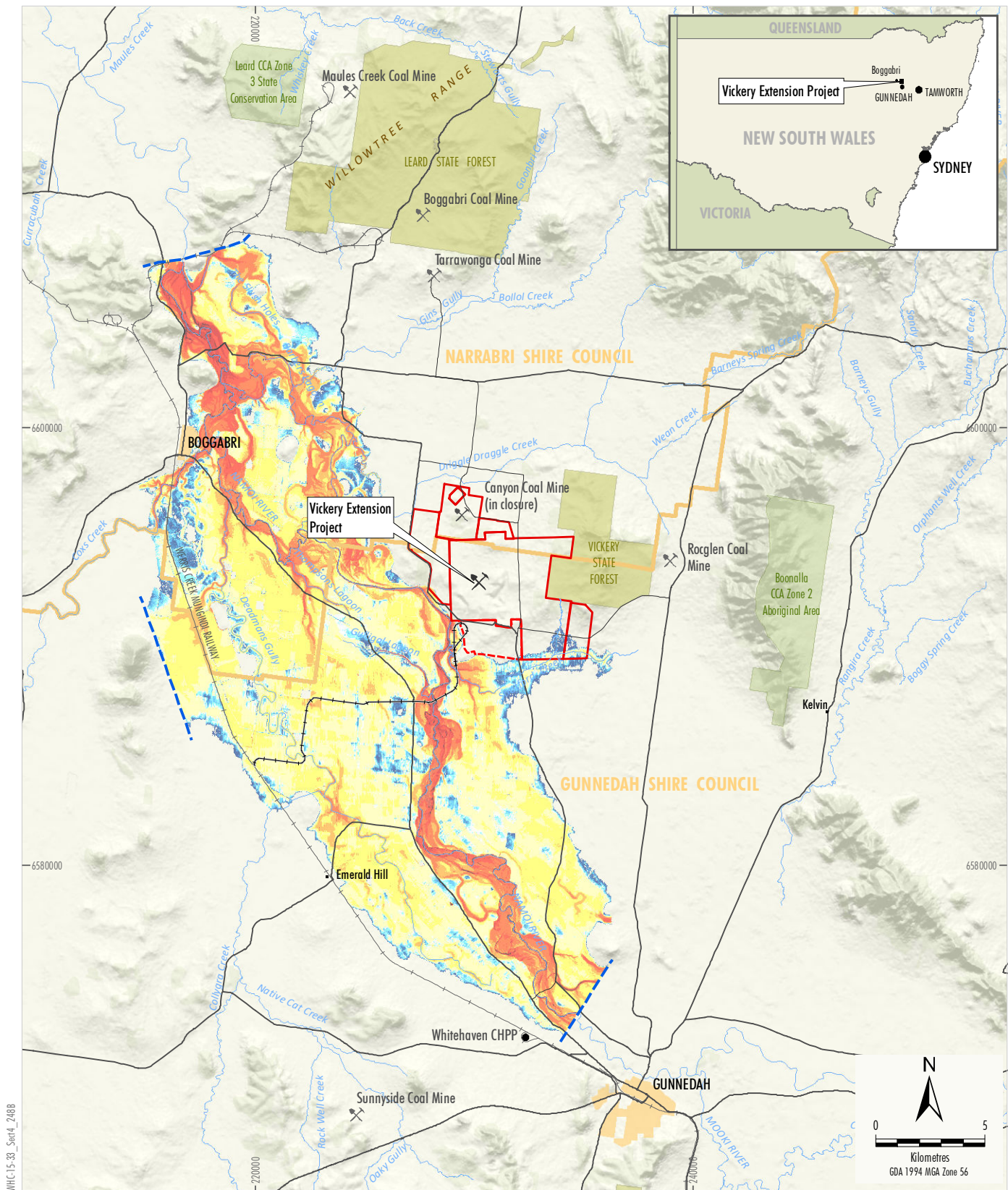
Adopted Objectives from the Draft Floodplain Management Plan

The Project mining area and rail spur are located within a number of management zones defined within the Draft FMP.

Table 4-13
Predicted Design Event Peak Flood Discharges for the Local Drainages

Location Description	XP-RAFTS Design Event Peak Discharge (m ³ /s)			
	20% AEP	5% AEP	1% AEP	PMF
Stratford Creek upstream of Namoi River confluence	46	108	206	1,466
Driggle Draggie Creek	73	168	317	2,036
Bollol Creek	52	116	218	1,270
Collygra Creek upstream of the Project rail spur	75	189	377	2,012

Source: After Appendix C.



LEGEND

- Mining Tenement Boundary (ML and CL)
- Mining Lease Application (MLA)
- Local Government Boundary
- State Forest
- State Conservation Area, Aboriginal Area
- Major Roads
- Railway
- Indicative Project Rail Spur
- Model Boundaries

Depth (m)

- 0.0 > 0.1
- 0.1 > 0.2
- 0.2 > 0.3
- 0.3 > 0.4
- 0.4 > 0.5
- 0.5 > 1.0
- 1.0 > 1.5
- 1.5 > 2.0
- 2.0 > 3.0
- 3.0 > 4.0
- 4.0 > 5.0
- > 5.0

Source: LPMA - Topographic Base (2010); NSW Department of Industry (2015);
WRM Water & Environment (2018)

WHITEHAVEN COAL

VICKERY EXTENSION PROJECT

Predicted Existing Flood Depths and
Extents Along Namoi River
Floodplain for the 1% AEP Event

Figure 4-12

The Draft FMP describes management rules for the various management zones in consideration of a large design flood, that approximates a 5% AEP flood event, and a small design flood that approximates a 20% AEP flood event.

The objectives within the Draft FMP that have been adopted by WRM (2018) for the flood assessment are:

- flood levels should not increase by more than 20 centimetres (cm) on adjacent privately-owned landholdings;
- increases in flood level and velocity should not impact on high value infrastructure (e.g. dwellings);
- peak flood flow should not be redistributed more than 5% across the floodplain;
- flood velocity should not increase by more than 50%;
- flood connectivity to ecological and/or cultural assets and fish passage should be maintained;
- drainage time on adjacent landholdings within 24 hours of existing drainage time should be maintained;
- the cumulative impact that the proposed works and other existing works on the landholding may have on adjacent landholdings should be considered; and
- there should be no additional impact on heritage sites and values.

The above objectives have been assessed by WRM (2018) against the large design event (5% AEP) and the small design event (20% AEP), as well as the 1% AEP event (noting that the Project would not require a flood work approval under the *Water Management Act, 2000* due to section 4.41 of the EP&A Act).

Project Mining Area

The Project mining area is located beyond the Namoi River peak flood extents for all events. Accordingly, the Project mining area would not alter the flooding characteristics along the Namoi River, and the Project mining area is not at risk of flood impacts from the Namoi River (Appendix C).

WRM (2018) modelling results show localised and shallow depths of flooding from Stratford Creek and South Creek occur in the south-east of the Project mining area. As part of the Project infrastructure design, bunds/levees would be constructed in this area to prevent inundation of the infrastructure areas and open cut from high flow events in Stratford Creek and South Creek.

Based on the modelling results, the height of the proposed bunds/levees would range between 0.3 to 1.6 m to achieve flood immunity during an extreme flood event (i.e. three times the 1% AEP) and prevent flood water entering the final void following mine closure (Appendix C).

The inclusion of the bunds/levees in this area would result in a localised and small change to flood depths (i.e. less than 5 cm) and flood velocities (less than 0.5 m/s) in the surrounding areas extending no more than 500 m from the southern-most levee for the 1% AEP event. The predicted magnitude and extent of the flood level changes are even smaller for the 20% and 5% AEP events (Appendix C).

There are no predicted changes in flood levels downstream of Blue Vale Road and therefore no change in flood levels is predicted at privately-owned dwellings or privately-owned agricultural infrastructure.

Blue Vale Road has been constructed perpendicular to Stratford Creek and the creek does not have a defined channel where it crosses the road. The road is constructed at-grade on the floodplain and is periodically inundated by flows down Stratford Creek and elsewhere on the floodplain.

The approved Blue Vale Road realignment would generally be constructed at-grade with minimal filling or earthworks and would be designed to have the same flood immunity as the existing road. The predicted flood depths and flood velocities in the surrounding areas would be similar to the current conditions and therefore additional inundation of neighbouring properties is not predicted.

No historic sites or cultural assets identified for the ACHA (Appendix G) or Historic Heritage Assessment (Appendix K) are predicted to be impacted through the changes to flood characteristics as a result of the Project mining area (Appendix C).

Development of the Project mining area would maintain flood connectivity to ecological assets and maintain fish passage along Stratford Creek and South Creek.

Accordingly, it is predicted that the design of the Project mining area would comply with the adopted objectives from the Draft FMP.

Project Rail Spur

Following preliminary analysis of the proposed rail corridor as part of the Flood Assessment (Appendix C), the conceptual design of the Project rail spur has been refined to improve the conveyance of the Namoi River flood flows through the incorporation of sufficient openings.

As described in Section 2.4.3, where the Project rail spur crosses the Namoi River and Kamilaroi Highway it would be elevated on a viaduct structure to minimise impacts to the flooding regime.

Flood Depths

WRM (2018) predicts the changes in flood depth for the 20% and 5% AEP events are generally confined to Whitehaven-owned land. There are no predicted impacts to flood levels at the Kamilaroi Highway or at dwellings for these events (Appendix C).

For the 1% AEP event, the flood levels are predicted to increase by up to 0.3 m within Whitehaven-owned land. This impact is predicted to dissipate to zero within 1.5 km of the rail spur (Appendix C).

A negligible impact at the nearest privately-owned dwelling is predicted for the 1% AEP event (i.e. approximately 1 cm). Any change to flood levels at any other dwellings as a result of the construction of the rail spur would be even less (Appendix C).

The 1% AEP flood level on the Kamilaroi Highway at the rail spur overpass location is predicted to increase by up to 0.1 m. However, the Kamilaroi Highway would already be inundated by up to 1 m and therefore impassable for a flood event of this magnitude (Appendix C).

Flood Velocities

Changes to flood velocities for the 20% and 5% AEP events are predicted to be small and generally confined to the rail corridor itself on Whitehaven-owned land (Appendix C).

Changes to flood velocities through the openings under the rail spur for the 20% and 5% AEP events are generally predicted to be approximately 20% higher than flood velocities under existing conditions, with the exception of isolated areas of very low velocities under existing conditions (Appendix C).

Changes to flood velocities for the 1% AEP event are similar to the impacts described above and would also comply with the velocity impact requirement set in the Draft FMP (Appendix C).

The change in flood velocity on privately-owned land is predicted to be less than 0.1 m/s for floods up to and including the 1% AEP event (Appendix C).

Flood Distribution

Given the flat nature of the Namoi River floodplain, the Draft FMP has recognised that it is important to maintain the existing distribution of flood flows across the floodplain for both small and large design events.

WRM (2018) predicts that the distribution of flow across the floodplain would not be significantly altered by the Project rail spur and would not result in a consequential effect to neighbouring properties or the environment (Appendix C).

Development of the Project rail spur would maintain flood connectivity to ecological assets and maintain fish passage along the Namoi River, Deadmans Gully and Stratford Creek.

No historic sites or cultural assets identified for the ACHA (Appendix G) or Historic Heritage Assessment (Appendix K) are predicted to be impacted through the changes to flood characteristics as a result of the Project rail spur (Appendix C).

Accordingly, it is predicted that the design of the Project rail spur would comply with the adopted objectives from the Draft FMP.

Project Borefield

The Project borefield is located to the north of the Project mining area and would be predominantly above ground.

The Project borefield would not alter flooding characteristics on privately-owned land.

4.6.3 Mitigation Measures, Management and Monitoring

Infrastructure Design

Flood management infrastructure (including a permanent flood bund) would be constructed as described in Section 2.10.1.

To avoid and/or minimise the potential flooding impacts as a consequence of the Project, the Project rail spur design has included various openings to assist the flow of floodwaters during flood events.

Residual predicted flooding impacts described in Section 4.6.2 would be mitigated further during the detailed design and construction of the Project.

Localised areas of predicted increased velocity would be investigated further during detailed design to develop suitable management measures (e.g. rock lining or vegetation at openings along the Project rail spur) to minimise erosion potential during flood events.

Monitoring

A visual inspection of the Project infrastructure, including the Project rail spur, within and adjacent to inundated areas would be carried out following significant flood events to identify any potential issues with erosion, settlement or slumping. If required, blockages and debris within the Project rail spur openings and associated infrastructure (e.g. service tracks and fencing) would be cleared as soon as practicable following flood events.

Water Management Plan

The Water Management Plan to be developed for the Project would describe proposed flood mitigation and protection works proposed for the Project, as well as the process for undertaking remedial and/or contingency measures if potential issues with erosion, settlement or slumping of Project infrastructure are identified during visual inspections following significant flood events.

4.7 OPERATIONAL AND CONSTRUCTION NOISE

A Noise and Blasting Assessment was undertaken for the Project by Wilkinson Murray (2018) and is provided in Appendix D. A summary of the assessment is provided below.

This section describes the assessment of potential noise impacts from the operation and construction of the Project in accordance with the:

- NSW Noise Policy for Industry (NPfI) (EPA, 2017); and
- Interim Construction Noise Guideline (DECC, 2009).

Consideration was also given to the NSW Government (2014) *Voluntary Land Acquisition and Mitigation Policy - For State Significant Mining, Petroleum and Extractive Industry Developments* (Voluntary Land Acquisition and Mitigation Policy).

The Noise and Blasting Assessment was peer reviewed by Glenn Thomas (Director, SLR Consulting). The peer review report is presented in Attachment 4.

Section 4.7.1 provides a description of the existing noise environment. Section 4.7.2 describes the potential operational noise impacts of the Project, including cumulative impacts. Section 4.7.3 outlines mitigation measures, management and monitoring for the Project.

Potential blast impacts are described in Section 4.8.2. Potential noise impacts from rail and road transport movements are described in Section 4.13.

4.7.1 Existing Environment

Noise Measurement and Description

The assessed noise levels presented in Appendix D and summarised in this section are expressed in A-weighted decibels (dBA). The logarithmic dBA scale simulates the response of the human ear, which is more sensitive to mid to high frequency sounds and relatively less sensitive to lower frequency sounds. Table 4-14 provides information on common noise sources in dBA for comparative reference.

Hearing 'nuisance', for most people, begins at noise levels of about 70 dBA, while sustained (i.e. eight hours) noise levels of 85 dBA can cause hearing damage.

Measured or predicted noise levels are expressed as statistical noise exceedance levels (L_{AN}) which are the levels exceeded for a specific percentage (N) of the interval period. For example, L_{A10} is the noise level that is exceeded for 10% of the sampling period and is also considered to be the average maximum noise level.

Table 4-14
Relative Scale of Various Noise Sources

Noise Level (dBA)	Relative Loudness	Common Indoor Noise Levels	Common Outdoor Noise Levels
110 to 130	Extremely noisy	Rock band	Jet flyover at 1,000 m
100	Very noisy	Internal demolition work (jackhammer)	Petrol engine lawn mower at 1 m
90	Very noisy	Food blender at 1 m	Diesel truck at 15 m
80	Loud	Garbage disposal at 1 m, shouting at 1 m	Urban daytime noise
70	Loud	Vacuum cleaner at 3 m, normal speech at 1 m	Commercial area heavy traffic at 100 m
60	Moderate to quiet	Large business office	-
50	Moderate to quiet	Dishwasher next room, wind in trees	Quiet urban daytime
40	Quiet to very quiet	Small theatre, large conference room (background), library	Quiet urban night-time
30	Quiet to very quiet	Bedroom at night, concert hall (background)	Quiet rural night-time
20	Almost silent	Broadcast and recording studio	-
0 to 10	Silent	Threshold of hearing	-

Source: After United States Department of the Interior (1994) and Richard Heggie Associates (1995).

The equivalent continuous noise level (L_{Aeq}) refers to the steady sound level, which is equal in energy to the fluctuating levels recorded over the sampling period.

Background Noise Levels

The Rating Background Level is the background noise level determined without the subject premises in operation, in accordance with the NPfI.

Given the Approved Mine has not commenced operations, Wilkinson Murray (2018) referred to background noise surveys conducted in 2011 as part of the environmental assessment completed for the Approved Mine (Wilkinson Murray, 2013).

Review of these background noise levels indicated the Rating Background Levels are 35 dBA, 30 dBA and 30 dBA during the day, evening and night periods, respectively. These Rating Background Levels have therefore been adopted for the Project (Appendix D).

4.7.2 Potential Impacts

The operational noise component of the Noise and Blasting Assessment (Appendix D) included assessment of the following potential impacts:

- on-site operational noise (including the potential for sleep disturbance); and
- construction noise.

These aspects are described further below and in Appendix D. Blasting is addressed in Section 4.8 and road and rail transport noise is addressed in Section 4.13.

Operational Noise Criteria

The NPfI assessment procedure for industrial noise sources has two components (EPA, 2017):

- controlling potential intrusive noise levels in the short-term for residences; and
- maintaining noise level amenity for particular land uses, for residences and other land uses.

The NPfI prescribes detailed calculation routines for establishing Project-specific $L_{Aeq(15 \text{ minute})}$ intrusive criteria and $L_{Aeq(\text{period})}$ amenity criteria. The NPfI Project-specific intrusive and amenity assessment criteria for the Project (i.e. Project noise trigger levels) are presented in Table 4-15.

As the applicable Project-specific intrusive criteria are the most stringent, Appendix D assesses Project-only noise levels against the intrusive criteria. Cumulative noise levels are assessed against the recommended amenity noise criteria level, which is at least 5 dBA greater than the Project-specific amenity level (as per Table 4-15).

In those cases where the NPfI Project-specific assessment criteria are exceeded, it does not automatically follow that all people exposed to the noise would find the noise noticeable or unacceptable.

Table 4-15
NPfI Project-specific Intrusive and Amenity Assessment Criteria for Operational Noise (dBA)

Receiver	Intrusive $L_{Aeq}(15 \text{ minute})^1$			Amenity $L_{Aeq}(15 \text{ minute})^1$		
	Day	Evening	Night	Day	Evening	Night
All residential receivers	40 dBA	35 dBA	35 dBA	48 dBA	43 dBA	38 dBA

Source: After Appendix D.

¹ Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night–time 10.00 pm to 7.00 am.

Table 4-16 presents the methodology used for assessing operational noise against the NPfI Project-specific noise assessment criteria.

For the purposes of assessing potential noise impacts consistent with the Voluntary Land Acquisition and Mitigation Policy, exceedances can be separated into a Noise Management Zone (i.e. negligible, marginal or moderate impacts of 1 to 5 dBA above the criteria) and a Noise Affectionation Zone (i.e. greater than 5 dBA above the criteria, with impacts considered to be significant) (Table 4-16).

Operational Noise Modelling

The Environmental Noise Model was used by Wilkinson Murray (2018) to simulate the Project components using noise source information (i.e. indicative sound power levels and locations) and to predict noise levels at relevant receiver locations.

The Environmental Noise Model is compatible with the NPfI (EPA, 2017) and has been previously accepted by the EPA and DPE for use in environmental noise assessments, including the Approved Mine (Appendix D).

The model considers meteorological effects, surrounding terrain, distance from source to receiver and noise attenuation.

The locations of modelled receivers (i.e. dwellings) are shown on Figure 1-5a.

Assessment of Meteorological Conditions

The noise modelling completed for the Project is based on meteorological data obtained from an on-site meteorological station (located at the former Canyon Coal Mine) for a three year period from 1 January 2013 to 31 December 2015. The meteorological data used includes wind speed, wind direction and stability class (Appendix D).

Wilkinson Murray (2018) assessed the meteorological data in accordance with Fact Sheet D of the NPfI to determine the significance of noise-enhancing meteorological conditions.

Based on the site-specific meteorological data, moderate to strong temperature inversions were not determined to be significant for the Project. Notwithstanding, temperature inversions were conservatively considered in the assessment as a component of the night-time noise enhancing conditions (Appendix D). Temperature inversions with winds were not considered as they would occur infrequently (i.e. less than 10% in any season) (Appendix D).

Details of the analysis and meteorological conditions modelled are provided in Appendix D. Section 4.2 provides a summary description of meteorology and topography in the vicinity of the Project.

Noise Modelling Scenarios

Three operational scenarios of the Project were assessed for potential noise impacts (Appendix D):

- Project Year 3 – representative of initial operations (i.e. mining operations in the north-west and central portions of the open cut and waste rock emplacement at the Western Emplacement);
- Project Year 7 – representative of ongoing operations (i.e. mining operations in the eastern portion of the open cut and waste rock emplacement at the Western Emplacement); and
- Project Year 21 – representative of ongoing operations (i.e. mining operations in the southern portion of the open cut).

Table 4-16
Significance of Residual Noise Impacts and Potential Treatments

Residual Noise Exceeds NPfl Criteria By	Total Cumulative Industrial Noise Level	Significance of Residual Impact	Example of Potential Treatment
0 to 2 dBA	Not applicable	Negligible	The exceedance would not be discernible by the average listener and therefore would not warrant receiver-based treatment or controls.
3 to 5 dBA	< recommended amenity noise level or > recommended amenity noise level, but the increase in total cumulative industrial noise level resulting from the development is less than or equal to 1 dB	Marginal	Provide mechanical ventilation/comfort condition systems to enable windows to be closed without compromising internal air quality/amenity.
3 to 5 dBA	> recommended amenity noise level and the increase in total cumulative industrial noise level resulting from the development is more than 1 dB	Moderate	As for 'marginal', but also upgraded façade elements, such as windows, doors or roof insulation, to further increase the ability of the building façade to reduce noise levels.
>5 dBA	=< recommended amenity noise level	Moderate	
>5 dBA	> recommended amenity noise level	Significant	May include suitable commercial agreement where considered feasible and reasonable.

Source: After EPA (2017).

The operational scenarios were selected in consideration of maximum potential noise emissions (e.g. to account for the maximum mobile equipment fleet and proximity to sensitive receivers) to evaluate the potential impacts at the nearest privately-owned receivers over the life of the Project.

Assessment of Feasible and Reasonable Noise Mitigation Measures

Wilkinson Murray (2018) conducted an assessment of feasible and reasonable noise mitigation measures for the Project.

A number of iterative steps were undertaken to develop noise mitigation measures for the Project, including the following (Appendix D):

1. Preliminary noise modelling of scenarios representative of the maximum noise emissions from the Project to identify potential for noise exceedances. As a result of this preliminary modelling, modifications to the mine plan were undertaken in order to improve acoustic performance, including:

- a. Removal of the proposed Blue Vale Open Cut.

- b. Redesign of the waste rock emplacement area and mine progression direction to provide opportunities for shielding of operations during adverse meteorological conditions.
- c. Treatment of a selection of mobile plant and infrastructure items to reduce emitted noise levels.

2. Evaluation of various combinations of noise management and mitigation measures to assess their relative effectiveness.
3. Review of the effectiveness of these measures and assessment of their feasibility.
4. Adoption of management and mitigation measures to minimise noise emissions associated with the Project.

Table 4-17 provides a summary of the mitigation measures proposed for all Project years.

Additional noise modelling indicated that to further reduce maximum noise levels (i.e. to avoid exceedances at receivers on property 127) would require significant additional modifications to operations (e.g. shutdowns).

Table 4-17
Proposed Project Noise Mitigation Measures

Proposed Noise Mitigation Measures		Details	Relevant Noise Modelling Scenario
1	Treatment of plant	Noise controls on a selection of mobile plant during fleet procurement (e.g. consideration of extra quiet mobile plant models) to reduce emitted noise levels.	All
		Enclosure/acoustic shrouding of selected infrastructure items in the mine infrastructure area.	All
2	Acoustic design incorporated into mine planning	Optimising shielding of selected haul roads, truck numbers assigned to haul roads (with more trucks using haul roads further away from receivers) and alignment of haul roads away from receivers where possible.	All
3	Real-time monitoring and meteorological forecasting	Meteorological forecasting system and real-time noise and meteorological monitoring used to anticipate upcoming periods of noise-enhancing weather conditions ¹ that may generate noise exceedances at private receivers.	All
		The predictive meteorological forecasting system would be used in conjunction with the real-time monitoring system and would provide an alert for mine personnel to review the real-time data and manage mining activities for that day as may be required. Details regarding the real-time monitoring and meteorological forecasting system would be provided in a Noise Management Plan.	All

Source: After Appendix D.

¹ Noise-enhancing weather conditions are discussed further in Appendix D.

Whitehaven concluded that a material impact to the Project schedule and associated operating costs to provide a negligible environmental benefit (i.e. the difference between 35 dBA and 36 dBA or 37 dBA would not be discernible to the average listener) for a small number privately-owned receivers would not be reasonable.

Low-frequency Noise Assessment

A low-frequency noise assessment was conducted for the Project to ascertain whether any receivers should be subject to a modifying factor correction due to dominant low-frequency content prior to comparing to the relevant Project noise trigger levels.

The low-frequency noise assessment examined likely noise levels at a selection of representative receivers based on overall 'C' weighted and 'A' weighted predicted or measured levels, normalised to the 63 hertz (Hz) third-octave component, which is considered the most reliable third-octave (Appendix D).

The low-frequency noise assessment indicated it is unlikely that any of the receivers surrounding the Project would be subject to dominant low-frequency noise. Therefore, no modifying factor correction for low-frequency noise is warranted for the Project (Appendix D).

If monitoring results are found to contain dominant low-frequency content appropriate modifying factors would be applied to measures noise levels (Appendix D).

Predicted Noise Levels

Project-only Noise Emissions

Table 4-18 presents a summary of predicted exceedances of noise criteria due to the noise from the Project, based on maximum noise predictions for all modelled scenarios.

Indicative noise contours of maximum noise predictions, which occur during Project Year 7 and Project Year 21, are presented on Figures 4-13 and 4-14, respectively.

In summary, the operational noise assessment indicated the following (Appendix D):

- During the daytime, operational noise levels (assessed under relevant meteorological conditions) are not predicted to exceed the 40 dBA $L_{Aeq,15\ min}$ criterion at privately-owned receivers throughout the Project mine life.

Table 4-18
Summary of Potential Operational Noise Exceedances at Privately-owned Receivers
under Adverse Meteorological Conditions

Period	Noise Management Zone		Noise Affection Zone
	Negligible Residual Impact	Marginal to Moderate Residual Impact	Significant Residual Impact
	1 - 2 dBA above NPfl Criteria	3 - 5 dBA above NPfl Criteria	>5 dBA above NPfl Criteria
Daytime ¹	-	-	-
Evening and Night-time ¹	131a, 131b and 132	127b*	127c*

Source: After Appendix D.

Note: Based on maximum predicted noise levels for all scenarios under NPfl meteorological conditions.

¹ Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am.

* The owner of this property has the right to acquisition upon request under Development Consent (SSD-5000) for the Approved Mine for predicted noise impacts.

- During the evening and night-time, exceedances of the 35 dBA $L_{Aeq,15\ min}$ criterion by between 1 to 2 dBA (i.e. negligible exceedances) are predicted for privately-owned receivers 131a (throughout the Project mine life), 131b (approximately from Year 7) and 132 (approximately from Year 16) during adverse meteorological conditions.
- During the evening and night-time, an exceedance of the 35 dBA $L_{Aeq,15\ min}$ criterion of 3 to 5 dBA (i.e. a marginal to moderate exceedance) is predicted for privately-owned receiver 127b during adverse meteorological conditions throughout the Project mine life.
- During the evening and night-time, exceedances of the 35 dBA $L_{Aeq,15\ min}$ criterion by greater than 5 dBA (i.e. significant exceedances) are predicted for privately-owned receiver 127c during adverse meteorological conditions throughout the Project mine life.

Under Development Consent (SSD-5000), the owner of property 127 has the right to acquisition upon request based on the predicted impacts of the Approved Mine. In addition, Whitehaven has been in discussions with the owner of this property in regard to at-receiver noise mitigation actions (e.g. acoustic treatment of dwellings).

The relatively limited number of exceedances (Table 4-18) indicates that, with the implementation of Project noise mitigation measures (Table 4-17), noise from the Project would be managed to the maximum extent reasonable, and no other measures would be of material benefit (Appendix D).

25% of Land Assessment

Wilkinson Murray (2018) also reviewed the potential impacts on the closest privately-owned land to the Project, namely property 127.

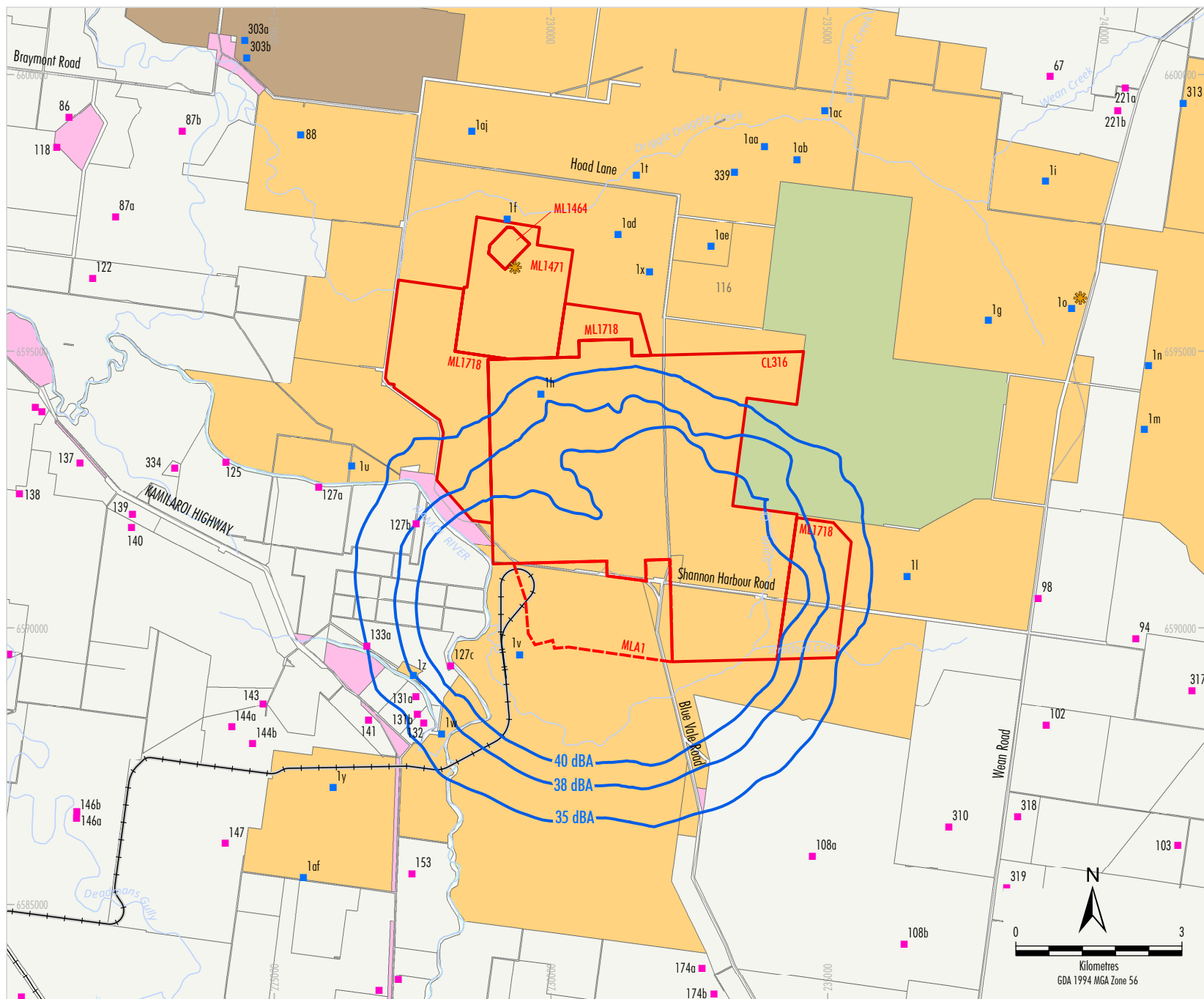
Less than 25% of property 127 is predicted to be affected by noise in accordance with the Voluntary Land Acquisition and Mitigation Policy.

Operational noise impacts on receivers at property 127 are provided in Table 4-18.

Cumulative Noise Emissions

Cumulative noise impacts resulting from the concurrent operation of the Project and the Tarrawonga, Rocglen and Boggabri Coal Mines were assessed against the NPfl recommended amenity criteria. The Maules Creek Coal Mine, located some 20 km north of the Project, would not materially impact on receivers identified as part of this assessment, and therefore was not included as part of the cumulative assessment (Appendix D).

The methodology used for cumulative assessment was to logarithmically add the respective night-time noise predictions during adverse meteorological conditions, which represent the worst-case period in terms of the Project's predicted contributions to cumulative noise levels, of the four mines for key receivers and compare the overall cumulative noise levels against the NPfl amenity criteria.



- LEGEND**
- Mining Tenement Boundary (ML and CL)
 - Mining Lease Application (MLA)
 - Indicative Rail Spur Alignment
 - Mine-owned Dwelling
 - Private Dwelling
 - State Forest
 - Crown Land
 - Whitehaven Owned Land
 - Whitehaven/Idemitsu Boggabri Coal Joint Owned Land
 - Privately Owned Land and Other Land
 - ✱ Meteorological Station
 - Maximum Noise Level Predicted Under all Assessable NPH Meteorological Conditions

Source: Department of Land and Property Information - Land Tenure (2016); Department of Industry (2015); Wilkinson Murray (2018)


VICKERY EXTENSION PROJECT
Maximum Predicted Noise Level -
Year 21

Figure 4-14

The assessment indicated that cumulative noise levels from the concurrent operation of the Project and the Tarrawonga, Rocglen and Boggabri Coal Mines would comply with the recommended amenity criterion (40 dBA $L_{Aeq,9\text{ hr}}$ or 43 dBA $L_{Aeq,15\text{ min}}$) at night at all privately-owned receivers (Appendix D).

Construction Noise

Assessment of the potential for noise impacts was conducted for the construction of the mine infrastructure area, Project rail spur and rail loop, realignment of Blue Vale Road and approved private haul road and Kamilaroi Highway overpass.

In practice, noise resulting from construction of the mine infrastructure area and rail loop would be largely indistinguishable from operational noise emissions of the Project. Wilkinson Murray (2018), therefore, conservatively summed construction noise emissions from these activities with daytime operational noise predictions for Project Year 3. While there would be some overlap between the commencement of mining operations and construction of the mine infrastructure area and rail loop, this is considered to be very conservative as the Year 3 operational noise modelling includes the use of the mine infrastructure area.

Exceedances of the daytime 40 dBA $L_{Aeq,15\text{ min}}$ operational noise criterion at receiver 127c would occur when predicted construction noise emissions are added to Year 3 daytime operational noise predictions (Appendix D). Exceedances of the Project-specific noise criteria are predicted at this receiver (refer above). Under Development Consent (SSD-5000), the owner of property 127 has the right to acquisition upon request based on the predicted impacts of the Approved Mine. Whitehaven has been in discussions with the owner of this property in regard to at-receiver noise mitigation actions (e.g. acoustic treatment of dwellings).

Noise resulting from the construction of the Project rail spur would be distinct from operational noise levels of the Project. Wilkinson Murray (2018), therefore, assessed the predicted Project rail spur construction noise against the recommended noise management levels defined in the *Interim Construction Noise Guideline* (DECC, 2009). Activities associated with the construction of the rail spur would by nature progressively move along the proposed rail spur corridor and would involve a number of workfronts operating simultaneously.

Wilkinson Murray (2018) concluded no privately-owned residences would be considered 'highly noise affected' or 'noise affected' by construction activities undertaken during recommended standard hours in accordance with the *Interim Construction Noise Guideline* (DECC, 2009).

If significant construction activities for the Project rail spur are conducted outside recommended standard hours (e.g. Saturday afternoon or Sunday during the day), receivers 132 and 144b would be considered 'noise affected' in accordance with the *Interim Construction Noise Guideline* (DECC, 2009). Work on Saturdays and Sundays between 7.00 am and 6.00 pm is justified as it would allow continuity of work for the construction crew which would assist in reducing the length of the construction period and therefore the period of impact at receivers (Appendix D).

Construction works associated with the realignment of Blue Vale Road would take place later in the life of the Project than other construction activities (approximately Year 7). Wilkinson Murray (2018) determined noise associated with the realignment of Blue Vale Road would have a negligible impact when compared with noise generated by the mining operations at Year 7 (Appendix D).

The Approved Mine EIS (Whitehaven, 2013) concluded no receiver would be either 'highly noise affected' or 'noise affected' as defined in the *Interim Construction Noise Guideline* (DECC, 2009) for the construction of the approved private haul road and Kamilaroi Highway overpass. Potential impacts associated with construction of the overpass for the Project would be consistent with those assessed and subsequently approved for the Approved Mine.

Operation of the temporary infrastructure area may also occur concurrently with construction activities (Section 2.4.1). Wilkinson Murray (2018) determined that noise emissions from the temporary infrastructure area would be equal to or less than the Year 3 operational noise predictions. Therefore noise impacts from the concurrent operation of the temporary infrastructure area and construction activities would be no more than those predicted for the concurrent operation of Year 3 mining operations and construction activities (Appendix D).

Sleep Disturbance

Wilkinson Murray (2018) has conducted an assessment of potential sleep disturbance impacts. A sleep disturbance criterion of L_{AFmax} 52 dBA has been adopted in accordance with the NPfI. No receivers are predicted to experience exceedances of the relevant sleep disturbance criterion during the night-time as a result of the Project (Appendix D).

Project Rail Spur

The assessment of the potential noise impacts associated with Project rail movements along the Project rail spur against the criteria specified in Appendix 3 of the *NSW Rail Infrastructure Noise Guideline (RING)* (EPA, 2013) is provided in Section 4.13.1 and Appendix D. It concludes no privately-owned receivers are predicted to experience exceedances of the relevant non-network rail line criteria (Appendix D).

4.7.3 Mitigation Measures, Management and Monitoring

Noise mitigation and management measures for the Project are described in this section and would be incorporated into the Noise Management Plan.

Noise Management and Affection Zones

The privately-owned receivers where noise emissions are predicted to exceed the Project-specific criteria can be divided into a Noise Management Zone and a Noise Affection Zone (Table 4-18).

Proposed management procedures, in addition to the mitigation and management measures described below, for receivers in these zones may include:

- response to any community issues of concern or complaints including discussions with relevant landowners;
- refinement of on-site noise mitigation measures and mine operating procedures;
- implementation of feasible and reasonable acoustical mitigation at receivers, in accordance with the Voluntary Land Acquisition and Mitigation Policy (marginal to moderate residual impact); and
- entering into agreements with landowners (including acquisition for receivers identified to be in the Noise Affection Zone).

Mitigation Measures

The at-source noise mitigation measures described in Table 4-17 (e.g. treatment of plant and haul road orientation) would be implemented to reduce noise levels from the typical operations of the Project as far as feasible and reasonable.

Real-time Monitoring and Meteorological Forecasting

The noise management system for the Project would include a real-time noise and meteorological monitoring network, as well as a meteorological forecasting system.

Real-time noise monitors would be installed in locations that would provide representative noise levels at the most sensitive receivers surrounding the Project (e.g. to the south-west). Locations for these monitors would be determined once operations commence and in consultation with the relevant government agencies and local landowners.

Real-time meteorological data would be recorded at the on-site meteorological station (Figure 4-13).

A meteorological forecasting system would also be implemented for the Project to anticipate upcoming periods of adverse weather conditions (e.g. based on wind speed, direction and atmospheric stability).

Pro-active Noise Management System

The pro-active noise management system would be implemented to manage noise levels from the Project at receiver locations (i.e. to reduce the likelihood that Project noise levels would exceed predicted operational noise levels at receiver locations).

The meteorological forecasting system would be used in conjunction with the real-time noise monitoring system and would provide an alert for mine personnel to review the real-time data and manage mining activities as may be required.

The Noise Management Plan would provide details on the operation of the pro-active noise management system. It is anticipated that the process would involve a review of meteorological forecasting data by a nominated person prior to the commencement of each mining shift. If favourable conditions are predicted, then typical operations would be conducted. If unfavourable conditions are predicted, Whitehaven would plan operational alternatives.

Adverse conditions would be identified during the initial ramp-up of the Project when a reduced Project fleet is operational (i.e. Year 1) using a combination of real-time noise and meteorological monitoring.

In addition, adverse conditions would be identified using a Project noise model, which would be validated against the real-time noise monitoring results.

During operations, if noise from the Project exceeds specified trigger levels, mine personnel would be alerted and additional mitigation measures would be implemented until noise levels reduce below the trigger levels. This would occur even if mining operations have already been modified.

The trigger levels would be specified such that the equivalent noise level at the closest receivers would be below predicted operational noise levels.

The pro-active noise management system would be used during all stages of the Project.

Attended Noise Monitoring

Attended noise monitoring would be undertaken regularly at locations representative of the most sensitive receivers to determine compliance of Project noise levels with noise trigger levels (Appendix D).

Monitoring results would be assessed against the NPfl with respect to modifying factors (including for low frequency noise). If monitoring results are found to contain dominant low-frequency content appropriate modifying factors would be applied to measured noise levels (Appendix D).

Noise Management Plan

A Noise Management Plan would be prepared for the Project, which would describe the noise management system for the Project, including details of:

- the noise mitigation measures for the Project;
- attended noise monitoring locations;
- real-time noise monitoring locations;
- the predictive meteorological forecasting system;
- the pro-active noise management system;
- specified trigger levels for the implementation of additional mitigation measures; and
- protocols for the implementation of additional mitigation measures.

4.8 BLASTING

A Noise and Blasting Assessment for the Project was undertaken by Wilkinson Murray (2018) and is provided in Appendix D. The blasting assessment was conducted in accordance with the EPA guideline *Assessing Vibration: a technical guideline* (DEC, 2006).

The Noise and Blasting Assessment was peer reviewed by Glenn Thomas (Director, SLR Consulting). The peer review report is presented in Attachment 4.

Section 4.8.1 provides an overview of relevant blast criteria. Predicted blasting emissions and potential impacts are described in Section 4.8.2. Section 4.8.3 outlines mitigation measures, management and monitoring for the Project.

4.8.1 Blast Measurement and Description

Overpressure (or airblast) is reported in linear decibels (dBL) and is the measurable effect of a blast on air pressure, including generated energy that is below the limit of human hearing. Ground vibration is the measurable movement of the ground surface caused by a blast and is measured mm/s as Peak Particle Velocity (PPV) vibration velocity.

Discernible blast emission effects can be divided into the three categories listed below:

1. Occupants of a building can be inconvenienced or disturbed (i.e. temporary amenity effects).
2. Contents of a building can be affected.
3. Integrity of a building structure can be affected.

An individual's response to blasting vibration and overpressure is highly dependent on previous experience and expectations.

Blasting Criteria

Ground vibration and airblast levels that cause human discomfort are generally lower than the recommended structural damage limits. Therefore, compliance with the lowest applicable human comfort criteria generally means that the potential to cause structural damage to buildings is minimal.

The EPA adopts the ANZEC (1990) *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* for assessing potential annoyance from blast emissions during daytime hours, as listed below (Appendix D):

- The recommended maximum level for airblast is 115 dBL.
- The level of 115 dBL may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 120 dBL at any time.
- The recommended maximum for ground vibration is 5 mm/s PPV vibration velocity.
- The PPV level of 5 mm/s may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 10 mm/s at any time.

AS 2187.2: 2006 *Explosives - Storage and Use – Part 2: Use of Explosives* provides guidance in assessing blast-induced ground (and structural) vibration and airblast effects on buildings and their occupants. In relation to building damage airblast criteria, AS 2187.2 recommends a maximum airblast of 133 dB (peak linear). In accordance with AS 2187.2, Wilkinson Murray also adopted 10 mm/s as the building damage vibration criterion (Appendix D).

There are no regulatory criteria nominated in Australia for the assessment of damage to items of heritage significance from vibration and airblast.

Based on literature, Wilkinson Murray adopted the following vibration and airblast criteria for the assessment (Appendix D):

- Grinding groove site (AHIMS 20-4-0009) – vibration limit of 80 mm/s.
- Kurrumbede Homestead – vibration limit of 10 mm/s and airblast limit of 133 dB.

4.8.2 Predicted Blasting Emission Effects

Blasting activities for the Project are described in Section 2.5.6.

No exceedances of vibration and airblast criteria are predicted to occur at any privately-owned receiver. Blasts within the western part of the open cut, where the distance to privately-owned residences is closest, would be conducted using site rules that would be developed using site-specific blast monitoring data gathered during the initial stage of mining operations (Appendix D).

No exceedances of the nominated airblast and vibration criteria are predicted at either the grinding groove site (AHIMS 20-4-0009) or Kurrumbede Homestead (Appendix D).

A further assessment of the blast emissions of the Project against the non-discretionary development standard for mining is provided in Attachment 5.

Flyrock

Flyrock is any material ejected from the blast site by the force of the blast. Flyrock would be managed by appropriate blast design and blast execution in accordance with best practice blast management procedures. These procedures would be described in the Project Blast Management Plan (Section 4.8.3).

4.8.3 Mitigation Measures, Management and Monitoring

Blast and vibration management would be conducted in accordance with a Blast Management Plan which would be prepared for the Project.

The Blast Management Plan would include:

- safety control measures and notification/closure procedures in relation to blasting within 500 m of public roads (e.g. Blue Vale Road and Braymont Road) and the Vickery State Forest;
- procedures for the management of livestock in close proximity to blast events;
- blast controls and/or blast optimisation measures to enable compliance with relevant criteria at receiver locations;
- blast monitoring; and
- a blast notification list (nominally landowners within 2 km of the Project).

The Blast Management Plan would describe blast monitoring for the Project. It is anticipated that blast monitoring would be conducted at nearby privately-owned receivers (e.g. to the south-west), at the Kurrumbede Homestead and at the nearby grinding groove site. Exact locations would be determined in consultation with landholders and regulatory bodies.

Blast management measures that relate to blast fumes are provided in Section 4.9.3.

4.9 AIR QUALITY

An Air Quality and Greenhouse Gas Assessment for the Project was undertaken by Ramboll (2018) and is presented as Appendix E. The assessment was conducted in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (Approved Methods) (EPA, 2016).

Consideration was also given to the Voluntary Land Acquisition and Mitigation Policy (NSW Government, 2014).

The Air Quality and Greenhouse Gas Assessment was peer reviewed by Aleks Todoroski (Director, Todoroski Air Sciences). The peer review report is presented in Attachment 4.

A description of the existing environment relating to air quality is provided in Section 4.9.1. Section 4.9.2 describes the potential air quality impacts of the Project, including cumulative impacts, and Section 4.9.3 outlines Project air quality mitigation measures, management and monitoring.

The assessment focuses on potential impacts associated with particulate matter generated by mining activities. Emissions of other pollutants, such as carbon monoxide, nitrogen dioxide and sulfur dioxide also arise due to fuel combustion in mobile equipment. However, emissions of pollutants associated with fuel combustion are considered too low to generate any significant off-site concentrations and are unlikely to compromise ambient air quality goals (Appendix E).

Project greenhouse gas emissions are described in Section 4.10.

4.9.1 Existing Environment

Air Quality Criteria

Concentrations of Suspended Particulate Matter

Project mining activities have the potential to generate particulate matter (e.g. dust) emissions in the form of:

- total suspended particulate matter (TSP);
- particulate matter with an equivalent aerodynamic diameter of 10 micrometres (μm) or less (PM_{10}) (a subset of TSP); and
- particulate matter with an equivalent aerodynamic diameter of 2.5 μm or less ($\text{PM}_{2.5}$) (a subset of TSP and PM_{10}).

Exposure to suspended particulate matter can result in adverse health impacts. The likely risk of these impacts to a person depends on a range of factors including the size, chemical composition and concentration of the particulate matter, and the existing health of the person (NSW Health and NSW Minerals Council, 2011).

Relevant health based air quality impact assessment criteria (i.e. criteria set at levels to reduce the risk of adverse health effects) for PM_{10} , $\text{PM}_{2.5}$ and TSP concentrations, as specified by the EPA in the Approved Methods (EPA, 2016), are provided in Table 4-19.

Table 4-19
Criteria for Particulate Matter Concentrations

Pollutant	Averaging Period	Impact Assessment Criteria ($\mu\text{g}/\text{m}^3$) ¹	Acquisition Criteria ($\mu\text{g}/\text{m}^3$) ²
TSP	Annual mean	90 ³	90 ³
PM_{10}	24-hour maximum	50 ³	50 ⁴
	Annual mean	25 ³	30 ³
$\text{PM}_{2.5}$	24-hour maximum	25 ³	-
	Annual mean	8 ³	-

Source: Appendix E.

$\mu\text{g}/\text{m}^3$ = micrograms per cubic metre.

¹ Approved Methods impact assessment criteria (EPA, 2016).

² Voluntary Land Acquisition and Mitigation Policy acquisition criteria (NSW Government, 2014).

³ Criterion is cumulative (i.e. includes background concentrations but excludes regional dust events such as bushfires).

⁴ Criterion is Project-only (5 allowable exceedances over the life of the development).

The 2016 update to the 'Approved Methods', gazetted on 20 January 2017, includes particulate matter assessment criteria that are consistent with revised *National Environment Protection (Ambient Air Quality) Measure* (AAQ NEPM) national reporting standards (National Environment Protection Council [NEPC], 1998; NEPC, 2015).

Air quality acquisition criteria specified in the Voluntary Land Acquisition and Mitigation Policy (NSW Government, 2014) are also provided in Table 4-19.

Dust Deposition

Particulate matter has the potential to cause nuisance (amenity) effects when it is deposited on surfaces.

The amenity criteria for the maximum increase in dust deposition and maximum total dust deposition, as specified by the EPA in the Approved Methods (EPA, 2016), are provided in Table 4-20.

Table 4-20
Criteria for Dust Deposition (Insoluble Solids)

Pollutant	Averaging Period	Maximum Increase in Deposited Dust Level	Maximum Total Deposited Dust Level
Deposited Dust	Annual mean	2 g/m ² /month	4 g/m ² /month

Source: Appendix E.

g/m²/month = grams per square metre per month.

Existing Air Quality

PM₁₀, PM_{2.5} and dust deposition data are collected in the vicinity of Project. The nearest operational mines are located approximately 5 and 10 km away (the Rocglen and Tarrawonga Coal Mines, respectively).

As no mining activity is conducted at the Approved Mine, the monitoring captures particulate matter from localised particulate matter sources (e.g. vehicles using unsealed roads, stock movements, exposed areas and agricultural activity), as well as any influence from existing mining operations in the region (e.g. Rocglen, Tarrawonga, Boggabri and Maules Creek Coal Mines) and other regional particulate matter sources (e.g. bushfires and dust storms).

Concentrations of Suspended Particulate Matter

PM₁₀ and PM_{2.5} monitoring data have been collected by Whitehaven at the Wil-gai property using a tapered element oscillating micrometer (TEOM) since 2012. The location of the TEOM is shown on Figure 4-15.

Recorded annual average PM₁₀ and PM_{2.5} concentrations for 2013 to 2016 are provided in Table 4-21.

Table 4-21
Annual Average PM₁₀ and PM_{2.5} Concentrations

Pollutant	2013	2014	2015	2016
PM ₁₀ concentration (µg/m ³)	12.0	13.8	9.6	12.5
PM _{2.5} concentration (µg/m ³)	5.3	4.6	4.1	5.3

Source: Appendix E.

Concentrations of TSP are not measured in the vicinity of the Approved Mine, however annual average TSP concentrations can be derived based on typical ratios of PM₁₀/TSP (Appendix E). A PM₁₀/TSP ratio of 0.5 has been applied to the annual average PM₁₀ concentrations, consistent with the ratio applied for other Whitehaven-owned mines in the region, to derive a representative TSP background concentration ranging from approximately 19.2 to 27.7 µg/m³.

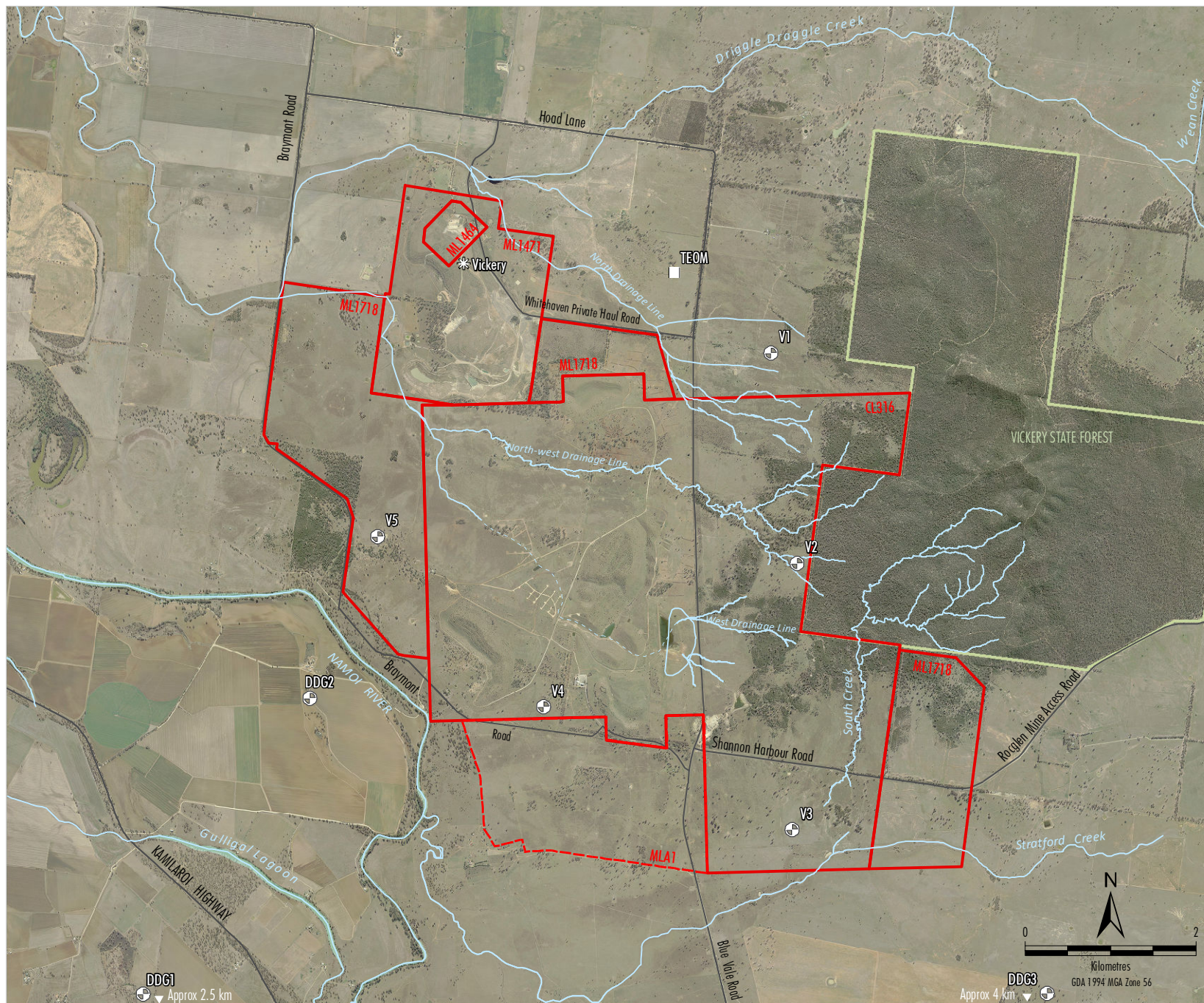
Dust Deposition

Dust deposition monitoring data have been collected by Whitehaven at eight locations in the vicinity of the Project since late 2011. The locations of the dust deposition monitors are shown on Figure 4-15. The dust gauges are located at least 5 km from the nearest active mining operation.

The average across all sites for the 2012 to 2016 monitoring period ranges from 2.1 to 3.7 g/m²/month (Appendix E). The average dust deposition across all sites and years is 2.8 g/m²/month, which is generally consistent with levels recorded in rural areas of NSW (Appendix E).

Background Air Quality for Assessment Purposes

The assessment of Project and cumulative annual average air quality impacts requires background particulate matter concentrations and dust deposition levels to be defined and added to dispersion modelling results for Project emissions.



- LEGEND**
- Mining Tenement Boundary (ML and CL)
 - Mining Lease Application (MLA)
 - State Forest
- Whitehaven Monitoring**
- +

 Dust Deposition Gauge
 - TEOM
 - +

 Meteorological Station

Source: LPMA - Topographic Base (2010) and Orthophoto (Boggabri 2011); Department of Industry (2015); Whitehaven (2016)


VICKERY EXTENSION PROJECT
Air Quality Monitoring Sites

Figure 4-15

The estimated background dust levels calculated by Ramboll (2018) based on the air quality monitoring undertaken in the vicinity of the Project are presented in Table 4-22.

Table 4-22
Estimated Background Dust Levels

Pollutant	Averaging Period	Estimated Background Dust Level	Unit
PM _{2.5}	Annual	5.3	µg/m ³
	24-hour	Daily varying	
PM ₁₀	Annual	12	µg/m ³
	24-hour	Daily varying	
TSP	Annual	23.9	µg/m ³
Dust Deposition	Annual	2.8	g/m ² /month

Source: Appendix E.

4.9.2 Potential Impacts

Assessment Methodology

Modelling Scenarios

The three operational scenarios of the Project assessed for potential noise impacts (i.e. Project Years 3, 7 and 21) (Section 4.7.2) were also assessed for air quality (Appendix E).

The operational scenarios were selected in consideration of maximum potential dust emissions (e.g. to account for the maximum coal production rate, maximum waste rock extraction rate and maximum active disturbance area) to evaluate the potential impacts at the nearest privately-owned receivers over the life of the Project.

Emission Inventories

Air quality emission inventories were prepared for the operational scenarios in consideration of the indicative mining activities for each year, including ROM coal extraction, waste rock removal rates, haul distances and routes, active stockpile and pit areas and mobile equipment operating hours.

The major emission sources are predicted to be associated with the following activities (Appendix E):

- hauling of waste rock and ROM coal in trucks on unpaved roads (including diesel particulate emissions);

- handling and loading/unloading of waste rock, ROM and product coal;
- wind erosion of exposed areas; and
- dozer operations.

Consistent with the Approved Methods (EPA, 2016), emission factors developed by the United States Environmental Protection Agency (US EPA) have been used to estimate the particulate matter emissions generated by the Project (Appendix E).

The emission factors for dust generated by haul trucks sourced from the US EPA include both mechanically generated (i.e. wheel generated) and combustion emissions. However, emission controls applied are often only relevant to the mechanically generated portion of the emissions (e.g. surface treatments do not control combustion emissions). Therefore surface treatment emission controls (e.g. watering haul roads) have only been applied to the portion of total hauling emissions that are mechanically generated (Appendix E).

A full description of the dispersion model methodology and emission inventories is provided in Appendix E.

Comparison with Best Practice Mitigation Measures

In 2011, the EPA commissioned a review of methods to minimise coal mining particulate matter emissions called the *NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining* (Katestone Environmental Pty Ltd, 2011) (the Best Practice Report).

Best practice dust mitigation measures to be implemented for the Project were developed with reference to the recommendations of the Best Practice Report.

Dust mitigation measures that would be implemented for the Project would include:

- use of water carts/trucks to control emissions from haul roads;
- use of large vehicles (reducing the number of trips required to haul coal or waste rock on-site);
- restricting speed on haul roads;
- progressive rehabilitation of disturbed areas;
- minimising pre-strip areas;
- surface stabilisation of exposed areas;

- minimisation of travel speed and distance travelled by dozers;
- minimisation of drop heights for dumping of overburden and ROM coal;
- direct placement of waste rock where possible;
- delay of blasts during unfavourable weather conditions; and
- minimisation of blast area.

In addition to the above, Whitehaven would implement a real-time reactive air quality management system for the Project (Section 4.9.3). The real-time air quality management system would include options for adjusting on-site operations when high dust concentrations are measured by the real-time dust monitors (Appendix E).

Dispersion Modelling

The AERMOD modelling system was used by Ramboll (2018) to assess potential air quality impacts associated with the Project.

AERMOD is a NSW EPA-approved, steady-state plume dispersion model (Appendix E).

In the model, emission sources were categorised into three source types (Appendix E):

- wind insensitive (where the emission rate is independent of wind speed);
- wind sensitive (where there is a relationship between the emission rate and wind speed); and
- wind erosion (where the emission rate is dependent on wind speed).

The annual emissions for wind insensitive sources were evenly apportioned for each hour of the year, whereas the emission rates for wind sensitive and wind erosion sources were varied in each hour according to the wind speed (Appendix E).

Cumulative Impacts

The assessment of potential cumulative impacts has considered the Project, existing background sources (Section 4.9.1) and relevant existing mining operations (i.e. the Tarrawonga, Boggabri, Rocglen and Maules Creek Coal Mines) based on information presented in their respective environmental assessments (Appendix E).

Potential Project-only Impacts

No exceedances of the EPA criteria were predicted at any privately-owned receiver for Project-only 24-hour average PM₁₀ or PM_{2.5} concentrations, annual average PM₁₀, PM_{2.5}, TSP concentrations or dust deposition levels (Appendix E).

Figures 4-16 to 4-18 show Project-only 24-hour PM₁₀ concentrations for Project Years 3, 7 and 21. Additional air quality contour plots are provided in Appendix E.

25% of Land Assessment

Ramboll (2018) reviewed the relevant air quality contours and land tenure information for the Project and concluded that no privately-owned property is predicted to experience exceedances of the relevant Voluntary Land Acquisition and Mitigation Policy (NSW Government, 2014) air quality criteria on greater than 25% of land (Appendix E).

A further assessment of the Project air quality emissions against the non-discretionary development standard for mining is provided in Attachment 5.

Potential Cumulative Impacts

Annual Average PM₁₀

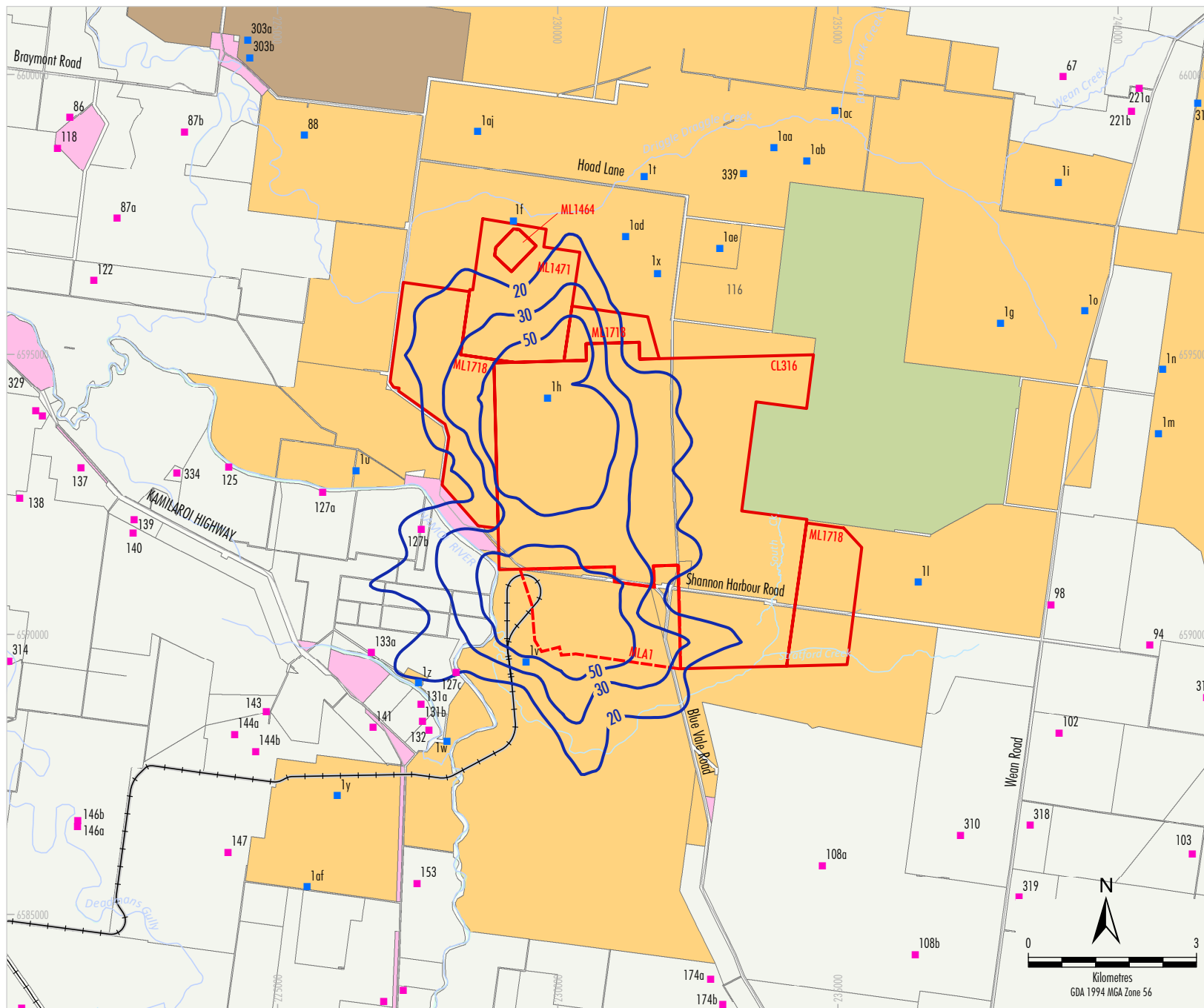
No privately-owned receivers are predicted to experience annual average PM₁₀ concentrations above the EPA assessment criterion (25 µg/m³) due to the cumulative contributions from the Project, plus the Tarrawonga, Boggabri, Rocglen and Maules Creek Coal Mines and background levels (Appendix E).

24-hour Average PM₁₀

The EPA contemporaneous assessment method was applied by Ramboll (2018) to analyse the potential maximum cumulative 24-hour average PM₁₀ concentrations arising from the Project (Appendix E).

The contemporaneous assessment adds the following to predict cumulative 24-hour PM₁₀ concentrations for each day of the modelled scenario (Appendix E):

- model-predicted Project 24-hour average PM₁₀ concentrations;
- model-predicted 24-hour average PM₁₀ concentrations contributed by other local mines; and
- measured 24-hour average PM₁₀ concentrations.



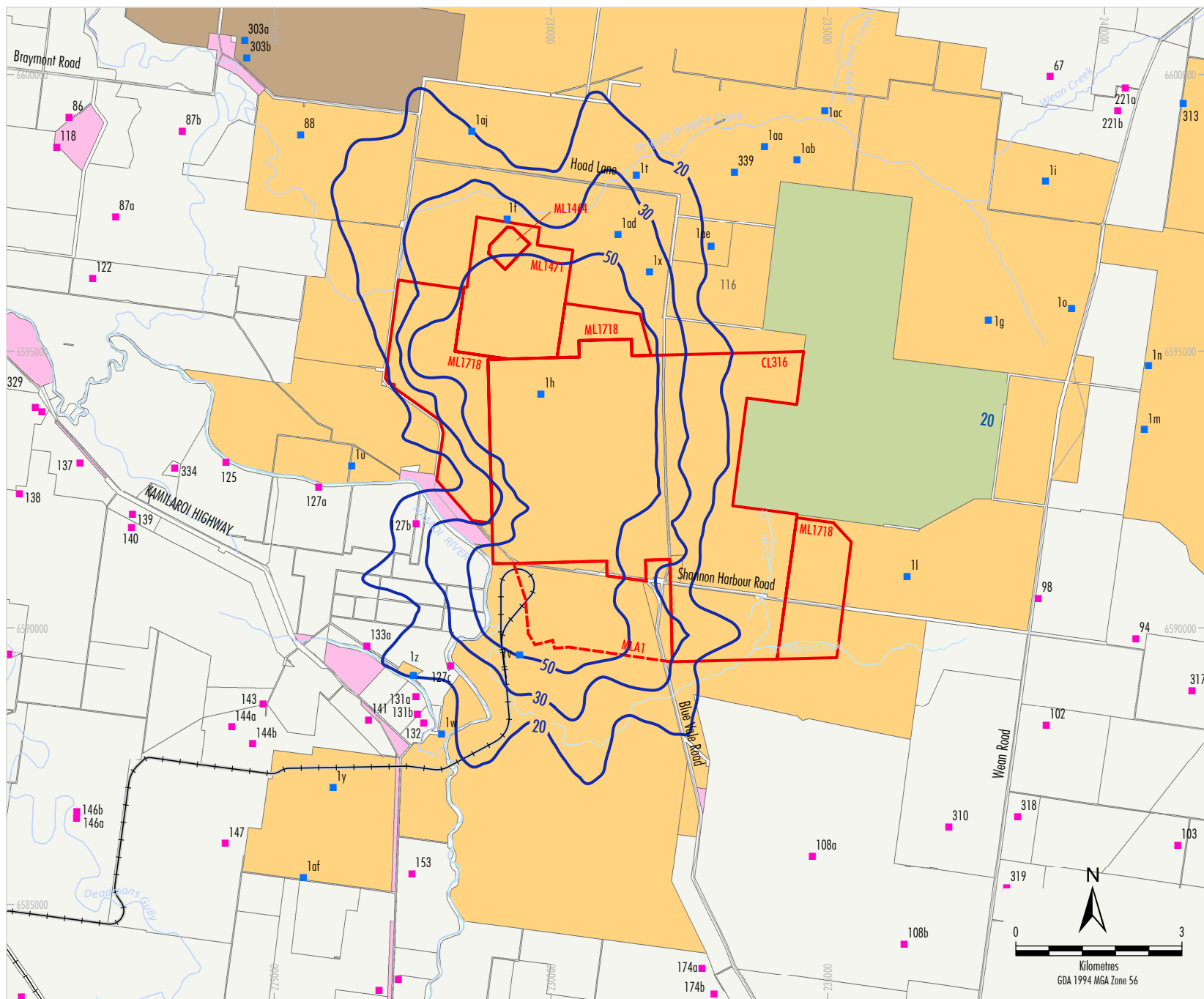
LEGEND

- Mining Tenement Boundary (ML and CL)
- Mining Lease Application (MLA)
- Mine-owned Dwelling
- Private Dwelling
- State Forest
- Crown Land
- Whitehaven Owned Land
- Whitehaven/Idemitsu Boggabri Coal Joint Owned Land
- Privately Owned Land and Other Land
- +— Indicative Rail Spur Alignment
- Project-only 24-hour PM₁₀ Air Quality Contour (μg/m³)

Source: Department of Land and Property Information - Land Tenure (2016); Department of Industry (2015); Ramboll (2018)


VICKERY EXTENSION PROJECT
 Project 24-hour average PM₁₀
 Air Quality Contours - Year 3

Figure 4-16



LEGEND

- Mining Tenement Boundary (ML and CL)
- Mining Lease Application (MLA)
- Mine-owned Dwelling
- Private Dwelling
- State Forest
- Crown Land
- Whitehaven Owned Land
- Whitehaven/Idemitsu Boggabri Coal Joint Owned Land
- Privately Owned Land and Other Land
- Indicative Rail Spur Alignment
- Project-only 24-hour PM₁₀ Air Quality Contour (µg/m³)

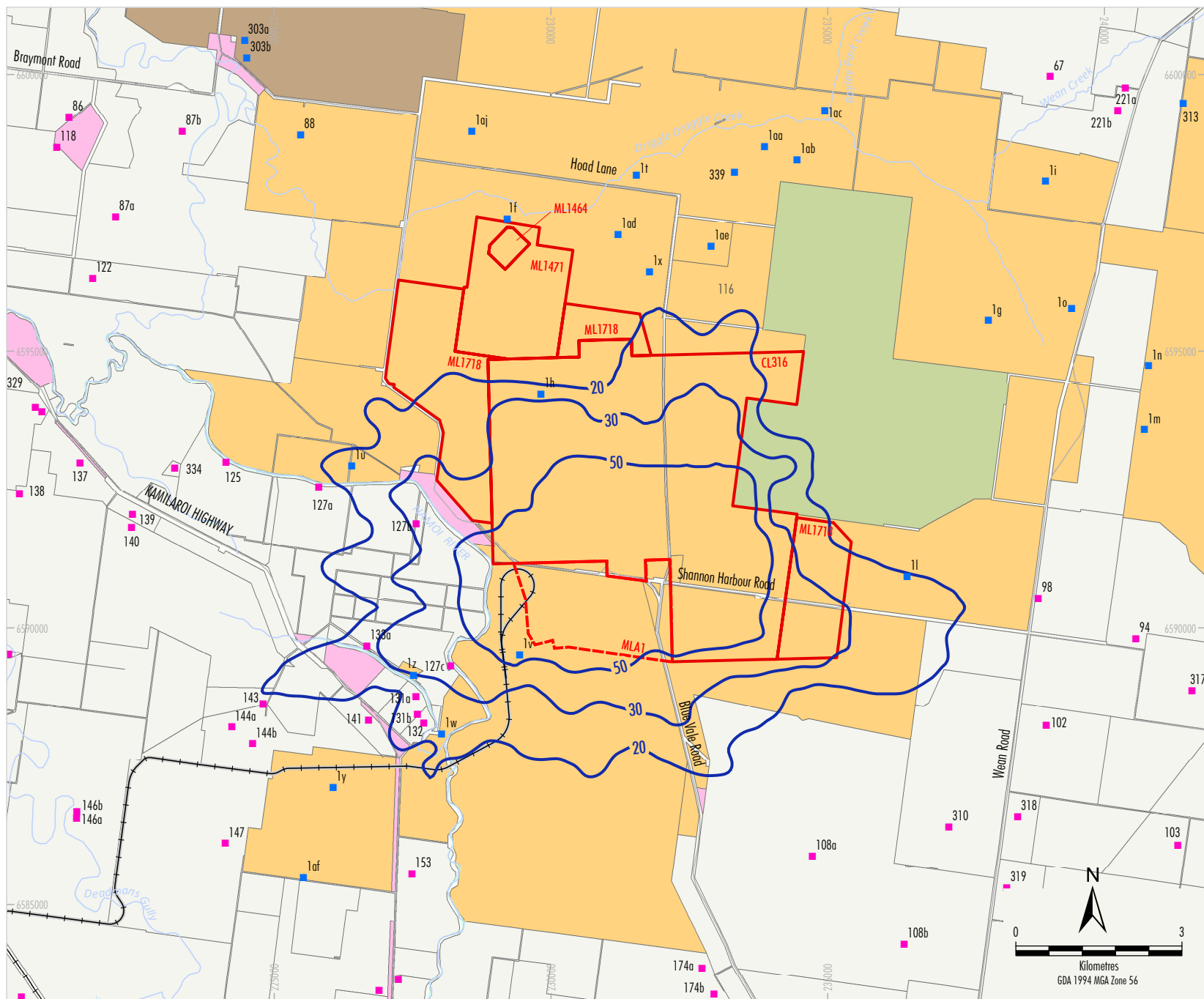
Source: Department of Land and Property Information - Land Tenure (2016); Department of Industry (2015); Ramboll (2018)

WHITEHAVEN COAL

VICKERY EXTENSION PROJECT

Project 24-hour average PM₁₀ Air Quality Contours - Year 7

Figure 4-17



- LEGEND**
- Mining Tenement Boundary (ML and CL)
 - Mining Lease Application (MLA)
 - Mine-owned Dwelling
 - Private Dwelling
 - State Forest
 - Crown Land
 - Whitehaven Owned Land
 - Whitehaven/Idemitsu Boggabri Coal Joint Owned Land
 - Privately Owned Land and Other Land
 - +—+—+— Indicative Rail Spur Alignment
 - Project-only 24-hour PM₁₀ Air Quality Contour (µg/m³)

Source: Department of Land and Property Information - Land Tenure (2016); Department of Industry (2015); Ramboll (2018)



VICKERY EXTENSION PROJECT
Project 24-hour average PM₁₀
Air Quality Contours - Year 21

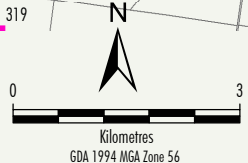


Figure 4-18

No exceedances of the EPA 24-hour average PM₁₀ criterion (50 µg/m³) were predicted at any privately-owned receiver due to the cumulative contribution from the Project, the Tarrawonga, Boggabri, Rocglen and Maules Creek Coal Mines and background sources (Appendix E).

Annual Average TSP

No exceedances of the EPA annual average TSP criterion (90 µg/m³) were predicted at any privately-owned receivers due to the cumulative contributions from the Project, the Tarrawonga, Boggabri, Rocglen and Maules Creek Coal Mines and background sources (Appendix E).

Annual Average PM_{2.5}

No exceedances of the EPA annual average PM_{2.5} criterion (8 µg/m³) were predicted at any privately-owned receivers due to the cumulative contributions from the Project, the Tarrawonga, Boggabri, Rocglen and Maules Creek Coal Mines and background sources (Appendix E).

24-hour Average PM_{2.5}

The EPA contemporaneous method was also applied by Ramboll (2018) to analyse the potential maximum cumulative 24-hour average PM_{2.5} concentrations arising from the Project (Appendix E).

No exceedances of the EPA 24-hour average PM_{2.5} criterion (25 µg/m³) were predicted at any privately-owned receivers due to the cumulative contributions from the Project, the Tarrawonga, Boggabri, Rocglen and Maules Creek Coal Mines and background sources (Appendix E).

Dust Deposition

No privately-owned receivers are predicted to experience dust deposition levels above the EPA maximum total deposited dust level criterion (4 g/m²/month [annual average]) due to the cumulative contributions from the Project, the Tarrawonga, Boggabri, Rocglen and Maules Creek Coal Mines and background sources (Appendix E).

Potential Blast Fume Emissions

Blasting activities have the potential to result in fugitive fume and particulate matter emissions. Particulate matter emissions from blasting are included in the dispersion modelling results (Appendix E).

Particulate matter emissions from blasting are controlled during operations by adequate stemming of the blast.

Measures to minimise or avoid imperfect blasts, which may result in oxides of nitrogen (NO_x) fumes being emitted, would be implemented in accordance with *Code of Practice: Prevention and Management of Blast Generated NO_x Gases in Surface Blasting* (Australian Explosives Industry and Safety Group Inc., 2011) and these measures would be incorporated into the Blast Management Plan (Section 4.8.3).

Spontaneous Combustion

Spontaneous combustion events have the potential to give rise to odour emissions. Based on experience from previous mining in the vicinity of the Project (i.e. the former Canyon Coal Mine), Whitehaven does not expect spontaneous combustion events to occur for the Project. Measures to avoid potential spontaneous combustion events, including mine planning, risk identification and assessment and identification of potential hot spots would be included in the Air Quality Management Plan (Section 4.9.3).

Potential Construction Impacts

Construction activities would potentially generate particulate matter emissions. These would typically be contained to specific areas (e.g. the mine infrastructure area), be of limited duration and relatively easy to manage through dust control measures (Appendix E).

Construction dust emissions would be effectively managed through best practice mitigation measures, which would be incorporated into the Air Quality Management Plan, as described in Section 4.9.3 and Appendix E.

Coal Transport

Potential impacts from rail transportation of coal along the Project rail spur were considered by Ramboll (2018). Analysis of the potential impacts associated with rail transport suggests that:

- dust levels associated with rail transportation of coal are low relative to ambient air quality goals; and
- the risk of adverse impacts from fugitive coal dust emissions associated with coal transportation is considered low (Appendix E).

Haulage of ROM coal via the Approved Road Transport Route to the Whitehaven CHPP would be conducted consistent with the Development Consent conditions for coal haulage for the Approved Mine.

The Approved Mine EIS (Whitehaven, 2012) concluded ROM coal haulage by truck along the Approved Road Transport Route would result in negligible dust emissions. Potential air quality impacts from ROM coal haulage along the Approved Road Transport Route for the Project would be consistent with those assessed and subsequently approved for the Approved Mine.

Dust from Local Unsealed Roads

Project-related and other mine-related traffic (e.g. employees) on unsealed local roads in the vicinity of the Project have the potential to elevate background particulate matter concentrations at receiver locations.

Whitehaven would encourage employees and delivery drivers to use sealed roads (i.e. in preference to unsealed roads) whenever possible.

In addition, the real-time monitoring and management systems for the Project (Section 4.9.3) would identify periods when background particulate matter levels are elevated, which would include contributions from unsealed local roads. Appropriate mitigation and response measures would be implemented at the Project to manage total particulate matter concentrations at receiver locations during periods of elevated background levels.

4.9.3 Mitigation Measures, Management and Monitoring

Real-time Air Quality Monitoring and Management

Whitehaven currently operates a meteorological monitoring station and real-time air quality monitoring station in the vicinity of the Project.

The real-time monitoring network would be reviewed for the operation of the Project and detailed in the Air Quality Management Plan.

When specified short-term trigger levels are reached or exceeded, a message would be delivered to a Whitehaven representative, alerting them to the elevated short-term dust levels. The Project meteorological station would report wind conditions at the time, allowing personnel to evaluate the likely origin of the elevated dust levels enabling appropriate mitigation and response measures to be implemented.

An additional component of the air quality management system would be a meteorological forecasting system, enabling short-term mine planning to be conducted in consideration of potential upcoming weather conditions with the potential to exacerbate air quality impacts (e.g. to allow planning for increased levels of controls or limiting mining activities in certain areas) (Appendix E).

Air Quality Management Plan

An Air Quality Management Plan would be prepared for the Project and would include:

- details of the air quality mitigation measures to be implemented for the Project;
- the real-time air quality monitoring program;
- details of trigger levels for the investigation of additional mitigation measures;
- response protocols during adverse conditions; and
- details of the meteorological forecasting system.

Blast Management Plan

A Blast Management Plan would be developed for the Project, as described in Section 4.8.3.

Fume emissions would be managed in accordance with the *Code of Good Practice: Prevention and Management of Blast Generated NO_x Gases in Surface Blasting* (Australian Explosives Industry and Safety Group Inc., 2011) and would be incorporated into the Blast Management Plan. Measures that would be implemented include:

- the use of risk assessments prior to blasting, in order to review factors such as:
 - geological conditions;
 - ground conditions (e.g. presence of clay or loose/broken ground or heavy rain affected ground);

- location of the blast relative to previous blasts which may have triggered fume events;
- blasting product selection; and
- presence of groundwater;
- use of the outcomes of the risk assessment to alter the blasting method where necessary by:
 - minimising the time between drilling and loading, and loading and shooting of the blast;
 - formulation of explosive products to an appropriate oxygen balance to reduce the likelihood of fumes; and
 - adjusting the blast scheduling to avoid unfavourable meteorological conditions.

4.10 GREENHOUSE GAS EMISSIONS

4.10.1 Quantitative Assessment of Potential Scope 1, 2 and 3 Greenhouse Gas Emissions

A quantitative assessment of Project greenhouse gas emissions was undertaken by Ramboll (2018) and is provided in Appendix E.

The Air Quality and Greenhouse Gas Assessment was peer reviewed by Aleks Todoroski (Director, Todoroski Air Sciences). The peer review report is presented in Attachment 4.

A summary of the Project greenhouse gas assessment is provided below.

Greenhouse Gas Protocol Emission Scopes

The *Greenhouse Gas Protocol* (GHG Protocol) (World Business Council for Sustainable Development [WBCSD] and World Resources Institute [WRI], 2004) defines three ‘scopes’ of emissions (Scopes 1, 2 and 3). Scopes 1 and 2 have been defined such that two or more entities would not account for the same emissions in the same scope.

Scope 1: Direct Greenhouse Gas Emissions

Direct greenhouse gas emissions are defined as those emissions that occur from sources that are owned or controlled by the entity (WBCSD and WRI, 2004). Direct greenhouse gas emissions are those emissions that are principally the result of the types of activities undertaken by an entity that are listed below:

- Generation of electricity, heat or steam – emissions result from combustion of fuels in stationary sources (e.g. boilers, furnaces and turbines).
- Transportation of materials, products, waste, and employees – emissions result from the combustion of fuels in entity owned/controlled mobile combustion sources (e.g. trucks, trains, ships, aeroplanes, buses and cars).
- Fugitive emissions – emissions result from intentional or unintentional releases (e.g. equipment leaks from joints, seals, packing, and gaskets; methane emissions from coal mines and venting; hydrofluorocarbon emissions during the use of refrigeration and air conditioning equipment; and methane leakages from gas transport) (WBCSD and WRI, 2004).

Examples of Scope 1 emissions for the Project include emissions from diesel consumption, fugitive emissions released during coal extraction, and emissions from the use of explosives.

Scope 2: Electricity Indirect Greenhouse Gas Emissions

Scope 2 emissions are a category of indirect emissions that account for greenhouse gas emissions from the generation of purchased electricity consumed by the entity.

Purchased electricity is defined as electricity that is purchased or otherwise brought into the organisational boundary of the entity (WBCSD and WRI, 2004). Scope 2 emissions physically occur at the facility where electricity is generated (WBCSD and WRI, 2004). Entities report the emissions from the generation of purchased electricity that is consumed in its owned or controlled equipment or operations as Scope 2.

Scope 3: Other Indirect Greenhouse Gas Emissions

Under the GHG Protocol, Scope 3 is an optional reporting category that allows for the treatment of all other indirect emissions.

Scope 3 emissions are defined as those emissions that are a consequence of the activities of an entity, but which arise from sources not owned or controlled by that entity. Some examples of Scope 3 activities provided in the GHG Protocol are extraction and production of purchased materials, transportation of purchased fuels, and use of sold products and services (WBCSD and WRI, 2004).

The GHG Protocol provides that reporting of Scope 3 emissions is optional (WBCSD and WRI, 2004). If an organisation believes that Scope 3 emissions are a significant component of the total emissions inventory, these can be reported along with Scope 1 and 2. However, the GHG Protocol also notes that reporting Scope 3 emissions can result in double counting of emissions and can also make comparisons between organisations and/or projects difficult because reporting is voluntary.

The main source of Scope 3 emissions associated with the Project would be from the transportation and end use (i.e. combustion) of product coal from the Project.

Greenhouse Gas Emissions Estimation Methodology

Project direct and indirect greenhouse gas emissions have been estimated by Ramboll (2018) (Appendix E) using published emission factors from the *National Greenhouse Accounts Factors August 2015* (NGA Factors) (DotE, 2015). Fugitive emissions have been calculated using site-specific emission data.

The NGA Factors provide greenhouse gas emission factors for carbon dioxide, methane and nitrous oxide. Emission factors are standardised for each of these greenhouse gases by being expressed as a carbon dioxide equivalent (CO₂-e) based on their Global Warming Potential. This is determined by the differing periods that greenhouse gases remain in the atmosphere and their relative effectiveness in absorbing outgoing infrared radiation (e.g. methane has a Global Warming Potential 21 times that of carbon dioxide) (DotE, 2015).

Project Greenhouse Gas Emissions

A summary of key potential Project greenhouse gas emission sources considered in the greenhouse gas estimate and their respective scopes is provided in Table 4-23.

Table 4-23
Summary of Key Potential Project Greenhouse Gas Emissions

Component	Direct Emissions	Indirect Emissions	
	Scope 1	Scope 2	Scope 3
Electricity Consumption for the Processing of ROM Coal	N/A	Emissions from the consumption of purchased electricity used at the Project.	Emissions from the extraction, production and transport of fuel burned for the generation of electricity consumed, and the electricity lost in delivery in the transmission and distribution network.
Diesel Consumption	Emissions from the combustion of diesel at the Project.	N/A	Emissions attributable to the extraction, production and transport of diesel consumed at the Project.
Explosives	Emissions from the use of explosives.	N/A	N/A ¹
Fugitive	Fugitive emissions that result from the extraction of coal.	N/A	N/A
Product Coal Transport	N/A	N/A	Emissions from the combustion of diesel used during road and rail haulage.
Combustion of Coal	N/A	N/A	Third party emissions from the combustion of product coal from the Project.

Source: After Appendix E.

¹ The contribution of Scope 3 emissions from explosive use is not material in the context of overall emissions.

The total direct (i.e. Scope 1) emissions over the life of the Project are estimated to be approximately 3.2 million tonnes of carbon dioxide equivalent (Mt CO₂-e), which is an average of approximately 0.13 Mt CO₂-e per annum over the life of the Project (Appendix E).

The total indirect emissions (i.e. Scopes 2 and 3) over the life of the Project are estimated to be approximately 390 Mt CO₂-e, which is an average of approximately 15.6 Mt CO₂-e per annum. Approximately 99% (388 Mt CO₂-e) of these emissions would be associated with the Scope 3 combustion of product coal by third parties (Appendix E). As the Project would produce coal for export to overseas markets, combustion of coal overseas would not contribute to Australian greenhouse gas emissions reductions targets.

Project Greenhouse Gas Emissions Intensity

The estimated greenhouse gas emissions intensity of the Project is approximately 0.02 tonnes of carbon dioxide equivalent per tonne (t CO₂-e/t) of ROM coal (this includes all Scope 1 and 2 emissions). This is comparable to the greenhouse gas emissions intensity of other existing local mines, including (Appendix E):

- Tarrawonga Coal Mine (0.07 t CO₂-e/t ROM)¹;
- Boggabri Coal Mine (0.06 t CO₂-e/t ROM);
- Rocglen Coal Mine (0.06 t CO₂-e/t ROM)¹; and
- Maules Creek Coal Mine (0.02 t CO₂-e/t ROM).

The Project would have the benefit of reducing the greenhouse gas emissions intensities of the Rocglen and Tarrawonga Coal Mines as a result of reduced haulage distances to the Project CHPP, as opposed to the Whitehaven CHPP.

Potential Impacts of Greenhouse Gas Emissions on the Environment

The Project's contribution to projected climate change, and the associated environmental impacts, would be in proportion with its contribution to global greenhouse gas emissions (Appendix E).

The Project's contribution to Australian emissions would be relatively small, as estimated annual average Scope 1 emissions from the Project (0.13 Mt CO₂-e) represent approximately 0.024% of Australia's annual greenhouse gas emission from 2016 (530 Mt CO₂-e) (Appendix E).

Increased global greenhouse gas levels are discussed further in Section 6.1.3

4.10.2 Australian Greenhouse Gas Emissions Reduction Targets

The potential impacts of greenhouse gas emissions from all Australian sources will be collectively managed at a national level, through initiatives implemented by the Commonwealth Government.

The Commonwealth Government has committed to reduce greenhouse gas emissions by 5% below 2000 levels by 2020, consistent with Australia's commitments under the Kyoto Protocol (Department of Foreign Affairs and Trade, 2015). In addition to the 2020 target, the Commonwealth Government has also committed to reducing greenhouse gas emissions by 26 to 28% below 2005 levels by 2030, as part of the Paris Agreement (Department of the Environment, 2015a).

The Emissions Reduction Fund has been in effect since April 2015 and a Commonwealth Government policy designed to incentivise business and other entities to adopt better technologies and practices to reduce greenhouse gas emissions (Commonwealth of Australia, 2017). In addition to the Fund, a range of policies including the Renewable Energy Target and the National Energy Productivity Plan, have been implemented to help Australia meet its greenhouse gas commitments (Commonwealth of Australia, 2017).

Whitehaven would implement Project-specific greenhouse gas mitigation measures, as described below.

4.10.3 Project Greenhouse Gas Mitigation Measures, Management and Monitoring

The potential for reducing greenhouse gas emissions at the Project is related predominantly to consumption of diesel by plant and equipment. Whitehaven currently employs methods to maximise efficiency of the mining fleet at its existing operations through regular maintenance scheduling, implementation of high efficiency motors, reduction of engine idle times and, where possible, minimising the gradient and length of loaded haul runs for the operating haul trucks. This is achieved by appropriate mine scheduling and planning, and these methods would be applied to the Project.

¹ Incorporates ROM coal haulage to the Whitehaven CHPP.

Revegetation of previously cleared areas as part of biodiversity offset measures would also assist with reducing the Project's net greenhouse gas emissions. This revegetation would be in addition to the extensive on-site revegetation of Project disturbance areas (Section 5).

Ongoing monitoring and management of greenhouse gas emissions and energy consumption at the Project would occur through Whitehaven's participation in the Commonwealth Government's *National Greenhouse and Energy Report Scheme* (NGERS).

Under NGERS requirements, relevant sources of greenhouse gas emissions and energy consumption must be measured and reported on an annual basis, allowing major sources and trends in emissions/energy consumption to be identified.

4.11 BIODIVERSITY

A Biodiversity Assessment Report and Biodiversity Offset Strategy was undertaken by Resource Strategies (2018) and is presented as Appendix F. A separate Aquatic Ecology Assessment was prepared by Eco Logical Australia (ELA) (2018) and is presented as Appendix N.

Both of the biodiversity assessments were prepared in accordance with the SEARs for the Project and relevant State and Commonwealth requirements. In regard to the State requirements, the *NSW Biodiversity Offset Policy for Major Projects* (the NSW Offset Policy) (OEH, 2014a) (and supporting *NSW Framework for Biodiversity Assessment* [FBA] [OEH, 2014b]) was applied.

The Biodiversity Assessment Report and Biodiversity Offset Strategy was peer reviewed by Dr Colin Driscoll (Hunter Eco). The peer review report is presented in Attachment 4.

The Biodiversity Assessment Report Development Site Footprint (BAR Footprint) (Figures 4-19a and 4-19b) is defined as the development site construction and operational footprint for the purposes of the Biodiversity Assessment Report and Biodiversity Offset Strategy. The BAR Footprint is the additional surface disturbance area outside of the Approved Mine under Development Consent (SSD-5000).

A description of the existing environment relating to the biodiversity values relevant to the BAR Footprint is provided in Section 4.11.1. Section 4.11.2 describes the potential impacts of the Project, Section 4.11.3 outlines mitigation measures, management and monitoring and Section 4.11.4 describes the Biodiversity Offset Strategy.

4.11.1 Existing Environment

This section describes the environmental features relevant to the Project. A description of the Approved Mine extent is provided directly below, followed by a description of the biodiversity values relevant to the BAR Footprint.

Approved Mine

Niche (2013) mapped nine native vegetation communities within the Approved Mine extent (including along the approved private haul road and Kamilaroi Highway Overpass).

Box-Gum Woodland² was mapped by Niche (2013) along South Creek (just north of the Shannon Harbour Road), within the northern central portion of the approved open cut extent and along the approved private haul road and Kamilaroi Highway overpass corridor. In addition, Weeping Myall Woodland³ was mapped along the Blue Vale Road realignment.

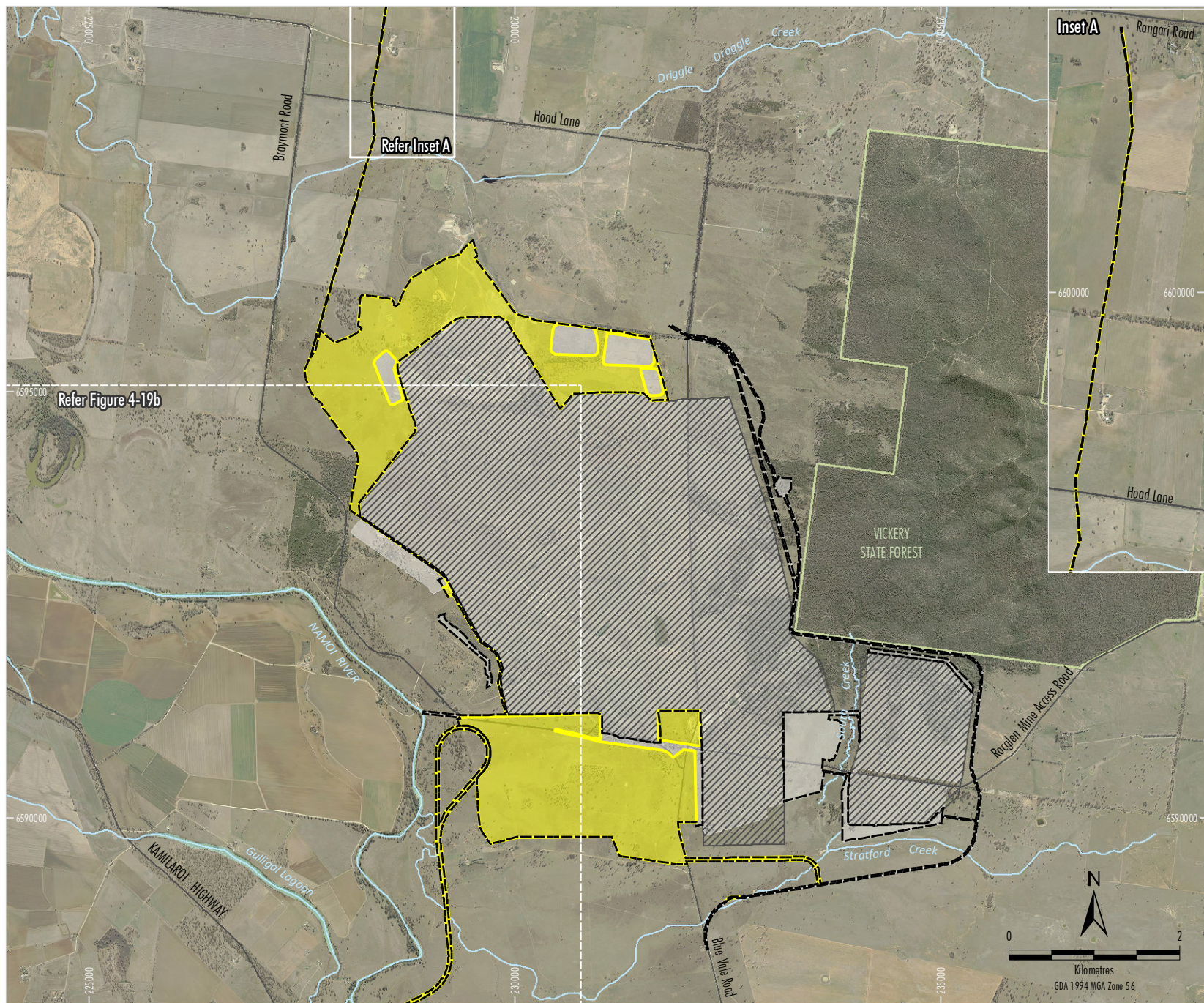
One threatened flora species was recorded within the Approved Mine, namely the Winged Peppergrass (*Lepidium monoplacoides*) listed under the *NSW Biodiversity Conservation Act, 2016* (BC Act) and the EPBC Act. A total of 50 Winged Peppergrass individuals were recorded within the Approved Mine extent.

Landscape Features

The Project is located within the Brigalow Belt South Region Interim Biogeographic Regionalisation for Australia (IBRA) Bioregion and Liverpool Plains IBRA sub-region.

² White Box Yellow Box Blakely's Red Gum Woodland listed as an Endangered Ecological Community (EEC) under the BC Act (Box-Gum Woodland EEC) and White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland listed as a Critically Endangered Ecological Community (CEEC) under the EPBC Act (Box-Gum Woodland CEEC).

³ Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes bioregions listed as an Endangered Ecological Community under the BC Act (Weeping Myall Woodland EEC) and Weeping Myall Woodlands listed as an Endangered Ecological Community under the EPBC Act (Weeping Myall Woodlands EEC).



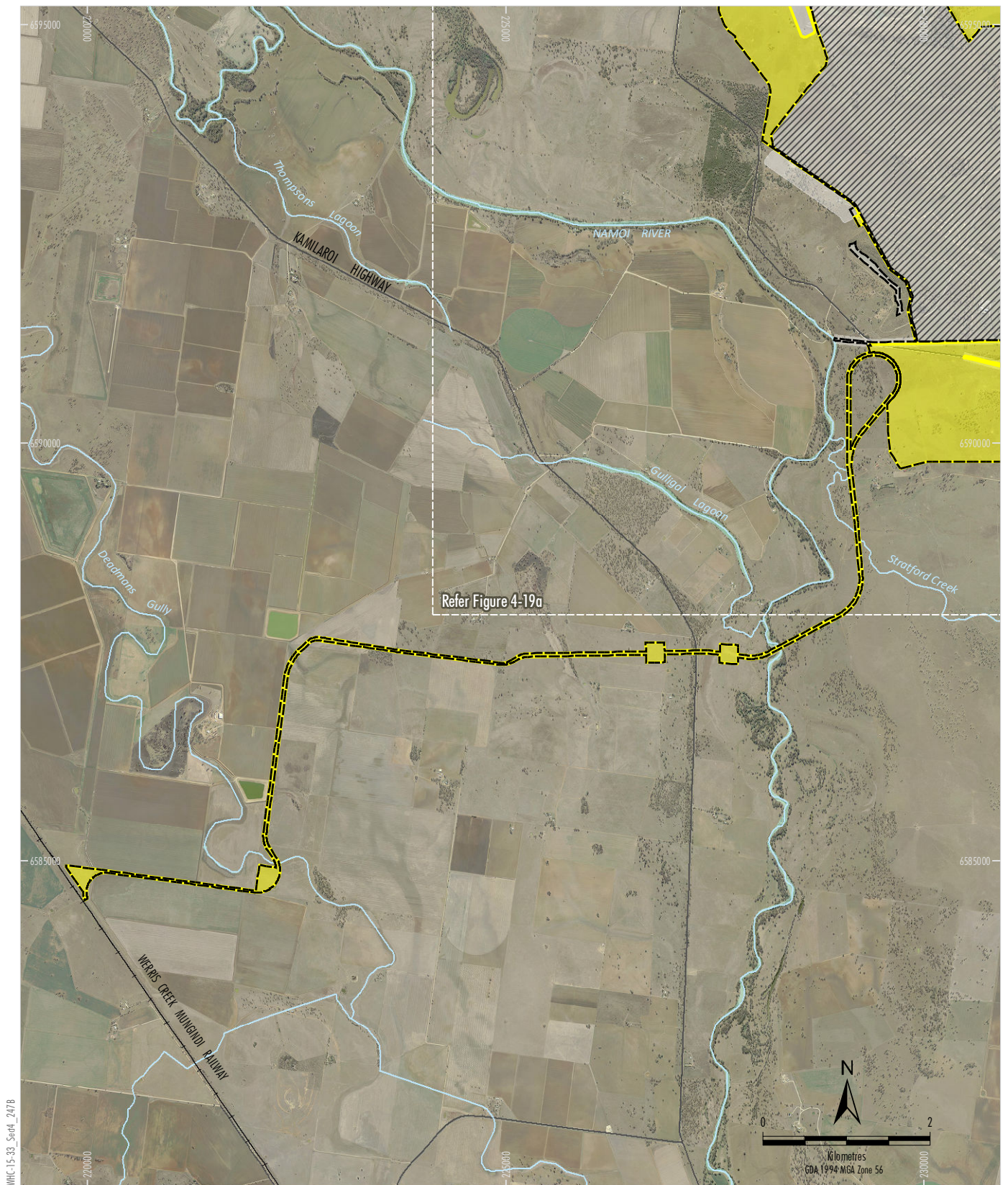
- LEGEND**
- State Forest
 - Approximate Extent of Approved Mine
 - Vickers Coal Project (EPBC 2012/6263) Footprint - Not a Controlled Action - Particular Manner
 - Approximate Extent of Vickers Extension Project (EPBC 2016/7649) Footprint
 - Biodiversity Assessment Report Development Site Footprint

Source: Orthophoto - Department of Land and Property Information, Aerial Photography (July 2011)



VICKERY EXTENSION PROJECT
Project Assessment Area - Mining Area

Figure 4-19a



WMC-15-33_Snd_247B

LEGEND

- Approximate Extent of Approved Mine
- Vickers Coal Project (EPBC 2012/6263) Footprint - Not a Controlled Action - Particular Manner
- Approximate Extent of Vickers Extension Project (EPBC 2016/7649) Footprint
- Biodiversity Assessment Report Development Site Footprint

Source: Orthophoto - Department of Land and Property Information, Aerial Photography (July 2011)



VICKERY EXTENSION PROJECT

Project Assessment Area -
Project Rail Spur

Figure 4-19b

The Project is situated within the Namoi catchment. The main surface water drainage feature in the area surrounding the Project is the Namoi River, located to the south-west of the Project mining area (Figure 4-19a) (Section 4.2.2).

The Project is located approximately 1.5 km west of the Vickery State Forest, with the BAR Footprint located predominantly within the Liverpool Alluvial Plains Mitchell Landscape (OEH, 2017; Mitchell, 2002).

Native Vegetation and Threatened Ecological Communities

Flora surveys of the BAR Footprint and surrounds were conducted by FloraSearch (2018) (Attachment C of Appendix F).

The vegetation surveys included sampling of floristic plots, collection of Biometric data and targeted searches for threatened ecological communities listed under the BC Act and EPBC Act that could potentially occur in the Project area.

The BAR Footprint is 775.8 ha in size comprising 77.8 ha (10%) of native woodland/forest vegetation and 502 ha (65%) of secondary/derived native grassland (Table 4-24; Figures 4-20a and 4-20b). The remaining 196 ha (25%) consists of previously cleared land comprising exotic grassland or land with no vegetation cover.

The secondary/derived native grasslands in the BAR footprint occur as a result of native grassland species that have recolonised land which has been previously cultivated (e.g. via windblown or animal carried seed) or are native grasslands that remain after removal of the woody canopy vegetation (shrubs and trees).

Six native vegetation communities were identified within the BAR Footprint (Table 4-24; Figures 4-20a and 4-20b). None of these communities are listed as a threatened ecological community under the BC Act and/or EPBC Act (Attachment C of Appendix F).

Aquatic Habitat

Aquatic ecology surveys were undertaken by Coast Ecology (2012) on two ephemeral drainage lines for the Approved Mine in February and March 2012.

More recently, ELA (2018) undertook aquatic ecology surveys at six sites between 29 February 2016 and 2 March 2016 (Appendix N). Four sites were located on the Namoi River and two sites were located on Driggle Draggie Creek.

Aquatic habitat assessments (including water quality parameters) were undertaken, and aquatic flora (i.e. macrophytes), aquatic fauna and macroinvertebrates were surveyed. Aquatic habitat assessments were conducted in consideration of the *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI Fisheries, 2013).

The four aquatic ecology survey sites located on the Namoi River were found to be in a condition typical of inland rivers in their drying phase (Appendix N). Flow in the Namoi River was low when sampled in late February and early March, with water restricted to standing pools (Appendix N).

All sites surveyed along the Namoi River contained mostly pollution tolerant macroinvertebrate families (Appendix N). ELA (2018) determined that the Namoi River contained habitat for larger native fish species (Appendix N).

The two sites along Driggle Draggie Creek were both found to contain only poor aquatic habitat (Appendix N). ELA (2018) determined that neither site would provide habitat suitable for larger native fish species and that Deadmans Gully and Stratford Creek are in a similar state.

Aquatic Ecological Communities

The naturally occurring watercourses surrounding the Project area are all part of the *Lowland Darling River Aquatic Ecological Community*, listed as an EEC under the *NSW Fisheries Management Act, 1994* (FM Act) (Appendix N).

Threatened Flora Species

Floristic surveys within the Project area and surrounds (including targeted searches for potentially occurring threatened species listed under the BC Act and EPBC Act) were previously undertaken by Niche (2013; 2014), Geoff Cunningham Natural Resource Consultants Pty Ltd (2004; 2006; 2007; 2008; 2009; 2010), Countrywide Ecological Service (2006; 2007a; 2008; 2009a; 2010) and Hunter Eco (2018a; 2018b). Additional targeted searches were undertaken by FloraSearch (2018) during 2015, 2016 and 2017.

A description of the methodology employed during each of these surveys is provided in Appendix F.

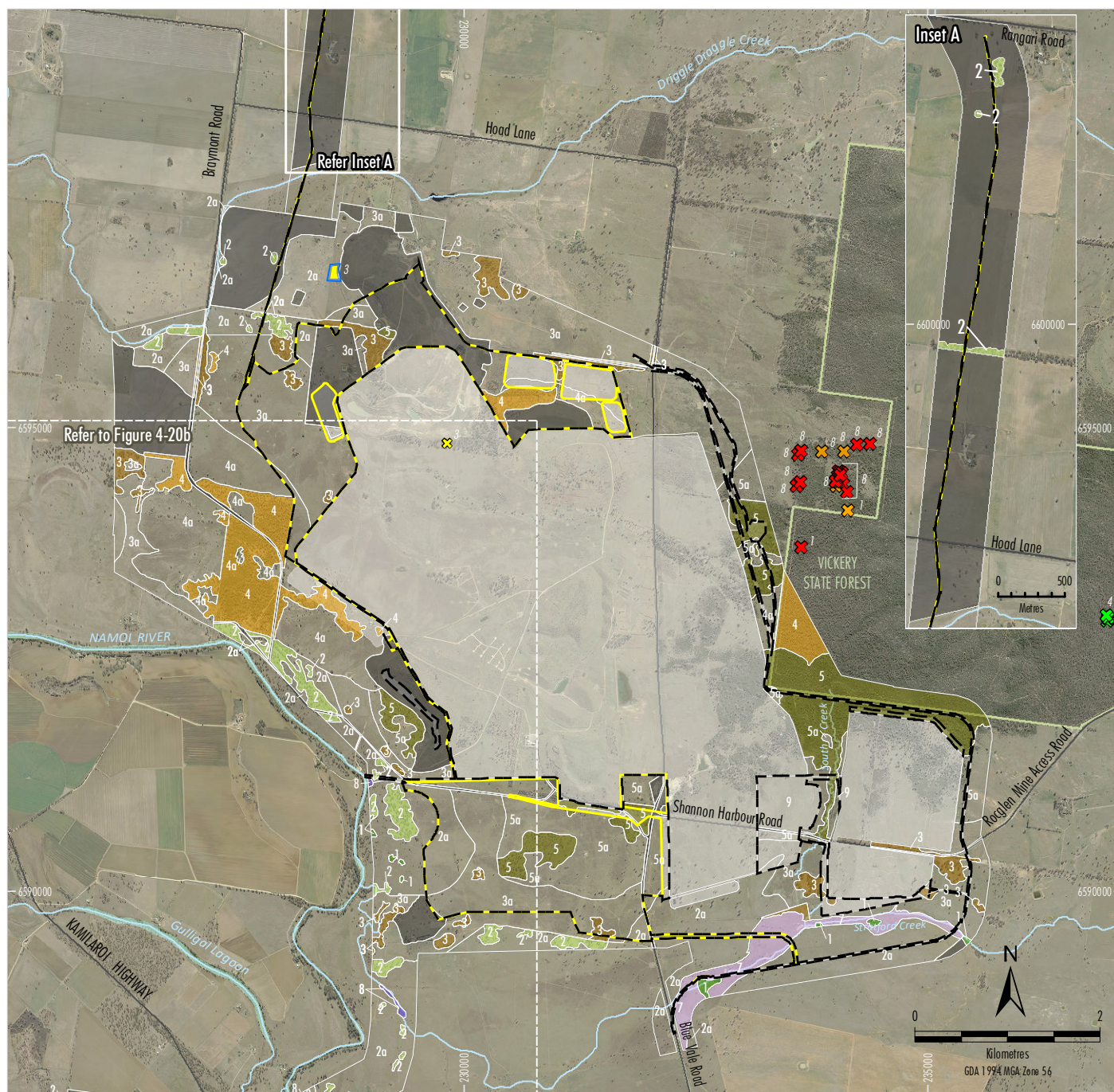
No threatened flora species have been recorded within the BAR Footprint (Figures 4-20a and 4-20b).

Table 4-24
Project Ecosystem Credit Requirements

Mapping Unit	Vegetation Community	Biometric Vegetation Type	Area within NSW Assessment Footprint (ha)	Ecosystem Credit Requirement
Semi-arid Woodlands (Grassy Sub-formation)				
2	Poplar Box Woodland on Alluvial Clay Soils	NA185	3.6	3,540
2a	Poplar Box Woodland on Alluvial Clay Soils (secondary/derived grassland)		79.5	
Dry Sclerophyll Forests (Shrub/Grass Sub-formation)				
3	Pilliga Box – Poplar Box Shrubby Woodland	NA324	23.2	6,955
3a	Pilliga Box – Poplar Box Shrubby Woodland (secondary/derived grassland)		265.8	
4	White Box – Silver-leaved Ironbark Shrubby Open Forest	NA349	17	1,795
4a	White Box – Silver-leaved Ironbark Shrubby Open Forest (secondary/derived grassland)		23	
Dry Sclerophyll Forests (Shrubby Sub-formation)				
5	Narrow-leaved Ironbark – White Box Shrubby Forest	NA311	33	4,025
5a	Narrow-leaved Ironbark – White Box Shrubby Forest (secondary/derived grassland)		130	
Freshwater Wetlands				
7	Mixed Marsh Sedgeland	NA201	2	46
Forested Wetlands				
8	River Red Gum Riparian Tall Woodland	NA193	1	40
8a	River Red Gum Riparian Tall Woodland (secondary/derived grassland)		1.7	
Total Woodland/Forest			77.8	-
Total Derived Native Grassland			502	-
Total Native Vegetation			579.8	-
Total Disturbed Land			196	-
Total NSW Assessment Footprint			775.8	16,401

Source: Appendix F.

Note: Numbering of vegetation communities as per Attachment C of Appendix F. Vegetation communities 1 and 6 do not occur in the BAR Footprint.



LEGEND

- State Forest
- Approximate Extent of Approved Mine
- Biodiversity Assessment Report
- Development Site Footprint - for Mining Area
- Approximate Extent of Vickery Extension Project (EPBC 2016/7649) Footprint

Vegetation Communities

- Semi-arid Woodlands (Grassy Sub-formation)**
 - 1 Weeping Myall Woodland (NA219)*
 - 2 Poplar Box Woodland on Alluvial Clay Soils (NA185)
 - 2a Poplar Box Woodland on Alluvial Clay Soils (Secondary/derived grassland) (NA185)
- Dry Sclerophyll Forests (Shrub/Grass Sub-formation)**
 - 3 Pilliga Box – Poplar Box Shrubby Woodland (NA324)
 - 3a Pilliga Box – Poplar Box Shrubby Woodland (Secondary/derived grassland) (NA324)
 - 4 White Box – Silver-leaved Ironbark Shrubby Open Forest (NA349)
 - 4a White Box – Silver-leaved Ironbark Shrubby Open Forest (Secondary/derived grassland) (NA349)
- Dry Sclerophyll Forests (Shrubby Sub-formation)**
 - 5 Narrow-leaved Ironbark – White Box Shrubby Forest (NA311)
 - 5a Narrow-leaved Ironbark – White Box Shrubby Forest (Secondary/derived grassland) (NA311)
- Freshwater Wetlands**
 - 7 Mixed Marsh Sedgeland (NA201)
- Forested Wetlands**
 - 8 River Red Gum Riparian Tall Woodland (NA193)
- Cleared Land**
 - 9 Exotic Dominant Grasslands
- DL Disturbed Land**
- * Listed as the Weeping Myall Woodland EEC

Note: Vegetation community 6 and 8a is not present within the mining area.

Threatened Flora

- ✱ Belson's Panic (*Homopholis belsonii*)
- ✱ Scant Pomaderis (*Pomaderris queenslandica*)
- ✱ *Tylophora linearis*
- ✱ Winged Peppergrass (*Lepidium monoplacoides*)
- Winged Peppergrass Protection Area

Source

- (1) FloraSearch (2018)
- (3) Niche (2013)
- (4) OEH (2017)
- (8) Hunter Eco (2018)

Note: Sources 2 and 5 to 7 are not shown on this figure.

Source: Orthophoto - Department of Land and Property Information, Aerial Photography (July 2011); FloraSearch (2018)



VICKERY EXTENSION PROJECT

Vegetation Communities and
Threatened Flora Species -
Mining Area

Figure 4-20a



LEGEND

- Approximate Extent of Approved Mine
- Biodiversity Assessment Report
- Development Site Footprint
- Approximate Extent of Vickers Extension Project (EPBC 2016/7649) Footprint
- Existing Approved Offset Area for the Approved Mine
- Modified Offset Area 5

Vegetation Communities

- Semi-arid Woodlands (Grassy Sub-formation)
- 1 Weeping Myall Woodland (NA219)
- 2 Poplar Box Woodland on Alluvial Clay Soils (NA185)
- 2a Poplar Box Woodland on Alluvial Clay Soils (Secondary/derived grassland) (NA185)
- Dry Sclerophyll Forests (Shrub/Grass Sub-formation)
- 3 Pilliga Box — Poplar Box Shrubby Woodland (NA324)
- 3a Pilliga Box — Poplar Box Shrubby Woodland (Secondary/derived grassland) (NA324)

- Dry Sclerophyll Forests (Shrub/Grass Sub-formation)
- 4 White Box — Silver-leaved Ironbark Shrubby Open Forest (NA349)
- 4a White Box — Silver-leaved Ironbark Shrubby Open Forest (Secondary/derived grassland) (NA349)
- Dry Sclerophyll Forests (Shrubby Sub-formation)
- 5 Narrow-leaved Ironbark — White Box Shrubby Forest (NA311)
- 5a Narrow-leaved Ironbark — White Box Shrubby Forest (Secondary/derived grassland) (NA311)
- Forested Wetlands
- 8 River Red Gum Riparian Tall Woodland (NA193)
- 8a River Red Gum Riparian Tall Woodland (Secondary/derived grassland) (NA193)
- Cleared Land
- DL Disturbed Land

Note: Vegetation communities 1, 5, 6 and 7 are not present in the Project Rail Spur

Source: Orthophoto - Department of Land and Property Information, Aerial Photography (July 2011); FloraSearch (2018)

WHITEHAVEN COAL

VICKERY EXTENSION PROJECT Vegetation Communities - Project Rail Spur

Figure 4-20b

Threatened Fauna Species

Fauna surveys within the Project area and surrounds (including targeted searches for potentially occurring threatened species listed under the BC Act and EPBC Act) were previously undertaken by Countrywide Ecological Service (2004; 2006; 2007a; 2007b; 2009b), Geoff Cunningham Natural Resource Consultants Pty Ltd (2006; 2007; 2008; 2009; 2010), Cenwest Environmental Services (2011), Niche (2013; 2014), RPS Harper Somers O'Sullivan (2010) and Kendall and Kendall (2011).

A description of the methodology employed during each of these surveys is provided in Appendix F. More recently, Future Ecology (2018) undertook targeted surveys for threatened fauna species requiring surveys as determined by the OEH *Credit Calculator for Major Projects and BioBanking* (the OEH Credit Calculator) (OEH, 2016) (Appendix F). Future Ecology (2018) also undertook targeted surveys for potentially occurring threatened fauna species listed under the EPBC Act (in addition to those requiring survey by the OEH Credit Calculator).

Appendix F provides a summary of the threatened fauna species records in the locality from survey records or database records. Threatened fauna species records (from previous surveys and database searches) are shown on Figures 4-21, 4-22a and 4-22b.

Eleven threatened fauna species have been recorded within the BAR Footprint, namely:

- Little Eagle (*Hieraetus morphnoides*);
- Speckled Warbler (*Chthonicola sagittata*);
- Hooded Robin (south-eastern form) (*Melanodryas cucullata* subsp. *cucullata*);
- Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis* subsp. *temporalis*);
- Diamond Firetail (*Stagonopleura guttata*);
- Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*);
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*);
- Eastern Freetail-bat (*Mormopterus norfolkensis*);
- Squirrel Glider (*Petaurus norfolcensis*);
- Koala (*Phascolarctos cinereus*); and
- Painted Honeyeater (*Grantiella picta*).

An additional five threatened fauna species have been recorded outside, but in the vicinity of, the BAR Footprint. These include:

- Eastern Cave Bat (*Vespadelus troughtoni*);
- Dusky Woodswallow (*Artamus cyanopterus cyanopterus*);
- Turquoise Parrot (*Neophema pulchella*);
- Spotted Harrier (*Circus assimilis*); and
- Little Lorikeet (*Glossopsitta pusilla*).

Further to the above, the Corben's Long-eared Bat (*Nyctophilus corbeni*) and the Large-eared Pied Bat (*Chalinolobus dwyeri*) have been potentially recorded, although these species cannot be identified to species level based on call data alone (Appendix F).

ELA (2018) also undertook targeted surveys for threatened aquatic fauna within the Namoi River. The Murray Cod (*Maccullochella peelii*) (listed as vulnerable under the EPBC Act) and the Eel-tailed Catfish (*Tandanus tandanus*) (an endangered population under the FM Act) were recorded in the Namoi River during the recent surveys (Appendix N).

Threatened Species - Species Credit Species under the NSW Offset Policy

Two species credit species (as defined by the FBA [OEH, 2014b]) have been recorded inside the BAR Footprint during previous surveys, namely, the Koala and Squirrel Glider. A third species credit species is included in the species credit calculation for the BAR Footprint, namely, the Regent Honeyeater (*Anthochaera phrygia*) as it was nominated in the SEARs for the Project.

Threatened Species That Require Further Consideration under the NSW Offset Policy

The OEH's comments in the SEARs for the EIS requested further consideration of the impacts on the following species:

- Tylophora linearis;
- Bluegrass (*Dichanthium setosum*);
- Finger Panic Grass (*Digitaria porrecta*);
- Belson's Panic (*Homopholis belsonii*);
- Native Milkwort (*Polygala linariifolia*);

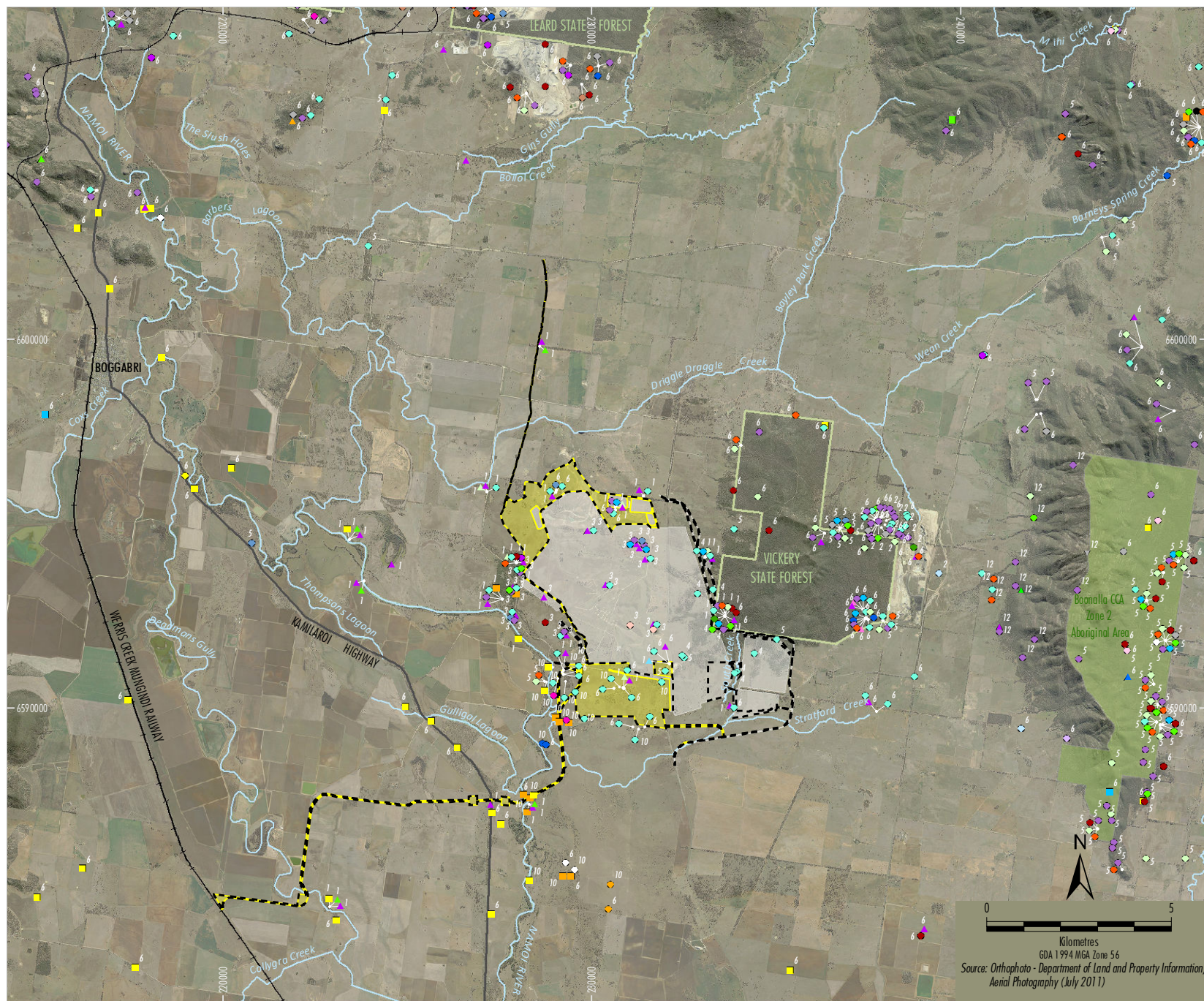
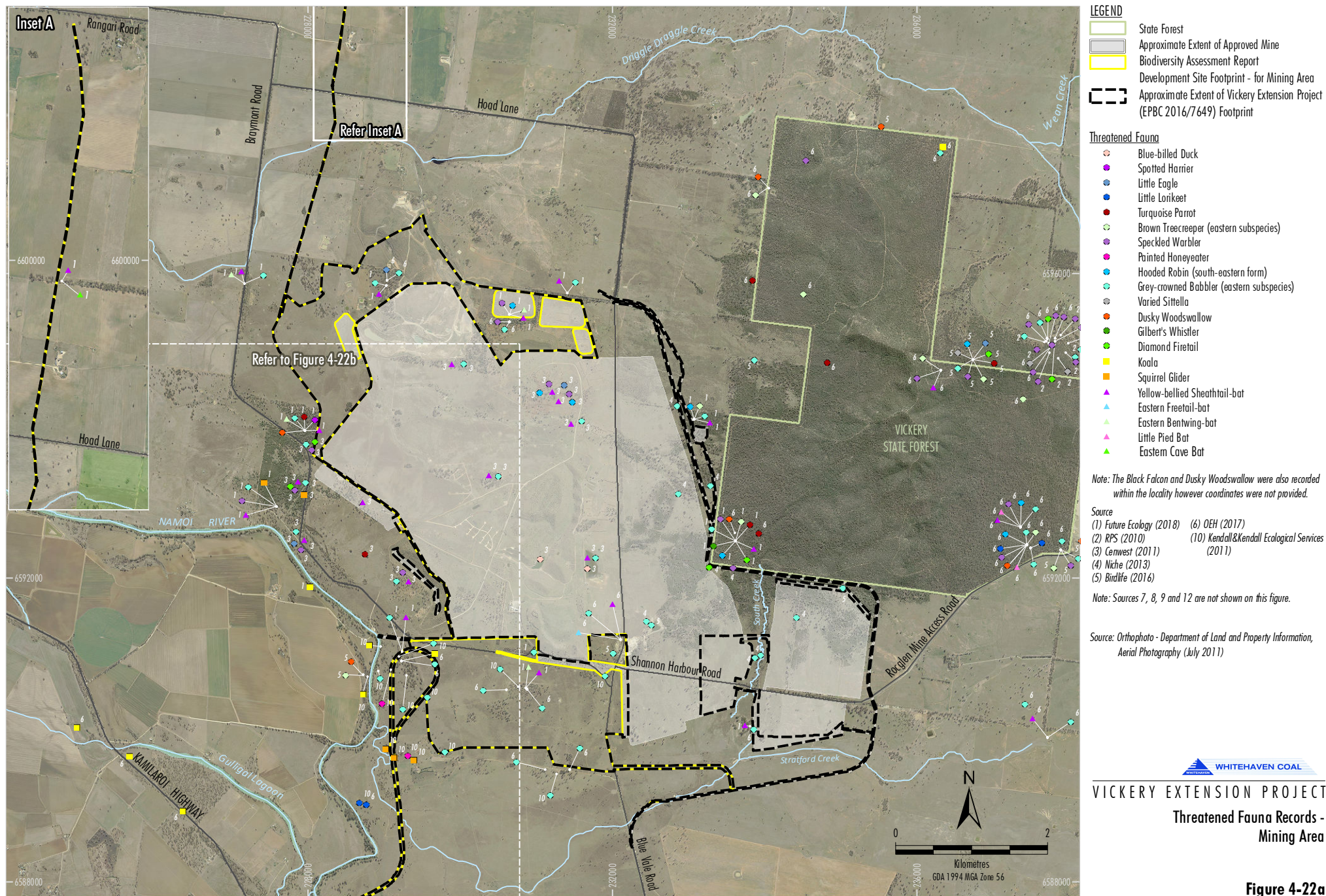
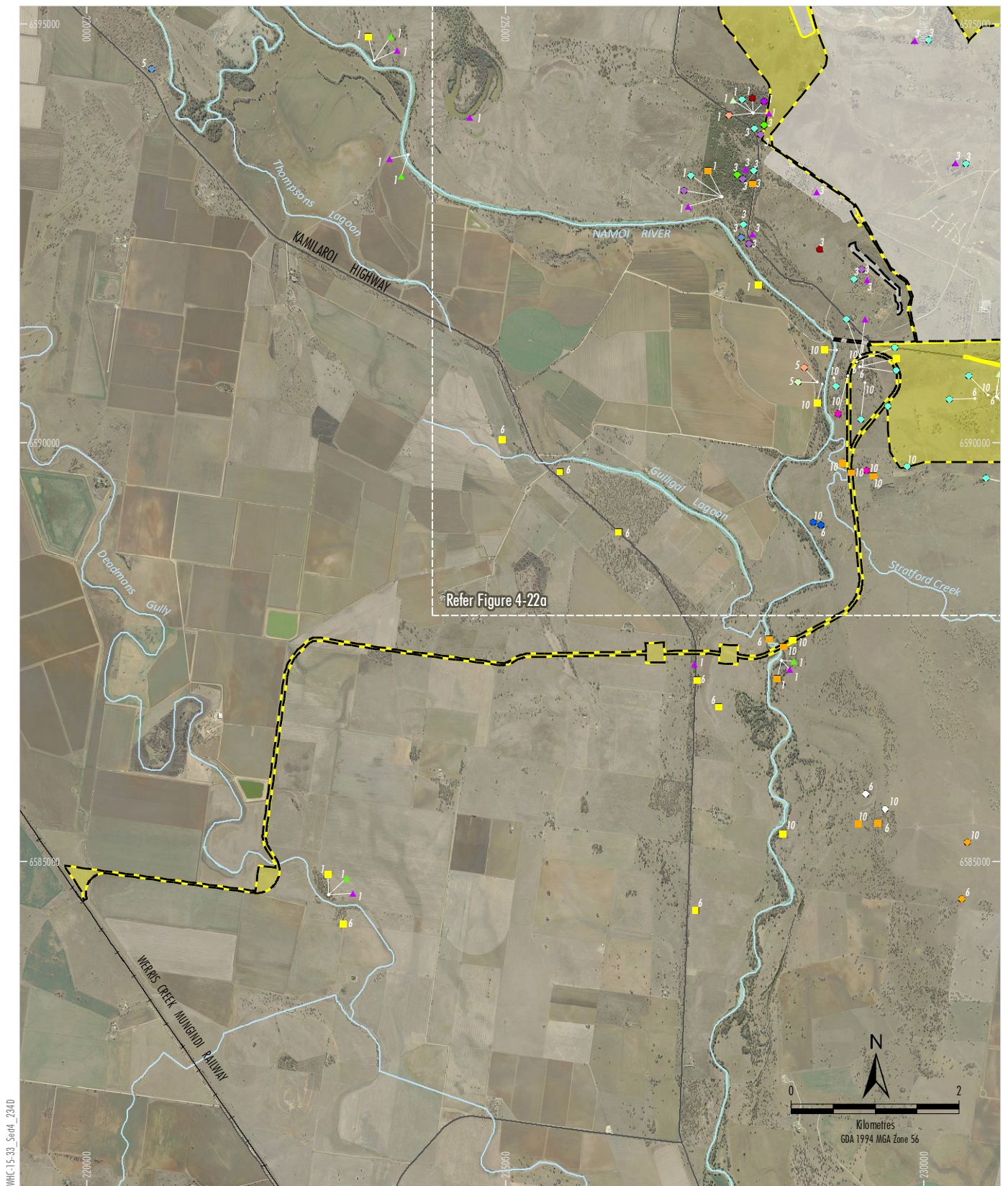


Figure 4-21





WMC-15-33_Sadd_234D

LEGEND

- Approximate Extent of Approved Mine
- Biodiversity Assessment Report Development Site Footprint
- Approximate Extent of Vickers Extension Project (EPBC 2016/7649) Footprint

Threatened Fauna

- | | |
|---|---|
| ● Black Falcon | ● Brown Treecreeper (eastern subspecies) |
| ● Square-tailed Kite | ● Speckled Warbler |
| ● Spotted Harrier | ● Painted Honeyeater |
| ● Little Eagle | ● Grey-crowned Babbler (eastern subspecies) |
| ● Little Lorikeet | ● Varied Sittella |
| ● Turquoise Parrot | ● Dusky Woodswallow |
| ○ Barking Owl | ● Diamond Firetail |
| | ■ Koala |
| | ■ Squirrel Glider |
| | ▲ Yellow-bellied Sheath-tail-bat |
| | ▲ Eastern Bentwing-bat |
| | ▲ Corben's Long-eared Bat |
| | ▲ Large-eared Pied Bat |
| | ▲ Eastern Cave Bat |

Source
 (1) Future Ecology (2018)
 (5) BirdLife (2016)
 (6) OEH (2017)
 (7) Parsons Brinckerhoff (2010)
 Note: Sources 2 to 4 are not shown on this figure.

Source: Orthophoto - Department of Land and Property Information, Aerial Photography (July 2011)



VICKERY EXTENSION PROJECT

Threatened Fauna Records - Project Rail Spur

Note: The Masked Owl, Little Lorikeet, Brown Treecreeper, Diamond Firetail and Yellow-bellied Sheath-tail-bat were also recorded within the locality however coordinates were not provided.

Figure 4-22b

- Scant Pomaderris (*Pomaderris queenslandica*);
- Austral Toadflax (*Thesium australe*);
- Ooline (*Cadellia pentastylis*);
- Black-necked Stork (*Ephippiorhynchus asiaticus*);
- Brush-tailed Rock-wallaby (*Petrogale penicillata*);
- Large-eared Pied Bat (*Chalinolobus dwyeri*); and
- Eastern Cave Bat (*Vespadelus troughtoni*).

None of the species listed above have been confirmed within the BAR Footprint and none of them are species credit species which are considered likely to use habitat within the BAR Footprint (Appendix F).

It is possible that potential foraging habitat for the Corben's Long-eared Bat and the Large-eared Pied Bat occurs in the BAR Footprint and wider landscape, however, no potential breeding habitat for these cave-dwelling bats occurs in the BAR Footprint or surrounds. The Large-eared Pied Bat and Corben's Long-eared Bat are considered further in Appendix F.

Vegetation Communities That Require Further Consideration under the NSW Offset Policy

The SEARs contained five threatened ecological communities for further consideration (Attachment 1), however none of these communities were recorded in the BAR Footprint and do not require further consideration (Appendix F).

Landscape Features That Require Further Consideration under the NSW Offset Policy

The Project rail spur would disturb riparian corridors associated with 4th order streams or higher, namely the Namoi River, Driggle Draggie Creek, Deadmans Gully, Stratford Creek and an unnamed ephemeral drainage line (referred to as the north-west drainage line) (Figures 2-3 and 4-11).

In accordance with the FBA (OEH, 2014b), this disturbance requires further consideration. The potential impacts from the Project on these watercourses are considered further in Appendix F.

Introduced Flora

The occurrence of weeds within the BAR Footprint and surrounds is generally high, with a total of 80 introduced species identified (Attachment C of Appendix F).

Three of these species are listed as priority weeds under the NSW *Biosecurity Act, 2015* for the North West Region, namely, African Boxthorn, Velvet Mesquite and Tiger Pear (Attachment C of Appendix F).

Introduced Fauna

Of the 201 fauna species recorded during surveys, nine species were introduced, namely the Common Myna, Common Starling, Feral Pig, Cat, Cow, Brown Hare, Red Fox, House Mouse and European Rabbit (Attachment D of Appendix F).

Matters of National Environmental Significance

The Vickery Coal Project (EPBC 2012/6263) was previously referred under the EPBC Act in January 2012 and was determined to be not a controlled action if implemented in a particular manner (EPBC 2012/6263).

The referred Action for the Project (EPBC 2016/7649) does not include the components and operations of the Vickery Coal Project (EPBC 2012/6263). Hence, the Commonwealth Assessment Footprint is the additional surface disturbance area outside of the Vickery Coal Project (EPBC 2012/6263). The Commonwealth Assessment Footprint is approximately 208.6 ha larger than the BAR Footprint.

The Commonwealth Assessment Footprint is referred to in this section when discussing MNES.

No threatened ecological communities or flora species listed under the EPBC Act have been recorded in the Commonwealth Assessment Footprint. Two threatened fauna species listed under the EPBC Act have been recorded in the Commonwealth Assessment Footprint, namely the Koala and Painted Honeyeater (Figure 4-21).

The following bat species have been potentially recorded within the Commonwealth Assessment Footprint (Appendix F):

- Corben's Long-eared Bat (this species cannot be identified to species level based on call data alone); and
- Large-eared Pied Bat (identified to genus level only, calls could not be distinguished from other potentially occurring bat species).

Threatened fauna listed under the EPBC Act with potential habitat resources in the Commonwealth Assessment Footprint are:

- Swift Parrot;
- Regent Honeyeater;
- Painted Honeyeater;
- Koala;
- Corben's Long-eared Bat; and
- Large-eared Pied Bat.

In addition, the Murray Cod was recorded in the Namoi River (Appendix N).

4.11.2 Potential Impacts

This section describes the potential impacts associated with the Project. A description of the potential impacts from the Approved Mine is provided directly below, followed by a description of the potential impacts associated with the BAR Footprint.

Approved Mine

The Approved Mine has a disturbance footprint of approximately 2,242 ha. This area includes 464 ha of scattered remnants of native woodland, semi-cleared woodland and White Cypress re-growth, and 1,284 ha of grassland areas with occasional re-growth trees. The remainder of the area consists of previously disturbed rehabilitation areas and other non-vegetated areas such as farm dams, roads, tracks and existing infrastructure.

Approximately 6 ha of Box-Gum Woodland EEC/CEEC is approved to be cleared within the Approved Mine mining area and approved private haul road and Kamilaroi Highway overpass.

In accordance with the referral decision for the Vickery Coal Project (EPBC 2012/6263), the Winged Peppercreess located within the Approved Mine extent would be translocated to the fenced protection area to the north of the Project mining area (Section 4.11.3).

The potential impacts on biodiversity associated with the Approved Mine were approved by the Minister, subject to the conditions of Development Consent (SSD-5000). The disturbance footprint for the Approved Mine would also be disturbed for the Project⁴.

Native Vegetation and Threatened Ecological Communities

The Project would require clearance of approximately 579.8 ha of native vegetation in the BAR Footprint. (Table 4-24; Figures 4-20a and 4-20b), comprising 77.8 ha of native woodland/forest and 502 ha of secondary/derived native grassland.

A number of measures to avoid and minimise impacts on biodiversity were proposed for implementation at the Approved Mine (Section 4.11.3). These would be continued for the Project (e.g. vegetation clearance protocols and weed management).

Potential indirect impacts from the Project on vegetation (and other terrestrial biodiversity) have been assessed in Appendix F. It is concluded that there would be no significant indirect impacts on the surrounding biodiversity as a result of the Project.

The former mining and agricultural (grazing) land uses of the Project locality would result in the Project having relatively minor impacts to biodiversity.

The FBA (OEH, 2014b) requires the use of an online programme (the OEH Credit Calculator) to assess biodiversity impacts and determine the biodiversity offset requirements for those impacts.

The result of running the OEH Credit Calculator is the Project requires a Biodiversity Offset Strategy that accounts for a total of 16,401 ecosystem credits (Table 4-24).

Aquatic Ecology

The construction of the Project rail spur would require the crossing of the Namoi River and the ephemeral Deadmans Gully and Stratford Creek, and would require minor disturbance of stream banks.

Construction of the Project rail spur would not include any dredging or reclamation works within the Namoi River.

⁴ With the exception of an approved soil stockpile to the west of the Western Emplacement that would not be disturbed for the Project.

If detailed design indicates that a bridge is not able to span the full width of the Namoi River, a piled foundation may need to be placed in the river bed or bank. If this is required, the piled foundation would be driven into the ground using a piling rig during a period of low/no flow within the river.

Any construction works associated with the Namoi River would be temporary and the piles would not restrict flow or result in the restriction of fish passage during or after construction. In addition, sediment controls would be used on the river bank to minimise sediment generation and bank disturbance.

With the implementation of these measures, it is not expected that the Namoi River crossing would significantly impact the aquatic ecology values of the Namoi River (Appendix N).

The design and construction of the Project rail spur would be undertaken in accordance with DPI Fisheries (2013) *Policy and Guidelines for Fish Habitat Conservation and Management (Update 2013)* through the use of box culverts and/or an elevated viaduct structure to cross Deadmans Gully and Thompsons Lagoon.

Consistent with the management measures for the Approved Mine, the Namoi River pump station would be designed consistent with DPI Fisheries (2013) *Policy and Guidelines for Fish Habitat Conservation and Management (Update 2013)*.

Advisian (2018) concludes the Project would result in negligible changes in water quality and flows in the Namoi River.

Potential indirect impacts to aquatic ecology associated with adverse changes in water quality and flow would therefore not result in any significant impact to aquatic ecology (Appendix N).

The Project would not have a significant impact on any threatened aquatic flora species listed under the FM Act, BC Act or EPBC Act (Appendix N).

Threatened Species - Species Credit Species under the NSW Offset Policy

The Project requires a Biodiversity Offset Strategy that accounts for species credits for the Regent Honeyeater, Squirrel Glider and Koala (Table 4-25).

Table 4-25
Project Species Credit Requirements

Species	Clearance Area within BAR Footprint	Species Credit Requirement
Regent Honeyeater (<i>Anthochaera phrygia</i>)	48.1 ha of potential habitat	3,703
Squirrel Glider (<i>Petaurus norfolcensis</i>)	74.7 ha of potential habitat	1,643
Koala (<i>Phascolarctos cinereus</i>)	50.3 ha of potential habitat	1,308

Source: Appendix F.

Landscape Features That Require Further Consideration under the NSW Offset Policy

Parts of the riparian buffers associated with the Namoi River, Driggle Draggie Creek, Deadmans Gully, Stratford Creek and the north-west drainage line would be disturbed by the Project (including the Project rail spur and groundwater borefield and pipeline).

The Project rail spur corridor is approximately 40 m wide at crossings of the Namoi River and other streams. Disturbance to the 50 m buffer (either side of the Namoi River and Driggle Draggie Creek) and 40 m buffer (either side of Deadmans Gully and Stratford Creek) would result in approximately 0.2 ha of disturbance at the Namoi River and Driggle Draggie Creek and 0.16 ha of disturbance at the Deadmans Gully and Stratford Creek crossings.

The assessment footprint for the proposed groundwater borefield and pipeline is conservatively assumed to be approximately 10 m wide at the crossing of Driggle Draggie Creek. Disturbance to the 50 m buffer (either side of the watercourse) would result in approximately 0.05 ha of disturbance at the crossing.

Given the above, it is concluded that the Project would not substantially reduce the width of vegetation in the riparian buffer bordering these 4th order and higher streams (Appendix F). As such, it would be appropriate for these impacts to occur without modifications to the Project or additional offsets (i.e. beyond the ecosystem credits and species credit requirements provided above which consider this minor disturbance).

Threatened Species That Require Further Consideration under the NSW Offset Policy

Further consideration is given to the impacts on Swift Parrot, Regent Honeyeater, Koala, Corben's Long-eared Bat and Large-eared Bat in Appendix F.

The Project would not cause the extinction of these species from an IBRA subregion, nor would it significantly reduce the viability of these species.

Threatened Species - Assessment of Significance under Section 5A of the EP&A Act

Assessments of Significance have been prepared for the Project in accordance with section 5A of the EP&A Act and the *Threatened Species Assessment Guidelines - the Assessment of Significance* (Commonwealth Department of Environment and Climate Change [DECC], 2007) on the threatened species and communities known or predicted to occur in the BAR Footprint (Attachment A of Appendix F and Appendix B of Appendix N).

It is concluded that the Project is not likely to have a significant impact on any threatened species and communities listed under the BC Act, such that a local population would be lost.

Koala Habitat Assessment under State Environmental Planning Policy No 44 – Koala Habitat Protection

Future Ecology (2018) has concluded that River Red Gum Riparian Tall Woodland along the Namoi River in the BAR Footprint (approximately 1 ha) is considered likely to be core habitat for the Koala under the definition of SEPP 44.

Measures are proposed to manage the Project impact to the core koala habitat along the Namoi River (Appendix F). Whitehaven will prepare a Koala Plan of Management for the Project that describes these management measures.

Clause 9 of SEPP 44 (relating to the requirement to prepare a Koala Plan of Management for core koala habitat) does not apply to development applications made under Part 4 of the EP&A Act, which are determined by a consent authority other than a local council and, more specifically, that clause 9 of SEPP 44 does not apply to State Significant Developments.

Vickery State Forest

The Project would not involve any clearance within the Vickery State Forest. The BAR Footprint is approximately 1.5 km away from the Vickery State Forest at its closest point.

The Project would avoid direct impacts on the Vickery State Forest and any potential indirect impacts would be minor and temporary in nature (Appendix F).

In the long-term, the Project is likely to improve the connectivity of the Vickery State Forest through the rehabilitation of the Project mine landforms to provide an almost continuous linkage to the Namoi River (Section 5).

Matters of National Environmental Significance

An analysis of the nature and extent of the likely impacts of the Project on all threatened species and communities listed under the EPBC Act that may be impacted is provided in Attachment B of Appendix F and Appendix B of Appendix N in accordance with the *Significant Impact Guidelines 1.1 - Matters of National Environmental Significance* (DotE, 2013).

The analysis considers threatened species and communities listed under the EPBC Act that have been recorded in the Commonwealth Assessment Footprint or surrounds, as well as those listed in the DotE (now the DEE) comments in the SEARs for the EIS.

The impacts on MNES would be localised and negligible on a regional, State and National scale. The Project would not have a significant negative impact on the conservation status, condition or trend of any MNES at a local or regional scale (Appendix F).

Cumulative Impacts

The Approved Mine is located in a widely cleared landscape. It was approved under the EP&A Act in September 2014. The Approved Mine will clear approximately 1,748 ha of native vegetation (of which approximately 464 ha is woodland/forest and 1,284 ha is derived grassland) and has an approved Biodiversity Offset Strategy of approximately 3,423 ha under Development Consent (SSD-5000) (comprising 2,063 ha within offset areas and 1,360 ha of mine site rehabilitation within the Approved Mine footprint).

Operating mines in the vicinity of the Project include the Rocglen, Tarrawonga, Boggabri and Maules Creek Coal Mines (Figure 1-2). In addition to potential cumulative impacts, these mining operations also have potential cumulative benefits in the form of offset areas (Appendix F).

The change in potential cumulative impacts on threatened species and communities arising from the Project is considered to be minimal because of the localised nature of the Project compared to the wider distribution of the species (their habitats) and communities (Appendix F).

The Project would result in the loss of approximately 579.8 ha of native vegetation (in addition to the disturbance of 1,748 ha of native vegetation for the Approved Mine), and as such, the Project includes the progressive re-establishment of native woodland/forest on mine rehabilitation (Section 5) and an additional Biodiversity Offset Strategy to compensate for the loss (Section 4.11.4) (in addition to the Biodiversity Offset Strategy for the Approved Mine).

4.11.3 Mitigation Measures and Management

Existing Mitigation Measures and Management

A number of measures were proposed to be implemented at the Approved Mine to avoid and minimise impacts on biodiversity.

These existing measures are summarised in Table 4-26, based on the Approved Mine EIS (Whitehaven, 2013) and correspondence between Whitehaven and the NSW Department of Planning and Infrastructure (DP&I) (now the DP&E) (i.e. a letter dated 3 December 2013). These existing measures would be continued for the Project.

Additional Avoidance

Although the location of the Project is determined by the presence of coal seams, avoidance of potential biodiversity impacts has been considered in the Project design where possible based on the outcomes of baseline survey work. Avoidance measures for the Project (including the Approved Mine) include:

- Removal of the Blue Vale Open Cut from the Project mine plan, resulting in a reduction in disturbance of approximately 200 ha.
- Optimising the placement of waste rock to minimise the footprint of the waste rock emplacement, avoiding any additional disturbance between the Western Emplacement for the Approved Mine and the Namoi River.

- Design of the Project to avoid the Winged Peppercrest Protection Area located adjacent to the Canyon Coal Mine rehabilitation area.
- Design of the Blue Vale road realignment to avoid Weeping Myall Woodland EEC (unless additional offset is provided).
- Situating the Project rail spur lay down areas on previously cleared land to avoid disturbance to native vegetation.
- Avoiding the development of an approved soil stockpile to the west of the Western Emplacement to avoid disturbance of a patch of native forest.
- Reducing the number of final voids (compared to the Approved Mine), with the area that would otherwise be the northern final void for the Approved Mine now to be rehabilitated to woodland/forest.

Additional Mitigation Measures and Management

Additional impact mitigation measures associated with the Project (in addition to those that will be implemented at the Approved Mine [Table 4-26]) would include the following:

- The Project rail spur has been sited such that impacts on mature vegetation would be minimal (i.e. it would cross the river at a location where the coverage of large trees is sparse).
- The Project rail spur crossing of the Namoi River would be constructed within a 40 m construction corridor length.
- Sediment controls, including up-catchment diversions and silt fences would be used to prevent sediment being carried into the Namoi River during construction.
- Following construction of the Project rail spur crossing, species characteristic of the River Red Gum Riparian Tall Woodland (NA 193) would be planted in the construction corridor along the river, including River Red Gum (*Eucalyptus camaldulensis*).
- Weeds would be managed at the Project rail spur crossing of the Namoi River during construction.
- Increasing the area of woodland/forest in the rehabilitated final landform (when compared to the Approved Mine).

Table 4-26
Existing Impact Avoidance and Mitigation Measures

Measure	Commitment/Objective	Source
General		
Minimising Impacts on Fauna During Vegetation Clearance, including Pre-clearance Surveys	Measures that will be used to minimise potential impacts on fauna during vegetation clearance include: - clearing of hollow bearing trees will, where practicable, be restricted to late summer and autumn; - areas requiring clearing will be delineated and will be restricted to the minimum area necessary to undertake the approved activities; and - suitably trained or qualified person(s) will be present during the felling of identified hollow bearing trees to provide assistance with the identification, and if necessary, rescue and care of any injured fauna.	Whitehaven (2013)
Pre-clearance Surveys for Finger Panic Grass (<i>Digitaria porrecta</i>)	Pre-clearance surveys will be undertaken for the Finger Panic Grass in suitable potential habitat between the months of December and May. The surveys will be undertaken by an appropriately qualified person. If Finger Panic Grass is identified during the pre-clearance surveys, the following management measures will be evaluated and applied, where practicable: - evaluation of whether the occurrence can be avoided (e.g. modifying a stockpile); - further survey work to evaluate the complete extent of the population; - collection and propagation of seed/vegetative material for use in revegetation and rehabilitation; and/or - conservation of Finger Panic Grass in an offset area or funds towards conservation of Finger Panic Grass in NSW.	
Maximising Salvage of Resources for Re-use	Habitat features such as tree hollows, logs and stags will be salvaged from the disturbance areas where possible. Tree hollows and logs will be selectively chosen for placement in areas where habitat enhancement is required. Cleared vegetation from within areas of disturbance will be re-used in the mine rehabilitation program.	
Collection and Propagation of Seed	Seed collection and propagation will be undertaken for use in rehabilitation activities.	Niche (2013)
Translocation of Winged Peppergrass (<i>Lepidium monoplacoides</i>)	Translocation of approximately 46 Winged Peppergrass plants from within the Approved Mine footprint to the fenced protection area ¹ to the west of the former Canyon Coal Mine will be undertaken. This will include: - collection of seed from Winged Peppergrass plants within the Approved Mine footprint, and subsequent planting of these seeds within the fenced protection area¹ to the west of the Canyon Coal Mine; and - translocation of individual Winged Peppergrass plants by hand from within the Approved Mine footprint, to within the fenced protection area¹ to the west of the Canyon Coal Mine. This will be undertaken using appropriate techniques as described in Guidelines for the translocation of threatened plants in Australia (Vallee <i>et al.</i>, 2004).	EPBC 2012/6263
Erosion Management	Staged clearing, progressive rehabilitation and management of tracks and roads (including the use of cross-banks, drains, culverts and sedimentation basins) will be implemented, in order to minimise sediment-laden scouring, runoff and subsequent deposition.	Niche (2013)
Bushfire Risk Management	Bushfire management measures will include clearing restrictions, controlled grazing where practicable, restricted vehicle movements, fire breaks, the use of diesel vehicles, prohibition of smoking in fire prone areas and rapid response to any outbreak of fire.	
Blue Vale Road Design	Whitehaven will design the Blue Vale Road diversion to avoid impacts on the Weeping Myall Woodland EEC, or offset the impact.	Development Consent (SSD-5000)

Table 4-26 (Continued)
Existing Impact Avoidance and Mitigation Measures

Measure	Commitment/Objective	Source
Approved Private Haul Road and Kamilaroi Highway Overpass	The approved private haul road and Kamilaroi Highway overpass would be constructed to minimise the number of mature trees that would be felled.	Whitehaven (2013)
Local Biodiversity Enhancement Measures² (Figure 4-23)		
Winged Peppercress (<i>Lepidium monoplocoides</i>) Protection Area	The Winged Peppercress population (of 418 plants) to the west of the former Canyon Coal Mine will be managed in accordance with the EPBC Act Notification of Referral Decision (EPBC 2012/6263). The management will include fencing and signposting the patch with a 20 m buffer to exclude stock and accidental disturbance (Figure 4-23). The Winged Peppercress patch will also be monitored and maintained in accordance with the particular manner decision.	EPBC 2012/6263
Driggle Draggie Creek Management Area	Approximately 1.2 km of Driggle Draggie Creek will be fenced to exclude grazing livestock, thereby promoting regeneration of woodland/forest during the life of the Approved Mine (Figure 4-23).	Whitehaven letter to DP&I dated 3 December 2013
Controlled Grazing of Native Grasslands	Grazing of native grasslands will be undertaken throughout the Local Biodiversity Enhancement Measures (LBEM) Area (Figure 4-23) with the aim of maintaining groundcover in grazing paddocks.	
South Creek Management Area	Approximately 5.6 ha of native vegetation along South Creek (between the open cut and the Secondary Infrastructure Area) would be fenced to exclude grazing livestock during the life of the Approved Mine (Figure 4-23).	
Scattered Trees	A total of 50 trees per annum for the life of the mine (25 years) will be planted (from hiko) throughout the LBEM Area (Figure 4-23) to provide habitat for threatened woodland birds (such as the Grey-crowned Babbler [<i>Pomatostomus temporalis temporalis</i>], Hooded Robin [<i>Melanodryas cucullata malvillensis</i>] and Speckled Warbler [<i>Chthonicola sagittata</i>]). Native flora hiko plantings will include Poplar Box (<i>Eucalyptus populnea</i>), White Box (<i>Eucalyptus albens</i>) and Silver-leaved Iron Bark (<i>Eucalyptus melanophloia</i>). The planted trees will be individually fenced or fenced in small clumps.	
Corridor Enhancement and Plantings	Approximately 11 km of native vegetation woodland corridors (minimum of 12 m wide) will be established beside the Blue Vale Road realignment primarily for a visual screen (Figure 4-23). The corridor will comprise existing vegetation as well as plantings of native plants that are compatible with the surrounding vegetation, in a composition similar to surrounding vegetation communities.	
Weed Management	Noxious and environmental weeds within the LBEM Area will be monitored and controlled.	
Feral Pest Management	Feral pests within the LBEM Area (Figure 4-23) will be monitored and controlled (in consideration of reducing the risk of potential secondary poisoning).	
Mine Rehabilitation		
Establishing native vegetation and fauna habitat	Establishing native vegetation and fauna habitat on the mine rehabilitation through seeding/planting and introduction of naturally scarce fauna habitat.	Whitehaven (2013)
Reuse of Salvaged Resources	Reuse of vegetative material and soil resources.	

Source: Appendix F.

¹ All fenced areas will be signposted and new fences will be made from barbless (plain) wiring.

² **Local Biodiversity Enhancement Measures**

As part of the Approved Mine, Whitehaven developed LBEMs, which are designed to increase the amount and diversity of native fauna habitat during the life of the mine in the Whitehaven-owned properties adjoining the Approved Mine, without significantly impacting the agricultural productivity of the properties. The location of LBEM Areas shown on Figure 4-23 are indicative only. Final LBEM Areas would be further defined and presented in the Biodiversity Management Plan.

The LBEMs are not biodiversity offsets, and as a result, are not subject to conservation in perpetuity (i.e. their purpose is to mitigate short to medium term impacts, and in the longer term, their role will be in essence replaced by the on-site rehabilitation). Whitehaven may investigate undertaking further biodiversity/conservation works on these lands. Any additional commitments may be used as a biodiversity offset.

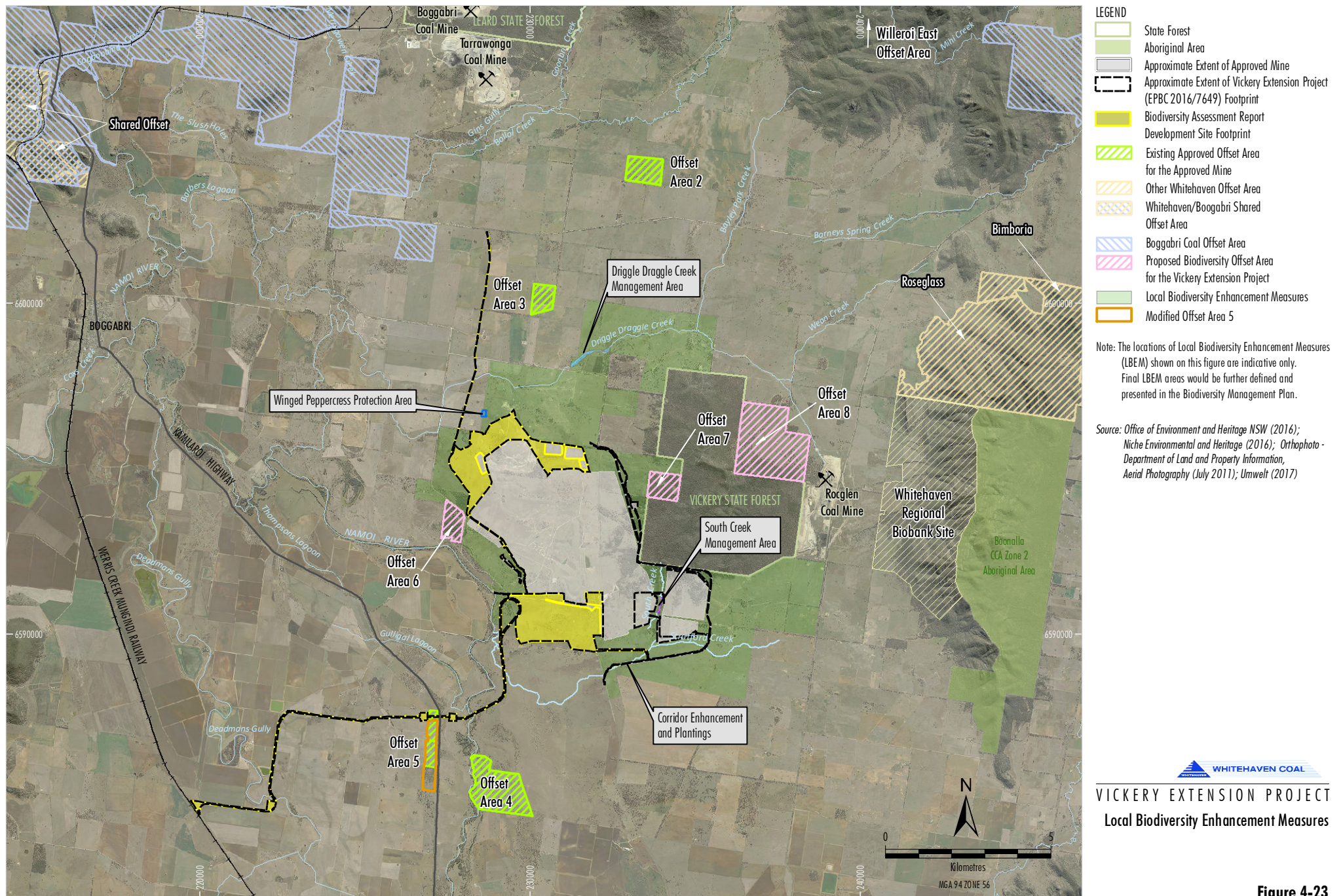


Figure 4-23

Other Measures

Other measures Whitehaven would implement, which are relevant to reducing potential indirect impacts on biodiversity, include:

- A noise monitoring and management system to maintain compliance with operational noise limits (Section 4.7.3).
- An air quality monitoring and management system to maintain compliance with air quality limits (Section 4.9.3).
- A blast monitoring system to maintain compliance with blasting limits (Section 4.8.3).
- Measures that would be employed to mitigate potential impacts from night-lighting, including (where practicable), the use of directional lighting techniques and implementation of light shrouds and reflectors to limit the spill of lighting (Section 4.14.3).

4.11.4 Project Biodiversity Offset Strategy

Existing Biodiversity Offset Strategy

The existing Biodiversity Offset Strategy for the Approved Mine is outlined in Table 4-27 and existing approved Offset Areas are shown on Figures 4-24a and 4-24b. The Biodiversity Offset Areas were approved by the DP&E in September 2014.

The existing Biodiversity Offset Strategy covers a total area of approximately 3,423 ha (approximately 2,063 ha of land-based offset areas on Whitehaven-owned land and 1,360 ha of mine rehabilitation to woodland/forest at the Approved Mine) (Table 4-27).

Additional Biodiversity Offset Strategy

The existing Biodiversity Offset Strategy for the Approved Mine would be augmented to account for additional residual impacts on flora and fauna from the Project.

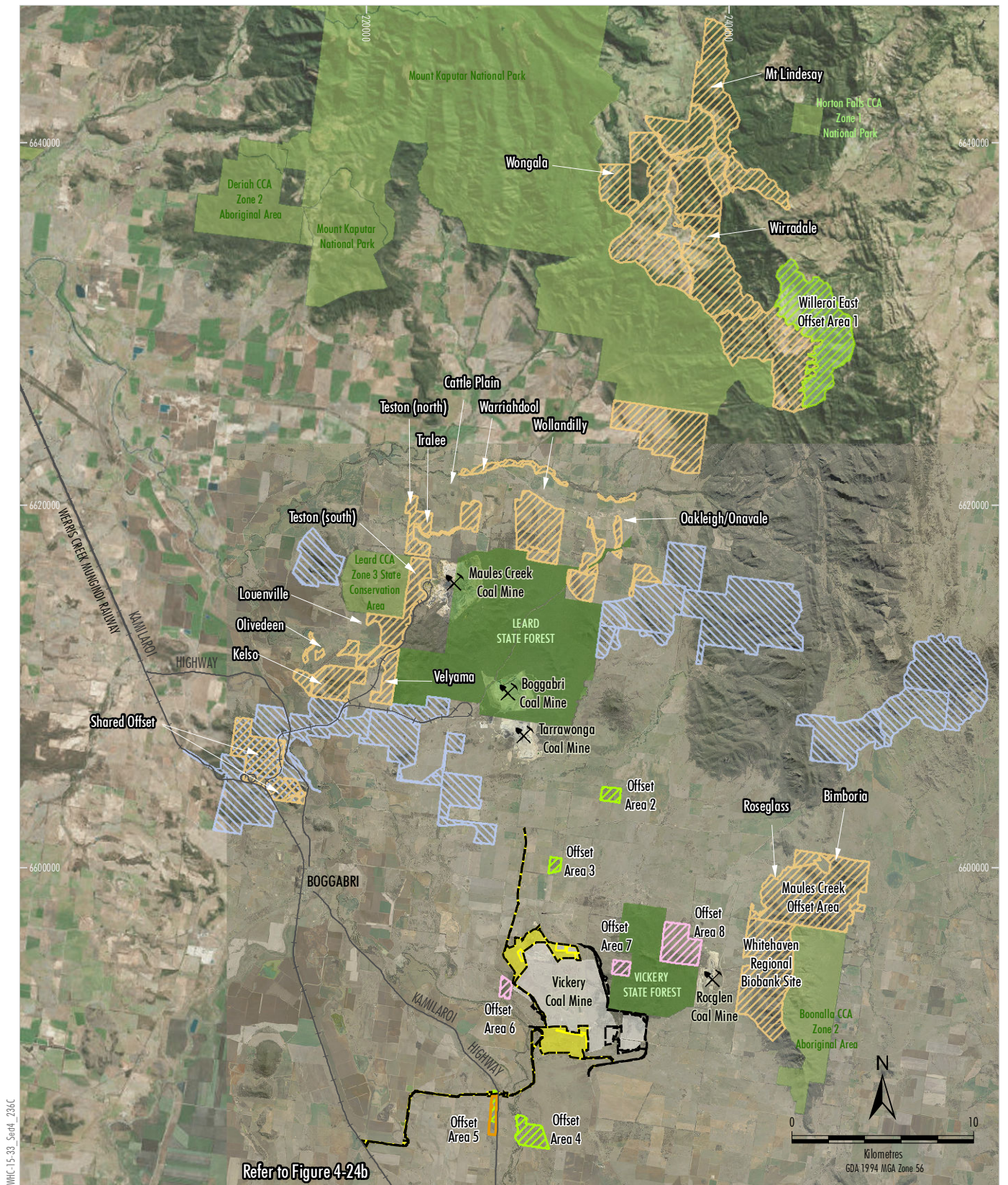
A summary of the additional Biodiversity Offset Strategy for the Project is presented in Table 4-28.

Table 4-27
Existing Biodiversity Offset Strategy

Existing Biodiversity Offset Area	Size (ha)	Location	General Description
Willeroi East (Offset Area 1)	1,671	Willeroi East is located approximately 35 km to the north-northeast of the Approved Mine within the eastern half of the former 'Willeroi' property (Figure 4-24a). Willeroi East is connected to Mount Kaputar National Park via offset areas for other projects in the region (Figure 4-24a).	Willeroi East contains approximately 1,396 ha of existing forest/woodland, 248 ha of derived native grasslands and 27 ha of eroded/scald land (which will be actively managed and rehabilitated) (Figure 4-24a). This includes approximately 156 ha of Box-Gum Woodland EEC, and 19 ha of <i>Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions</i> EEC.
Offset Areas 2, 3, 4 and 5*	391.5	Offset Areas 2 and 3 are located to the north of the Approved Mine, while Offset Areas 4 and 5 are located to the south (Figures 4-24a and 4-24b). All four areas are all located within approximately 10 km of the Approved Mine (Figures 4-23, 4-24a and 4-24b).	Offset Areas 2 to 5 contain approximately 227 ha of existing forest/woodland and approximately 164.5 ha of native and non-native grasslands (Figures 4-24a and 4-24b). This includes approximately 107 ha of Poplar Box Grassy Woodland and approximately 45 ha of Box-Gum Woodland EEC.
Mine Rehabilitation Area	1,360	The rehabilitation area is located on the post-mine landform within the Approved Mine footprint.	Approximately 1,360 ha of the Approved Mine final landforms will be revegetated to woodland/forest areas.
Total	3,422.5		

Source: Appendix F.

* Note: Offset Area 5 is proposed to be modified.



LEGEND

- State Forest
- State Conservation Area, Aboriginal Area
- Approximate Extent of Approved Mine
- Approximate Extent of Vickery Extension Project (EPBC 2016/7649) Footprint
- Biodiversity Assessment Report Development Site Footprint

- Existing Approved Offset Area for the Approved Mine
- Other Whitehaven Offset Area
- Boggabri Coal Offset Area
- Proposed Biodiversity Offset Area
- Whitehaven/Boggabri Shared Offset Area
- Modified Offset Area 5

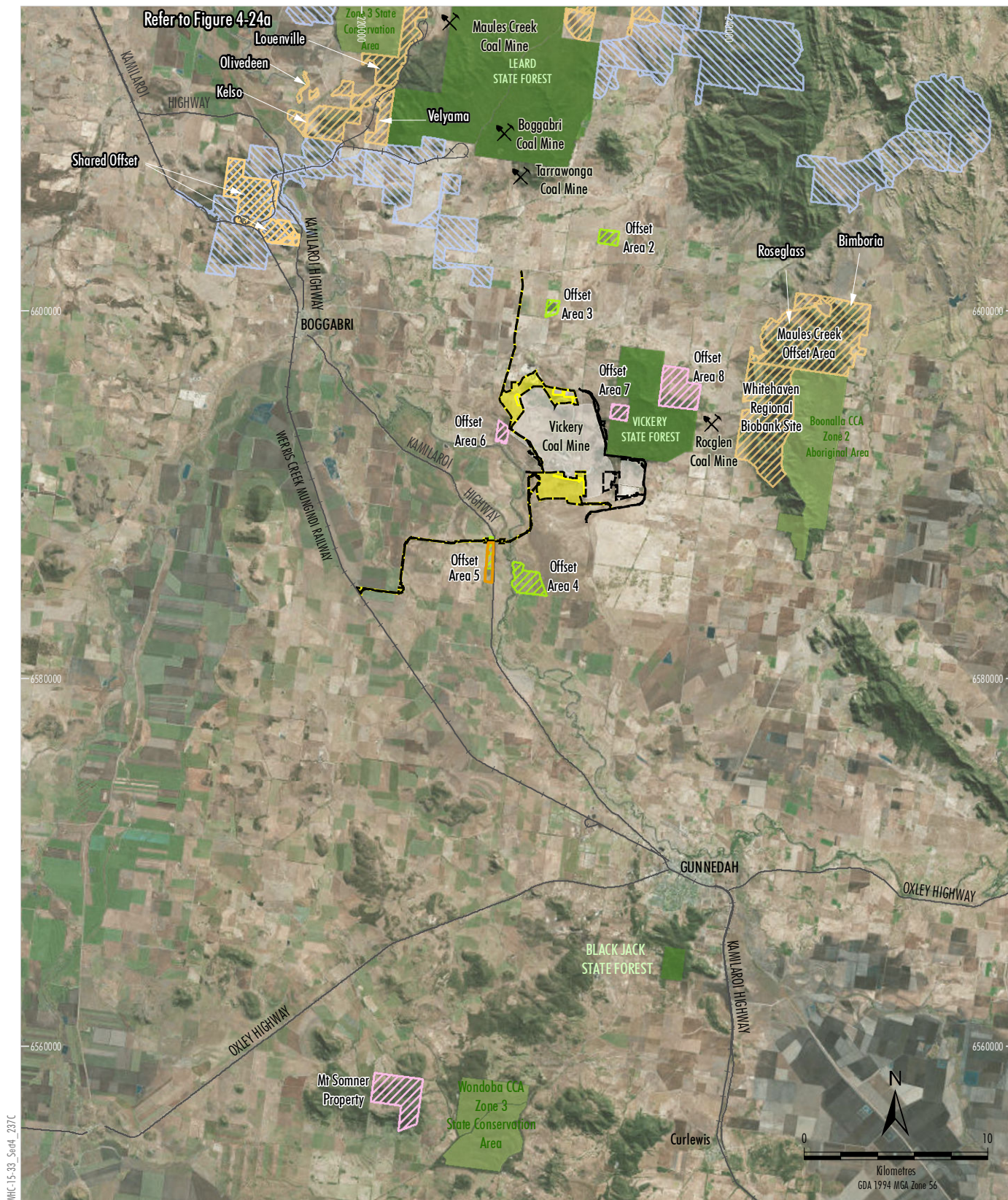
Source: Department of Land and Property Information (2015); Whitehaven Coal Limited (2015); Orthophoto: Department of Land and Property Information, Aerial Photography (Sept 2015, July 2011); Esri Mapping (2015); Umwelt (2017)



VICKERY EXTENSION PROJECT

Existing Approved and Proposed Biodiversity Offset Areas - North

Figure 4-24a



Source: Department of Land and Property Information (2015); Whitehaven Coal Limited (2015); Orthophoto: Department of Land and Property Information, Aerial Photography (Sept 2015, July 2011); Esri Mapping (2015); Umwelt (2017)

WHITEHAVEN COAL

VICKERY EXTENSION PROJECT

Existing Approved and Proposed Biodiversity Offset Areas - South

Figure 4-24b

Table 4-28
Project - Additional Biodiversity Offset Strategy

Offset Mechanism	Description
Mine Site Rehabilitation	
Ecosystem Credits from Mine Rehabilitation on the BAR Footprint	Whitehaven would establish 482 ha of woodland/forest on the post mine landforms associated with the BAR Footprint (excluding the Approved Mine) to produce 1,914 ecosystem credits.
Ecosystem Credits from Mine Rehabilitation on Additional Areas of the Approved Mine Footprint	Whitehaven would establish 523 ha of woodland/forest on the post mine landforms associated with the Approved Mine Footprint in areas previously proposed to be revegetated to pasture (i.e. establishment of woodland/forest additional to the area nominated within the approved Biodiversity Offset Strategy) to produce 2,077 ecosystem credits.
Acquiring or Retiring Credits	
Retiring Existing Credits on the Existing Whitehaven Biobank Site	Whitehaven has an established biobank site which generates 13,754 credits. Of the total 13,754 credits generated 869 credits remain which are available for use (Figures 4-24a and 4-24b). No species credits have been generated at the Whitehaven BioBank site.
BioBanking Public Registers	Credits could be satisfied by purchasing them through the OEH <i>Biodiversity Credits Register</i> , identifying them on the <i>Biobank Site Expressions of Interest Register</i> or placing the credits required on the <i>Credits Wanted Register</i> (note, Whitehaven placed the credits on the <i>Credits Wanted Register</i> in February 2017).
Establishing a Land-Based Offset Area	Whitehaven could establish additional offset areas surrounding the Project (Offset Areas 6, 7 and 8) (Figures 4-24a and 4-24b) which would generate 5,347* ecosystem credits in addition to 2,051* species credits for the Regent Honeyeater, Koala and Squirrel Glider, respectively.
Mount Somner	The Mount Somner Property is a landholding owned by Whitehaven, located approximately 30 km south-west of the BAR Footprint and 20 km south-west of Gunnedah (Figure 4-24b). Mount Somner would generate 4,032 ecosystem credits, along with 2,954* species credits for the Regent Honeyeater and Koala, respectively (Appendix F).
Other Potential Additional Offset Areas	Other potential additional offset areas could be sought from within the relevant IBRA subregions.
Contributing Money to Supplementary Measures	
Supplementary Measures	If appropriate land-based offsets are not feasible, Whitehaven could provide funds for 'supplementary measures' (e.g. a financial contribution to a monitoring program benefitting a species potentially impacted by the Project). A maximum of 10% of the Commonwealth offset requirements could be satisfied through supplementary measures.
Contributing to a Fund	
Biodiversity Offset Fund	Whitehaven could make a financial contribution the Biodiversity Conservation Fund.

Source: After Appendix F.

* A portion of which are required for the Project.

OEH describes an objective of the NSW Offset Policy is to provide greater flexibility for proponents to meet their offset requirements while ensuring that the best and most credible offsets are provided.

Credit requirements would be offset for the Project using mine site rehabilitation as well as one, or a combination, of the following (OEH, 2014a):

- acquiring or retiring credits under the biobanking scheme in the BC Act:
 - retiring existing credits on the existing Whitehaven Biobank Site;
 - purchasing existing credits on the *Biodiversity Credits Register* (OEH, 2018); and/or
 - creating new credits by establishing a land-based offset area owned by Whitehaven or another entity.
- making payments into an offset fund (i.e. the Biodiversity Conservation Fund); and/or
- providing supplementary measures as outlined in the NSW Offset Policy (OEH, 2014a).

Each of the above offsetting methods is described in Table 4-28, while Table 4-29 provides a summary of the credit requirements and how the requirements could be satisfied.

Modified Offset Area 5

Due to land access constraints, rail design requirements and the objective of minimising disruption to agricultural properties, the Project rail spur traverses the northern portion of Offset Area 5 (Figure 4-20b) (part of the existing Biodiversity Offset Strategy for the Approved Mine). Whitehaven proposes that the boundary of Offset Area 5 is revised to include further habitat to the south of the approved Offset Area 5 boundary (Figure 4-20b). The modified Offset Area 5 is 13 ha larger than the approved Offset Area 5.

Commonwealth Offset Requirements

The bilateral agreement made under section 45 of the EPBC Act between the Commonwealth of Australia and the State of NSW relating to environmental assessment (the NSW Assessment Bilateral Agreement – dated 26 February 2015), enables the Commonwealth Minister for the Environment to rely on assessment processes of the State of NSW in assessing actions referred under the EPBC Act.

The Commonwealth Assessment Footprint comprises two areas (Appendix F):

- The BAR Footprint for the Project.
- An additional portion of the Approved Mine which was not previously referred under the EPBC Act (EPBC 2012/6263).

Potential habitat clearance for the relevant EPBC-listed species (i.e. Swift Parrot, Regent Honeyeater and Koala) would be adequately offset via the following (Appendix F):

- Potential EPBC-listed species habitat disturbance within the BAR footprint would be satisfied by the Proposed Offsets for the Project as described in Table 4-29, which includes species credits for the Regent Honeyeater and Koala, and sufficient ecosystem credits to account for potential impacts to Swift Parrot habitat.
- Potential EPBC-listed species habitat disturbance outside the BAR Footprint has already been accounted for in the existing Biodiversity Offset Strategy for the Approved Mine.

4.12 ROAD TRANSPORT

A Road Transport Assessment for the Project was undertaken by GTA Consultants (2018) and is presented in Appendix I.

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

Section 4.12.1 provides a description of the existing road network and traffic volumes. Section 4.12.2 provides an assessment of the potential impacts of the Project to the road network in the vicinity of the Project. Section 4.12.3 provides relevant mitigation, management and monitoring measures for road transport.

Table 4-29
NSW Summary of Credit Requirements and Proposed Offset Methods[#]

Credit Type	Project Credit Requirements	Credits Gained from Mine Rehabilitation*	Credits Required from Proposed Offsets			Additional credits acquired, retired, converted to the fund or supplementary measures	Offset Requirement Met
			Existing Credits in the Regional Biobank Site*	Proposed Offset Areas 6, 7 and 8*	Mount Somner Property*		
NA185	3,540	-	-	-	-	3,540 (100%)	Yes
NA324	6,955	3,991 (~57%) [^]	-	333 (~5%)	-	2,631 (~38%)	Yes
NA349	1,795	-	-	533 (~30%)	1,262 (~70%)	0	Yes
NA311	4,025	-	869 (~21%)	3,156 (~79%)	-	0	Yes
NA201	46	-	-	-	-	46 (100%)	Yes
NA193	40	-	-	-	-	40 (100%)	Yes
Ecosystem Credits	16,401	3,991 (~24%)	869 (~5%)	4,022 (~25 %)	1,262 (~8 %)	6,257 (~38%)	Yes
Regent Honeyeater Species Credits	3,703 (due to clearance of 48.1 ha)	-	A	2,051 (~55%)	1,652 (~45%)	0	Yes
Squirrel Glider Species Credits	1,643 (due to clearance of 74.7 ha)	-	A	1,643 (100%)	-	0	Yes
Koala Species Credits	1,308 (due to clearance of 50.3 ha)	-	A	1,308 (100%)	-	0	Yes

Source: Appendix F.

[#] There is optionality around fulfilling the offset requirement for the Project, however Whitehaven would commence the mechanism for securing the offset requirements (regardless of the offset mechanism) within 5 years of commencement of clearing native woodland/forest (or to a timeframe specified by DP&E).

* Whitehaven-owned land.

[^] Example rehabilitation credit allocation, the vegetation type proposed to be rehabilitated would be specified in the MOP.

A This property is likely to contain potential habitat for this species. No species credits have yet been generated at the Whitehaven biobank site.

4.12.1 Existing Environment

Road Hierarchy and Existing Conditions

State Roads

The Kamilaroi Highway (Route B51) runs generally north-south, located to the west of the Project mining area (Figure 4-25) and provides a link between the Upper Hunter region and the north-west of NSW. The Kamilaroi Highway provides access to regional centres such as Gunnedah, Boggabri, Narrabri and Bourke (Appendix I).

In the vicinity of the Project, the Kamilaroi Highway has a single travel lane in each direction, with auxiliary turn lanes at some intersections, and a posted speed limit of 100 km per hour. At its intersection with Rangari Road a separate right turn lane and a left turn deceleration lane are provided on the Kamilaroi Highway to allow through traffic to pass vehicles slowing to turn into Rangari Road.

The intersections with Blue Vale Road and with the Whitehaven CHPP access road have separate deceleration and acceleration lanes to accommodate the slower moving ROM coal trucks on the Approved Road Transport Route with minimum disruption to through traffic.

Regional Roads

Rangari Road (Main Road 357) runs generally east-west, located to the north of the Project (Figure 4-25) and links between Kamilaroi Highway to the west and Manilla to the east.

Rangari Road typically has a single travel lane in each direction, and a posted speed limit of 80 km per hour. Rangari Road crosses the Namoi River about 1.6 km to the east of its intersection with the Kamilaroi Highway.

At this bridge, Rangari Road is narrowed to a single lane with a 10 km per hour speed limit, and eastbound traffic is required to give way to westbound traffic. Rangari Road is also known as 'Boggabri-Manilla Road' or 'Manilla Road' (Appendix I).

Local Roads

Hoad Lane provides a connection northwards from Blue Vale Road at the Braymont Road/Blue Vale Road intersection, then an east-west connection to Braymont Road (Figure 4-25). A private road access to the former Canyon Coal Mine (part of the Approved Road Transport Route) intersects with Hoad Lane (Figure 4-25).

South of the Approved Road Transport Route, Hoad Lane has a sealed surface, with a single travel lane in each direction, and centre road markings along most of its length. A right turn deceleration lane is provided on Hoad Lane for northbound vehicles turning right into Shannon Harbour Road, and a southbound acceleration lane is provided on Hoad Lane for vehicles turning left from Shannon Harbour Road. To the north of the Approved Road Transport Route, and to the east of Braymont Road, Hoad Lane has an unsealed surface (Appendix I).

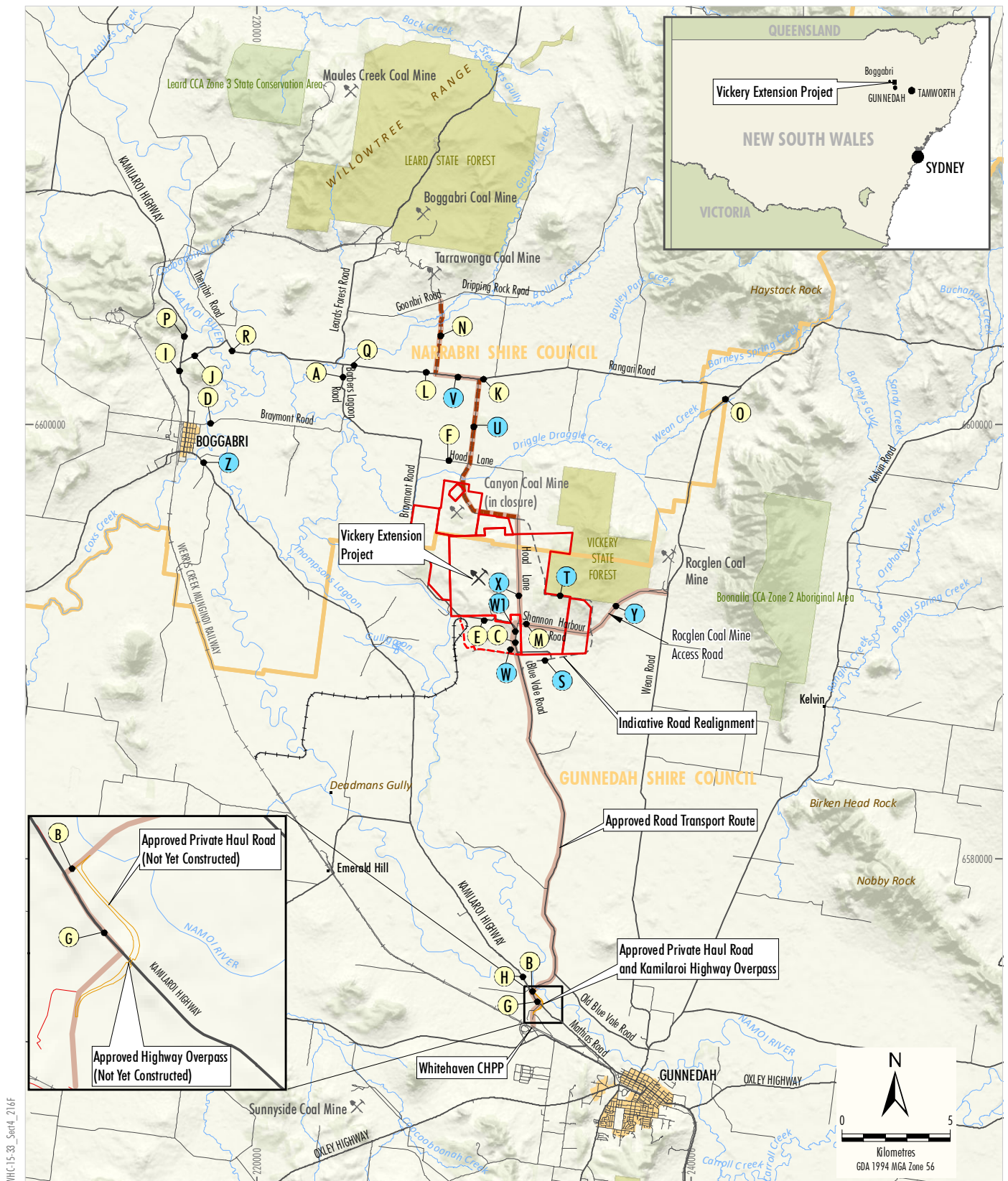
Blue Vale Road provides a north-south connection from the Kamilaroi Highway to the north-west of Gunnedah to the intersection of Hoad Lane and Braymont Road (Figure 4-25). At this intersection, Hoad Lane continues to the north, forming a staggered T-intersection with Shannon Harbour Road. Blue Vale Road has a sealed surface with a single travel lane in each direction and centre line marking along much of its length (Appendix I).

Shannon Harbour Road forms part of the Approved Road Transport Route connecting Rocglen Coal Mine Access Road and Hoad Lane (Figure 4-25). Shannon Harbour Road has a sealed surface with a single travel lane in each direction. Rocglen Coal Mine Access Road connects Shannon Harbour Road to Wean Road to the east via Riordan Road (Appendix I).

Braymont Road provides a link from the township of Boggabri east and south-east to meet with Blue Vale Road some 20 km north of Gunnedah (Figure 4-25). Braymont Road crosses the Namoi River via a bridge to the east of Boggabri. West of the Namoi River, Braymont Road has a sealed surface with a single travel lane in each direction. East of the Namoi River, it has an unsealed surface, and follows a straight east-west alignment for about 6 km, before a 90 degree (°) bend where it intersects with Barbers Lagoon Road at a three-way intersection. Braymont Road continues in a north-south direction after this intersection and runs to the west and south of the Project before joining Blue Vale Road at a T-intersection (Appendix I).

Approved Road Transport Route

The Approved Road Transport Route is an approved haul route used to transport coal from the Tarrawonga and Rocglen Coal Mines and the Approved Mine to the Whitehaven CHPP.



The Approved Road Transport Route consists of (Figure 4-25):

- the Whitehaven private haul road between the Tarrawonga Coal Mine and Rangari Road;
- a section of Rangari Road;
- the Whitehaven private haul road south of Rangari Road, which crosses Hoad Lane and passes through the former Canyon Coal Mine and past the Project to Hoad Lane;
- a section of Hoad Lane between the Whitehaven private haul road and Blue Vale Road;
- a section of Shannon Harbour Road between the Rocglen Coal Mine Access Road and Hoad Lane;
- Blue Vale Road between Hoad Lane and the Kamilaroi Highway;
- a section of the Kamilaroi Highway between Blue Vale Road and Whitehaven CHPP access road; and
- the Whitehaven CHPP access road.

Until the Project CHPP, train load-out facility and Project rail spur reach full operational capacity, transport of ROM coal from the Project by road to the Whitehaven CHPP would be conducted consistent with the Development Consent conditions for coal haulage for the Approved Mine (i.e. up to a total of 3.5 Mtpa, or up to 4.5 Mtpa ROM coal transport subject to the construction of the approved private haul road and Kamilaroi Highway overpass) (Section 2.7.1).

Existing Traffic Volumes

Available traffic volume data from RMS, the *Vickery Coal Project Transport Assessment Baseline Assessment* (Halcrow, 2012), the *Tarrawonga Coal Project Road Transport Assessment* (Halcrow, 2011) and the *Maules Creek Coal Project Traffic and Transport Impact Assessment* (Hyder Consulting, 2010) were reviewed for the Road Transport Assessment (Appendix I).

Additional traffic counts were conducted in 2015 and 2016 (Appendix I). Relevant traffic count locations are shown on Figure 4-25 and the existing weekday traffic volumes are summarised in Table 4-30.

Roadway Capacity

Austrroads (2009) defines a Level of Service as a qualitative measure describing operational conditions within a traffic stream (in terms of speed, travel time, room to manoeuvre, safety and convenience) and their perception by motorists and passengers. Level of Service A provides the best traffic conditions, with no restriction on desired travel speed or overtaking.

GTA Consultants (2018) concluded that drivers would be expected to experience good levels of service on the surrounding road network without the Project, taking into account the combined effects of the likely major developments and background growth.

Road Safety

A review of the RMS road accident data in the vicinity of the Project was undertaken by GTA Consultants (2018). A review of the crash data identified no particular accident pattern or causation factors on the Approved Road Transport Route or Rangari Road or their intersections with public roads (Appendix I). Further, only one crash was related to coal haulage activities.

School Bus Operation

School buses operate on several of the roads in the vicinity of the Project, primarily along the Kamilaroi Highway and on Blue Vale Road (Appendix I). School buses generally travel between 6.10 am and 9.00 am in the morning, and between 2.55 pm and 5.45 pm in the afternoon (Appendix I).

Road Maintenance Agreements

Whitehaven has entered into road maintenance agreements with both the Narrabri Shire Council and Gunnedah Shire Council.

The road maintenance agreement with Narrabri Shire Council covers the section of the Approved Road Transport Route within the Narrabri LGA, and requires the road and intersections to be maintained in good condition at all times at Whitehaven's cost. Maintenance requirements are determined through joint inspections carried out every four months.

The road maintenance agreement with Gunnedah Shire Council covers the maintenance of roads used by Whitehaven in association with its operations in the region.

Table 4-30
Surveyed Average Weekday Traffic Volumes

Site ¹	Road and Location	Average Weekday Traffic (vehicle trips/day)	
		Light	Heavy
A	Barbers Lagoon Road south of Rangari Road ³	45	21
B	Blue Vale Road north-east of Kamilaroi Highway ⁴	1,152	589
C	Blue Vale Road south of Shannon Harbour Road ²	196	456
D	Braymont Road east of Boggabri ²	82	16
E	Braymont Road west of Blue Vale Road ²	156	118
F	Hoad Lane west of Approved Road Transport Route ²	42	7
G	Kamilaroi Highway south-east of Blue Vale Road ⁴	2,997	1,188
H	Kamilaroi Highway north-west of Blue Vale Road ^{2, 3}	1,122	1,366
I	Kamilaroi Highway south of Rangari Road ³	2,129	666
J	Rangari Road east of Kamilaroi Highway ³	808	149
K	Rangari Road east of Approved Road Transport Route ²	62	6
L	Rangari Road west of Approved Road Transport Route ²	293	343
M	Shannon Harbour Road east of Blue Vale Road ²	83	134
N	Approved Road Transport Route south of Dripping Rock Road ²	143	325
O	Wean Road south of Rangari Road ²	33	16
P	Kamilaroi Highway north of Rangari Road ³	1,517	683
Q	Rangari Road east of Barbers Lagoon Road ³	279	106
R	Rangari Road east of Therribri Road ³	534	135

Source: After Appendix I.

¹ Refer to Figure 4-25.

² Surveyed during 2010 and 2011.

³ Surveyed during 2015.

⁴ Surveyed during 2016.

4.12.2 Potential Impacts

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

Project Traffic Generation

Traffic generated by the Project would include construction traffic, operational traffic and ROM coal haulage. Table 4-31 summarises the estimated total Project traffic generation for Project Years 1, 2 and 12.

Analysis of Project Year 1 considers construction-related road transport impacts for the Project, in addition to ROM coal transport from the Tarrawonga and Rocglen Coal Mines at the maximum approved rate of 3.5 Mtpa along the Approved Road Transport Route to the Whitehaven CHPP.

Analysis of Project Year 2 considers Project operational activities including mining of ROM coal at a rate of 1 Mtpa, with ROM coal transported from the Project to the Whitehaven CHPP along the Approved Road Transport Route (in addition to ROM coal from the Tarrawonga and Rocglen Coal Mines).

Analysis of Project Year 12 considers the maximum operational activities including mining and processing of ROM coal at the Project CHPP at a rate of 10 Mtpa, and transport of product coal from the site via the Project rail spur.

Cumulative Traffic Increases

In order to conservatively consider the potential impacts of the Project, an annual baseline background growth rate and the expected traffic generation from other mines/projects was adopted by GTA Consultants (2018) in the Road Transport Assessment (Appendix I).

Table 4-31
Average Weekday Project Traffic Distribution (vehicle trips/day)

Site ¹	Road and Location	Year 1		Year 2		Year 12	
		Project	No Project	Project	No Project	Project	No Project
B	Blue Vale Road north-east of Kamilaroi Hwy	2,205	2,179	2,055	2,175	2,261	3,059
C	Blue Vale Road south of Shannon Harbour Road	1,258	1,232	1,098	1,218	N/A	N/A
G	Kamilaroi Highway south-east of Blue Vale Road	4,223	4,165	4,059	4,179	4,443	5,241
H	Kamilaroi Highway north-west of Blue Vale Road	2,798	2,766	2,790	2,790	3,041	3,041
I	Kamilaroi Highway south of Rangari Road	3,522	2,962	2,941	2,973	3,315	3,227
J	Rangari Road east of Kamilaroi Highway	931	395	335	385	661	573
K	Rangari Road east of Approved Road Transport Route	204	204	204	204	212	212
L	Rangari Road west of Approved Road Transport Route	1,520	984	924	974	1,280	1,192
M	Shannon Harbour Road east of Blue Vale Road	234	532	249	431	232	N/A
O	Wean Road south of Rangari Road	53	77	66	72	120	96
P	Kamilaroi Highway north of Rangari Road	3,108	3,124	3,122	3,140	3,462	3,462
S	Blue Vale Road Realignment south of Shannon Harbour Road	N/A	N/A	N/A	N/A	1,219	2,017
T	Blue Vale Road Realignment north of Shannon Harbour Road	N/A	N/A	N/A	N/A	1,374	1,244
U	Approved Road Transport Route south of Rangari Road	1,386	850	786	836	1,100	1,012
V	Rangari Road on Approved Road Transport Route	1,580	1,044	980	1,030	1,387	1,335
W	Project Construction Access off Blue Vale Road Realignment	N/A	N/A	748	N/A	1,668	N/A
W1	Project Construction Access off Braymont Road	890	N/A	N/A	N/A	N/A	N/A
X	Hoad Lane north of Shannon Harbour Road	1,561	997	978	1,016	N/A	N/A
Y	Shannon Harbour Road east of Blue Vale Road Realignment	234	532	249	431	232	208
Z	Kamilaroi Highway south of Boggabri	2,846	2,766	2,790	2,790	3,041	3,041

Source: After Appendix I.

¹ Refer to Figure 4-25.

Table 4-31 presents the predicted traffic flows in Project Years 1, 2 and 12 with and without the Project.

It is expected that for all locations considered by GTA Consultants (2018) the service conditions would remain at satisfactory levels as a result of the Project, based on the estimated traffic volumes shown in Table 4-31 (Appendix I).

Proposed Road Realignments

The approved Blue Vale Road realignment would be constructed for the Project adjacent to the western and southern boundaries of the Vickery State Forest and around the secondary infrastructure areas to allow continued public access around the Project (Figure 4-25) (Section 2.12.3). Construction of the Blue Vale Road Realignment would be undertaken prior to disturbance of Hoad Lane/Blue Vale Road.

The Blue Vale Road realignment would be designed and constructed in accordance with the Austroad Guidelines and in consultation with the Gunnedah and Narrabri Shire Councils.

The Blue Vale Road Realignment would add approximately 5 km to the travel distance along Hoad Lane and Blue Vale Road, resulting in increased travel time of between 3 to 5 minutes for the small number of non-mining related users of the road. GTA Consultants (2018) concluded that the Blue Vale Road Realignment would not significantly alter traffic conditions.

Proposed Intersections

Access to the mine infrastructure area would be via a sealed private access road from the Approved Road Transport Route (Section 2.12.2). Access to the secondary infrastructure areas would be via the realigned Blue Vale Road.

The new intersections associated with these access roads would be designed and constructed in accordance with Austroad Guidelines and in consultation with Narrabri Shire Council and Gunnedah Shire Council.

Public Road Closures

Extension of the Project south of CL 316 into EL 7407 requires the closure of approximately 3 km of Braymont Road from its intersection with Blue Vale Road to the western boundary of CL 316 (Section 2.12.4). There is no privately-owned land on this section of road.

The impact of closing approximately 3.5 km of Braymont Road from its intersection with Blue Vale Road, on conditions on Blue Vale Road and Hoad Lane, would be negligible given its existing use for through traffic (Appendix I).

The section of Shannon Harbour Road west of its intersection with the Blue Vale Road Realignment would be closed. There is no privately-owned land on this section of road and the existing Blue Vale Road would remain accessible via the Blue Vale Road Realignment (Appendix I).

Road Safety Review

GTA Consultants (2018) anticipates that Project traffic would not exacerbate any specific safety concerns at any particular location.

Notwithstanding the above, improvements as a result of existing road maintenance agreements with the Narrabri and Gunnedah Shire Councils would improve road safety for the sections of the Approved Road Transport Route that would be used for the Project.

Once the Project CHPP and rail spur are operational, a reduction in heavy vehicles is predicted on public roads as ROM coal from the Project and other Whitehaven mines would no longer be hauled by road between the Project and the Whitehaven CHPP.

School Bus Operation

School buses would continue to operate on several of the roads in the vicinity of the Project. School buses would generally travel between 6.10 am and 9.00 am in the morning, and between 2.55 pm and 5.45 pm in the afternoon (Appendix I). There is potential for interaction between school buses and Project traffic during morning and afternoon school travel periods.

Implementation of Whitehaven's Traffic Management Plan would govern the potential interaction between Project traffic and school buses.

Temporary Road Closures Associated with Blasting

During mining operations there would be occasions when blasting would be required within 500 m of Blue Vale Road, Hoad Lane, Braymont Road, and sections of the Blue Vale Road realignment and Shannon Harbour Road. Approvals would be sought from the Gunnedah Shire Council and/or Narrabri Shire Council to temporarily close sections of the local roads to allow blasting to occur.

Level Crossings

The Project is expected to generate an average of 10 and a maximum of 16 train movements per day via the Project rail spur and the Werris Creek Mungindi Railway (Section 2.7.2).

GTA Consultants (2018) assessed the increase in likelihood that road traffic would be delayed by rail traffic as a result of the Project. It was concluded that the probability of delay of road traffic due to rail traffic would remain low (Appendix I).

4.12.3 Mitigation Measures, Management and Monitoring

The existing road system would satisfactorily accommodate the expected future traffic generated by the Project without need for additional specific measures or upgrades (beyond those proposed as part of the Project) (Appendix I).

Notwithstanding the above, Whitehaven's existing Traffic Management Plan would be revised for the Project in consultation with RMS, the Gunnedah Shire Council and Narrabri Shire Council.

Where new roads and intersections are to be constructed for the Project, these would be designed and constructed in accordance with Austroad Guidelines and in consultation with Narrabri Shire Council and Gunnedah Shire Council as relevant.

Whitehaven would further consider the comments raised by the RMS in relation to the Project rail spur crossing of the Kamilaroi Highway (Section 3.1) during detailed design.

Whitehaven currently has road maintenance agreements with the Narrabri Shire Council and the Gunnedah Shire Council. It is anticipated that similar agreements would continue to be maintained over the life of the Project, based on the levels of traffic generated.

4.13 ROAD AND RAIL TRANSPORT NOISE

Road and rail transport noise was considered as part of the Noise and Blasting Assessment undertaken for the Project by Wilkinson Murray (2018) and provided in Appendix D. A summary of the assessment is provided below.

The Noise and Blasting Assessment was peer reviewed by Glenn Thomas (Director, SLR Consulting). The peer review report is presented in Attachment 4.

The road and rail transport noise assessment for the Project was conducted in accordance with the:

- *NSW Road Noise Policy* (DECCW, 2011); and
- *RING* (EPA, 2013).

Section 4.13.1 describes the potential road and rail transport noise impacts of the Project, including cumulative impacts. Section 4.13.2 outlines mitigation measures, management and monitoring for the Project.

4.13.1 Potential Impacts

Road Traffic Noise

Road Noise Assessment Study Area

The road noise assessment focuses on Blue Vale Road and the Kamilaroi Highway, as these roads are the most likely to be affected by noise generated by road transport movements associated with the Project (Appendix D).

Road Noise Criteria

Road traffic noise along public roads was assessed by Wilkinson Murray (2018) in accordance with the *NSW Road Noise Policy*, which establishes criteria for the assessment of road noise in NSW (Appendix D). The total traffic noise and relative increase criteria are provided in Table 4-32.

Table 4-32
NSW Road Noise Policy Criteria for Residential Land Uses

Road	Type of Project and Land Use	Total Traffic Noise Criteria ¹	Relative Increase Criteria
Blue Vale Road and Kamilaroi Highway	Land use developments generating additional traffic on existing arterial/sub-arterial roads	Daytime 60 dBA L _{Aeq} (15 hour)	Existing L _{Aeq} (15 hour) plus 12 dBA
		Night-time 55 dBA L _{Aeq} (9 hour)	Existing L _{Aeq} (9 hour) plus 12 dBA

Source: Appendix D.

¹ Daytime 7.00 am to 10.00 pm; Night-time 10.00 pm to 7.00 am.

In relation to situations where exceedances of the road traffic noise assessment criteria are predicted, the *NSW Road Noise Policy* states that an increase of up to 2 dB is considered to be barely perceptible (DECCW, 2011).

Predicted Road Noise Emissions

The road noise assessment considered road noise associated with the following Project years:

- Year 1 – Project-related construction traffic and ROM coal haulage (3.5 Mtpa) to the Whitehaven CHPP on the Approved Road Transport Route.
- Year 8 – Project at full development with no haulage of Project ROM coal from the Project to the Whitehaven CHPP by road (i.e. coal haulage off-site via Project rail spur, including coal from other Whitehaven mines).

The methodology for the assessment of road noise was to:

- calculate existing traffic noise levels;
- calculate road noise levels in Project Years 1 and 8 corresponding to Project and cumulative traffic movements; and
- compare these noise levels with the relevant *NSW Road Noise Policy* criteria.

Along Blue Vale Road and the Kamilaroi Highway, noise levels resulting from daytime and night-time cumulative traffic in Years 1 and 8 are predicted to comply with the relevant criteria at the nearest privately-owned receivers (Appendix D).

Once the Project CHPP and rail spur are operational, a reduction in road traffic noise is predicted along Blue Vale Road and the Kamilaroi Highway as ROM coal from the Project and other Whitehaven mines would no longer be hauled by road between the Project and the Whitehaven CHPP.

Should the combined total ROM coal transported to the Whitehaven CHPP exceed 3.5 Mtpa, the approved private haul road and Kamilaroi Highway overpass would be constructed. Potential impacts associated with transport movements on the approved private haul road and Kamilaroi Highway overpass, if constructed, would be consistent with those assessed and subsequently approved for the Approved Mine.

Rail Noise

Rail Noise Assessment Criteria

The EPA's RING assessment trigger levels for additional rail traffic on an existing rail network are presented in Table 4-33. It is noted these trigger levels are generally consistent with the ARTC's EPL 3142 in regard to noise level goals for rail noise emissions.

Table 4-33
Network Rail Line Rail Infrastructure Noise Guideline
Rail Noise Assessment Trigger Levels

Descriptor	Rail Noise Assessment Trigger Levels
Daytime/evening [$L_{Aeq}(15 \text{ hour})$]	65 dBA
Night-time [$L_{Aeq}(9 \text{ hour})$]	60 dBA
Maximum pass-by [$L_{Amax}(95\text{th percentile})$]	85 dBA

Source: Appendix D.

Appendix 3 of the RING deals with non-network rail lines on or exclusively servicing industrial sites. Where a non-network line extends beyond the boundary of the industrial premises, noise from that section of the track should be assessed against the recommended acceptable L_{Aeq} noise level from industrial sources for the relevant receiver type (Appendix D). The criteria for the noise impacts associated with the non-network rail line adopted for the assessment are provided in Table 4-34.

Table 4-34
Non-network Rail Noise Assessment Criteria Adopted

Type of Receiver	Time of Day	Acceptable L_{Aeq} Noise Level (dBA)
Rural residence	Day	50
	Evening	45
	Night	40

Source: Appendix D.

Predicted Rail Noise Emissions

The rail noise assessment considered the non-network railway line between the Project rail loop and the Werris Creek Mungindi Railway (i.e. the Project rail spur) and portions of the Werris Creek Mungindi Railway and Main Northern Railway (Appendix D).

Using data on existing, approved and proposed train movements, Wilkinson Murray (2018) assessed cumulative train movements and the distance to the rail line coinciding with the closest receivers for each relevant section of the railway lines. Cumulative trains from the Project, nearby mining operations, agricultural freight and passenger trains were assessed (for the network line).

Project Rail Spur

Along the non-network rail line section between the Project rail loop and the Werris Creek Mungindi Railway, no exceedances of the relevant criteria are predicted at privately-owned receivers due to Project trains when considering local noise-enhancing meteorology (Appendix D).

There is an approved (but not yet constructed) dwelling location on Property 144. Noise levels from trains on the Project rail spur would be managed such that there would be no more than negligible exceedances (i.e. 1 to 2 dB) of the relevant criteria if the dwelling is constructed in the absence of an agreement with the landowner (Appendix D).

Werris Creek Mungindi Railway and Main Northern Railway

The network rail line noise assessment indicated Project rail movements would result in a negligible increase in noise along the Werris Creek Mungindi Railway and Main Northern Railway, with any increase being less than 2 dB (the relevant threshold in the RING rail noise assessment requirements).

4.13.2 Mitigation Measures, Management and Monitoring

The Project would use best practice rolling stock including locomotives approved to operate on the NSW rail network in accordance with EPLs issued by the EPA.

Whitehaven would have a suitably qualified person/s review the final rail design to determine whether it incorporates all reasonable and feasible mitigation. Whitehaven would also undertake commissioning trials of the spur to determine the optimal train speed to minimise noise impacts.

As described in the *NSW Road Noise Policy*, projects that generate additional traffic on existing roads are likely to have limited potential for noise control, because these developments are not usually linked to road improvements.

4.14 VISUAL CHARACTER

A Visual Assessment for the Project was undertaken for the Project and is presented in Appendix L.

A description of the existing visual setting of the Project is provided in Section 4.14.1. Section 4.14.2 describes the potential visual impacts of the Project, including cumulative impacts and Section 4.14.3 outlines visual impact mitigation and management measures.

The Visual Assessment (Appendix L) considered the *Dark Sky Planning Guideline* (DP&E, 2016) in relation to potential night-lighting impacts.

4.14.1 Existing Environment

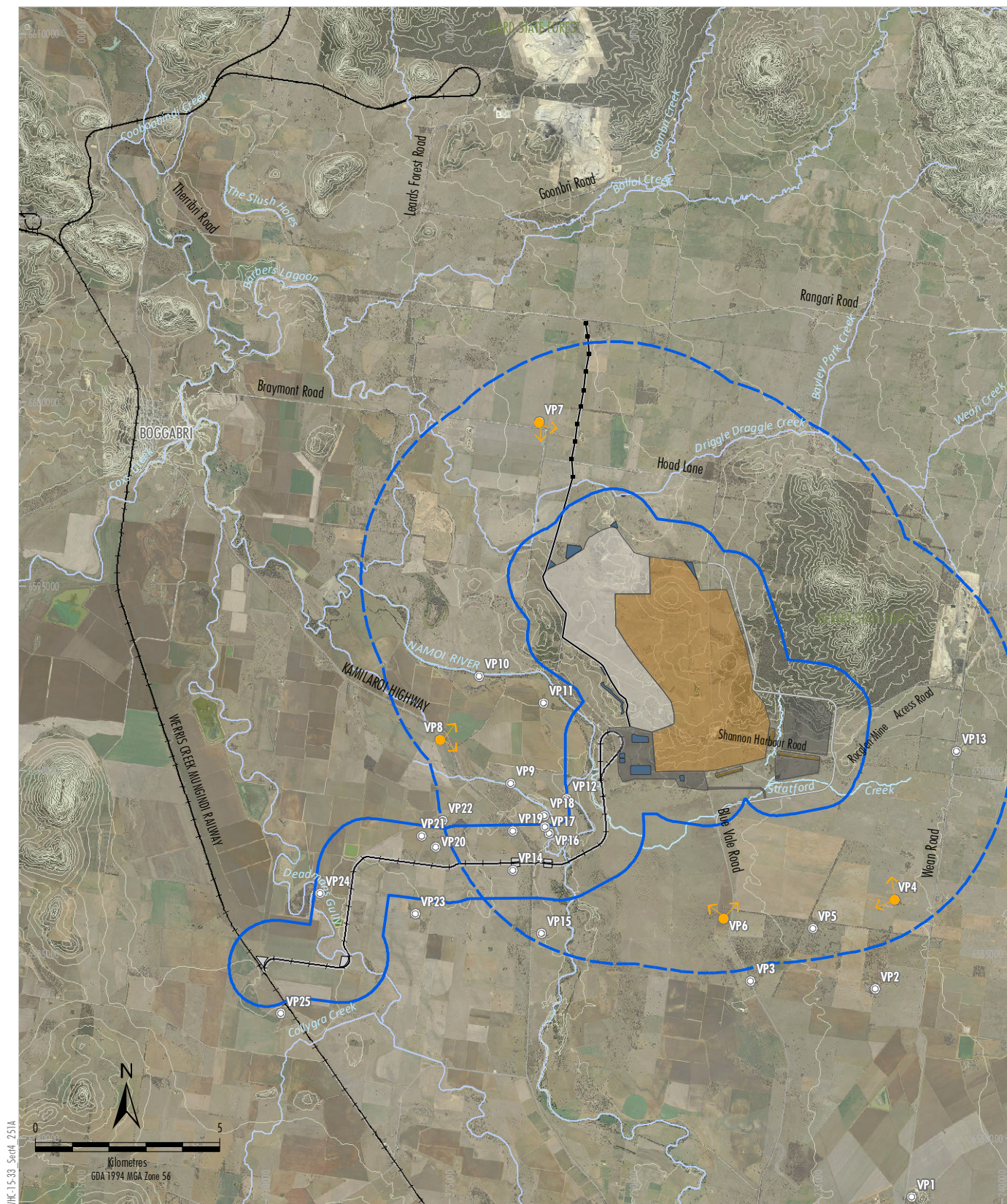
The Project area and surrounds comprise a number of distinct land use types and landscape units. These include agricultural areas, the existing Rocglen, Tarrawonga, Boggabri and Maules Creek Coal Mines, the former Canyon Coal Mine, the Vickery State Forest, residential dwellings, an unnamed wooded range approximately 9 km east and the Namoi River (Appendix L). Land use and key landscape features that contribute to visual character and scenic quality are described below in the context of the regional, sub-regional and local settings (Figure 4-26).

Topographic features in the vicinity of the Project are described in Section 4.2.2.

Regional Setting (>5 km)

The regional setting has attributes of moderate scenic quality due to the contrast between the vegetation and topography of the ranges (e.g. the unnamed wooded range 9 km to the east of the Project) and agricultural areas of the valley that add to visual interest (Appendix L).

The regional setting also has many attributes of low scenic quality due to the presence of coal mines and the generally flat, cleared dryland agricultural areas that dominate the landscape (Appendix L).



LEGEND

- Railway
- Project Components**
- Indicative Extent of Open Cut
- Indicative Extent of Out of Pit Waste Rock Employment
- Indicative Extent of Infrastructure Area
- Indicative Extent of Soil Stockpile
- Indicative Extent of Water Storage
- Indicative Rail Spur Alignment
- Indicative Location of Groundwater Bores and Pipeline

- Project Mining Area Local Setting Boundary (1 km from Project Mining Area)
- Project Mining Area Sub-Regional Setting Boundary (5 km from Project Mining Area)
- Viewpoint
- Visual Simulation Location

Source: Orthophoto - Department of Land and Property Information, Aerial Photo (July 2011); Department of Industry (2016); Whitehaven (2016)



VICKERY EXTENSION PROJECT

Viewpoints and Visual Simulation Locations

Figure 4-26

Gunnedah and Boggabri are the closest towns to the Project regional setting, located approximately 25 km to the south and 10 km to the north-west of the Project, respectively (Appendix L).

Sub-regional Setting (1 to 5 km)

The sub-regional setting has generally low scenic quality due to the presence of flat, cleared dryland agricultural areas (Appendix L).

Attributes of moderate scenic quality in the sub-regional setting include the Vickery State Forest and the meandering form of the Namoi River, with its associated riparian remnant vegetation (Appendix L).

Within the sub-regional setting, the eastern section of the Vickery State Forest is a heavily vegetated and elevated area. The remainder of the sub-regional setting is generally free of vegetation, apart from remnants located along waterways and road reserves (Appendix L).

The Rocglen Coal Mine is the only coal mine in the sub-regional setting and is located approximately 4.5 km to the east of the Project.

There are no small villages or towns in the sub-regional setting. There are a number of privately-owned dwellings in the sub-regional setting, predominantly to the south and west of the Project (Appendix L).

Local Setting (<1 km)

The local setting, apart from the Vickery State Forest, has been heavily modified over time with the majority of vegetation disturbed by historic agricultural clearing and previous mining operations, including the former Vickery and Canyon Coal Mines.

The visual character of the local setting is considered to be of low scenic quality with the exception of the Vickery State Forest, which is considered to be of moderate scenic quality (Appendix L).

There are no villages, towns or privately-owned dwellings in the local setting of the Project mining area.

4.14.2 Potential Impacts

The major aspects of the Project considered to have the potential to impact on the visual landscape include (Appendix L):

- development of the open cut;

- development of the waste rock emplacement to a maximum height of approximately 370 m AHD (approximately 110 m above the nearby Namoi River floodplain and approximately 110 m lower than the peak of the ridge in the Vickery State Forest);
- development of the mine infrastructure area, secondary infrastructure areas and associated access road and coal handling infrastructure;
- construction of the Project rail spur and rail loop connecting to the Werris Creek Mungindi Railway; and
- use of lighting during night-time operations.

Visual Assessment Methodology

The potential visual impacts were assessed by evaluating the level of visual modification of the Project in the context of the visual sensitivity of relevant surrounding land use areas (Appendix L).

The degree of visual modification of a proposed development is the contrast between the development and the existing visual landscape, and is generally considered to decrease with distance (Appendix L).

Visual (viewer) sensitivity is a measure of how critically a change to the existing landscape would be viewed from various land use areas, where different activities are considered to have different sensitivity levels. For example, a viewer would generally be more sensitive to visual modifications at their dwelling than at a road they travel along (Appendix L).

Visual impacts were determined in consideration of the matrix presented in Table 4-35.

Table 4-35
Visual Impact Matrix

		Viewer Sensitivity		
		H	M	L
Visual Modification	H	H	H	M
	M	H	M	L
	L	M	L	L
	VL	L	VL	VL

Source: Appendix L.

VL = Very Low; L = Low; M = Moderate; H = High.

Visual Impact Assessment

Visual simulations were prepared for the viewpoint locations identified in Table 4-36 and are provided as Figures 4-27 to 4-30. The simulations were prepared to show the existing views, as well as simulations of the Project landforms and infrastructure during the stage of the Project when the greatest potential visual impact would occur at that view point.

Post-rehabilitation simulations were also developed to illustrate the conceptual landform following completion of mining and rehabilitation activities.

Figure 4-31 shows a simulation of the Project rail spur where it passes over the Kamilaroi Highway.

The maximum height of the Project waste rock emplacement would be similar to that of the maximum height of the Approved Mine (Appendix L). Therefore, the level of visual modification due to the Project would be similar to that of the Approved Mine.

The Vickery State Forest is not routinely accessed by the public and views of the Project from parts of the Vickery State Forest that are accessible are obstructed by dense vegetation. Therefore, visual impacts from the Vickery State Forest due to the Project are expected to be very low (Appendix L).

Project Mining Area

Dwellings

Whitehaven has purchased a number of properties surrounding the Project mining area (Figure 1-5a), reducing the number of private dwellings potentially impacted by the Project.

Regional Setting

Dwellings in the regional setting (e.g. the ‘Bengalala’ [VP1] and ‘Coulston [1]’ [VP2] dwellings) have visual sensitivities of low, given their distance from the Project (Figure 4-26).

While the Project may be visible from the dwellings, low levels of visual modification due to Project landforms would occur given the distance from the dwellings to the Project (Table 4-37).

As such, low levels of potential visual impact would be expected. Following progressive and final rehabilitation, levels of visual impact would reduce to very low (Appendix L).

Sub-regional Setting

Dwellings in the sub-regional setting (Figure 4-26) have visual sensitivities between moderate and high, depending on their distance from the Project mining area. While the Project may be visible from the dwellings, given the distance from the dwellings to the Project, moderate levels of visual modification due to Project landforms would occur (Table 4-37). As such, moderate to high levels of potential visual impact would be expected. Following progressive and final rehabilitation levels of visual impact would reduce to low or very low (Appendix L).

Local Setting

There are no privately-owned dwellings in the local setting of the Project mining area.

Table 4-36
Visual Simulation Locations

Viewpoint Location ¹		Potential View of Project	Visual Simulation Figure
VP4	Adjacent to the ‘Brolga’ dwelling (privately-owned)	Distant views of the waste rock emplacement and mine infrastructure, where vegetation and topography permit. Potential distant views of secondary infrastructure area.	Figure 4-27a and 4-27b
VP6	Blue Vale Road, 3 km south of the Project	Distant views of the waste rock emplacement and mine infrastructure, where roadside vegetation and topography permit.	Figure 4-28a and 4-28b
VP7	Braymont Road, 2.2 km north-west of the Project	Distant views of the waste rock emplacement from sections of Braymont Road, where roadside vegetation and topography permit.	Figure 4-29a and 4-29b
VP8	Kamilaroi Highway, 3.5 km south-west of the Project	Distant views of the waste rock emplacement on sections of the Kamilaroi Highway, where vegetation and topography permit.	Figure 4-30a and 4-30b

Source: After Appendix L.

¹ Refer to Figure 4-26 for viewpoint locations.



Existing View



Existing View with Simulation outline - Year 21



VICKERY EXTENSION PROJECT

Existing View and Visual Simulation
Outline (Year 21) -
Brolga Residence (VP4)

Figure 4-27a



Simulation - Year 21



Simulation - Post-Mining

WHC-15-33 EIS Sept 010A



Existing View



Existing View with Simulation Outline - Year 21

WHC15-33 EIS Sect4_003F

Figure 4-28a



Simulation - Year 21



Simulation - Post-Mining



VICKERY EXTENSION PROJECT

Visual Simulation
(Year 21 and Post-Mining) -
Blue Vale Road (VP6)

Figure 4-28b



Existing View



Existing View with Simulation Outline - Year 7



VICKERY EXTENSION PROJECT

Existing View and
Visual Simulation Outline (Year 7) -
Braymont Road (VP7)

Figure 4-29a



Simulation - Year 7



Simulation - Post-Mining

WHC15-33: EIS Sept 4, 012A



VICKERY EXTENSION PROJECT

Visual Simulation
(Year 7 and Post-Mining) -
Braymont Road (VP7)

Figure 4-29b



Existing View



Existing View with Simulation Outline - Year 7

WHIC-15-33 EIS Ser4 005E



VICKERY EXTENSION PROJECT

Existing View and
Visual Simulation Outline (Year 7) -
Kamilaroi Highway (VP8)

Figure 4-30a



Simulation - Year 7



Simulation - Post-Mining

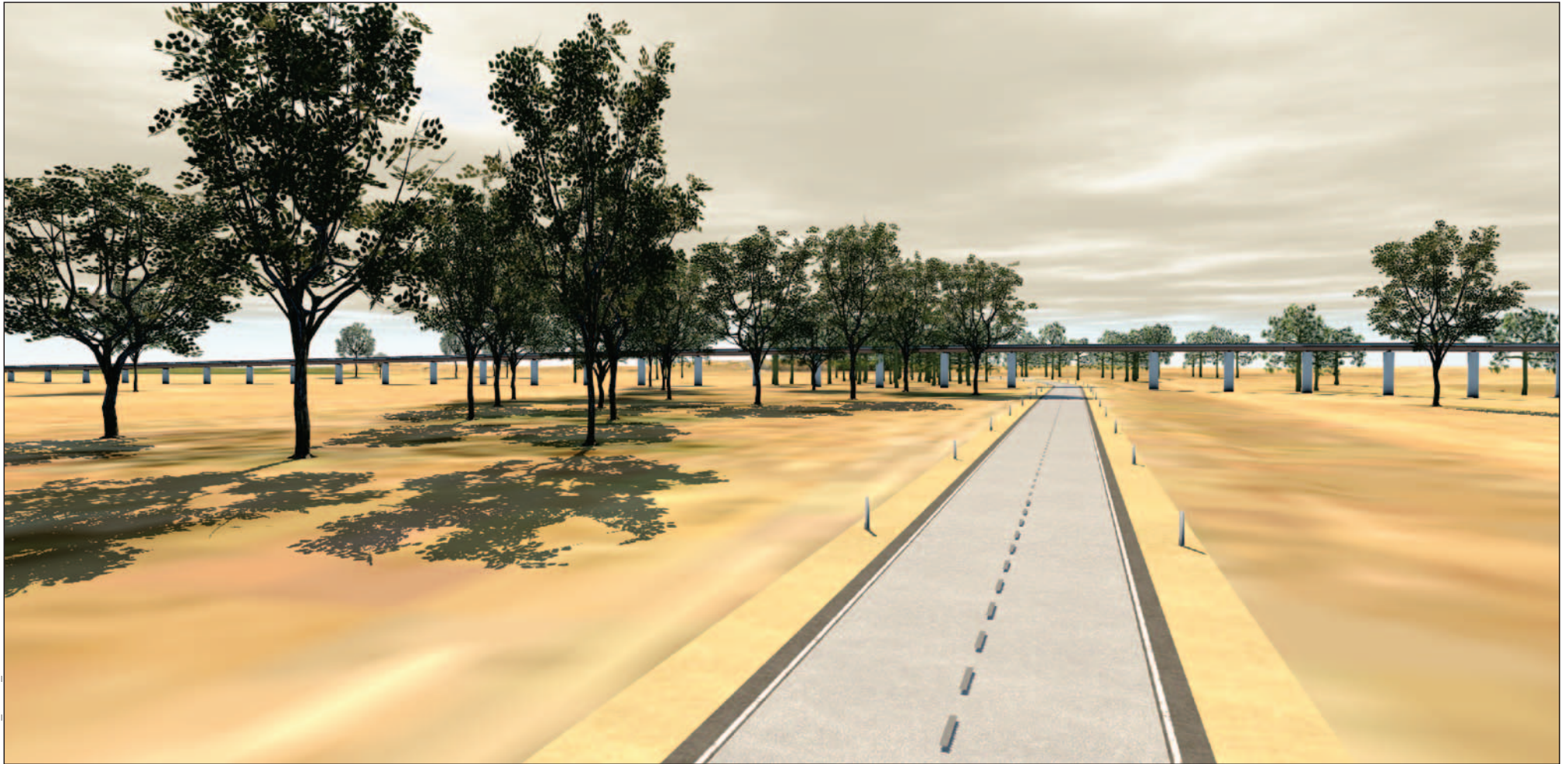
WHC-15-33 ES Sept4 013A



VICKERY EXTENSION PROJECT

Visual Simulation
(Year 7 and Post-Mining) -
Kamilaroi Highway (VP8)

Figure 4-30b



WMC-15-33_EIS Serd_009A

Simulation - Looking Northbound

Source: Whitehaven (2018)

Table 4-37
Summary of Visual Assessment

Location ¹	Visual Modification Level	Visual Sensitivity	Potential Impact	Potential Impact After Rehabilitation
Project Mining Area				
VP1 (Property ID 340; Bengalala)	L	L	L	VL
VP2 (Property ID 108b; Coulston [1])	L	L	L	VL
VP3 (Blue Vale Road)	L/M	L	L	VL
VP4 (Property ID 310; Brolga) (Figure 4-27a and 4-27b)	M	M	M	VL/L
VP5 (Property ID 108b; Coulston [2])	M	M	M	VL/L
VP6 (Blue Vale Road) (Figure 4-28a and 4-28b)	M/H	L	L/M	VL/L
VP7 (Braymont Road) (Figure 4-29a and 4-29b)	M/H	L	L/M	VL/L
VP8 (Kamilaroi Highway) (Figure 4-30a and 4-30b)	M	L	L	VL/L
VP9 (Property ID 133a; Clinton)	M	M	M	L
VP10 (Property ID 127a; Mirrabinda [1])	M	H	H	L
VP11 (Property ID 127b; Mirrabinda [2])	M	H	H	L
VP12 (Property ID 127c; Mirrabinda [3])	M	H	H	L
VP13 (Property ID 98; Roseberry)	M	M	M	VL/L
Project Rail Spur				
VP12 (Property ID 127c; Mirrabinda [3])	VL	H	L	N/A
VP15 (Property ID 153; Avona)	VL	H	L	N/A
VP16 (Property ID 132; Lanreef)	L	H	M	N/A
VP17 (Property ID 131a; Dennison)	L	H	M	N/A
VP18 (Property ID 131b)	L	H	M	N/A
VP19 (Property ID 141)	L	H	M	N/A
VP20 (Property ID 144b)	VL	H	L	N/A
VP21 (Property ID 144a)	L	H	M	N/A
VP22 (Property ID 143)	L	H	M	N/A
VP23 (Property ID 147; Killara)	L	H	M	N/A
VP24 (Property ID 146; Calrossie)	L	H	M	N/A
VP25 (Property ID 322)	VL	H	L	N/A
Project Rail Spur Overpass of Kamilaroi Highway				
VP9 (Property ID 133a; Clinton)	VL	H	L	N/A
VP12 (Property ID 127c; Mirrabinda [3])	VL	H	L	N/A
VP14 (Kamilaroi Highway – Rail Overpass) (Figure 4-31)	L	M	L	N/A
VP15 (Property ID 153; Avona)	VL	H	L	N/A
VP16 (Property ID 132; Lanreef)	L	H	M	N/A
VP17 (Property ID 131a; Dennison)	L	H	M	N/A
VP18 (Property ID 131b)	L	H	M	N/A
VP19 (Property ID 141)	L	H	M	N/A

Source: After Appendix L.

H – High; M – Moderate; L – Low; VL – Very Low.

¹ Refer to Figure 4-26.

Roads

Views of the Project would be available from a number of locations along public roads (i.e. Blue Vale Road, Braymont Road and the Kamilaroi Highway) (Appendix L).

These roads (with the exception of the Kamilaroi Highway) are local roads (Appendix I). The local roads have low levels of visual sensitivity (Appendix L). The proportion of Project-related vehicles on the local roads would be high, and it is anticipated that usage by non-mining vehicles in this area would be relatively low (Appendix L).

Blue Vale Road and Braymont Road are expected to have moderate to high levels of visual modification, given their close proximity to Project landforms and infrastructure areas (Appendix L). Given the low visual sensitivities of the local roads, low to moderate levels of potential visual impact would be expected in the local setting (Table 4-37). Following progressive and final rehabilitation, levels of visual impact on the local roads would reduce to low or very low (Appendix L).

Views of the Project mining area to vehicles travelling along Blue Vale Road (as realigned) would in part be screened by existing vegetation and vegetative screens that would develop over time, and in some cases bunds proposed to be installed along sections of the Blue Vale Road realignment. These vegetative screens and bunds would mitigate visual impacts over time along the Blue Vale Road realignment, although it is anticipated that residual visual impacts would be experienced by motorists due to the close proximity to the Project mining landforms (Appendix L).

The visual sensitivity of the Kamilaroi Highway (a state road) would be low given its distance to the Project mining area (Appendix L). Given the moderate level of visual modification, a low level of potential visual impact would be expected for portions of the Kamilaroi Highway located in the sub-regional setting (e.g. VP8) (Table 4-37). With progressive and final rehabilitation, the level of visual impact on the Kamilaroi Highway in the sub-regional setting would reduce to low or very low (Appendix L).

Visual simulations of the Project mining area at representative points along Blue Vale Road, Braymont Road and Kamilaroi Highway in the sub-regional setting are shown in Figures 4-27 to 4-30.

Project Rail Spur

Rural residences in the local and sub-regional setting of the Project rail spur alignment include 'Mirrabinda (3)' (VP12), 'Avona' (VP15), 'Lanreef' (VP16), 'Dennison' (VP17), Property ID 131b (VP18), Property ID 141 (VP19), Property ID 144b (VP20), Property ID 144a (VP21), Property ID 143 (VP22), 'Killara' (VP23), 'Calrossie' (VP24) and Property ID 322 (VP25) (Figure 4-26).

These properties may have views of the Project rail spur, depending on the extent of intervening topography and vegetation.

Intermittent views of the Project rail spur would also be available from the road network in the vicinity of the Project rail spur where vegetation and topography permit.

The Project rail spur would generally be an elevated structure with some infilled embankment sections. Where the Project rail spur crosses the Namoi River it would be elevated further on a viaduct structure to minimise impacts to the flooding regime.

As the Project rail spur would only comprise a small proportion of the overall viewscape, it is anticipated that low to very low levels of visual modification would occur from rural residences.

The visual sensitivity of the rural residences in the local and sub-regional setting of the Project rail spur would be high.

For the closest rural residences, the low level of visual modification during operations coupled with the high level of visual sensitivity indicates a moderate level of potential visual impact would be expected as a result of the Project rail spur (Table 4-37). For other rural residences, generally more than 1.5 km away from the Project rail spur, a low level of potential visual impact is expected (Table 4-37).

Project Rail Spur Overpass of Kamilaroi Highway

The Project rail spur would include an overpass where it crosses the Kamilaroi Highway.

The overpass would be constructed of concrete spans between piers supporting the rail track. A simulation of the overpass is provided on Figure 4-31.

The Kamilaroi Highway is located within a landscape that is generally flat, with bands of vegetation present along the edge of the highway and along local roads and property or paddock boundaries. The highway landscape includes signage, road intersections, rail crossings and, occasionally, road and rail overpasses/grade separations.

The rail overpass is typical of infrastructure within a highway setting. In this regard it is considered to have a high degree of visual compatibility or fit. As a result, the visual modification level is considered to be low from the highway itself and low to very low from the closest residences (Appendix L).

For users of the Kamilaroi Highway in the local setting, a low level of potential visual impact would be expected (Appendix L).

A moderate level of visual impact is expected from the closest private residences to the rail overpass (Table 4-37) and a low level of visual impact is expected for other private residences (Table 4-37).

Approved Private Haul Road and Kamilaroi Highway Overpass

In the event that the approved private haul road and Kamilaroi Highway overpass are constructed as part of the Project, it would be constructed as per the Approved Mine and, therefore, the conclusions of the *Vickery Coal Project Visual Assessment* (Urbis, 2012) (i.e. low level of potential visual impact) would be relevant to the Project.

Night-Lighting

Direct Night-Lighting

Direct views of Project lighting sources would be possible from public roads and some residences. Lights associated with the Project that may be directly visible from some public roads and residences include stationary work lights, fixed/permanent lights and vehicle-mounted lights. Direct views to the lighting sources would be obscured from most residences by vegetation within the landscape and around residences. The headlights of trains using the Project rail spur would intermittently be visible to some residences and sections of public roads.

In-Direct Night-Lighting

There is potential for the Project to spill a certain amount of light from vehicles and stationary work lights, producing sky glow. When there is cloud cover at night this may also result in some reflection off the cloud base.

Lighting of night-time works is essential for the safety of personnel operating at the Project.

The intensity, nature and degree of night-lighting for the Project would be similar to, or slightly greater than, the existing night-lighting at the Tarrawonga and Rocglen Coal Mines, and the intensity assessed for the Approved Mine.

Potential impacts from night-lighting required for the Project would be minimised through the implementation of mitigation measures described in Section 4.14.3.

Siding Springs Observatory

The Siding Springs Observatory is located approximately 115 km to the south-west of the Project. As such, the Project is within the Dark Sky Region, as defined in the *Dark Sky Planning Guideline* (DP&E, 2016). There are a number of light sources and small towns (e.g. Coonabarabran) between the Project and the Siding Springs Observatory, which may contribute to sky glow at the Siding Springs Observatory (Appendix L).

Any potential impact associated with night-lighting required for the Project (i.e. for safety reasons) would be similar to those assessed for the Approved Mine (Appendix L). These potential impacts would be minimised as far as possible through the implementation of mitigation measures described in Section 4.14.3.

Cumulative Impacts

The assessment of potential cumulative visual impacts considers the combined effects of the Project with the effects of the existing Rocglen Coal Mine.

Due to the elevated and hilly topography of the Vickery State Forest, views of both the Project and the Rocglen Coal Mine landforms would generally be only available from viewpoints to the south and south-east of the Project. As with views of the Project, these viewpoints would generally be limited to elevated areas and/or areas where no vegetation screening is present (e.g. from paddocks and private roads).

The Roseberry residence (VP13) would be potentially exposed to views of both the Project and the Rocglen Coal Mine landforms. However, given the intervening topography and the presence of screening vegetation around the dwelling these would generally be intermittent or partial views. The cumulative views would also be similar to the cumulative visual impacts associated with the Approved Mine and the Rocglen Coal Mine, or less, given the approved Eastern Emplacement is no longer proposed for the Project.

The night-time setting is currently subject to the effects of lighting from the Rocglen Coal Mine. However, the Rocglen Coal Mine is contained to some extent between the rising topography of the Vickery State Forest and the unnamed range to the east.

Cumulative visual impacts as a result of the Project and the Rocglen Coal Mine are considered to be low to moderate and confined to viewpoints to the south and south-east of the Project. These impacts would reduce to low once final rehabilitation has been completed.

4.14.3 Mitigation Measures, Management and Monitoring

The mitigation and management measures that would be implemented for the maintenance of visual amenity at the Project are described below.

Progressive Rehabilitation

Progressive rehabilitation of the Project landforms would be undertaken and would assist in reducing the contrast between them and the surrounding environment. The design of the waste rock emplacement would assist with the visual shielding of the active open cut operations from viewpoints to the north, west and south-west of the Project. The level of visual modification by the waste rock emplacement itself would vary over time, reducing as vegetation becomes established and mature.

Introduction of macro-relief (i.e. 10 to 20 m hills similar to those found in the Vickery State Forest) to the top surface of the waste rock emplacement would improve the integration of the landform with the surrounding environment and mitigate potential visual impacts (Section 5).

Rehabilitation would be conducted in accordance with the rehabilitation and landscape management strategy presented in Section 5.

Visual Screening

Vegetative screens, and in some cases bunds, would be installed along sections of the Blue Vale Road realignment where prominent views of the active mine operations would be available to road traffic. Vegetative screens would take some years to develop and once developed would only provide partial screening.

The vegetative screens and bunds, over time, would mitigate some of the visual impact along the Blue Vale Road realignment, although it is anticipated that residual visual impacts would be experienced by motorists due to the close proximity to the Project landforms.

In addition, upon receiving a request from an owner of any privately-owned dwelling with direct views of the Project, Whitehaven would assess whether there is a high visual impact. In the event the Project is concluded to be resulting in a high visual impact at a dwelling, Whitehaven would implement reasonable and feasible visual mitigation measures in consultation with the owner to minimise the visibility of the Project from the dwelling.

Night-lighting

Measures to mitigate potential impacts from night-lighting (including sky glow) could include one or more of the following, where practicable and without compromising operational safety:

- All external lighting associated with the Project would comply with AS 4282:1997 – *Control of the Obtrusive Effects of Outdoor Lighting* (e.g. upward light spill would be minimised through adequate aiming of lights and the use of shielded fittings where practicable).
- Night-lighting would be restricted to the minimum required for operations and safety requirements so as to avoid over-lighting.
- Appropriate positioning and orientation of lights.
- Use of warm white colours, where appropriate.
- Screens would be installed where required along sections of the Project rail spur to mitigate potential train lighting impacts to neighbouring residents and users of the Kamilaroi Highway.
- Mitigation measures at private residences, where warranted and if requested by the landholder (e.g. curtains, cladding, screens and tree planting).

These measures consider the lighting principles outlined in the *Dark Sky Planning Guideline* (DP&E, 2016).

4.15 ABORIGINAL CULTURAL HERITAGE

An ACHA was undertaken for the Project by Whincop Archaeology (2018) and is presented in Appendix G.

The ACHA for the Project has been undertaken in accordance with the following guidelines and regulations:

- *Aboriginal cultural heritage consultation requirements for proponents 2010* (DECCW, 2010a).
- *Aboriginal Cultural Heritage: Standards and Guidelines Kit* (NSW National Parks and Wildlife Service, 1997).
- *Ask First: A Guide to Respecting Indigenous Heritage Places and Values* (Australian Heritage Commission, 2002).
- Clause 80C of the *NSW National Parks and Wildlife Regulation, 2009*.
- *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (DECCW, 2010b).
- *Draft Guidelines for Aboriginal Cultural Heritage Assessment and Community Consultation* (DEC, 2005).
- *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales* (DECCW, 2010c).
- *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW* (OEH, 2011).
- *National Parks and Wildlife Act 1974: Part 6 Approvals – Interim Community Consultation Requirements for Applicants* (DEC, 2004).
- *Engage Early* (DotE, 2016).
- *NSW Minerals Industry Due Diligence Code of Practice for the Protection of Aboriginal Objects* (NSW Minerals Council, 2010).
- The Australian International Council on Monuments and Sites (ICOMOS) *The Burra Charter: The Australia ICOMOS Charter for Places of Cultural Significance* (Australia ICOMOS, 2013).

A description of Aboriginal heritage (cultural and archaeological) in the vicinity of the Project and the consultation undertaken with the Aboriginal community is provided in Section 4.15.1. Section 4.15.2 describes the potential impacts of the Project on Aboriginal heritage, while Section 4.15.3 outlines mitigation measures, management and monitoring.

4.15.1 Existing Environment

Aboriginal Cultural Heritage Assessment

The ACHA (Appendix G) incorporates relevant information from previous assessments (including for the Approved Mine), the results of Project field surveys and associated consultation with the Aboriginal community, including:

- results from extensive fieldwork and archaeological and cultural investigations previously undertaken at the Approved Mine and surrounds;
- search results from the OEH Aboriginal Heritage Information Management System (AHIMS) database and other heritage registers;
- results from extensive consultation with the Aboriginal community regarding archaeological and cultural heritage values;
- a detailed description of the methods implemented and the results of archaeological and cultural surveys conducted by archaeologists and representatives of the Aboriginal community for the Project during 2016 and 2017; and
- a detailed description of the consultation undertaken for the Project from 2015 to 2018.

The key steps involved in the preparation of the ACHA and associated consultation are described below.

Aboriginal History

The Project area is located on lands covered by the Kamilaroi (or Gamilaraay) dialect of the “Darling Tributaries” languages (Wafer and Lissarrague, 2008).

At the time of first contact with European observers, the Kamilaroi were hunter-fisher-gatherers and appear to have lead a semi-nomadic lifestyle (Appendix G).

The reports by Allan Cunningham and Major Thomas Mitchell indicate that such villages were associated with substantial permanent water supplies, such as at Barbers Lagoon (approximately 4.5 km north-west of the Project) on the Namoi River (Appendix G).

It is expected that traditional values and activities remained on the Liverpool Plains, practiced by the Kamilaroi people up until the 20th century. In the early 20th century Aboriginal people in the area were settled on reserves at Baan Baa and Borah Crossing, approximately 30 to 40 km north-west and south-east of the Project, respectively (Appendix G).

The number of Kamilaroi people is reported to have declined over time due to the loss of land, disturbance to the environment and to social networks and the influence of disease. Post-contact, many Kamilaroi people are reported to have worked in association with pastoral stations and homesteads (O'Rourke, 1997).

Previous Archaeological Investigations

A number of Aboriginal heritage surveys and assessments have been undertaken in the Project area and surrounds over the past 40 years, including survey and assessment for the Approved Mine.

The investigations and surveys undertaken in the immediate area included:

- a survey for a proposed mining operation at Boggabri, which included an inspection of the original Vickery Coal Mine area (Kamminga, 1978);
- a survey and assessment of the original Vickery Coal Mine (Thompson, 1981);
- extensive archaeological investigations undertaken for areas now associated with the Boggabri, Tarrawonga and Maules Creek Coal Mines, including portions of the Project area (Haglund, 1985); and
- a comprehensive assessment for the Approved Mine (Landskape, 2012); and
- various due diligence assessments (University of Queensland Culture and Heritage Unit 2015, 2016).

The ACHA prepared by Landskape (2012) as part of the EIS for the Approved Mine (Whitehaven, 2013) covered a large portion of the Project area and included extensive surveys and community consultation.

In addition to the above, a number of relevant archaeological investigations have been undertaken for nearby mines and in the broader region including:

- surveys and investigations for the nearby Maules Creek Coal Mine (Haglund, 1983, 1986; Dallas, 1986);
- surveys and investigations for the nearby Tarrawonga Coal Mine (Archaeological Surveys and Reports, 2005; Dunk and Vermeltfoort, 2011; Landskape, 2010; Kayandel, 2011);
- surveys and investigations for the nearby Boggabri Coal Mine (Hamm, 2005, Archaeological Surveys and Reports, 2005; Insite Heritage, 2010); and
- other investigations in the broader region including an investigation undertaken by Balme (1984) and Haglund (1982).

A detailed description of the investigations and surveys undertaken in the Project area and surrounds is provided in Appendix G.

Heritage Register Searches

Searches of the following heritage registers and planning instruments were undertaken in 2015, 2016, 2017 and 2018 (Appendix G):

- AHIMS database;
- *Gunnedah Local Environmental Plan 2012*;
- *Narrabri Local Environmental Plan 2012*;
- *Aboriginal and Torres Strait Islander Heritage Protection Act, 1984*; and
- Commonwealth Heritage List and National Heritage List (via the Australian Heritage Database).

Community Consultation

Consultation for the Project was undertaken in accordance with the OEH policy *Aboriginal cultural heritage consultation requirements for proponents 2010* (DECCW, 2010a) and the NSW *National Parks and Wildlife Regulation, 2009*.

Table 4-38 summarises the main stages of the Aboriginal heritage consultation process undertaken for the Project. A similar consultation process was undertaken for the Approved Mine between 2011 and 2012.

Table 4-38
Summary of Aboriginal Heritage Consultation Undertaken for the Project

Date	Consultation
Notification of Project and Registrations	
9 September 2015	Letters requesting the names of Aboriginal parties or groups that may have been interested in registering for the consultation process were sent to the Office of the Registrar (<i>Aboriginal Land Rights Act, 1983</i>), the OEH Dubbo Environment Protection and Regulation Group, the Gunnedah Shire Council, the Narrabri Shire Council, NTSCORP, Red Chief LALC, North West Local Land Services and the National Native Title Tribunal, in order to identify Aboriginal stakeholders.
14 September to 3 November 2015	Responses to the above request were received from the Gunnedah Shire Council, National Native Title Tribunal, NTSCORP, OEH, Red Chief LALC and the Office of the Registrar (<i>Aboriginal Land Rights Act, 1983</i>).
6 October 2015	Letters seeking registrations of interest were sent to the Aboriginal parties identified by the above step.
6 October 2015	Letters advising of automatic registration for the consultation process were sent to all RAPs who had previously registered an interest in the Approved Mine.
8 October 2015	A public notice was placed in the <i>Namoi Valley Independent</i> inviting interested Aboriginal parties or groups to register.
27 October 2015	Record of names of RAPs provided to the OEH and Red Chief LALC in accordance with the OEH policy <i>Aboriginal cultural heritage consultation requirements for proponents 2010</i> (DECCW, 2010a) (except for the RAPs who requested that their names not be provided).
2 December 2015 to 29 January 2016	Additional registration period undertaken due to investigation of an alternative Project rail spur alignment. This additional registration process mirrored the same approach outlined above including the following: - Project notifications distributed 2 December 2015. - Registration invitations (and registration letters to existing RAPs) distributed 22 December 2015. - Public notice published in <i>Namoi Valley Independent</i> on 7 January 2016. Letters to OEH and Red Chief LALC distributed 29 January 2016.
January 2016	A total of 68 organisations and/or individuals were registered as RAPs for the Project following completion of the registration periods (September 2015 to January 2016).
Proposed Methodology Review and Information Session	
6 November 2015	Provision of the Proposed Methodology for undertaking the ACHA was distributed to the RAPs ¹ . A request for comments on the Proposed Methodology and an invitation to attend an information session to discuss the Project and Proposed Methodology were included.
22 December 2015	Following the additional registration process held in December 2015 and January 2016, an addendum to the Proposed Methodology was provided to all RAPs, including a description of an additional proposed survey area ² .
November to December 2015	Feedback from the RAPs in regard to the Proposed Methodology was received, and consideration was given to all comments.
5 February 2016	An additional information session regarding the Project and the Proposed Methodology was held at the request of the Gomeroi Native Title Applicants.
Field Surveys	
6 November 2015	Invitation sent to the RAPs to attend field surveys for the Project*.
11 to 12 December 2015	An investigation of possible scarred trees previously identified was undertaken.
11 to 15 January 2016, 18 to 22 January 2016, 1 to 5 February 2016	An Aboriginal cultural heritage survey was conducted by archaeologists from Whincop Archaeology accompanied by RAPs and their representatives. The cultural significance of the Project area and the identified Aboriginal heritage sites was discussed with the RAPs and representatives.
22 to 24 February 2016	An additional investigation of possible scarred trees previously identified was undertaken.
14 to 15 December 2016	An additional Aboriginal cultural heritage survey was conducted of portions of the Project rail spur alignment by an archaeologist from Whincop Archaeology accompanied by two RAPs. The cultural significance of the Project area and the identified Aboriginal heritage sites was discussed with the RAPs
1 August 2017	An archaeologist from Whincop Archaeology undertook a site inspection of portions of the revised Project rail spur alignment unable to be accessed during the surveys.

Table 4-38 (Continued)
Summary of Aboriginal Heritage Consultation Undertaken for the Project

Date	Consultation
Draft ACHA Review, Information Sessions and Site Inspection	
18 March 2016	A copy of the initial draft ACHA was provided to all RAPs for their review and comment. The initial draft ACHA included survey results, archaeological and cultural significance assessment (based on feedback received during consultation and fieldwork), potential impacts and proposed mitigation and management measures. Feedback was requested by 27 April 2016. An invitation was also provided to all RAPs to attend information sessions in April 2016 to discuss the findings, provide any information on cultural knowledge/significance, provide an opportunity to comment on the initial draft ACHA and to take part in a site inspection of a selection of identified Aboriginal heritage sites.
6 and 7 April 2016	Information sessions and on-site inspections offered to all RAPs on 6 and 7 April 2016.
April/May 2016	Comments received on the draft ACHA were considered and included in the ACHA (Appendix G).
23 December 2016	Revised draft ACHA was provided to all RAPs for their review and comment following further detailed planning and design. Feedback was requested by 3 February 2017. No comments were received from the RAPs.
29 June 2018 and 6 July 2018	Revised draft ACHA was provided to all RAPs for their review and comment following finalisation of the Project rail spur alignment.
August 2018	Comments received on the revised draft ACHA were considered and included in the final ACHA (Appendix G).

Source: After Appendix G.

¹ Excluding those RAPs who were not registered until the additional registration process in December 2015 and January 2016. Copies of the Proposed Methodology were provided to these RAPs at a later date.

² Copies of both the Proposed Methodology and Proposed Methodology Addendum were provided for review and comment to the RAPs who registered during the additional registration process in December 2015 and January 2016.

* The fieldwork participation process is described in detail in Appendix G.

A detailed account of the consultation process (including consultation records and a detailed consultation log) for the Project is provided in Appendix G.

Consultation with the RAPs regarding the Approved Mine and the Project has been extensive and involved various methods including public notices, onsite meetings, written and verbal correspondence, archaeological survey attendance and on-site inspections.

Additional information regarding consultation undertaken with the Aboriginal community is provided in Section 3.

Survey Methodology

Surveys undertaken for the Project focused on areas with the potential to be impacted by the Project that were not part of the Approved Mine. These areas are shown on Figure 4-32 as the “Approximate Extent of Vickery Extension Project Additional Areas”.

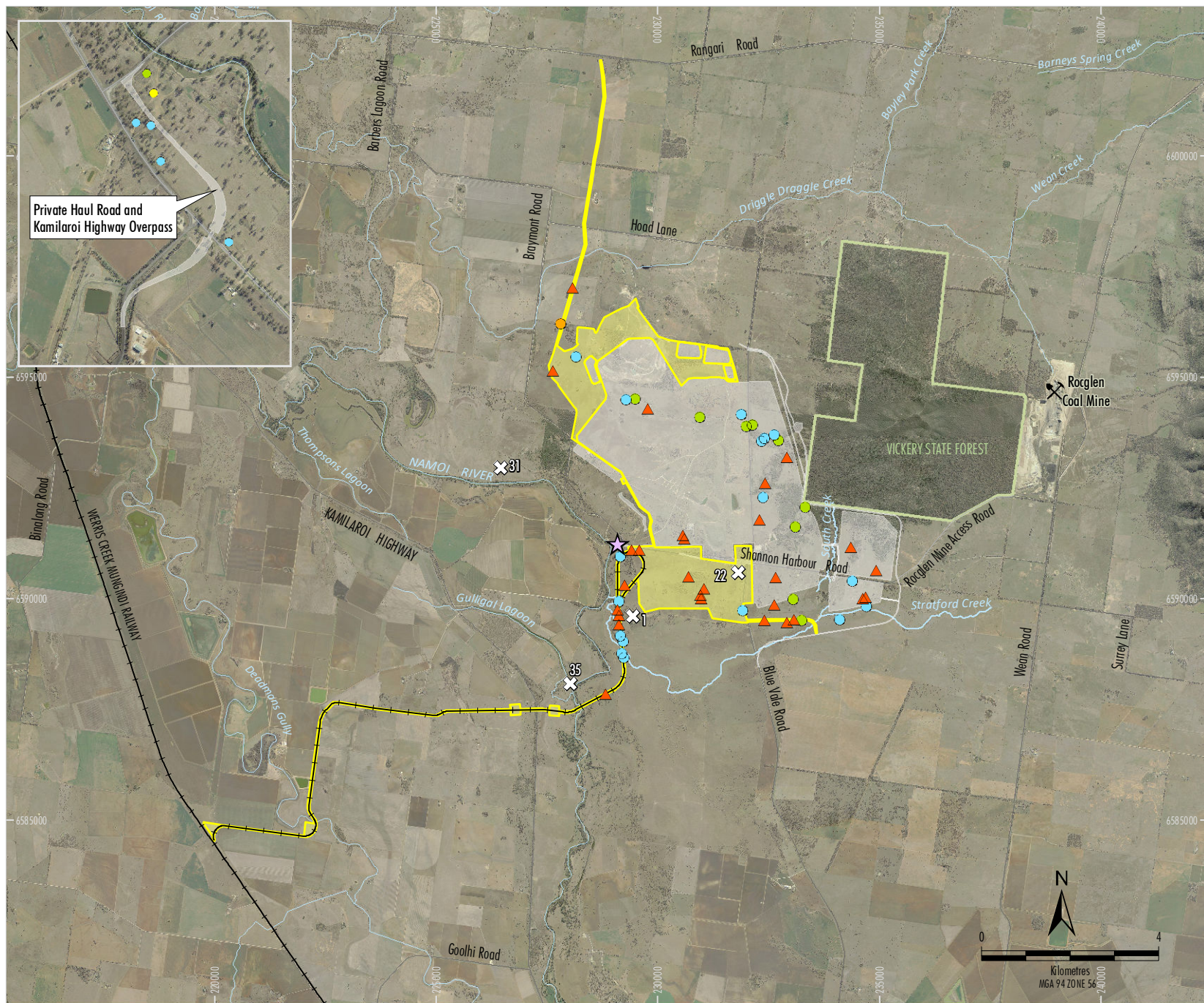
The surveys were informed by the archaeological predictive model and were undertaken to ground truth sites recorded previously in addition to identifying new sites (Appendix G).

During the survey and throughout the consultation process, the representatives of the RAPs were asked to identify any areas of cultural significance within the Project area and surrounds or any cultural values relevant to the area. All cultural comments relating to the Project area and/or the wider region were recorded and are included in Appendix G.

Some small areas (i.e. portions of the Project rail spur) were unable to be accessed during the field surveys. A subsequent site inspection was undertaken by Whincop Archaeology on 1 August 2017, identifying no unusual or culturally sensitive landforms. These areas of the Project rail spur would be subject to additional inspection with RAPs present prior to surface disturbance.

Summary of Archaeological Findings

Following review of the desktop investigation outcomes and the results of the Project surveys, a total of 62 Aboriginal heritage sites were identified within the Project area (including the Approved Mine) and immediate surrounds (Table 4-39).



- LEGEND**
- State Forest
 - Approximate Extent of Approved Mine
 - Approximate Extent of Vickers Extension Project Additional Areas
 - Indicative Rail Spur Alignment
 - Historic Heritage Site
- Aboriginal Heritage Sites**
- Isolated Artefact - Low Significance
 - Artefact Scatter - Low Significance
 - Artefact Scatter - Low-Moderate Significance
 - Artefact Scatter - Moderate Significance
 - Artefact Scatter and Scarred Tree - Low-Moderate Significance
 - Artefact Scatter and Grinding Grooves - Moderate Significance

Source: Orthophoto - Department of Land and Property Information, Aerial Photography Flown (July 2011); Landscape Natural and Cultural Heritage Management (2012); Whinop Archaeology (2018); Extent Heritage (2018)


VICKERY EXTENSION PROJECT
 Heritage Sites Within and in Proximity to the Project Area

Figure 4-32

Table 4-39
Aboriginal Heritage Sites within Project Area and Immediate Surrounds and Level of Proposed Impact

Site Type	Scientific Significance	Level of Proposed Impact	Aboriginal Heritage Site Name	Number Recorded	Approved Mine Impact	Additional Project Impact
Artefact Scatter	Low	Direct (Total)	VEP AS 14, VEP AS 20, VEP AS 21, VEP AS 23, VEP AS 24, VEP AS 27, VEP AS 29, VEP AS 38, VCP-OS-036*, VCP-OS-051*, VCP-OS-055*, VCP-OS-057*, VCP-OS-058*, VCP-OS-067*, VCP-OS-069*	15	7	8
		Direct (Partial)	VCP-OS-009*, VCP-OS-014*, NR-OS-001*, NR-OS-003*	4	4	0
		Nil	NR-OS-002, NR-OS-004	2	0	0
	Low-Moderate	Direct (Total)	BBS/ Red Chief LALC/ Whitehaven Rd 1*, Greenwood Creek*, VCP-OS-001*, VCP-OS-046*, VCP-OS-056*, VM-OS-1*, VCP-OS-011	7	6	1
		Direct (Partial)	VCP-OS-049*, Naomi River/ CWR*, NR-OS-006*	3	3	0
		Nil	VCP-OS-021	1	0	0
	Moderate	Nil	AHIMS 20-4-0013	1	0	0
Isolated Find	Low	Direct (Total)	VEP IA 01, VEP IA 24, VEP IA 36, VEP IA 37, VEP IA 39, VEP IA 41, VEP IA 42, VEP IA 43, VEP IA 49, VEP IA 52, VEP IA 53, VEP IA 54, VEP IA 55, VCP-IF-010, VCP-OS-008, VCP-IF-017*, VCP-IF-018*, VCP-IF-034*, VCP-IF-040*, VCP-IF-043*, VCP-IF-055*, VCP-IF-060*, VCP-IF-070*, VCP-IF-090*, VCP-IF-095*, VCP-IF-109*	26	11	15
		Nil	VCP-IF-014, VCP-OS-007	2	0	0
Grinding Grooves and Artefact Scatter	Moderate	Nil	AHIMS 20-4-0009 ¹	1	0	0
TOTAL				62	31	24

Source: After Appendix G.

* Approved for impact for the Approved Mine.

¹ An investigation by Wilkinson Murray (2018) determined that no vibration-induced damage was likely to occur at the site (Appendix D). The 'Wilga' site is therefore considered to have Nil impact and therefore no loss of value (Appendix G).

This included 22 newly recorded sites (i.e. recorded during the surveys undertaken for the Project) and 40 previously recorded sites (i.e. recorded during previous archaeological investigations, including the assessment prepared for the Approved Mine) (Appendix G).

A detailed description of each of the Aboriginal heritage sites identified during the survey is provided in Appendix G. The distribution of the Aboriginal heritage sites within the Project area is presented on Figure 4-32.

The archaeological significance of the 62 known Aboriginal heritage sites identified within the Project area and immediate surrounds can be summarised as follows (Table 4-39) (Appendix G):

- 49 were assessed as being of low scientific significance;
- 11 were assessed as being of low-moderate scientific significance; and
- 2 were assessed as being of moderate scientific significance.

Cultural Values Assessment

In addition to the consultation conducted for the ACHA, a cultural values assessment for the Project was undertaken by Whincop Archaeology (2018). The cultural values assessment was based on:

- review of background resources, including previous cultural value studies for the surrounding region, and existing and historic mining operations (Haglund, 1986; Vickery Joint Venture, 1986; Dunk and Vermeltfoort, 2011; Insite, 2010; AECOM 2010) and for the Approved Mine (Landskape, 2012);
- historical research;
- discussions with RAPs during field survey;
- discussions with RAPs during community information sessions and site inspections;
- requests for comments during the review period for the Proposed Methodology; and
- requests for comments during the review period for the draft ACHA report.

During the field surveys, attending RAPs were invited to provide any relevant cultural information or values. The archaeologists encouraged participants to provide these values and to engage in discussion regarding bush tucker and medicine, fauna and cultural associations and knowledge of the study area (Appendix G).

A number of general cultural values associated with the broader surrounds have been identified through the consultation undertaken to date. These include the presence of culturally significant fauna and flora species and the connection to Country as an area that Aboriginal people would have occupied in the past. (Appendix G).

The Aboriginal community did not identify the landscape within the Project area as being of high cultural significance or as being interconnected with known heritage places (Appendix G).

The Namoi River is considered to be of cultural significance to the Aboriginal community. Several of the RAPs advised that the riverine environs have special significance to the Aboriginal community. Local Aboriginal people previously and still visit the Namoi River for social events including meetings, fishing, mussel collecting and family outings (Landskape, 2012).

4.15.2 Potential Impacts

Direct Impacts

The Project may result in direct disturbance (either total or partial) of 55 known Aboriginal heritage sites, comprising:

- 27 sites within the Approved Mine mining area, previously approved for impact.
- 4 sites within the Approved Mine private haul road and Kamlaro Highway overpass, previously approved for impact.
- 24 sites within the additional disturbance areas associated with the Project.

While some of these sites may be avoided during the detailed design phase of the surface infrastructure, it has been conservatively assumed that all sites located within the Project mining area, borefield and Project rail spur would be disturbed.

All of the Aboriginal heritage sites with the potential to be impacted by surface disturbance are open artefact sites⁵ that have been assessed to be of low or low-moderate significance. The site of moderate significance adjacent to the northern borefield would be avoided by the Project (Appendix G) (Table 4-39).

The location and design of ancillary infrastructure (e.g. access tracks) required progressively over the life of the Project is flexible and would be located to avoid or minimise potential impacts to known Aboriginal heritage sites (Appendix G).

Indirect Impacts

Possible causes of indirect impacts to Aboriginal heritage sites in close proximity to the Project include:

- potential impacts associated with blasting induced vibration;
- accidental disturbance by peripheral activities; and
- inappropriate visitation of known Aboriginal cultural heritage sites.

The nature of open artefact sites is such that vibration does not pose a material risk.

Potential vibration impacts to the grinding groove site (AHIMS 20-4-0009) were assessed by Wilkinson Murray (2018) as part of the Noise and Blasting Assessment. It was predicted that Project blasts would not damage the grinding groove site (Appendix D).

Potential impacts associated with accidental disturbance by peripheral activities and inappropriate visitation would be effectively managed by the measures described in Section 4.15.3 and are not considered material risks.

Cumulative Impacts

A consideration of the potential cumulative impacts associated with the Project, including the Approval Mine, has been undertaken and is presented in Appendix G. This assessment includes a consideration of the known and previously unidentified potential heritage resources that may be impacted by surrounding projects.

The identified Aboriginal heritage sites within the Project area are generally of a low scientific significance (Table 4-39). In terms of cultural values, the Project is considered to cause few impacts additional to those that have already occurred, and these would be mitigated by the ongoing program of archaeological recording recommended by Whincop Archaeology (2018) and summarised in Section 4.15.3.

Whincop Archaeology (2018) concluded the Project would not substantially increase cumulative impacts on Aboriginal heritage in the region.

4.15.3 Mitigation Measures, Management and Monitoring

The mitigation, management and monitoring measures detailed below have been developed in consultation with the RAPs, in consideration of the cultural and archaeological significance of the Aboriginal heritage sites predicted to be impacted, and the cultural significance of the broader area.

Heritage Management Plan

A Heritage Management Plan would be developed in consultation with the RAPs and the OEH. The Heritage Management Plan would be developed prior to any Project-related works that would potentially harm Aboriginal cultural heritage sites.

A summary of measures expected to be included in the Heritage Management Plan and implemented over the life of the Project are provided below. Further detail is provided in Appendix G.

Surface Disturbance

For those areas where Aboriginal cultural heritage sites may be subject to direct surface disturbance as a result of the Project, a number of mitigation measures and management strategies have been identified, including (Appendix G):

- Maintenance of an Aboriginal Cultural Heritage Sites Database for known Aboriginal heritage sites within the Project area.
- Undertaking archaeological survey of potential impact areas within the Project rail spur that have not been subject to systematic survey sampling.

⁵ The term 'open artefact site' refers to both artefact scatters and isolated finds.

- Implementation of a protocol for surface disturbance works to reduce the risk of accidental damage to known Aboriginal cultural heritage sites.
- Where practicable, known Aboriginal heritage sites would be avoided by flexible components (e.g. ancillary infrastructure).
- The location of known Aboriginal heritage sites would be considered during final detailed engineering designs of road realignments and ancillary infrastructure.
- Salvage of a representative collection of visible surface artefacts should be undertaken in consultation with the RAPs.
- Monitoring of blast vibration at the grinding groove site (AHIMS 20-4-0009).

During development of the Heritage Management Plan, the RAPs would be requested to provide advice on the storage of collected artefacts and the management of artefacts at the completion of Project activities (e.g. artefact replacement onto the post-mining landscape or retained for display/educational purposes).

General Measures

Where the above specific mitigation measures and management strategies are not applicable, a number of general measures have been formulated in consultation with the RAPs to mitigate impacts, including (Appendix G):

- Ongoing consultation with the RAPs over the life of the Project, including Aboriginal representation during archaeological fieldwork (e.g. salvage of artefacts prior to disturbance).
- Opportunities for Aboriginal community members to access known Aboriginal heritage sites located on Whitehaven-owned land (e.g. for cultural reasons or as part of scheduled field activities).
- A communication protocol should be developed that describes clear methods of communication, including expectations of suitable notification and response times between the proponent and the RAPs.
- All relevant contractors and staff engaged for the Project who may have interactions with Aboriginal heritage sites would receive heritage awareness training as part of the induction process.
- Should any skeletal remains be detected during the course of the Project, work with the potential to impact the remains would cease immediately and the find would be reported to the relevant authorities (including the Police, the OEH and RAPs). Subject to the Police requiring no further involvement, the management of any Aboriginal skeletal remains would be determined in consultation with the DP&E, the OEH and the RAPs.
- A protocol would be developed for the management of previously unidentified Aboriginal cultural heritage sites.

4.16 HISTORIC HERITAGE

A Historic Heritage Assessment for the Project was undertaken by Extent Heritage Pty Ltd (Extent) (2018) and is presented in Appendix K.

The assessment was prepared in consideration of the relevant principles and articles contained in (but not limited to):

- *The Burra Charter: The Australia ICOMOS Charter for Places of Cultural Significance* (Australia ICOMOS, 2013);
- *NSW Heritage Manual* (NSW Heritage Office and NSW Department of Urban Affairs and Planning, 1996);
- *Assessing Heritage Significance* (NSW Heritage Office, 2001);
- *Assessing Heritage Significance for Historical Archaeological Sites and 'Relics'* (NSW Heritage Office, 2009); and
- *Statements of Heritage Impact* (NSW Heritage Office, 2002).

A description of existing historic heritage within the Project area is provided in Section 4.16.1. Section 4.16.2 describes the potential impacts of the Project on historic heritage, while Section 4.16.3 outlines mitigation measures, management and monitoring.

4.16.1 Existing Environment

Historical Overview

Aboriginal people of the Kamilaroi (or Gamilaraay) language group occupied the Liverpool Plains region at the time of European contact (Appendix G).

Surveyor-General John Oxley passed through the Gunnedah Basin during his 1818 expedition, however, it was Alan Cunningham during his 1827 expedition to the Darling Downs who discovered the Namoi River. The first European in the local area however, was not an explorer, but the escaped convict George ‘the Barber’ Clarke, who lived with the Kamilaroi Aboriginal people for 5 years from 1826.

Clarke based himself at Barbers Lagoon on Wilberoi Reserve (approximately 6 km south-east of Boggabri and 5 km north-west of the Project) and rustled cattle from the squatters further south.

In 1829 the Colonial Government established the ‘Limits of Location’, bounding nineteen counties within which settlement could be sanctioned and more easily controlled. The promise for better grazing land enticed pastoralists to send their stock beyond the ‘Limits of Location’ (i.e. to the Boggabri region), which resulted in the squatting boom.

The initial agricultural land use in the Project area and surrounds was sheep grazing on native pastures in the 1830s and 1840s, which was gradually combined with small scale dryland cropping of barley and some wheat using horse-drawn ploughs and harvesters. Anecdotal information from local landholders indicates that the dryland cropping was low yielding and was largely abandoned in the early to mid 1900s, when tractors were introduced to the region and the cropping potential of the black soils on the Gunnedah Region’s floodplains was discovered.

Heritage Register Searches

Extent completed historic and archival research and a review of heritage registers, including searches of the following (Appendix K):

- NSW State Heritage Register.
- Former Register of the National Estate.
- National Trust Register.
- National Heritage List.

- Schedules of the *Gunnedah Local Environmental Plan 2012*.
- Schedules of the *Narrabri Local Environmental Plan 2012*.
- Australia Institute of Architects Register of Significant 20th Century Buildings.

No items listed on local, regional, state or national historic registers are located in the Project area (Appendix K).

Previous Investigations

A Non-Aboriginal Heritage Assessment was prepared by Heritage Management Consultants Pty Ltd (2012) for the Approved Mine. No items of state or regional historic heritage significance were identified in the disturbance footprint of the Approved Mine (Whitehaven, 2013).

Fourteen items of potential historic heritage significance were also identified during surveys undertaken for the Approved Mine. These items included cottages and sheds, building foundations, dips, surveyors scarred trees and survey marks and agricultural items. None of these items were assessed as being of heritage significance (Heritage Management Consultants Pty Ltd, 2012).

Two heritage items were identified outside the Approved Mine disturbance area. The Broadwater Homestead Complex (Site 31) contains a number of well-maintained buildings that reflect rural settlement of the local area in the late 19th and early 20th century. The deteriorating condition of other buildings of the same period elsewhere in the region suggests that the complex is locally important.

The Kurrumbede Homestead Complex (Site 1) is located to the south of the Project mining area. Several archaeological investigations have been undertaken in relation to this site, including assessments undertaken by Miller and Macartney (1956), Kingston (1986) and Lewis (1998), and is described in more detail below.

Project Investigation

Following a desktop assessment and review of previous investigations, additional site investigations were conducted by Dr Andrew Sneddon of Extent in 2016 across the Project area and immediate surrounds (Appendix K).

During this survey, three potential historic heritage sites were identified in the vicinity of the Project – the Kurrumbede Homestead Complex (Site 1), a Weatherboard Home (Site 22) and a homestead known as ‘The Rampadells’ (Site 35).

Four other items of potential historic heritage significance were also identified, including a demolished house and associated structural remains, remains of timber racing barriers, a homestead (including associated ancillary structures) and a bottle dump. None of these items were considered to be of heritage significance (Appendix K) and are therefore not discussed further in Section 4.16.2.

Heritage Items within and in Proximity of the Project Area

As a result of the heritage register searches, previous historic heritage investigations and the site investigation undertaken by Extent for the Project, one item of historic heritage significance (potential local significance) (Site 22) has been identified within the Project extension area, and three sites (two of potential local significance [Sites 31 and 35] and one of potential state significance [Site 1]) within the immediate vicinity of the Project (Table 4-40).

Sites 1, 22, 31 and 35 are not listed on any historic heritage registers. However, for the purpose of this assessment, these sites are conservatively assessed as being of local and/or state significance.

The Kurrumbede Homestead Complex (Site 1) is of potential state historic heritage significance and comprises a main homestead and associated suite of farm buildings dating from approximately 1907. The homestead represents a unique construction type (using concrete blocks) and is associated with local poet Dorothea Mackellar. Site 1 is located outside of the Project area and would not be directly impacted by the Project (Figure 4-32).

The Weatherboard Home (Site 22) is of potential local historic heritage significance as it reflects the pattern and nature of the local area’s historical development and is a less common structural example within the local area. Site 22 is located within the Project mining area and would therefore be directly impacted by the Project (Figure 4-32).

Table 4-40
Historic Heritage Sites of Significance within Project Area and Immediate Surrounds

Site Number*	Historic Heritage Item	Identified in Historic Heritage Register?	Description	Significance	Located within Project Area
1	Kurrumbede Homestead Complex	No	Suite of farm buildings dated from 1907/1908 including a main residence and surrounding structures.	Potential Local/State	No
22	Weatherboard Home	No	A weatherboard home with board-and-batten exterior cladding and a wrap-around veranda on the front and side elevations.	Potential Local	Yes – within Project mining area
31	Broadwater Homestead Complex	No	Weatherboard corrugated iron roofed cottage, occupied; brick modern cottage occupied; old woolshed with old press and horse tack room (not accessed); several outbuildings and old tractors in paddock.	Potential Local	No
35	‘The Rampadells’	No	Weatherboard corrugated iron roofed cottage with a verandah on the south-east elevation (facing the Namoi River).	Potential Local	No

Source: After Appendix K.

* Corresponds with the site number presented on Figure 4-32.

The Broadwater Homestead Complex (Site 31) was assessed as part of the Historic Heritage Assessment for the Approved Mine (Whitehaven, 2013). The site is of potential local heritage significance as it contains a number of well-maintained buildings that reflect rural settlement of the local area in the late 19th and early 20th Century. Site 31 is located outside the Project area and would not be directly impacted by the Project (Figure 4-32).

‘The Rampadells’ (Site 35) is of potential local historic significance, as it a good representative example of a rural homestead in western NSW at the turn of the twentieth century, and surviving examples that display the same level of intactness (both interior and exterior) are becoming less common in the local area. Site 35 is located outside the Project area and would not be directly impacted by the Project (Figure 4-32).

4.16.2 Potential Impacts

Potential Direct Impacts

The Weatherboard Home (Site 22) is located within the Project mining area and would be directly disturbed by the Project (Figure 4-32). Extent (2018) considers the loss of this structure would constitute a low-level adverse heritage impact. Archival recording of this site would occur prior to disturbance (Section 4.16.3) consistent with the recommendations of Extent (2018).

Potential Indirect Impacts

Extent (2018) considered potential indirect impacts of to the Kurrumbede Homestead Complex (Site 1) from the Project associated with blasting (building damage), air quality, noise, visual amenity and loss of accessibility. Extent (2018) concluded any potential indirect impacts of the Project to the Kurrumbede Homestead Complex (Site 1) would be manageable and reversible (as they would occur during the life of the Project only), given that:

- Blast modelling (Wilkinson Murray, 2018) predicts there would be no exceedance of blast vibration and overpressure criteria for building damage at Site 1.
- While the Project may increase dust deposition levels at Site 1, fouling and deterioration of the buildings could be prevented through standard maintenance and upkeep.

- As the Kurrumbede Homestead is positioned to face south-west (i.e. away from the Project and towards the Namoi River) and is surrounded by trees/landscaping, the potential visual impacts of the Project are low.
- Noise from the Project would be audible at Site 1, however at levels consistent with a “quiet to very quiet” relative loudness (Table 4-14).
- Site 1 is not currently accessible to the public as it is located on Whitehaven-owned land (and given its proximity to the Approved Mine). Whitehaven would consider using the Kurrumbede Homestead as office space during the life of the Project, which in combination with regular upkeep, would prevent deterioration of buildings.

In summary, amenity impacts (e.g. audible noise and visual modification) may occur at the Kurrumbede Homestead Complex as a result of the Project, however, such impacts would not be experienced by the general public. Although indirect impacts to the Kurrumbede Homestead Complex are considered to have a low potential of occurring (Appendix K), vibration monitoring and structural inspections of the infrastructure would be undertaken (Section 4.16.3).

Potential indirect impacts to the Broadwater Homestead Complex (Site 31) and ‘The Rampadells’ (Site 35) have been assessed and would be less than those for the Kurrumbede Homestead Complex. No specific management measures are considered necessary for these sites (Appendix K).

Cumulative Impacts

Extent (2018) concluded that the direct impacts to Site 22 would result in a low-level adverse heritage impact, to be mitigated with archival recording of the site. Indirect impacts to other heritage sites would be manageable and reversible.

Given the minor nature of the additional potential impacts predicted by Extent (2018), no significant impacts to historic heritage in the Project region is expected when the Project is considered cumulatively with other projects in the region.

4.16.3 Mitigation Measures, Management and Monitoring

Management measures for the identified historic heritage sites would be described in a Heritage Management Plan developed for the Project.

Specific management measures for each historic heritage site, which would potentially experience direct or indirect impacts associated with the Project are provided in Table 4-41. Consistent with the findings of the Non-Aboriginal Heritage Assessment conducted for the Approved Mine, no mitigation measures, management or monitoring programs are proposed for Site 31. No mitigation measures, management or monitoring programs are proposed for Site 35 (Appendix K).

Similarly, no specific management measures are proposed for items identified during the surveys that are not considered to be of historic heritage significance (Appendix K). However, some of these items may be of interest to local collectors, and prior to Project disturbance, would be offered to the Boggabri Historical Society and/or the Gunnedah Museum.

The Economic Assessment was prepared in accordance with the *Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals* (NSW Government, 2015) and the *Technical Notes supporting the Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals* (DP&E, 2018).

The Economic Assessment was conducted at two different scales to assess the potential impact of the Project on the region and in NSW. The region adopted for the economic impact assessment was the Gunnedah, Narrabri, Liverpool Plains and Tamworth Regional LGAs (Appendix J).

The economic assessment is primarily concerned with the effect of a proposal on an economy in terms of specific indicators, such as value added, employment and income. The economic assessment is based on input-output modelling developed by AnalytEcon.

A summary of the existing regional and NSW economies is provided in Section 4.17.1. The potential impacts of the Project on the regional and NSW economies are described in Section 4.17.2, while mitigation and management measures are provided in Section 4.17.3.

4.17 ECONOMIC EFFECTS

An Economic Assessment for the Project was undertaken by AnalytEcon (2018) and is presented in Appendix J.

The Economic Assessment was peer reviewed by Dr Brian Fisher (BAEconomics). The peer review report is presented in Attachment 4.

4.17.1 Existing Environment

The population of the region (i.e. Gunnedah, Narrabri, Liverpool Plains and Tamworth Regional LGAs) is approximately 94,904 (Appendix J).

Table 4-41
Management Measures for Relevant Historic Heritage Items

Site Number ¹	Historic Heritage Item	Management Measures
1	Kurrumbede Homestead Complex	Undertake airblast and vibration level monitoring at the homestead during operations. Prior to the commencement of mining, the homestead would be inspected by a structural engineer to confirm relevant blast vibration limits. A Heritage Management Plan, including specific management measures for the Kurrumbede Homestead Complex, would be prepared for the Project.
22	Weatherboard Home	Prior to direct disturbance to the site, photographic archival recording would be undertaken in accordance with the following NSW Government guidelines: - How to Prepare Archival Records of Heritage Items (NSW Heritage Office, 1998); and - Photographic Recording of Heritage Items Using Film or Digital Capture (NSW Heritage Office, 2006).

Source: After Appendix K.

¹ Corresponds with the numbers presented on Figure 4-32.

The services, agriculture, construction, manufacturing and mining sectors are the largest sectors from an employment perspective in the region (Appendix J).

The agricultural and mining sectors are of greater relative importance to the regional economy than to the NSW economy, while the manufacturing sectors is of less relative importance to the regional economy than they are to the NSW economy (Appendix J).

Unemployment is markedly higher in the region than for NSW as a whole. High unemployment is noted as an ongoing cause for concern across the region (Appendix R).

4.17.2 Potential Impacts

The economic assessment in Appendix J included consideration of the impacts of the Project on both the regional (i.e. Gunnedah, Narrabri, Liverpool Plains and Tamworth Regional LGAs) and NSW economies.

Employment and Income

The average Project operational workforce would be in the order of approximately 344 full-time equivalent on-site personnel (Appendix J). At full development, the Project operational workforce would be in the order of 450 full-time equivalent on-site personnel (Section 2.15).

Construction/development activities (e.g. construction of the mine infrastructure area and service facilities) would require an additional construction workforce of up to approximately 500 full-time equivalent personnel (Section 2.15).

The projected direct employment would be accompanied by an increase in disposable income (Appendix J):

- approximately \$224 million in NPV terms in the region; and
- approximately \$271 million in NPV terms in NSW.

The Project is also projected to result in indirect employment impacts associated with related upstream or downstream industries. Over the life of the Project, it is projected to generate an additional (Appendix J):

- approximately 181 full-time equivalent jobs in the region; and
- approximately 316 full-time equivalent jobs in NSW.

The projected growth in indirect employment would be accompanied by an increase in disposable income (Appendix J):

- approximately \$92 million in NPV terms (or \$8 million per annum) in the region; and
- approximately \$146 million in NPV terms (or \$12 million per annum) in NSW.

Value Added

Value added is the additional value of goods and services that are newly created in an economy, and that are available for domestic consumption or for export (Appendix J).

The Project is projected to generate incremental indirect value added benefits of approximately \$322 million in NPV terms (or approximately \$25 million per annum) in other industries in NSW.

Agricultural Activities

AnalytEcon (2018) estimated the direct agricultural impacts of the Project (including potential biodiversity offset areas that would no longer be available for agricultural use) would be equal to a loss of agricultural gross margins of approximately \$17.9 million in NPV terms (approximately \$1.6 million per annum).

AnalytEcon (2018) evaluated the potential indirect economic impacts on agriculture in the regional economy as a result of the Project (i.e. the effects of reduced agricultural production on the demand for downstream agricultural services and upstream value adding enterprises).

The indirect impacts to agricultural activities effectively represent an offset to the indirect benefits of the Project to the regional economy, corresponding to a reduction of approximately 0.5 full-time equivalent jobs per annum and a reduction in disposable income of approximately \$0.7 million per annum (Appendix J).

End of Project Life

The establishment and operation of the Project would stimulate demand in the regional and NSW economies leading to increased employment and value added (Appendix J). Cessation of the mining operations would result in a contraction in regional economic activity.

The magnitude of the regional economic impacts from cessation of the Project would depend on a number of interrelated factors, including the movements of workers and their families, alternative development opportunities and economic structure and trends in the regional economy at the time.

New mining resource developments in the region would help broaden the region's economic base and buffer against impacts of the cessation of individual activities. The Gunnedah Basin has a range of coal and coal seam methane resources, with a range of development proposals pending.

4.17.3 Mitigation Measures, Management and Monitoring

Planning for mine closure would be conducted over the life of the Project, in consultation with the Gunnedah Shire Council, Narrabri Shire Council, DP&E and the local community, and would include consideration of amelioration of potential adverse socio-economic effects due to the reduction in employment at Project closure (Section 5.8).

4.18 SOCIAL AND COMMUNITY INFRASTRUCTURE

A Social Impact Assessment was prepared by Elliott Whiteing (2018) to consider the potential impacts of the Project on employment, population, community infrastructure demand and social values in the local and regional community (Appendix R).

A summary of the social baseline results including outcomes of community consultation is provided in Section 4.18.1. Potential estimated Project-only and cumulative employment, population and community infrastructure demands are described in Section 4.18.2. Proposed mitigation measures are provided in Section 4.18.3.

The Social Impact Assessment was prepared in accordance with the SEARs and the *Social Impact Assessment Guideline for State significant mining, petroleum production and extractive industry development* (DPE, 2017).

4.18.1 Existing Environment

Area of Social Influence

The Social Impact Assessment defines the Gunnedah and Narrabri LGAs as the primary region of social influence for the Project, as this is where the majority of the Project operational workforce are predicted to reside.

The Gunnedah and Narrabri LGAs had a total population of approximately 25,000 people in 2016 (Appendix R).

Boggabri is the closest town to the Project, with a population of approximately 850 people in 2016 (Appendix R). The Social Impact Assessment includes a focus on Boggabri as it is expected to host the majority of the Project construction workforce (in the Boggabri Accommodation Village) and is predicted to experience an increase in population of approximately 5 to 10% over the Project mine life.

The private landholders living in close proximity to the Project are also within the area of social influence, and were consulted as part of the Social Impact Assessment.

Community Consultation

The Social Impact Assessment has been informed by consultation undertaken by Whitehaven for the Approved Mine EIS and during the preparation of the Project EIS (Section 3).

Consultation undertaken by Elliott Whiteing for the Project Social Impact Assessment is summarised in Table 4-42.

Table 4-42
Summary of Social Impact Assessment Stakeholder Engagement and Consultation undertaken by Elliott Whiteing

Stakeholder	Engagement Method
Gunnedah Shire Council	- Meeting with General Manager and Director Planning and Environmental Services to discuss existing social conditions, and potential Project impacts and opportunities. - Meeting with Councillor who is a member of the Vickery CCC to discuss mining industry contributions to local community and economy.
Narrabri Shire Council	Meeting with Mayor, General Manager, Director Development and Economic Growth, and Economic Development Manager to discuss existing social conditions, and potential Project impacts and opportunities.
Community members	- Face to face interview with Red Chief LALC and phone interview with Winanga-Li Aboriginal Child and Family Centre, to discuss existing social conditions, and potential Project impacts and opportunities of specific relevance to Aboriginal people. - Attendance at Vickery CCC (by phone conference) to listen to community concerns about the Project, and invite discussion about the Project's potential social impacts and benefits. - Focus on existing community issues and potential social impacts and opportunities as part of workshops with social infrastructure and business representatives.
Social infrastructure providers and local businesses	- SIA workshops in Gunnedah, Boggabri and Narrabri to seek input from local service providers about existing community issues, potential project impacts and potential effects on community health and emergency services, including: - Interview with Chairperson of Boggabri Business and Community Progress Association. - Interviews with Gunnedah Hospital and Health Service Manager, and with the Boggabri Primary School Principal.
Landholders	Face to face interviews (12) and phone interviews (5) with owners of properties near the Project to discuss properties' social values, potential for project to impact on social values including amenity, quality of life, health and social cohesion, and potential for benefits as a result of the Project.

Source: Appendix R.

Social Baseline

A description of the existing population profile, employment, housing, health and education resources in the region is provided in Appendix R. This includes key local and regional social baseline findings identified during consultation.

Whitehaven's existing operations, and associated employment, expenditure and sponsorship form part of the social baseline for the region. Whitehaven is the largest employer in the region and has provided expenditure of approximately \$1.5 billion in the region since 2012.

Key findings from consultation for the Social Impact Assessment note the shift to employment in the mining industry in Gunnedah and Narrabri, and to a lesser extent in Boggabri. The agriculture industry continues to be a major employing sector, however has declined in prominence due to technological advances and specialised contractors (Appendix R).

Stakeholders also acknowledged improvements in Indigenous unemployment statistics, attributed to increasing employment opportunities with Whitehaven's existing operations in the region (Appendix R).

4.18.2 Potential Social Impacts and Opportunities

Elliott Whiteing (2018) has assessed potential social impacts and opportunities of the Project for the local and regional communities.

The potential cumulative impacts of the Project and other proposed, approved or recently commenced projects within the Project region have been considered in Appendix R.

The economic benefits of the Project to residents of the region, as well as of NSW, are described in Section 4.17.

Gunnedah and Narrabri Local Government Areas

Outcomes of consultation indicate there is general support and acknowledgement of the potential benefits of the Project, as well as the benefits of existing mining operations, to the Gunnedah and Narrabri LGAs (and the towns of Gunnedah and Narrabri, specifically) (Appendix R).

Potential opportunities of the Project to the Gunnedah and Narrabri LGAs include (Appendix R):

- employment pathways that enable people to stay in the region, including the region's younger people;
- further employment opportunities for people who may currently be socio-economically disadvantaged;
- potential for increased, sustainable population growth due to Project personnel and their immediate families moving to the region;
- support for local businesses due to increased trade (from employee expenditure and Whitehaven's direct expenditure in the region); and
- diversification of employment in the region (e.g. beyond the agriculture industry), particularly during periods such as the current drought.

Notwithstanding, the need for Whitehaven to work collaboratively with the community and local governments was identified, to manage any associated incremental changes to social character and stresses to community infrastructure, such as (Appendix R):

- access to services and facilities (including health, emergency and childcare services);
- draw of labour from other industries; and
- vocational training to maximise local employment opportunities.

The proportion of Project operational personnel and their immediate family predicted to move to the region would represent population growth of approximately 1.4% and 0.9% in the Gunnedah and Narrabri LGAs, respectively (Appendix R).

This is not expected to significantly impact on social character in the region or provision of community infrastructure to existing residents, and has the potential to offset population decline that could otherwise occur in the absence of the Project (Appendix R).

Boggabri Town Centre

Consultation with community members and key social infrastructure providers within Boggabri identified concerns that, to date, Boggabri had not experienced the same level of benefits that Gunnedah and Narrabri had experienced as a result of the region's existing mining operations (Appendix R).

Specific to the Project, concerns identified by community members and key social infrastructure providers within Boggabri include (Appendix R):

- increased non-local population during the Project construction period, with potential for changes to social character and/or reduced access to community infrastructure;
- continuation of social benefits to the Gunnedah and Narrabri town centres, with limited perceived benefit for Boggabri; and
- housing availability and affordability (particularly for lower income residents) during Project operations.

Management strategies have been developed to address these concerns (Section 4.18.3), such as the provision of construction and operational workforce data to key agencies to support planning and allow local businesses to maximise opportunities that may arise for the Project.

Local Landholders

Local landholders within the immediate vicinity of the Project identified concerns regarding potential impacts to the amenity of their property, property values, water resources, flooding characteristics and rural character of the region (regardless of predicted compliance with regulatory levels, where relevant) (Appendix R).

The Project is located on land owned by Whitehaven, or where Whitehaven has entered into access agreements, and so the Project would not directly disturb any privately-owned properties.

Management strategies for local landholders are described in Section 4.18.3, and are in addition to the specific management strategies for minimising potential impacts to amenity, water resources and flooding described in the relevant sections of the EIS.

Environment

Stakeholders consistently stated the Project should be operated in a manner that minimises and avoids impacts to the surrounding environment, including the Namoi River, its flood plains and the Upper Namoi Alluvium groundwater system. Measures to avoid, mitigate, manage and offset the potential environmental impacts of the Project are described throughout this EIS.

Whitehaven's decision to remove the Blue Vale Open Cut from the Project scope was viewed positively by the community (Appendix R).

4.18.3 Mitigation Measures, Management and Monitoring

Whitehaven would continue to work in partnership with the Narrabri Shire Council, Gunnedah Shire Council and the local community to maximise potential opportunities and minimise potential social impacts of the Project.

A number of mitigation and management strategies have been identified by Elliott Whiteing (2018), including:

- Stakeholder engagement and consultation strategies, including:
 - community consultation on EIS findings;
 - ongoing communication and engagement programs;
 - dedicated contact points within Whitehaven to facilitate community liaison;
 - a community complaints and response procedure;
 - co-operation on cumulative impacts to provision of community infrastructure; and
 - support of community cohesion and development via engagement with key community stakeholders.
- Local landholder amenity and quality of life strategies, including:
 - ongoing local landholder engagement program; and
 - preparation of property specific mitigation plans, if requested by the landowner.
- Community infrastructure and wellbeing strategies, including:
 - provision of construction and operational workforce data to key agencies to support service planning;
 - funding and support of local community infrastructure providers via Voluntary Planning Agreements; and
 - education and promotion of environmental health and water resource management in the region.
- Housing and workforce management strategies, including:
 - encouraging Project contractors and suppliers to preferentially employ local residents within the region;
 - operations recruitment strategy, including preferential employment of local residents and implementation of the Whitehaven Workforce Diversity Policy;
 - support for locally based training programs;
 - encouraging non-local personnel to use the Boggabri Accommodation Camp;
 - settlement and integration strategies for personnel moving to the region;
 - implementation of a personnel behaviour code of conduct within local towns; and
 - monitoring of cumulative impacts to housing availability and affordability, in consultation with DP&E and other mining operations.
- Local business opportunities strategies, including:
 - development of a local content strategy for Project contractors/suppliers and implementation of a local supplier database;
 - consultation with local business groups and chambers, including the Boggabri Business and Community Progress Association; and
 - support of a courtesy bus between the Boggabri Accommodation Camp and Boggabri town.

4.19 HAZARD AND RISK

A PHA to evaluate the potential hazards associated with the Project was conducted by a multi-disciplinary team. The PHA was conducted in accordance with the general principles of risk evaluation and assessment outlined in the DP&I *Multi-Level Risk Assessment* (DP&I, 2011).

The PHA also addresses the requirements of *State Environmental Planning Policy No. 33 (Hazardous and Offensive Development)* (SEPP 33) and has been assessed in general accordance with *Hazardous Industry Planning Advisory Paper No. 6: Hazard Analysis* (NSW Department of Planning, 2011).

Potential incidents and hazards identified for the Project are described in Section 4.19.1. Proposed preventative and control measures to address potential hazards are described in Section 4.19.2.

4.19.1 Hazard Identification and Risk Assessment

Potentially hazardous materials required for the Project include hydrocarbons (petrol, diesel, oils, greases, degreasers and kerosene), explosives, chemicals and Liquid and Non-Liquid Wastes (Appendix P).

In accordance with DP&I (2011), the PHA specifically covers the risks from fixed installations. As such, the main focus of the assessment was the on-site storage of potentially hazardous materials (Appendix P).

The following generic classes of incidents were identified:

- leaks/spills;
- fire;
- explosion; and
- theft.

These incident classes were applied to the Project component areas to identify scenarios for which treatment measures were developed.

Following identification of the potential hazards associated with the Project, a qualitative assessment of the risks to the public, property and the environment associated with the Project was undertaken (Appendix P).

An assessment of the combination of the consequence and probability rankings concluded that the overall risk rankings for the identified hazards would be low, and therefore tolerable (Appendix P).

4.19.2 Hazard Prevention and Mitigation Measures

A number of hazard control and mitigation measures could be described in management plans for the Project. The relevant management plans would include:

- Blast Management Plan.
- Water Management Plan.
- Pollution Incident Response Management Plan.

Management measures would also be developed to control and mitigate potential waste and bushfire hazards.

In addition, the following hazard control and mitigation measures could be adopted for the Project:

- **Maintenance** – Maintenance of all mobile and fixed plant and equipment.
- **Staff Training** – Only those personnel authorised to undertake skilled and potentially hazardous work would be permitted to do so.
- **Engineering Structures** – Mining and civil engineering structures would be constructed in accordance with applicable codes, guidelines and Australian Standards. Where applicable, Whitehaven would obtain the necessary licences and permits for engineering structures.
- **Contractor Management** – All contractors engaged by Whitehaven would be required to operate in accordance with the relevant Australian Standards and NSW legislation.
- **Water Management** – water management structures would be constructed to separate runoff from undisturbed areas and disturbed areas (Section 2.10).
- **Coal Stockpile Management** – Coal stockpiles would be managed to reduce the potential for spontaneous combustion.
- **Storage Facilities** – Storage and usage procedures for potentially hazardous materials (e.g. fuels, oils, greases) would be developed in accordance with Australian Standards and relevant legislation.

- **Emergency Response** – Fire fighting and spill management equipment would be kept on-site in appropriate locations. Emergency response training, procedures, manuals and systems would continue to be implemented.