

4.8 SOILS AND LAND AND SOIL CAPABILITY

The soils assessment of the amended Project was undertaken in two parts. The assessment of soils within the Mine Area and power line corridors was completed by Geoff Cunningham Natural Resource Consultants Pty Ltd as part of the 2013 Project assessment whilst the assessment of soils within the private haul road corridor was completed by Soil Management Designs as part of the amended Project. The full assessments are presented in Volume 4 Parts 10A and 10B of the Specialist Consultant Studies Compendium and are referenced throughout this section as GCNRC (2013a) and SOILmgt (2016), with a summary of the assessments presented in the following subsections. Relevant soils information is also discussed in Section 4.17 with respect to agricultural resources within the Site.

4.8.1 Introduction

Based on the risk assessment undertaken for the amended Project (Section 3.3.1 and **Appendix 6**), the potential impacts relating to soils and their risk rankings after the adoption of standard mitigation measures are as follows.

- Inadequate soils available for rehabilitation purposes leading to less successful rehabilitation and increased rehabilitation costs and maintenance to the Mine Area and private haul road corridor (low).
- Degradation of soil in stockpiles leading to less successful rehabilitation and increased rehabilitation costs and maintenance (low).
- Erosion of soil stockpiles within the Waukivory Creek / Oaky Creek catchment areas leading to increased sediment loads in both creeks (low).

In addition, the Director-General's Requirements issued by the then DP&I (now DPE) identified "Soil, Land Capability, and Agricultural Suitability" as key issues requiring assessment. The principal assessment matters relating to soils and agriculture include the following.

- Soils and land capability (including salinisation and contamination).
- Pre-mining and post-mining agricultural assessment and mapping (including Land Capability and Agricultural Suitability mapping) of soil characteristics across all proposed disturbance areas, and an assessment of their value and rehabilitation limitations.
- A detailed description of the measures that would be implemented to avoid, reduce or mitigate impacts of the development on local agricultural resources and/or enterprises.

It is noted that since the DGRs were issued and the release of the Upper Hunter Strategic Rural Land Use Plans, the former "Land Capability and Agricultural Suitability" mapping has been superseded by "Land and Soil Capability" mapping of NSW (OEH) which includes the former Gloucester LGA.

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the DGRs from the EPA, the former Gloucester Shire Council, DRE and Hunter-Central Rivers NSW Catchment Management Authority. The matters identified are generally consistent with the DGRs.

The soils assessment outlined in this section focusses upon the physical and chemical attributes of the soil resources within the Site, particularly with respect to their stripping, stockpiling, management and re-use. GCNRC (2013b), i.e. Appendix 1 of the Agricultural Impact Statement Volume 5, Part 13 of the *Specialist Consultant Studies Compendium*, presents an additional assessment of the agricultural characteristics of the soils within the Mine Area. This additional assessment was assembled given the Applicant's objective is to return all areas of disturbance in the Mine Area to the same land capability that existed prior to mining, with a mixture of grazing and passive native conservation uses.

4.8.2 Soils Occurrences

4.8.2.1 Local Setting

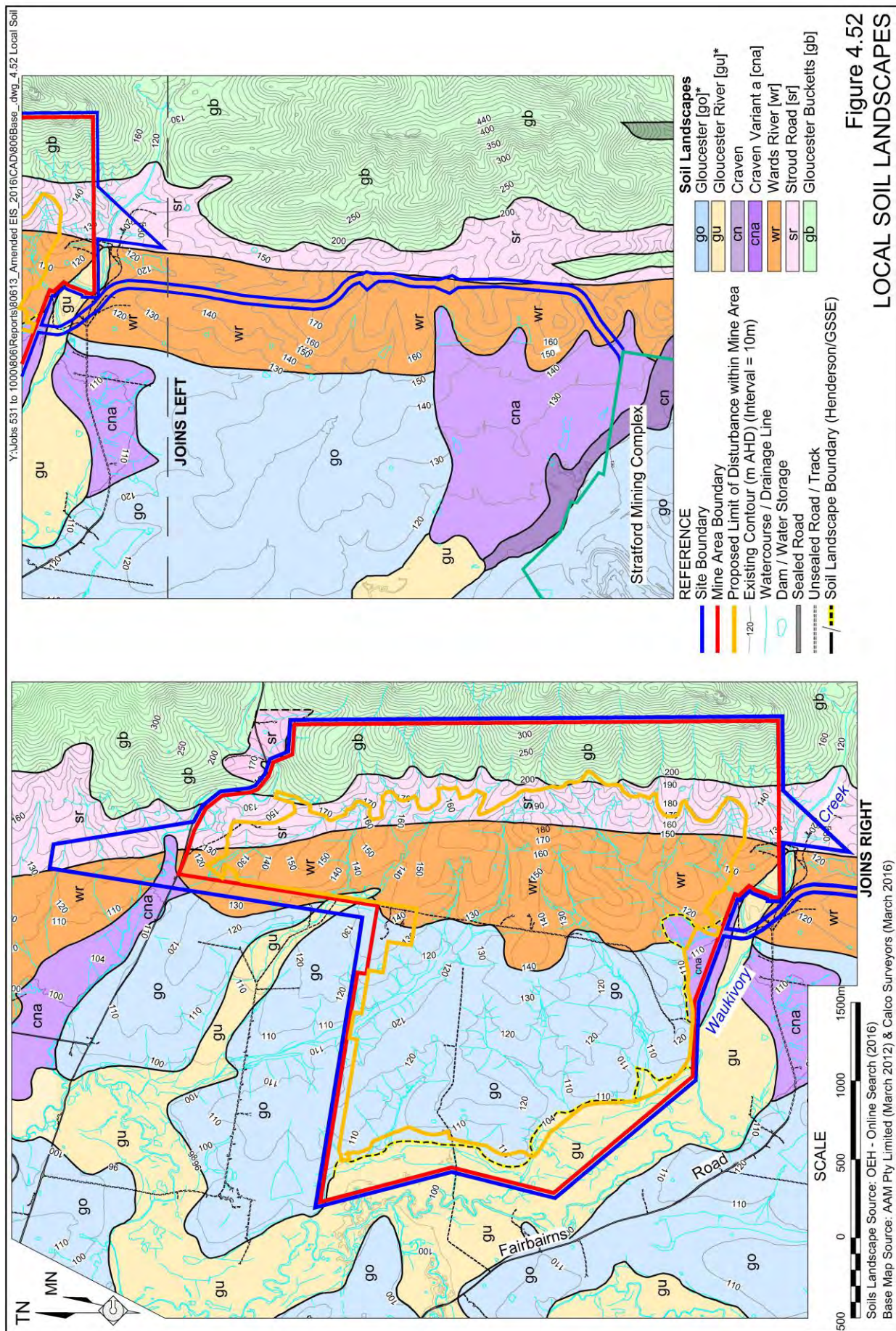
A review of published literature was conducted by GCNRC (2013a) and SOILmgt (2016) to identify the soil types present within the Site.

The Site is located within an area covered by the Dungog 1:100 000 scale Soil Landscapes Map – **Figure 4.52** (Henderson 2000a), with the following six soil landscape units defined within Henderson (2000b) identified as present within and in the vicinity of the Site.

- Gloucester (go) Soil Landscape;
- Gloucester River (gu) Soil Landscape;
- Gloucester Bucketts (gb) Soil Landscape;
- Wards River (wr) Soil Landscape;
- Stroud Road (sr) Soil Landscape; and
- Craven (cn) Soil Landscape (variant a).

The Gloucester (go) Soil Landscape comprises undulating low hills on sedimentary rocks with rocky outcrops generally absent, and is the most common soil landscape across the Mine Area. The soils of this soil landscape are classified as Sodosols, Kurosols and Tenosols within the Australian Soils Classification.

The Wards River (wr) Soil Landscape comprises low rolling hills on sediments of the Gloucester Coal Measures. The Wards River Soil Landscape is the second most common soil landscape within the Mine Area and is the principal soil landscape within the private haul road corridor. The soils of this landscape are classified as Kurosols and Tenosols within the Australian Soils Classification.



The Gloucester River (gu) Soil Landscape occurs in the western part of the Mine Area and across the northern part of the private haul road corridor and occupies broad level alluvial plains with occasional small swamps and swampy oxbows associated with the Avon River and Waukivory Creek. These soils are classified as Chromosols and Hydrosols within the Australian Soils Classification.

The Stroud Road (sr) Soil Landscape is present in the eastern section of the Mine Area and is characterised by rolling and undulating hills on volcanics. Landforms include moderately broad crests with some rock outcrop, convex upper slopes, lower ridges and moderately broad drainage plains. Within the Australian Soils Classification, the soils of the crests, outcrops and upper slopes are classified as Tenosols and Dermosols, whilst those of the lower ridges are classified as Ferrosols and those of the drainage plains are classified as Vertosols.

The Gloucester Buckets (gb) Soil Landscape comprises rolling to very steep hills on volcanics and sediments and occurs in the far eastern section of the Mine Area, generally beyond the proposed limit of disturbance. Relief varies between 60m and 350m with slopes typically 25% to >50%. Terracetting and hummocky terrain are present along with small (30m-50m) scarps. Rock outcrop and surface boulders are common. The soils are classified as Rudosols and Tenosols within the Australian Soil Classification.

The Craven (cn) Soil Landscape (variant a) occurs within low and wide drainage depressions with deep eroded watercourses and long swamps. These soil landscapes occur in areas associated with major watercourses and are located within the southern sections of the Mine Area and private haul road. The soils are classified as Kurosols within the Australian Soil Classification.

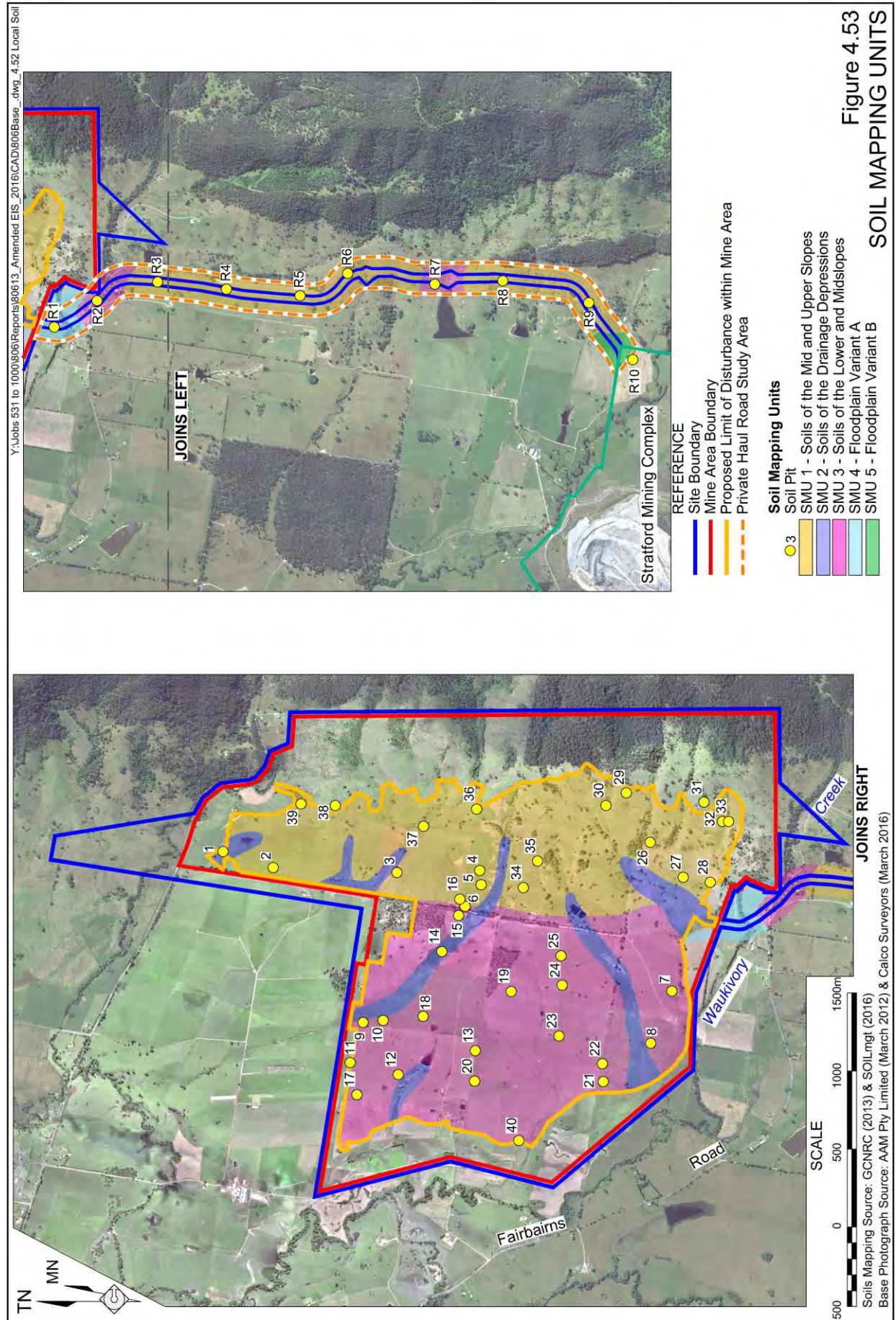
4.8.2.2 Site Soils

In order to provide a level of detail in the soils mapping which would be more appropriate for the effective management of the soils resources within the Site, detailed investigations were undertaken including a desktop assessment, test pitting, profile description and physical and chemical analyses.

Prior to field investigations, the Site was subjected to air photo interpretation to ascertain the nature of the landforms present and to develop a broad appreciation of the landform units that would require sampling.

Field sampling involved test pitting using a backhoe and the complete description of 40 profiles within the Mine Area to a maximum depth of 2.5m below ground level and a further 10 profiles within the private haul road corridor to a maximum depth of 1.4m below ground level. The location of each soil sampling site is shown in **Figure 4.53**. The soil profiles at each test pit location were fully examined with the following soil properties noted.

- Texture
- Fabric
- Structure
- Consistence
- Colour
- Gravel/stone occurrence
- Presence of roots
- Presence of lime
- Presence of manganese
- pH



Chemical analyses of the defined layers within the 40 pits within the Mine Area and seven representative pits within the private haul road corridor were conducted either in the field (pH) or at NATA accredited soil testing laboratories to determine the following.

- Particle size analysis (Mine Area only)²
- Dispersion percentage (Mine Area only)
- Emerson aggregate test (Mine Area only)
- Aggregate Stability in Water Test (ASWAT) (private haul road only)
- Electrical conductivity
- pH (water and CaCl₂)
- Phosphorus content
- Coherence

A total of 139 samples from the Mine Area soil profiles and 22 samples from the private haul road soil profiles were analysed.

Additional laboratory testing was undertaken on all topsoils within the areas to be disturbed within the Mine Area and selected samples within the private haul road corridor to characterise the agricultural value of the soils that would be disturbed for inclusion in the *Agricultural Impact Statement* accompanying the EIS. These tests included:

- % OC (percentage organic carbon)
- CEC (cation exchange capacity)
- Exchangeable aluminium
- Exchangeable calcium
- Exchangeable potassium
- Exchangeable magnesium
- Exchangeable sodium
- Aluminium saturation

The calcium/magnesium ratio was calculated by the laboratory on the basis of the elemental analyses.

The relevant results of these tests are summarised and discussed in the *Agricultural Impact Statement* (Volume 5 Part 13 of the *Specialist Consultant Studies Compendium*).

4.8.3 Soil Mapping Units and Attributes

4.8.3.1 Soils Descriptions

The following five soil mapping units (SMU) were identified within the Site (see **Figure 4.53**).

- Soil Mapping Unit 1 – Soils of the Mid and Upper Slopes.
- Soil Mapping Unit 2 – Soils of the Drainage Depressions.
- Soil Mapping Unit 3 – Soils of the Lower and Midslopes.
- Soil Mapping Unit 4 – Floodplain Variant A.
- Soil Mapping Unit 5 – Floodplain Variant B.

The correlation between the SMUs and the soil landscape units identified by Henderson (2000b) is shown in **Table 4.56**.

² Along the route of the private haul road, particle size analysis (PSA) was assessed via hand texturing and estimation of coarse fragment percentage; soil samples were collected for detailed PSA, if required at a later date.

Table 4.56
Soil Landscape and Mapping Units

Soil Landscape Units	Soil Mapping Unit
Gloucester (go)	Soil Mapping Units 1 and 3
Gloucester River (gu)	Soil Mapping Unit 4
Wards River (wr)	Soil Mapping Unit 1 and 2
Stroud Road (sr)	Soil Mapping Unit 1
Gloucester Buckets (gb)*	Soil Mapping Unit 1
Craven (cn)	Soil Mapping Unit 5
* Outside proposed area of disturbance but within proposed Biodiversity Offset Area.	
Source: GCNRC (2013a) – Section 3 and SOILmgt (2016) – Section 3	

The following descriptions of each soil mapping unit have been paraphrased from the technical descriptions prepared based upon the test pitting, with the full technical descriptions presented within GCNRC (2013a) and SOILmgt (2016).

Soil Mapping Unit 1 - Soils of the Mid and Upper Slopes

The Australian Soil Classification names of soils in this SMU are Tenosols and Kurosols. These soils were excavated to a maximum depth of 150cm, with numerous pits on crest locations only excavated to 50cm. These soils are located on high ridge crest, upper slope and terrace and mid-slope locations. Within both the Mine Area and private road corridor, SMU1 is described as follows.

- Surface Condition – usually firm, surface stone often absent.
- Topsoil – well-structured with depths ranging from 12cm to 32cm; gritty medium clay, medium clay, silty clay, medium - heavy clay present; pH 5.5 – 6.0; no lime or manganese present; some to moderate amounts of angular gravel, occasionally with some stones present; not mottled; not bleached; brown, grey or blackish coloured; occasionally hydrophobic. A bleached A2 soil horizon is occasionally encountered between 30cm and 37cm thick; pH 6.0 - 7.0; medium to heavy clay texture; much small gravel present; not hydrophobic.
- Subsoil – comprises one to three horizons, mainly clay textured; pH 4.5-6.5; gravel up to 10cm present; lower horizons the soil only occupies the interstices between the gravel; generally brown and grey coloured; not mottled; usually well structured, sometimes massive.

Soil Mapping Unit 2 - Soils of the Drainage Depressions

The Australian Soil Classification name of soils in this SMU is Sodosols. These soils are located within the drainage depressions associated with watercourses that traverse the Mine Area and pits were excavated to between 200cm and 250cm depth.

- Surface Condition – soft or firm; sometimes cracked; surface stone absent.
- Topsoil – between 15cm and 36cm deep; medium clay, medium - heavy clay; many roots; no lime or manganese present; pH 5.5 to 6.5; some angular, rounded angular and rounded gravel <1cm to 4cm, gravel and stones absent at times; not mottled; not bleached; brown or red coloured; well structured; sometimes hydrophobic.

- Subsoil – comprises three or four horizons; generally clay textured, coloured in shades of brown and grey; not bleached; usually not mottled but, some mottling occurs at depth in some profiles; pH 4.5-7.0, occasionally pH 7.5-8.0; lime coatings rare; gravel and stones sometimes present; usually well structured, occasionally massive; usually not hydrophobic.

Soil Mapping Unit 3 – Soils of the Lower and Midslopes

The Australian Soil Classification name of soils in this SMU are Dermosols, Kurosols and Tenosols. The majority of these soils were excavated to 250cm with a few very shallow profiles. The soils occur on lower and mid-slope locations within the Mine Area and in two small areas along the private haul road.

- Surface Condition – soft, firm and cracked, occasionally hard setting. Surface stone usually absent.
- Topsoil – clay loam, silty clay, light clay, light to medium clay, medium clay, medium to heavy clay; many roots; no lime or manganese present; pH 4.5 - 6.5; gravel and stones absent or some rounded / angular, flat, rounded or angular gravel <1cm to 4cm present, at times to 10cm; not mottled; not bleached; generally brown coloured, sometimes black, darker when moist; well structured; rarely hydrophobic.

A bleached A2 soil horizon occasionally encountered with silty clay, light clay, medium to heavy clay, heavy clay textured roots; few, common or many; no lime present; no manganese present; pH 4.5 - 6.0; gravel and stones absent or some angular and rounded / angular gravel <1cm to 2cm present; not mottled; pale grey and brown coloured.

- Subsoil – comprises one to four horizons; lower horizons quite thick; usually clay textured; becoming more mottled with depth; well-structured or massive; pH generally 4.0 to 6.5, rarely 7.0 to 8.5; gravel and stones absent or common with some larger stones at depth; not hydrophobic.

Soil Mapping Unit 4 – Floodplain Variant A

The Australian Soil Classification name of soils in this SMU is Dermosols. These soils were excavated to a depth of 140cm, although the soil profile extended beyond this depth. These soils occur within the floodplain of Waukivory Creek.

- Surface Condition – soft. Surface stone absent.
- Topsoil – 50cm deep; silty clay loam, many roots; no lime or manganese present; pH 4.5 to 5.0; gravel and stones absent; not mottled; not bleached; black coloured; well structured; not hydrophobic.
- Subsoil – pH 4.5 to 5.0; comprises two horizons; silty light clay to light medium clay; moderate abundance of stones below 95 cm; dark grey coloured; no mottling, well structured; not hydrophobic.

Soil Mapping Unit 5 – Floodplain Variant B

The Australian Soil Classification name of soils in this SMU is Kandosols. These soils were excavated to a depth of 140cm, although the soil profile extended beyond this depth. These soils occur within the floodplain of Dog Trap Creek at the southern end of the private haul road.

- Surface Condition – soft. Surface gravel and stone absent.
- Topsoil – light clay; many roots; no lime or manganese present; pH 6.0; gravel and stones absent; not mottled; not bleached; brown coloured; well structured; not hydrophobic.
- Subsoil – comprises three horizons; clay textured; pH 5.5 – 7.5; lime and manganese absent; gravel and stones absent; brown coloured; mottled in colours of yellow below 115 cm; massive structure; not hydrophobic.

4.8.3.2 Soils Sampling and Analysis Description

Analyses and results of the testing program relevant to the management of soils within the Mine Area and private haul road corridor during stripping, stockpiling and rehabilitation are summarised in **Tables 4.57, 4.58 and 4.59** and discussed in Sections 4.8.3.3 and 4.8.3.4. Detailed descriptions and additional discussions on individual SMU and soil horizon profile results are provided in Section 6.2 of GNCRC (2013a) and Section 3 of SOILmgt (2016), with a brief description of each of the analyses provided as follows.

Particle Size Analysis

The Particle Size Analyses identify the amounts of clay, silt, fine sand, coarse sand and gravel contained within each sample. The texture class of each soil layer is determined by an analysis of the materials that is less than 2mm in size, i.e. the sample from each tested horizon with the gravel removed.

Dispersion Percentage and Emerson Aggregate Tests

The Dispersion Percentage test indicates the proportion of the soil material less than 0.005mm in size that would disperse on wetting. The Emerson Aggregate Test (EAT) provides a measure of the coherence of soil aggregates when the soil is immersed in water. The degree of soil aggregate stability is determined on a scale from Class 1 showing the least degree of stability to Class 8 showing the greatest degree of stability. Subclasses, between (1) to (4) indicate the ‘milkiness’ or semi-dispersion of each Class with (1) indicating slight milkiness and (4) indicating total aggregate dispersion. Classes 1 and 2, as well as Class 3 (subclass 1 and 2) are considered unstable while Class 3 (subclass 3 and 4) and Classes 4 to 8 are considered stable.

Aggregate Stability in Water Test

Soil dispersibility can also be measured by the Aggregate Stability in Water (ASWAT) test (Field *et al.*, 1997). The ASWAT test has been related to the Emerson Aggregate Test by Hazelton and Murphy (2007) and can be linked with management issues such as the need for gypsum application and avoidance of wet working (McKenzie, 2013). ASWAT scores of 0 to 1 indicate stable, non-dispersive soils. Scores of 2 to 6 indicate soils with slight to moderate dispersibility for which energy inputs (e.g. tillage, rain drop impact) to wet soil should be avoided. Scores above 6 indicate moderate to very highly dispersive soils to which lime and/or gypsum should be added to overcome dispersion issues.

Soil Chemical Attributes (Soil pH (CaCl₂) and Electrical Conductivity)

The representative samples used for physical tests were also subject to chemical analysis to determine the likely salinity values. pH levels were measured within the field investigation program with Electrical Conductivity (EC) values determined at the Soil Conservation Service laboratory. The pH measurements were recorded in the laboratory using a CaCl₂ solution. Experience in the Gloucester district³ indicates that a pH of 4.6 (CaCl₂) is the cut-off point below which soils require liming to reduce acidity and lessen the chances of detrimental nutrient imbalances occurring and reducing the ability for plants to establish and persist. Ideally a pH of 5.5 (CaCl₂) should be maintained for most pasture legumes.

4.8.3.3 Soils Sampling and Analysis Results – Mine Area

Particle Size Analysis

The results for the Particle Size Analyses of the Mine Area samples are displayed in **Table 4.57** and indicate that the soil textures, as determined from particle size analysis, were generally somewhat coarser (less clayey) than the results from field testing. Within the topsoil and subsoil horizons, gravel contents throughout SMU 1 were generally higher than in the other SMU horizons.

Table 4.57
Physical Analysis Data for Tested Soil Layers – Mine Area*

SMU	Layer	Texture	PSA% Clay	PSA% Silt	PSA% Fine Sand	PSA% Coarse Sand	PSA% Total Sand	PSA% Gravel
1	1	loam - silty clay	4 – 39	19 – 44	11 – 43	7 – 33	23 – 52	0 – 44
	2	silty loam – silty clay	4 – 62	4 – 40	4 – 44	1 – 27	6 – 60	<1 – 86
	3	silty loam – clay	9 – 48	5 – 35	8 – 46	5 – 27	19 – 56	2 – 55
	4	clay loam	28 – 31	20	26 – 30	9 – 13	33 – 43	9 – 14
2	1	silty loam – clay loam	21 – 37	17 – 30	7 – 42	7 – 25	23 – 55	<1 – 35
	2	silty clay loam – clay	29 – 66	11 – 28	6 – 23	2 – 16	14 – 39	<1 – 46
	3	clay	43 – 78	12 – 23	5 – 17	2 – 10	9 – 21	<1 – 27
	4	silty clay – clay	41 – 74	15 – 26	6 – 32	1 – 7	10 – 35	0 – 6
	5	clay	40	16	29	11	40	4
3	1	loamy sand – clay	8 – 38	9 – 37	20 – 48	4 – 37	24 – 75	<1 – 33
	2	loamy sand – clay	10 – 73	4 – 30	5 – 43	1 – 34	6 – 75	<1 – 73
	3	silty loam – clay	20 – 80	3 – 51	6 – 50	<1 – 22	7 – 61	<1 – 90
	4	silt loam – clay	15 – 81	0 – 50	5 – 60	0 – 15	17 – 75	<1 – 6
	5	silty clay loam	27 – 36	42 – 47	9 – 22	3 – 7	16 – 25	1 – 6
* Whole Soil Particle Size Analysis.								
Source: GCNRC (2013a) - Tables 5, 7 and 9.								

³ Source: Peter Beale (Agronomist – DPI – Agriculture) pers. Comm.

Dispersion Percentage, Emerson Aggregate and Soil Chemical Attributes

The results of the D%, EAT, EC and pH test results for each soil horizon sample within the Mine Area have been collated, with the range of minimum and maximum values displayed in **Table 4.58**.

Table 4.58
D%, EAT Ranges, EC and pH Results for Tested Soil Layers – Mine Area

SMU	Layer	Texture	D%	D% level of dispersion*	EAT	EAT level of dispersion*	ECe (dS/m)	pH (CaCl ₂)	Soil Salinity Status [#]
1	1	loam – silty clay	10 – 52	S – H	3(1) – 8	N – S	0.01 – 0.24	4.4 – 6.1	NS – SS
	2	silty loam – silty clay	14 – 74	S – VH	2(1) – 8	N – M/H	<0.1 – 0.05	4.0 – 6.7	NS
	3	silty loam – clay	14 – 50	S – M/H	2(1) – 5	S – M/H	<0.1 – 0.6	3.7 – 7.1	NS
	4	clay loam	46 – 55	M – H	3(1) – 3(2)	S	0.1 – 0.2	4.1 – 4.2	NS
2	1	silty loam – clay loam	13 – 42	N – M	5 – 8	N – S	0.01 – 0.77	5.7 – 6.9	NS – MS
	2	silty clay loam – clay	0 – 51	N – H	3(1) – 6	N – M	0.03 – 1.39	3.8 – 8.1	NS – HS
	3	clay	0 – 71	N – VH	2(3) – 6	N – VH	0.04 – 2.28	3.7 – 7.5	NS – ES
	4	silty clay – clay	3 – 75	N – VH	1 – 4	M – VH	0.05 – 0.77	3.8 – 8.1	NS – MS
	5	clay	75	VH	2(3)	VH	0.43	8.0	SS
3	1	loamy sand – clay	5 – 47	S – M	3(1) – 8	N – S	<0.01 – 0.12	4.2 – 5.6	NS – SS
	2	loamy sand – clay	22 – 86	S – VH	2(1) – 8	N – VH	<0.01 – 0.19	4.0 – 5.0	NS
	3	silty loam – clay	18 – 90	S – VH	2(1) – 5	S – VH	0.01 – 0.51	3.7 – 6.0	NS – SS
	4	silt loam – clay	23 – 80	S – VH	1 – 5	S – VH	<0.01 – 0.31	3.7 – 6.9	NS – SS
	5	silty clay loam	50 – 52	M – H	2(1) – 3(1)	S – H	0.18 – 0.51	4.0 – 8.5	NS – MS
* N = Negligible, S = Slight, M = Moderate, H = High and VH = Very High.									
# NS = non-saline, SS = slightly saline, MS = moderately saline, HS = highly saline and ES = extremely saline.									
Source: GCNRC (2013a) - Tables 4 to 16.									

4.8.3.4 Soils Sampling and Analysis Results – Private Haul Road

The results of the texture, ASWAT, EC and pH test results for each soil horizon sample tested within the private haul road corridor have been collated in **Table 4.59**.

Table 4.59
Texture, ASWAT, EC and pH Results for Tested Soil Layers – Private Haul Road

SMU	Layer	Texture	ASWAT Score	ASWAT Soil Management Response	pH (CaCl ₂)	ECe (dS/m)	Soil Salinity Status [#]
1	1	Loam – Light clay	3 - 13	Avoid energy inputs to wet soil – Add gypsum / lime	4.3 – 4.5	0.17 - 0.34	NS
	2	Sandy clay loam - Medium heavy clay	4 - 13	Avoid energy inputs to wet soil – Add gypsum / lime	3.9 – 4.3	0.17 - 0.27	NS
	3	Sandy clay loam - Medium heavy clay	7 - 8	Add gypsum / lime	3.8 – 4.0	0.17 - 0.47	NS
3	1	Silty loam – silty light clay	0 - 4	Stable – avoid energy inputs to wet soil	5.3 - 5.4	0.26 - 0.52	NS
	2	Silty clay loam – medium clay (sandy)	0 - 5	Stable – avoid energy inputs to wet soil	4.3 - 5.6	0.26 - 0.35	NS
	3	Medium heavy clay – heavy clay	10	Add gypsum / lime	5.9	1.39	NS
	4	Medium heavy clay – heavy clay	0	Stable	5.9	3.2	SS
4	1	silty clay loam	0	Stable	4.6	0.26	NS
	2	Silty clay loam	1	Stable	4.7	0.17	NS
	3	Silty light clay	1	Stable	4.9	0.17	NS
	4	Light medium clay	1	Stable	5.2	0.09	NS
5	1	Light clay	4	Avoid energy inputs to wet soil	4.5	0.69	NS
	2	Heavy clay	15	Add gypsum / lime	4.5	0.75	NS
	3	Medium heavy clay	10	Add gypsum / lime	4.5	2.95	SS
	4	Medium heavy clay	3	Avoid energy inputs to wet soil	5.0	4.42	MS
# NS = non-saline, SS = slightly saline, MS = moderately saline, HS = highly saline and ES = extremely saline.							
Source: SOILmgt (2016) – Modified after Appendices 3 and 5.							

4.8.3.5 Summary of Outcomes from Soil Analysis

The results of the soils sampling and analyses indicate the following.

- SMU 1 - Topsoils would be able to be successfully stored in long-term stockpiles. The subsoils would require careful management to maintain stockpile integrity and stability, with an application of lime required to ensure that plant growth on these stockpiles is not limited by soil acidity, particularly when the subsoils in this SMU have dispersive tendencies. Soil salinity is not of concern within this SMU and no special precautions against soil salinity issues are warranted.
- SMU 2 - Topsoils generally exhibit lower dispersibilities than the subsoils. Although many horizons have low dispersibility values, enough contain relatively dispersible horizons to warrant caution in their management. pH values are generally conducive to plant growth without causing any major impediments to establishment of vegetative cover on the SMU 3 stockpiles with which the materials would be stored. Due to the saline characteristics of the SMU 2 subsoil, it would be buried in the mine voids or active overburden emplacement and not stockpiled.

- SMU 3 - Topsoils would be able to be successfully stored in long-term stockpiles. The subsoils would require careful management to maintain the stockpiles' integrity and stability, with an application of lime required to ensure that plant growth on these stockpiles is not limited by soil acidity, particularly when the subsoils in this SMU have dispersive tendencies. Soil salinity is not of concern within this SMU and no special precautions against soil salinity issues are warranted.
- SMU 4 - Soil disturbance within this SMU would be limited to the construction of the private haul road. The topsoil and subsoil test results indicate that all samples are non-dispersive but are limited by soil acidity. Application of lime to the topsoil layer is required to ensure that plant growth is not limited. Given that subsoil would, as much as possible, be incorporated within fill embankments and exposed fill batters covered with topsoil, no specific subsoil treatment is required.
- SMU 5 - Soil disturbance within this SMU would be limited to the construction of the private haul road. The topsoil layer is slightly dispersive and acidic and therefore application of lime is required to ensure plant growth is not limited. The subsoil is moderately to strongly dispersive, however, given that subsoil would be incorporated within fill embankments and covered with topsoil, no specific subsoil treatment is required.

4.8.3.6 Erosion Potential

The soils within the Site have a good cover of introduced and, to a lesser extent, native species and are considered generally stable, although the removal of the existing cover would destabilise the surface of the disturbed areas. The laboratory analyses relating to erosion potential have been previously presented in Section 4.8.3.3 and 4.8.3.4.

In order to minimise the potential for erosion, where possible, an adequate groundcover would be maintained on the existing landform and established on all disturbed areas such as stockpiles, and the groundcover establishment monitored on all rehabilitated areas. In the event that groundcover cannot be successfully established on topsoil and subsoil material and signs of dispersion are evident, the soil would be treated with gypsum to promote soil aggregation and minimise erosion potential.

4.8.3.7 Soil Stripping Suitability and Value for Rehabilitation

Table 4.60 identifies the proposed soil stripping depths as recommended by GCNRC (2013a) for the Mine Area.

Table 4.60
Indicative Soil Stripping Depths – Mine Area

Soil Mapping Unit (SMU)	Topsoil (cm)	Subsoil (cm)
1	10	10-70
2	15	Nil
3	15	15-100

Source: GCNRC (2013a) – Section 8

With the exception of the subsoils of SMU 2, all soil materials stripped from areas of disturbance within the Mine Area would be used in the rehabilitation of the final landform. The SMU 2 subsoils pose a risk to rehabilitation success because of their elevated salinity values and would be placed within the mine void areas or active overburden emplacement.

Within the private haul road corridor, the topsoil from all soil mapping units would be stripped to a depth of approximately 15cm (SOILmgt, 2016). All topsoil material would be limed to overcome soil acidity and support good growth of vegetation in order to stabilise the haul road batters or to achieve natural regeneration. Subsoil would only be removed where required to achieve the required road elevation or where it is not geotechnically suitable as part of the road formation.

Because of the dispersibility of some subsoil and topsoil layers for particular SMUs within the Mine Area, gypsum or a gypsum-lime blend would be added, as required, to enhance their capacity to support a good growth of stabilising vegetation.

4.8.4 Soils Stockpiling and Management

4.8.4.1 Mine Area Soils Stockpiling and Management

Topsoils and subsoils within the Mine Area would be stripped as outlined in Section 4.8.3.7 and stockpiled to a maximum height of approximately 2m and approximately 4m respectively, i.e. except for the northern section of the northern and western amenity barrier which would be constructed largely of subsoil. Although stripped topsoil and subsoil would be preferentially placed directly on areas requiring rehabilitation, during the site establishment and construction stage, and at other times throughout the life of the amended Project, any excess quantities of topsoil and subsoil would effectively be stockpiled at greater depths on the faces of the amenity barriers. Stockpiled topsoil and subsoil would be vegetated as soon as practicable with an appropriate groundcover if they are to remain in place for more than 3 months.

Subsoils located within watercourses (SMU 2) would not be stockpiled but would be removed and placed directly into the active overburden emplacement or mine void so as to avoid the interaction of these the high salinity subsoils with the surface water flowing within these watercourses.

The Applicant would maximise the storage of topsoil and subsoil on the outer and upper surfaces of the northern and western amenity barrier and the two interim amenity barriers and effectively use these surfaces as soil stockpile areas.

Stockpile locations and details would be identified within the Mining Operation Plan and relevant Annual Reviews.

4.8.4.2 Private Haul Road Corridor Soils Stockpiling and Management

Due to physical and chemical limitations of the subsoils within the private haul road corridor, subsoils excavated from the roadwork cuttings would be placed as much as possible within the fill areas. Exposed subsoil on fill batters would be covered with at least 0.2m of topsoil and a groundcover established as soon as practicable. Deep rooted species such as Japanese Millet, Rye Corn, Red Clover and medics would be used on the batters to encourage organic matter accumulation.

Prior to stripping of topsoil within the private haul road corridor, the soil would be limed in accordance with the recommended rates within SOILmgt (2016). Where slopes permit, stripped topsoil would be directly placed on completed fill batters up to 0.2m thick. Given the planned post-mining retention of the road surface within the majority of the private haul road corridor, there would be excess topsoil following the rehabilitation of the cut and fill batters. Any topsoil unable to be directly placed and any excess topsoil not utilised to stabilise the road batters would be stockpiled in low (<1m high) longitudinal mounds on the upslope side of the road and vegetated with an appropriate pasture mix, or mulched.

4.8.4.3 General Soil Management and Mitigation Measures

The amended Project would involve the disturbance of in situ soils, most of which would be suitable for use in the rehabilitation activities. Where soils cannot be directly transferred to a rehabilitation area, they would be stockpiled or otherwise stored, i.e. with the exception of those subsoils which are unsuitable for use in rehabilitation and which would be placed directly into the active overburden emplacement or within the fill embankments during construction of the private haul road.

The following general soil management procedures would be implemented for stripping, handling and stockpiling both topsoils and subsoils within the Site.

- All soils would be handled as little as possible to minimise structural damage.
- Vegetation groundcover would be stripped with the topsoil to provide physical protection, reduce soil loss and provide a seed source when respread.
- Stripping and stockpiling would be planned with consideration of the development sequence of the open cut pits and overburden emplacement areas such that the potential for erosion and sediment generation is minimised, the soil material can be directly placed onto areas awaiting rehabilitation when possible, that soil stockpiles are not double handled and the period of soil storage in stockpiles is minimised.
- Soils would not be stripped or replaced during wet conditions.
- Machinery used for stripping operations would place their loads neatly and uniformly so that the stockpile does not require further forming prior to establishment of vegetation cover.
- To minimise compaction and any further degradation of soil structure, driving of machinery on the topsoil and subsoil stockpiles would be prohibited once the stockpiles are created.
- Topsoil stockpiles would not exceed approximately 2m in height, while the subsoil stockpiles would generally not exceed approximately 4m in height.
- If required, upslope water diversion structures would be installed to direct overland surface water flow away from the soil stockpiles.
- Downslope sedimentation controls such as silt-stop fencing would be installed as required, until such time as the surfaces of the soil stockpiles are appropriately stabilised.

- The formed soil stockpile surfaces would have a generally uneven surface that is as 'rough' as possible, in a micro-sense, to assist in surface water runoff control and seed retention and germination.
- Soil stockpiles to remain in place for more than 3 months would be sown with stabilising groundcover species as soon as practicable after placement and watered if necessary to expedite establishment. The vegetation would help stabilise the surface and minimise erosion and sedimentation.
- Stabilisation measures would be taken to minimise loss of soil materials from the stockpiles prior to the establishment of a stabilising groundcover. Stabilisation measures would potentially include the use of a straw or similar mulch.

The soil stripping, stockpiling and management practices would be refined, if warranted, throughout the life of the amended Project.

4.8.4.4 Assessment of Impacts

Some of the soils (both topsoils and subsoils) have physical (dispersibility) and chemical (salinity and acidity) attributes which pose limitations to their stability in the stockpiled and final rehabilitated landform situations. The limitations are discussed in detail in previous sections and in GCNRC (2013a) and SOILmgt (2016).

However, with adherence to the proposed soil stripping, handling, storage and management procedures (including use of soil ameliorants) as outlined in Sections 4.8.4.1 to 4.8.4.3, the above attributes would result in a minimal impact on the Site from a soils handling or long-term stability viewpoint nor impact the likely success of the proposed rehabilitation and long-term land use of the Site.

4.8.4.5 Monitoring Soil Impacts

Regular inspections of topsoil and subsoil stockpiles and rehabilitated areas would be undertaken throughout the life of the amended Project to ensure they are appropriately stabilised. Any areas of instability would be addressed immediately using the best available technology ranging from reseeded, applications of additional fertiliser or ameliorants and, where necessary the use of mulches.

4.8.5 Land and Soil Capability

The Land and Soil Capability system has been the system in use in NSW (as of September 2012) to assess the inherent physical capacity of the State's land to sustain a range of long-term land uses and management practices without degradation of soil, land, air or water resources. The system builds upon the former 'rural land capability classification system' used by the Soil Conservation Service of NSW (Emery, 1986) and also draws upon the field and laboratory data for soils in New South Wales held within the Soil and Land Information System (SALIS) database, maintained by the Office of Environment and Heritage. Within each class, there are limitations caused by differences in climate, soil type, existing erosion, slope, landform position, acidity, salinity drainage, rockiness and a range of other physical factors. Each limitation needs to be managed to avoid land degradation and to make full use of the potential of the land.

The current Land and Soil Capability system maps the soil and land capability of an area of land based upon an eight-class system. Class 1 land is capable of sustaining most land uses including those that have a high impact on the soil (regular cultivation), whilst Class 8 represents land that can only sustain very low impact land uses such as nature conservation. GCNRC (2013b) provides a detailed description of each class type.

4.8.5.1 Existing Land and Soil Capability

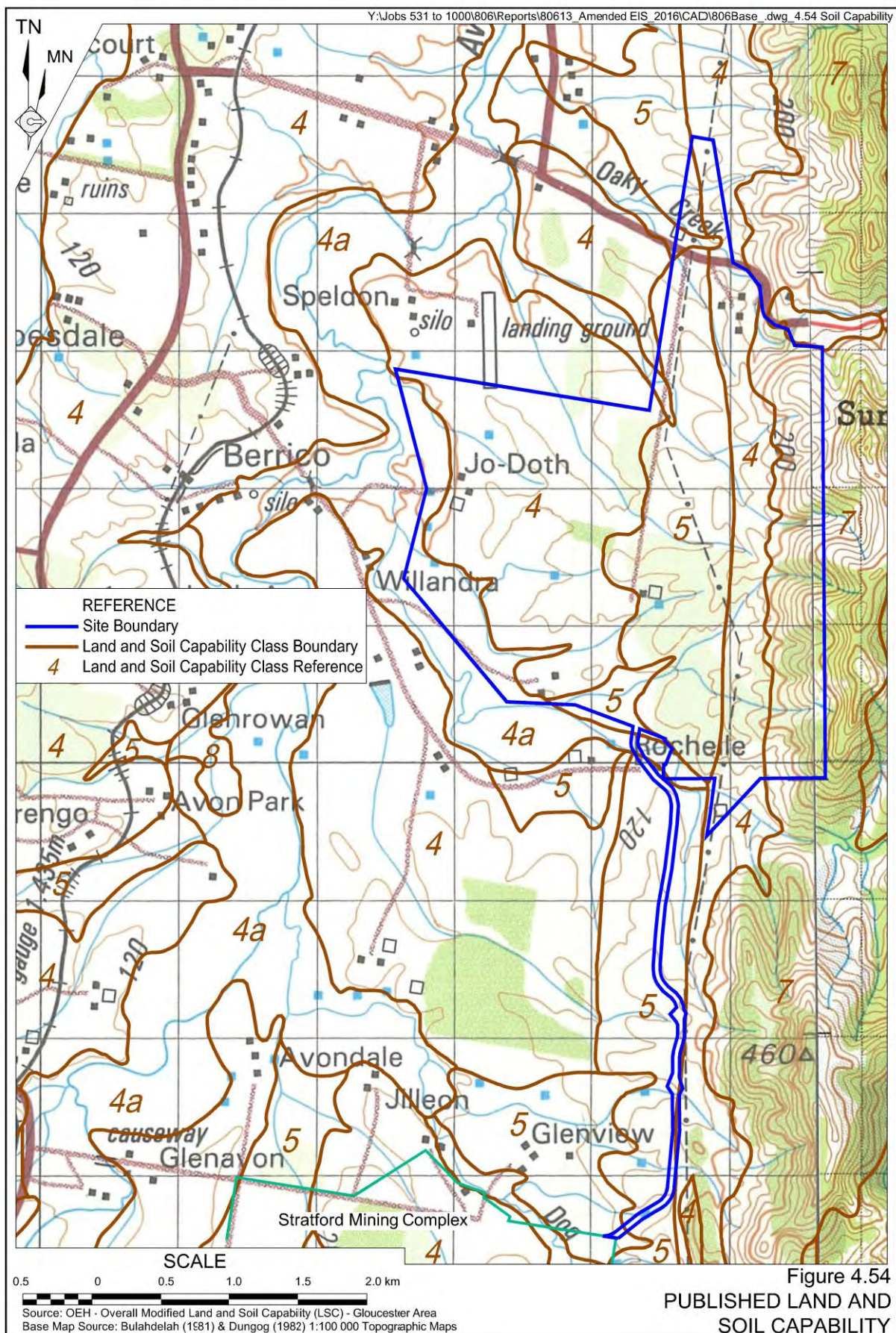
Figure 4.54 displays the Land and Soil Capability for the area within and around the Site, i.e. based upon published mapping. A more detailed figure that displays the Land and Soil Capability of the Mine Area and private haul road is displayed in **Figure 4.55** based upon the detailed mapping by GCNRC and SOILmgt.

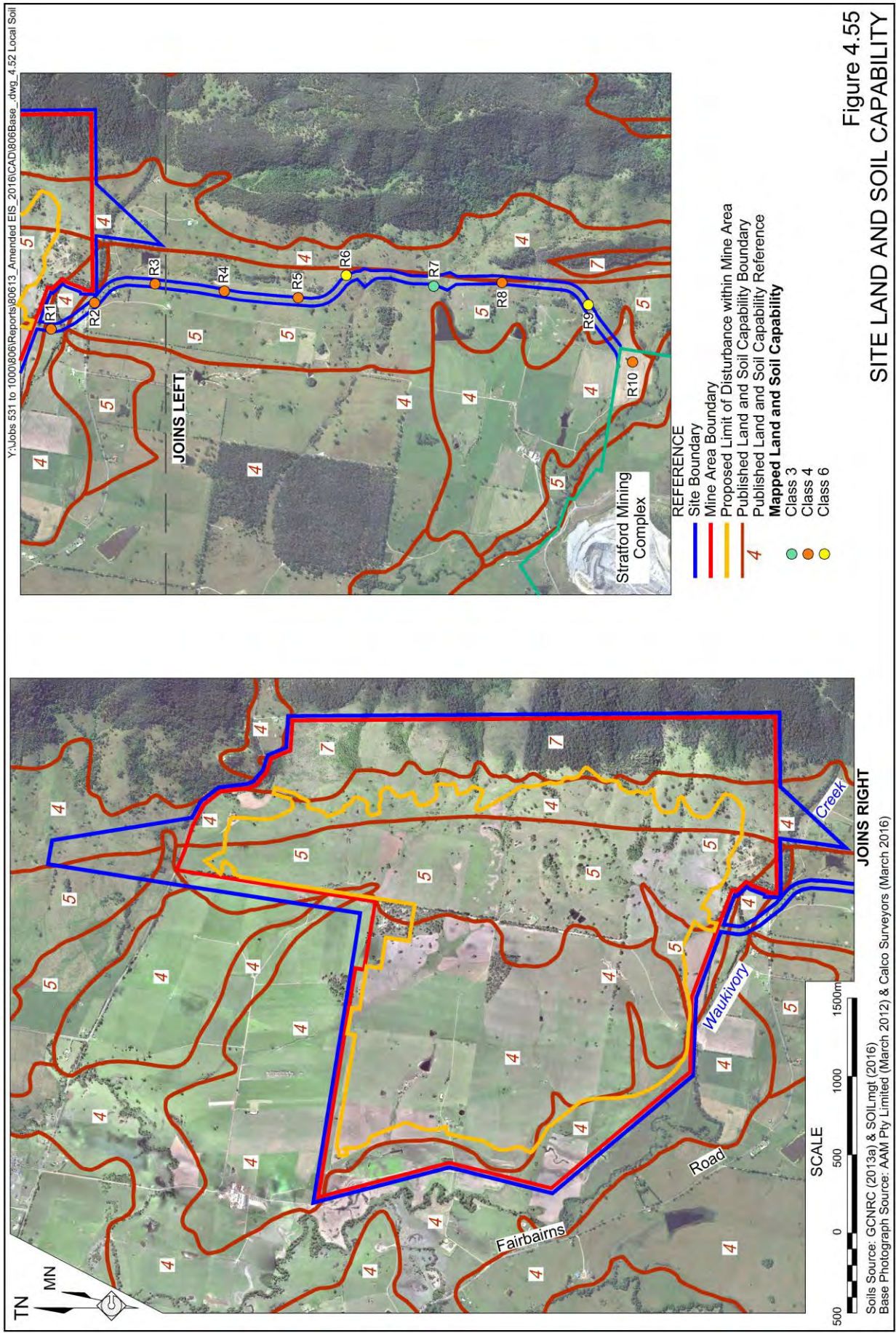
Land and Soil Capability Classes 4 and 5 predominate within the Mine Area disturbance area while the ridge east of the disturbance area, associated with the Gloucester Bucketts [gb] soil landscape, is principally Class 7 land. The physical and chemical analyses of the soils sampled during the soil survey of the Mine Area confirm the limitation of the soils within the Mine Area and indicate that the existing identified Land and Soil Classification classes are correct (GCNRC, 2013a).

Within the private haul road corridor, the published Land and Soil Capability mapping indicates that the land is principally Class 5 with smaller areas of Class 4 located on the alluvial soils of Waukivory and Dog Trap Creeks. However, the physical and chemical analysis of the soils sampled within the private haul road corridor, which were used to define the Land and Soil Capability for each soil pit, indicate the land is principally Class 4 and Class 6 with one soil pit (R7) classified as Class 3 land (SOILmgt, 2016). The assessed Land and Soil Capability for each soil pit within the private haul road corridor is displayed in **Figure 4.55**.

The following Land and Soil Capability (LSC) class descriptions indicate the differences between the classes of land within the Site.

- **LSC Class 3 land** - High capability land. Land has moderate limitations and is capable of sustaining high-impact land uses, such as cropping with cultivation, using more intensive, readily available and widely accepted management practices. However, careful management of limitations is required for cropping and intensive grazing to avoid land and environmental degradation.
- **LSC Class 4 land** - Moderate to severe limitations. Land generally not capable of sustaining high impact land uses unless using specialised management practices with high level of knowledge, expertise, inputs, investment and technology. Limitations are more easily managed for lower impact land uses (e.g. grazing).
- **LSC Class 5 land** - Severe limitations. Land not capable of sustaining high impact land uses except where resources allow for highly specialised land management practices to overcome limitations (e.g. high value crops). Lower impact land uses (e.g. grazing) can be managed by readily available practices.





- **LSC Class 6 land** - Low capability land. Land has very high limitations for high-impact land uses. Land use restricted to low-impact land uses such as grazing, forestry and nature conservation. Careful management of limitations is required to prevent severe land and environmental degradation
- **LSC Class 7 land** - Extremely severe limitations. Land incapable of sustaining most land uses. Limitations cannot be overcome.

4.8.5.2 Post-mining Land and Soil Capability

It is proposed that all land disturbed within the Mine Area would be returned to Land and Soil Capability Classes 4 and 5. The areas of the lower western final slopes would be Class 4 land whilst the area on the upper, eastern side would be Class 5 land.

Whilst the majority of private haul road would be retained for future land uses, the rehabilitated batters and the section of the road near Fairbairns Road to be rehabilitated would be returned to Land and Soil Capability Classes 4 and 6.

These classes of land would continue to sustain the pre-mining grazing activities commensurate with the existing soil limitations.

4.8.6 Conclusion

The key outcomes from the land and soils capability assessment are as follows.

- Within the Mine Area, the topsoil material (typically 10cm to 20cm thick) and the subsoil material (typically 70cm to 100cm thick) are generally favourable for use in rehabilitating the disturbed landscape. The exception is the subsoil within SMU 2 which has saline tendencies and would need to be buried rather than being directly emplaced or stored in subsoil stockpiles and subsequently used in rehabilitation activities.
- Within the private haul road corridor, the topsoil material (typically 10cm to 20cm thick) is favourable for use in rehabilitating the disturbance areas. However, the subsoils (typically 23cm to 80cm thick) are generally not suitable for rehabilitation due to dispersive tendencies and require coverage by a topsoil layer for stability.
- All soils would be subject to structural degradation if worked when too moist.
- All soil stockpiles would be stabilised during the period between stripping and respreading when the stockpiles are to remain in place for in excess of 3 months.
- With the adoption of suitable management and mitigation measures, the soil resources would be available for long-term agricultural production.
- The existing land within the Site typically has Class 4, Class 5 or Class 6 Land and Soil Capability. A similar level of Land and Soil Capability is predicted following the rehabilitation of the land disturbed within the Site.

4.9 TRAFFIC AND TRANSPORTATION

The traffic and transportation assessment of the amended Project was undertaken by Constructive Solutions Pty Ltd. The full assessment is presented in Volume 4 Part 9 of the Specialist Consultant Studies Compendium and is referenced throughout this document as Constructive Solutions (2016), with a summary of the assessment presented in the following subsections.

4.9.1 Introduction

Based on the risk assessment undertaken for the amended Project (Section 3.3.1 and **Appendix 6**), the potential impacts relating to traffic and transportation and their risk rankings after the adoption of standard mitigation measures are as follows.

- Increased traffic on Fairbairns Road leading to rail-related accidents/incidents at the uncontrolled rail crossing (high).
- Increased traffic on Jacks Road leading to rail-related accidents/incidents at the controlled rail crossing (medium).
- Road-related accidents/incidents due to amended Project traffic along local and regional road networks (medium).
- Damage to existing transport infrastructure (roads and bridges) due to unsuitable use resulting in community complaints and impact on the local road network (medium).
- Accelerated road pavement deterioration due to use by vehicles travelling to and from the Mine Area arising from increased traffic levels attributable to the amended Project (low).

In addition, the Director-General's Requirements issued by the then DP&I (now DPE) identified "Traffic and Transport" as one of the key issues requiring assessment. The relevant principal assessment matters relating to traffic and transportation include the following.

- Accurate predictions of the road traffic generated by the Project.
- A detailed assessment of the potential impacts of the development on the capacity, efficiency and safety of the local and regional road network, with particular regard to a cumulative traffic impact assessment; condition assessment of the existing network; proposed new road infrastructure; and impacts on level crossing operations.
- A detailed description of the measures that would be implemented to maintain and/or improve the capacity, efficiency and safety of the road network in the surrounding area over the life of the Project.

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the DGRs from the former Gloucester Shire Council, NSW Health - Hunter New England Local Health District, NSW Transport - Roads and Maritime Services (RMS) and BGSPA. The additional matters identified in the additional correspondence are generally consistent with the DGRs although, based on the proposed project at the time, the

former Gloucester Shire Council specified that the intersections of Jacks Road and The Bucketts Way, and Jacks Road and Waukivory Road, and the bridges over the Avon River and Waukivory Creek would need to be upgraded. Reference is retained to Gloucester Shire Council or Gloucester LGA in this subsection in recognition of the functions the former Council had prior to the merger with Great Lakes and Greater Taree LGAs. All references to Council with regard to future activities, etc. would apply to the newly-formed Mid-Coast Council.

The assessment has been undertaken in accordance with the *Guide to Traffic Generating Development (RTA, 2002)*, *Austroads Road Design Guide* and other relevant guidelines.

4.9.2 Existing Road Traffic Environment

4.9.2.1 Existing Road Network and Access

The existing road network in the vicinity of the Site is shown in **Figure 4.56**. Access to the Mine Area for vehicles approaching from the east of Gloucester would involve exiting The Bucketts Way (MR90) onto Waukivory Road (SR17) approximately 1km east of the eastern edge of Gloucester township. Vehicles approaching from the south of Gloucester would exit The Bucketts Way onto Jacks Road (SR18) just south of the township. Jacks Road joins Waukivory Road east of the Avon River. Vehicles would then turn off Waukivory Road onto McKinleys Lane (SR89). As discussed in Section 2.4.4, long-term access to the Mine Area would be provided by an approximately 50m section of McKinleys Lane and a new Mine Area access road constructed to the east of and generally parallel to the existing McKinleys Lane road reserve.

It is noted that access to the Mine Area and areas further east via Jacks Road is currently restricted as the bridge across the Avon River has been load limited to vehicles below 15t gross vehicle mass due to concerns associated with the integrity of the timber structure. Therefore, prior to the replacement of the bridge during the site establishment and construction stage, any vehicles approaching the Mine Area from south of the Gloucester township (or from within Gloucester itself) would need to utilise the Gloucester heavy vehicle bypass (see **Figure 4.56**) and travel towards the Mine Area via The Bucketts Way east of Gloucester and Waukivory Road.

During the site establishment and construction stage, access for the construction of the private haul road, including the bridge over Waukivory Creek and the Fairbairns Road underpass would be provided via Wenham Cox Road and Fairbairns Road exiting from The Bucketts Way approximately 9km and 2km south of Jacks Road respectively (see **Figure 4.56**).

4.9.2.2 Existing and Forecast Road Traffic Levels

With the exception of Wenham Cox Road, daily traffic volume data for the potentially affected road network was obtained from RMS and Gloucester Shire Council for the traffic counter sites displayed on **Figure 4.56**. The most recent RMS and Gloucester Shire Council counts were undertaken at various times between April 2015 and February 2016 and are summarised in **Table 4.61** together with relevant available data since 2008. Traffic volumes on Wenham Cox Road were obtained from a one week survey undertaken in April-May 2016 by GTA Consultants as part of the investigations for the Stratford Mining Complex Modification documentation.

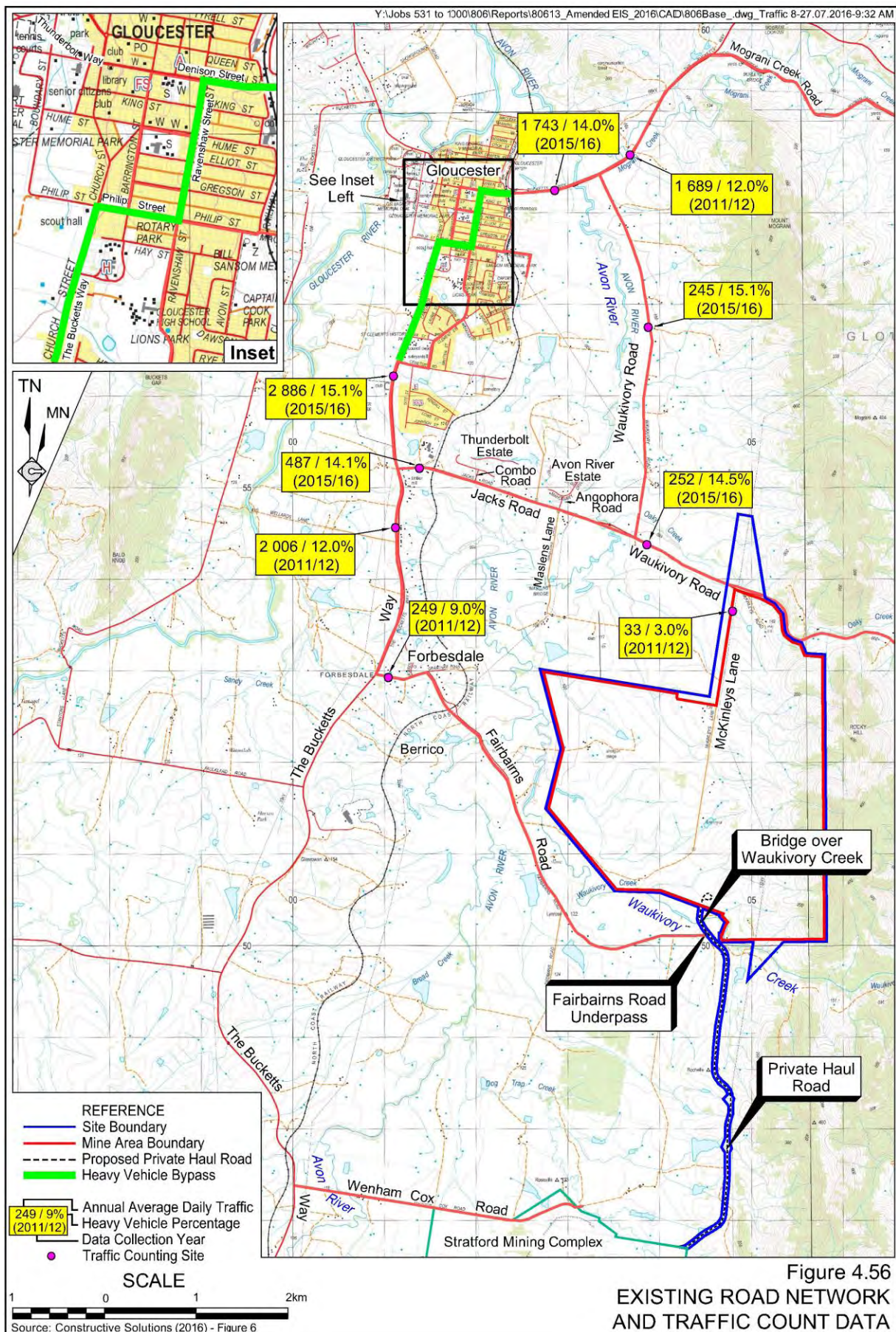


Figure 4.56
 EXISTING ROAD NETWORK
 AND TRAFFIC COUNT DATA

Table 4.61
Historical, Current and Forecast Daily Traffic Volumes

Road	Site ¹	Existing and Forecast Traffic								
		2008	2009	2011 to 2013 (% HV)		2015/2016 (% HV) ²		2019 (Est.) ³	2029 (Est.)	2039 (Est.)
The Bucketts Way	North of Jacks Road	2 978	3 345	3253	12%	2886	15.1%	3248	4365	5867
	South of Jacks Road	-	-	2806	12%	2450	15.0%	2757	3706	4980
Jacks Road	300m East of The Bucketts Way	470	520	559	12%	487	14.1%	548	737	990
Waukivory Road	East of Jacks Road	186	211	214	9%	252	14.5%	284	381	512
	North of Jacks Road	-	247	245	11%	245	15.1%	276	371	498
The Bucketts Way	West of Waukivory Road	1 741	2 120	1886	12%	1743	14.0%	1962	2636	3543
	East of Waukivory Road	-	-	1689	12%	1550	14.0%	1745	2345	3151
McKinleys Lane		-	44	33	3%	33	3%	37	50	67
Wenham Cox Road				156 ⁴	10%	57 ⁵	9%	62	84	112
1. Shown on Figure 4.56. 2. 2015/16 counts that were not available (shown in red) were estimated based on the 2011/2013 counts and the nearby turning traffic where applicable. These were then utilised to provide the projected forecast traffic volumes. 3. 2019 is assumed to equate to the first year of mining. Estimate assumes 3% annual growth. 4. Wenham Cox Road count taken from the Stratford Extension Project Transport Assessment (Halcrow 2012). The average weekday count has been utilised and the heavy vehicle percentage assumed based on the other local roads considered. Notably, the data includes vehicles associated with exploration activities being undertaken by Yancoal at that time resulting in atypically higher traffic levels. 5. GTA Consultants (2016)										
Source: Constructive Solutions (2016) – Table 2										

Consistent with the 10 year traffic growth projection requested by RMS in their correspondence provided with the DGRs, **Table 4.61** also outlines the forecast future ambient traffic levels (i.e. in the absence of the amended Project) for the year 2029. Forecast growth has also been extrapolated to the year 2039 to present the potential background traffic levels during the final rehabilitation stage following the cessation of coal extraction.

Based on advice from Gloucester Shire Council, a 3% growth rate was assumed to calculate forecast traffic volumes for the year 2029 (Year 10) although this trend is not evidenced in the available counts between 2011/13 and 2015/16. It is likely that at least some of the observed traffic reductions over the 2011/13 to 2015/16 period, particularly on The Bucketts Way south of Gloucester, are attributable to the cessation of mining activity at the Stratford Mining Complex in mid-2014 and, in the case of Wenham Cox Road, a change in the nature of activities being undertaken. In 2012, Gloucester Coal Limited (now Yancoal) was undertaking exploration activity at the eastern end of Wenham Cox Road which resulted in atypical traffic levels and, with the cessation of these activities, the daily traffic volumes have decreased significantly and are consistent with the local access role it performs. Applying a 3% average annual growth rate uniformly is therefore considered extremely conservative as some of the 2015/2016 counts have remained stagnant or declined slightly since 2008.

4.9.2.3 Existing Road Conditions

Information on existing road conditions was collected by Constructive Solutions through site inspections during April 2011, June 2012 and January 2016. A summary of the existing conditions of the relevant roads and associated structures is provided as follows.

The Bucketts Way

The Bucketts Way (MR90) is a regional road which provides an alternate route to the Pacific Highway (SH10) from near Karuah to Taree via Gloucester. Maintenance of The Bucketts Way within the former Gloucester LGA is the responsibility of Council, however, funding is provided by RMS for the maintenance of the road. In the vicinity of the Site, The Bucketts Way consists of two lanes of one way traffic in each direction varying from 3m to 3.5m wide, with sealed shoulders of widths varying from 0.5m to 2.5m (see **Plate 4.1**). The pavement condition is generally good, however, there are several sections where pavement defects are evident.

The posted speed limit on The Bucketts Way in the vicinity of the Jacks Road intersection is 80km/h, and 90km/h near the intersection with Waukivory Road east of Gloucester. Approximately 800m north of Jacks Road, the posted speed limit changes to 60km/h, reducing to 50kph north of Philip Street (see **Figure 4.56**).

A heavy vehicle bypass of the main streets of Gloucester is in place which directs vehicles with a gross vehicle mass in excess of 3 tonnes onto Philip and Ravenshaw Streets before returning to The Bucketts Way (see **Figure 4.56**). The posted speed limit along the bypass is 50kph, extending east along The Bucketts Way for approximately 500m east of the bridges and the North Coast Railway Line before increasing to 90kph. The width of the bypass route is typically two travel lanes of 3.25m with sealed shoulders/kerbside parking of 3.5m.

Waukivory Road

Waukivory Road (SR17) is a local road managed by Council. The approximately 5.2km section of Waukivory Road between The Bucketts Way and McKinleys Lane comprises an approximately 6m wide sealed pavement with 1m unsealed shoulders. This section is relatively flat with good horizontal and vertical alignment. The seal quality is poor with general pavement deformation evident (see **Plate 4.2**), particularly north of Jacks Road. There is no sign posted speed limit along the section of Waukivory Road north of Jacks Road but the speed limit along Waukivory Road east of Jacks Road is 80km/h.

Jacks Road

Jacks Road (SR18) is a local road managed by Council and provides access from The Bucketts Way to both Thunderbolt and Avon River Estates, and seven privately owned rural-residential properties. The road consists of a 6m to 7m wide seal on an 8m wide formation with localised road widening present at the entries to both rural-residential estates. Overhead street lighting is provided at the entrance to the Thunderbolt Estate. The pavement is considered to be in a reasonable condition (see **Plate 4.3**). The posted speed limit on Jacks Road between The Bucketts Way and Waukivory Road is 60km/h with the exception of a short section at the eastern end which is 80km/h.

Jacks Road crosses the North Coast Railway Line approximately 400m east of its intersection with The Bucketts Way. The railway line crossing incorporates flashing lights in conjunction with boom gates on a 60km/h section of the road. The alignment approaching the crossing is

straight to the east but on a horizontal and vertical curve to the west. There are 0.5m wide concrete medians to deter vehicles from driving around the lowered boom gates (see **Plate 4.4**). Overhead street lights are located on both approaches to the rail crossing. The Jacks Road rail crossing is ranked 198th in NSW in terms of risk according to the Australian Level Crossing Assessment Model (ALCAM) database, that is, there are 197 crossings with public roads in NSW which are assessed as having higher risk.

Jacks Road also crosses the Avon River approximately 2.4km east of its intersection with The Bucketts Way. The existing bridge consists of one traffic lane and a footpath and has a timber substructure, timber girders and a timber/concrete superstructure. As discussed in Section 4.9.2.1, the bridge is currently load limited to vehicles with a gross vehicle mass of less than 15t. With the proposed road upgrades (see Section 4.9.3), including the upgrade of the bridge and removal of the load limit, it is expected that Jacks Road would be more frequently utilised to bypass the Gloucester township and provide a more significant function for regional traffic.

McKinleys Lane

McKinleys Lane (SR89) is a local road managed by Council that currently services four residences all of which are either owned or under an option to purchase by the Applicant. The road consists of a gravel pavement approximately 6m in width between table drains (see **Plate 4.5**). The condition of the road varies with the time between grading and seasonal influences, e.g. large pothole formation following rainfall is a common occurrence.

Fairbairns Road

Fairbairns Road (SR16) is a local road managed by Council which provides access to the Forbesdale subdivision east of The Bucketts Way and a number of rural lifestyle blocks and agricultural properties south of the Mine Area.

The formation consists of a 5.5m to 6m wide seal with unsealed shoulders approximately 0.5m wide (see **Plate 4.6**). The pavement is in reasonable condition. There is no posted speed limit for the length of the road.

Fairbairns Road crosses the North Coast Railway Line approximately 1km east of its intersection with The Bucketts Way. The railway line crossing incorporates flashing lights only (see **Plate 4.7**). The alignment on both approaches is poor with limited sighting distance and, although there is no posted speed limit, the alignment is likely to result in low approach speeds. The Fairbairns Road rail crossing is ranked 186th on the ALCAM database.

Fairbairns Road also crosses the Avon River approximately 1.5km east of its intersection with The Bucketts Way. A 10t load limited timber bridge crosses Avon River, however, a second timber bridge on a side track adjacent to the original bridge has been constructed as a heavy vehicle detour (see **Plate 4.8**).

Wenham Cox Road

Wenham Cox Road (SR15) is a local road that proceeds east from The Bucketts Way just to the north of Stratford. The road is a no through road used for local access.



Plate 4.1: The Bucketts Way east of Gloucester - typical alignment and condition.
 (Ref: Constructive Solutions 2016 - Plate 3)

Plate 4.2: Waukivory Road - example of pavement failure.
 (Ref: Constructive Solutions 2016 - Plate 2)



Plate 4.3: Jacks Road - typical alignment and condition.
 (Ref: Constructive Solutions 2016 - Plate 5)

Plate 4.4: Rail Crossing of Jacks Road - Looking East.
 (Ref: Constructive Solutions 2016 - Plate 29)





Plate 4.5: McKinleys Lane - typical alignment and condition.
 (Ref: Constructive Solutions 2016 - Plate 7)

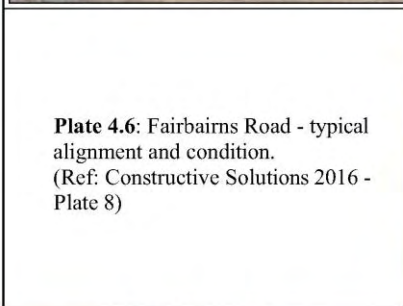


Plate 4.6: Fairbairns Road - typical alignment and condition.
 (Ref: Constructive Solutions 2016 - Plate 8)



Plate 4.7: Fairbairns Road Rail Crossing - looking west.
 (Ref: Constructive Solutions 2016 - Plate 30)



Plate 4.8: Fairbairns Road - bridges over Avon River.
 (Ref: Constructive Solutions 2016 - Plate 10)



The road consists of a 5m to 6m wide seal on a similar width formation within a narrow road corridor. The road generally has good horizontal and vertical alignment. The pavement condition is considered reasonable although some signs of pavement deterioration are evident. The sealed section ends at 5.8km with the unsealed section extending a further 1.2km.

There are two narrow one lane drainage structures including a low level bridge over the Avon River at 0.55km and a narrow multi cell pipe culvert at 2km. The bridge consists of a single span concrete deck over steel girders. Priority at each structure is controlled by a give way sign and associated hold lines.

4.9.2.4 Existing Intersections

During the April 2011, June 2012 and January 2016 site inspections, Constructive Solutions also collected the following information on the status of existing intersections.

Waukivory Road and The Bucketts Way

Waukivory Road meets The Bucketts Way in a T intersection configuration. A sight screen is located opposite the T intersection but there are no give way/stop signs or line markings on Waukivory Road. The Bucketts Way is signposted as 90km/h at this location. The general geometry of the intersection appears reasonable for the existing traffic volumes and the pavement is in good condition. Sight distances are considered good in both directions along The Bucketts Way with 280m and 390m to the west and east respectively. The minimum safe intersection sight distance for 90km/h is 214m.

Jacks Road and The Bucketts Way

Jacks Road forms a T intersection with The Bucketts Way, and is flared at its approach to the intersection. The intersection has a basic layout, with no auxiliary turn lanes or shoulder widening treatments. Consequently, through vehicles on The Bucketts Way must slow or stop if a vehicle ahead is waiting to turn left or right into Jacks Road. The basic rural intersection layout is currently appropriate as the amount of traffic travelling into and from Jacks Road is low.

There are no give way/stop signs or line markings on Jacks Road at the intersection and no sight screen opposite the T intersection. The Bucketts Way is signposted as 80km/h at this location. The general geometry of the intersection appears reasonable for the existing traffic volumes on both roads, however, general pavement deformations are evident. Sight distances are approximately 140m and 180m to the north and south respectively. The minimum safe intersection sight distance is 181m at 80km/h.

There is a rural property driveway access opposite the intersection on the western side of The Bucketts Way. The location of the driveway coupled with the available sight distance from the intersection is considered undesirable. It is understood that there is a proposal for the land west of the intersection to be rezoned to allow a residential subdivision.

Fairbairns Road and The Bucketts Way

The western end of Fairbairns Road terminates at a T intersection with The Bucketts Way. The intersection is located on a crest and The Bucketts Way is signposted as 80km/h at this location. The intersection has a basic layout, with no auxiliary turn lanes or shoulder widening

treatments. Therefore through vehicles on The Bucketts Way must slow or stop if a vehicle ahead is waiting to turn left or right into Fairbairns Road. The general geometry of the intersection appears reasonable for the existing traffic volumes on the respective roads. Sight distances are estimated to be >500m and 120m to the south and north respectively. The sight distance to the north is limited by a crest in the road and is below the minimum safe intersection sight distance of 181m at 80km/h.

There is a private driveway access approximately 10m north of the intersection on the western side of The Bucketts Way. The location of the driveway, coupled with the available sight distance from the intersection, is considered undesirable, particularly for vehicles turning out of Fairbairns Road to the right, heading north.

Waukivory Road and Jacks Road

The existing intersection of Waukivory Road and Jacks Road is a very basic T intersection configuration without auxiliary turn lanes or shoulder widening. No line markings or stop/give way signs have been erected, however, a sight screen has been located opposite the T intersection.

Prior to the closure of the Jacks Road bridge across the Avon River (in mid 2012), through vehicles on Jacks/Waukivory Road were required to slow or stop if a vehicle ahead was waiting to turn left or right into Waukivory Road. With the re-opening of the bridge in late 2014, this requirement remains. Sight distances are estimated to be 300m and 320m to east and west respectively, exceeding the minimum safe intersection sight distance of 181m at 80km/h.

Waukivory Road and McKinleys Lane

The existing intersection between Waukivory Road and McKinleys Lane is a very basic T intersection configuration, with no auxiliary turn lanes or shoulder widening provided. Through vehicles on Waukivory Road must slow or stop if a vehicle ahead is turning left or right into McKinleys Lane. Sight distances are estimated to be 250m and 410m to the east and west respectively and exceed the minimum safe intersection sight distance of 181m at 80km/h.

No line markings or stop/give way signs or sight screen have been erected at this intersection.

Wenham Cox Road and The Bucketts Way

The existing intersection between Wenham Cox Road and The Bucketts Way is a very basic T intersection configuration, with no auxiliary turn lanes or shoulder widening provided. The intersection is located on a short straight and The Bucketts Way is signposted at 90km/h at this location. The general geometry of the intersection appears reasonable for the existing traffic volumes on the respective roads. Sight distance is estimated to be greater than 500m and approximately 200m to the south and north respectively. The minimum safe intersection is 214m for 90km/h.

There is no hold line, give way or stop sign, however, there is a sight screen opposite Wenham Cox Road.

4.9.2.5 Existing Road Users

School bus routes for both primary and secondary school children are located along The Bucketts Way, Jacks Road, Waukivory Road and Fairbairns Road. Newcombe Coach Lines advise that, at present, there is one school bus route that services Waukivory Road to the Waukivory locality (“Waukivory School Run”) and another which services Jacks Road, The Bucketts Way and Fairbairns Road (“Fairbairns School Run”) (see **Figure 4.57**). There are currently no school bus routes servicing Wenham Cox Road.

The majority of the pick-up and drop-off locations are adjacent to the roadway along the nominated routes. Notable exceptions are the Thunderbolt and Avon River Estates where pick-ups and drop-offs occur within the estates and not along Jacks Road.

Indicative times for the use of school buses along each of the respective routes are as follows.

Waukivory School Run

The morning pick-up run leaves the bus depot in Gloucester at 7:30am and travels along Waukivory Road past McKinleys Lane at approximately 7:40am. The bus returns with school children from the Waukivory locality passing McKinleys Lane on the return trip at approximately 8:20am before ultimately returning to the depot at about 8:45am.

The afternoon drop-off run leaves the bus depot at 3:00pm, travels through Gloucester and passes McKinleys Lane at approximately 3:30pm before returning from Waukivory and passing McKinleys Lane at approximately 4:00pm, returning to the depot via Gloucester at about 4:20pm.

Fairbairns School Run

The scheduled morning pick-up run leaves the bus depot in Gloucester at 7:40am and travels along The Bucketts Way east of Gloucester and Mograni Creek Road before turning around and heading down Waukivory Road. The bus then turns right onto Jacks Road before turning left onto The Bucketts Way and left down Fairbairns Road, reaching its turnaround location at “Turnaround Junction Mailboxes” at approximately 8:10am before returning to the depot via Gloucester at about 8:45am.

The scheduled afternoon school drop off run leaves the bus depot at 3:00pm and travels through Gloucester, reaching the turnaround location on Fairbairns Road at approximately 3:40pm, before returning along Jacks Road via The Bucketts Way. The bus then travels along Waukivory Road, The Bucketts Way and Mograni Creek Road before turning around and returning to the bus depot at 4:20pm.

There is very limited pedestrian or cycling activity along the road network outside Gloucester township. No pedestrians and only two cyclists were observed outside these areas during the inspections undertaken by Constructive Solutions personnel.

4.9.2.6 Accident Statistics

Detailed crash reports were obtained from the NSW Transport Centre for Road Safety. The data obtained summarised crashes on the relevant road sections between 1 October 2010 and 31 December 2014. A summary of the available data is provided in **Table 4.62**.

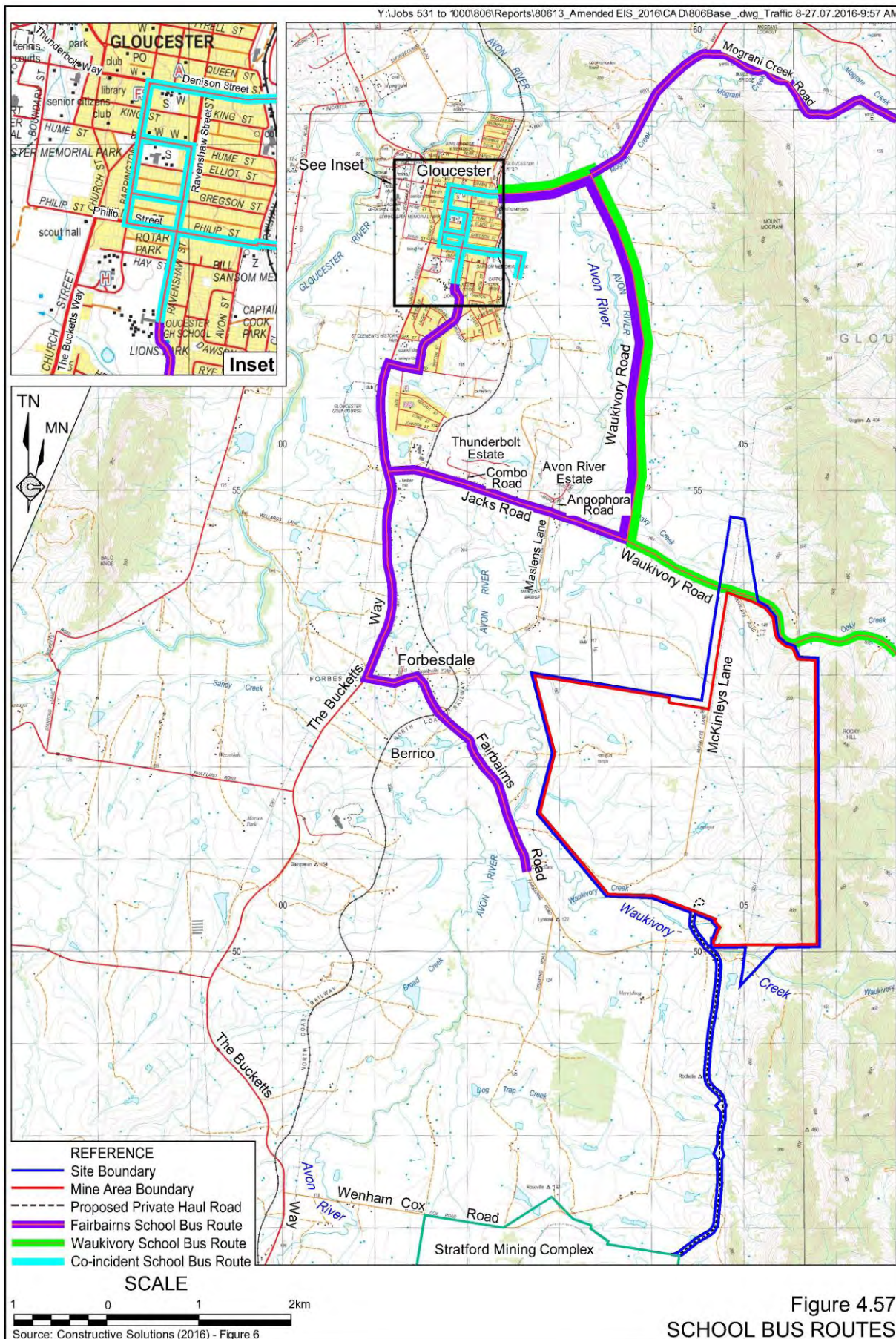


Table 4.62
Crash Data – October 2010 to December 2014

Road	Extent		Fatal	Injury	Non Casualty
The Bucketts Way (south)	Jacks Road	LGA Boundary*	4	76	58
The Bucketts Way (east)	Waukivory Road	Krambach	1	24	14
The Bucketts Way (township)	Jacks Road	Waukivory Road	0	5	3
Jacks Road	The Bucketts Way (south)	Waukivory Road	0	0	0
Waukivory Road	The Bucketts Way (east)	McKinleys Lane	0	1	1
Wenham Cox Road	Advised that no accidents occurred in the previous 5 years [#]				
Fairbairns Road	Full extent		0	1	0
McKinleys Lane	Advised that no accidents occurred in the previous 5 years [#]				
[#] Advised by Acting Road Safety and Traffic Officer – RMS Hunter Region.					
*Gloucester LGA/Great Lakes LGA Boundary					
Source: Constructive Solutions (2016) – Table 10					

The frequency of crashes for the roads, where data was made available, did not appear to be unusual or concentrated for Jacks Road, Waukivory Road or the section of The Bucketts Way between these two roads via the heavy vehicle bypass. The sections of The Bucketts Way to the south (south of Jacks Road) and east of Gloucester (east of Waukivory Road) do have a high rate of traffic incidents. However, there are likely to be a range of contributing factors including substandard road geometry, a lack of shoulder and verge width and a lack of overtaking opportunities.

4.9.3 Management and Mitigation Measures

General Measures

The following general management and mitigation measures as recommended by Constructive Solutions (2016) would be implemented to ensure the impacts of both site establishment and construction and operational traffic are acceptable.

- Preparation and implementation of a Construction Transport Management Plan for the site establishment and construction stage which addresses the following.
 - The use of the Gloucester heavy vehicle bypass, The Bucketts Way and Waukivory Road for construction traffic until the new bridge across the Avon River on Jacks Road is constructed.
 - Use of the two adjacent bridges on Fairbairns Road, particularly the bridge on the sidetrack, and existing crossings on Wenham Cox Road; structural capacities; safe approach speeds and driver awareness to minimise potential adverse traffic interactions.
 - The need for interim speed limits and other interim controls, particularly for heavy vehicles.
 - Management of speed and other related driving characteristics of all personnel, including sub-contractors.
 - Driver awareness and interim traffic management arrangements, particularly when approaching the rail crossings on Jacks Road and Fairbairns Road, and a review of the need for specific risk management strategies (such as advanced warning and duplication of signs, etc.).

- Consideration of pedestrians and cyclists, and the school bus routes and pick-up and drop-off locations.
- Avoiding/minimising site establishment and construction stage traffic, particularly large or oversize loads, during busy periods such as the Christmas or Easter holidays.
- Managements of speed, fatigue and other related driving characteristics.
- Construction of all proposed road and intersection upgrades in accordance with Austroads Standards with suitable dimensional capacity to accommodate the dimensions of any anticipated oversized loads.
- Management of any impacts arising from road and bridge construction works for vehicles accessing the Mine Area and private residences.
- Preparation and implementation of an Operational Transport Management Plan for the period of mining operations.
- Preparation and implementation of a Code of Conduct for contractors / employees travelling to and from the Site. The code would identify the designated access routes to the component areas of the Site, and cover the Applicant's expectations with respect to drivers' behaviour, the avoidance (wherever practical) of the school bus operating periods, or specific driving protocols when avoidance is not practical. The code would also include disciplinary procedures in the event of non-compliance with the code.
- Regular discussions with the school bus company(ies) to ensure that information regarding school bus routes, times and pick-up / drop-off locations remains up to date.
- Education of the workforce through inductions, toolbox talks etc.
- Payment of a road maintenance contribution to Council commensurate with traffic volumes generated on Jacks Road and Waukivory Road. Any maintenance contribution would take into consideration the road upgrades that are proposed by the Applicant.
- Payment of an annual contribution towards the maintenance of The Bucketts Way with the contribution calculation method consistent with that in Development Consent SSD 4966 for the Stratford Extension Project.

In addition to the general management and mitigation measures, a range of specific road and intersection upgrade works are proposed. These are summarised as follows.

Jacks Road and Waukivory Road (east of Jacks Road)

- Upgrade to an 8.0m seal (2 x 3.25m travel lanes plus 0.75m sealed shoulders) on an 8.0m formation.
- Install line markings, including edge lines, to define the travelling lanes.
- Remove and replace the existing bridge over the Avon River with a two lane bridge and improve the road alignment by straightening the approaches to the bridge.

- Install “Transverse bar” or hold line marking and/or “Give Way” signs for vehicles exiting Maslens Lane, rural properties and the Thunderbolt and Avon River Estates via Angophora Road and Combo Road respectively.
- Consideration of potential improvements in sight distance and advanced warning of the rail crossing during road design and upgrade works to Jacks Road.

Jacks Road and The Bucketts Way Intersection

- Upgrade the existing intersection (see indicative layout on **Figure 4.58**) to include:
 - a deceleration lane in the form of a channelised right lane to accommodate light vehicles and heavy vehicles approaching from the south;
 - a deceleration lane for vehicles turning left into Jacks Road to prevent unnecessary impedance to through traffic; and
 - installation of “Transverse bar” or hold line marking, sight screen, and “Give Way” signs for vehicles leaving Jacks Road.
- Encourage Council to extend the 60km/h speed restriction to the south of the intersection to reflect the limited sight distance at the intersection.

Waukivory Road and Jacks Road Intersection

- Upgrade the existing intersection (see indicative layout on **Figure 4.58**) to include:
 - an auxiliary right lane to reduce the impact on through traffic;
 - general widening to improve dimensional capacity and safety; and
 - installation of “Transverse bar” or hold line marking and “Give Way” signs for vehicles turning out of Waukivory Road.

Waukivory Road and McKinleys Lane Intersection

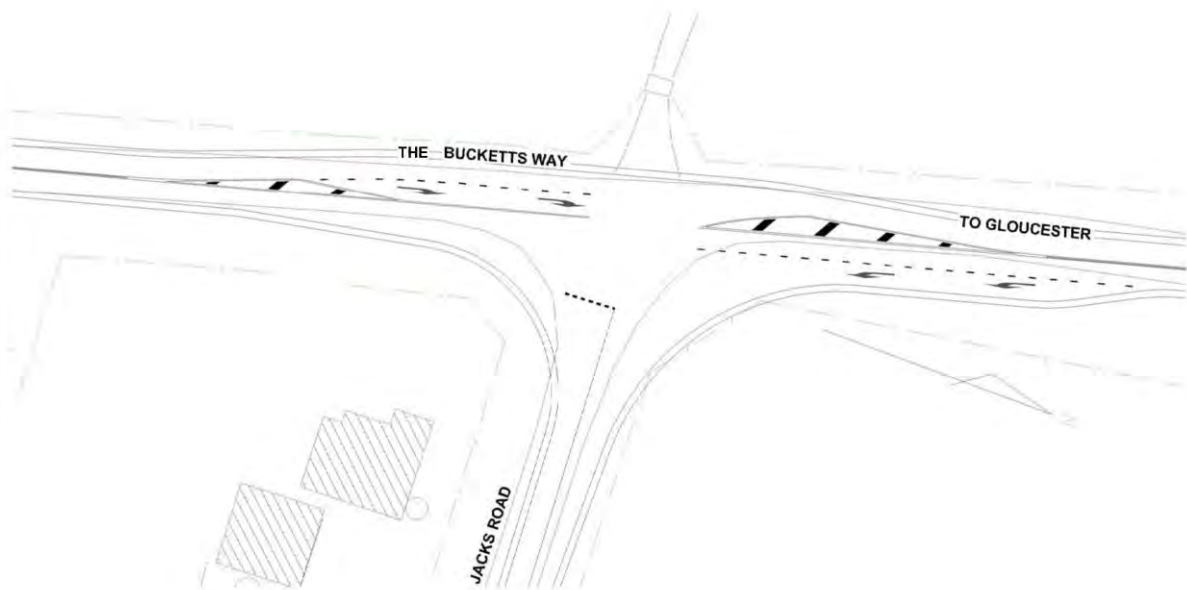
- Upgrade the existing intersection to include an auxiliary right lane to reduce the impact on through traffic.
- Installation of “Transverse bar” or hold line marking, “Give Way” signs and a sight screen for vehicles turning out of McKinleys Lane.

4.9.4 Assessment of Impacts

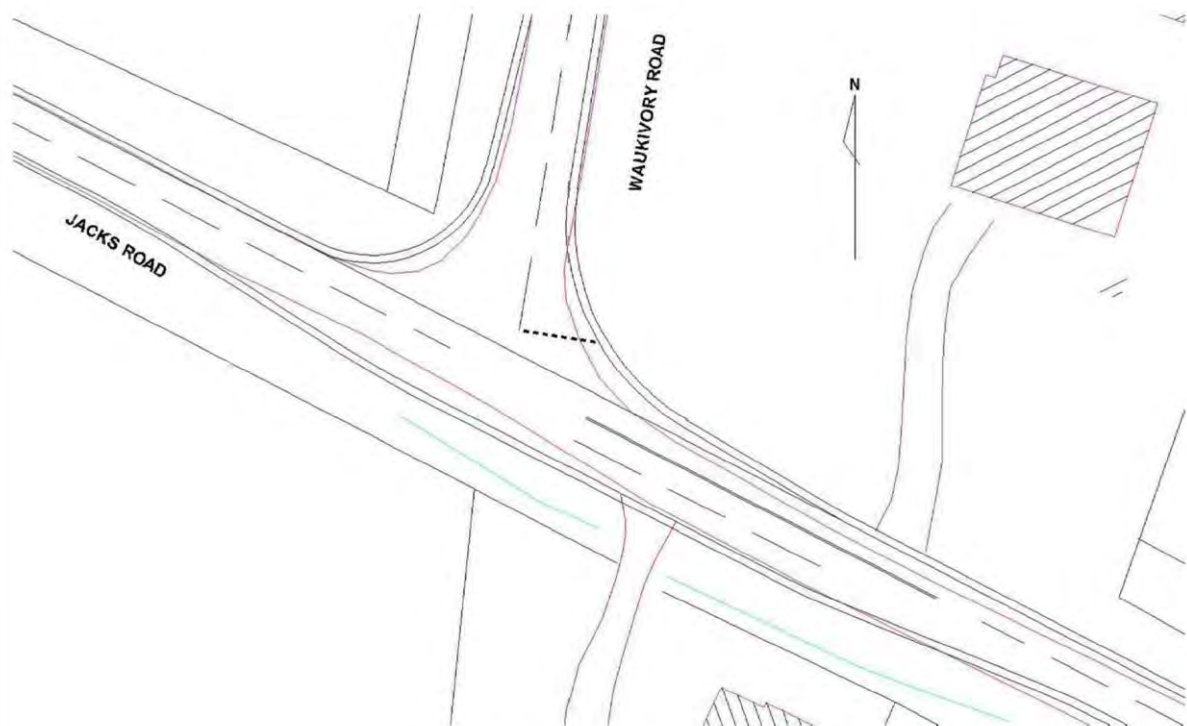
4.9.4.1 Introduction

The use of the private haul road to transport sized coal to the Stratford Mining Complex is an essential component of the amended Project and would minimise the potential impacts on the surrounding public road network. The implementation of the mitigation measures outlined in Section 4.9.3 would also further reduce the potential for impacts. An assessment of potential residual road traffic impacts during the site establishment and construction and operational stages is provided in the following subsections.

Y:\Jobs 531 to 1000\806\Reports\80613_Amended EIS_2016\CAD\806Base.dwg_4.58 Intersection Upgrades



Jacks Road / The Bucketts Way



Jacks Road / Waukivory Road

Figure 4.58
 PROPOSED INTERSECTION UPGRADES
 INDICATIVE LAYOUTS

4.9.4.2 Site Establishment and Construction Traffic

Although the average daily increase in traffic volumes as a consequence of site establishment and construction stage would not be significant, daily and periodic variances would occur.

Prior to the replacement of the bridge on Jacks Road across the Avon River, site establishment and construction traffic approaching from the south to access the Mine Area would be required to utilise the heavy vehicle bypass through Gloucester, Waukivory Road, McKinleys Lane and the Mine Area access road. It is anticipated that construction of the Jacks Road bridge would take approximately 3 to 4 months (between months 4 and 8 – see **Table 2.3**) following the completion of the required geotechnical and design works and receipt of necessary approvals from Council.

During the site establishment and construction stage, traffic volumes on The Bucketts Way, Jacks Road and Waukivory Road would increase by an estimated average of 0 to 108 light vehicle movements and 0 to 14 heavy vehicle movements per day between Months 2 and 10. Traffic volumes on The Bucketts Way and Waukivory Road would increase by an estimated average of 52 to 94 light vehicle movements and 7 to 19 heavy vehicle movements between Months 2 and 9 (see **Table 2.9**). The peak of combined average daily traffic volumes on Waukivory Road (east) would occur during Month 5 of construction with an estimated 158 light vehicle movements and 30 heavy vehicle movements. A full monthly breakdown of traffic volumes and types is provided in Appendix D of Constructive Solutions (2016).

With the planned construction of the private haul road from south to north, access to the private haul road corridor for haul road construction would be via Wenham Cox Road, i.e. with the exception of the construction of the bridge over Waukivory Creek and underpass for Fairbairns Road, which would be accessed via Fairbairns Road. Following completion of the private haul road towards the end of the site establishment and construction stage (see **Table 2.3**), the Stratford Mining Complex access would be utilised for the delivery of plant and equipment to the Mine Area. Delivery of the mining equipment required for Year 1 operations would result in a total of approximately 90 movements by a mixture of platform low loaders, floats, semi-trailers and drop-deck semi-trailers, all of which would enter the Mine Area from The Bucketts Way via the Stratford Mining Complex and the private haul road. The adoption of this construction sequence and agreement with Yancoal to utilise the Stratford Mining Complex access for plant and equipment deliveries to the Mine Area would reduce the volume of construction stage traffic that would otherwise need to utilise the heavy vehicle bypass through Gloucester or Jacks or Waukivory Road.

Traffic volumes associated with construction of the private haul road would increase on:

- Wenham Cox Road by an estimated average of 24 light vehicles and 3 to 15 heavy vehicles/day;
- Fairbairns Road by an estimated average of 20 light vehicles and 2 to 7 heavy vehicles/day; and
- via the Stratford Mining Complex access by an estimated average of 0 to 2 heavy vehicles/day (see **Table 2.9**).

Constructive Solutions (2016) has determined that the potential impacts during the site establishment and construction stage could be adequately managed through appropriate planning and implementation of the traffic management measures outlined within Section 4.9.3,

in particular the Construction Traffic Management Plan. Given the relatively short term nature of the site establishment and construction stage, no specific road upgrades other than those required for the operational stage of the amended Project are proposed.

4.9.4.3 Operational Traffic Impacts

Following the site establishment and construction stage, and apart from further deliveries of mining equipment to the Mine Area, the principal vehicle movements associated with the amended Project would comprise light vehicles driven by mine employees and contractors, and heavy vehicles supplying consumables to and servicing the mine. **Table 4.63** provides a summary of the likely operational traffic on the nominated work days (Monday to Saturday) and the effective increase relative to forecast traffic levels at mine commencement (2019) for each of the road sections potentially impacted. **Tables 4.64** and **4.65** then provide a summary of the effective increase relative to forecast traffic levels in the Years 2029 and 2039.

In each of **Tables 4.63, 4.64** and **4.65**, it has been assumed that light vehicle traffic entering and leaving the Mine Area would be split 70%/30% between Route 1 (via The Bucketts Way south of Gloucester and Jacks Road) and Route 2 (via the Bucketts Way east of Gloucester and Waukivory Road). For Route 1, it is assumed that 80% of light vehicle traffic entering Jacks Road would originate from Gloucester and 20% originate south of Jacks Road. For light vehicle traffic travelling via Route 2, an estimated 70% would originate in Gloucester and 30% would originate east of Waukivory Road.

Table 4.63
Average Daily Mine Operation and Combined Forecast Traffic Volumes at Mine Commencement (2019)*

Road	Site	2019 Traffic*				Mine Traffic [#]		Combined Traffic				Total & % Increase	
		LV		HV		LV	HV	LV		HV		TOTAL	%
The Bucketts Way	North of Jacks Road	2758	85%	490	15%	68	1	2826	85%	491	15%	3317	2%
	South of Jacks Road	2344	85%	414	15%	17	4	2361	85%	418	15%	2779	1%
Jacks Road		471	86%	77	14%	85	5	556	87%	82	13%	638	16%
Waukivory Road	East of Jacks Road	243	86%	41	15%	122	7	365	88%	48	12%	413	45%
	North of Jacks Road	234	85%	42	15%	37	2	271	86%	44	14%	314	14%
The Bucketts Way	West of Waukivory Road	1687	86%	275	14%	26	1	1713	86%	276	14%	1989	1%
	East of Waukivory Road	1500	86%	244	14%	11	1	1511	86%	245	14%	1756	1%
McKinleys Lane		36	97%	1	3%	122	7	158	95%	8	5%	166	347%
Wenham Cox Road		56	91%	6	9%	0	0	56	91%	6	9%	62	0%

LV & HV are acronyms for light vehicles and heavy vehicles respectively.

* 2019 traffic is based on 2015/16 counts shown in **Table 4.61** and 3% annual growth rate. In the absence of 2015/16 counts, estimates have been applied in line with the 2011/2013 counts.

[#] Mine traffic volumes shown are the estimated average daily operational movements which would occur in 2019, the projected commencement (Year 1) of mining operations.

Source: Constructive Solutions (2016) – Table 7

Table 4.64
Average Daily Mine Operation and Combined Forecast (Year 2029) Traffic Volumes*

Road	Site	2029 Forecast Traffic*				Mine Traffic#		2029 Combined Traffic				Total & % Increase	
		LV		HV		LV	HV	LV		HV		TOTAL	%
The Bucketts Way	North of Jacks Road	3706	85%	659	15%	151	2	3857	85%	661	15%	4518	4%
	South of Jacks Road	3150	85%	556	15%	38	7	3188	85%	563	15%	3751	1%
Jacks Road		633	86%	104	14%	189	9	822	88%	113	12%	935	27%
Waukivory Road	East of Jacks Road	326	86%	55	15%	270	13	596	90%	68	10%	664	74%
	North of Jacks Road	315	85%	56	15%	81	4	396	87%	60	13%	455	23%
The Bucketts Way	West of Waukivory Road	2267	86%	369	14%	57	3	2324	86%	372	14%	2696	2%
	East of Waukivory Road	2016	86%	328	14%	24	1	2041	86%	329	14%	2370	1%
McKinleys Lane		48	97%	1	3%	270	13	318	96%	14	4%	333	567%
Wenham Cox Road		76	91%	8	9%	0	0	76	91%	8	9%	84	0%

LV & HV are acronyms for light vehicles and heavy vehicles respectively.

* Forecast traffic is based on data provided in **Table 4.61** assuming a 3% annual growth rate and the same percentage of heavy vehicles.

Mine traffic volumes shown are the estimated average daily operational movements which would occur in Year 10 of mining operations.

Source: Constructive Solutions (2016) – Table 8

Table 4.65
Average Daily Mine Operation and Combined Forecast (Year 2039) Traffic Volumes*

Road	Site	2039 Forecast Traffic*				Mine Traffic#		2039 Combined Traffic				Total & % Increase	
		LV		HV		LV	HV	LV		HV		TOTAL	%
The Bucketts Way	North of Jacks Road	4981	85%	886	15%	34	0	5014	85%	886	15%	5900	1%
	South of Jacks Road	4233	85%	747	15%	8	1	4242	85%	748	15%	4990	0%
Jacks Road		850	86%	140	14%	42	1	892	86%	141	14%	1033	4%
Waukivory Road	East of Jacks Road	438	86%	74	15%	60	2	498	87%	76	13%	574	12%
	North of Jacks Road	423	85%	75	15%	18	1	441	85%	76	15%	517	4%
The Bucketts Way	West of Waukivory Road	3047	86%	496	14%	13	0	3060	86%	496	14%	3556	0%
	East of Waukivory Road	2710	86%	441	14%	5	0	2715	86%	441	14%	3156	0%
McKinleys Lane		65	97%	2	3%	60	2	125	97%	4	3%	129	92%
Wenham Cox Road		102	91%	10	9%	0	0	102	91%	10	9%	112	0%

LV & HV are acronyms for light vehicles and heavy vehicles respectively.

* Forecast traffic is based on data provided in **Table 4.61** assuming a 3% annual growth rate and the same percentage of heavy vehicles.

Mine traffic volumes shown are the estimated average daily operational movements which would occur in Year 20 of mining operations.

Source: Constructive Solutions (2016) – Table 9

It is noted that all residences currently accessed by McKinleys Lane would be demolished or used for site offices and/or amenities. As a result, all traffic travelling on the northernmost 50m of McKinleys Lane would be mine-related.

The potential operational impacts on the relevant roads resulting from the above traffic increases relate to the efficiencies of the intersections, rail crossings, interactions with school buses and other users, and are summarised as follows.

SIDRA Intersection Analysis

Based on the higher volume of background traffic relative to other intersections and the expected access routes to the Mine Area, the Jacks Road intersection with The Bucketts Way was considered to be the key intersection for performance assessment. Therefore, the performance of the Jacks Road intersection with The Bucketts Way was modelled using the intersection performance simulation software SIDRA. The purpose of the intersection analysis was to determine whether the existing intersection has the capacity to perform satisfactorily during peak periods with the additional traffic anticipated during operations.

SIDRA modelling was initially completed for Year 10 of the 2013 Project based on traffic projections for 2027 and the 2011/2013 count data. For the amended Project, consideration is given to Year 10 based on projections for 2029 and the 2015/2016 count data. A review of **Table 4.66**, which provides a comparison of the traffic projections based on the most recent (2015/2016) data and the projected traffic numbers based on the 2011/13 count data, shows that the projected traffic levels for 2029 for each of The Bucketts Way north and south of Jacks Road, and for Jacks Road, are approximately 75% of those used in the 2027 SIDRA analysis.

Table 4.66
Traffic Projection Comparison

Site	2013 Project				amended Project			
	2011/12	2022	2027*	2032	2015	2019	2029	2039
The Bucketts Way - north of Jacks Road	3253	4630	5367	6223	2886	3248	4365	5867
The Bucketts Way – south of Jacks Road	2806	3884	4503	5220	2450	2757	3706	4980
Jacks Road	559	774	898	1040	487	548	737	990
* used in SIDRA analysis								
Source: Constructive Solutions (2016) – Table 12								

As a result of this comparison, it is considered unnecessary to update the SIDRA modelling as the use of the 2013 SIDRA analysis provides a conservative assessment (given the use of higher ambient traffic volumes). Furthermore, with the revised traffic assumptions associated with the amended Project, the reduced total number of employee movements, and the shift changeover periods identified in **Table 2.11**, there would be a general reduction in traffic levels compared to those modelled for the 2013 Project.

The performance of the intersection, previously modelled for the year 2027 assuming forecast ambient traffic based on 2011/2013 data and mine traffic associated with the 2013 Project, is summarised in **Table 4.67**. Detailed SIDRA outputs are provided in Appendix B of Constructive Solutions (2016).

Table 4.67
Modelled Future Traffic Conditions – Peak Operation

Intersection	Peak Flow Periods	Degree of Saturation	Delays (Sec)	Level of Service ¹	Queue (m)	Demand Flow (v/hr)	Effective Capacity (v/hr)
Jacks Road / The Bucketts Way	4:30 – 5:30pm	0.196	13.9	A	9.6	714	2 228
¹ Level of Service is a qualitative measure describing operational conditions within a traffic stream and takes into account service measures such as speed and travel time, freedom to manoeuvre, traffic interruptions, safety, comfort and convenience. There are six levels of service, designated A (best – free flow) to F (worst – breakdown in flow) (Austroads, 1988).							
Source: Constructive Solutions (2016) – modified after Table 11							

The analysis indicated that the intersection would continue to operate far below its capacity when modelled utilising the combined projected background traffic and mine traffic movements, was predicted to have a low degree of saturation and excellent level of service. This demonstrates that there would be no significant impact on the performance of the intersection and the road network in the vicinity of the Site during the operational stage at both existing and forecast traffic volumes.

Notwithstanding this, with the proposed upgrade of The Bucketts Way and Jacks Road intersection to provide a channelised right turn lane and auxiliary left turn lane, the performance of the intersection would improve further, particularly for through traffic which would not be impeded to the same extent by turning traffic as currently experienced.

Consistent with the outcomes of discussions with the RMS, the remaining intersections along the nominated access route were not modelled as the peak traffic at these intersections is significantly less than the corresponding effective capacity. In any event, given the other intersections where mine traffic is anticipated generally have a similar configuration and significantly less traffic, similar results would be anticipated. Therefore any additional SIDRA modelling would provide no additional value to the assessment.

The Bucketts Way

It is not anticipated that the amended Project would have a significant impact on traffic levels on The Bucketts Way given the relatively low volumes of traffic projected by the amended Project in comparison with existing volumes and projected growth.

Traffic generated by the amended Project has been estimated to represent a 1% to 4% increase in the total traffic volumes on The Bucketts Way in the vicinity of Jacks Road although the majority of light vehicle mine traffic would occur at the commencement and end of each shift. Notably, the majority of the scheduled shift changes (see **Table 2.11**) fall outside the hours of higher traffic numbers on The Bucketts Way which occur between 9:00am and 5:00pm. The percentage of heavy vehicles would remain relatively unchanged with the distribution of heavy vehicle movements spread throughout each day.

Sections of The Bucketts Way have recently been upgraded utilising funding provided by the Department of Regional Infrastructure and Development totalling \$16 million. The sections which have been recently upgraded include:

- between Phillip Street and Cemetery Road which is just to the north of the Jacks Road intersection;
- at Craven Village, approximately 18km south of Gloucester; and
- at Wallanbah Road, approximately 14km east of Gloucester.

Despite these upgrades, it is recognised that some components of The Bucketts Way are still in need of significant repair to reach a suitable level of service to accommodate the existing and forecast traffic volumes throughout the region, irrespective of whether the amended Rocky Hill Coal Project proceeds.

Whilst the percentage increase in traffic resulting from the amended Project would be negligible (between 1% and 4%), it is accepted that the amended Project would have some impacts on the existing road pavement. These impacts would be commensurate with the number and type of heavy vehicles utilising The Bucketts Way to travel to and from the Site. The increase in heavy vehicles would result in an increase in maintenance requirements and an accelerated reduction in pavement life. However, these increases would be offset through the payment of the nominated road maintenance contribution to Council, consistent with the contributions for the Stratford Extension Project.

The Bucketts Way and Jacks Road Intersection

The operation of the mine, with Jacks Road as the primary access route, would increase the number of turning movements through the intersection with The Bucketts Way, with mine-related traffic on Jacks Road resulting in an estimated initial increase of between 16% in 2019 and 27% in 2029 decreasing over the subsequent life of the amended Project, assuming increases in background traffic volumes.

As discussed previously, SIDRA modelling demonstrates that the intersection would operate well below its capacity with the addition of the traffic travelling to and from the Mine Area. Despite this, the Applicant proposes to upgrade the intersection with channelised right (CHR) and auxiliary left lanes to improve safety and ensure the intersection has the capacity to accommodate any significant increase in ambient traffic which occurs throughout the mine life.

These treatments, together with a recommended extension of the 60km/h speed limit to the south of the intersection, would significantly improve safety at this location. The channelised right turn lane would also assist in ensuring that northbound through traffic is not impeded by heavy vehicles accessing the Mine Area, local industrial ventures or rural properties turning right into Jacks Road.

The Bucketts Way and Waukivory Road Intersection

Use of this intersection by some operational traffic is anticipated. The increase in traffic turning at the intersection as a result of the amended Project is estimated to be a maximum of 39 movements per day in 2019 and 85 movements per day in 2029 which represent an increase of vehicles turning at this intersection of 14% and 23% respectively.

Given the available sight distance, the standard and condition of the intersection and the low volumes of background traffic, the existing configuration is considered adequate and a reduction in the level of service is not anticipated.

Jacks Road

Although the existing pavement integrity and formation/seal width are considered satisfactory for the current level of use, Jacks Road would be upgraded as discussed in Section 4.9.3 to accommodate the projected increases in light and heavy vehicle movements.

Mine traffic interaction with the existing traffic associated with the Thunderbolt and Avon River Estates (and any future subdivisions on Jacks Road) and rural-residential and rural properties adjacent to Jacks Road has a potential to conflict with traffic movements to and from the Mine Area. Access to these subdivisions and the rural-residential and rural properties is via intersections with Angophora Road, Combo Road and Maslens Lane, and driveways to individual private residences. By the installation of “Give Way” signs and/or holding lines for these intersections and making mine personnel aware of these intersections, no further measures are deemed necessary.

The proposed replacement of the bridge over the Avon River would be a significant enhancement for local traffic throughout and beyond the life of the amended Project, and save Council a significant capital outlay that would otherwise be required to repair/replace the existing structure.

Jacks Road and Waukivory Road Intersection

This intersection currently has no controls, no designated turning lanes, and no line marking. The proposed upgrade of this intersection would provide an auxiliary right turn lane for vehicles travelling west to turn right onto Waukivory Road (see **Figure 4.58**). This would improve traffic flow and reduce the likelihood of rear-end collisions.

Waukivory Road (North of Jacks Road)

Given the relatively low increase in operational traffic volumes, no significant impacts are anticipated, provided suitable maintenance arrangements are in place. Therefore, no upgrade to the road has been recommended by Constructive Solutions (2016).

Waukivory Road (East of Jacks Road)

With the proposed road widening and pavement strengthening, it is assessed that the road would perform adequately throughout the life of the amended Project.

McKinleys Lane

The proposed upgraded intersection of McKinleys Lane and Waukivory Road would provide for sufficient dimensional capacity to allow large articulated and oversize vehicles to turn into and out of McKinleys Lane within their respective lanes. This would afford priority to through traffic on Waukivory Road. As use of McKinleys Lane beyond the entrance to the Mine Area access road would no longer be required, no impacts would occur on the un-used, unsealed section of the lane. This section of road would be isolated, ripped and allowed to regenerate naturally.

Jacks Road Rail Crossing

On average, up to approximately 200 mine-related vehicle movements per day are anticipated on Jacks Road, increasing the total number of vehicle movements per day to 638 vehicles at the commencement of the amended Project and, providing for increases in ambient traffic, to 935 in year 2029 (Year 10 of operations) and 1 033 in year 2039 (Year 20 of operations). The increase is not anticipated to have a significant impact on the safety or capacity at the rail crossing on Jacks Road given the active controls that are in place and the relative infrequency of trains. Furthermore, there are no intersections within the vicinity of this rail crossing that are likely to create issues with short stacking, or queuing as a result of the increase in traffic, even at shift changes.

School Buses

School bus routes incorporate The Bucketts Way, Jacks Road, Waukivory Road and Fairbairns Road. Based on the current school bus schedule, the majority of the pick-ups and drop-offs within the vicinity of the roads to be utilised by mine-related traffic would occur between 8:00am and 8:45am and between 3:00pm and 4:00pm. The scheduled operational shift times (see **Table 2.11**) do not coincide with these times. If, in the future, shift time changes are contemplated, the school bus times would be avoided, where possible.

With the implementation of the management measures (including inductions / toolbox talks and the Driver's Code of Conduct) making employees aware of the school bus times and pick-up / drop-off locations, the potential for adverse interactions between bus and light vehicle traffic would be minimised. The Driver's Code of Conduct would also encourage drivers of heavy vehicles to avoid, whenever possible, the morning and afternoon periods when the school bus is carrying school children.

With the adoption of these measures, it is not anticipated that the operational traffic would significantly impact on school bus operations along the various routes.

Other Road Users

There is very limited pedestrian or cycling activity along the road network outside Gloucester township. No pedestrians and only two cyclists were observed outside these areas during inspections undertaken by Constructive Solutions personnel. On this basis, it is not anticipated that there would be any significant impact on pedestrian and cyclist activity as a result of the increase in traffic movements associated with the amended Project.

Widening of the pavement and seal should, nevertheless, assist any cyclists that may utilise Jacks Road and Waukivory Road east of Jacks Road where routine interaction with Project-related vehicles may occur.

4.9.4.4 Cumulative Impacts

Consideration has also been given to other major developments within the Gloucester area which could result in a cumulative traffic impact. For the purpose of this assessment, it was considered that major existing developments that were in an operational stage had already been accounted for in the traffic counts.

The major developments where additional traffic would be generated, assuming they proceed, include the:

1. Stratford Extension Project; and
2. Martins Lime Project.

Whilst AGL has advised that the Gloucester Gas Project will no longer proceed there is likely to be some remaining traffic generated from the decommissioning process. However, this is scheduled to be completed by late 2017, i.e. before the commencement of any on or off-site activities associated with the amended Project.

Of these two major developments, only the Stratford Extension Project is likely to generate significant additional traffic movements along The Bucketts Way south of Gloucester. Traffic associated with the Martins Lime Project would predominantly utilise the section of The Bucketts Way to the east of Gloucester.

Based on the available information, it is estimated that the Stratford Extension Project would generate approximately 400 vehicle movements per day, representing an additional 158 vehicle movements per day above previous operations within the Stratford Mining Complex, on the section of The Bucketts Way south of the township of Gloucester. This equates to an increase of 13.9% over the existing 2 886 movements recorded (see **Table 4.61**). However, this will be partly offset by the projected closure of the Duralie Coal Mine in 2017 which is expected to reduce traffic levels on The Bucketts Way south of Gloucester.

It is considered that the 3% annual traffic growth utilised for estimating the increases in forecast traffic easily accommodates the additional movements that may result along The Bucketts Way south of Gloucester over the life of the amended Project. Additionally, the available spare capacity of the Jacks Road intersection with The Bucketts Way is significant (see **Table 4.67**). Therefore the additional through traffic is unlikely to affect the performance of this intersection, particularly following the proposed intersection upgrades.

4.9.5 Conclusion

An assessment of the proposed changes to the road network indicates that, with the implementation of the proposed mitigation and management measures, the amended Project would not cause any significant adverse impacts upon the existing road network, rail crossings or road users. A range of measures proposed would, however, improve road efficiency and safety, the benefits of which would extend beyond the life of the amended Project.

4.10 ABORIGINAL CULTURAL HERITAGE

The Aboriginal cultural assessments of the amended Project were undertaken by Archaeological Surveys and Reports Pty Limited (ASR). The assessments draw together studies undertaken by ASR and the results of Aboriginal heritage surveys undertaken across the Mine Area and power line corridors in 2012 and the proposed private haul road in 2016. The assessments arising from both surveys are presented in Volume 5 Part 11A and Part 11B of the Specialist Consultant Studies Compendium, respectively and are referenced throughout this section as ASR (2016a) and ASR (2016b), with a summary of the assessments presented in the following subsections.

4.10.1 Introduction

Based on the risk assessment undertaken for the amended Project (Section 3.3.1 and **Appendix 6**), the potential impacts relating to Aboriginal cultural heritage and their risk rankings after the adoption of standard mitigation measures are as follows.

- Unauthorised destruction of known Aboriginal heritage sites (low).
- Unauthorised destruction of unknown Aboriginal heritage sites within approval areas (low).

In addition, the Director-General's Requirements issued by the then DP&I (now DPE) identified "Aboriginal Heritage" as one of the key issues requiring assessment. The principal assessment matters from DP&I relating to Aboriginal heritage include the following.

- Demonstrate effective consultation with Aboriginal communities in determining and assessing impacts, and developing and selecting mitigation options and measures.
- Outline any proposed impact mitigation and management measures (including an evaluation of the effectiveness and reliability of the measures).

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the DGRs from the EPA, the former Gloucester Shire Council, NSW Heritage Council, NSW Health-Hunter New England Local Health District and BGSPA. The additional matters identified are generally consistent with the DGRs.

As GRL is seeking development consent under Part 4 (Division 4.1) for State significant development, the Aboriginal cultural heritage assessment for the amended Project was undertaken in accordance with the following guidelines, codes or legislation.

- *Aboriginal Cultural Heritage Consultation Requirements for Proponents* (DECCW, 2010a).
- *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW* (NSW Minerals Council, 2010).
- *National Parks and Wildlife Amendment Regulation 2010*.
- *National Parks and Wildlife Amendment (Archaeological Investigations) Regulation 2010*.
- *National Parks and Wildlife Amendment (Aboriginal Objects and Aboriginal Places) Regulation 2010*.
- *The Burra Charter: The Australia ICOMOS Charter for Places of Cultural Significance, 2013* (Australia ICOMOS, 1999).
- *Code of Practice for Archaeological Investigation in NSW* (DECCW, 2010c).

While the codes of practice for archaeological assessment in NSW (DECCW, 2010b) and for the Protection of Aboriginal Objects in NSW (NSW Minerals Council, 2010) do not specify that there should be Aboriginal consultation when undertaking an "assessment", other than to provide any cultural information associated with the Site, in accordance with the ethics of the Australian Association of Consulting Archaeologists Inc., of which Mr John Appleton, consulting Archaeologist of ASR is a member, all registered Aboriginal stakeholders with an interest in the Site were consulted (see Section 4.10.5).

The assessment of *Aboriginal* archaeology for the amended Project has been separated into two components. The first component relates to the assessment associated with the Mine Area and power line corridors undertaken in May and August 2012. The second component relates to the assessment of the corridor for the proposed private haul road undertaken in March 2016. This section provides a summary of the background investigations, Aboriginal consultation and

subsequent Aboriginal stakeholder involvement in the field investigations, led by Mr Appleton. Also presented are assessments of significance and the proposed management of the artefacts found through the field investigations.

4.10.2 Ethnohistory

The following subsection presents a summary of the ethnohistory of Aboriginal habitation of the Stroud-Gloucester Valley, a topic that has been extensively documented, with most sources acknowledging the possibility of variable interpretations and inconsistencies regarding borders and extent of tribal areas. The following information is summarised from information provided by Mr Mick Leon (representing Do-Waa-Kee), Mr Rob Yettica (representing Cultural Consulting Services) and Mr Bob Syron (representing the Gringai Clan Worimi Nation).

At the time of European settlement in the Gloucester-Stroud area (1830 – 1840), the area was inhabited by the Kattang speaking peoples of the Gringai, Worimi and Kabook tribes. These tribes were divided into a number of local groups, each with a degree of autonomous identity and rights associated with a specific geographical estate. Each of the tribes are said to have enjoyed a healthy and abundant lifestyle prior to European settlement, with some local groups having up to 500 members. Neighbouring tribes included the Biripi, Awabakal, Wonnarua and Geawegal peoples.

Mr Yettica identified the land within the proposed Mine Area as having traditionally been inhabited by the Worimi tribal group. In addition, Mr Syron identified the land upon which the proposed private haul road would be constructed as Worimi country, which he indicated extended from Cape Hawke, Tuncurry and Taree in the north to Maitland and the Hunter River in the south.

By 1850, the majority of coastal ranges and plains had been settled and modified by Europeans and traditional Aboriginal social and land use systems were noticeably affected. With reduced or refused access to their traditional lands, the remaining Kattang speakers became dependent on food and supplies provided by European settlers, many residing on the periphery of European settlements, with a number of camp sites used by such “fringe-dwellers” having been reported in the Copeland and Barrington areas.

In the Gloucester-Stroud area today, most of the Aboriginal population are direct descendants of the region’s traditional tribal groups, with most descendants still observing their cultural connections with the lands and waters of the Gloucester-Stroud area. Each tribe has significant areas and items that remain integral to the continuance of customary lore.

Mr Syron has added that the *Waukivory* (or “Big Battle”) area was the main hunting ground of the Worimi, which in legend was supposed to have been won in a battle between coastal tribes and the *Kabook* – Cherry Tree Clan (R. Syron, pers. comm. as recorded in ASR, 2016b).

A brief overview of the Aboriginal family histories in the Stroud-Gloucester Valley provided by Mr Syron is available in ASR (2016b).

4.10.3 Previous Surveys

4.10.3.1 Introduction

The results of surveys to identify and record evidence of previous Aboriginal visitation or usage of the land within and in the vicinity of the Site have been assembled from a search of the Aboriginal Heritage Information Management System (AHIMS) database. The sites recorded on the AHIMS database within the archaeological Study Area for the amended Project were identified during: an incomplete survey conducted in 2011 by Kayandel Archaeological Services; surveys commissioned by GRL in 2010 during the exploration phase for the Rocky Hill Coal Project (by Mr Rob Yettica); and in 2009 by an independent surveyor (Mr Rick Bullers) who was undertaking an assessment for the Gloucester Coal Seam Gas Project (AECOM, 2009b).

4.10.3.2 Archaeological Record

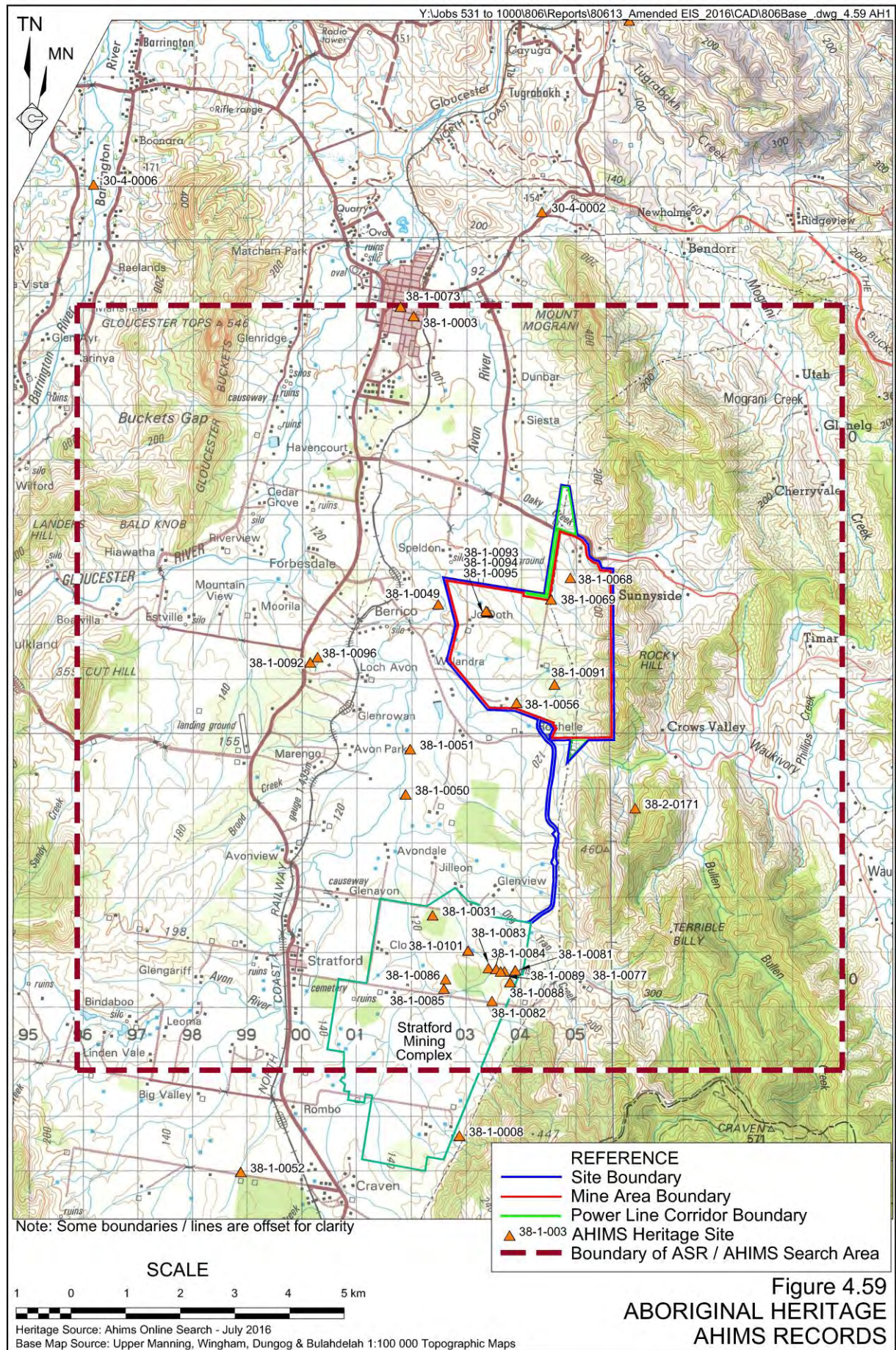
The search of the AHIMS database on 27 July 2016 within a 196km² area centred on the Site identified 27 sites that had previously been recorded. This search was an update to the same search area used by ASR in March 2012. At the time of the original search in 2012, 10 sites were identified within the same area⁴. **Figure 4.59** displays the location of the AHIMS search area and the location of 26 of the 27 recorded sites. The location of one site is noted as being restricted in the AHIMS database. OEH has further notified ASR that this site is located on the western escarpment of the range known as the Gloucester Bucketts and would not be impacted by the amended Project.

Eleven recorded sites are located within the Stratford Mining Complex. The ACHA for the Stratford Extension Project indicated that seven of these sites are to be salvaged with three remaining sites to remain undisturbed. One site (38-1-0031) is recorded as being located within the Stratford Mining Complex, however this isolated stone artefact is recorded as having been salvaged in January 2008 in accordance with Aboriginal Heritage Impact Permit (AHIP) #2858.

No sites identified on **Figure 4.59** were located in the proposed private haul road corridor. Five of the 27 recorded sites were identified within the proposed Mine Area. Two sites identified by Kayandel Archaeological Services (Kayandel) in June 2011 were registered on the AHIMS as Site 38-1-0091 and Site 38-1-0095, while two sites located in 2010 by Mr Robert Yettica are registered on the AHIMS database as Site 38-1-0068 and Site 38-1-0069. A third site, found in 2009 by Mr Rick Bullers, is recorded as PAD1 (Gloucester) and registered on the AHIMS as Site 38-1-0056.

An artefact scatter located within the Stratford Mining Complex (recorded as Stratford 2 Open Site) is within the 196km² area centred on the Site. The site was identified in archaeological investigations undertaken by Brayshaw McDonald in 1994 within the Stratford Mining Complex and included a single multiplatformed core and a single flake. The site was never recorded on the AHIMS database and could not be relocated in field surveys undertaken in October 2011 by Kayandel for the Stratford Extension Project.

⁴ At the time of the ASR field surveys and assessment of the Mine Area in August 2012 the sites identified by Kayandel Archaeological Services in June 2011 were not yet listed on the AHIMS database. These have since been registered and include Kayandel site GL-IF-1, registered as Site 38-1-01091; Kayandel site GL-IF-2, registered as Site 38-1-01092; Kayandel site GL-IF-4, registered as Site 38-1-01093; Kayandel site GL-IF-5, registered as Site 38-1-01094; Kayandel site GL-IF-7, registered as Site 38-1-01095; and Kayandel site GL-IF-8, registered as Site 38-1-01096.



4.10.3.3 Previous Site Surveys

Three previous formal investigations specifically targeting the Site have been undertaken by qualified archaeologists and/or Aboriginal stakeholders.

A formal investigation was undertaken by Mr Rick Bullers between 6 and 17 October 2009 to investigate the proposed pipeline route for the AGL Gloucester Coal Seam Gas Project (AECOM, 2009b). A PAD was identified within the Mine Area and registered on the AHIMS database as 38-1-0056.

Aboriginal Cultural Heritage Assessment – 2010

In 2010, Mr Robert Yettica of Yettica Cultural Consulting Services was engaged by GRL to undertake an assessment of the Aboriginal cultural heritage values within the areas to be disturbed during a coal exploration drilling program. Mr Yettica's brief was to identify whether Aboriginal sites existed in a number of parallel corridors being considered for the drilling program and if so, the locations of the proposed drill holes would be adjusted. Mr Yettica was assisted by Aboriginal representative Mr Isaac Paulson with their 2010 investigation identifying two isolated artefacts that were subsequently recorded on the AHIMS Site Register as Sites #38-1-0068 and #38-1-0069 (**Figure 4.59**).

Aboriginal Cultural Heritage Assessment – 2011

In June 2011, Kayandel Archaeological Consultants were engaged on behalf of GRL to undertake an Aboriginal cultural heritage assessment of an area being considered at that time for the proposed coal mine and its related infrastructure. Kayandel archaeologists were assisted in the investigation by Messrs Mick Leon and Barry Bungie of Doo-wa-kee and Messrs Robert Yettica and Isaac Paulson, representing Forster LALC. Prior to the 2011 survey, Kayandel undertook a search of the AHIMS database within a 490 km² search area. A total of 108 sites had been recorded at that time. The investigation took place in June 2011, and resulted in eight sites being found. Kayandel recorded all sites to be isolated artefacts. These sites have been registered on the AHIMS database under six Site IDs (38-1-0091 to 38-1-0096 inclusive). The smaller number of AHIMS Site IDs is considered to be due to the close location of several sites and the question of whether photographs of the “core” identified during the surveys showed the diagnostic features of a core. The area surveyed by Kayandel covered the majority of the Mine Area, including the proposed 132kV power line corridor, except for the areas immediately north of Waukivory Road and south of Fairbairns Road required for the power line corridor (see **Figure 4.60**).

Aboriginal Sites Officer walk-over of the proposed private haul road corridor in February 2016

Mr Mick Leon of Gangga Marrang performed a walk-over of the corridor for the private haul road in February 2016 prior to the soil samples being collected within the corridor by representatives of SOILmgt. Mr Leon recorded two isolated artefacts, details of which are included in Section 4.10.7.

4.10.4 Predictive Model

ASR developed a predictive model for each survey to establish the likely distribution of archaeological material against which the effectiveness and subsequent analysis of the survey results could be tested, compared and reasoned. The predictive models considered the existing archaeological record, resource availability, knowledge of the habitation and land use patterns of the Aboriginal people of the region (generally) and factors affecting identification.

The predictive models proposed for the Site recognised there were reliable water sources (the Avon River and Waukivory and Dog Trap Creeks) but no exposures of bedrock in the creeks or sandstone exposures that might be the site of engravings or axe-grinding grooves, no shelters or overhangs that might contain painted art or occupation deposits, and that there were unlikely to be any surviving Bora Rings or stone arrangements. The predictive models identified that the most likely evidence of Aboriginal occupation within the Site would be:

- isolated artefacts visible in erosion features on ridges, spur tops or along creek banks; and
- low-density artefact scatters visible in erosion features on ridges, spur tops or along creek banks, but it would be unlikely that any debitage would be visible.

The models identified that there was a low potential for trees more than 150 years old exhibiting scarred surfaces and a very low potential for trees more than 150 years old exhibiting carved surfaces to be present.

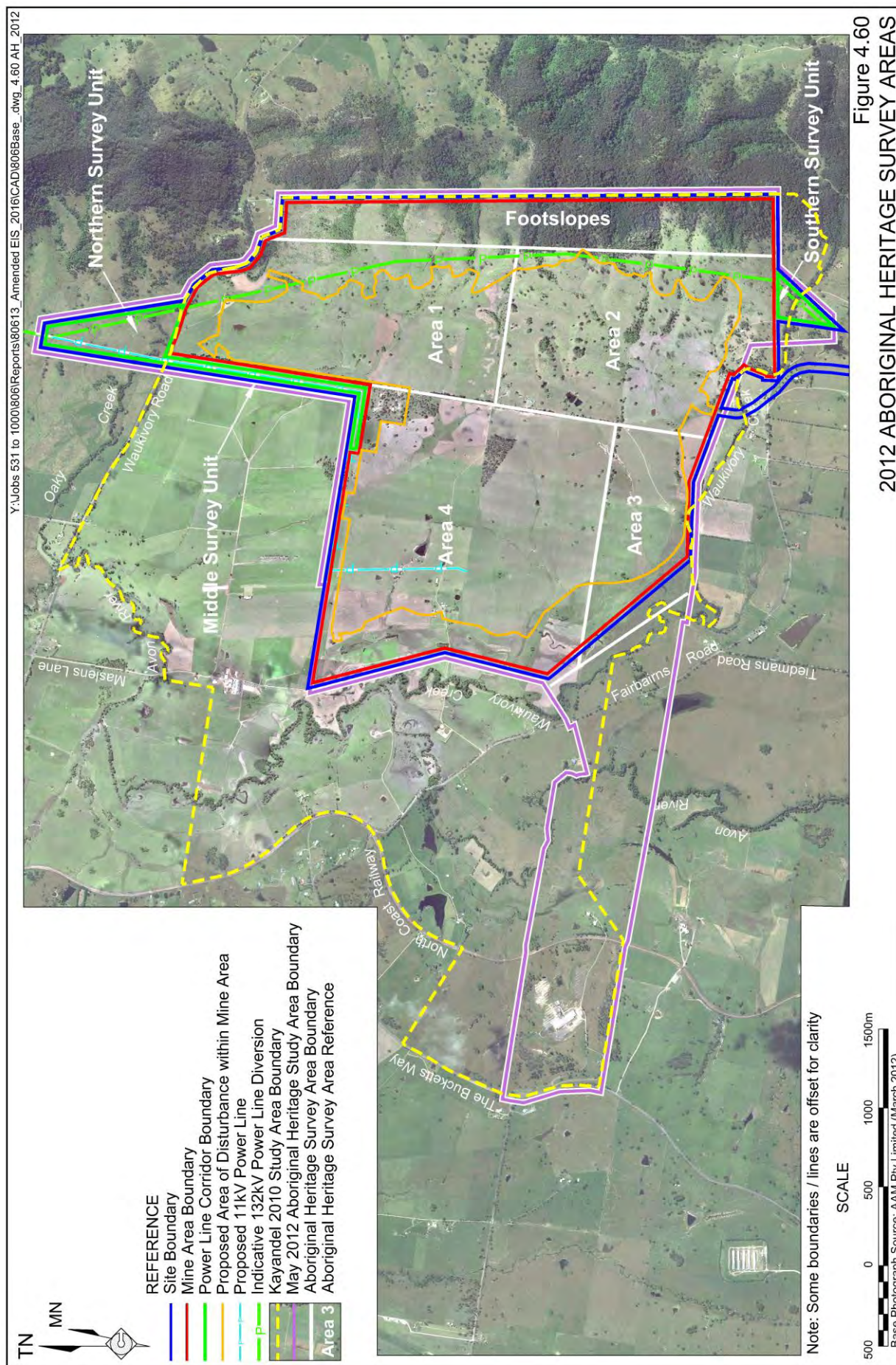
4.10.5 Consultation

4.10.5.1 Mine Area and Power Line Corridors May 2012 and August 2012

4.10.5.1.1 Prior to Survey

In accordance with *Aboriginal Cultural Heritage Consultation Requirements for Proponents* (DECCW, 2010a), letters were sent to Planning and Aboriginal Heritage Section - Northeast (OEH); National Native Title Tribunal (NNTT); Forster Local Aboriginal Land Council (LALC); the former Gloucester Shire Council; NTS Corp Limited; Northern Rivers CMA; and Office of the Registrar of the *Aboriginal Lands Right Act 1983* (ALRA), requesting that they provide lists of registered Aboriginal stakeholders for the area. An advertisement was also placed in the “Gloucester Advocate” on 13 January 2012 inviting all Aboriginal stakeholders with an interest in the Study Area (**Figure 4.60**) to register their interest. A complete record of all correspondence is located within Appendices iii - v of ASR (2016a).

A total of 13 Aboriginal stakeholders registered their interest in the assessment of the Mine Area. Three parties, comprising four people, requested to participate in fieldwork. Those stakeholders who registered their interest but did not want to participate in any fieldwork, requested a copy of the report once it had been submitted with the *Environmental Impact Statement* (for the 2013 Project).



4.10.5.1.2 During the Survey

The following Registered Aboriginal Parties⁵ assisted ASR in a three-day investigation of the Mine Area (**Figure 4.60**) undertaken between 1 May 2012 and 3 May 2012.

- Mr Mick Leon, Doo-wa-kee (and Forster LALC).
- Messrs Robert Yettica and Isaac Paulson, Yettica Cultural Consulting Services.
- Messrs Garmen Miles and Will Hall, Forster LALC.

The Study Area shown on **Figure 4.60** and adopted for the 2012 survey incorporated the Mine Area and the power line corridors. Additional areas that were at that time to be included in the Site (i.e. the Overland Conveyor Corridor and Rail Load-out Facility) were also surveyed at this time. The power line corridors external to the Mine Area were separately surveyed by ASR – see Section 4.10.6.2. No Aboriginal representatives were present for the additional power line corridors survey.

Given Messrs Leon, Yettica and Paulson participated in the Kayandel survey in 2011, it was possible to re-visit the sites or areas of the sites identified during that survey.

4.10.5.1.3 Following the Survey

It was agreed by all Aboriginal stakeholders present during the survey that Mr Leon, in consultation with Mr Yettica, would write a report on behalf of all stakeholders including a statement of cultural significance of the identified sites for inclusion as an appendix to ASR's report (see Appendix vii – ASR 2016a).

No Aboriginal stakeholder report was required for the additional power line survey.

All stakeholders who requested were provided with a copy of the final draft report by ASR for review and comment.

4.10.5.2 Private Haul Road Corridor March 2016

4.10.5.2.1 Prior to the Survey

In accordance with “*Aboriginal Cultural Heritage Consultation Requirements for Proponents*” (DECCW, 2010a), on 27 January 2016 letters were sent to Planning and Aboriginal Heritage Section - Northeast (OEH); National Native Title Tribunal (NNTT); Forster Local Aboriginal Land Council (LALC); the former Gloucester Shire Council; NTSCorp; NSW & ACT Registry; Hunter and Central Rivers CMA; and Office of the Registrar, ALRA, requesting that they provide lists of Aboriginal stakeholders for the area. A copy of an example of the letter is included as Appendix iii of ASR (2016b). In addition, an advertisement was published in the “Gloucester Advocate” on 3 February 2016 inviting all Aboriginal stakeholders with an interest in the Study Area to register their interest.

⁵ In accordance with the *Aboriginal Cultural Heritage Consultation Requirements for Proponents* (DECCW, 2010a), this document refers to those Aboriginal parties that have registered their interest in the Project as Registered Aboriginal Parties. Those parties registered with OEH as Aboriginal parties in the area of interest are referred to as registered Aboriginal stakeholders.

Correspondence with both the Northeast and Hunter Central Coast offices of OEH resulted in identification of 102 stakeholders registered in the area of interest. During the consultation process, Mr Mick Leon and Ms Kellie Syron registered under the group name Gangaa Marang. The Karuah LALC was also contacted separately on the recommendation of Mr Leon. Following further consultation with OEH regarding the potential for conflict due to the inclusion of Worimi, Birpi and Wonnarua parties as having interest in the Gloucester area, a final list of 90 stakeholders was initially consulted.

Following the initial consultation, a list of 23 Registered Aboriginal Parties for the assessment was compiled from those that:

- registered and attended the field survey;
- registered but could not attend the field survey; and
- requested to review a copy of the draft report only.

A total of 10 Registered Aboriginal Parties attended the field survey that took place on 17 March 2016.

4.10.5.2.2 During the Survey

During the survey, it was identified that the dense grass groundcover within the corridor was preventing an effective survey. Mr Appleton discussed the survey conditions with the stakeholders present and suggested that in the event development consent is granted, it should be recommended that during the early stages of construction of the private haul road there should be monitoring of grass stripping in those sections of the corridor in which there was potential for sites to be present.

4.10.5.2.3 Following the Survey

At the completion of the field survey of the private haul road corridor, all attendees provisionally agreed to Mr Appleton's recommendation pending the stakeholders' review of the draft assessment report.

On 15 April 2016, a copy of the draft Aboriginal Cultural Heritage Assessment Report for the private haul road was sent to all Registered Aboriginal Parties and each of the registered Aboriginal stakeholders originally consulted. Feedback on the draft report was provided by eight of the 10 Registered Aboriginal Parties that had participated in the field work and two of the Registered Aboriginal Parties that were sent a copy of the draft report only.

4.10.6 Survey Methodology

4.10.6.1 The Mine Area - May 2012

The Mine Area was split into three workable sections, each of which was surveyed in a day. **Figure 4.60** displays the areas within each section that were surveyed in May 2012. Areas 1 and 2 were surveyed on Day 1, Areas 3 and 4 were surveyed on Day 2 with the remaining areas surveyed on the third day. Mr Appleton subsequently established that the surveys undertaken satisfied the survey effectiveness requests as prescribed in "*National Parks and Wildlife Amendment (Archaeological Investigations) Regulation 2010*".

The fieldwork was undertaken by the six fieldwork attendees by walking abreast in lines approximately 20m-30m apart over each area, paying close attention to erosional features or ground exposures in their particular ‘corridor’ and any old growth trees, bedrock exposures, creek lines and dams. At the end of each ‘corridor’ walk, all surveyors would move to the next transect and repeat the exercise until the area was sufficiently covered.

Mr Appleton undertook a further visit to the PAD (Site 38-1-0056 see **Figure 4.59**) in June 2012 with Mr Bob Corbett of GRL and Mr Yettica to re-locate and to define the location and size of the PAD previously recorded in the southern part of the Mine Area by Mr Bullers in 2009.

4.10.6.2 Power Line Corridors - August 2012

The fieldwork within the sections of the power line corridors external to the Mine Area was undertaken by Mr Appleton on 31 August 2012 within the three separate areas as shown in **Figure 4.60** and designated as:

- the **Northern Survey Unit** (the area of the re-aligned 132kV power line route which also includes part of the proposed 11kV power line route) – the triangular area to the north of Waukivory Road;
- the **Middle Survey Unit** (the area of the proposed 11kV power line corridor) – adjacent to McKinleys Lane; and
- the **Southern Survey Unit** (the area of the re-aligned 132kV power line) – the triangular area that straddles Waukivory Creek beyond the southern boundary of the Mine Area boundary.

4.10.6.3 Private Haul Road Corridor - March 2016

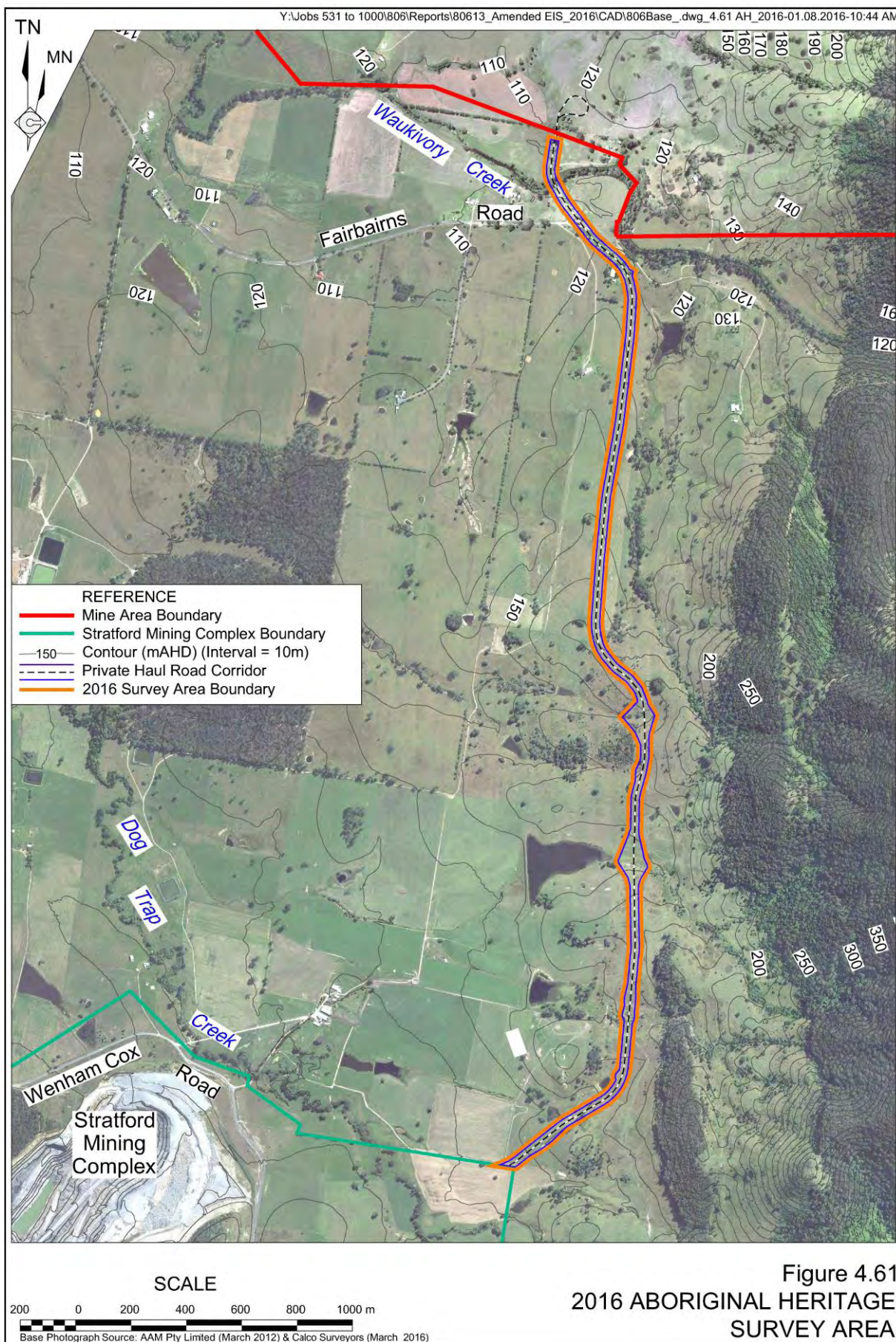
The field survey of the private haul road corridor involved traversing the proposed alignment of the 4.4km private haul road along a 50m-wide corridor (see **Figure 4.61**). The fieldwork was undertaken by the ten attendees and Mr John Appleton walking abreast with close attention paid to creek lines and dams, erosional features or ground exposures.

A mobile GPS device was used to ensure the correct alignment was followed.

The two sites previously identified by Mick Leon of Gangaa Marrang during his walk over of the private haul road corridor in February 2016 were relocated using the GPS coordinates recorded by Mr Leon.

4.10.7 Survey Results

The combined field surveys undertaken within the Site have resulted in a total of eight sites being identified within the Site (**Figure 4.62**). One of the sites identified by Mr Mick Leon and also recorded by ASR is not located within the private haul road corridor but may be impacted by construction activity and was therefore included in the results presented by ASR (2016b). Each of the nine sites is described in **Table 4.68** including the site type, context and relevant comments.



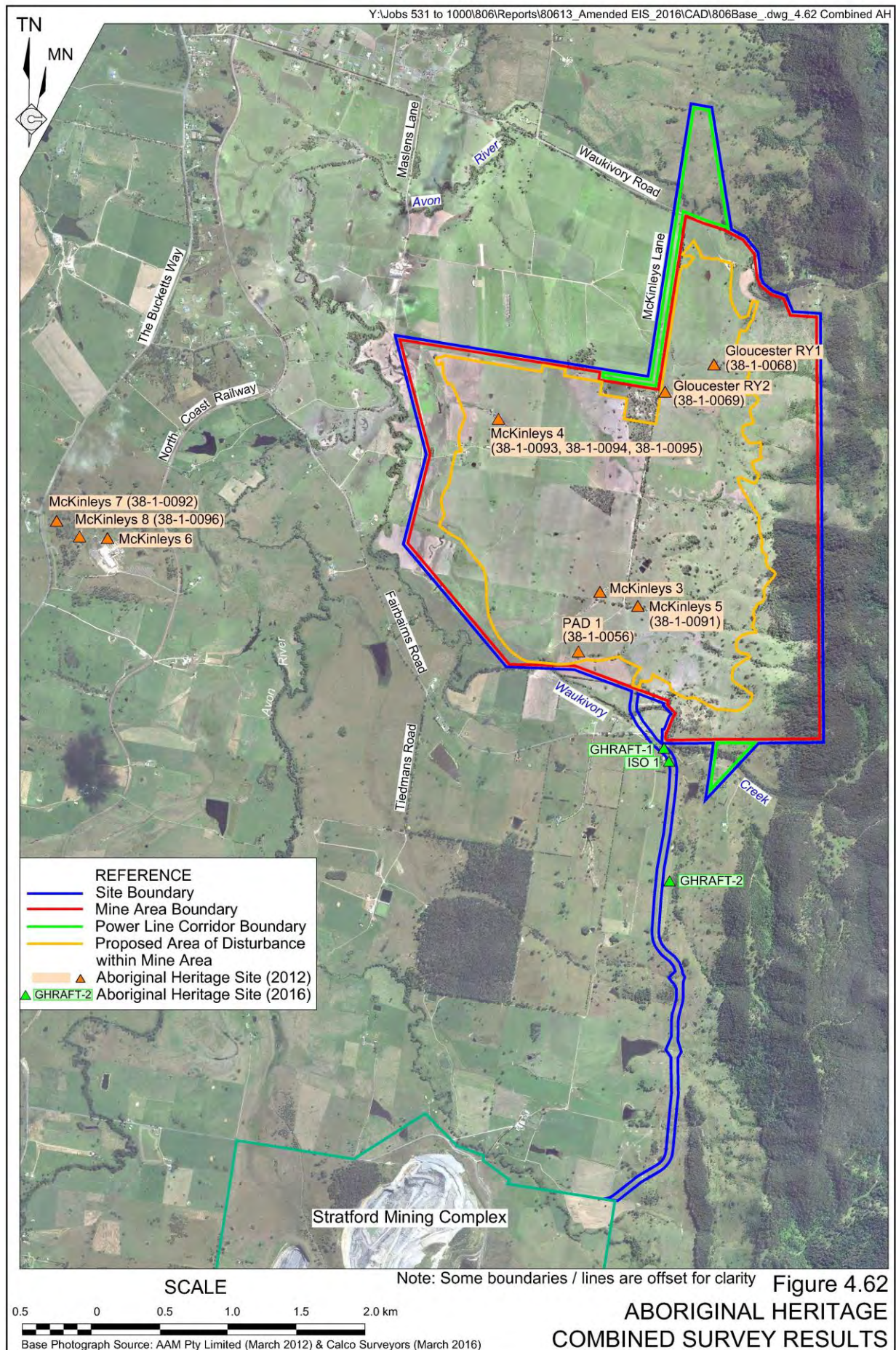


Table 4.68
Identified Aboriginal Heritage Items within the Site

AHIMS Ref. or ID	Site Type	Site Context	Comments
AHIMS Recorded Sites			
38-1-0056 ("PAD 1")	PAD	Cleared pasture	The PAD occurs on a cleared, densely grassed high spur point overlooking Waukivory Creek. The potentially sensitive area was subsequently identified by Rob Yettica and Appleton in June 2012 to be an area of approximately 28m across the spur ridge (E to W) x 10m (N to S). The GPS reading for the centre of the site was E.404327, N.6450698.
38-1-0068 ("Gloucester RY 1")	Artefact Scatter	Cleared pasture	Site identified by Robert Yettica as bulbs, where tools were knapped off. This site was not able to be relocated during the 2012 field surveys.
38-1-0069 ("Gloucester RY 2")	Isolated Artefact	Cleared pasture with dark humic soils	The site location as identified by Rob Yettica as a stock pad beside a small creek, in a swale next to the eastern road-easement fence adjacent to McKinleys Lane.
38-1-0093 38-1-0094 38-1-0095	Open artefact scatter	Clay soils with pebbles on 3-5° slope Recorded in a massively and actively eroding, sheer-sided gully - approximately 2m deep - below a dam in a cleared paddock.	Previously recorded by Kayandel as "GL-IF-004", "GL-IF-005", "GL-IF-006", and "GL-IF-007" A total of five artefacts were identified by ASR as a single site "McKinleys 4" as the artefacts were all in one area and therefore considered to be an artefact scatter.
38-1-0091	Isolated artefact (axe)	Located partly hidden by a large rock, on a narrow bench, a third of the way down of a very steep-sided drop-off. Deep grass cover, no surface exposure.	Previously recorded by Kayandel as "GL-IF-1", and identified by ASR as "McKinleys 5".
2012 Survey Results			
McKinleys 3	Artefact Scatter	Colluvial clays	Artefacts distributed over 40m x 20m area bisected length-wise by the creek. Artefact density Av. 1 per 80m ² . Maximum density: 2 per m ² . 10 artefacts were recorded in actively eroding, severely stock-worn shoulders of a small creek on a gentle foot-slope. The area is devoid of trees, having been cleared for pasture. Because the creek flow is seepage from a dam, the constant trickle of water attracts stock.
2016 Survey Results			
GHRAFT-1	Isolated artefact	Located on a mown area adjacent to the residence approach road.	Initially identified by Mick Leon in February 2016. Unlikely to be in its original depositional location.
Fairbairns Road ISO 1	Isolated artefact	Located in an erosion feature in a mown area downslope of the homestead.	Extremely unlikely that it is in its original depositional location.
GHRAFT-2	Isolated artefact	Located in a used cattle path beneath vegetation adjacent to a watercourse.	Unlikely to be in its original depositional location.
Source: ASR (2016a) – Section 5 and ASR (2016b) – Section 5			

It is acknowledged that the dense groundcover within the private haul road corridor prevented an effective survey from being undertaken. In accordance with the predictive model prepared by ASR, it was concluded that the area between Waukivory Creek and Fairbairns Road would be an ideal location for sites due to slopes being less than 5° and their close proximity to the creek. However, this location is highly disturbed and remains unlikely to contain identifiable artefactual material.

The power line corridor survey undertaken in August 2012 by ASR revealed no additional Aboriginal heritage sites in any of the three targeted areas.

The results of the field survey undertaken within areas formerly proposed as the location for an overland conveyor and rail load-out facility have not been reported here as their locations are not relevant to the assessment of the amended Project. However, the identification of these sites provides additional knowledge of Aboriginal habitation of the area. The sites have been identified on **Figure 4.62**. The two sites identified by Kayandel have been registered on the AHIMS database as Site 38-1-0092 and Site 38-1-0096. The site identified by ASR will be registered on the AHIMS database.

4.10.8 Potential Impacts on Aboriginal Heritage Sites

With the exception of “GHRAFT-2”, all identified sites would be destroyed⁶ by the amended Project if it proceeds, either by direct disturbance from mining activities or from other activities such as the construction of the private haul road or other mine-related infrastructure. The proposed approach to the salvage and relocation of all identified artefactual material that would be impacted or potentially impacted by the amended Project would alleviate the destruction and ultimate loss of Aboriginal heritage. ASR (2016b) recommended salvage of GHRAFT-2 as it is immediately downslope of the private haul road corridor, and may be impacted by slope-wash when the groundcover upslope is removed, or buried in slope-wash born sediments.

4.10.9 Management, Mitigation and Contingency Measures

4.10.9.1 Management Measures

The Applicant recognises that the amended Project would have an impact on the Aboriginal heritage within the local area and has committed to a retrieval and salvage operation where an impact to known sites cannot be avoided. The operation would be undertaken by a qualified archaeologist and with representatives invited to attend from each of the Registered Aboriginal Parties with direct association with Worimi Country, or by their chosen representatives. Any salvage operation would be undertaken following consultation with the Registered Aboriginal Parties and form part of the Aboriginal Cultural Heritage Management Plan prepared following the receipt of development consent for the amended Project. The salvage operation would ultimately re-locate the objects from the sites to a secure place agreed upon by the Worimi stakeholders or their appointed representatives.

In situ protection of the identified sites is not possible due to the proposed locations of the mine, private haul road and ancillary infrastructure. It is noted, however, that as these artefacts would be removed from their original locations, a residual impact on the Site itself would be incurred.

⁶ The removal or salvage of an artefact from its in situ location constitutes the Site being destroyed.

Limited sub-surface investigations (topsoil and subsoil scraping) are proposed to occur at three sites where there may be some potential for further artefacts to exist in the substrate. These three sites are Site 38-1-0069 (“Gloucester RY 2”), Site 38-1-0056 (“PAD1 (Gloucester)”), and “McKinleys 3”.

ASR (2016b) identified the land that lies between Waukivory Creek and Fairbairns Road as the location within the private haul road corridor most likely to contain artefacts. As a result, a representative from each of the Registered Aboriginal Parties with direct association with Worimi Country or by their chosen representatives will be invited to monitor turf stripping in this section of the corridor.

An Aboriginal Cultural Heritage Management Plan, prepared following the receipt of development consent for the amended Project, would incorporate mechanisms for the continued consultation with Aboriginal stakeholders throughout the life of the amended Project.

4.10.9.2 Mitigation Measures

Mitigation measures are primarily implemented when there are known sites within a proposed area of disturbance and measures are required to either avoid or minimise the potential impact to those sites. As the identified sites lie within the proposed mine footprint, mitigation measures are neither the preferred nor practical options.

4.10.9.3 Contingency Measures

The most practical way to implement contingency measures relates to informing and educating the mine workforce who are likely to be either operating the machinery on areas to be disturbed for the first time or in a role in which they can observe any artefacts as they become visible. This would be achieved through a Site induction in artefact recognition and the correct procedure if and when artefactual material is recognised. The Applicant proposes to engage a fully qualified archaeological consultant to conduct the initial briefing, and produce a one or two-page hand-out to be provided to each mine worker during their initial site induction. The hand-out will clearly set out the procedure they must follow if artefactual material is identified and the penalties if the procedure is not followed.

It should be noted that soil stripping is likely to be undertaken by open bowl scrapers or with the surface material pushed by bulldozers into windrows for subsequent collection by front-end loaders and trucks. Personnel would be educated to recognise Aboriginal sites during this process and be made aware of the potential to uncover these during operations.

During the construction of the private haul road and periods of surface disturbance during the construction stage, regular tool-box meetings would be used to reiterate the responsibilities and obligations of mine personnel and contractors under the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW* (NSW Minerals Council, 2010).

This method is deemed more practical by both archaeologists and OEH to that of monitoring for archaeological material over the life of the amended Project, as effective monitoring can only be undertaken by qualified archaeologists and can prove both costly and time consuming and provide no certainty that any artefacts would be discovered.

In addition to appropriate induction and continuing education at the mine, a requirement will be implemented to halt all works in the immediate area if Aboriginal artefactual material is uncovered. In this instance, a suitably qualified archaeologist and/or Aboriginal community representative would be contacted to determine the significance of the object(s). The site would be appropriately registered within the AHIMS and no further work would be undertaken within the immediate area of the site until a management strategy for the newly identified site is prepared in consultation with OEH and the Aboriginal community representative(s).

In the event human remains are located during ground disturbance activities, all works would be halted in the immediate area to prevent any further impacts to the remains. The NSW Police, the Aboriginal community and OEH would then be notified. If the remains are found to be of Aboriginal origin and the Police consider the site not an investigation site for criminal activities, OEH would be further notified of the situation and works would not resume in the designated area until approval in writing is provided by OEH. In the event that a criminal investigation ensues, works would not to resume in the designated area until approval in writing has been received from NSW Police and OEH.

In summary, should items of cultural heritage significance be discovered within the Site, all reasonable efforts would be made to avoid impact to cultural heritage values. If impacts are unavoidable, management measures would be negotiated with the appropriate Government agencies or Aboriginal parties.

4.10.10 Assessment of Impacts

4.10.10.1 Assessment of Significance

The NSW OEH policy to safeguard all sites, Aboriginal places and archaeological material of significance, wherever possible, requires that some means of assessing the significance of the sites is necessary. This is not only for the purpose of determining whether the proposed development can proceed as proposed, but also to provide Cultural Resource Managers with the information for future management of the area.

Cultural Significance

The Aboriginal or cultural significance of Aboriginal relics and sites can only be assessed by the Aboriginal community, and in particular, the Elders. The initial assessment of cultural significance of the Aboriginal sites identified within the Mine Area was undertaken by Mr Leon and Mr Yettica in their report prepared following review of a copy of the draft Aboriginal Cultural Heritage Assessment report for the Mine Area and Power Line Corridors (ASR, 2016a). They noted the educational importance of artefactual material for the local Aboriginal community and educational bodies.

Mr Syron stressed the cultural association the Worimi people, and particularly the Gringai Clan and the Cook family and descendants, had with the Waukivory Creek area, and how significant it was to all Worimi people. He wrote of the importance of Waukivory as a hunting ground won by the Kabook (*Cherry Tree Clan* of the Worimi) in an ‘affray’ with a coastal tribe.

Mr Todd Heard of the Gringai Traditional Owners stated that all artefacts:

“... are of cultural value and significance for Aboriginal people”.

He also referred to how the impact from the private haul road:

“... will represent a change (to) the aesthetics of the land from a cultural perspective and this factor is of great importance to Aboriginal people”.

Research Potential

All of the sites recorded within the Site, with the exception of “McKinley 3”, are of very low research potential as they are located within actively degrading B horizon soils, with the only potentially archaeologically sensitive areas being the intact sides of the scour or watercourse. The recommended scraping management measures at three of the sites during the salvage operations and the proposed monitoring of turf stripping between Waukivory Creek and Fairbairns Road (see Section 4.10.9.1) are not to address potential research significance but to address the Aboriginal concerns that there might be other nearby artefacts of potential cultural significance that should similarly be salvaged.

Educational Potential

Because the identified sites are located on private land, the sites would not be accessible to the public and therefore provide no potential educational value. However, if the artefacts are collected and put on display at a location selected on the basis of the Worimi stakeholders’ or their chosen representatives’ recommendations, the re-located sites may have the potential to fulfil a future educational role.

Aesthetic Value

All of the sites have been assessed as having no aesthetic value.

Uniqueness and/or Rarity

The search of the AHIMS Sites Register by Kayandel Archaeological Consultants in May 2011 found that 108 sites had been recorded in the 490km² search area centred on the Mine Area. The amended Project would result in removal of nine sites (six of which were not identified at the time of the Kayandel Archaeological Consultants AHIMS search) which would represent less than 8% of sites within the 490km² area. Against this information, none of the sites recorded within the Site are assessed as being either rare or unique.

Based on the above, it is considered that the overall significance of the sites to be removed is low, given that they would be re-located and subsequently available for the Aboriginal and broader community to view.

4.10.10.2 Assessment of Site Impacts

The conclusions from the comprehensive investigation of the Site and the identified Aboriginal heritage sites are that the amended Project would impact directly on all but one of the identified sites recorded within the Site.

Salvaging the artefacts would effectively destroy the in situ sites but their salvage would ensure the safety of the artefactual material which, if retained in secure premises such as a museum or Aboriginal Land Council Office, would become far more accessible than they would be if not salvaged but destroyed. Following the receipt of development consent, and the approval of the

Aboriginal Cultural Heritage Management Plan, a qualified archaeologist and Aboriginal stakeholders with connection to Worimi county or their chosen representatives would re-visit the sites to salvage the previously identified artefacts and any other artefacts at those locations that may be opportunistically encountered.

Once the artefacts have been removed, there would be no constraints to the development of the amended Project other than the standard provision as to what the Applicant and its contractors must do in the event that further archaeological material becomes exposed during site works.

4.10.10.3 Impact Assessment in a Regional Context

When considering whether or not to salvage certain artefacts, a further consideration is the extent to which the removal of the artefacts has a cumulative impact on the archaeological record, given that other sites in the region may have been destroyed previously.

A total of 32 sites exist within the original AHIMS search area of 196km² (comprising 27 previously registered AHIMS sites, an additional site recorded in 2012 to the west of the Mine Area and the additional four sites identified during the field surveys undertaken by ASR within the Site). Potential cumulative impacts would include the salvage of the three artefacts recorded during the survey of the proposed private haul road corridor together with the salvage of six sites within the Mine Area and the eight sites within the Stratford Mining Complex that will be salvaged within the 196km² search area.

The number and location of sites recorded in the AHIMS database and identified during field surveys of the Mine Area and private haul road corridor is a result of the intense archaeological assessment undertaken for these projects and would not be representative of areas of the landscape that have not had the same level of archaeological scrutiny. When considering cumulative impacts on a broader scale, i.e. throughout the Gloucester Valley, it is recognised that the valley has been subject to a long history of agricultural activities. When Kayandel Archaeological Services undertook a search of the AHIMS database in May 2011, 108 sites had been recorded within a 490 km² search area. In the context of an area over twice the size of that reviewed by ASR and the history of agricultural activities in this area, the amended Project would not significantly increase cumulative impacts to Aboriginal cultural heritage.

The removal and storage/display of the artefacts at an appropriately publicly accessible location would also provide the Aboriginal and broader community with an opportunity to view them, something which would not have otherwise been readily possible due to their location on private land.

4.10.11 Monitoring

As discussed in Section 4.10.9.3, monitoring for archaeological material following receipt of development consent and during subsequent mining operations is not feasible for the amended Project. The alternative of educating mine workers to be vigilant, to identify any Aboriginal artefacts encountered and to follow the correct procedures, is deemed more appropriate in this situation.

4.10.12 Conclusion

The preparation and implementation of an Aboriginal Cultural Heritage Management Plan to outline the approach to salvaging the identified artefactual material from sites and the education of the mine workforce would result in a manageable impact on the Aboriginal heritage as a result of the amended Project.

4.11 HISTORIC HERITAGE

The historic heritage assessment of the amended Project was undertaken by Richard Lamb and Associates (RLA). The full assessment is presented in Volume 5 Part 12 of the Specialist Consultant Studies Compendium and is referenced throughout this document as RLA (2016b) with a summary of the assessment presented in the following subsections. This historic heritage assessment cross-references, and should be read in conjunction with, the Visual Impacts Assessment (RLA, 2016a).

4.11.1 Introduction

Based on the risk assessment undertaken for the amended Project (Section 3.3.1 and **Appendix 6**), the potential impact relating to historic heritage and its risk rankings after the adoption of standard mitigation measures is as follows.

- Impact on scenic historic heritage, with landscape changing from rural to industrial (low).

In addition, the Director-General's Requirements issued by the then DP&I (now DPE) identified "Historic Heritage" as one of the key issues requiring assessment. The principal assessment matters relating to historic heritage include the following.

- Include a statement of heritage impact (including significance assessment) for any State significant or locally significant historic heritage items.
- Outline any proposed mitigation and management measures (including an evaluation of the effectiveness and reliability of the measures).

Additional matters for consideration in preparing the EIS were identified in correspondence attached to the DGRs from the EPA, the former Gloucester Shire Council, NSW Health-Hunter New England Local Health District, NSW Heritage Council and the BGSPA. The additional matters identified in the additional correspondence are generally consistent with the DGRs.

4.11.2 The Historical Record

4.11.2.1 Introduction

The following subsections outline the historic heritage of the area in the vicinity of the Site and have been drawn from a range of sources, including the various heritage registers referenced in RLA (2016b) to determine if any historic heritage listed items occur within or in the vicinity of the Site.

European involvement in the Stroud-Gloucester Valley has been recorded since the grant of land to the Australian Agricultural Company (AACo.) in the 1820s and the establishment of the township of Stroud in the 1830s, which eventually became the AACo. administrative centre. The grant of land to the AACo. included 464 640 acres (1 880km²) within the Stroud-Gloucester Valley as well as land within the Liverpool Plains (246 600 acres), Peel River (312 290 acres) and Newcastle (2 000 acres plus a number of small individual parcels of land), totalling 1,029,530 acres. The agricultural industry prospered with a range of products including high quality merino wool production. As the wool industry diminished, exploration of the Stroud-Gloucester Valley continued. Gloucester, at the northern end of the Stroud-Gloucester Valley, was surveyed in 1855 but remained a hamlet with a population of about 75 and as low as 30 until the end of the century and the eventual sale and subdivision of the AACo. land in the Gloucester area. This sale, which commenced in 1903, resulted in Gloucester developing into a thriving rural town.

Gloucester Estates Ltd initially purchased a proportion of the subdivided land from the AACo and employed successful promotions to lure new settlers to the area, resulting in an increasing population within the Gloucester locality. Smaller settlements between Stroud and Gloucester such as Wards River, Stroud Road and Weismantels were established with all townships experiencing periods of growth and decline due to changes in the local timber industry, the arrival of the railway, changes in rural economics and the increasing reliance on local roads. These fluctuations, based upon the aforementioned issues, also resulted in Stroud experiencing a population decline, with Gloucester continuing to steadily grow as a consequence of other industries being introduced within the Stroud-Gloucester Valley such as mining, in both historic and recent times, as well as the establishment of the tourism industry.

The bulk of the built evidence of the AACo., which is now recorded on the various heritage registers (see Section 4.11.2.2), is located within Booral and Stroud, with both towns retaining a stock of early buildings and sites from the first settlement period.

4.11.2.2 Historic Heritage Registers

Searches were undertaken within the following schedules, registers and lists for items with statutory protection in the Stroud-Gloucester Valley.

- Department of the Environment Register – for items on the National Heritage List and the Commonwealth Heritage List.
- Office of Environment and Heritage (OEH) Database – for items listed under the:
 - State Heritage Register (SHR) as administered by the Heritage Council of NSW and under the statutory protection of the *NSW Heritage Act 1977*.
 - State Heritage Inventory (SHI) – this includes items listed by local government and State agencies.
- Great Lakes Local Environmental Plan 2014 (GLLEP).
- Gloucester Local Environmental Plan 2010 (GLEP).
- Great Lakes Heritage Study – Great Lakes Council (2009).

Additional searches were undertaken in registers that do not have statutory protection and include:

- The Register of the National Trust of Australia (NSW) (NTANSW);
- The Register of the National Estate (the RNE)⁷; and
- Registers compiled by professional bodies such as the Royal Australian Institute of Architects, Institution of Engineers Australia and others.

The results of the searches of the above heritage registers are listed in Table 2.1 of RLA (2016b) with the results of the searches in relation to the amended Project categorised below into Commonwealth, State, Local and Non-statutory heritage listings.

Commonwealth Heritage Listed Sites

The Gondwana Rainforests of Australia – Barrington Tops is located within the same sub-region as the Site and is listed within the National Heritage List. This listed site is located at least 30km west of the Site.

State Heritage Listed Sites

No sites identified within the State Heritage Registers as having State heritage values are located in the vicinity of the Site. Five sites listed in the State Heritage Register are located in the wider Gloucester Valley context, however none of these sites are located in the vicinity or within the visual catchment of the Site. It should be noted that as no State heritage-listed sites are present within the vicinity of the Site, a Section 167 Certificate was not required to be obtained from the NSW Heritage Branch.

The Stroud-Gloucester Valley is not listed as an item on the NSW State Heritage Register and is not listed on the 2015-2016 Nominations for the State Heritage Register List. In 2013, a draft nomination was prepared for the “Vale of Gloucester Valley Landscape”, however no further action has been made in relation to the draft nomination.

Local Heritage Listed Sites

No listed sites with State or local heritage values are recorded within the local heritage registers as being in the vicinity of the Site or within its visual catchment. The majority of individual sites are located within Booral, Stroud and Gloucester townships with others in local settlements between these locations. A few listed sites (St Paul’s Anglican Church and Rectory, the original Gloucester Public School building and Gloucester Cottage) are located either adjacent to or close to the heavy vehicle bypass route within Gloucester, a route currently used by heavy vehicles and one that would be used by heavy vehicles travelling along The Bucketts Way south of Gloucester and from within Gloucester to and from the Mine Area prior to the replacement of the Jacks Road bridge.

Non-statutory Heritage Listed Sites

The Site lies within an area listed by the National Trust of Australia (NSW) (NTANSW) as the Stroud-Gloucester Valley incorporating The Vale of Gloucester as a ‘Landscape Conservation Area’ (LCA). The listing, originally nominated to the Register of the National Estate, does not

⁷ The RNE was closed in 2007 and is no longer a statutory register. It was replaced by National Heritage List and the Commonwealth Heritage List. See Section 2.2.3 of RLA 2016b.

have statutory force and the Stroud-Gloucester Valley has since been nominated for the State Heritage Register and National Heritage List by the BGSPA. Neither of the nominations has been acted upon.

There are no further entries relevant to the amended Project on non-statutory registers of other professional bodies.

4.11.3 Landscape Heritage Setting

4.11.3.1 The Gloucester Basin and Vale of Gloucester

The Site is situated within a geographically distinctive area known as the Gloucester Basin (also known as the Stroud-Gloucester Syncline (due to this underlying geological formation)). The Site is, in turn, located within a wider area entitled the Stroud-Gloucester Valley. The Stroud-Gloucester Syncline does not include, and is visually and geologically separated from, the Booral-Stroud area. The Gloucester Basin, as a geologically and visually definable area, has been used as the landscape setting for the purposes of assessing the visual impacts of the amended Project (see Section 4.5 and RLA (2016a)).

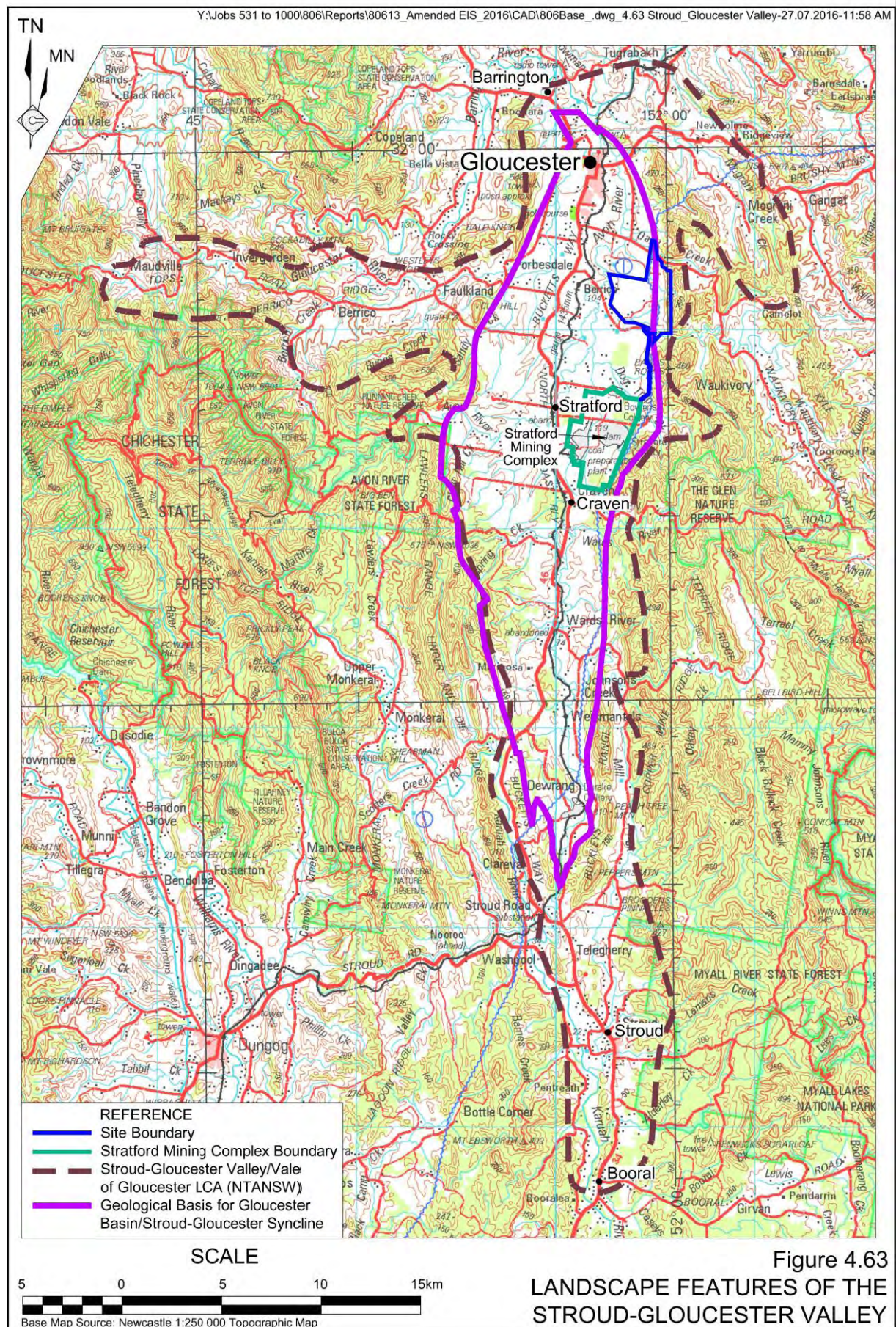
The area classified by the NTANSW as the Vale of Gloucester LCA has been identified by the BGSPA for its combination of historical, scenic and geological features. Whereas, the historical values are not confined to the Gloucester Basin, the geological and scenic values that are specifically relevant to impacts of the amended Project on those values are. The limits of the Vale of Gloucester LCA were extended in 2011 to include from the north of Gloucester to the south of Stroud, a length of approximately 60km. It is up to 10km wide slightly to the south of the Site, but it also contains the Booral-Stroud area, the Gloucester/Barrington River valley that stretches approximately 15km to the west from it and the Mograni Creek valley of approximately 8km in length in the northeast. These do not appear to share the geological features that are cited as the reason for the geological significance of the LCA.

Figure 4.63 displays the location of the Stroud-Gloucester Valley as presented in the BGSPA submission to the NTANSW, as well as the geological basis for reference to the Gloucester Basin, the towns located within and in the vicinity of the valley, and other relevant landscape features.

The reference to the Vale of Gloucester is attributed to Robert Dawson, a land agent for AACo. who is credited with first describing attributes of the valley as reminiscent of the Vale of Gloucester in Britain.

4.11.3.2 Cultural Heritage of the Stroud-Gloucester Valley

The BGSPA sponsored document, “The Stroud-Gloucester Valley: a heritage landscape under threat” states that the Valley is a cultural landscape of State and of National significance, not only because of listed heritage items, but also because of the interactions between all of the things that give it cultural values. It concedes that there is little authentic landscape fabric of the first settlement period, but calls for a more inclusive understanding of the scenic, historic, cultural and geological values of the landscape from a cultural landscape perspective. A holistic approach to assessing the landscape may lead to a development being unacceptable because of significant effects on non-tangible values, such as value to a community, place attachment, effects on scenic views, etc.



RLA considers that the landscape that contains the Site is primarily a generic scenic rural cultural landscape that has evolved its existing character without any specific design or formalising influences from the past. There is little material evidence remaining of the grazing land use, crop land or fabric of the historical agricultural use of the Stroud-Gloucester Valley. Though the wider Stroud-Gloucester Valley contains many individual items of cultural heritage significance, none is in the vicinity of the Site and no views towards or from these sites would be affected by the amended Project.

The *Heritage Council Victoria Landscapes of Cultural Heritage Significance: Assessment Guidelines 2015* provides an alternative approach to the assessment of cultural heritage landscapes. These guidelines describe ‘organically evolved landscapes’ as those that reflect the influence of social, economic, administrative and/or religious imperatives. An alternative definition is as an ‘associative cultural landscape’ that would have powerful religious, artistic or cultural associations rather than material cultural evidence. RLA (2016b) considers the Stroud-Gloucester Valley under these criteria to be an organically evolved landscape as it displays the accumulated layers of cultural change rather than any design intent. However, the social values attributed to the natural and scenic landscape could be argued to also place the Stroud-Gloucester Valley into the associative cultural landscape category.

Section 3.3 of RLA (2016b) addresses the various forms of heritage discourse that may be legitimately used to construct heritage value, whether this be as an object or a place to be conserved and managed, or by acknowledging the symbolic role that a place is given based on the process of remembering and commemorating the values that are attributed to it. RLA (2016b) acknowledges that it is a legitimate form of heritage discourse for the BGSPA or any other group to propose a social historical criterion of significance. However, it remains important that these values are assessed by the relevant authority and, where appropriate, given statutory protection.

Regardless of the above, the fact that a place can be interpreted in relation to broad themes, rather than as an item or individual place, is not a test of its significance. The question to be answered with regard to satisfying the heritage significance criteria is not whether the story that is interpreted from the landscape can be documented, but whether the story throws light on an important aspect of the lives of people in the past. It does not follow that because a location is a part of a landscape that may be interpreted under the social value criterion, that all parts of that landscape have equal cultural heritage significance. Neither does it follow that a negative impact on part of that landscape necessarily leads to the diminution of the values over the entire place nor, if the impact occurs, that it will be permanent. An assessment of potential impact is provided in Section 4 of RLA (2016b) and Section 4.11.4 of this document through the preparation of a Statement of Heritage Significance (SHS) and a Statement of Heritage Impact (SoHI).

4.11.3.3 Heritage Views

The effect of changing rural economics, settlement and development patterns over time often leads to progressive changes to the overlays of culture that occurred during the historical development of the underlying natural landscape. A rural cultural landscape (such as the agricultural landscape of the Stroud-Gloucester Valley) is unintentionally changed by these processes, and views may be created or lost between items as a result. Most of the authentic

context of the cultural landscape of the first settlement period of development of the Stroud-Gloucester Valley is no longer evident; while progressive development has included additional significant and non-significant buildings and sites.

Whether the views are authentic heritage views relates to their authenticity relative to established heritage values. The presence of a new or unique item in the setting is not a heritage impact unless it diminishes the significance of that setting when considered against the criteria for which it was listed as being of significance.

Authentic heritage views may exist in the context where a view has been deliberately designed to be appreciated and either contrived to be conserved, or where it has subsequently been recognised as important and identified as deserving retention/interpretation. The heritage value of the views in question therefore relate to the association of the Stroud-Gloucester Valley with the AACo. As a result of the homogenisation of the appearance of the rural landscape of the lower slopes and valley floors by the almost total clearing of woodlands and forests and the scale and character of agricultural uses, the existing views are now not associated with the early private towns. This is not to dismiss the scenic quality of these views, however this is more a matter of visual amenity (which is addressed in Section 4.5) than of cultural heritage.

4.11.4 Management and Mitigation Measures

The RLA (2016b) assessment concluded that potential impacts to views within the Stroud-Gloucester Basin should be assessed as matters of visual amenity. Management, mitigation and contingency measures that relate to potential impacts to visual amenity are discussed in Section 4.5.4.

No specific different or additional measures to manage historic heritage are considered necessary.

4.11.5 Assessment of Impacts

The following subsections discuss the potential for the amended Project to impact upon the identified historic heritage buildings and structures, and the potential for impacts upon landscape heritage.

During the preparation of the 2013 EIS, the Applicant commissioned Mr John Appleton, Archaeologist with Archaeological Surveys and Reports Pty Limited, to identify any registered historic heritage sites within the Site during the Aboriginal heritage survey. The only structure of potential interest as a historic heritage item was a house currently owned by Mr and Mrs E. McKinley, on McKinleys Lane. Mr Appleton inspected the “Aminya” cottage which Mr McKinley advised was extended / modified from a former wooden hut and concluded it was not of heritage significance as it had no attributes that might be assessed to be of local, State or national heritage significance. Notwithstanding the assessment, the Applicant has committed to observing the demolition of the “Aminya” cottage to record any items of historical significance.

4.11.5.1 Heritage Buildings and Structures

Searches of the schedules, registers and lists of items with statutory protection revealed that there are no historic heritage listed sites within, on or in the vicinity of the Site and, as such, there would be no physical impacts upon the historic heritage in that area. It should be noted that heritage buildings or structures recorded within the Gloucester LEP 2010, particularly those sites within Gloucester township, do not have direct views to the Site. The use of the Gloucester heavy vehicle bypass by heavy vehicles travelling to and from the Mine Area from The Bucketts Way south of Gloucester or from within Gloucester itself, principally during the site establishment and construction stage prior to the replacement of the Jacks Road bridges, would not have any different impact to that already experienced along that route.

4.11.5.2 Landscape Heritage Impacts

Landscape heritage impacts can be measured and quantified following preparation of a Statement of Heritage Significance (SHS) to determine the heritage significance of the landscape, and the preparation of a subsequent Statement of Heritage Impact (SoHI). The SHS and SoHI are used as tools by RLA (2016b) to identify the heritage significance of an item, place or area; the impacts of any changes being proposed, and how any impacts arising from the change(s) would be mitigated.

Statement of Heritage Significance Methodology

As a prerequisite to a SoHI, a SHS is required to be undertaken involving consideration of the seven NSW Heritage System criteria to determine whether the item in question can be determined as having heritage significance. Section 4.1.3 of RLA (2016b) provides an overview of each criterion and its relevance to the Stroud-Gloucester Valley. There are no items of heritage significance impacted by the amended Project and the Site is not considered a heritage item itself. Notwithstanding this, the Site occurs within the Stroud-Gloucester Valley and a SHS was prepared for the whole valley as required for a SoHI, because the impacts of the amended Project would be on values which are not confined to individual sites.

Statement of Heritage Significance Results

Sections 4.1.1 to 4.1.3 of RLA (2016b) provide an overview and a justification of the significant scenic, historic, social and geological values of the Stroud-Gloucester Valley under the relevant NSW heritage criteria. RLA (2016b) concludes that the Site is not a heritage item and that views of it are not considered heritage views. RLA (2016b) also notes that whether the Stroud-Gloucester Valley overall can be considered as having heritage significance remains unproven, as the Stroud-Gloucester Valley is recognised only within the non-statutory National Trust of Australia NSW register.

Statement of Heritage Impact Methodology

The SoHI guidelines, administered by the Heritage Office of NSW, and using the Heritage Manual guidelines entitled 'Heritage Office Local Government Heritage Guidelines (2002)' under the provision of the *NSW Heritage Act 1977*, provide a way to determine any impacts on landscape heritage. Under the Heritage Manual guidelines, a SoHI must address particular categories to identify the heritage significance of the item/place or area, assess the impacts of the proposed changes, and determine how the changes are to be mitigated.

Statement of Heritage Impact Results

The results of the Statement of Heritage Impact (Section 4.3 of RLA (2016b)) recognised that while the Site and the Stroud-Gloucester Valley have significance under some heritage criteria, the views affected are not considered to be heritage views. Overall, the landscape would not be significantly and permanently affected as the amended Project would not cause any physical change to identified heritage items, sites or curtilages, or views of or between identified items. The changes would fundamentally be on intangible values and be visual, rather than heritage, impacts. Taking into account the localised effects of the amended Project and its short life span in the historical sense, the overall significance of the Stroud-Gloucester Valley will not be substantially diminished by the amended Project in the long term.

4.11.6 Conclusion

The assessment undertaken by RLA (2016b) followed the methodology described in the NSW Heritage Manual, as required by the DGRs. This includes a holistic assessment of potential landscape heritage impacts. In addition to the assessment requirements, RLA (2016b) also considered the *Heritage Council Victoria Landscapes of Cultural Heritage Significance: Assessment Guidelines 2015* and the assessment prepared by the BGSPA.

There are no sites or items with statutory protection in the vicinity of the Site, nor any that have a view of or from it. Potential impacts to historic heritage therefore relate to intangible and predominantly social values. The scenic significance of the Stroud-Gloucester Valley is acknowledged, however, classification as a heritage view remains contested.

RLA (2016b) concluded that the Stroud-Gloucester Valley should be considered an organically evolved landscape, that is, a landscape in which the accumulated activities and development in the past is evident in the layers of culture evident in the present. The heritage associations of the Stroud-Gloucester Valley are not contested, however there is no statutory listing over the landscape that would conclusively establish significance. It has been argued that the amended Project would result in an historically brief change to the landscape that, following rehabilitation and relinquishment of mining in the area, would result in a landform consistent with the existing landform and that of the larger Stroud-Gloucester Valley.

In summary, based upon the assessments presented in RLA (2016b), including the Statement of Heritage Significance and the Statement of Heritage Impact, it is concluded that:

- no registered items with statutory protection would be impacted by the amended Project;
- the Site is not classified as a heritage item nor is it agreed that the views of it can be classified as heritage views; and
- the amended Project would not unacceptably diminish the overall landscape heritage of the Stroud-Gloucester Valley.

4.12 TERRESTRIAL ECOLOGY

The terrestrial ecology assessment of the amended Project was undertaken by Biosis Pty Ltd. The full assessment is presented in Volume 4 Part 7 of the Specialist Consultant Studies Compendium and is referenced throughout this section as Biosis (2016), with a summary of the assessment presented in the following subsections.

It is noted that Ecotone Ecological Consultants Pty Ltd, the authors of the 2013 Terrestrial Ecology Assessment was acquired by Biosis Pty Ltd in mid-2014. The botanist and zoologists who were involved in the 2013 Project were also involved with the terrestrial ecology assessment for the amended Project.

4.12.1 Introduction

Based on the risk assessment undertaken for the amended Project (Section 3.3.1 and **Appendix 6**), the potential impacts relating to terrestrial ecology and their risk rankings after the adoption of standard mitigation measures are as follows.

- Loss of habitat for terrestrial fauna species, loss of threatened or rare native vegetation or vegetation communities and biodiversity values. (low).
- Injuries to native fauna during clearing / earthworks (low).
- Adverse impact on groundwater dependent ecosystems (low).
- Indirect impacts to fauna communities due to light / noise / blasting (low).

In addition, the Director-General's Requirements (DGRs) issued by the then DP&I (now DPE) (see **Appendix 3**) identified "Biodiversity" as one of the key issues requiring assessment in the EIS. In particular, the DGRs require that the EIS:

- provides a description of measures that would be implemented to avoid, reduce or mitigate impacts on biodiversity;
- provides accurate estimates of proposed vegetation clearing;
- conducts a detailed assessment of potential impacts on:
 - terrestrial or aquatic threatened species or populations and their habitats, endangered ecological communities and groundwater dependent ecosystems;
 - regionally significant remnant vegetation, or vegetation corridors; and
- provides a comprehensive offset strategy to ensure the Project maintains or improves the terrestrial and aquatic biodiversity values of the region in the medium to long term.

The NSW Office of Environment & Heritage (OEH), which is responsible for the management of biodiversity within NSW, also provided detailed matters to be addressed in the assessment of the Project on biodiversity. A summary of these matters (and the additional matters of other government agencies and authorities consulted by the DP&I during the compilation of the DGRs) is provided in **Appendix 4**.

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the DGRs from the EPA, DRE, Hunter-Central Rivers NSW Catchment Management Authority, and the former Great Lakes Council. The additional matters identified are generally consistent with the DGRs. Issues relating to aquatic ecology are addressed in Section 4.13 and CEL (2016).

Following consultation with the OEH regarding the amended Project, additional matters for consideration in preparing the EIS for the amended Project were provided. These requirements were provided in correspondence dated 4 January 2016 and included updated advice regarding use of the Framework for Biodiversity Assessment and BioBanking Assessment Methodology including the BioBanking Credit Calculator, and changes to relevant listings of threatened species within the *Threatened Species Conservation Act 1995*.

The terrestrial ecological assessment was undertaken in accordance with the following guidelines.

- Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities - Working Draft (DEC, 2004).
- Draft Guidelines for Threatened Species Assessment (DEC and DPI, 2005).
- BioBanking Assessment Methodology 2014 (BBAM) (OEH, 2014a).
- BioBanking Assessment Methodology and Credit Calculator Operational Manual (DECC, 2009a).
- Threatened Species Assessment Guidelines: the Assessment of Significance (DECC, 2007).
- Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna – Amphibians (DECC, 2009b).
- EPBC Act Policy Statement 1.1 Significant Impact Guidelines Matters of National Environmental Significance, May 2006 (DEWHA, 2006).
- Guidelines for developments adjoining land and water managed by the Department of Environment, Climate Change and Water (DECCW, 2010a).
- The NSW Guide to Surveying Threatened Plants (OEH, February 2016). This document was published after the field surveys had been completed. However, a retrospective review of this guideline indicates that all surveys were undertaken in accordance with the requirements specified therein.

A Referral under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) was submitted to the then Department of Sustainability, Environment, Water, Population and Communities on 5 April 2012 and it was determined on 11 May 2012 that the proposed Rocky Hill Coal Project, as identified at that date, was not a Controlled Action under the EPBC Act.

The amended Project varies from the original ‘action’ referred to the Minister, however does not require a second referral. This matter is discussed in detail in Section 3.2.3.2. Biosis (2016) considered species or ecological communities identified or likely to occur within the Site and concluded that no significant impact was likely to occur for any threatened species, threatened ecological community or migratory species currently listed under the EPBC Act. These results

are summarised in Section 4.12.5.6. Based on the Biosis (2016) assessment, it has been concluded that a referral of the amended Project to the Commonwealth Department of Environment for assessment of potential impacts to species listed within the EPBC Act is not required.

4.12.2 Study Methodology

4.12.2.1 Introduction

The terrestrial ecological investigations and impact assessment comprised four stages.

- **Stage 1** – a desktop assessment involving a review of available terrestrial biodiversity literature, databases and previous studies to identify known or likely threatened species, populations, ecological communities or other matters relating to local biodiversity that may need to be addressed or considered.
- **Stage 2** – field surveys designed to target the various vegetation types, fauna habitats, threatened flora and fauna species and/or threatened ecological communities identified in Stage 1.
- **Stage 3** – an impact assessment to evaluate the impacts the amended Project would likely have on the identified terrestrial ecology.
- **Stage 4** – identification and evaluation of measures that may be adopted to avoid, minimise and mitigate potential impacts on terrestrial biodiversity as a result of the amended Project, and an assessment of areas that would be suitable to provide biodiversity offsets for residual impacts.

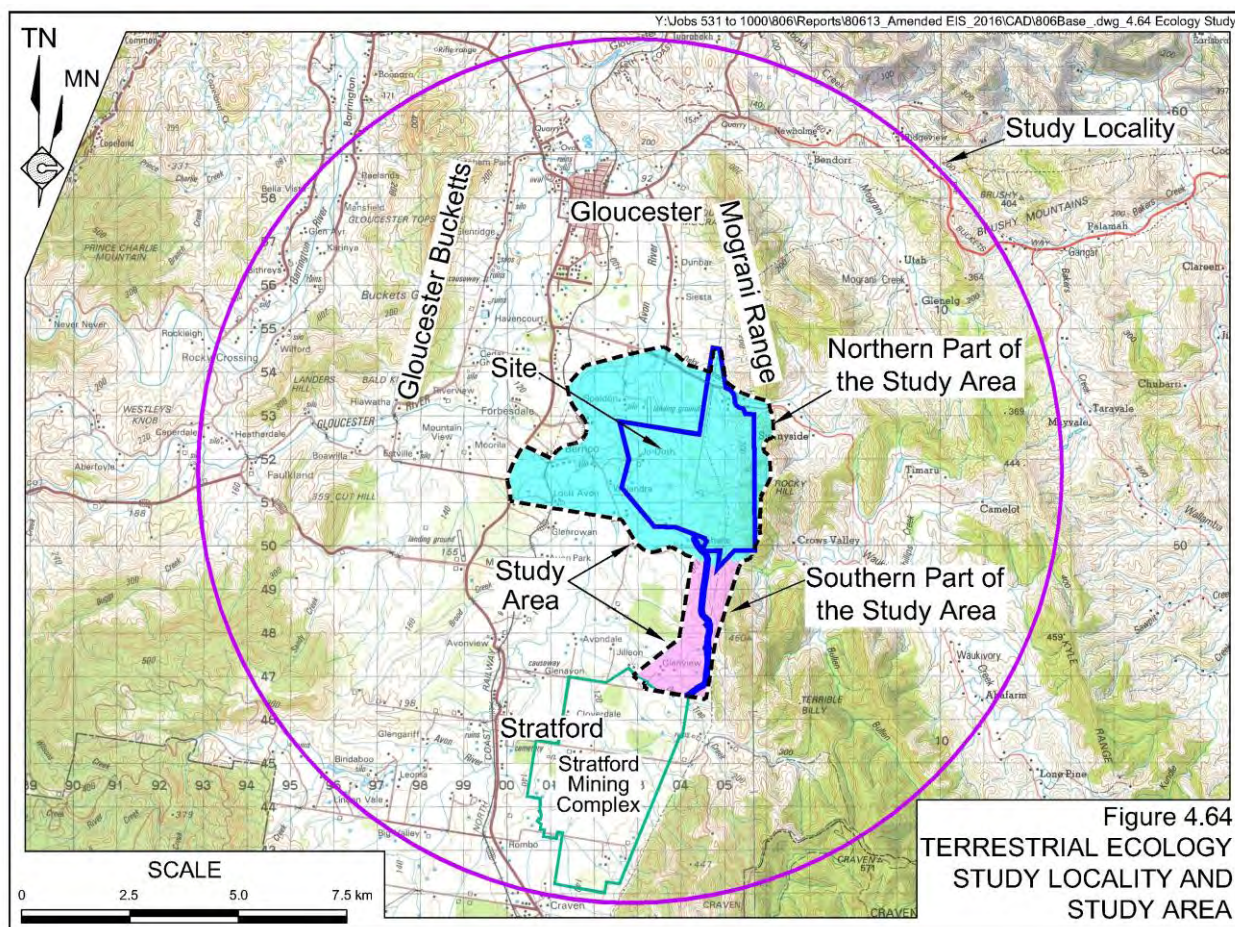
For the purposes of the study and assessment of terrestrial ecology, the Study Area incorporates the Site, its immediately surrounding land and the area of the potential biodiversity offset. The Study Locality for the assessment is defined as the land within a 10km radius of the centre of the Study Area. The ecological impact assessment involved investigations within and in the vicinity of the Mine Area (the northern part of the Study Area) and the area within and surrounding that designated for the proposed private haul road (the southern part of the Study Area).

Figure 4.64 displays the boundaries of the terrestrial ecology Study Locality, Study Area and Site.

The following subsections provide an overview of the methodology adopted in the assessment.

4.12.2.2 Desktop Assessment

Reviews of the documented records and predicted occurrences of threatened and significant flora and fauna species within both the Study Area and Study Locality were undertaken. Records were initially accessed from the NSW Office of Environment and Heritage (OEH) Atlas of NSW Wildlife database in 2009 prior to the initial field surveys, with further reviews undertaken on 10 August 2012 and again in January 2016. Additional records of threatened flora and fauna species were obtained from ecological surveys and assessment reports previously undertaken within the Study Locality and additional species considered to have potential to occur in the Study Locality were also identified.



Previous documents that were reviewed for terrestrial biodiversity information comprised:

- Flora and Fauna Surveys and Fauna Impact Statement (FIS) for Timber Harvesting within Terree (Ecotone Ecological Consultants Pty Ltd, 1994);
- EIS and supporting documents for the Stratford Coal Project (Stratford Coal, 1994);
- Supporting Documents for the Gloucester-Chichester Management Areas EIS – for Flora, Fauna, bats and frogs (State Forests of NSW, 1995);
- EIS and supporting documents for the Bowens Road North Project (Stratford Coal, 2001);
- Gloucester Gas Project Environmental Assessment, AGL, (AECOM, 2009a);
- Gloucester Coal Seam Gas Project, Pilot Well Sites and Water Monitoring Site, Ecological Assessment AGL Upstream Investments (Alison Hunt & Associates, March 2011); and
- EIS and supporting documents for the Stratford Extension Project (Stratford Coal, 2012).

A summary of results of the database searches and review of previous ecological assessments is as follows.

Threatened Flora

From a combination of the database research, literature review and the assessment requirements that accompanied the DGRs (including correspondence received from the OEH on 4 January 2016), a total of 19 threatened flora species and an additional 18 rare or significant flora species were identified that are known or have some potential to occur within the Study Locality and Study Area. Those species listed in the TSC Act, EPBC Act or the national ROTAP (*Rare or Threatened Australian Plants* (Briggs & Leigh, 1996)) database are provided in **Table 4.69**.

Table 4.69
Threatened, Rare or Significant Flora Species Known or with the Potential to Occur within the Study Locality

Page 1 of 2

Scientific Name	Common Name	Status		ROTAP risk code
		TSC Act	EPBC Act	
<i>Acacia barringtonensis</i>		-	-	3RCa
<i>Acacia fulva</i>	Velvet Wattle	-	-	2RC-
<i>Asperula asthenes</i>	Trailing Woodruff	V	V	3VC-
<i>Asperula charophyton</i>	Strapleaf Woodruff	-	-	3RCa
<i>Callistemon linearifolius</i>	Netted Bottle Brush	V	-	2RCi
<i>Chiloglottis platyptera</i>	Barrington Tops Ant Orchid	V	-	2KC-
<i>Cryptostylis hunteriana</i>	Leafless Tongue Orchid	V	V	3VC-
<i>Cynanchum elegans</i>	White-flowered Wax Plant	E	E	3ECi
<i>Diurius flavescens</i>	Pale Yellow Doubletail	C	-	2K
<i>Diuris pedunculata</i>	Small Snake Orchid	E	E	2E
<i>Diuris praecox</i>	Rough Double Tail	V	V	2VC-
<i>Dodonaea megazyga</i>		-	-	-
<i>Dodonaea rhombifolia</i>	Broad-leaf Hop-bush	-	-	3RCa
<i>Eucalyptus glaucina</i>	Slaty Red Gum	V	V	3VCa
<i>Eucalyptus largeana</i>	Craven Grey Box	-	-	3R
<i>Eucalyptus parramattensis</i>	Parramatta Red Gum	-	-	2V
<i>Eucalyptus rudderi</i>	Rudder's Box	-	-	3RC-
<i>Euphrasia arguta</i>		E	C	3X
<i>Galium curvihirtum</i>		-	-	-
<i>Grevillea obtusiflora</i>		E	E	-
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	Small-flower Grevillea	V	V	-
<i>Hibbertia hermanniifolia</i>		-	-	3RCa
<i>Leionema elatius</i> subsp. <i>elatius</i>		-	-	3K
<i>Leptospermum argenteum</i>		-	-	2RC-
<i>Melaleuca groveana</i>	Grove's Paperbark	V	-	3RC-
<i>Plantago palustris</i>		-	-	2RC-
<i>Plantago cladarophylla</i>		-	-	2RC-
<i>Plectranthus suaveolens</i>		-	-	3KC-

Table 4.69 (Cont'd)
Threatened, Rare or Significant Flora Species Known or with the Potential to Occur within the Study Locality

Page 2 of 2

Scientific Name	Common Name	Status		ROTAP risk code
		TSC Act	EPBC Act	
<i>Pomaderris helianthemifolia</i>		-	-	-
<i>Pomaderris queenslandica</i>	Scant Pomaderris	E	-	-
<i>Prasophyllum</i> sp. A		-	-	-
<i>Pterostylis chaetophora</i>	Ruddy Hood Orchid	V	-	-
<i>Pterostylis riparia</i>		-	-	-
<i>Senna acclinis</i>	Rainforest Cassia	E	-	3RC-
<i>Syzygium paniculatum</i>	Magenta Lilly Pilly	E	V	3VCi
<i>Tetradlea juncea</i>	Black-eyed Susan	V	V	3VCa
<i>Thesium australe</i>	Austral Toadflax	V	V	3VCi+

V=Vulnerable E=Endangered C=Critically Endangered

For more information on ROTAP risk codes please see Table 6 of Biosis (2016) or <http://anpsa.org.au/coding.html>

Source: Modified after Biosis (2016) – Table 7 and Table A8-1

Threatened Ecological Communities

Additionally, 12 endangered ecological communities (EECs) and one vulnerable ecological community as defined by the *Threatened Species Conservation Act, 1995*, (TSC Act) were considered to have potential to occur within the Study Locality, and possibly the Study Area. The list of potential communities was compiled based on Threatened Ecological Communities (TECs) considered by OEH to have potential to occur within the Dungog and Bulahdelah 1:100 000 map sheets. These communities are also potentially suitable habitat for threatened species previously identified within these communities. It is noted that no critically endangered ecological communities have potential to occur in the Study Locality or Study Area.

Endangered and Vulnerable Ecological Communities

The EECs and Vulnerable Ecological Communities (VECs) (TSC Act) identified as having the potential to occur within the Study Locality and Study Area are as follows.

- Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions.
- Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions.
- White Box Yellow Box Blakely's Red Gum Woodland.
- River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions.
- Sub-tropical Coastal Floodplain Forest of the NSW North Coast Bioregions.
- Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions.
- Lowland Rainforest on Floodplain in the NSW North Coast Bioregion.
- Grey Box - Grey Gum Wet Sclerophyll Forest in the NSW North Coast Bioregion.

- Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions.
- Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions.
- Hunter Valley Vine Thicket in the NSW North Coast and Sydney Basin Bioregions.
- Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions.

Vulnerable Ecological Communities

- Lower Hunter Valley Dry Rainforest in the Sydney Basin and NSW North Coast Bioregions.

The actual occurrence or absence of these EECs or VECs within the Study Area is addressed in Section 4.12.3.2 on the basis of field surveys results.

Flora and Fauna Habitat Corridors

The other notable result of the desktop assessment was the potential for habitat corridors. A narrow habitat corridor comprising remnant mature forest vegetation remains along the roadside of McKinleys Lane (see Section 4.12.3.1). This corridor provides a tenuous link from small patches of forest within the Study Area, to riparian vegetation along Oaky Creek (north of the proposed area of disturbance) and then to the extensive forest vegetation along the Mograni Range to the east. There is limited connectivity at the northern end of the McKinleys Lane corridor to riparian vegetation along the Avon River to the west of the proposed area of disturbance, via Oaky Creek.

Riparian vegetation along Waukivory Creek (typically located 100m to 400m outside the southern and western boundaries of the Mine Area) provides a narrow corridor between the Mograni Range and riparian vegetation along the Avon River. A narrow riparian corridor also occurs along some sections of Dog Trap Creek which encroaches into the southern extent of the Study Area. These corridors are contiguous with narrow corridors of riparian vegetation along the Gloucester and Manning Rivers and form part of a significant corridor network in the region.

The potential establishment of a *Tops to Lakes* vegetation corridor is currently in the early stages of investigation by Hunter Local Land Services and the former Great Lakes Council. No mapping is yet available but, from aerial photographs, the narrowest gap between forested areas leading down from Barrington Tops towards the Myall and Wallis Lakes occurs at Wards River, approximately 13km south of the Study Area.

The other potential location for such a corridor would be at Craven, approximately 5km south of the Site, where a relatively narrow gap of cleared land separates The Glen Nature Reserve from the Avon River State Forest and Running Creek Nature Reserve.

The land within the Site is unlikely to form part of any future *Tops to Lakes* vegetation corridor.

Fauna

Using the combination of the database search, literature review, assessment requirements that accompanied the DGRs (including correspondence received from the OEH on 4 January 2016), and other species that Biosis considers have the potential to occur, a total of 67 species of threatened fauna listed under the TSC Act and the EPBC Act were identified as known or as having potential to occur within the Study Area and/or Study Locality, and as having suitable habitat present (see **Table 4.70**). An additional 13 species of migratory birds, listed under the EPBC Act were also identified (see **Table 4.71**).

Table 4.70
Threatened Fauna Species Known or with Potential to Occur within the Study Locality and Study Area

Page 1 of 2

Scientific Name	Common Name	Status	
		TSC Act	EPBC Act
<i>Litoria aurea</i>	Green and Golden Bell Frog	E	V
<i>Litoria booroolongensis</i>	Booroolong Frog	E	
<i>Litoria brevipalmata</i>	Green-thighed Frog	V	
<i>Litoria daviesae</i>	Davies' Tree Frog	V	
<i>Mixophyes balbus</i>	Stuttering Frog	E	V
<i>Mixophyes iteratus</i>	Giant Barred Frog	E	E
<i>Anseranas semipalmata</i>	Magpie Goose	V	
<i>Anthochaera phrygia</i>	Regent Honeyeater	C	C
<i>Botaurus poiciloptilus</i>	Australasian Bittern	E	E
<i>Burhinus grallarius</i>	Bush Stone-curlew	E	
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo	V	
<i>Calyptorhynchus lathami</i>	Glossy Black-Cockatoo	V	
<i>Chthonicola sagittata</i>	Speckled Warbler	V	
<i>Circus assimilis</i>	Spotted Harrier	V	
<i>Climacteris picumnus</i> subsp. <i>victoriae</i>	Brown Treecreeper (eastern subspecies)	V	
<i>Coracina lineata</i>	Barred Cuckoo-shrike	V	
<i>Daphoenositta chrysoptera</i>	Varied Sittella	V	
<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork	E	
<i>Epthianura albifrons</i>	White-fronted Chat	V	
<i>Falco subniger</i>	Black Falcon	V	
<i>Glossopsitta pusilla</i>	Little Lorikeet	V	
<i>Hieraaetus morphnoides</i>	Little Eagle	V	
<i>Irediparra gallinacea</i>	Comb-crested Jacana	V	
<i>Ixobrychus flavicollis</i>	Black Bittern	V	
<i>Lathamus discolor</i>	Swift Parrot	E	E
<i>Lophoictinia isura</i>	Square-tailed Kite	V	
<i>Melanodryas cucullata</i>	Hooded Robin	V	
<i>Neophema pulchella</i>	Turquoise Parrot	V	
<i>Ninox connivens</i>	Barking Owl	V	
<i>Ninox strenua</i>	Powerful Owl	V	

Table 4.70 (Cont'd)
**Threatened Fauna Species Known or with Potential to Occur within the Study Locality
and Study Area**

Page 2 of 2

Scientific Name	Common Name	Status	
		TSC Act	EPBC Act
<i>Pachycephala olivacea</i>	Olive Whistler	V	
<i>Pandion cristatus</i>	Osprey	V	
<i>Petroica boodang</i>	Scarlet Robin	V	
<i>Petroica phoenicea</i>	Flame Robin	V	
<i>Pomatostomus temporalis</i> subsp. <i>temporalis</i>	Grey-crowned Babbler (eastern subspecies)	V	
<i>Ptilinopus magnificus</i>	Wompoo Fruit-Dove	V	
<i>Ptilinopus regina</i>	Rose-crowned Fruit-Dove	V	
<i>Ptilinopus superbus</i>	Superb Fruit-Dove	V	
<i>Stagonopleura guttata</i>	Diamond Firetail	V	
<i>Turnix maculosa</i>	Red-backed Button-quail	V	
<i>Tyto novaehollandiae</i>	Masked Owl	V	
<i>Tyto tenebricosa</i>	Sooty Owl	V	
<i>Aepyprymnus rufescens</i>	Rufous Bettong	V	
<i>Cercartetus nanus</i>	Eastern Pygmy-possum	V	
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	V
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	V	E
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	V	
<i>Kerivoula papuensis</i>	Golden-tipped Bat	V	
<i>Macropus parma</i>	Parma Wallaby	V	
<i>Miniopterus australis</i>	Little Bentwing-bat	V	
<i>Miniopterus schreibersii</i> subsp. <i>oceanensis</i>	Eastern Bentwing-bat	V	
<i>Mormopterus norfolkensis</i>	Eastern Freetail-bat	V	
<i>Myotis macropus</i>	Large-footed Myotis	V	
<i>Petaurus australis</i>	Yellow-bellied Glider	V	
<i>Petaurus norfolcensis</i>	Squirrel Glider	V	
<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	E	V
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	V	
<i>Phascolarctos cinereus</i>	Koala	V	V
<i>Planigale maculata</i>	Common Planigale	V	
<i>Potorous tridactylus</i>	Long-nosed Potoroo	V	V
<i>Pseudomys novaehollandiae</i>	New Holland Mouse		V
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V	V
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat	V	
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	V	
<i>Thylogale stigmatica</i>	Red-legged Pademelon	V	
<i>Vespadelus troungtoni</i>	Eastern Cave Bat	V	
<i>Hoplocephalus stephensii</i>	Stephens' Banded Snake	V	
V=Vulnerable E=Endangered C=Critically Endangered			
Source: Modified after Biosis (2016) – Table 12 and Table A8-2			

Table 4.71
Migratory Species Known or with Potential to Occur within the Study Locality
and Study Area (EPBC Act)

Scientific Name	Common Name
<i>Apus pacificus pacificus</i>	Fork-tailed swift
<i>Ardea ibis</i>	Cattle egret
<i>Ardea modesta</i>	Eastern great egret
<i>Cuculus optatus</i>	Oriental cuckoo
<i>Gallinago hardwickii</i>	Latham's snipe
<i>Hirundapus caudacutus</i>	White-throated needletail
<i>Merops ornatus</i>	Rainbow bee-eater
<i>Monarcha melanopsis</i>	Black-faced monarch
<i>Symposiachrus trivirgatus</i>	Spectacled monarch
<i>Motacilla tschutschensis</i>	Yellow wagtail
<i>Myiagra cyanoleuca</i>	Satin flycatcher
<i>Pandion haliaetus</i>	Osprey
<i>Rhipidura rufifrons</i>	Rufous fantail
Source: Biosis (2016) –Table A8-3	

4.12.2.3 Flora Field Surveys

The Northern Part of the Study Area

Flora field surveys were undertaken throughout the northern part of the Study Area on four occasions between July 2010 and May 2012. The initial field survey was undertaken over most of this part of the Study Area on 8 and 21 July 2010. Following clarification of the proposed area of disturbance and consideration of the eastern side of the Applicant's property to provide possible offset areas, further flora fieldwork was conducted in these areas on 16 to 18 March 2011. Additional fieldwork was undertaken on 2 to 4 August 2011 using plots and transects for the BioBanking methodology, with a supplementary survey of the grassland condition and paddock trees in the eastern part of the Mine Area undertaken on 10 and 11 May 2012, including additional BioBanking plots and transects.

The survey methodology involved five components.

- A general traverse on foot within the parts of the Study Area where at least a remnant native tree and/or shrub layer occurred, using the random meander method of Cropper (1993). Areas that were largely cleared and devoid of native vegetation, except for scattered trees, were generally surveyed from a slowly moving vehicle driving along adjoining roads, tracks or through the pasture itself. Any significant features detected in this way were examined in further detail on foot. The foot or vehicle meander was used to assess the range of floristic variation, vegetation structure, extent of modification, disturbance, weed invasion and the condition of the vegetation generally.

- Adoption of the suggested length of walking transects and flora quadrats per stratification unit (DEC, 2004) within each natural vegetation unit according to the total area of each unit. A total of six standard 400m² quadrats was established, i.e. either 20m x 20m, or 40m x 10m in linear vegetation such as riparian communities. In addition, nine BioBanking plots were established in the proposed area of disturbance. All vascular flora species were recorded within the quadrats, along the transects and along the random meanders.
- A targeted search for potential threatened flora species (as listed in **Table 4.69**) or potential, locally-occurring endangered flora populations for which potential habitat was available and detectable at the time of the survey.
- Objective field analysis of the condition of grassland and clusters of paddock trees in the eastern part of the proposed area of disturbance east of McKinleys Lane for use in the BioBanking methodology.
- BioBanking transects and plots targeting both the proposed area of disturbance and components of the wider Study Area identified as potentially suitable as an offset area. These were used to provide the prescribed data for calculation of biodiversity credits required due to the proposed vegetation disturbance and biodiversity credits generated by the proposed Biodiversity Offset Area. A total of nine transects and plots were examined in the proposed area of disturbance and 12 transects and plots were examined in the proposed Biodiversity Offset Area.

The distribution of vegetation communities within the Study Area was based on a combination of high resolution aerial photography interpretation and ground truthing from fieldwork.

The survey methodology complied with current best practice flora survey guidelines for a full impact assessment, such as the document *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities – Working Draft* (DEC, 2004). A retrospective review of the methodology used also confirmed the requirements of the *BioBanking Assessment Methodology* (BBAM) (OEH, 2014a) and the *NSW Guide to Surveying Threatened Plants* (OEH, 2016) had been satisfied. The combined survey effort met or exceeded the suggested or required minimum survey effort for the proposed area of disturbance.

The Southern Part of the Study Area

Flora field surveys were carried out in the southern part of the Study Area by a botanist on 2 and 3 November 2015 and 1 December 2015.

The survey methodology involved the following components.

- Traverses of the southern part of the Study Area by vehicle and on foot, focussing in greater detail on areas where particular native vegetation or flora features were observed.
- Ground-truthing of habitat types and assessment of potential for threatened flora species to occur.
- Recording the general condition of native vegetation and the effects of current seasonal conditions.

- Mapping vegetation type boundaries and other flora features through use of a hand-held GPS and Samsung Galaxy Tab A tablet. The tablet was set to track locations with a 5m accuracy.

4.12.2.4 Fauna Field Surveys

Fauna surveys were undertaken throughout the northern part of the Study Area between 15 and 18 April 2011 and of the southern part of the Study Area between 2 and 4 November 2015 and between 16 and 18 November 2015. Fauna habitat assessments, targeted surveys for threatened species and searches for any evidence of the presence of threatened species were undertaken using a range of survey methods in suitable habitat.

The fauna survey methods and sampling effort employed during the fauna surveys included:

- walking traverse/habitat assessments;
- diurnal bird census;
- frog searches;
- reptile searches;
- spotlight surveys;
- call broadcast surveys;
- harp trap surveys;
- ultrasonic bat call surveys;
- Elliott and cage trapping; and
- Platypus searches.

Supplementary surveys were carried out to establish the presence or absence of the Giant barred frog, *Mixophyes iterates*, within or in the vicinity of the northern part of the Study Area. The Giant barred frog is listed as Endangered under the TSC Act and EPBC Act and has been detected approximately 27km south of the Mine Area. The Spring (11 and 13 October 2011) and Summer (18 and 19 January 2012) frog surveys were undertaken with the methodology employed for these targeted surveys exceeding requirements set out in the *Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna - Amphibians* (DECC, 2009b).

Opportunistic records of fauna species were made during all fieldwork periods.

4.12.3 Survey Results

4.12.3.1 Introduction

The natural vegetation throughout the Study Area is in a highly modified condition, with most of it having been cleared to provide pasture for cattle grazing. Small remnants of natural vegetation in a disturbed condition remain. These comprise a narrow linear strip of remnant natural vegetation adjacent to McKinleys Lane; three small remnant patches in the central part of the Study Area; one large patch of native Dry sclerophyll forest to the east of the private haul road and small remnants adjacent to Waukivory Creek, Dog Trap Creek and within the southern part of the Study Area. Vehicular tracks are present through some of the remnant vegetation patches which have undergone past tree thinning and clearing of the shrub layers to varying degrees.

Scattered isolated trees or clumps of trees occur sporadically throughout the cleared pasture areas. In spite of the extent of past vegetation clearing throughout the Study Area, very little erosion or soil instability is present.

Much larger areas of intact natural vegetation remain in the steeper elevated land to the east of the Study Area. However, some infrequent cattle grazing still occurs in these areas, and parts of the lower slopes have been partially cleared or under-scrubbed. Full clearing of the natural vegetation and conversion to open pasture have been carried out up to and over the ridgetop in some areas.

The main ecological function of those areas of remnant vegetation in the Study Area is in forming part of a corridor that provides connectivity both for movement of fauna and for exchange of genetic material between native flora and fauna species locally. This would tend to reduce the risk of local populations becoming isolated.

The following subsections summarise the vegetation communities, flora and weed species identified, and fauna habitats and fauna species observed throughout the Study Area and proposed areas of disturbance in particular.

4.12.3.2 Vegetation Communities

A total of four vegetation communities are present within the Study Area and are displayed on **Figure 4.65**.

1. Cleared open pasture with isolated paddock trees.
2. Ironbark / Grey Gum / Spotted Gum / White Mahogany Open Forest/ Woodland (Moderate to Good and Low Condition) (also referred to as Dry sclerophyll forest)
3. River Oak / Cabbage Gum / Broad-leaved Apple Riparian Forest (also referred to as Riparian Forest)
4. Giant Stinging Tree / Fig Rainforest Gullies (also referred to as Dry rainforest)

The cleared open pasture (Community 1) is an artificial vegetation community with no native tree or shrub layers (except for occasional isolated paddock trees) and a ground layer of predominantly introduced pasture grasses and herbaceous weeds. The remaining three vegetation communities occurring within the Study Area (Communities 2, 3 and 4) comprise remnant native vegetation with various levels of disturbance, including some areas of tree and understorey clearing.

The Plant Community Types (PCTs) that are considered to broadly correspond to the vegetation communities within the Study Area are listed in **Table 4.72**, together with the State-wide classifications of Vegetation Formation and Vegetation Class of Keith (2004) to which they belong. The classification system used for the BioBanking Assessment Methodology (OEH, 2014a) has been updated to remove all Biometric Vegetation Types (BVTs) and in their place uses PCTs for classification purposes (see Section 4.12.3.2 of Biosis (2016) for a more detailed description of the PCTs and BVTs used for the assessment). Consequently, **Table 4.72** includes PCTs identified in accordance with the BioBanking Assessment Methodology (OEH, 2014a) that are used for assessment of biodiversity offsetting requirements (Section 4.12.4.4). Biosis (2016) noted that each community can contain elements of, or intergrade with, other related PCTs. In reality, local vegetation communities comprise many intergrading vegetation types depending on the habitat and, in particular, environmental factors such as slope, moisture, soil type and exposure. This makes it difficult to map variants of the communities used for classification. Community 2 shows elements of other vegetation types but Biosis determined that it corresponded principally to PCT 1590. Communities 3 and 4 are distinct and identifiable.

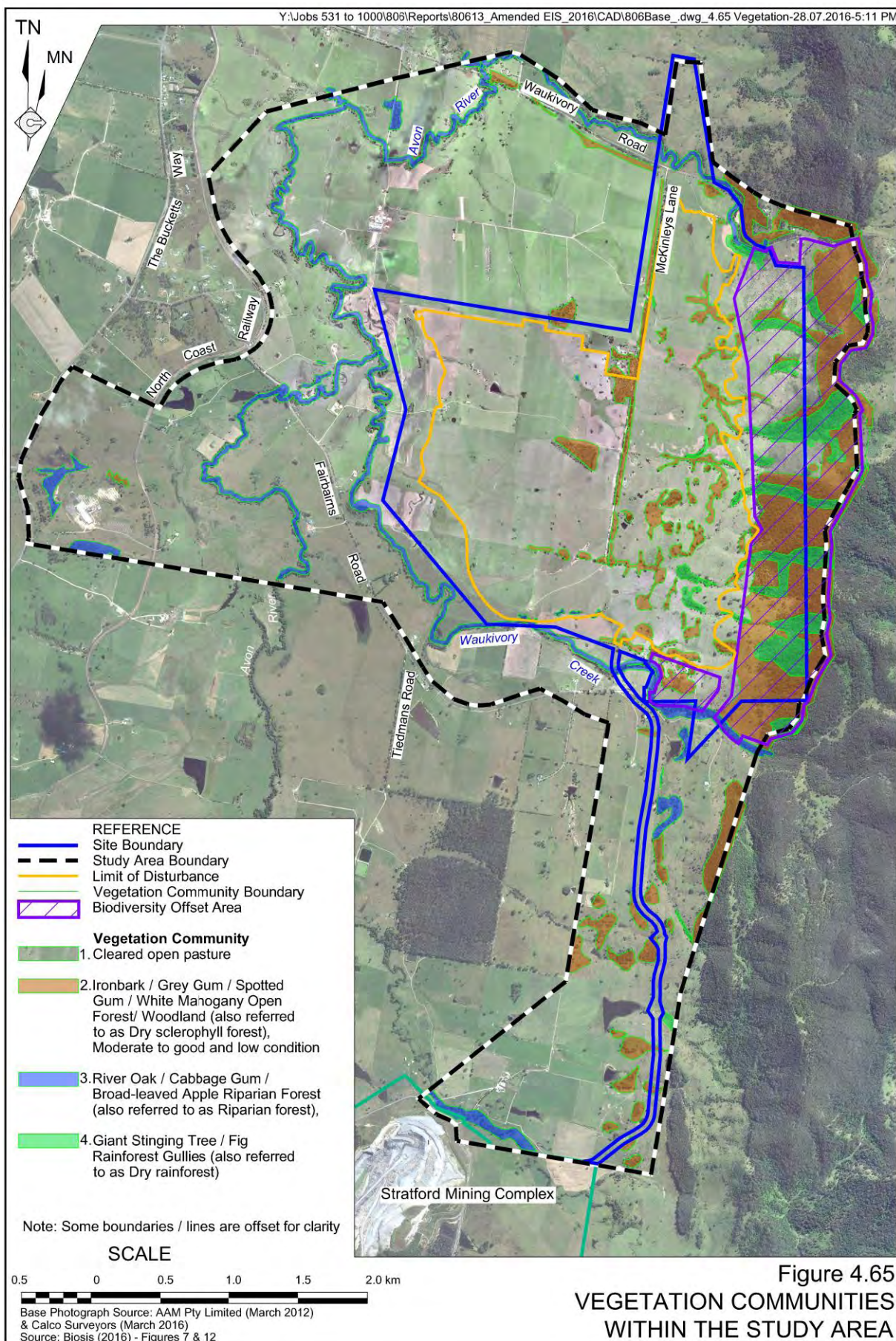


Table 4.72
Corresponding Vegetation Types from State-wide and Regional Classifications

Vegetation Communities (and PCT identifier)	Vegetation Formation (Keith, 2004)	Vegetation Class (Keith, 2004)	Threatened Ecological Community
Community 1 – Cleared Open Pasture	Unclassified	Unclassified	No
Community 2 - Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest (PCT1590)	Dry sclerophyll forests (shrub/ grass sub-formation)	Hunter-Macleay Dry Sclerophyll Forests	No
Community 3 - River Oak - White Cedar Grassy Riparian Forest (PCT1714)	Forested Wetlands	Eastern Riverine Forests	No
Community 4 - Shatterwood - Giant Stinging Tree - Yellow Tulipwood dry rainforest (PCT1142)	Rainforests	Dry Rainforests	Yes – Lower Hunter Valley Dry Rainforest
Note: Community 2 will be referred to as Dry sclerophyll forest through the remainder of this section.			
Source: Biosis (2016) – Modified after Table 15			

One Threatened Ecological Community listed under the TSC Act is present within the Study Area. The location, structure, habitat and species composition of the dry rainforest community (Community 4) indicates that it constitutes the Vulnerable Ecological Community (VEC) *Lower Hunter Valley Dry Rainforest in the Sydney Basin and NSW North Coast Bioregions*. As described in the Final Determination for the VEC (NSW Scientific Committee, 2008), the community occurs on Carboniferous volcanics and sediments of the Barrington footslopes along the northern rim of the Hunter Valley floor, occupying watercourses and steep hillslopes. It often occurs on steep rocky or scree slopes. The community usually forms a closed forest 15m-20m high with emergent trees (usually eucalypts) 20m-30m high. Vines are abundant in most parts of the community, although the shrub and ground layers are not necessarily dense as indicated by the Final Determination. Of the assemblage of 60 species that characterise the VEC (NSW Scientific Committee, 2008), 48 (80%) were found to be present in Community 4, including most of the common species.

In terms of species composition, Community 4 (or parts of it) also has some affinities with the Endangered Ecological Community (EEC) *Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions* (NSW Scientific Committee, 2006). One of the corresponding BVTs (DECC, 2009a), *Giant Stinging Tree - Fig dry subtropical rainforest of the North Coast and Brigalow Belt South* also correlated with the species composition of Community 4, up to a point. However, the rocky substrate and steep gully habitat, together with the general abundance of vines, suggested a greater affinity with the VEC *Lower Hunter Valley Dry Rainforest*. A much higher proportion of the assemblage of species that characterise *Lower Hunter Valley Dry Rainforest* are present in Community 4 (80%), than for *Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions* (45%).

Regardless of the above, GRL and Biosis acknowledge that there are many factors to consider in determining the identity of a threatened ecological community and that some of these factors may be more strongly associated with one or the other vegetation communities. Taking into account that the Biodiversity Offset Area provides more than the required number of ecosystem credits for Community 4 (approximately 84% excess credits – see Section 2.16.9.5 and **Table 2.18**), it is considered that the substitution of an alternative vegetation community (even

if it were an endangered ecological community) in the BioBanking calculations would result in only minor changes to the required credits and that these would remain satisfied within the proposed Biodiversity Offset Area.

The riparian vegetation (Community 3) also shares some similarities with the EEC *River-flat eucalypt forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions*. Community 3 occurs within the Study Area in two forms or variants. One variant is dominated by eucalypts such as Cabbage Gum (*Eucalyptus amplifolia*), Broad-leaved Apple (*Angophora subvelutina*) and paperbarks, with a minor presence of casuarinas. It occurs as small, isolated patches on wetter floodplains. The other variant is characterised by a near monoculture of River Oaks (*Casuarina cunninghamiana* subsp. *cunninghamiana*) with no eucalypts and occurs on the banks of the major watercourses (Avon River and Waukivory Creek). This variant occupies by far the larger area of the two.

Community 3 could have been mapped as two separate communities to reflect this variation and clarify the distinction. In determining the vegetation community to be applied for calculating offsetting requirements, it was noted that the variant characterised by Cabbage Gum and Broad-leaved Apple that could qualify as an EEC, although documented as part of the study and mapped as part of Community 3, does not occur within any part of the area of disturbance. The only disturbances would be to small areas of River Oaks. Therefore the amended Project would not disturb any part of Community 3 that could constitute the EEC. As with Community 4, given the excess of credits available within the Biodiversity Offset Area for this community (approximately 54% excess credits – see Section 2.16.9.5 and **Table 2.18**), it is considered that the substitution of an alternative vegetation community in the BioBanking calculations would result in only minor changes to the required credits and that these would remain satisfied within the proposed Biodiversity Offset Area.

No other of the endangered or vulnerable ecological communities identified in Section 4.12.2.2 were identified in the Study Area.

4.12.3.3 Flora

A moderate to high species diversity was found to be present in the Study Area, with approximately 25% of species being exotic. Within the northern part of the Study Area, 312 flora species from 98 families were identified comprising 20 ferns, two conifers, 225 dicotyledons and 65 monocotyledons. An additional 32 flora species were recorded in the southern part of the Study Area that were not recorded in the northern part of the Study Area.

Neither any threatened flora species listed under the TSC Act nor any flora species that forms part of an Endangered Population listed under the TSC Act was recorded within the Study Area during the field surveys. Similarly, no rare flora species listed exclusively by ROTAP was recorded within the Study Area during the field surveys.

4.12.3.4 Noxious Weeds and other Exotic Species

Noxious and environmental weeds occur in patches throughout the Study Area at low to moderate density. Five weed species that are declared under the *Noxious Weeds Act 1993* throughout the former Gloucester Local Government Area are present within the Study Area.

- Crofton weed (*Ageratina adenophora*)
- Lantana (*Lantana camara*)

- African boxthorn (*Lycium ferocissimum*)
- Blackberry (*Rubus fruticosus* aggr. spp.)
- Noogoora burr (*Xanthium occidentale*).

Lantana is absent throughout most of the Study Area, but is present in the vicinity of some watercourses and gully areas, such as areas bordering the rainforest gully areas of the steep slopes to the east of the Mine Area. Invasion and establishment of Lantana (*Lantana camara*) is also a listed Key Threatening Process under the TSC Act.

Apart from declared noxious species, common agricultural or environmental weed species recorded within the Study Area include Whisky grass (*Andropogon virginicus*) which occurred at high density throughout some pasture areas, Camphor laurel (*Cinnamomum camphora*), Small-leaved privet (*Ligustrum sinense*), Fleabane (*Conyza* sp.), Spear thistle (*Cirsium vulgare*), Fire weed (*Sencio madagascariensis*), Paddy's lucerne (*Sida rhombifolia*), Stinking Roger (*Tagetes minuta*), Redflower mallow (*Modiola caroliana*), Purple top (*Verbena bonariensis*) and Veined verbena (*Verbena rigida*).

Most of the southern part of the Study Area consists of cleared open pasture predominantly comprising exotic grasses and ground layer species. The area occupied by the Denyer Dairy consists of entirely exotic improved and irrigated pasture.

4.12.3.5 Fauna

Eight fauna habitat types are present within the Study Area.

1. Cleared open paddocks (Vegetation Community 1) – the cleared open paddocks typically comprise native and introduced grasses and forbs. This habitat type covers the majority of the Study Area and is an important foraging area for many species of bird, and larger mammal species such as the eastern grey kangaroo. A large area in the valley floor in the southern part of the Study Area comprises irrigated improved pasture and fodder crops used for dairy cattle.
2. Ironbark / Grey Gum / Spotted Gum / White Mahogany open forest / Woodland (Vegetation Community 2) – this habitat typically comprises a canopy layer of Ironbark, Grey Gum, Spotted Gum and White Mahogany with a grass/shrub layer and a middle storey. This type of habitat provides refuge for woodland bird and mammal species and shelter for macropods on the lower plains.
3. River Oak / Cabbage Gum / Broad-leaved Apple Riparian Forest (Vegetation Community 3) – this habitat typically comprises narrow bands of riparian forest dominated by River oaks and/or an open Eucalypt tree layer, Paperbark/Myrtle/Wattle small tree layer, a sparse to moderate shrub layer and a dense grassy understorey. This habitat type has the capability of supporting a range of species that use creek lines, rivers and small streams for foraging, refuge and roosting.
4. Giant Stinging Tree / Fig Rainforest Gullies (Vegetation Community 4) – the rainforest habitat comprises giant stinging trees, figs, vines and other species indicative of rainforest habitat. This habitat is dark and moist and may support a

range of species that typically use rainforest areas for foraging and refuge. Within this habitat, rock crevices and tree hollows are present that range in size and provide potential refuges for arboreal mammals, ground dwelling mammals and microbats.

5. Farm dams – the farm dams are predominantly used for sourcing stock and domestic water, although some are utilised directly for stock watering. Most dams have a perimeter vegetated with cumbungi and phragmites. These dams provide good habitat for some amphibians, and foraging habitat for microbats and water birds.
6. Watercourses – the watercourses (i.e. creeks and river) that traverse the Study Area (Avon River, Waukivory, Oaky and Dog Trap Creeks) exhibit small to large pondages with shallow rocky overflow areas. Many of the watercourses have an abundance of debris such as logs. These habitats may support a range of species such as platypus, and aquatic reptiles such as turtles and water dragons.
7. Bridges/ culverts – the bridges and culverts throughout the Study Area range from concrete to composite, i.e. timber and concrete structures. These bridges provide potential roosting habitats for microbats, and refuge for reptiles such as pythons and small lizards.
8. Dead stags/paddock trees with hollows – dead stags are large trees that have died and are slowly breaking down. Most of the isolated paddock trees within the Study Area contain fissures/cracks/hollows that may provide roosting habitat for microbats, birds and arboreal mammals. They are moderately common throughout the Study Area.

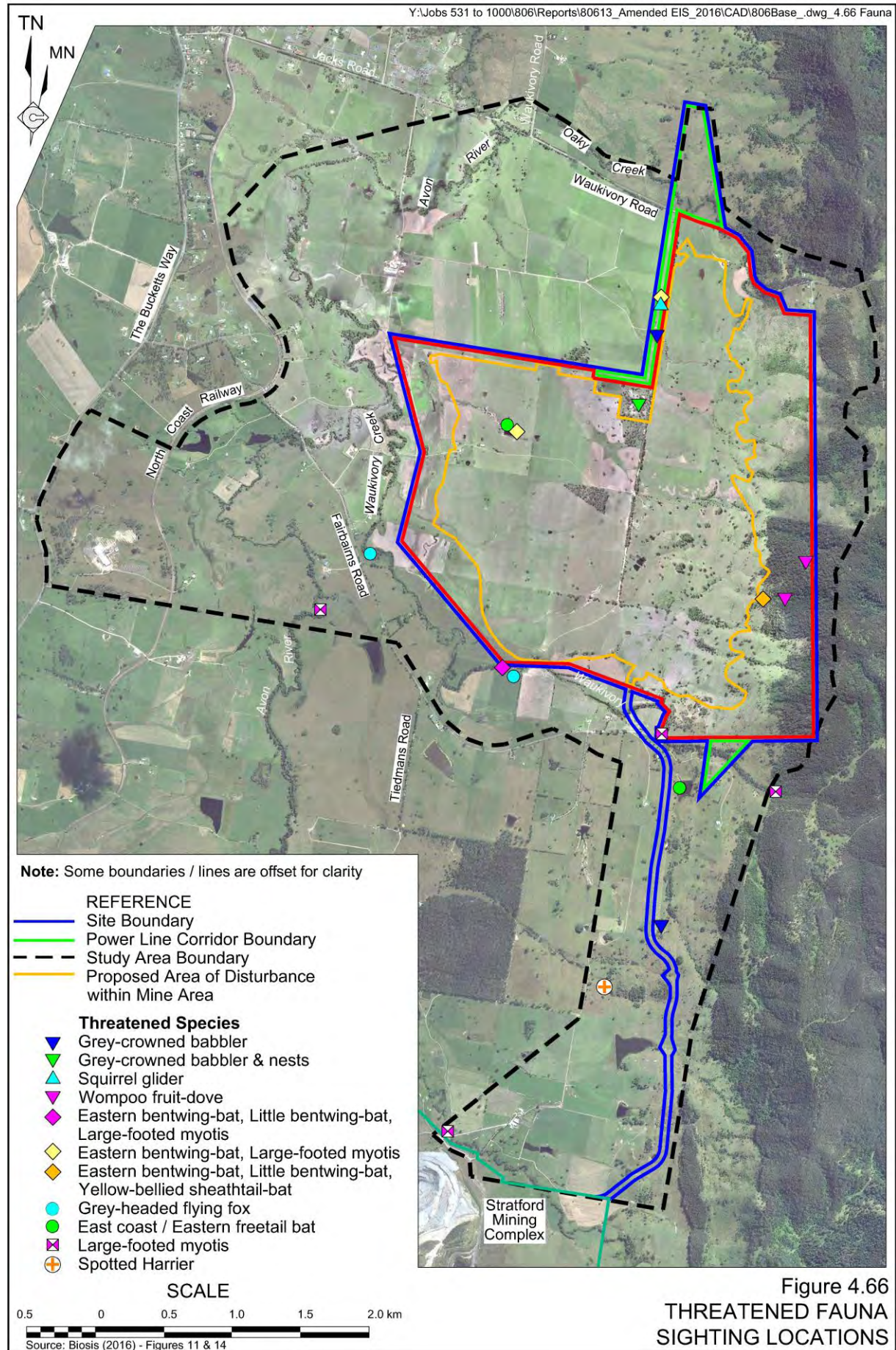
The density of hollow-bearing trees was recorded within the BioBanking plots, with results taken into consideration in the calculation of biodiversity offsetting. Hollows were fairly common in the Dry sclerophyll forest and less common in the riparian and rainforest vegetation. Some isolated paddock trees scattered throughout the Study Area contain hollows.

A total of 153 species of vertebrate fauna were positively identified during the field surveys, including 16 species of frogs, seven reptiles, 28 species of mammals and 102 species of birds. Of these species, 12 are listed under the TSC Act or EPBC Act (locations for identified threatened species are displayed on **Figure 4.66**).

No Platypus were detected but since they are a very secretive species, it cannot be assumed that Platypus do not occur within the rivers and creeks of the locality. No Koala scats were observed during Koala scat searches and no scratch marks on the trunks of trees that resembled the characteristic scratch marks made by the Koala were observed.

Weather and seasonal conditions were very suitable for the detection of Giant barred frogs, but none were detected around the Study Area, despite the species being detected at the reference site on Mammy Johnsons Creek in Spring, and calling well at the reference site in summer.

The eight vertebrate fauna species introduced to Australia positively identified in the field surveys comprised the Common Myna, Common starling, Black Rat, Rabbit, Cow, Dog, Fox and Sheep.



The following provides a list of each of the 12 species listed under the TSC Act or EPBC Act that was positively identified and the method used during the field surveys to identify each species.

Birds

- Wompoo fruit-dove (*Ptilinopus magnificus*)

The Wompoo fruit-dove was identified via its unique call in the rainforest habitat.

- Grey-crowned babbler (*Pomatostomus temporalis temporalis*)

Grey-crowned babblers were identified:

- along McKinleys Lane, with nests and birds identified in the yard of a property adjacent to McKinleys Lane, in the area identified for the proposed administration area; and
- in vegetation along a small watercourses, located parallel and to the east of the proposed private haul road.

- Spotted Harrier (*Circus assimillus*)

Observed flying over the southern part of the Study Area.

Migratory Birds

- Cattle egret (*Ardea ibis*)

Observed in various locations foraging in association with cattle, in the northern and southern parts of the Study Area.

- Black-faced monarch (*Monarcha melanopsis*)

Heard calling in the southern part of the Study Area.

Arboreal Mammals

- Squirrel glider (*Petaurus norfolcensis*)

A squirrel glider was trapped in an arboreal tree trap along McKinleys Lane. Trees in this location contain substantial hollows and, although the vegetation corridor is only narrow, it does provide some connectivity to remnant patches where there are substantial areas for foraging for this species.

Insectivorous Bats

Five threatened insectivorous bat species were recorded within the Study Area during the field surveys, four of which were recorded with “definite” confidence and one with “probable” confidence level, based on the analysis of calls recorded by Anabat recorders.

- Little bent-wing bat (*Miniopterus australis*)

The Little bent-wing bat was recorded with “definite” confidence in the riparian habitat along Waukivory Creek, on the edge of the rainforest area, and in the vegetated corridor of McKinleys Lane. These bats prefer to roost in caves, abandoned mines, tunnels, stormwater drains and buildings. The Little bent-wing bat typically forages between the shrub layer and the canopy of well-timbered areas.

- Eastern bent-wing bat (*Miniopterus schreibersii oceanensis*)

The Eastern bent-wing bat was recorded with “definite” and “probable” confidence at three Anabat detector sites: the rainforest edge, the vegetated corridor of McKinleys Lane and the riparian habitat. This species is predominantly a cave dweller but, like the Little bent-wing bat, is also known to use human structures for roosting. In forested habitats, this species forages just above the canopy and, in more open areas, forages a few metres from the ground.

- Large-footed myotis (*Myotis macropus/Myotis adversus*)

The Large-footed myotis was recorded with “definite” confidence in the riparian area along Waukivory Creek, at a farm dam in the centre of the Mine Area, along Dog Trap Creek and within the vegetated corridor of McKinleys Lane. Some Large-footed myotis were also detected at additional locations during the Giant barred frog surveys. This species is typically associated with streams and permanent waterways. The Large-footed myotis lives in most habitat types as long as it is near water as they forage over water for small fish and aquatic insects.

- Eastern freetail bat (*Mormopterus norfolkensis*)

The Eastern freetail bat was recorded with “definite” confidence at an Anabat detector site at a farm dam within the Mine Area and another farm dam within the southern part of the Study Area. This species was also recorded with “probable” confidence at an Anabat detector site at Dog Trap Creek.

- Yellow-bellied sheath-tail bat (*Saccolaimus flaviventris*)

The Yellow-bellied sheath-tail bat was recorded with “probable” confidence by one Anabat recorder on the edge of the rainforest area on the upper slope of the Study Area. This species prefers relatively large tree hollows for roosting and typically forages above the canopy.

Fruit-bats

- Grey-headed flying fox (*Pteropus poliocephalus*)

While carrying out frog surveys along Waukivory Creek, Grey-headed flying foxes were opportunistically observed foraging within the riparian vegetation.

4.12.4 Management, Mitigation and Offsetting Measures

4.12.4.1 Introduction

In line with Step 4 of the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005), the Applicant has designed the amended Project to minimise impacts on threatened species by avoiding, then mitigating and finally offsetting impacts. The following subsections present the design features, operational controls and management measures proposed to avoid, then minimise and then offset impacts on local flora and fauna.

It is noted that the Applicant has not received any certification from OEH or the Director-General of the Department of Primary Industries that the measures to mitigate or offset the biodiversity impact of the amended Project would be adequate, i.e. a consideration under Clause 14 of the Mining SEPP 2007. However, a submission received from OEH following the exhibition period for the 2013 Project provided the following comment.

In general, this biodiversity offset area will conserve and manage similar vegetation types and EEC on a 'like for like' basis thus meeting an 'improve or maintain' outcome.

While the amended Project will be assessed on its merits, the proposed Biodiversity Offset Area (see Section 2.16.9.3) is similarly located and provides for an excess of credits beyond those required due to impacts to native vegetation (a total surplus of between approximately 12% and 84% credits) across the four identified vegetation communities – see Section 2.16.9.5 and **Table 2.18**).

4.12.4.2 Avoidance of Impacts

The nature of the proposed open cut mining makes it impossible to totally avoid impacts on biodiversity. However, the amended layout of the Site (**Figure 2.1**) has been designed by the Applicant with the intent to maximise disturbance in areas previously disturbed by clearing activities and minimise the clearing of remnant native vegetation.

The Applicant has planned to avoid clearing the roadside vegetation corridor along the northern section of McKinleys Lane and within the corridor designated for the private haul road not required for the road surface. The Applicant has also planned to avoid those parts of the Study Area containing better quality terrestrial habitats and riparian habitats. However, indirect impacts may occur in these areas as a result of vehicle movements, noise, lighting and dust. To further assist with avoiding the indirect impacts as a result of vehicle movements, a sign would be erected where the Mine Area access road intersects with McKinleys Lane highlighting that the area is likely to be a fauna crossing point and that drivers should proceed with caution.

The amended Project also includes the retention of most of the trees within the Dry sclerophyll forest patch adjoining the western side of McKinleys Lane where the site offices and amenities are proposed.

The corridor for the private haul road has been designed to avoid direct impacts to remnant native vegetation and other native fauna habitat, where practical. The corridor has been positioned primarily within cleared open pasture. Though some areas of cut and fill required for construction of the road would encroach within areas of native vegetation, the extent would be minimised, as much as practically possible.

The Applicant proposes to relocate the existing 132kV power line that traverses the eastern side of the Mine Area prior to any substantial disturbance within the existing power line easement. Preliminary planning has identified an indicative 100m wide corridor for the re-located 132kV power line (see **Figure 2.15**). The alignment of the corridor has been selected to avoid the clearing of any substantial areas of remnant native vegetation. Rather, the corridor has been positioned such that it is primarily confined to grassland with occasional paddock trees, with limited, if any, clearing of rainforest within gullies to provide the required clearance to the overhead power line.

4.12.4.3 Mitigation of Impacts

The second priority is to mitigate any disturbance to natural vegetation and threatened species habitat. Individual Grey-crowned babbblers, Squirrel gliders, Bush-tailed phascogales and some other threatened fauna could potentially be impacted along McKinleys Lane or within the southern section of the Study Area. The amended Project has been designed to avoid direct impact on the known habitat for these species. However, since the size of the local populations

of these species and their movement patterns are unknown, the local populations of these threatened species will be monitored in accordance with the proposed Biodiversity Management Plan in order to identify how they can be better managed to improve their viability in the longer term.

Potential indirect impacts to the roadside vegetation corridor along most of McKinleys Lane would be mitigated by tree planting along Waukivory Road, some of which has already commenced. Additional tree planting would also occur on other privately-owned land with the agreement of the landowners. Progressive revegetation of the landform would create substantial areas of open woodland and native vegetation corridors to the north and east of McKinleys Lane. As use of McKinleys Lane beyond the entrance to the Mine Area access road would no longer be required, this section of road would be isolated, ripped and allowed to regenerate naturally. **Figure 2.19** displays the extent of planned native revegetation at the end of the mine life. It is estimated that surface disturbance to the east of McKinleys Lane for development of the interim overburden emplacement would not commence until Year 6 of development (Section 2.7.2 and **Figure 2.10**) and that progressive rehabilitation would commence from Year 7 and be largely completed by the end of Year 8 (**Figure 2.12**). It is also proposed to improve the connectivity between the narrow McKinleys Lane vegetation corridor and the extensive vegetation along the Mograni Range to the north and east by tree planting, and possibly by the construction of glider poles on both sides of the proposed Mine Area Access Road. This would be subject to the outcomes of further fauna monitoring within this location.

It is acknowledged that the proposed Biodiversity Offset Area does not contain habitat suitable for the Grey-crowned Babbler. However, increased habitat very similar to that currently occurring along McKinleys Lane is being created by GRL along Waukivory Road by the vegetation corridors already planted, and further plantings are proposed as part of the Mine Area rehabilitation plan.

Additionally, the western and northern amenity barrier would be planted with grass, tree and shrub species that currently occur adjacent to McKinleys Lane and elsewhere in the Study Area. This barrier would provide limited compensatory foraging, roosting and nesting habitat whilst it is in place.

The measures to mitigate the temporary loss of habitat and native vegetation that would be an unavoidable part of the amended Project include:

- the temporary planting of the western and northern amenity barrier with indigenous trees and shrubs;
- the establishment of roadside vegetation corridors along Waukivory Road; and
- the progressive revegetation of the landform to include native vegetation corridors.

The corridors to be established on the final landform within the Mine Area would ultimately improve connectivity of the vegetation along McKinleys Lane with the more extensive vegetation along the Mograni Range. The requirement for a generally cleared easement for the re-located 132kV power line along the boundary between the proposed Mine Area and the proposed Biodiversity Offset Area is likely to impose a partial impediment to ground and arboreal fauna movement east from the Mine Area during construction and west from the Biodiversity Offset Area post-construction. However, it is understood that the vegetation within

the watercourses along the re-located easement can be largely retained due to the greater distance between the ground and the power lines. These watercourses will continue to provide important movement corridors. In addition, potential for retaining low vegetation and/or fallen timber within the easement would be explored with TransGrid during the detailed design required for the power line relocation.

Other operational safeguards proposed to mitigate the unavoidable impacts on native vegetation and threatened flora species include the following.

- i) All personnel, including contractors, would be required to complete a site induction that would inform participants of their responsibility for the management of potential threatened flora and fauna.
- ii) Following the site establishment and construction stage, and throughout the remaining life of the amended Project, vegetation would be preferentially cleared within approved areas in campaigns linked to the area required for each subsequent 12 months of activity (**Figure 2.10**).
- iii) A pre-clearing protocol would be included within the Biodiversity Management Plan which would identify the following as a minimum.
 - Where practicable, the clearing campaigns, particularly the removal of trees, would be scheduled for the late summer to autumn period in order to minimise potential impacts on fauna that might be nesting, roosting or otherwise utilising the areas scheduled for disturbance.
 - A visual inspection of mature trees to be removed would be undertaken and any threatened fauna appropriately re-located. The inspection for fauna would be undertaken immediately prior to the clearing operations or alternatively, procedures would be adopted to ensure any hollows are not occupied between the time of the visual inspection and the commencement of tree clearing operations. Any trees with hollows to be removed would be placed within the corridors to be established on the rehabilitated landform or within the Biodiversity Offset Area.
- iv) Topsoil would be directly transferred onto rehabilitation areas as soon as possible to maximise the opportunity for retention of the natural seed stock, and thereby maximise the occurrence of locally occurring indigenous species on the final landform.
- v) Defined areas on the final landform would be replanted and/or seeded with local indigenous species including suitable threatened species known from the locality (see **Figure 2.19**).
- vi) When appropriate, and where environmental weeds are sufficiently dense in areas to be cleared, weed spraying or other appropriate measures would be undertaken prior to the topsoil stripping activities to avoid their proliferation on stockpiles or in subsequently rehabilitated areas, with similar treatment undertaken, as necessary, prior to the replacement of previously stockpiled materials.
- vii) Drainage constructed within filled landforms within the private haul road would include structures that permit the passage of native fauna, where safe and practical to do so.

Each operational safeguard would be included within the Biodiversity Management Plan to be prepared within 12 months of the receipt of development consent or as determined within the development consent conditions.

4.12.4.4 Offsetting of Impacts

As there would be residual impacts on native vegetation as a result of the amended Project, the BioBanking Assessment Methodology (OEH, 2014a) and BioBanking Credit Calculator (Version 4.0) have been adopted to calculate the credits required and the credits available within the proposed Biodiversity Offset Area, an area to the east of the proposed area of disturbance within the Mine Area. For the purpose of calculating the required biodiversity offset, Biosis (2016) has considered all stands of remnant vegetation and paddock trees within the disturbance area within the Mine Area, the approximately 100m wide power line transmission corridor and the disturbance corridor associated with the private haul road.

The objective of the offset is to ensure that the amended Project meets the “No Net Loss” benchmark nominated by DECCW (2010a).

Residual impacts would be offset within a proposed 267ha Biodiversity Offset Area to be established along the mid and upper slopes of the Mograni Range on the eastern side of the Study Area. The proposed Biodiversity Offset Area would provide more than the required number of ecosystem credits (2 114 ecosystem credits generated to meet a requirement of 1 681 credits) to offset the impacts on all native vegetation communities affected. No species credits are required as the Grey-crowned babbler is an ecosystem credit species and the habitat within the Biodiversity Offset Area is of higher quality for the Squirrel glider and Brush-tailed Phascogale. Section 2.16.9 describes the proposed the Biodiversity Offset Strategy. Details of the calculations underpinning the value and appropriateness of the Biodiversity Offset Area are presented in Appendix 6 and Appendix 7 in Biosis (2016).

4.12.5 Assessment of Impacts

4.12.5.1 Introduction

This subsection presents an assessment of the anticipated Project-related impacts on listed fauna, flora and ecological communities within and in the vicinity of the Site. The residual impacts are presented assuming the adoption of the various measures outlined in Section 4.12.4. For threatened fauna species that are present or likely to use habitat within the Site, separate detailed assessments are provided in accordance with the provisions of the TSC Act and the EPBC Act. This subsection concludes with an assessment of the likely impacts associated with the amended Project upon Matters of National Environmental Significance (MNES), groundwater dependent ecosystems and habitat corridors.

4.12.5.2 Vegetation Communities

Figure 4.65 displays the vegetation communities identified within the proposed disturbance area within the Mine Area and the private haul road corridor. **Table 4.73** lists the area of each vegetation community that would be removed including the effective area of clearing used in the biobanking assessment (see Section 2.16.9.2) in accordance with the BioBanking Assessment Methodology (OEH, 2014a).

Table 4.73
Disturbance Area within each Vegetation Community Type

Vegetation Community	Description	Threatened Ecological Community	Disturbance Area (ha)
2	Ironbark / Grey Gum / Spotted Gum / White Mahogany Open Forest/ Woodland (comprising 16.8ha in moderate to good condition and 30.1ha in low condition)	No	46.9*
3	River Oak / Cabbage Gum / Broad-leaved Apple Riparian Forest	No	0.7
4	Giant Stinging Tree / Fig Rainforest Gullies	Yes – Lower Hunter Valley Dry Rainforest (Vulnerable)	4.2
Total Area of Removal or Modification to Native Vegetation			51.8**
Notes: * The effective area of clearance within this community is 36.6ha. The effective clearing area is a term used for the area of Low Condition Vegetation in the proposed area of disturbance that has been adjusted to account for reduced canopy cover according to the BioBanking Assessment Methodology. Therefore the vegetation clearing in Community 2 is effectively 16.8ha in moderate to good condition and 19.8ha in low condition following appropriate conversion (OEH, 2009 and OEH, pers. comm., 2016). ** The total effective area of clearance is 41.5ha			
Source: Biosis (2016) – Compiled from Table 21 and Table 22			

Only one vegetation community within the Study Area (Community 4) has been identified as a Vulnerable Ecological Community (VEC) pursuant to the TSC Act. This dry rainforest community mainly occurs in watercourses on the steeply sloping forested land on the eastern side of the Study Area. However, some smaller remnant patches occur on the cleared, flatter land within the Mine Area (**Figure 4.65**). Two remnant patches of this vegetation are also present within the southern part of the Study Area but would not be disturbed by the private haul road.

The amended Project would result in the direct removal or modification of isolated remnant patches of the VEC totalling 4.2ha within the overall disturbance area. The 4.2ha includes the lower ends of rainforest gully patches that extend downslope from the proposed Biodiversity Offset Area. The areas that would be removed represent the small isolated remnants that have been retained within the surrounding cleared exotic pasture landscape or, in the case of the ends of gully patches, represent small and usually degraded patches directly connected to substantially larger patches that occupy the hillside watercourses in the proposed Biodiversity Offset Area. The area required for out-of-pit overburden emplacement was determined on the basis of the volume of material required to be stored which was in excess of available in-pit storage capacity; the mine development sequence; the recognised importance of developing a final landform which emulates the landform prior to mining, and a desire to minimise visual impacts and confine the overburden emplacement activity to areas which had been cleared of the majority of native vegetation in the past. Avoidance of the outliers would preclude achievement of the above objectives which are material to the design of the amended Project. Given the area of the VEC that would remain and be managed in the proposed Biodiversity Offset Area is in the order of 12 times the area to be cleared, this level of removal would not have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

There is potential for the composition of the ecological community to undergo indirect modification where small areas are removed at the ends of the retained gully patches. These could be affected by edge effects such as hydrological changes, weed invasion and increased

light at the newly created edges. However, none of these local changes would result in the local occurrence of the ecological community being placed at risk of extinction. The Applicant would identify how the edge effects would be minimised in its Biodiversity Management Plan.

4.12.5.3 Threatened Flora Species

The database and literature search described in Section 4.12.2.2 identified 19 threatened flora species and an additional 18 rare or significant flora species (see **Table 4.69**) that had previously been recorded or were considered to have some potential to occur in the Study Locality and potentially in the Study Area. However, the various field surveys did not detect any threatened flora species within the Study Area.

4.12.5.4 Threatened Fauna Species

The database and literature search identified 67 threatened fauna species (see **Table 4.70**) that had previously been recorded or were considered to have potential to occur in the Study Area and/or Study Locality. Following the field habitat assessment and surveys, these species were assessed for their potential to occur in the habitats within the proposed areas of disturbance and, for threatened fauna, whether foraging, sheltering and/or breeding habitat was likely to be present. This assessment resulted in the refinement of the list to 38 species (26 birds including six migratory bird species and 12 mammals) for impact assessment (see **Table 4.74**).

The potential impacts of the amended Project on the 32 subject species listed under the NSW TSC Act, were assessed in accordance with the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, July 2005) and in accordance with Section 5a of the EP&A Act, as specified in the DGRs.

Of the 38 subject species, only ten species listed under the TSC Act and two species listed under the EPBC Act were detected within the Study Area during field survey. Four species were recorded within the roadside vegetation along McKinleys Lane, namely the Grey-crowned babbler, Squirrel glider, the Eastern bent-wing bat and the Large-footed myotis. The Grey-crowned babbler was also recorded in Dry sclerophyll forest adjacent to the proposed private haul road. The Eastern bent-wing bat was detected in the vicinity of farm dams to the east of the private haul road and in the northwestern section of the Mine Area. The Eastern free-tail bat was also detected in the vicinity of a farm dam in the northwestern section of the Mine Area.

The Eastern bent-wing bat, Eastern free-tail bat and the Large-footed myotis are highly mobile and may forage over a large area. Potential impacts to these species would principally result from removal of foraging habitat and may impact roosting and breeding behaviours. The Grey-crowned babbler and the Squirrel glider are relatively sedentary and are likely to have small populations resident along the roadside vegetation which may be affected by the amended Project, despite the locations in which where they were detected being excluded from the proposed area of disturbance.

The Cattle egret (a migratory species listed under the EPBC Act) was observed foraging in grassland and pasture within the northern and southern parts of the Study Area and the Black-faced monarch (a migratory species listed under the EPBC Act) was heard near the eastern boundary of the southern part of the Study Area. These species are not identified on **Figure 4.66** as precise locations were not able to be identified. The Cattle egret was observed on multiple occasions and it was not possible to determine if a single or multiple individuals were observed.

Table 4.74
Threatened Fauna Species Assessed

Scientific Name	Common Name	Status TSC Act	Status EPBC Act
BIRDS			
<i>Ephippiorhynchus asiaticus</i>	Black-necked stork	E	-
<i>Falco subniger</i>	Black falcon	V	-
<i>Circus assimilis</i>	Spotted harrier*	V	-
<i>Lophoictinia isura</i>	Square-tailed kite	V	-
<i>Hieraeetus morphnoides</i>	Little eagle	V	-
<i>Glossopsitta pusilla</i>	Little lorikeet	V	-
<i>Chthonicola sagittata</i>	Speckled warbler	V	-
<i>Daphoenositta chrysoptera</i>	Varied sittella	V	-
<i>Neophema pulchella</i>	Turquoise parrot	V	-
<i>Xanthomyza Phrygia</i>	Regent honeyeater	E	CE
<i>Melithreptus gularis gularis</i>	Black-chinned honeyeater	V	-
<i>Lathamus discolor</i>	Swift parrot	E	E
<i>Ninox connivens</i>	Barking owl	V	-
<i>Ninox strenua</i>	Powerful owl	V	-
<i>Tyto novaehollandiae</i>	Masked owl	V	-
<i>Pomatostomus temporalis temporalis</i>	Grey-crowned babbler*	V	-
<i>Turnix maculosus</i>	Red-backed button-quail	V	-
<i>Epthianura albifrons</i>	White-fronted chat	V	-
<i>Petroica phoenicea</i>	Flame robin	V	-
<i>Ptilinopus magnificus</i>	Wompoo fruit-dove*	V	-
<i>Monarcha melanopsis</i>	Black-faced monarch*	-	M
<i>Ardea ibis</i>	Cattle egret*	-	M
<i>Ardea modesta</i>	Eastern great egret	-	M
<i>Merops ornatus</i>	Rainbow bee-eater	-	M
<i>Rhipidura rufifrons</i>	Rufous fantail	-	M
<i>Myiagra cyanoleuca</i>	Satin flycatcher	-	M
MAMMALS			
<i>Phascogale tapoatafa</i>	Brush-tailed phascogale	V	-
<i>Chalinolobus dwyeri</i>	Large-eared pied bat	V	V
<i>Miniopterus schreibersii oceanensis</i>	Eastern bent-wing bat*	V	-
<i>Myotis macropus</i>	Large-footed myotis*	V	-
<i>Vespadelus troughtoni</i>	Eastern cave bat	V	-
<i>Miniopterus australis</i>	Little bent-wing bat*	V	-
<i>Falsistrellus tasmaniensis</i>	Eastern false pipistrelle	V	-
<i>Mormopterus norfolkensis</i>	Eastern free-tail-bat*	V	-
<i>Saccolaimus flaviventris</i>	Yellow-bellied sheath-tail bat*	V	-
<i>Scoteanax rueppellii</i>	Greater broad-nosed bat	V	-
<i>Pteropus poliocephalus</i>	Grey-headed flying-fox*	V	V
<i>Petaurus norfolcensis</i>	Squirrel glider*	V	-
E = Endangered V = Vulnerable M=Migratory CE= Critically Endangered * = Detected within Study Area			
Source: Biosis (2016) – Modified after Table 23 and Table A8-4			

The majority of the other detected subject species were in the rainforest community on the upper eastern slopes of the Mine Area, in the riparian areas of Waukivory Creek and Dog Trap Creek, or in the Dry sclerophyll forest on the upper slopes. It is unlikely that there would be a direct impact from the amended Project on the habitats on the upper slopes, however, indirect impacts relating to noise, vibration and dust may potentially have an impact on these habitats.

Table 4.75 provides a summary of the assessment of impact for each of the 38 threatened or migratory species. In summary, Biosis (2016) has concluded the following based upon the assessments outlined in **Table 4.75**.

- Impacts are unlikely or not expected for 29 of the subject species.
- It is possible that adverse impacts may occur to three mammal species.
- It is unlikely that impacts would occur to the six migratory species.

From this assessment, the amended Project could possibly have impacts on the Brush-tailed phascogale (vulnerable), Grey-crowned babbler (vulnerable) and Squirrel glider (vulnerable). The Grey-crowned babbler and Squirrel glider were recorded within the road-side vegetation adjacent to McKinleys Lane and additional Grey-crowned babblers were identified to the east of the private haul road. The desktop assessment and anecdotal evidence identified that the Brush-tailed phascogale has been recorded in the vicinity of the Site. All three species utilise Dry sclerophyll forest (Community 2). A decline in the local population of these species may occur if they become isolated in the remnant vegetation along McKinleys Lane. A series of mitigation measures including tree planting and glider poles has been proposed and would be implemented along with a monitoring program.

As discussed in Section 4.12.4, priority has been given to avoiding and mitigating any disturbances to natural vegetation and threatened species. The roadside vegetation corridor adjacent to the northern section of McKinleys Lane was avoided in the design of the amended Project, and to further assist in mitigation of indirect impacts to that vegetation, tree planting along Waukivory Road has been initiated. As use of McKinleys Lane beyond the entrance to the Mine Area access road would no longer be required, this section of road would be isolated, ripped and allowed to regenerate naturally. Vegetation planted on the western and northern amenity barrier would be consistent with the vegetation along McKinleys Lane in order to mitigate impacts to threatened species identified in this location. Any hollow-bearing trees would be avoided where practical and cleared trees with hollows would be placed within areas being rehabilitated or the Biodiversity Offset Area to improve the habitat within these locations. Furthermore, revegetation of the landform would be progressively carried out to create woodland and native vegetation corridors to the north and east of McKinleys Lane. The amended Project also includes retaining most of the trees within the Dry sclerophyll forest patch adjoining the western side of McKinleys Lane where the administration area is proposed. In addition, the route for the private haul road was determined following consideration of likely habitat areas within the southern part of the Study Area. While vegetation clearing would not be completely avoided in this location, disturbance areas have been minimised as much as practically possible.

Table 4.75
Threatened Fauna Species Summary of Impact Assessment

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Scientific Name	Common Name	Status TSC Act	Status EPBC Act
BIRDS			
<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork	E	-
The Black-necked stork was not recorded in the Study Area during the field surveys. While the Black-necked stork has been previously recorded within the Study Locality and within 2km of the Study Area (NSW OEH Wildlife Atlas), there are no previous records of the Black-necked stork breeding in the Gloucester area (Clancy and Anderson, 2010). The amended Project would remove a relatively small area of cleared open pasture (approximately 446ha) that would constitute marginally suitable foraging habitat for the Black-necked stork. However, there are vast tracts of more suitable habitat for foraging directly to the north and west of the proposed area of disturbance. It is unlikely that the amended Project would affect the breeding habitat of this species, however, it may result in a small reduction of potential foraging habitat. This small reduction is unlikely to have a significant effect on the life cycle of any local population of this species.			
<i>Lophoictinia isura</i> *	Spotted harrier	V	-
This species was recorded during the surveys of the southern part of the Study Area and has been recorded once within the Study Locality according to the NSW OEH Wildlife Atlas. No evidence of a nest was seen but there were a number of tall eucalypts which could be used for nesting by this species. The amended Project would remove a relatively small area of potential foraging habitat (approximately 446ha of cleared open pasture) for the Spotted harrier and possibly some potential nest site trees. Since the foraging habitat within the area of disturbance would constitute a very small part of the foraging range of a Spotted harrier and there were no nests observed on the Study Area, it is unlikely that the amended Project would have a significant effect on the life cycle or the long-term viability of any local population of this species.			
<i>Lophoictinia isura</i>	Square-tailed kite	V	-
This species was not recorded during the field surveys within the Study Area nor recorded by the NSW NPWS Wildlife Atlas within the Study Locality, although it could forage throughout the habitats in the Study Area. No evidence of a nest was seen but there were a number of tall eucalypts which could be used for nesting by this species. The amended Project would disturb approximately 497ha of land, of which only a small portion (open woodland, rainforest and riparian forest – approximately 51.8ha) would constitute potential breeding sites. Considering the large areas used by this bird and the lack of any sightings of this species in the Study Area during the field studies, the amended Project is not expected to have a significant effect on the life cycle or long-term viability of any local population of this species.			
<i>Hieraeetus morphnoides</i>	Little eagle	V	-
This species was not recorded during the field surveys within the Study Area but has been recorded in the NSW NPWS Wildlife Atlas as occurring within the Study Locality. This species could forage throughout the Study Area and potentially nest in one of the tall eucalypts within the Study Area, although no large nests were observed during the survey. The amended Project would remove a relatively small area of potential foraging habitat (approximately 446ha of cleared open pasture) and possibly some potential nest site trees. Since the foraging habitat would constitute a very small part of the foraging range of a Little eagle and there were no nests observed, it is unlikely that the amended Project would have a significant effect on the life cycle or the long-term viability of any local population of this species.			
E = Endangered V = Vulnerable M=Migratory CE= Critically Endangered * = Detected within Study Area			

Table 4.75 (Cont'd)
Threatened Fauna Species Summary of Impact Assessment

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Scientific Name	Common Name	Status TSC Act	Status EPBC Act
BIRDS (Cont'd)			
<i>Falco subniger</i>	Black falcon	V	-
This species was not recorded during the field surveys within the Study Area but has been recorded in the NSW NPWS Wildlife Atlas as occurring within the Study Locality (last record was dated 2003). This species could forage throughout the Study Area and potentially nest in one of the tall eucalypts within the Study Area, although no large nests were observed during the survey. The amended Project would remove a relatively small area of potential foraging habitat (approximately 446ha of cleared open pasture) and possibly some potential nest site trees. Since the foraging habitat would constitute a very small part of the foraging range of a Black falcon and there were no nests observed, it is unlikely that the amended Project would have a significant effect on the life cycle or the long-term viability of any local population of this species.			
<i>Glossopsitta pusilla</i>	Little lorikeet	V	-
The Little lorikeet was not recorded during the surveys within the Study Area nor has this species been recorded within the Study Locality according to the NSW NPWS Wildlife Atlas. This species was recorded in field surveys for the recent Stratford Extension Project. It is generally considered to be a nomadic species which responds to mass flowering events of eucalypts and feeds largely from flowers. This species could forage on flowering trees (open forest/woodland) in the Study Area from time to time and could also nest in the Study Area given the presence of hollows of a suitable size, if there was a sufficient supply of food nearby. Due to its nomadic nature, its local population would extend across at least hundreds of square kilometres and include the nearby ranges and coast. It is considered unlikely that the amended Project would have any significant adverse effect on the life cycle or long-term viability of any local population of the Little lorikeet, given the habit of this species to move relatively large distances in response to availability of seasonal food resources and the lack of records in the wildlife atlas and during the field surveys. The amended Project would therefore be unlikely to have a significant effect on this species.			
<i>Chthonicola sagittata</i>	Speckled warbler	V	-
<i>Daphoenositta chrysoptera</i>	Varied sittella	V	-
<i>Neophema pulchella</i>	Turquoise Parrot	V	-
<i>Petroica phoenicea</i>	Flame robin	V	-
The Speckled warbler, the Turquoise parrot, the Flame robin and the Varied sittella were not recorded in the Study Area during the field surveys however, the Speckled warbler, Flame robin and Varied sittella have been recorded in the Study Locality (NSW OEH Wildlife Atlas) and within the Stratford Mining Complex. All of these species are resident in a home range area for most or all of the year, occurring in relatively open forest, woodland and nearby grassland. The Speckled warbler and Turquoise parrot forage mainly on the ground while the Varied sittella and Flame robin forage mainly for insects in the canopy. The Turquoise parrot requires tree hollows for nesting. The amended Project would result in the loss of 46.9ha of potential foraging and breeding habitat (open forest/woodland) and adjacent grassland and this reduction in area of available habitat could result in the displacement of some birds if they are present. The Speckled warbler is likely to have restricted local populations. It has been recorded to the southwest of the Study Area in the Gloucester Tops area. There is much more habitat that would be suitable for all four species on the eastern side of the Study Area (namely on the steep slopes and top of Mograni Range).			
E = Endangered V = Vulnerable M=Migratory CE= Critically Endangered * = Detected within Study Area			

Table 4.75 (Cont'd)
Threatened Fauna Species Summary of Impact Assessment

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Scientific Name	Common Name	Status TSC Act	Status EPBC Act
BIRDS (Cont'd)			
The Speckled warbler and the Varied sittella would be expected to forage and possibly nest in regenerating native vegetation, particularly if this occurred in adjacent habitat. Considering that much of the vegetation suitable for these species would remain untouched on the upper slopes, the small loss of habitat caused by the amended Project would be compensated in the interim by vegetation to be established within the western and northern amenity barrier and, in time, by the open woodland and native vegetation corridors to be established as part of the rehabilitation plan for the disturbance area, and the proposed revegetation of the cleared parts of the proposed Biodiversity Offset Area. In conclusion, it is unlikely that the amended Project would have a significant effect on these species.			
<i>Xanthomyza Phrygia</i>	Regent honeyeater	E	CE
<i>Lathamus discolour</i>	Swift parrot	E	E
<i>Melithreptus gularis</i>	Black-chinned honeyeater	V	-
None of these species was recorded in the Study Area during the surveys but all have some potential to use the Study Area for foraging for eucalypt blossom. The Regent honeyeater and Swift parrot have recognised breeding areas in particular parts of New South Wales and Tasmania, respectively, none of which are located within the Study Locality. The Black-chinned honeyeater is widespread in NSW but rare in coastal districts. It tends to use the largest remnants of vegetation, so is unlikely to be affected by the relatively minor removal of small patches of vegetation for this amended Project. The Regent honeyeater and Swift parrot are listed species under the EPBC Act, and an assessment using the Significant Impact Criteria for Matters of National Environmental Significance was undertaken by Biosis (2016 – Appendix 8). The assessment determined that significant impacts would be unlikely to occur as a result of the amended Project. The amended Project would result in the loss of a relatively small portion of potential foraging habitat for these species in the Study Area (maximum 16.8ha – open forest/woodland in moderate to good condition). Since the Regent honeyeater and Swift parrot are migratory or nomadic, and travel large distances in response to availability of food resources, it is unlikely that the Study Area provides an important foraging area for either of them. Similarly, the Black-chinned honeyeater prefers the larger patches of woodland/forest. It is therefore unlikely that the amended Project would have a significant effect on the habitat, life cycle or long-term viability of any local population of these species.			
<i>Epthianura albifrons</i>	White-fronted Chat	V	-
The White-fronted chat was not recorded during the field surveys within the Study Area but has been recorded in the NSW OEH Wildlife Atlas as occurring in the Study Locality (last record in 2000). The amended Project would remove a relatively small area of potential foraging habitat (damp open grassland) for the White-fronted chat. It is unlikely that the amended Project would have a significant effect on the life cycle or the long-term viability of any local population of this species.			
<i>Turnix maculosus</i>	Red-backed button quail	V	-
The Red-backed button quail was not recorded during the field surveys within the Study Area and has not been recorded in the NSW OEH Wildlife Atlas as occurring in the Study Locality. The amended Project would remove a relatively small area of potential foraging habitat (damp open grassland and pasture) for the Red-backed button quail. It is unlikely that the amended Project would have a significant effect on the life cycle or the long-term viability of any local population of this species.			
E = Endangered V = Vulnerable M=Migratory CE= Critically Endangered * = Detected within Study Area			

Table 4.75 (Cont'd)
Threatened Fauna Species Summary of Impact Assessment

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Scientific Name	Common Name	Status TSC Act	Status EPBC Act
BIRDS (Cont'd)			
<i>Ninox connivens</i>	Barking owl	V	-
<i>Ninox strenua</i>	Powerful owl	V	-
<i>Tyto novaehollandiae</i>	Masked owl	V	-
None of these owl species was recorded in the Study Area during the surveys, but the Powerful owl has been recorded in the Study Locality (last dated record was over 36 years ago). Each of these species has been recorded during previous surveys to the north and south of the Study Area and there is some potential for these species to use the forested parts of the Study Area, at least for foraging. Some potential roosting habitat was present in the Study Area for the Barking Owl and Powerful Owl. Potential nest hollows for the Powerful, Barking and Masked owls were observed in the Study Area during the surveys in the form of large tree hollows, although their suitability was difficult to determine. The amended Project would effectively lead to the removal of 47.6ha (open forest/woodland and riparian forest) of potential foraging habitat for the Powerful, Masked and Barking owls, and some potential nest hollows and potential daytime roost sites for the owls (17.5ha – incorporating open forest/woodland in moderate to good condition and riparian forest). Each of these species forages over a large territory encompassing at least 800ha and probably more than 1000ha. They have all been recorded showing high fidelity to nesting sites, using the same site over many years. The amended Project is unlikely to have a significant effect on the life cycle of these forest owls, since only a very small fraction of the home range of a single pair of each species at most would be impacted, and far better quality and more extensive tracts of suitable foraging, roosting and nesting habitat occurs to the east of the Study Area. The size of the local populations of the Masked, Powerful and Barking owls are not known, although the Masked owl has been recorded south of the Study Area in The Glen Nature Reserve and it is likely that their distributions extend through the forest to the east of the Study Area, along the Mograni Range. On the basis of what is known about the local occurrences of these species, and their potential habitat within the proposed area of disturbance, it is unlikely that the amended Project would have a significant effect on the life cycles of the Powerful, Masked or Barking owl.			
<i>Pomatostomus temporalis temporalis</i> *	Grey-crowned babbler	V	-
The Grey-crowned babbler was recorded on several occasions during the field surveys: a group of this species was identified foraging along the northern section of McKinleys Lane; a group and its nests was observed in the yard of a property on the western side of McKinleys Lane, and a group and its nests were recorded in the southern part of the Study Area. This species has also been recorded many times throughout the Study Locality (NSW NPWS Wildlife Atlas). The Grey-crowned babbler is a communal-breeding species noted for its gregarious social behaviour. It is sedentary and territorial, with co-operatively breeding social groups (known as family groups). It is rarely seen singly or in unattended pairs. Grey-crowned babblers have a "flock" behaviour, with individuals usually within 15m of each other, and groups usually occupying an area of less than 30m in diameter. The activity range of Grey-crowned babbler groups varies from 2 to 53ha and increases with increasing group size and habitat connectivity (GSC, 2005). The Gloucester Shire Council <i>Grey-crowned babbler Retention Plan 2005</i> reported approximately 20 family groups distributed throughout the former Gloucester LGA, from Gloucester township to Monkerai in the south, both sides of The Bucketts Way (GSC, 2005).			
E = Endangered V = Vulnerable M=Migratory CE= Critically Endangered * = Detected within Study Area			

Table 4.75 (Cont'd)
Threatened Fauna Species Summary of Impact Assessment

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Scientific Name	Common Name	Status TSC Act	Status EPBC Act
BIRDS (Cont'd)			
Two family groups of Grey-crowned babbler are known to currently occur in the southern half of Gloucester township (GSC, 2005). These groups form the northerly extent of the Grey-crowned babbler population within the former Gloucester LGA (GSC, 2005). The Study Area lies to the south-east of Gloucester township and it is likely that the Grey-crowned babblers recorded within the Study Area form part of one of the recognised family groups. The amended Project would disturb an estimated area of 497ha of which a small portion totalling 16.8ha (open forest/woodland in moderate to good condition only) provides potentially suitable habitat for the Grey-crowned babbler. It is proposed that the roadside vegetation that bounds McKinleys Lane and in the southern part of the Study Area where the Grey-crowned babblers were observed would remain untouched. Progressive revegetation of the western and northern amenity barrier and across the Mine Site generally would provide suitable habitat for this species. Tree planting along Waukivory Road has been commenced and revegetation of the landform will be progressively carried out to create woodland and native vegetation corridors to the north and east of McKinleys Lane. Monitoring of Grey-crowned babblers at the Tarrawonga Mine near Gunnedah suggests that where this species occupies habitat adjacent to mining activities, it is resilient to the mining activities (Countrywide Ecological Service, 2010). Despite these proposed mitigation measures and the recorded resilience of the species, it remains possible that the amended Project could have an adverse impact on the group of Grey-crowned babblers that inhabit McKinleys Lane area by forcing them to relocate to sub-optimal habitat elsewhere, but is unlikely to affect the population located to the east of the proposed private haul road. This would be unlikely to result in a noticeable decline in the local population of this species.			
<i>Ptilinopus magnificus</i> *	Wompoo fruit-dove	V	-
The Wompoo fruit-dove was recorded during field surveys in the rainforest community (Community 4) on the steep upper slopes of the eastern side of the Study Area. The Wompoo fruit-dove prefers rainforest, dry rainforest and moist eucalypt forest habitats and feed on the fruits of trees and vines in these areas. The amended Project would remove 4.2ha of suitable habitat (rainforest) for this species. However, these remnant patches represents only a small proportion of the total area of suitable habitat available for this species within the Study Area. The portions of habitat that would be removed may be used for occasional foraging by this species, however they are unlikely to provide suitable breeding opportunities due to these areas being primarily small isolated patches disconnected from the more extensive suitable habitat on the steep upper slopes and watercourses to the east. It is unlikely that the amended Project would have a significant impact on the life cycles of the Wompoo, dove.			
E = Endangered V = Vulnerable M=Migratory CE= Critically Endangered * = Detected within Study Area			

Table 4.75 (Cont'd)
Threatened Fauna Species Summary of Impact Assessment

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Scientific Name	Common Name	Status TSC Act	Status EPBC Act
MIGRATORY BIRDS			
<i>Monarcha melanopsis</i> *	Black-faced monarch	-	M
<i>Ardea ibis</i> *	Cattle egret	-	M
<i>Ardea modesta</i>	Eastern great egret	-	M
<i>Merops ornatus</i>	Rainbow bee-eater	-	M
<i>Rhipidura rufifrons</i>	Rufous fantail	-	M
<i>Myiagra cyanoleuca</i>	Satin flycatcher	-	M
The Black-faced Monarch was observed in the southern part of the Study Area and the Cattle Egret was observed in both the southern and northern parts of the Study Area during field surveys. The amended Project would result in the removal of an estimated 497ha of potential foraging habitat for these species (incorporating all vegetation community types). Each species may be present from time-to time in the vegetation communities identified within the Study Area. An assessment using the Significant Impact Criteria for Matters of National Environmental Significance was undertaken by Biosis (2016 – Appendix 8). The assessment determined that the amended Project would be unlikely to substantially modify, destroy nor isolate important habitat nor cause invasive species harmful to the six migratory bird species to become established in existing habitat. An ecologically significant proportion of the population of these species would not occur within the Study Area. Therefore the amended project is unlikely to have an impact on the species.			
MAMMALS			
<i>Phascogale tapoatafa</i>	Brush-tailed phascogale	V	-
The Brush-tailed phascogale was not recorded in the Study Area during field surveys. However, this species has been identified by a local resident on McKinleys Lane, was recorded in previous surveys of large patches of vegetation to the west of the private haul road in surveys for the Stratford Extension Project and has also been recorded within the Study Locality (NSW OEH Wildlife Atlas). It is an arboreal marsupial carnivore that prefers Dry sclerophyll forest with a sparse ground cover of herbs, grasses, or leaf litter. It is an agile climber, preferring trees with a diameter at breast height (dbh) greater than 25cm to forage in. It forages on arthropods but will also eat other invertebrates, nectar and sometimes small vertebrates. Due to past clearing and agriculture activities, most remnant woodland habitat in the Study Area likely to be preferred by the Brush-tailed phascogale is confined to narrow strips along roads and streams. Along these strips there are sometimes up to 10 times the number of large mature trees compared to many State forests and parks, as these areas have not been harvested for timber. Populations in these types of areas are often dense with females occupying home ranges of 2.3 - 8.0ha with an average of 5.0ha. Home ranges of males are somewhat larger (greater than 20ha), as a male's home range may take in several female home ranges. Approximately 46.9ha of suitable Dry sclerophyll forest habitat occurs within the proposed area of disturbance. This area could be occupied by as many as six females, but is likely only to support one or two males. The removal of this vegetation could potentially affect the life cycle of any local population of the Brush-tailed phascogale by displacing individuals into surrounding territories; reducing the available breeding and roosting habitat by removing hollow-bearing trees; disturbing and possibly causing death to individuals during tree clearing operations, and reducing genetic variation within the remaining population by limiting the number of occupied territories in this area. The amended Project would retain most of the trees within the Dry sclerophyll forest patch adjoining the western side of McKinleys Lane where site offices and amenities are to be located and the remnant vegetation along the northern section of the lane. The proposed western and northern amenity barrier will be planted out with tree and shrub species that currently occur along McKinleys Lane and the other Dry sclerophyll forest areas.			
E = Endangered V = Vulnerable M=Migratory CE= Critically Endangered * = Detected within Study Area			

Table 4.75 (Cont'd)
Threatened Fauna Species Summary of Impact Assessment

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Scientific Name	Common Name	Status TSC Act	Status EPBC Act
MAMMALS (Cont'd)			
Vegetation removal for the private haul road would be limited, however the road may restrict movement of this species between the forested areas of the Mograni Range and the larger patches of dense vegetation in the valley floor. Coal haulage is only proposed between 7:00am and 6:00pm and would therefore only occur after dark during winter when the species enters torpor. In conclusion, should a Brush-tailed phascogale population currently occur within or traverse the Study Area, it is possible that the amended Project could have an impact on the life cycle of that population as a result of road kills.			
<i>Chalinolobus dwyeri</i>	Large-eared pied bat	V	V
<i>Miniopterus schreibersii oceanensis</i> *	Eastern bent-wing bat	V	-
<i>Myotis macropus</i> *	Large-footed myotis	V	-
<i>Vespadelus troughtoni</i>	Eastern cave bat	V	-
<i>Miniopterus australis</i> *	Little bent-wing bat	V	-
The Eastern bent-wing bat, Little bent-wing bat and the Large-footed myotis were recorded on the Study Area with definite confidence levels during the survey, while the Eastern cave bat and Large-eared pied bat were not recorded during field survey. The Large-footed myotis was recorded at seven separate locations in the Study Area on the flatter areas, probably due to the presence of water bodies that include the Avon River, Waukivory, Dog Trap and Oak Creek and a number of farm dams. This species was also recorded during surveys for the Stratford Extension Project. The Eastern cave bat had not been previously recorded in the Study Locality and was identified with only "possible" confidence, although it is difficult to distinguish from similar species by call analysis. The Large-eared pied bat was not recorded during the field surveys but has been recorded in the Study Locality. The Eastern bent-wing bat and Little bent-wing bat are both likely to forage throughout most of the Study Area, particularly in and near the forested areas: the Eastern bent-wing bat was recorded at three different locations while the Little bent-wing bat was recorded in two different locations. The Large-footed myotis could forage over water bodies within the Study Area and potentially roost in tree hollows, although it more commonly roosts under bridges and other structures closer to more extensive bodies of water. The most likely effects of the amended Project on the life cycle of these five bat species would be to cause a change in roosting and possibly breeding behaviour due to the loss of some potential roost/breeding sites such as old farm buildings and, in the case of the Large-footed myotis, potential tree-hollow roosts. The amended Project would disturb approximately 497ha of land (incorporating all vegetation community types), of which only a small portion would constitute potential breeding sites. For the Eastern cave bat and the Little bent-wing bat, the likely effects of the amended Project would be a decrease in the area of available habitat for foraging, although it is noted that extensive areas occur nearby. If disturbance to a breeding site occurred during the breeding cycle it could lead to mortality of individual bats, and/or an abandonment of the breeding attempt. A clearing protocol included as part of a Biodiversity Management Plan for the amended Project would alleviate this potential by specifying clearing and demolition activities outside the breeding period for these bats.			
E = Endangered V = Vulnerable M=Migratory CE= Critically Endangered * = Detected within Study Area			

Table 4.75 (Cont'd)
Threatened Fauna Species Summary of Impact Assessment

Page 8 of 9

Scientific Name	Common Name	Status TSC Act	Status EPBC Act
MAMMALS (Cont'd)			
The local populations of the Eastern bent-wing bat, Little bent-wing bat and Large-eared pied bat are likely to be extensive, utilising large areas of adjacent forest, and more open habitats in the case of the Eastern bent-wing bat. The Large-footed myotis was detected in several locations near water within the Study Area and may occur widely in the Study Locality, particularly in association with the Avon River and Waukivory and Oak Creek. The Eastern cave bat has not been recorded within the Study Locality. However, there may be a local population of this species that exists in the Study Area. Throughout the forest adjacent to the Study Area extending to the south and east, there would appear to be potentially suitable habitat for this species. Therefore, the Study Area is unlikely to play an important role in maintaining the long-term viability of the local population of any of these five species. The Large-eared pied bat is a listed species under the EPBC Act, and an assessment using the Significant Impact Criteria for Matters of National Environmental Significance was undertaken by Biosis (2016 – Appendix 8). The assessment determined that significant impacts would be unlikely to occur as a result of the amended Project. Therefore the amended project is unlikely to have a significant impact on the species. In consideration of the above, the amended Project is unlikely to have a significant effect on the life cycle of any of these bat species.			
<i>Falsistrellus tasmaniensis</i>	Eastern false pipistrelle	V	-
<i>Mormopterus norfolkensis</i> *	Eastern free-tail bat	V	-
<i>Saccolaimus flaviventris</i> *	Yellow-bellied sheath-tail-bat	V	-
<i>Scoteanax rueppellii</i>	Greater broad-nosed bat	V	-
The Yellow-bellied sheath-tail bat was identified in the northern part of the Study Area during the field surveys by ultrasonic detection to the probable level and the Eastern free-tail bat was identified in the northern part of the Study Area by ultrasonic detection to the definite level of confidence. The Eastern false pipistrelle and Greater broad-nosed bat were not recorded during field survey. The Greater broad-nosed bat and the Eastern free-tail bat have been recorded within the Study Locality (NSW NPWS Wildlife Atlas). The Eastern false pipistrelle and the Greater broad-nosed bat have been recorded in the Glenn Nature Reserve and at Terreel to the south of the Study Area. All of these species have the potential to forage throughout the Study Area, particularly in and near the forested areas, and also to roost and breed in tree hollows. The amended Project would disturb around 497ha of land which contains potential foraging habitat (incorporating all vegetation community types). Of this land 51.8ha contains potential roosting habitat (incorporating open forest/woodland, riparian forest and rainforest of any condition). There would be a loss of potential roost sites and breeding sites through the removal of hollow-bearing trees. These impacts would result in a change of foraging behaviour and possibly force a change in roosting and breeding behaviour. Bats may have to slightly extend their foraging ranges into the adjacent forest and use alternative roost sites to any used within the potential disturbance area. If disturbance to a breeding roost site occurred during a critical stage in the breeding cycle, a failed breeding attempt and/or mortality of individual bats could occur. The local populations of each of these four species are expected to extend into large areas of forest adjoining the Site to the east, and in the case of the Yellow-bellied sheath-tail bat, possibly as far as northern Australia. The amended Project could directly affect the habitat of these species, but this habitat is not expected to be important for the long-term viability of the local population of any of these species. It is unlikely that the amended Project would have a significant effect on any of these four species.			
E = Endangered V = Vulnerable M=Migratory CE= Critically Endangered * = Detected within Study Area			

Table 4.75 (Cont'd)
Threatened Fauna Species Summary of Impact Assessment

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Scientific Name	Common Name	Status TSC Act	Status EPBC Act
MAMMALS (Cont'd)			
<i>Pteropus poliocephalus</i> *	Grey-headed flying fox	V	V
The Grey-headed flyingfox was opportunistically recorded at Waukivory Creek immediately to the south of the proposed area of disturbance within the Mine Area. This species has the potential to forage on the flowers of eucalypts, figs and other rainforest tree fruits, throughout the Study Area and region. The Grey-headed flyingfox is a listed species under the EPBC Act, and an assessment using the Significant Impact Criteria for Matters of National Environmental Significance was undertaken by Biosis (2016 – Appendix 8). The assessment determined that significant impacts would be unlikely to occur as a result of the amended Project. The amended Project would result in the loss of approximately 51.8ha of potential foraging habitat for the Grey-headed flyingfox (open forest/woodland, riparian forest and rainforest of any condition), but would have no direct effect on roosting or breeding habitat. Based on the capacity of this species to travel long distances to exploit seasonal food sources, the effect of the amended Project on the life cycle or habitat of the Grey-headed flyingfox would be minor. The amended Project is not expected to have a significant effect on this species.			
<i>Petaurus norfolcensis</i>	Squirrel glider	V	-
The Squirrel glider was recorded in the Study Area during field surveys and has been detected to the south and the west of the Study Area during field surveys for the Stratford Extension Project. This species was only captured in the Dry sclerophyll forest (Community 2) corridor along McKinleys Lane. However, it is likely that it could potentially forage the length of McKinleys Lane, adjacent forest/woodland areas and could also exist in the elevated forested parts of the eastern side of the Study Area. It is documented that populations of Squirrel gliders can persist in roadside corridors such as McKinleys Lane, mainly due to fact that these corridors often have mature trees and these mature trees often hold hollows that this species requires for both breeding and roosting. The size of the population along McKinleys Lane is currently unknown, but is only likely to comprise one or two family groups. The amended Project would effectively remove a maximum of 16.8ha of potential foraging, sheltering and breeding habitat (open forest/woodland in moderate to good condition) for the Squirrel glider. The McKinleys Lane population may well currently be isolated from other potential populations to the north or east of the Study Area. If a connection exists, then it is tenuous along McKinleys Lane to Waukivory Road and east to the forested slopes of the Mograni Range. While the roadside vegetation along the northern section of McKinleys Lane is proposed for retention, indirect impacts from adjacent mining, light, noise and blasting may occur. This has the potential to affect this species life cycle by causing a change in foraging behaviour; a change in roosting behaviour; displacement of individuals; disruption of the social structure of the population and, where the new access road crosses the McKinleys Lane near its intersection with Waukivory Road, potential mortality of individual gliders. However, most traffic is expected to be slow moving in this location due to the proximity of the intersection. Even with the mitigation measures proposed to improve connectivity between the McKinleys Lane roadside vegetation and the more extensive vegetation of the Mograni Range (including preparation of a Squirrel-glider management and monitoring plan and management measures such as glider poles), it is possible that the amended Project could have an adverse effect on the local population that exists in the McKinleys Lane corridor. Should the local population become isolated it is possible that a decline in the local population of the species may occur.			
E = Endangered V = Vulnerable M=Migratory CE= Critically Endangered * = Detected within Study Area			
Source: Modified after Biosis (2016) – Section 5.2.2 and Appendix 8			

4.12.5.5 Koala Habitat Assessment – SEPP 44

SEPP 44 – Koala Habitat Protection was discussed in Section 3.2.3.4. Biosis (2016) identified three Koala feed tree species listed under Schedule 2 of SEPP 44 as occurring within the Site. These comprised the Forest red gum (*Eucalyptus tereticornis*), Grey gum (*Eucalyptus punctata*) and Tallowwood (*Eucalyptus microcorys*). In some parts of the Study Area, particularly on the lower slopes and valley floor, at least 15% of the tree species comprise Koala feed tree species. Therefore, these parts would constitute ‘potential Koala habitat’.

No Koalas or evidence of Koalas were found during the surveys of the Site and its surrounds and there have only been 10 previous recorded sightings of Koalas within the Study Locality (10km radius of the Study Area) over the last 50 years. In the absence of sightings during the field surveys and in recent history, Biosis (2016) concluded that there is no core Koala habitat present within the Site.

The amended Project will result in removal of some areas of ‘potential Koala habitat’, but these areas are not ‘core Koala habitat’ in accordance with SEPP 44. Therefore, specific mitigation measures such as a Koala Plan of Management would not be required.

4.12.5.6 Matters of National Environmental Significance

On 11 May 2012, the then Department of Sustainability, Environment, Water, Population and Communities determined that the 2013 Project, as identified at that date, was not a controlled action.

The assessment of threatened flora and fauna for the amended Project included assessment of species listed under the EPBC Act (see Section 4.12.5.3 and Section 4.12.5.4). Subject species that were assessed by Biosis (2016) included two threatened bird species, two threatened mammal species and six migratory bird species.

The assessment (summarised in **Table 4.75** and presented in full as Appendix 8 of Biosis (2016)) concluded that no significant impact was likely to occur from the amended Project for any threatened species, threatened ecological community or migratory species currently listed under the EPBC Act.

Based on this assessment, it has been concluded that a further referral of the amended Project to the Commonwealth Department of Environment for assessment of potential impacts to species listed within the EPBC Act is not required. Referral of the amended Project is discussed in full in Section 3.2.3.2.

4.12.5.7 Groundwater Dependent Ecosystems

The Commonwealth Government Bioregional Assessment program (Commonwealth Government, May 2014) assessed the Gloucester Basin as the Gloucester Subregion. An assessment of potential groundwater dependent ecosystems, undertaken in conjunction with OEH, concluded that no groundwater dependent ecosystems are located in the Gloucester Subregion.

Notwithstanding the broad nature of the bioregional assessment, two ecosystems are considered dependent upon groundwater within and in the vicinity of the Mine Area, based upon site specific studies undertaken by Biosis (2016) (Terrestrial Ecology) and Cardno Ecology Lab

(Aquatic Ecology). These two studies have identified the presence of riparian vegetation adjacent to the Avon River and Waukivory Creek, and stygofauna within the alluvial groundwater system.

The riparian vegetation comprises mainly a River Oak / Cabbage Gum / Broad-leaved Apple Riparian Forest. However, only a small area of this community (0.7ha) is likely to be directly impacted by the amended Project. Stygofauna, i.e. specialised macroinvertebrates that have adapted to living in groundwater habitats, are present in small numbers in some of the groundwater bores located in the alluvium, the details of which are provided in Section 4.13.3.8. No obligate stygofauna were identified during sampling and existing literature suggests that, based on the extent of saline water beneath the Mine Area, it is unlikely that these stygofauna would occur within the Mine Area.

In addition, the Mine Area has been specifically located to minimise impacts on flood-prone land adjacent to the Avon River and Waukivory and Oak Creek.

The amended Project is therefore considered unlikely to have a significant effect on any groundwater dependent ecosystem.

4.12.5.8 Habitat Corridors

The existing vegetation within the Study Area provides narrow north-south habitat corridors through part of the Study Area providing tenuous links from small patches of forest to riparian vegetation along Oak Creek (north of the proposed area of disturbance) and then to the extensive forest vegetation along the Mograni Range to the east. There is also some connectivity at the northern end of the McKinleys Lane corridor to riparian vegetation along the Avon River to the west of the proposed area of disturbance, via Oak Creek.

The amended Project would not sever an existing link between two discrete habitat patches and, on a broad scale, would have a negligible impact on habitat connectivity. Therefore, the amended Project is unlikely to reduce habitat connectivity. However, the private haul road may impose some restriction on movement of common ground-dwelling fauna species in an east-west direction between remnant vegetation within the valley floor and the vegetation within the Mograni Range. This potential impact would be mitigated through limited road movements after dark, when most species are active. The Applicant's road-side plantings adjacent to The Bucketts Way, Fairbairns Road (see **Plates 2.4** and **2.6** in Section 2.16.6.2), Waukivory Road and other roads, together with the plantings that are part of the proposed Biodiversity Offset Area and the implementation of the proposed rehabilitation plan for the final landform (see Section 2.16.6) are all likely to, in time, improve local habitat connectivity.

4.12.6 Monitoring

The Applicant would ensure that the following terrestrial ecology-related monitoring is undertaken throughout the life of the amended Project. The results of the monitoring program would be reported in each Annual Review.

- A Squirrel glider and Grey-crowned babbler monitoring program would be established as part of the Biodiversity Management Plan for the amended Project. This would also serve to detect and monitor any Brush-tailed phascogales in the

McKinleys Lane area and in the vicinity of the private haul road. The Plan would provide for adaptive management if changes in the populations are identified from the monitoring (for example, erection of glider poles just outside the road alignment to aid the movement of gliders across the road at heights that would avoid vehicles hitting Squirrel gliders during a glide).

- All areas undergoing rehabilitation within the Mine Area would be monitored annually to determine the success or otherwise of the management, mitigation and ameliorative measures, and the rehabilitation programs. This would involve photography every 6 months from a set of photographic reference points.
- The entire Biodiversity Offset Area would be monitored on an annual basis in the manner detailed in the Biodiversity Management Plan.

4.12.7 Conclusion

An effective total area of 41.5ha of vegetation within three native vegetation communities, ranging from low condition to good condition, would be removed or modified within the 497ha area of disturbance. This comprises an effective 36.6ha of Dry sclerophyll forest, 0.7ha of Riparian vegetation and 4.2ha of dry Rainforest. The rainforest vegetation corresponds to the Vulnerable Ecological Community *Lower Hunter Valley Dry Rainforest in the Sydney Basin and NSW North Coast Bioregions*.

None of the 37 threatened and significant flora species that could potentially occur within the Study Locality were detected within the Study Area during the comprehensive flora surveys, while ten of the 70 threatened fauna species considered likely to occur at least periodically within the Study Locality were detected within the Study Area. Despite the limited extent of suitable habitat within the disturbance area, Biosis (2016) has concluded that up to 38 subject species (threatened fauna species under the TSC Act or EPBC Act and migratory species listed under the EPBC Act) could potentially occur at least on an occasional basis.

Biosis (2016) has undertaken an assessment of significance of impact in accordance with *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005) and the 7-part test of section 5A of the EP&A Act for 32 TSC-listed fauna species and for *Lower Hunter Valley Dry Rainforest in the Sydney Basin and NSW North Coast Bioregions* VEC as subject species. It is concluded from the assessment of significance of impact that the Squirrel glider and Grey-crowned babbler are the only local populations of threatened species that could potentially be adversely impacted by the amended Project. However, if currently present, other threatened species such as the Brush-tailed phascogale, could also be impacted to some degree.

A monitoring program for the populations of these species would be undertaken in the manner outlined in the Biodiversity Management Plan to enable adaptive management if changes in the populations are identified.

4.13 AQUATIC ECOLOGY

The aquatic ecology assessment of the amended Project was undertaken by Cardno Ecology Lab. The full assessment is presented in Volume 4 Part 8 of the Specialist Consultant Studies Compendium and is referenced throughout this section as CEL (2016), with the relevant information from the assessment summarised in the following subsections.

4.13.1 Introduction

Based on the risk assessment undertaken for the amended Project (Section 3.3.1 and **Appendix 6**), the potential impacts relating to aquatic ecology and their risk rankings after the adoption of standard mitigation measures are as follows.

- Chemical contamination of groundwater leading to impacts on groundwater biota and waters of the Avon River and Waukivory and Oaky Creeks (low).
- Modified groundwater quality / quantity post mine closure leading to impacts on aquatic ecological biodiversity, groundwater biota (stygo fauna) and biota of surface waters of the Avon River and Waukivory and Oaky Creeks (low).
- Changes to the chemical nature of receiving waters impacting aquatic ecology, riparian and groundwater dependent ecosystem assemblages (low).
- Changes to geomorphology and flow regimes of creeks / rivers resulting from abstraction or redirection of water or discharge of water and impacts to aquatic ecology, riparian and groundwater dependent ecosystem assemblages (low).
- Damage to the Avon River and/or Waukivory Creek due to necessary upgrade / replacement of watercourse crossings (low).

In addition, the Director-General's Requirements issued by the then DP&I (now DPE) identified the following "Biodiversity"- related issues for coverage in the EIS.

- A detailed assessment of potential impacts of the development on any terrestrial or aquatic threatened species or populations and their habitats, endangered ecological communities and groundwater dependent ecosystems.
- A comprehensive offset strategy to ensure the development maintains or improves the terrestrial and aquatic biodiversity values of the region in the medium to long term.

Additional matters for consideration in the EIS were also provided by the EPA, NOW and NSW Fisheries in 2012. The principal matters relating to aquatic ecology that NSW Fisheries requested be addressed in the EIS include the following.

- Describe and discuss significant habitat areas within the Study Area.
- Outline the habitat requirements of threatened species likely to occur in the Study Area.
- Indicate the location, nature and extent of habitat removal or modification which may result from the proposed action.

- Discuss the potential impact of the modification or removal of habitat.
- Identify and discuss any potential for the Project to introduce barriers to the movement of fish species.
- Describe and discuss any other potential impacts of the Project on fish species or their habitat.
- Clarify and assess the actual footprint and any the impacts of any works within or near Oaky Creek.
- Identify in the water management strategies the diversion of water around the open cut pits would not cause further degradation of the waterways.
- Outline the final land use and any proposed remediation work to be carried out on final voids.
- Consider how the Project has been or may be modified and managed to conserve fisheries habitat within the Site and in the Study Area.
- In discussing alternatives to the Project, and the measures proposed to mitigate any effects of the Project, consideration must be given to developing long-term management strategies to protect areas within the Study Area which are of particular importance for fish species. This may include proposals to restore or improve habitat.
- Any proposed pre-construction monitoring plans or on-going monitoring of the effectiveness of the mitigation measures must be outlined in detail, including the objectives of the monitoring program, method of monitoring, reporting framework, duration and frequency.

The EPA's matters focused on terrestrial ecological issues although some specific issues would equally apply to aquatic ecology. The requirements identified in the DGRs or correspondence from the various agencies as they relate to aquatic ecology are addressed within this section while those pertaining to the terrestrial ecology are addressed in Section 4.12 and Biosis (2016).

Cardno Ecology Lab commenced their initial desk-based studies and reconnaissance activities within the Mine Area and wider Study Area in October 2010. Detailed field assessments were undertaken to identify existing habitats, water quality characteristics and the aquatic flora and fauna of the Study Area (**Figure 4.67**). Field assessments relating to the Mine Area and its surrounds conducted in mid-November 2010 focused on the Avon River and Waukivory and Oaky Creeks, with inspections also undertaken of Gloucester River and Mograni Creek. Fieldwork relating to the private haul road was undertaken in February 2016 and focused on the Avon River and Waukivory Creek. Cardno Ecology Lab also coordinated a study to investigate the potential occurrence of stygofauna within the groundwater beneath the Mine Area in April and May 2011. The aquatic ecology study and assessment draw heavily upon the descriptive information presented earlier in this section with respect to groundwater (Section 4.6) and surface water (Section 4.7) and the related specialist studies. Where appropriate, reference is made to relevant text or figures in those sections.

4.13.2 Survey Methodology

4.13.2.1 Introduction

Following a review of aerial photography (Google Earth images) and relevant literature regarding known or likely aquatic habitats and biota, field surveys were undertaken targeting the various features of the surface water and groundwater environment, and the habitat and biota within them.

For the purposes of the aquatic ecology study and assessment, the Study Area incorporates the general setting in which the amended Project would occur. The Aquatic Ecology Study Area has been defined as including the following aquatic surface water habitats, i.e. within defined reaches of the Avon River, Waukivory Creek, Mograni Creek, Oaky Creek, Gloucester River and ephemeral unnamed watercourses (**Figure 4.67**).

- A reach of the Avon River upstream of its confluence with the Gloucester River.
- A reach of Waukivory Creek upstream of its confluence with the Avon River.
- A reach of Mograni Creek upstream of its confluence with the Avon River.
- A reach of Oaky Creek upstream of its confluence with the Avon River.
- A reach of the Gloucester River immediately upstream and downstream of its confluence with the Avon River.
- Several small, un-named ephemeral watercourses flowing westwards into and across the Mine Area from the Mograni Range to the east.

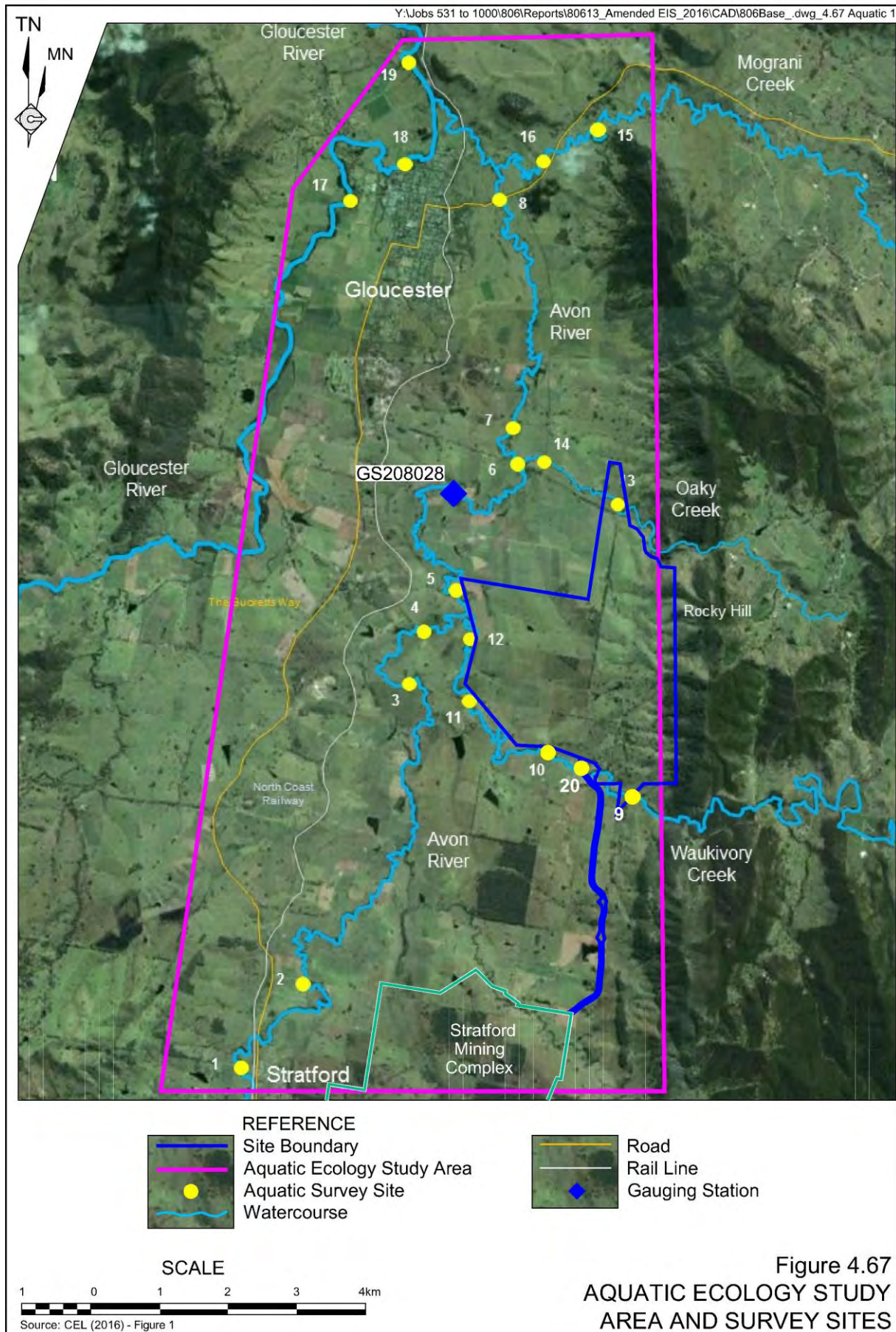
The Study Area incorporated watercourses that would and would not be potentially directly or indirectly affected by the amended Project.

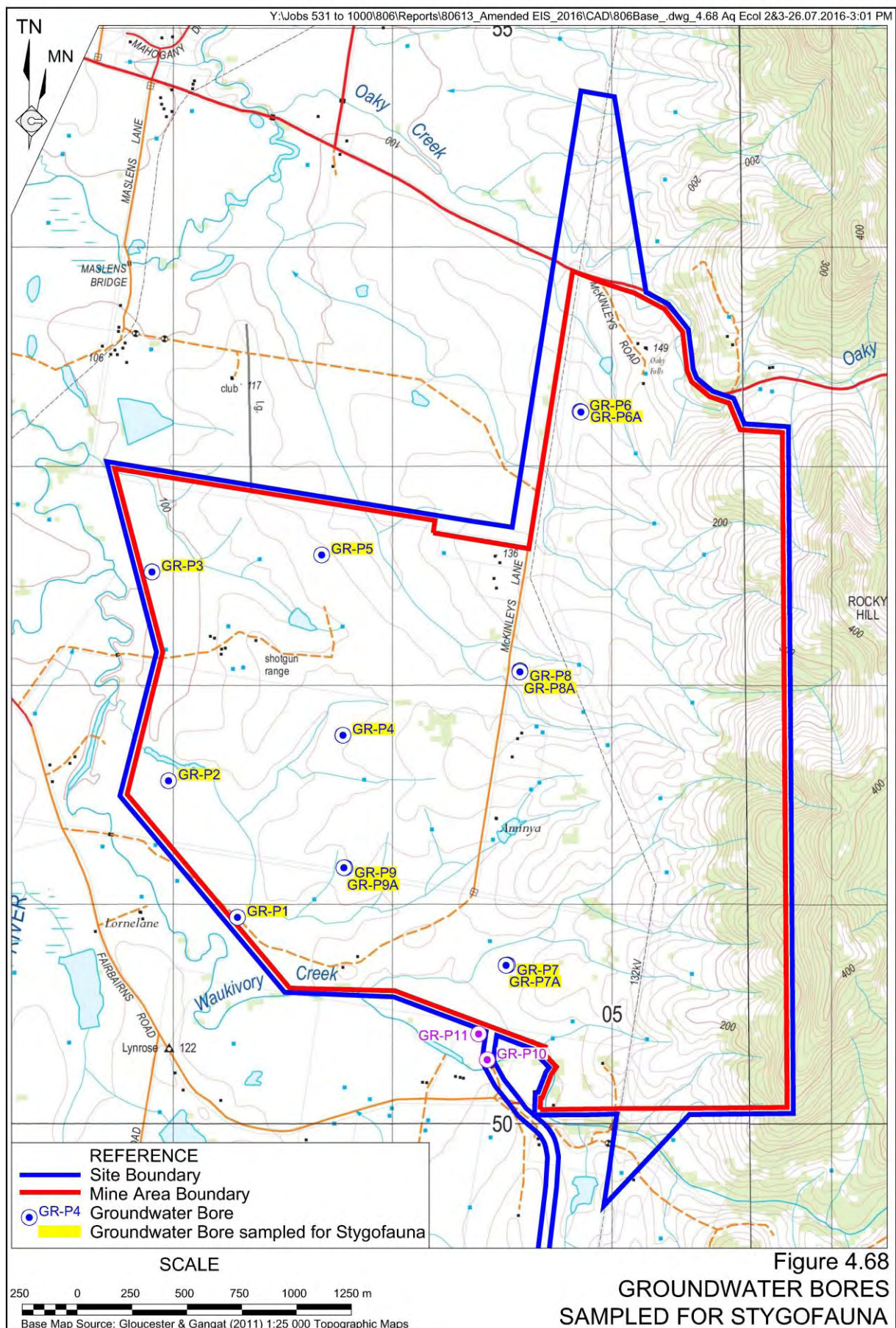
In addition to surface water, groundwater systems are associated with shallow alluvium, coal seams, interburden and regolith, all of which have the potential to be affected by the amended Project. As part of the aquatic ecological investigations, groundwater bores within the Mine Area (**Figure 4.68**) were sampled to identify the presence of macroinvertebrates that may inhabit the groundwater systems (known as stygofauna). The study of stygofauna was undertaken collaboratively between Cardno Ecology Lab (study design, project management and reporting), Carbon Based Environmental Pty Limited (collection and delivery of samples) and Macquarie University (sorting and identification of stygofauna; assistance with interpretation of data).

4.13.2.2 Literature Review

Aquatic Habitat and Biota

Many of the creeks and rivers within the Study Area have been cleared to the bank, with the few remaining strips of native riparian vegetation restricted to sections of the larger rivers, such as the Gloucester River (AECOM, 2009). Riparian habitat has also often been heavily disturbed by weeds including Camphor laurel (*Cinnamomum camphora*), Lantana (*Lantana camara*), Privet (*Ligustrum* species) and Willow (*Salix* species).





Degradation of riparian and aquatic habitat and poor water quality have impacted aquatic macroinvertebrate communities within the Study Area. This has been established through a range of previous studies including the following.

- Macroinvertebrate sampling in riffle and pool edge habitat in the Avon River (at the Jacks Road crossing) as part of a wider assessment of river health in NSW (Turak *et al*, 2000) and use of AusRivAS methods to assess the health of the Avon River reach downstream of Stratford during surveys in autumn (pool edge habitat only) and spring (pool edge and riffle habitat) in 1997. The AusRivAS assessments indicated some impairment to the aquatic macroinvertebrate community consistent with habitat degradation and poor water quality.
- A long-term monitoring program for Bowens Road North Coal Mine (within the Stratford Mining Complex) which found that macroinvertebrate communities from six sites, including two on the Avon River downstream of Stratford, were dominated by pollution-tolerant taxa indicating that water quality was “very poor” to “poor”, and that for the majority of sites and years sampled, the assemblages were moderately to grossly impaired (Invertebrate Investigations Australasia (IIA), 2009). Water chemistry, particularly Electrical Conductivity (EC) and flow levels were considered to have the greatest influence on macroinvertebrate biological diversity, with the lowest diversity recorded during periods of prolonged low flows and high EC (IIA, 2009).

Turak *et al*. (2000) surveyed three sites in the Gloucester River, two upstream of the Avon River confluence and one downstream. In contrast to the Avon River system, for all years, seasons and habitats, the Gloucester River sites were found to have healthy and rich macroinvertebrate assemblages equivalent to reference (undisturbed) conditions.

The Manning River system is relatively unusual in NSW in that all major rivers and creeks comprising the system are unregulated, i.e. their flow is not interrupted by weirs or dams. The NSW Detailed Weir Review has not identified any weirs that require remediation to restore natural flow regimes and fish passage for this system (NSW DPI, 2006a). NSW Fisheries have, however, identified five road causeways crossing the Gloucester River that may impede fish passage under low flow conditions, however these are all upstream of the Avon River confluence and would therefore have little or no effect on fish movement into the Avon River catchment (NSW DPI, 2006b). The Manning River system does not have large dams, or as far as is known, other large barriers, and hence it maintains connectivity between the watercourses throughout the Study Area and the Pacific Ocean. Numerous species of fish migrate between the upper reaches of rivers and estuaries or the sea, which potentially leads to a relatively large species richness of fishes within the Study Area. Previous surveys, published distributions and habitat requirements indicate that up to 25 fish species may be present within the Study Area, including 20 native species.

Stygofauna

Stygofauna comprise highly specialised aquatic macroinvertebrates and (rarely) some fish that are adapted to living in groundwater habitats such as groundwater systems or aquifers. The groundwater habitats within the Mine Area that may provide habitat for stygofauna include the alluvium and coal seams/interburden.

Stygofauna have been characterised as three broad groups, namely:

- stygoxenes, which occur in subterranean waters but must leave for some period(s) to complete their life cycles;
- stygophiles, which are able to live out their life cycles in subterranean or surface waters; and
- stygobites, which are obligate dwellers in subterranean waters.

Sampling of groundwater may yield all three types of stygofauna. It may also yield obligate surface dwellers, for example, where samples are taken from hyporheic habitats (the mixing zone between surface and groundwater – typically beneath or adjacent to streams). Finally, terrestrial or flying organisms may also be sampled in groundwater, when they fall into boreholes from the air or land surface.

Research on stygofauna in Australia has been relatively intensive in northern Western Australia, particularly in relation to mining activities (e.g. Pilbara region – Eberhard *et al.* 2005). Several studies in eastern Australia have identified a relatively diverse stygofauna present in alluvial groundwater systems, including sites in Queensland and the Hunter Region of New South Wales (Tomlinson and Boulton, 2010, Hancock and Boulton, 2008, 2009). In these latter studies, the greatest number of taxa were identified in bores with a low electrical conductivity (i.e. $EC < 1500 \mu S/cm$) and the richest bores (in terms of stygofauna) occurred where the water table was less than 10m below the surface and associated with alluvium of larger river systems with deep roots penetrating the saturated water of groundwater systems.

Comparative studies in New South Wales and Queensland have indicated that stygofauna in alluvial groundwater systems tend to be present in greater diversity and abundance than in coal seam groundwater systems (ALS 2010a, b and Eco Logical 2014, 2015a, b). The frequently high EC, low oxygen concentrations and limited connectivity of waters in the latter has been suggested as a cause of these depauperate assemblages of stygofauna (ALS 2010a and Eco Logical 2015a, b). As a rough guide, deep groundwater systems and/or groundwater with EC values exceeding $3000 \mu S/cm$ are thought generally to be unsuitable for stygofauna.

Threatened Species Issues for Aquatic Ecosystems

Tall knotweed (*Persicaria elatior*) is identified as a threatened species listed under both the EPBC Act and the TSC Act and may potentially occur within the Study Area. Three records of tall knotweed are known from the area around Raymond Terrace, just north of Newcastle and approximately 85km south of the Study Area. These records are confined to the Hunter River and Karuah River catchments. There are no records of this species from within the Manning River catchment. While it is possible that habitat for tall knotweed occurs within the Study Area, this may be due to OEH's definition of the species' listed habitat requirements. The listed habitat requirements are ubiquitous throughout NSW and therefore local records are appropriate determinants of the species' presence. As there are no records of this species from within the Manning River catchment, and it was not located during the fieldwork, it is therefore unlikely that this species occurs within the Study Area.

Salvinia (*Salvinia molesta*), an invasive aquatic weed of national significance (EPBC Act), was not found during field investigations throughout the Study Area. CEL (2016) noted that this species could potentially occur, or suitable habitat for it may occur, within the Study Area. It has also been declared a Class 3 Noxious Weed in the former Gloucester Local Government

Area and as such “the plant must be fully and continuously suppressed and destroyed”. Class 3 noxious weeds are plants that pose a serious threat to primary production or the environment of an area, are not widely distributed in the area and are likely to spread in the area or to another area.

Two key threatening processes pertaining to aquatic ecology are listed under Schedule 3 of the TSC Act and are relevant to the amended Project, namely:

1. alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands; and
2. predation by *Gambusia holbrooki* Girard, 1859 (Plague Minnow) *Gambusia holbrooki* is also known as mosquito fish.

Aquatic habitat protected in NSW under the Fish Habitat Protection Plan No.1 (*Fisheries Management Act 1994*) is present in the Study Area and in downstream areas. This includes, wetlands; sand and gravel substrata; reed beds and other aquatic plants; large woody debris and rocks. Section 1.2 of NSW Policy and Guidelines: Aquatic Habitat Management and Fish Conservation (Smith and Pollard, 1999; and Fairfull, 2013) requires environmental compensation (creation of new habitat of the type lost) on a 2:1 basis where a significant environmental impact on protected aquatic habitat is unavoidable.

Four key threatening processes listed under the *Fisheries Management Act 1994* are relevant to the amended Project namely:

1. degradation of riparian vegetation;
2. removal of large woody debris from NSW rivers and streams;
3. installation of in-stream structures and mechanisms that alter natural flow; and
4. introduction of fish to fresh waters within a river catchment outside their natural range.

4.13.2.3 Field Surveys

A preliminary site inspection of the Study Area focussing on the area in the vicinity of the Mine Area was undertaken on 19 and 20 October 2010 followed by more detailed field investigations of aquatic habitat, biota and water quality at sites within the Study Area between 15 and 19 November 2010 and 2 February 2016. Nineteen sites were surveyed within the Study Area during the November 2010 investigations (**Figure 4.67**) representing different sections of the watercourses of interest, and included places that may be affected by the 2013 Project or that may be able to serve as reference sites against which changes potentially attributed to the 2013 Project could be measured. The 2016 field investigations included an additional site (Site 20 – **Figure 4.67**) within Waukivory Creek, and a selection of sites previously surveyed in November 2010.

The aquatic ecology field investigations included descriptions of aquatic habitats, measurements of water quality, and assessments of aquatic biota including macrophyte (aquatic plants and algae), macroinvertebrate and fish assemblages. A number of sites were assessed for habitat and water quality only in order to characterise patterns in water chemistry throughout the Study Area. The 2016 sampling focused on describing the proposed crossing site of Waukivory Creek for the private haul road.

Stygofauna were sampled within five single and four paired groundwater bores drilled for monitoring groundwater features within the Mine Area (**Figure 4.68**). In total, 36 groundwater samples were collected from within three groundwater systems (alluvium, interburden and coal seams) on three occasions from April to May 2011. Eleven samples were collected from groundwater within the alluvium, 15 samples from the interburden and 10 samples from the coal seams. The total volume of water pumped was recorded and water samples were taken concurrently for measurement of water quality indicators.

Section 4.2 of CEL (2016) provides a detailed description of the methods used during the field surveys.

4.13.3 Survey Results

4.13.3.1 Introduction

Given there are no significant barriers to fish movement (e.g. weirs) between the Avon River/Waukivory Creek and the Pacific Ocean, the Avon/Waukivory system should support a relatively diverse fish fauna, including migratory species, such as eels (which were observed by CEL staff) and Australian bass (*Macquaria novemaculeata*). However, the condition of the various watercourses within and adjacent to the Site was assessed as having limited value as habitat for native fish, with mosquito fish (an introduced pest species) observed in the main watercourses and one farm dam within the Mine Area.

A standardised description of adjacent land and condition of riverbanks, channel and bed was recorded using the “Riparian, Channel and Environmental Inventory” (RCE), developed by the EPA, a method used to scale and quantify the environmental state of particular locations based on surrounding land use, geomorphology, channel bed forms, and riparian and instream vegetation. The highest possible score (52) is assigned to streams with no obvious physical disruption while the lowest score (13) is assigned to heavily disturbed streams. Additionally, the potential to provide fish habitat was graded according to criteria developed by the NSW Fisheries.

Table 4.76 provides the RCE Score and Fish Habitat Classification for each survey site. The following subsections provide descriptions of the condition and water quality of the watercourses, and results of biota surveys.

4.13.3.2 Avon River

Condition

The Avon River recorded poor to moderate RCE scores (**Table 4.76**) and was classified as moderate fish habitat following both the 2010 and 2016 field investigations. The sites within the Avon River with the highest RCE scores had wider and more complete riparian habitat, although the vegetation was often dominated by exotic trees, pasture grasses and annual weeds. The riparian zone along the Avon River had been heavily degraded and clearing of vegetation had led to bank erosion and invasion by exotic plant species. The channel was dominated by long pool sections but cobble/pebble riffle habitat was only observed at Site 6 (**Figure 4.67**). With the exception of this riffle, sand and silt comprised the dominant channel substrata. There was an increase in RCE score at Site 2, 5 and 6, a slight decrease at Site 4 but no change to fish habitat classification following the 2016 field investigations.

Table 4.76
RCE Score and Fish Habitat Classification within the Study Area

Site*	Watercourse	RCE Score	Fish Habitat Classification	Electrical Conductivity (µS/cm)	pH	Dissolved Oxygen (% sat.)	Turbidity (NTU)
ANZECC (2000) limit:				125 - 2200	6.5 – 8.5	85 - 110	6 - 50
2010 Field Investigations							
1	Avon River	27	2	↓	✓	↓	↑
2	Avon River	30	2	↓	✓	↓	↑
3	Avon River	27	2	✓	✓	↓	✓
4	Avon River	32	2	✓	✓	↓	↑
5	Avon River	25	2	✓	✓	↓	↑
6	Avon River	30	2	✓	✓	↓	↑
7	Avon River	27	2	✓	✓	↓	↑
8	Avon River	32	2	✓	✓	↓	↑
9	Waukivory Creek	34	2	↓	✓	↓	↑
10	Waukivory Creek	31	2	✓	✓	↓	↑
11	Waukivory Creek	29	2	✓	✓	↓	↑
12	Waukivory Creek	28	2	✓	✓	↓	↑
13	Oaky Creek	29	3	✓	✓	↓	✓
14	Oaky Creek	18	3	✓	✓	↓	✓
15	Mograni Creek	27	2	✓	✓	↓	↑
16	Mograni Creek	26	2	✓	✓	↓	↑
17	Gloucester River	34	1	↓	✓	↓	✓
18	Gloucester River	40	1	↓	✓	↓	✓
19	Gloucester River	31	1	✓	✓	↓	↑
2016 Field Investigations							
2	Avon River	32	2	↑	✓	↓	✓
4	Avon River	31	2	↑	✓	↓	✓
5	Avon River	31	2	↓	↓	↓	✓
6	Avon River	31	2	↑	✓	↓	✓
20	Waukivory Creek	44	2	↑	✓	↓	↓
Notes:							
* See Figure 4.67 for Site Locations.							
Fish Habitat Classification: 1-Major fish habitat, 2-Moderate fish habitat, 3-Minimal fish habitat and 4-Unlikely fish habitat.							
Water Quality Limits: ↑-above ANZECC (2000) (upper limit), ↓-below ANZECC (2000) (lower limit), and ✓-within ANZECC (2000) (limits).							
Source: CEL (2016) - Tables 4 and 7, and Appendix 3 modified.							

Water Quality

The dissolved oxygen concentration did not meet the ANZECC (2000) threshold limits for the protection of aquatic ecosystems in lowland rivers at any of the eight Avon River sites sampled in both 2010 and 2016 (**Table 4.76**). Turbidity levels were in excess of the ANZECC limits in

2010 at seven of the eight sites sampled reflecting the increased flow from the preceding rainfall events and the degraded channel banks and riparian vegetation in the region, but was within limits at the four sites sampled again in 2016.

EC and pH values were generally within the ANZECC threshold limits. Water in the Avon River exhibited marginally higher EC values than the lower reaches of Waukivory Creek and, as a result, inflows from Waukivory Creek appeared to reduce EC in the reach of the Avon River downstream of its confluence. This pattern of relatively higher EC values in the Avon River immediately upstream of Waukivory Creek recorded in 2016 is similar to that observed in October 2010. EC values recorded during high flows on 18 November 2010 were generally lower than those recorded at the same sites on 15 and 16 November 2010 and in February 2016 as EC values tend to decrease when flows increase in a watercourse.

Macrophytes

The macrophyte communities in the Avon River were characterised by mat rush (*Lomandra longifolia*), Common rush (*Juncus usitatus*), Umbrella sedge (*Cyperus eragrostis*), Spotted knotweed (*Persicaria strigosa*) and the introduced Curled dock (*Rumex crispus*) on the margins of the channel wetted-width. These species are generally more common on the banks that are only infrequently inundated during elevated flows. Macrophytes more commonly found within the wetted width included the submerged Blunt pondweed (*Potamogeton ochreatus*) and Water milfoil (*Myriophyllum latifolium*), and the emergent species of Water ribbons (*Triglochin microtuberosum*). The introduced species *Sagittaria platyphylla* was also observed in the pool edge habitat at Site 5 (**Figure 4.67**).

The native macrophyte species present within the Avon River have a wide distribution and are abundant in similar aquatic habitats elsewhere.

Macroinvertebrates

Macroinvertebrate assemblages in the Avon River were moderately to significantly impaired, suggesting pollution and/or local habitat degradation. In total, 58 taxa were recorded from the eight pool edge sites sampled, ranging from 20 taxa at Site 2 to 30 taxa at Site 1 (**Figure 4.67**). Three taxa (Caenidae, Dixidae and Ceratopogonidae) recorded in Waukivory Creek were absent from the Avon River samples.

Fish

The Avon River contained moderate fish habitat and was considered a Class 2 Waterway. The watercourse contained deep pools, undercut banks, submerged woody debris and limited riffle habitat at Site 6 (**Figure 4.67**). A culvert at Site 2 created a potential low-flow barrier to fish passage, but this is well upstream of the Site.

Nine species of fish were recorded in the Avon River with four or five species recorded at most sites. Assemblages were characterised by the Long finned eel (*Anguilla reinhardtii*), small native Gudgeons and the introduced mosquito fish. Freshwater shrimp (*Atyidae*) and freshwater prawns (*Macrobrachium* sp.) were commonly caught at each site. CEL staff also received anecdotal accounts from several local residents of the presence of larger species, including diadromous fishes such as Australian bass and sea mullet (*Mugil cephalus*).

4.13.3.3 Waukivory Creek

Condition

Waukivory Creek recorded poor to moderate RCE scores (**Table 4.76**). The two upstream sites (Sites 9 and 20) (**Figure 4.67**) recorded the highest RCE scores because they had relatively intact riparian vegetation, the channel bed was dominated by pebble and cobble and the creek supported short sections of riffle habitat. Further downstream and adjacent to the Mine Area, riparian habitat was degraded or absent entirely, channel banks were steep and often heavily eroded and livestock had unrestricted water access. This channel was dominated by long pool sections and sandy silt substratum, with one small riffle observed at a vehicle river crossing at Site 10.

Several other notable features were observed at Site 20 during the February 2016 field investigations. A small timber bridge spanned the creek approximately 1m above the water level. This bridge is located on the alignment of the proposed private haul road. The width of the channel at the bridge was approximately 9m. Flood debris around the timber pylons and on the bridge deck indicated inundation of the bridge during high flows. A riffle/run sequence was observed downstream of the bridge with a large pool extending directly upstream and downstream of the bridge with a water depth of <1m. The bed of the stream was dominated by cobbles and larger rocks, with a relatively small amount of silt. The edges of the banks contained large trees, including eucalypts, casuarinas and several large, unidentified trees. The edges graded into pasture on each side of the stream. During the visit, several water dragons and a large goanna were observed.

Water Quality

Dissolved oxygen and turbidity values did not meet the ANZECC (2000) threshold limits at any of the four sites sampled in 2010 nor at Site 20 sampled in 2016 (**Table 4.76**). In 2010, turbidity levels exceeded ANZECC limits reflecting the increased flow from the preceding rainfall events and the degraded channel banks and riparian vegetation within the catchment, but were within limits during the 2016 investigations. EC and pH values were generally within the ANZECC threshold limits in 2010 but EC values were exceeded during 2016. EC values recorded in 2010 and in 2016 were consistent with those taken at the Avon River, indicating a broad-scale difference in samples taken during 2010 and 2016.

Macrophytes

Fewer macrophytes were recorded in Waukivory Creek than in the Avon River. This may be due to several factors, including the smaller river order and larger percentage of hard substratum in Waukivory Creek or the fewer sites sampled (four sites in Waukivory Creek and eight sites in the Avon River – see **Figure 4.67**). The macrophyte communities at the Waukivory Creek sites were dominated by the same taxa that characterised the Avon River assemblages, namely mat rush, umbrella sedge, common rush, water ribbons and blunt pondweed. These macrophyte species are ubiquitous and abundant elsewhere. Similar macrophytes were recorded in 2010 and 2016 within Waukivory Creek, with Site 20 characterised by *Lomandra* and small amounts of *Juncus* growing along the channel edge and fine, short algae growing on rocks within the channel, but with no observed instream macrophytes.

Macroinvertebrates

Macroinvertebrate assemblages indicated that Waukivory Creek was moderately to significantly impaired, reflecting pollution and/or local habitat degradation. In total, 39 and 28 taxa were recorded from four pool edge samples and two riffle samples respectively, ranging from 19 taxa in the Site 10 (**Figure 4.67**) riffle to 27 taxa in the Site 10 pool edge. AusRivAS analyses of the macroinvertebrate assemblages taken in 2010 indicated that both riffle and pool edge habitat of Waukivory Creek ranged from significantly impaired to equivalent to reference condition.

Random passes with sweep nets through in-stream habitat during the 2016 field investigations yielded a range of taxa, including Crustaceans (*Paratya* and *Macrobrachium*), Dragonflies (*Odonata*), Mayflies (*Ephemeroptera*) and Midges (*Chironomidae*).

Fish

Waukivory Creek has moderate fish habitat and is considered a Class 2 Waterway. It contains deep pools, undercut banks, some submerged woody debris and riffle habitat in upstream sections. A four-box culvert at Site 9 (**Figure 4.67**) would present a barrier to upstream fish passage during periods of low flow.

Six species of fish were recorded from the creek and, as with the Avon River, the fish assemblage was dominated by long finned eels, gudgeons and mosquito fish. Freshwater shrimp and freshwater prawns were also recorded at each site.

Given the suitable habitat and lack of downstream barriers to passage, many diadromous species whose natural distribution includes the Manning River catchment would be expected to occur in the sections of Waukivory Creek inspected for this investigation.

4.13.3.4 Oaky Creek

Condition

The downstream section of Oaky Creek (Site 14) (see **Figure 4.67**) was considered to be highly degraded, i.e. the riparian habitat was virtually absent, dominated instead by pasture grasses and annual weeds. Downstream of the Waukivory Road eastern crossing, the banks of the creek consisted of steep and heavily eroded bare soil. The channel bed comprised loose fine sediments that had accumulated at several points, braiding the channel and providing habitat for annual weeds.

The riparian habitat upstream at Site 13 (**Figure 4.67**) was less degraded than at Site 14, but was still substantially modified. Bank erosion at Site 13 was present but less prevalent, and the channel bed was composed primarily of cobble and pebble.

Water Quality

EC, pH and turbidity values at both sites in Oaky Creek were within relevant ANZECC thresholds for protection of aquatic ecosystems. Dissolved oxygen concentration was below the lower ANZECC threshold and EC values were greater than at Site 6 in the Avon River, just downstream of the confluence of these two watercourses. Although elevated flows in November 2010 reduced Oaky Creek EC values relative to the values recorded during the October 2010 site inspection, the pattern of increasing EC from Site 13 to Site 14 in Oaky Creek and the higher EC at Site 14 than at Site 6 in the Avon River, remained the same on both occasions.

Macroinvertebrates and Fish

Macroinvertebrates and fish were not sampled in Oaky Creek due to the presence of limited habitat. Field observations indicated that the creek provided minimal fish habitat and it was therefore considered to be a Class 3 Waterway (**Table 4.76**).

4.13.3.5 Mograni Creek

Condition

Both sites sampled along Mograni Creek (Sites 15 and 16 – **Figure 4.67**) were degraded and had relatively poor RCE scores (**Table 4.76**). Riparian habitat was generally narrow and incomplete or absent entirely. Pasture grasses and annual weeds only partially stabilised eroded banks, and livestock access was common.

Water Quality

EC and pH values were within ANZECC thresholds for the protection of aquatic ecosystems at both sites (**Table 4.76**). EC was greater in Mograni Creek than in the Avon River at Site 8, just upstream of the Mograni Creek confluence. Dissolved oxygen and turbidity values did not meet the ANZECC thresholds at either site. Mograni Creek provided moderate fish habitat and was considered a Class 2 Waterway.

4.13.3.6 Gloucester River

Condition

The three Gloucester River sites varied in habitat quality, but generally displayed relatively higher RCE values ranging from 31 to 40 (see **Table 4.76**). Upstream from the confluence with the Avon River, Site 18 (see **Figure 4.67**) had a broad and complete riparian zone, with frequent alternation of riffle and pool habitat and little accumulation of loose sediments. In contrast, riparian vegetation was absent from large sections of the river downstream of the Avon River confluence at Site 19, as erosion was severe and bank collapses were prevalent.

Water Quality

At Sites 17 and 18 (**Figure 4.67**) (upstream of the Avon River confluence), pH and turbidity values were within ANZECC thresholds and the mean EC value was just below the ANZECC lower limit. Downstream of the confluence at Site 19, the EC values were slightly greater (but within ANZECC limits) and turbidity levels exceeded the upper ANZECC limit. Dissolved oxygen levels at all three sites were outside the ANZECC threshold limits.

The Gloucester River provided major fish habitat and was considered a Class 1 Waterway (**Table 4.76**). Anecdotal accounts received during field studies indicated the presence of freshwater catfish (*Tandanus tandanus*) and larger diadromous species (e.g. Australian bass and sea mullet) within the Gloucester River.

4.13.3.7 Unnamed Watercourses within and adjacent to the Mine Area

Site Locations and Condition

Five unnamed watercourses and two dams were surveyed within and adjacent to the Mine Area during the October 2010 site inspection.

All unnamed watercourses surveyed were ephemeral and drained into the Avon River or Waukivory or Oaky Creeks. In terms of quality of aquatic habitat, the watercourses were considered to be degraded, often consisting only of an indistinct channel that had been colonised by pasture grasses. Further, they were considered unlikely to provide fish habitat (Class 4 Waterways). Water would pool occasionally in some watercourses, e.g. in association with single pipe culverts or crossings across McKinleys Lane, which supported low-diversity macrophyte assemblages dominated by Cumbungi (*Typha orientalis*) which is tolerant of low flows. The EC values within these ephemeral pools were often higher than the other watercourses within the Study Area.

Two small dams were inspected on the most southern unnamed watercourse, approximately 250m east of Waukivory Creek Site 11 (**Figure 4.67**), on the creek floodplain within the Mine Area. Both dams were in open pasture and had been degraded by livestock. Common rush, pasture grasses and cumbungi fringed the pond edges and dense duckweed blanketed much of outer wetted width. Water milfoil, a macrophyte, and mosquito fish were abundant and dominant in the two dams inspected. Three further dams were present on this watercourse upstream of McKinleys Lane. At the time of the site inspection, access to these dams was not possible. Observations from the roadway and Google Earth indicated that the dams supported similar artificial and degraded lentic (still water) habitat and biota compared with those dams surveyed downstream.

All watercourses and dams within the Mine Area had low ecological value with regard to the relevant aquatic species identified and it was not considered necessary to include further sampling in the field assessment.

4.13.3.8 Stygofauna

Bore Depths and Water Chemistry

Water samples were collected from bores within the three groundwater systems within the Mine Area, i.e. from the:

- alluvial groundwater system at approximately 10m below ground level on average;
- interburden groundwater system at approximately 33m depth; and
- coal groundwater system at approximately 77m depth.

The average volume of water per sample ranged from about 35L (interburden) to 38L (alluvium and coal seams). EC values were generally high but variable, ranging from 1 240 μ S/cm to 7 690 μ S/cm. pH values were also variable, ranging from 6.19 to 11.90 pH units and were fairly constant across all samples with the exception of borehole GR-P6A which was highly alkaline. Mean EC values were generally high across all boreholes, but were variable, even within different groundwater systems, ranging from 1240 μ S/cm to 7690 μ S/cm.

Invertebrates

In total, 432 individuals from nine invertebrate taxa were collected during the survey. A broad breakdown of the collections from the various groundwater systems yielded the following information.

- Alluvial groundwater system – 384 individuals from five taxa (including 350 individuals of one phylum (Nematoda) on one occasion).
- Interburden groundwater system – 44 individuals from nine taxa.
- Coal groundwater system – 4 individuals from three taxa.

Nineteen of the 36 samples did not contain any invertebrates. Of the 17 samples containing invertebrates, eight contained terrestrial (winged) taxa or Collembola, which are not aquatic. The remaining nine samples contained a mixture of Acarina (mites), Nematoda (roundworms) and Oligochaeta (segmented worms). These taxa may occur in both soil and groundwater habitats and may be derived from either and hence are not considered to be stygofauna.

The mites (Acarina #1 and #3) were eyeless and lacking pigment, common traits of groundwater fauna, but these features can also occur in soil fauna. Crustaceans such as Copepoda, Amphipoda and Syncarida, which are considered to be obligate groundwater taxa, were not found in any of the samples. Acarina #1 occurred in one of the alluvium bores (GR-P3) during all three sampling periods and in one of the interburden bores (GR-P5) on the third sampling occasion. Acarina #3 was sampled from GR-P5 during the first two sampling periods and on each occasion both these bores had EC values above the level considered optimal for stygofauna (i.e. GR-P3: range 3610 – 3930 μ S/cm and GR-P5: 3680 – 4050 μ S/cm).

4.13.4 Potential Impacts on Aquatic Ecology

Sections 4.6 and 4.7 address groundwater and surface water impacts associated with the amended Project, respectively.

With the following minor exceptions, there would be little physical interaction between the Avon River, Waukivory and Oaky Creeks and the amended Project.

- A slight impingement upon part of the western and northern amenity barrier on the 1:100 year floodplain of the Waukivory Creek.
- The entry points of the clean water diversion channels into Waukivory Creek and Oaky Creek.
- The construction works proposed during the replacement of the bridge crossing of the Avon River at Jacks Road, all or part of which would be likely to occur at the same time irrespective of the amended Project.
- The bridge crossing of the private haul road at Waukivory Creek.
- The periodic release of water from sediment dams¹ within the Mine Area that satisfies discharge criteria, i.e. contributing to maintaining environmental flows (subject to conditions of the Site's environment protection licence).
- The re-location of the 132kV power line and the construction of the new 11kV power line.

¹ Note –Sediment dams would not be located within the saline water zone within the Mine Area.

Surface Water

WRM (2016) undertook a range of studies on watercourses within and adjacent to the Mine Area, including of geomorphology, flooding issues and water quality. The following potential impacts, relevant to the aquatic ecosystems of the Avon River and Waukivory and Oaky Creeks were considered in these assessments.

- The southern section of the western and northern amenity barrier of the Mine Area would impinge slightly on the 1:100 year floodplain of Waukivory Creek² but also prevent any flood waters from the Avon River and Waukivory Creek from entering the area of disturbance caused by mining.
- Existing water quality was assessed as being moderate compared against 95% protection levels for aquatic ecosystems, as listed by ANZECC (2000). Potential impacts to downstream water quality are discussed in Section 4.7.5.4 and were assessed for each of the three water management zones, with WRM (2016) noting the following.
 - Water captured within the saline water zone would be used within the Mine Area or treated within an on-site water treatment plant resulting in negligible risks of impact to nearby watercourses.
 - Water captured within the dirty water zone would be managed so that it is of suitable quality before its release to the downstream watercourses.

In summary, the quality of any water released to the Avon River and Waukivory and Oaky Creeks would be comparable to, or of higher quality, than that of surface water runoff elsewhere within the Avon River or Waukivory Creek catchments.

- The Site Water Balance established that all site water demands would be supplied using water captured from the saline water zone, recognising the following.
 - During the early stages of development of the open cut pits, groundwater inflows may not be as high as predicted and it may be necessary to draw supplementary supplies from the Avon River Water Source, relying upon GRL's water access licences (WALs).
 - The volume extracted would not exceed GRL's entitlement, which equates to 267 ML/yr.
- Runoff intercepted in the saline water zone would represent a small loss (between 0.2% and 1.4% over the life of the amended Project) from the receiving water catchment. Section 4.7.5.2 provides further information on the impacts of the amended Project to downstream flows.
- During operations, overburden emplacements would experience enhanced infiltration until they are topsoiled and vegetated. This would cause a reduction in runoff from the overburden areas until the surfaces are sufficiently stabilised. Once the final landform is established and vegetated, runoff characteristics would be similar to the pre-mining condition.

² The section of the barrier adjacent to the Avon River is above the 1:100 year flood level.

- Flood modelling by WRM (2016) predicted a reduction in the local catchment areas draining through the Mine Area and an increase in catchment draining to Oaky Creek due to the redirected flows from the northern diversion channel. Flood level impacts in the Avon River and Waukivory Creek would be restricted to areas immediately adjacent to the western and northern amenity barrier due to a minor reduction in the width of the floodplains caused by the positioning of the toe of this barrier. Flooding impacts are predicted to be minor (WRM, 2016), with a maximum localised difference of up to 0.1m in two small areas adjacent to the western and northern amenity barrier and between 0.5m and 1.0m within 100m of the private haul road crossing of Waukivory Creek. Flood velocity impacts in the Avon River and Waukivory Creek would be restricted to areas immediately adjacent to the western and northern amenity barrier, with maximum differences of approximately 0.4 m/s, and immediately downstream of the private haul road crossing of Waukivory Creek, with differences of up to 3.0m/s. Section 4.7.5.5 provides further detailed discussions regarding flood flows.
- WRM (2016) predicted that there would be no significant impacts on the geomorphic stability of channels of the Avon River or Waukivory Creek. Oaky Creek would be subject to an increased risk of bank erosion during flood events due to the increased flows but this increased risk would still be small and have no impact on the geomorphic stability of Oaky Creek.

Groundwater

Predictive modelling by AGE (2016) assessed impacts of the amended Project on the base flow recharge of the alluvial groundwater system. Modelling indicated a minor decrease in the transfer of saline water from the Permian rock units (and coal) to the alluvial groundwater system, with the greatest decrease occurring in Year 11. This flow would result from drawdown within the Permian system, with the water remaining within the Permian strata. Once mining ceases, the groundwater within the Permian rock units would begin to re-pressurise, with 95% recovery occurring within 5 years and almost complete recovery within 10 years of cessation of coal extraction. AGE (2016) suggested that the minor loss of water to the alluvial groundwater system from the Permian system did not warrant any mitigation measures. Further it is noted that the losses would be accounted for through the water access licences / entitlements held by the Applicant. Additional bores would be installed to monitor groundwater conditions during mining operations because ten of the existing bores in the Mine Area would be progressively removed during mining (AGE, 2016).

4.13.5 Management, Mitigation and Contingency Measures

The key management, mitigation and contingency measures required to retain or improve the aquatic ecological values of the watercourses in the vicinity of the Mine Area relate principally to the management of surface water and groundwater.

A comprehensive range of surface water and groundwater and surface water-related management and mitigation measures would be incorporated into the amended Project to mitigate its potential impacts (see Sections 4.6.6 and 4.7.4). Given both the surface water and groundwater assessments conclude that the likelihood of impacts would be minimal, no further

direct mitigation measures are proposed to protect or manage the native aquatic ecology in the vicinity of the Mine Area. However, CEL (2016) identified one species of invasive fish (mosquito fish) and two invasive weed species (*Sagittaria* and *Salvinia*) requiring management. These species would be managed in accordance with an approved Biodiversity Management Plan which would include sections on invasive species management and weed management. This would ensure that these invasive species are not introduced or spread. The Biodiversity Management Plan would specifically address mosquito fish by applying the following management measures, as appropriate.

- Treatment of water prior to dewatering existing farm dams on the Mine Area to kill mosquito fish.
- Screening of pipes when releasing water to watercourses from existing farm dams.

Two bridges would be replaced as part of the amended Project.

- The existing bridge over the Avon River at Jacks Road which is currently load limited and unsuitable for use by Project-related or other heavy vehicle traffic (i.e. >15t gross vehicle mass).
- The existing bridge used to access Lot 911 DP 748573, at the location of the proposed crossing of Waukivory Creek for the private haul road.

These construction works would be undertaken in accordance with guidelines issued by NSW DPI Fisheries (Fairfull and Witheridge, 2003; NSW DPI, 2006b; and Fairfull, 2013) and a Construction Water Management Plan prepared to minimise harm to the banks and bed, riparian vegetation and water quality.

4.13.6 Assessment of Impacts

The following subsections assess the impact of the amended Project on the habitats, water quality, aquatic flora and fauna, and stygofauna following the adoption of the identified management and contingency measures.

4.13.6.1 Habitats

Modelling by WRM (2016) indicates that any changes in water flow or flooding associated with the Avon River and Waukivory Creek would not alter channel structure and therefore aquatic habitats. The reductions in flows that may result from either a minor loss of groundwater inflow to the creeks/rivers or extraction of water under licence would not be expected to lower water levels to the point where physical barriers to movement by fishes within these watercourses would be created.

The northern clean water diversion channel would increase flows into Oaky Creek and may cause erosion at pinch points along the stream between the point of entry into Oaky Creek and its confluence with the Avon River. This may occur but only during the life of the amended Project as the diversion channel would be decommissioned following completion of coal extraction, and flows within Oaky Creek would revert to pre-mining conditions.

Oaky Creek was assessed as having minimal habitat for fish at the two sites examined between the Avon River and McKinleys Lane and the limited habitats would be expected to support a relatively depauperate macroinvertebrate fauna. However, CEL (2016) reports that a small increase in flow during the life of the amended Project may have a beneficial effect on aquatic ecology. Conversely, a larger increase in flow causing erosion would increase turbidity and transport sediments downstream. Given that the risk of increased erosion would be limited to several pinch points rather than the whole section of creek downstream of the diversion channel entries, potential impacts on aquatic ecology are expected to be limited during the period of mining. Should erosion be identified in Oaky Creek as part of the stability monitoring of that creek (see Section 4.7.5.6), remediation works would be undertaken to increase the amount of dissipation or slow the flow of water through other water management structures.

The entry point of the southern clean water diversion channel into Waukivory Creek would have dissipators and erosion control measures and is not predicted to lead to erosion either in the channel or in Waukivory Creek (WRM, 2016).

Although detailed designs for the replacement bridges would be prepared prior to their construction, CEL (2016) considered that it is likely that any impacts on stream ecology within the Avon River or Waukivory Creek would be minor, given the construction works would be undertaken in accordance with guidelines issued by NSW DPI Fisheries (Fairfull and Witheridge 2003, NSW DPI 2006b, Fairfull, 2013). The replacement of the Jacks Road bridge would most likely involve fewer pylons constructed within the stream channel than the existing bridge hereby limiting stream flow restrictions. The replacement of the existing bridge over Waukivory Creek for the private haul road crossing would improve stream ecology through removal of the existing pylons with the creek channel that obstruct creek flow and collect flood debris.

4.13.6.2 Water Quality

The water management system to be adopted for the amended Project relates to both the saline and sediment-laden water. The saline water would be used within the Site or treated and used for irrigation purposes on the Applicant's adjacent landholdings and/or rehabilitation areas. Sediment-laden water would be collected in sediment dams and not released until it satisfied water quality limits specified on the Site's environment protection licence. Finally, clean water would be intercepted prior to flowing into disturbed areas, and hence would be of comparable quality as existing runoff from the eastern side of the Mine Area.

Given the range of controls incorporated into the amended Project, it is predicted that water quality associated with the amended Project would not affect the ecology of surface waters.

4.13.6.3 Aquatic Flora and Fauna

Threatened Species Issues

Database searches only identified the tall knotweed (listed under the EPBC and TSC Acts) as potentially occurring within the Study Area. Neither this species, nor any other listed species were observed during the field investigations. Three records of tall knotweed found during the database search were all specimens in the Hunter and Karuah catchments. On the basis of the investigations undertaken, it is considered unlikely that there are threatened aquatic species that could be at risk as a result of the amended Project.

Invasive Species Issues

Three invasive species do or could occur within the watercourses within or in the vicinity of the Mine Area. *Salvinia* (Class 3 noxious weed) may occur within the Study Area but was not recorded during the field investigations. *Sagittaria* (also a Class 3 noxious weed) was recorded at one site on the Avon River, while mosquito fish were recorded at seven sites, i.e. four within the Avon River and two within Waukivory Creek (including the site of the proposed crossing of the private haul road). Mosquito fish were also recorded in the one dam sampled within the Mine Area.

The key issues associated with invasive species include the need to:

- report the occurrence of some species (in this case, *Salvinia*);
- ensure that activities associated with the amended Project do not lead to the introduction of invasive species; and
- ensure that activities do not facilitate the spread of invasive species in the vicinity of the Mine Area. These issues would be addressed as part of the Biodiversity Management Plan developed for the amended Project.

Key Threatening Processes

Two key threatening processes listed under Schedule 3 of the TSC Act have been identified as potentially relevant to the amended Project (Section 4.13.2.2).

1. Alteration to natural flow regimes of rivers and streams and their floodplains and wetlands - this issue is addressed as part of the Section 4.7.5.
2. Predation by mosquito fish - this species is already widespread in the Study Area, being present in the Avon River and Waukivory Creek, and at least one dam within the Mine Area. The amended Project would, therefore, not cause the introduction of this species in the area. However, the Applicant's intention to limit its spread by implementing the measures identified in Section 4.13.5 should be beneficial or would not exacerbate the problem for the native fish within the Avon River and Waukivory Creek.

The following four key threatening processes are relevant under the *Fisheries Management Act 1994*.

- Degradation of riparian vegetation - this could potentially occur locally as a result of construction of the private haul road where it crosses Waukivory Creek; replacement of the bridge over the Avon River at Jacks Road, or bank erosion along small sections of Oaky Creek. It is assessed that with the implementation of the mitigation measures proposed in Section 4.13.5, riparian vegetation would not be degraded for the following reasons.
 - The crossing proposed for the private haul road is essentially adjacent to pasture land and would be positioned to ensure minimal damage to native riparian vegetation (especially established native trees).

- The construction of the bridge crossings would be undertaken in accordance with the guidelines issued by NSW Fisheries and be the subject of a Construction Water Management Plan to minimise harm to the river banks and bed, riparian vegetation and water quality.
- Biodiversity offsetting for the amended Project takes into account the clearing of riparian vegetation (see Section 2.16.9).
- Much of the riparian habitat along the section of Oaky Creek under consideration borders on pasture. Any erosion attributed to the increased flows in Oaky Creek would be repaired and/or riparian vegetation replanted as necessary.
- Removal of large woody debris - this would not occur under the amended Project.
- Installation of instream structures and mechanisms that alter natural flow - this would not occur under the amended Project. Rather, the bridge construction would reduce or eliminate instream structures (see Section 4.12.6.1).
- Introduction of fish to freshwaters within a river catchment outside their natural range - this would not occur under the amended Project.

Biodiversity

The habitats and aquatic communities throughout and surrounding the Site were assessed as being moderately to significantly impaired in terms of the stream condition and of moderate to poor habitat quality for fish. Notwithstanding this, the river system as a whole is significant in that there are no major barriers to movement by fishes between the Pacific Ocean and the upper sections of the Waukivory Creek and the Avon River. Eels, which are migratory, were recorded during field investigations and anecdotal evidence indicates that other migratory fishes such as Australian bass and mullet may also occur in streams adjacent to the Mine Area.

Overall, the amended Project is not expected to interfere significantly with local ecological processes nor with longitudinal connectivity (i.e. fish passage) within the system.

4.13.6.4 Stygofauna

CEL (2016) concluded that the identified terrestrial or aquatic invertebrates occurring within boreholes within the Mine Area probably entered these boreholes through the surface orifices of the boreholes. No obligate stygofauna were identified during sampling and existing literature suggests that, based on the extent of saline water beneath the Mine Area, it is unlikely that these stygofauna would occur within the Mine Area. The amended Project would result in little or no disturbance to the alluvial sediments on the floodplains outside the Mine Area. As a result, the amended Project would result in negligible impacts to stygofauna.

4.13.6.5 Cumulative Impacts

The Stratford Mining Complex has potential to interact cumulatively with the amended Project. WRM (2016) and AGE (2016) have assessed cumulative impacts of these developments with the amended Project for surface water and groundwater, respectively.

AGE (2016) undertook predictive modelling of the Stratford Mining Complex and the amended Project and concluded that there would be no cumulative groundwater impacts between the Stratford Mining Complex and the amended Project as the predicted drawdown from both sites would not overlap.

On the basis of the groundwater modelling and the survey of stygofauna described in Section 4.13.2.3, it is concluded that:

- with the small likelihood that obligate stygofauna occur within the groundwater beneath the Mine Area, any cumulative effects of the amended Project with other development in the region would not be an issue for stygofauna; and
- cumulative interactions between groundwater and surface water would have minimal impacts on the habitats or biota of the watercourses in the area.

WRM (2016) assessed the cumulative impacts of the amended Project with the Stratford Mining Complex on surface waters in two ways, namely:

1. potential cumulative impacts on stream flow loss; and
2. potential impacts on downstream water quality.

In terms of potential stream flow loss, the existing Stratford Mining Complex is estimated to cause a long term loss of catchment of 2.1km² (WRM, 2016). The predicted reduction in baseflow as a result of this reduction in catchment area was estimated to be less than 0.1ML/d (WRM, 2016).

A variety of measures have been identified to manage water quality for the Stratford Mining Complex, including incorporation of contained water storages (Gilbert and Associates cited in WRM, 2016) with a very low risk of spillages. These, along with the measures designed for the amended Project, would ensure low risk of adverse impacts to aquatic ecology from poor water quality.

The amended Project incorporates a range of measures to minimise loss of surface water, including the use of water within licence allocations, use of diversion channels and release of water from dams, whilst saline water, derived largely from groundwater, would be used on site or treated to an EC level equivalent to that of the Avon River. These measures, combined with the small losses of catchment predicted for the Stratford Mining Complex indicate that the cumulative loss of surface water would be very small and have minimal effect on aquatic habitats and biota.

4.13.7 Monitoring

While the design of the amended Project indicates that impacts to aquatic ecosystems can generally be managed through design and implementation of water management planning, it remains important that specific aquatic ecological factors are monitored throughout the life of the amended Project.

It is proposed that the monitoring program would be undertaken at a selection of the sites already sampled within the Avon River and Waukivory and Oaky Creeks and at suitable reference creeks or rivers within the region. Monitoring would be initiated prior to

commencement of construction activities to improve the existing baseline data against which any future changes can be measured in the context of natural variability. Details of the aquatic ecology monitoring would be specified in the Aquatic Fauna and Flora Management Plan.

Given the likelihood that the obligate stygofauna are not abundant beneath or adjacent to the Site, it is not proposed that a monitoring program be developed and implemented for these organisms.

4.13.8 Conclusion

Investigations within the Study Area have shown that the aquatic environment is variable in condition, water quality and biota. It has also shown that it is unlikely that substantial numbers of stygofauna are present beneath or adjacent to the Mine Area.

Given the design of the amended Project and mitigation measures proposed, adverse impacts from the amended Project on the aquatic environment are considered unlikely. Monitoring is proposed to ensure the impacts to aquatic habitats, flora and fauna are identified and appropriately managed should they occur.

4.14 BUSH FIRE HAZARD

4.14.1 Introduction

The Director-General's Requirements (DGRs) nominate that "*The EIS must detail potential hazards including bush fires and floods*". This subsection focuses upon bush fire with flooding having been addressed in Section 4.7.5.5. Based upon the risk assessment undertaken for the amended Project (Section 3.3.1 and **Appendix 6**), the potential impacts relating to bush fire and their risk rankings after the adoption of standard mitigation measures are as follows.

- Fire initiated off site threatening mine operations, impacting on-site stock and infrastructure (medium).
- Fire initiated on site threatening mine operations or spreading off site (low).

This section identifies the dominant vegetation type(s) within and in the vicinity of the Site in order to determine the potential bush fire hazard associated with the amended Project. In identifying the bush fire hazard, the document produced by the Rural Fire Service (RFS) for DP&I entitled *Planning for Bush Fire Protection* (RFS, 2006) has been used. An addendum to Appendix 3 of the *Planning for Bush Fire Protection* guideline (RFS, 2010) was prepared in May 2010 and has been used in this assessment to assess bushfire hazard and the Bush Fire Attack level. The Australian Standard (AS) 3959-2009 Construction of buildings in bushfire-prone areas was also used to assess bushfire hazard. The Gloucester Bush Fire Management Committee's "Gloucester Bush Fire Risk Management Plan" (GBFMC, 2008) has also been utilised to determine the bush fire hazard within the local region. It should be noted that there are no stipulations provided on bush fire hazard or management within the Gloucester Local Environmental Plan 2010.

The bush fire assessment was prepared by R.W. Corkery and Co Pty Limited based, in part, on information provided in Biosis (2016) and through reference to the above RFS and Gloucester Bush Fire Management Committee documents.

4.14.2 Bush Fire Management Objectives

4.14.2.1 Planning for Bush Fire Protection 2006

The objectives of RFS (2006) considered in the assessment of bush fire with respect to the amended Project, are to:

- afford occupants of any building adequate protection from exposure to a bush fire;
- provide for a defendable space to be located around buildings;
- provide appropriate separation between a hazard and buildings which, in combination with other measures, prevent direct flame contact and material ignition;
- ensure that safe operational access and egress for emergency service personnel and residents is available;
- provide for ongoing management and maintenance of bush fire protection measures, including fuel loads in the Asset Protection Zone (APZ); and
- ensure that utility services are adequate to meet the needs of fire fighters (and others assisting in bush fire fighting).

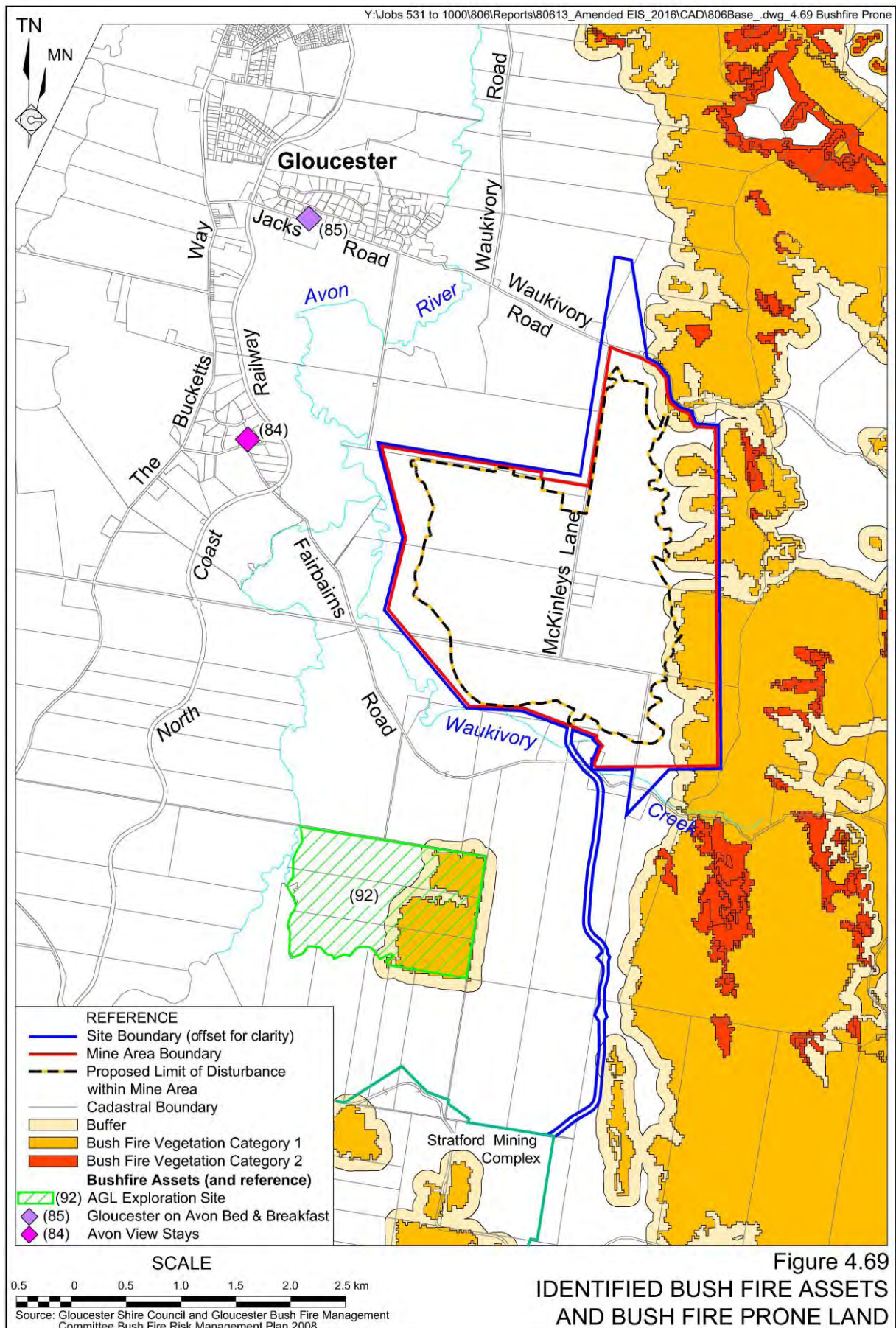
4.14.2.2 Gloucester Bush Fire Risk Management Plan

The objectives of the Gloucester Bush Fire Risk Management Plan are to:

- reduce the number of human-induced bush fire ignitions that cause damage to life, property and the environment;
- manage fuel to reduce the rate of spread and intensity of bush fires, while minimising environmental/ecological impacts;
- reduce the community's vulnerability to bush fires by improving their preparedness; and
- effectively contain fires with a potential to cause damage to life, property and the environment.

The Site is located within the GBFMC "Land Management Zone". No assets within the Site are identified within GBFMC (2008).

The closest GBFMC (2008)-identified assets to the Site on privately-owned land are the "Avon View Stays" (#84) and the "Gloucester on Avon Bed and Breakfast (#85)" (**Figure 4.69**), each of which are classed as "human settlement assets" with a medium risk ranking. The Coolibah Creek Homestead is listed in GBFMC (2008) as a "human settlement asset" (#53), however this property was purchased by the Applicant in 2010 and is no longer a tourist site.



4.14.3 Existing Bush Fire Hazard

Figure 4.69 identifies existing bush fire prone land status of the Site and surrounds as nominated in the former Gloucester Shire Council Bush Fire Prone Land Map. The mapping indicates that the majority of the Site is not bush fire-prone with the eastern margin of the Site, located on the lower slopes of the Mograni Range, partially classified as Vegetation Category 1. Small areas of buffer adjoin the areas nominated as Vegetation Category 1 near the eastern boundary of the permanent overburden emplacement and a 300m section of the private haul road. Vegetation Category 1 is considered to be the highest risk of bush fires as it has the highest combustibility and likelihood of forming fully developed fires including heavy ember production.

The results of the bush fire vegetation category zone mapping require the amended Project to be assessed against the specifications and requirements of the RFS (2006), with particular reference to the Asset Protection Zone and construction requirements.

4.14.4 Bush Fire Classification

4.14.4.1 Vegetation Classification

As identified in Section 4.12, significant sections of the Site have been cleared of large trees and shrubs and are now dominated by open, cleared grazing lands. However, some vegetated areas remain as shown in **Figure 4.65**, with the majority of the vegetated land located adjacent to unnamed watercourses and on the upper slopes of the Mograni Range to the east of the proposed disturbance area. **Figure 4.65** shows the vegetation communities as described in Biosis (2016) with the equivalent vegetation formations as described in RFS (2006) as follows.

- Community 1- Cleared Open Pasture with Scattered Trees - RFS Grasslands
- Community 2 - Dry sclerophyll equivalent (low to good condition) - RFS Dry sclerophyll forests (Open forests).
- Community 3 - Riparian - RFS Forested wetlands
- Community 4 - Rainforest - RFS Rainforest (Closed forest)

It should be noted that the vegetation community nominated by Biosis (2016) as “Cleared Open Pasture with Scattered Trees” is not a vegetation formation defined in RFS (2006) but has been designated as “Grasslands” due to the high presence of grasses and its occurrence on relatively flat topography in a region of moderate rainfall.

Within each vegetation formation, RFS (2006) assigns sub-formations (where applicable) to allow an estimate of fuel load to be calculated based upon the various vegetation types occurring within these broader groups. The vegetation formations and sub-formations are used in the determination of the bush fire hazard.

The following provides a description of the identified vegetation formations and sub-formations.

- Vegetation Community 1 – Grasslands – Dominated by large perennial tussock grasses and the presence of broad-leaved herbs in the inter-tussock spaces. Lack of woody plants. Associated with fertile heavy clay soils on flat topography in regions with low to moderate rainfall. Plants include grasses, daisies, legumes, geraniums, saltbushes and copperburrs. Maximum fuel load of 6t/ha.

- Vegetation Community 2 – Dry sclerophyll forests (Open forests) – Sub-formation 1 (Dry sclerophyll forest shrub/grass shrub sub-formation) – Dominated by eucalypts 10m to 30m tall with crowns that touch or overlap (i.e. foliage cover 20-50%). Prominent layer of hard-leaved shrubs. Infertile soils. Rainfall >500mm. Coast, tablelands and western slopes. Conspicuous presence of grasses in the understorey. Also have a significant shrub component, including a mixture of hard leaved and soft-leaved plants. Maximum fuel load of 25t/ha.
- Vegetation Community 2 – Dry sclerophyll forests (Open forests) – Sub-formation 2 (Dry sclerophyll forest shrubby sub-formation) – Dominated by eucalypts 10m to 30m tall with crowns that touch or overlap (i.e. foliage cover 20-50%). Prominent layer of hard-leaved shrubs. Understorey dominated by shrubs including waratahs, banksias, spider flowers, wattles pea flowers, gum trees, tea-trees, native fuchsias, boronias and wax flowers. Sparse ground cover comprised mainly of hard-leaved sedges. Maximum fuel load of 25t/ha.
- Vegetation Community 3 – Forested Wetlands – Restricted to riverine corridors and floodplains subject to periodic inundation. Dominated by eucalypts, tea-trees and paperbarks or sheoaks. Distinguished by presence of hydrophytes, woody plants that can live in flooded environments, e.g. sedges, rushes, buttercups, knot weeds, lignum, ferns and grasses. Found generally at low altitudes. Soils vary from peaty and semi-humic loam soils to mineral clays and sandy loams. Coast, tablelands, and inland. Maximum fuel load of 20t/ha.
- Vegetation Community 4 – Rainforest – Closed and continuous tree canopy composed of relatively soft, horizontally-held leaves. Generally lacking in eucalypts. Understorey typically includes ferns and herbs. Vines often present in canopy or understorey. Occur mainly in areas that are reliably moist, mostly free of fire and have soils of moderate to high fertility. Typically coastal and escarpment locations. Maximum fuel load of 10t/ha.

The vegetation in the vicinity of the Site is similar to the vegetation occurring within the Site as it is dominated by cleared agricultural land interspersed with woodland and open forest vegetation, predominantly along watercourses, elevated land or areas with greater topographic relief.

4.14.4.2 Slope Classification

Slopes throughout the Site typically range between 0° and 5° on the alluvial flats with slopes to the east of the Mine Area boundary often in excess of 30°. The maximum slopes within the Site within bush fire prone land vary from approximately 18° to 30°. For the purposes of the assessment, a downslope of 15° to 20° has been assumed as this is the highest slope category used in AS 3959-2009 for assessment of bush fire hazard.

4.14.4.3 Fire Danger Index (FDI)

Table A2.3 of RFS (2006) nominates Gloucester Shire LGA as occurring within the North Coast (2) NSW Fire Area which is designated a Fire Danger Index (FDI) of 80. This FDI is a number that has been determined by the NSW Rural Fire Service based upon assumed forest

fuels within certain geographical regions (usually based upon local government area boundaries). The FDI, a combination of air temperature, relative humidity, wind speed and drought, is used to determine the Fire Danger Rating on a particular day. An FDI of 1 (low-moderate) means that a fire will not burn or will burn so slowly that it can be easily controlled, whereas an FDI of 100 (Catastrophic) means that the fire will burn so fast and hot that it is uncontrollable. An FDI of 80 (Extreme) means that a fire will likely be uncontrollable, unpredictable and fast moving with flames in the tree tops and embers likely to start spot fires up to 6km ahead of the main fire.

4.14.5 Hazard Assessment

The bush fire hazard (referred to as the bush fire attack category in RFS (2010)), is calculated from a combination of the FDI, vegetation formation, the maximum slope and the proximity of construction activities to the bush fire hazard. It should be noted that the bush fire hazard assessment not only takes into account the vegetation and associated bush fire hazard within the Site, but the vegetation immediately in the vicinity of the Site and the general local area.

The infrastructure relevant to the bush fire hazard assessment includes the administration area and the ROM Pad (see **Figure 2.5**). The administration area and ROM Pad are approximately 900m and approximately 850m, respectively, from the nearest mapped bush fire prone land. In accordance with AS 3959-2009, the Bush Fire Attack level may be classed as low where the vegetation is less than 100m from the site being assessed. Therefore, the bush fire hazard for the Site is assessed to be low and it is assessed that minimal attack from radiant heat and flame would occur although some attack from burning debris is possible. Specific construction requirements at this hazard level are not warranted.

It is acknowledged that the administration area would be located within an area that contains mapped Dry sclerophyll forest (see **Figure 4.69**), although it should be noted that this area has not been mapped as bush fire prone land by the former Gloucester Shire Council. In order to manage risk associated with this vegetation, the management, mitigation and contingency measures described in the following sub-section would be implemented.

4.14.6 Management, Mitigation and Contingency Measures

The Applicant is conscious of the need to ensure adequate bush fire controls are maintained so that its activities do not increase the potential for fires on or in the vicinity of the Site. Based on the 'low' bush fire attack category throughout the Site, the following generic precautionary measures would be implemented to prevent ignition of a bush fire within the Site and to manage any fires that start within or could potentially impact upon the Site.

- In consultation with Gloucester Rural Fire Service (RFS), develop bush fire management protocols to be incorporated into a Biodiversity Management Plan for the Site. The plan would address the following.
 - Risk-based fire control and emergency system based on MDG 1032, namely the *Guideline for the Prevention, Early Detection and Suppression of Fires in Coal Mines*.

- Potential fuel sources within the proposed areas of disturbance, Biodiversity Offset Area and the remaining properties owned by GRL.
 - Mitigation Strategies for fires initiated within properties owned by GRL and those external to those owned by GRL.
 - Fire fighting equipment required on all mobile equipment, buildings and structures.
 - Training programs for all staff and contractors together with induction requirements in relation to specific fire fighting tasks and procedures and in the appropriate use of fire fighting equipment.
 - An emergency protocol and interaction with local emergency service providers.
- Regularly maintain the Mine Area access road, and any alternative emergency access roads, e.g. routes via the private bridge over Waukivory Creek, to enable safe access to and egress from the Site in the event an evacuation is called.
 - Maintain all earthmoving equipment in good working order with efficient exhaust systems and spark arrestors.
 - Ensure all mobile equipment is fitted with appropriately-sized and approved fire extinguishers suitable for the control of flammable liquid and electrical fires. All heavy machinery would be fitted with two extinguishers and all mine light vehicles fitted with one extinguisher.
 - Install approved 80 BE rated extinguishers at various locations around the Site, including at the refuelling areas, workshop, offices and amenities.
 - Maintain various items of fire fighting equipment, e.g. knapsack sprays and McLeod tools on the Site.
 - Provide training to Site personnel in relation to specific fire fighting tasks and procedures and in the appropriate use of fire fighting equipment.
 - Enforce clearing restrictions. Clearing operations would not be undertaken during periods of extreme fire danger as defined by the Bureau of Meteorology's Severe Weather Section.
 - Maintain firebreaks around the areas of activity and the Applicant's landholding as recommended by the RFS.
 - Restrict vehicle movements to defined tracks, areas and access tracks within the Site.
 - Make available suitable items of equipment for fire suppression activities in the event of a fire developing on or adjacent to the Site.
 - Ensure access to Site water storages is provided to the RFS and any reasonable assistance offered to RFS or police personnel, and follow all instructions provided by the RFS or police in the event of a local bush fire event threatening the Site.

- Require all personnel to assemble at the designated Emergency Assembly Areas, should an emergency be declared. A head count would be undertaken to confirm all Site personnel and visitors are accounted for. At this time, instructions as to specific procedures to be followed, i.e. Site protection or evacuation, would be provided in accordance with the Emergency and Evacuation Management Procedures and advice provided by the RFS.

In addition to the above safeguards, the Applicant would also regularly liaise with officers of the RFS and adjacent landowners regarding fire hazard minimisation within and adjacent to the Site. It is proposed that any on-site fire suppression activities would generally be the responsibility of, and undertaken by, trained mine site personnel, using equipment on site. However, GRL may call upon the assistance of the Gloucester Rural Fire Service under certain circumstances and in accordance with the bush fire management protocols specified in the Biodiversity Management Plan.

Management measures pertaining to spontaneous combustion are identified in Section 4.4.7.5.

4.14.7 Assessment of Impacts

Mining, sizing and ancillary activities undertaken within the Mine Area would increase the number and type of potential ignition sources within the Mine Area, although the activities would often be undertaken in areas devoid of vegetation or isolated from surrounding vegetation. Notwithstanding, the proposed management and mitigation measures, in conjunction with the nature of the activities within the Mine Area, would ensure that the potential for fire initiation and spread of fire is minimised. The increased availability of equipment for control of fires and the availability of, and accessibility to, additional water storages would also assist the control of fires in the local area, irrespective of their location.

4.14.8 Conclusion

This assessment of bush fire hazard has concluded that the amended Project would satisfy the objective of RFS (2006) and GBFMC (2008), and would minimise the risk of a bush fire hazard ignited from within the Site while effectively limiting the spread and damage from any bush fire ignited outside the Site, for example from within the lower slopes of the Mograni Range. The distance of on-site infrastructure from bush fire prone land removes the need to specifically address bush fire hazard management during construction of these items. Bush fire management would be addressed in a Biodiversity Management Plan.

4.15 LOCAL INFRASTRUCTURE AND SERVICES

4.15.1 Introduction

The Director-General's Requirements issued by the then DP&I (now DPE) requested that the EIS address the interaction between the Project and the existing and proposed power lines managed by TransGrid. This section also reviews the existing and proposed network managed by Essential Energy and the Applicant's intention for the Gloucester Airstrip.

4.15.2 TransGrid Network

4.15.2.1 Existing Network

TransGrid is the owner, operator and manager of the NSW high voltage electricity network connecting generators, distributors and major end users in NSW and the ACT, with local electricity supplies provided by Essential Energy. TransGrid maintains a 132kV power line within a 45m wide easement that traverses the eastern side of the Mine Area and is designated by TransGrid as “Line 96P”. As discussed in Section 2.10.1, the Applicant proposes to relocate Line 96P further to the east, generally beyond the proposed area of disturbance and in an area that avoids the clearing of dense remnant vegetation. **Figure 4.70** displays the existing alignment of Line 96P.

4.15.2.2 Proposed Network

As part of its responsibilities as the operator of the electricity transmission network in New South Wales, TransGrid, in collaboration with individual energy suppliers, identifies and provides for future electricity for residential, commercial and industrial requirements.

Two possible transmission infrastructure development options have been identified by TransGrid for the North Coast which broadly include:

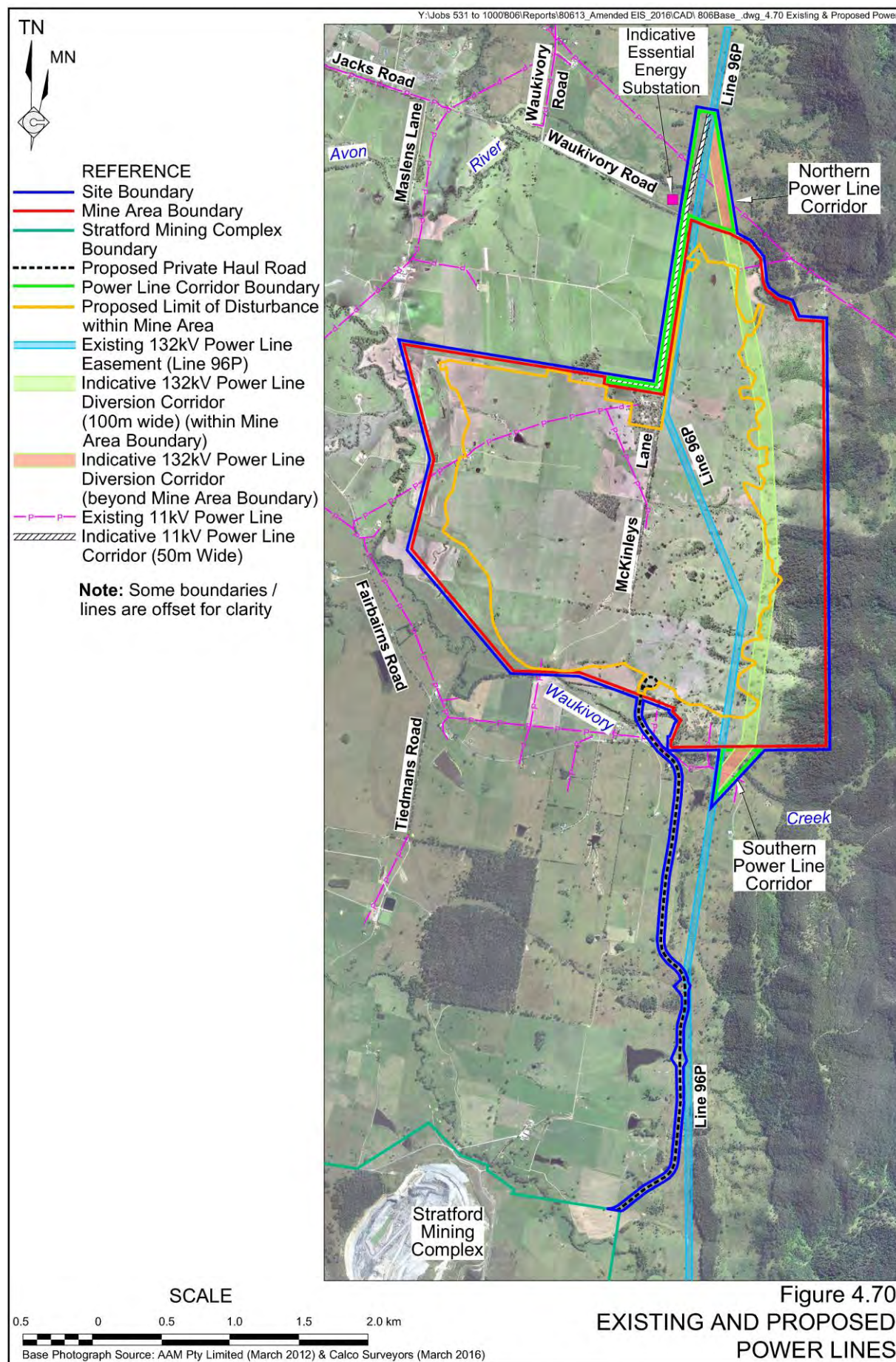
- construction of the Stroud to Lansdowne 330kV transmission line; or
- construction of the Stroud to Taree 132kV transmission infrastructure initially and 330kV transmission infrastructure later.

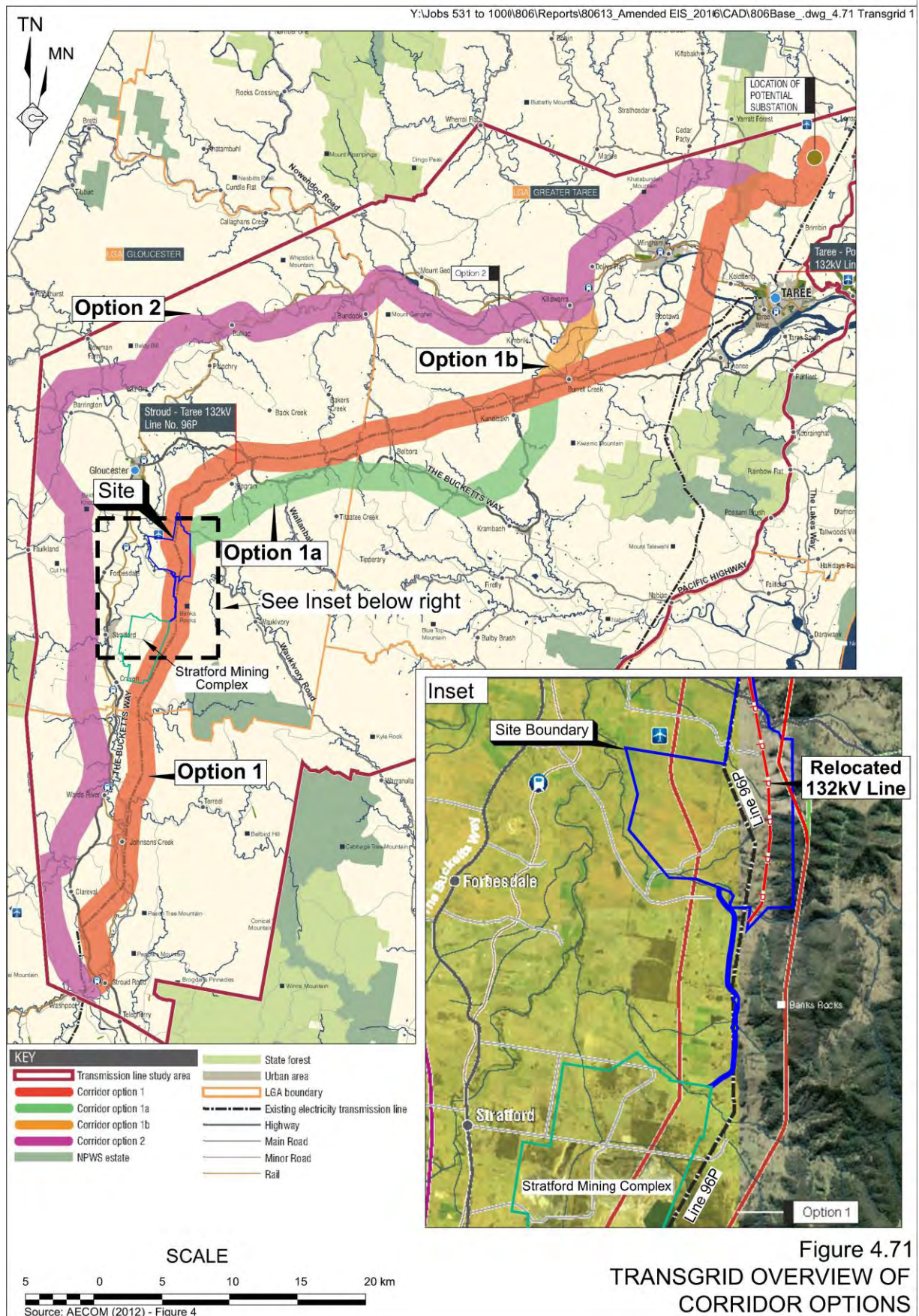
TransGrid initiated the planning of the Stroud to Lansdowne 330kV Transmission Line Project, involving the construction and operation of a new 330kV transmission line (initially to be operated at 132kV) between the Stroud Road 132kV Substation and a new substation to be established at Lansdowne, north of Taree. Preliminary environmental planning investigations were undertaken to inform the selection of a transmission line corridor and a substation site, the results of which were published in 2012 as part of the Stroud to Lansdowne Transmission Line Project: Options Selection Report (AECOM, 2012).

The Stroud to Taree 132kV Transmission Infrastructure Project would involve the construction and operation of a new 132kV transmission connection between the existing Stroud 132kV Substation and the existing Taree 132kV Substation. The new transmission line would be a double circuit, single pole configuration, likely to utilise concrete poles. The transmission poles are expected to be up to 26m in height, but may be higher where additional clearance height is required (for example, over navigable waters and major roads).

The new 132kV transmission line would require a 45m wide easement, although in locations where the transmission infrastructure would be located adjacent to existing transmission infrastructure, the co-location of easements may allow for a reduction in the total combined width of the easements.

The preferred transmission corridor route for the 330kV transmission line entitled ‘Corridor Option 1’ was tentatively decided upon and would be the subject of further analysis within an Environmental Impact Statement. Corridor Option 1, as shown on **Figure 4.71**, currently overlaps the eastern side of the Mine Area over parts of the interim and permanent out-of-pit overburden emplacements. The proposed alternate re-located 132kV power line lies within the TransGrid Option 1 Corridor.





Based on the most recent load forecast data, TransGrid has advised that the Stroud Road to Lansdowne transmission line is now unlikely to proceed until at least 2040, i.e. beyond the proposed completion date for the amended Project.

4.15.2.3 Interactions with the Amended Project

Notwithstanding TransGrid's decision to delay the Stroud to Taree 132kV Transmission Infrastructure Project, it remains a component of the amended Project to relocate Line 96P to the east of the proposed mine-related disturbances.

The proximity of the proposed re-located Line 96P to some components of the amended Project has been reviewed and the impacts of their interaction assessed. The interactions have been addressed either through design of the components within the Site to minimise or avoid adverse impacts or the adoption of a range of management practices to minimise impacts.

The proposed private haul road would be constructed to the west of proposed relocated Line 96P and closest to the line between Chainage 2 600m to 2 800m (see **Figure 2.8**). In that section, the road would be set back approximately 40m from the closest stanchion and the nearby roadside batter would be a considerable distance below the power lines themselves. Notwithstanding the preliminary design presented in this document, the Applicant would liaise regularly during the detailed design phase to ensure the access to and interaction with the Line 96P is acceptable to TransGrid.

From a soil erosion perspective, during the relocation of Line 96P, use would be made of existing tracks or those constructed by the Applicant to provide access to the eastern clean water diversion channels. Standard erosion controls would be adopted around each set of poles with any excess materials removed and placed within an overburden emplacement area within the Mine Area.

From a dust perspective, activities in close proximity to the re-located power line corridor could contribute short term elevated levels of dust. However, the level of dust suppression proposed should ensure that the amount of dust that could deposit on the conductors and the lines themselves is maintained at low and acceptable levels. Hence, no adverse impacts are expected (see Section 4.3.4.1 and 4.3.6.1).

From a vibration perspective, SLR (2016) nominates that the 50mm/sec ground vibration criterion at the power transmission poles would be satisfied at distances less than 284m, assuming a MIC of 828kg. Given the re-located 132kV line would be no closer than 700m from the nearest open cut pit (Avon Pit), no adverse blasting-related impacts are expected. Where applicable, the design of blasts would reflect the locations and vibration criterion relevant to the power lines.

The visual impacts of the re-located 132kV power line are addressed in Section 4.5.4.

The Applicant recognises that the land uses within the easement for the re-located Line 96P within the Mine Area would be restricted with vegetation growth predominantly comprising pasture grasses and low shrubs, and the need to restrict the use of earthmoving equipment beneath the power line. All safety-related issues and work practices within the easement would be agreed with TransGrid.

As noted in Section 3.2.2.3, the Applicant has undertaken extensive consultation with TransGrid regarding proposed mining operations, the necessity for the re-location of the existing Line 96P. TransGrid has previously indicated it is satisfied with the proposed corridor as shown on **Figure 4.70**, with the final details, including any required co-ordination agreement, to be determined as part of the detailed design and planning phases.

It is concluded that the re-located Line 96P would not have any adverse impacts on the existing network and it would be positioned to minimise impacts arising during activities in close proximity to the line itself.

Given the proposed delay in the construction of the dual circuit 132kV transmission line or 330kV transmission line to about 2040, there would be no interactions between the amended Project and Transgrid's proposed network.

4.15.3 Essential Energy Network

4.15.3.1 Existing Network

Essential Energy, the owner and electricity distributor of the low-voltage electricity network around Gloucester, currently maintains a series of low voltage power lines to a number of the properties within the Mine Area which are to be demolished to permit the activities within the Mine Area. The existing power supplies to those properties would be disconnected and the poles / power lines removed, and recycled, where practicable. The power lines to the existing buildings within the proposed administration area would be replaced by the new low voltage line to be constructed to service these facilities.

4.15.3.2 Proposed Network

Section 2.10.1 outlines the Applicant's plans to source power for various components within the administration area and the breaker station. The Applicant anticipates that the power for the water treatment plant, workshop and offices/amenities (within the administration area) could be sourced through the existing network or from a new substation to be constructed north of Waukivory Road. Power for the breaker station would initially be supplied via a silenced generator, i.e. until a permanent supply is provided via an upgrade of the existing service along Fairbairns Road or an extension of the line supplying the administration area. The Applicant would continue to liaise with Essential Energy to identify the most appropriate power source(s) for the various components on site.

Essential Energy are considering options for the supply of power to the Mine Area including:

- a new Essential Energy-owned 132kV / low voltage substation located beyond the northern side of Waukivory Road (see **Figure 4.70**);
- augmenting the existing network to link into the new low voltage distribution power line; and/or.
- a new low voltage overhead distribution power line to the Mine Area, generally along the route displayed in **Figure 4.70**.

A transformer/substation within the Mine Area would be located adjacent to the workshop and the water treatment plant, the main consumer of electrical power. The process for the installation of the substation, which would also potentially enable an augmented service to the township of Gloucester, has been initiated by Essential Energy with a Connection Inquiry to be lodged with TransGrid. The Essential Energy substation would be confined to an area nominally shown on **Figure 4.70**, cover approximately 1ha of exotic pasture without any identified Aboriginal heritage sites; and would be similar in appearance to many other such small stations across the Essential Energy network.

Although the Applicant has agreed to the provision of the land required for the substation, all approvals necessary for those Essential Energy facilities would be the responsibility of that authority.

The low voltage power line from the potential Essential Energy substation to the on-site power network within the administration area would be of a single pole construction, with poles typically approximately 11m high and 100m apart.

4.15.3.3 Impacts upon the Existing Network

The removal of the existing power lines and related structures would not have any adverse impact on the existing network. Small quantities of power removed from the network would not substantially impact upon Essential Energy's supply nor profitability. Rather, the proposed connection for the amended Project would result in greater quantities of power being consumed from the local network and provide Essential Energy with an additional substantial consumer of power from its network. The power consumed by the Applicant would not adversely affect any other Essential Energy consumers with a new substation, if installed to service the amended Project potentially enabling a substantial increase in the reliability of the electricity supply to the Gloucester township as a result of the direct supply from the TransGrid network.

4.15.3.4 Impacts of Substation Construction

The Applicant anticipates Essential Energy would adopt its standard construction techniques and environmental controls to avoid sediment-laden runoff from disturbed areas, hydrocarbon contamination, excessive noise or other adverse environmental impact from the construction and operation of its facility.

4.15.4 Gloucester Aircraft Landing Ground

The Gloucester Aircraft Landing Ground or the "Gloucester Airstrip" is located primarily on Lot 2 DP 234517, extending into Lot 251 DP 785579 (**Figure 1.2**) both of which are owned by the Applicant, and is provided to the Gloucester Aero Club as a service to the wider community. The Applicant also owns the parcels of land to the north of Lot 2.

The airstrip comprises a grass/dirt runway approximately 800m long and 25m wide with a 1° slope on a 170°/350° bearing. The airstrip, an authorised landing ground but not a licensed aerodrome, is suitable for general aviation light aircraft such as light single and twin engined aircraft, gliders, ultralights, helicopters and crop-dusting aircraft, and can only be used in daylight hours. The airstrip averages 5 to 10 landings per month, with landings increasing significantly on special occasions such as the annual fly-in in November, the annual gliders' week in August, pre-arranged parachute weekends and paragliding training. Special fly-ins with

nearby aero clubs such as Newcastle, Taree and Port Macquarie also occur. The airstrip is also commonly used by nearby training organisations as part of training for cross-country flying as it is a good example of an “out station” landing. The airstrip has been used for bush fire fighting fixed wing aircraft, is used once or twice per year by NPWS for helicopter winch training and is regularly used as a base for crop dusting activities in the local area.

Whilst the Applicant³ does not have any formal agreement with the Gloucester Aero Club Ltd regarding rental, maintenance, termination or closure of the airstrip, the Applicant is willing to continue to provide Gloucester and its surrounds access to leisure and agricultural aerial activities and, as such, will assist the Gloucester Aero Club in re-orientating and/or amending the positioning of the airstrip so that it can accommodate the proposed activities within the Mine Area while also meeting all aircraft safety requirements.

Figure 4.72 presents a possible option for the re-oriented airstrip. The re-orientation provides for an approximate 15° shift from the existing alignment. This indicative design is consistent with the provisions of the Civil Aviation Advisory Publication (CAAP) 92-1(1) Guidelines for Aeroplane Landing Areas which require a 900m approach and take-off area clear of obstruction and a divergence angle of 5°.

The Applicant proposes that in the event development consent is granted for the amended Project, discussions will be held with the Aero Club to progress the re-design of the airstrip with the assistance of a suitably qualified consultant.

There would be sufficient time (approximately 2 years) after a development consent is granted for the design to be completed and for the required earthworks to be undertaken (at the Applicant’s expense) to re-orientate the airstrip to ensure the 1:20 gradient approach and take off clear of obstructions is maintained.

4.16 AGRICULTURAL LANDS AND ENTERPRISES

An assessment of the interaction of the amended Project and the agricultural lands and enterprises within, adjacent to and throughout the Gloucester LGA was undertaken in conjunction with Essential Solutions Consulting. The full assessment is presented in Volume 5 Part 13 of the Specialist Consultant Studies Compendium, i.e. the amended Project’s Agricultural Impact Statement.

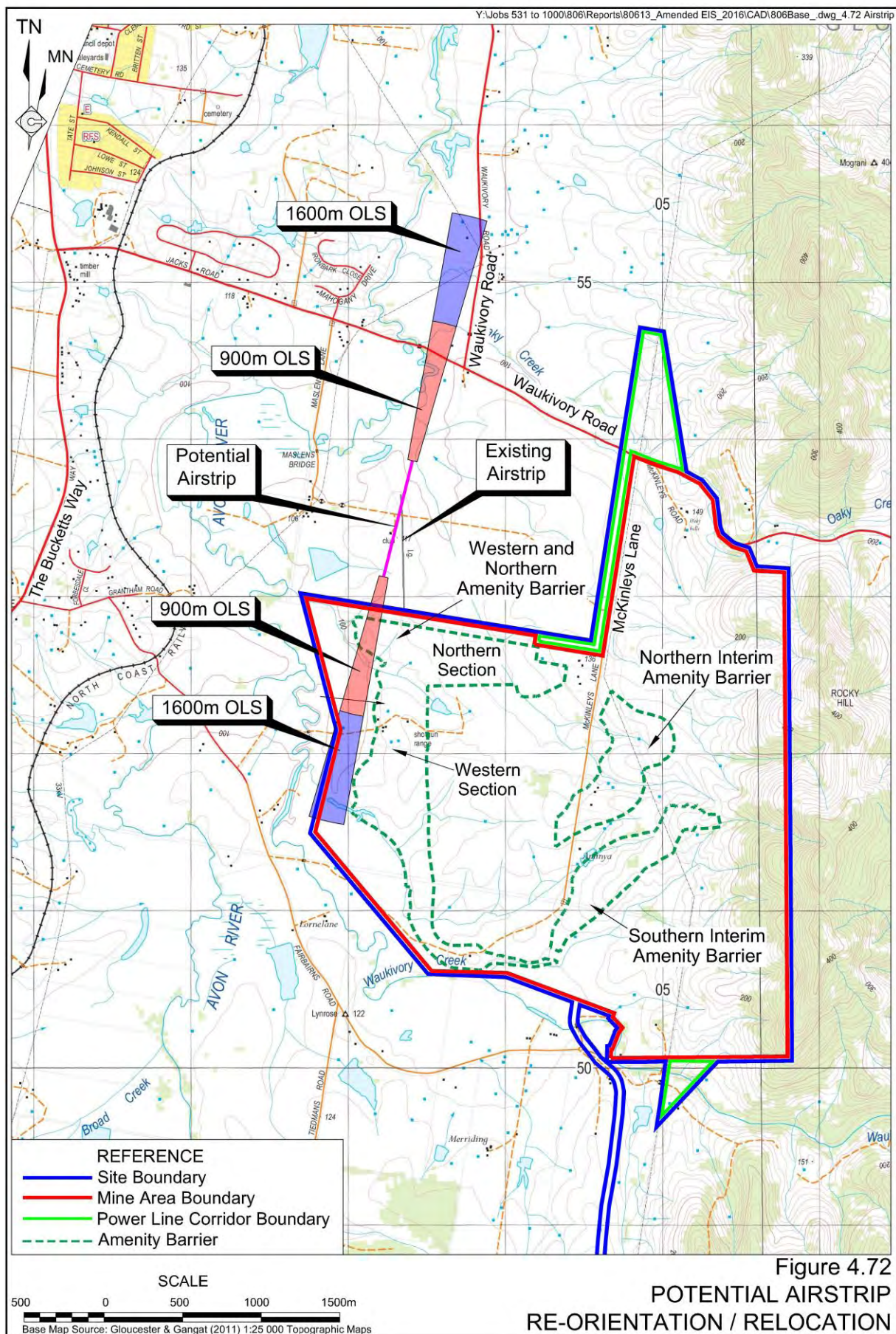
4.16.1 Introduction

Based on the risk assessment undertaken for the Agricultural Impact Statement, i.e. Table 1.2 of Volume 5 Part 13 of the *Specialist Consultants Studies Compendium*, the potential impacts relating to agricultural lands and enterprises and their risk rankings after the adoption of standard mitigation measures are as follows.

Air Quality

- Increased dust load on crops on surrounding agricultural land (low).
- Climate change impact from the amended Project, locally, regionally, and worldwide (low).

³ Neither did the former landowner have a formal agreement with the Gloucester Aero Club Ltd



Groundwater

- Reduction in baseflow in the Avon River / Waukivory Creek. Inflows between pits and alluvium and vice versa (medium).
- Discharge of poor quality groundwater / surface water from the post closure landform (medium).
- Impact on groundwater (alluvial) biota as a result of the interception of alluvial aquifers in the open cut pits (low).
- Reduced water within alluvial and non-alluvial groundwater systems (low).
- Noticeable reduction in base flow regimes in the Avon River and/or Waukivory Creek, with impacts on downstream aquatic ecology and other users, and concerns regarding alluvial groundwater systems (low).

Surface Water

- Discharge of sediment-laden water into Avon River/Waukivory Creek/Oaky Creek catchments (medium).
- Pollution of alluvial water and potentially Avon River/Waukivory Creek/Oaky Creek catchments (medium).
- Rapid discharge of saline / sediment-laden water downstream as a result of dam failure within the Avon River/Waukivory Creek/Oaky Creek catchments. Possible loss of life, damage to infrastructure (medium).
- Inability to discharge to surface water and groundwater systems without chemical or additional treatment (medium).
- Impact of chemical contamination on surface or groundwater biota within Avon River/Waukivory Creek/Oaky Creek surface water catchments and alluvial groundwater systems (low).

Soils

- Inadequate soil available for rehabilitation purposes for the Mine Area (medium).
- Degradation of soil in stockpiles leading to less successful rehabilitation and increased rehabilitation costs and maintenance in the Mine Area (medium).
- Erosion of soil stockpiles into the Waukivory Creek / Oaky Creek catchment areas (low).

Flora and Fauna

- Inappropriate maintenance/management propagates weeds on neighbouring properties and rehabilitation areas (low).
- Presence of feral animals on company-owned land due to inappropriate maintenance / management impacts on neighbouring properties (low).

In addition, the Director-General's Requirements issued by the then DP&I (now DPE) identified "Agricultural Lands and Enterprises" as key issues requiring assessment. The principal assessment matters relating to agriculture include the following.

- Assessment of land use, including agricultural, forestry, conservation and recreational use.
- Assessment of agricultural resources and/or enterprises in the local area, with particular reference to highly productive alluvial soils that may be impacted directly or indirectly, and including the following.
 - Pre-mining and post-mining agricultural assessment and mapping (including Land Capability and Agricultural Suitability mapping) of soil characteristics across all proposed disturbance areas, and an assessment of their value and rehabilitation limitations.
 - Any change in land use arising from requirements for biodiversity offsets.
 - A detailed description of the measures that would be implemented to avoid, reduce or mitigate impacts of the development on local agricultural resources and/or enterprises.
 - Justification for any significant long-term changes to agricultural resources, particularly highly productive soils⁴ potentially affected by the development.

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the DGRs from the EPA, the former Gloucester Shire Council, DRE, and the Hunter-Central Rivers NSW Catchment Management Authority. The additional matters identified in the additional correspondence are generally consistent with the DGRs.

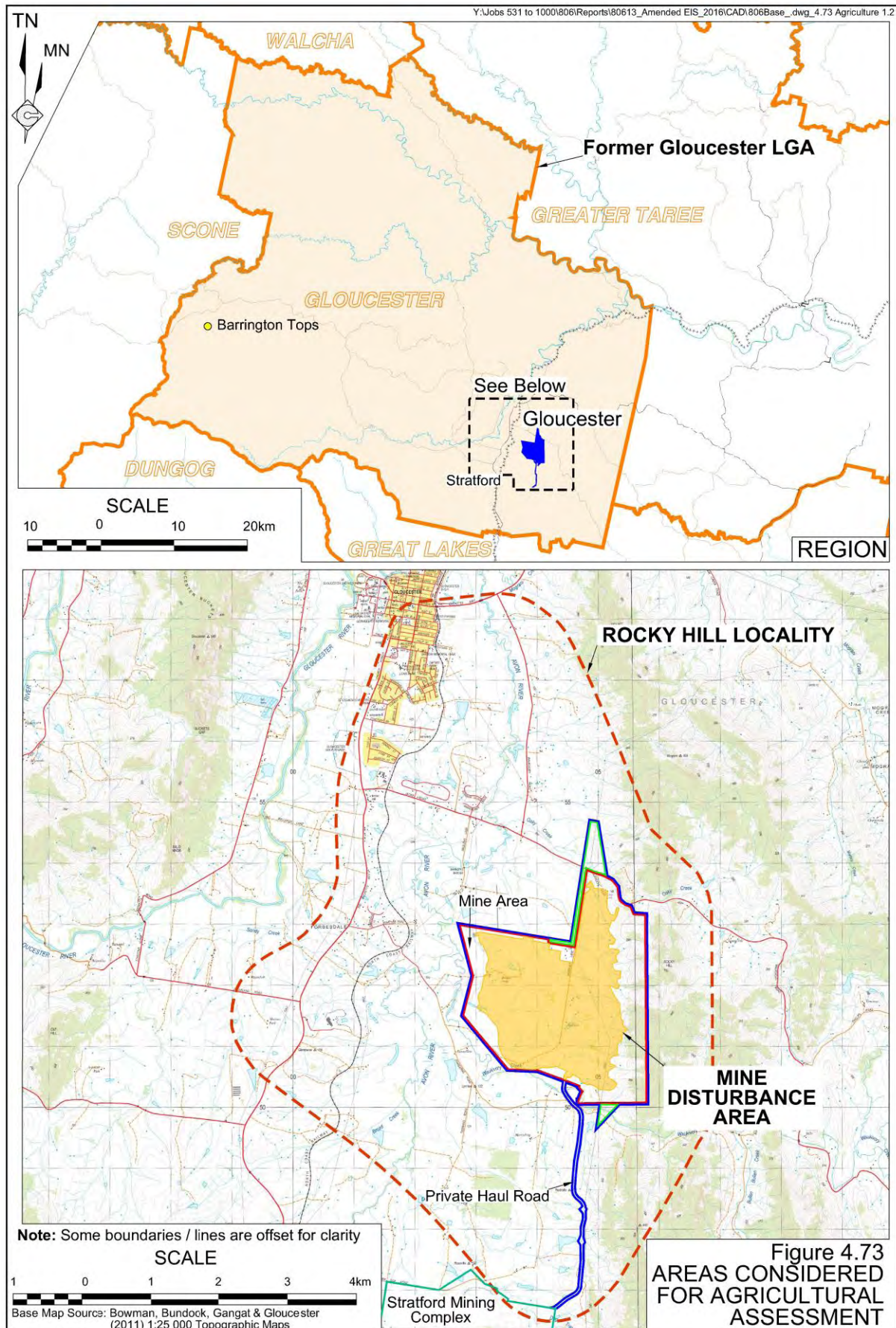
4.16.2 Agricultural Areas of Assessment

4.16.2.1 Introduction

In order to quantify and adequately assess the potential impacts on agricultural lands and enterprises as a result of the amended Project, three areas, namely the "Region", "Rocky Hill Locality" and the "mine disturbance area" were defined, as displayed on **Figure 4.73**. A further detailed discussion on each area of assessment, as well as additional, in-depth information relating to agricultural enterprises is discussed within the Agricultural Impact Statement (Volume 5 Part 13 of the *Specialist Consultant Studies Compendium*).

On 27 May 2016, the Minister for local government announced the merger of Great Lakes, Greater Taree and Gloucester Local Government Areas (LGAs) to form the Mid-Coast Local Government Area administered by the Mid-Coast Council. Given the agricultural impact assessment primarily pertains to the former Gloucester LGA, the term Gloucester Shire or Gloucester LGA have been retained throughout this subsection in order to provide a geographical context to the assessment.

⁴ It is noted that no highly productive soils are located within the Mine Area.



4.16.2.2 Regional Agricultural Setting and Agricultural Enterprises

The “Region” is geographically defined as generally conforming to the Gloucester Local Government Area (LGA), an area of 2 918km². The township of Gloucester is the major commercial and urban centre of the Region, located approximately 3.5km to 7km northwest of the Mine Area. Background agricultural information compiled for the Region shows the major regional agricultural enterprises to be dominated by the beef industry (for human consumption) and the dairy industry, with most dairies also conducting some form of beef production as part of their operations. This production may include beef cross bred calves as well as cull dairy bred cows, dairy bred steer calves and cull heifers.

Smaller, niche livestock operations also exist including goats for milk and meat, pigs and sheep for meat as well as specialised hormone free and organic beef operations. Fruit, herbs and vegetables are also grown, as well as grapes and olives and silver perch aquaculture operations including Pioneer Fish Farm. Other smaller agricultural enterprises within the Region include broad-acre crops and nurseries.

In addition to the primary agricultural enterprises, a number of tourist-based agricultural enterprises, referred to as “AgriTourism”, exist within the Region that supplement the wider Gloucester tourism industry. These AgriTourism enterprises include industries such as Bed and Breakfasts (B&Bs) and Farmstay accommodation. These agricultural and AgriTourism enterprises are serviced by the existing infrastructure, predominantly The Bucketts Way, Thunderbolts Way and the North Coast Railway, with the township of Gloucester providing numerous agriculture-related businesses.

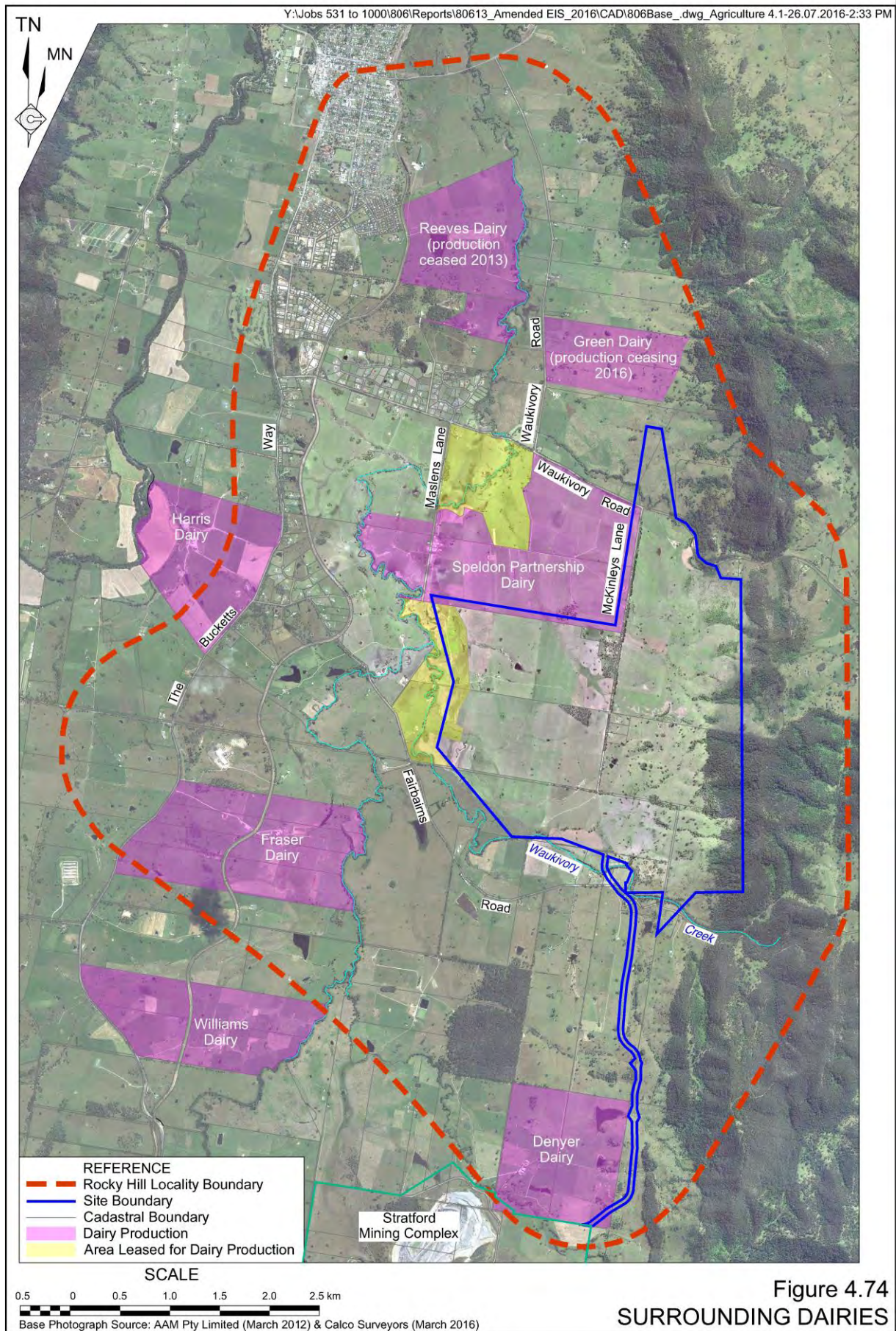
The regional AgriTourism enterprises exist primarily within the western section of the Gloucester Region but some occur within proximity to the Rocky Hill Locality, with examples such as “Earlyn”, “Ashmar Farmstays” adjacent to Waukivory Road to the southeast of the Site, along with the “Gloucester on Avon” and “Avon View” B&Bs within Thunderbolt and Forbesdale Estates respectively (see **Figure 4.9**). Further detailed information on these AgriTourism industries is discussed within the Agricultural Impact Statement (Section 2.9.3, Volume 5 Part 13 of the *Specialist Consultant Studies Compendium*).

4.16.2.3 Rocky Hill Locality Agricultural Setting and Agricultural Enterprises

The “Rocky Hill Locality” is defined as the area immediately in the vicinity of the Site as well as comprising the areas to the immediate south, west and north of the Site and including the southern extent of the township of Gloucester. The principal agricultural enterprises and operations occurring within the Rocky Hill Locality include dairying and beef operations. Jacks Road, Waukivory Road and Fairbairns Road provide the key access routes to the various enterprises and the regional transport infrastructure, with the agricultural business within the township of Gloucester acting as a focal point for the surrounding farms.

Dairy Operations

There are currently six operating dairies located within or adjacent to the Rocky Hill Locality, of which one (the Green Dairy) is due to cease production around mid-2016 (see **Figure 4.74**). The largest of the dairies within the Rocky Hill Locality (and Gloucester LGA), the Speldon Partnership dairy, is located between McKinleys Lane and Maslens Lane and has historically used 271ha of farmland on that site and grazing country elsewhere for dry cattle and heifers.



The Speldon Partnership dairy land has been purchased by the Applicant, and leased back to the former owner. Additionally, by early 2014, the Applicant had reached an agreement with the Partnership to allow grazing and fodder production to be undertaken on land within the Mine Area as well as adjoining land owned by the Applicant that will not be used for mining or mining-related purposes. This represents an increase of approximately 1 130ha of land available to the Speldon Partnership.

The Speldon Partnership's dairy is an intensive operation that involves heavy pasture improvement and, like most of the dairies in the Region, irrigates pastures at specific times. This irrigation is focussed on pasture for milking cows as well as fodder production for feeding during times of feed volume and quality shortages. The dairy had historically milked around 500 cows but that number has now increased to around 680 milking cows with the leasing of the additional land from the Applicant, making it a significant contributor to the local dairy industry.

The other large dairy within the Rocky Hill Locality is the Harris dairy, located west of The Bucketts Way immediately opposite the entrance to Fairbairns Road. The Harris dairy milks approximately 300 cows and has production levels around the local industry average. The Fraser, Williams, and Denyer dairies are smaller in scale and land size but also add significant value to the local economy.

Beef Operations

There have always been small scale beef operations within the Rocky Hill Locality, but very little of the land used for beef grazing in the area has historically been intensively developed. This is reflected in the low stocking rates in comparison to the dairy farms in the same area. The exception is the Harris property which has undergone significant pasture improvement, soil treatments and top dressing, with resultant higher stocking rates.

Other Agricultural Enterprises

There are no commercially grown fruit, vegetables, grapes or olives currently or recently grown, and no representatives of farm operations such as aquaculture, located within the Rocky Hill Locality.

Hillview Herb Farm currently operates its intensive herb farming operation adjacent to The Bucketts Way, opposite the Harris family dairy next to Fairbairns Road (see **Figure 4.74**).

The "Gloucester on Avon" and "Avon View" B&Bs are also located within the Rocky Hill Locality (see **Figure 4.9**) with "Avon View" potentially being within sight of some proposed mining-related operations, i.e. at a distance of approximately 1.7km.

4.16.2.4 Mine Disturbance Area Agricultural Setting and Agricultural Enterprises

The "mine disturbance area" as shown in **Figure 4.73** is defined as the area of land within the Mine Area that would be progressively removed from, and returned to, agricultural production over the life of the amended Project. The "mine disturbance area" also includes the area within the private haul road corridor.

The existing agricultural activities within the mine disturbance area are serviced by local roads, primarily Jacks Road, Fairbairns Road, Waukivory Road, Maslens Lane and McKinleys Lane.

Dairy Operations

There have previously been no dairy farming operations within the mine disturbance area, however, as stated in Section 4.16.2.3, the Applicant has reached an agreement with the Speldon Partnership to enable grazing and fodder production to be undertaken on land within the Mine Area and adjoining land owned by the Applicant. As a result, some of the disturbance area is now utilised to graze dry dairy cows and weaner heifers that are grown out prior to joining and subsequent usage for milk production.

Beef Operations

Prior to the Applicant's purchase of the properties within the Mine Area, no large scale commercial beef farms were in operation within the disturbance area. The various owners were generally running their own cattle on their properties or others' cattle on an agistment basis with small scale production providing a source of additional income rather than the landholders' primary source of income. Herd numbers were generally small and the intensity of land improvement works was low. Small scale grazing continued following the Applicant's purchase of the land until the Applicant divested itself of all stock and leased its land to the Speldon Partnership and others. These lease agreements, with the Speldon Partnership in particular, have resulted in an increased utilisation of the land and works to increase productivity.

Cattle continue to be run on these properties within the mine disturbance area which is identified as having a capacity for approximately 265 grown head⁵.

Other Agricultural Enterprises

There are no commercially grown fruit, vegetables or herbs currently or recently grown, with no representatives of other agricultural enterprises located within the disturbance area.

4.16.3 Agricultural Environmental Setting

4.16.3.1 Surface Water

The Site is located within the Avon River catchment that locally incorporates the Waukivory Creek and Oaky Creek catchments, with each of these watercourses lying outside the disturbance area. Both Waukivory Creek and Oaky Creek are tributaries of the Avon River, which is itself a tributary of the Gloucester River. Further downstream, the Gloucester and Barrington Rivers join, eventually feeding into the Manning River which flows eastward to the coast.

The Avon River is located within an area covered by a Water Sharing Plan (WSP), i.e. an area regulated under the "Water Sharing Plan for the Lower North Coast Unregulated and Alluvial Water Sources" (2009) with the tributaries Waukivory Creek and Oaky Creek also allocated under this plan. Water access licences (WALs) are required to extract surface water from sources within the WSP. The Applicant has acquired a sufficient number of Avon River Water Source WALs for a combined total of 267 entitlements units (1 entitlement unit is equivalent to 1ML/yr as per Avon River WSP).

⁵ Includes the 13.8ha area of private haul road 'disturbance' which equates to a capacity of 5.4 grown head of cattle.

4.16.3.2 Groundwater

The following three distinct groundwater systems occur within and in the vicinity of the Site, each displaying differing levels of yields and permeability.

- Permian coal seams and interburden.
- Shallow weathered bedrock (regolith) with associated colluvial deposits.
- Shallow alluvium associated with the floodplains of the Avon River and Waukivory Creek.

The shallow alluvial groundwater system typically follows the lower topography and comprises a sequence of silty sands, gravelly sands and clays invariably sitting on a siltstone basement and made up of 4.0m to 6.5m of mixed gravels overlain by 2m to 5m of clay and up to 1m of topsoil. The shallow groundwater follows the local topography within the Site before entering the Avon River and Waukivory Creek surface water systems.

Little use is made of groundwater within the aquifer systems for any purpose (including agriculture) within the Rocky Hill Locality, principally because of its saline nature. This is demonstrated by the fact that no groundwater bores are in use within 2km of the Mine Area.

4.16.3.3 Soils and Biophysical Strategic Agricultural Land

Soils within the Gloucester LGA are clearly interrelated with the topography and geology of the Region. A site-specific soil assessment has been completed by Geoff Cunningham Natural Resource Consultants for the Mine Area (GCNRC, 2013a) and Soil Management Designs for the private haul road (SOILmgt, 2016). Both assessments are summarised in Section 4.8.

Additional testing of soil chemistry was also undertaken to review the agricultural potential of the Mine Area and review its Biophysical Strategic Agricultural Land (BSAL) characteristics. As discussed in Section 3.2.3.5, the Site is located within the area covered by the Strategic Regional Land Use Plan – Upper Hunter (SRLUP-UH). No mapped BSAL is located within or in the vicinity of the Site and the Site is not located within a critical industry cluster. Notwithstanding that a Site Verification Certificate is not required⁶, a documented verification assessment has been undertaken (see Appendix 2, Volume 5 Part 13 of the *Specialist Consultant Studies Compendium*) which confirms the absence of BSAL within the Site. The principal parameters which excluded BSAL were slope and the depth to a physical or chemical barrier.

The soil chemistry testing also revealed that the soils within the Mine Area currently have considerable limitations for agricultural production which pose major limitations to high production without intensive land productivity intervention. These limitations include low pH, low cation exchange capacities, elevated aluminium and low to deficient calcium levels, and inadequate or grossly inadequate phosphorous levels. Similar deficiencies occur within the area of the private haul road corridor.

⁶ The Site Verification Certificate is not required as the DGRs for the Rocky Hill Coal Project were issued prior to 30 October 2013, i.e. the date the requirement for a certificate was introduced.

4.16.4 Management and Mitigation Measures

The following management and mitigation measures are drawn from a range of sources throughout this document as the productive capacity of agricultural lands relate primarily to soils, land capability, surface water and groundwater issues.

The amended Project would involve the disturbance of in situ soils, most of which would be suitable for use in the rehabilitation activities. The management measures required to ensure soils within the Site are retained and remain suitable for long-term agricultural productivity include the following.

- Appropriately stripping, storing and managing topsoils and subsoils to ensure their availability, for rehabilitation purposes and the return of the land (other than the habitat corridors) to its pre-mining level of agricultural productivity.
- Ensuring all medium to long-term soils stockpiles are constructed correctly with a cover crop introduced to reduce their potential for erosion before being utilised for rehabilitation.

Soil stripping and stockpile management practices are further outlined in Sections 2.7.2.3 and 4.8.4.

In order to create a final landform that is safe, stable and amenable to a combination of agricultural and native flora/fauna conservation activities, the Applicant would include a range of measures, including the removal and disposal of saline subsoils encountered during soil stripping activities within the Mine Area where SMU2 soils occur. During rehabilitation activities, the Applicant would:

- return both subsoils and topsoils to rehabilitated areas to re-establish a soil profile approximately 0.9m thick within the Mine Area;
- return topsoils to exposed fill surfaces along the private haul road to establish a 0.3m thick subsoil and 0.2m thick topsoil layer to stabilise the batters;
- undertake soil treatment programs to overcome the major deficiencies in the topsoils;
- return all land disturbed by mining to its pre-mining Land and Soil Capability Classes;
- retain the private haul road between Waukivory Creek and the southern Site boundary for future land uses; and
- revegetate rehabilitation areas with native trees and shrubs (where applicable) and pasture grasses.

The proposed rehabilitation measures discussed in Section 2.16 of this document would therefore return these areas to agricultural land of a form comparable with the pre-mining landscape.

The Applicant also recognises the value of water resources to agricultural production and accordingly plans to monitor its on-site water requirements, surface water make and groundwater inflows from the adjoining alluvial and hard rock aquifers, and to prevent any water contamination to the surrounding environment. Additionally, saline water accumulating on site in excess of that required for dust suppression purposes or available storage capacity

would be treated within an on-site water treatment plant with the treated water used on site or pumped to dams on the Applicant's landholdings for use in irrigating pasture and fodder production areas. It is expected that sufficient treated water would be available to irrigate between 226ha and 181ha at an annual rate of between approximately 4ML/ha and 5ML/ha. This would provide opportunities to further increase agricultural productivity on the Applicant's land during mining operations, further offsetting the temporary loss of agricultural production from the areas of mining disturbance.

Surface water within the Site would be separated and managed according to quality in accordance with an Operational Water Management Plan to ensure no adverse water quality impacts are experienced by downstream agricultural and other users. The proposed safeguards and mitigation measures are discussed in detail in Section 4.7.

As with surface water, groundwater would be managed through the Operational Water Management Plan with the proposed mitigation measures discussed in Section 4.6.

4.16.5 Assessment of Impacts

4.16.5.1 Soils and Land Capability

With the adoption of the proposed soil stripping, handling, storage and management procedures (including use of soil ameliorants) as outlined within Section 4.8.4.3, the physical (dispersibility) and chemical (acidity, salinity and elemental) attributes would result in minimal impact from a soils handling or long-term stability viewpoint, nor impact the likely success of the proposed rehabilitation and long-term land use of the Mine Area.

The existing low fertility of the soils established as a result of the soils investigation underpin the comparatively low soil and land capability value of the land within the Mine Area (Section 4.8.5). Consequently, with the addition of the proposed soil ameliorants, the agricultural value of the soils within the Mine Area would be greater than if the amended Project did not proceed.

The Applicant's amended Project would set aside at least 141ha of existing low productivity grazing land as part of its 267ha biodiversity offset package. The proposed fauna corridors on existing grazing land would also result in these areas of land (approximately 25ha) being removed long term from agricultural production. However, it needs to be acknowledged that the land within the Biodiversity Offset Area is very steep (Soil and Land Capability Class 7) and has limited value for grazing purposes. Hence, its permanent removal and that within the fauna corridors from agricultural production would not cause any substantial adverse impacts.

4.16.5.2 Water Resources

The requirement for water throughout the Mine Area during the first year of operations would be approximately 153ML for dust suppression. While this amount could be fully supplied by the Applicant's existing entitlement of 267ML/a from its five Water Access Licences, the Applicant anticipates that the majority of the water required during this period would be recovered from on-site dams and groundwater inflows to the active open cut pit. In the unlikely event that the Applicant needs to rely significantly on pumping water from either the Avon River or Waukivory Creek during Year 1 of operations, the impacts on downstream flows would be comparable to those when the former licence holders were pumping from the creek/river system.

From the beginning of the second year of activities, the predicted groundwater inflows and surface water captured within the saline water zone would be sufficient to meet the on-site requirements, thereby negating the need to pump any water from either the Avon River or Waukivory Creek. The Applicant intends to closely monitor water availability so that in the event negligible or no water is required to be pumped from the Avon River or Waukivory Creek, the Applicant can make the water available for short term use (e.g. annually) to other landholders in the Avon River catchment.

Based on the numerical modelling undertaken for the groundwater studies (AGE, 2016), it is predicted that there is unlikely to be any noticeable drawdown in the surrounding operational groundwater bores as a result of the amended Project, particularly given the absence of any operational groundwater bores within 2km of the Mine Area.

Further discussion relating to potential impacts upon surface water and groundwater resources is provided in Sections 4.6.7 and 4.7.5.

4.16.5.3 Agricultural Enterprises and Production

Beef Operations

There would be negligible impacts upon the overall total area of agricultural land available for beef grazing operations throughout the Rocky Hill Locality as the maximum area of beef grazing land removed throughout the life of the amended Project would be approximately 447ha⁷ of 108 602ha or approximately 0.4% of the total available grazing land area in the Gloucester LGA. Furthermore, the majority of the land that would be temporarily removed from agricultural use is not highly productive.

The scale of the land withdrawn and its productive capacity are considered insignificant when compared to the Region's overall production capacity. As a result, it is expected that there would be no consequential impacts on associated infrastructure or agricultural enterprises during mining operations.

Following the completion of rehabilitation, the improved soil fertility as a result of the addition of various soil ameliorants would in fact improve the long-term productive capacity of the disturbance area for its ongoing use for beef production.

Dairy Industry

As discussed in Section 4.16.2.3, in addition to the lease back of the land purchased from the Speldon Partnership, the Applicant has reached an agreement with the Partnership to enable grazing and fodder production to be undertaken on land within the Mine Area and adjoining land owned by the Applicant. This represents an increase of approximately 1 130ha of land available to the Partnership for its dairying and beef production activities. The agreement will lead to an increase in the productive capacity and financial return from that land and, based on historical production, will offset the temporary impact that the amended Project would have on productivity within the Rocky Hill Locality and the disturbance area.

To date, production rates at the Speldon Dairy have already improved significantly as a result of the leasing arrangement with the Applicant as evidenced by the increased number of dairy cows being milked, from 500 to 680, and total milk production up from 12 000 litres per day to

⁷ Includes 433ha within the Mine Area and 13.8ha within the private haul road corridor.

14 000 litres per day. This has led to increased employment at Speldon's operations of 2 additional full time employees and 5 part-time employees. Whilst this increase in dairy production will be accompanied by a small increase in heavy vehicle movements, the upgrade of local infrastructure required for the amended Project would more than adequately accommodate such increases.

Other Agricultural Enterprises

It is anticipated that no surrounding agricultural industries or infrastructure would be impacted as a direct result of the amended Project.

4.16.5.4 Agricultural-Related Socio-Economic Impacts

Agricultural Land Value

It is assessed that the value of agricultural land used commercially within the Rocky Hill Locality would be unlikely to change as a result of the amended Project. The lease agreement with the Speldon Partnership will ensure that the land within the vicinity of the Mine Area remains productive and maintains its land value. Furthermore, the Applicant would return the post-mining landform to either the existing or improved agricultural value. These and other management measures would assist to improve the productivity of the disturbance area such that productivity and the value of the land would increase, subject to other prevailing factors.

Agricultural Support Services

The Applicant has committed to the following management measures which will have direct or indirect benefits to regional agricultural support services.

- Sponsorship of three tertiary education scholarships annually and provide trade apprenticeships for local youth at the amended Project. Agriculture has been identified as one of the potential fields for recipients of their tertiary education scholarships.
- Implementation of a preferred supplier policy that utilises local suppliers and suppliers employing local people as far as commercially practicable.
- Implementation of measures to attract suppliers to relocate locally and for local suppliers to retain staff.
- Participation in the Chamber of Commerce and other business networks to monitor flow of employees from local businesses into mining.

It is anticipated that the presence of the amended Project within the local and regional areas would likely have a net positive influence in regards to agricultural support services, principally through the use of additional land and the increased productivity of the land for fodder production, cattle fattening and dairying purposes under Speldon Partnership Dairy agreement, with longer term and flow-on benefits arising from the return of land to agricultural following the mining operations.

Agricultural Employment and Labour

The potential impacts upon agricultural employment and labour as a result of the amended Project are outlined in **Table 4.77**.

Table 4.77
Production Loss/Gain and Labour Impact (Agricultural Workforce)

Industry Sector	Total Mine Disturbance Stock/Production Values	Current Gloucester Labour force	Gloucester Volumes	Labour per Unit	Potential Labour Loss / Gain
Beef	265	197	49 758 (\$12.18 mil)	1:252.6 beef cattle	-1.05 FTE
Dairy	0	169	5 341 (\$14.7 mil)	1:31.6 hd Cows	0
Support Service losses	\$184 000	40.5	\$51.9 mil	1:\$1.366 mil	-0.13 FTE
Additional stock due to intervention up to March 2016	310	197	55 100	1: 252.6 (B) 1:31.6 (D)	+1.23 FTE at beef values
Additional Service FTE from new production	\$217 000	40.5	51.9 mil	1:1.366 000	+0.16 FTE
Net Employee numbers					+0.21 FTE at beef values
* Land leased by Speldon is being used for beef and dairy production: hence calculation using beef labour rates.					
** Intervention activities on agricultural land generally take 4-5 years to reach optimal and sustainable productivity levels.					
*** Additional stock calculated as: Land leased by Speldon / current stocking rate – traditional stocking rates = 310 grown cattle					
FTE = Full-time Equivalent					
Source: Essential Solutions Consulting (2016) – Table 6.5					

Over the life of the amended Project, a maximum of approximately 447ha of agricultural land would be removed from production which, based on current carrying capacity, represents a maximum of 265 head of cattle (beef) displaced. At current average production values, the lost stock production (net) would equate to \$44,166 - \$72,080 per annum in the two most impacted years which equates to approximately one employee lost from the Beef Production Sector (1.05 FTE), 8% of an employee lost from the Production Support Sector (0.08 FTE) and 5% of a person lost from the Retail Service Sector (0.05 FTE) giving a total impact of up to 1.18 employees (see **Table 4.77**).

However, the increased volumes in dairy and beef production that have occurred up to March 2016 due to the Speldon Partnership agreement have more than offset the potential labour losses from historical beef farming operations, even during the years of maximum disturbance. Notably, with ongoing intervention, the recognition that it generally takes 4 to 5 years to reach optimal and sustainable levels, together with the supply of treated water for irrigation, the productivity of the lands subject to the lease agreement will continue to increase generating further employment.

It is also noted that the employment factor, i.e. the labour per stock unit is much higher for dairy production than beef production based upon statistics within the Region (1 full-time equivalent position per 252.6 head of beef compared to 1 full-time equivalent per 32 head of dairy cattle). As a result of this, and from the Rocky Hill Locality perspective, it has been shown that labour volumes in agriculture have grown as a direct result of this changed land use and that has led to flow-on effects which are also expected to filter into surrounding agriculture businesses. This trend has been demonstrated during the first 2 years of the agreement and the increased labour needs of Speldon based on increased production volumes, primarily with the dairy operations. The increased employment at Speldon's operations to date has included an additional 2 full time employees and 5 part-time employees, i.e. well above the projected 1.23 full-time equivalent positions based on beef labour rates.

Cumulative Agricultural Impacts

Section 6.4 of Volume 5 Part 13 of the *Specialist Consultant Studies Compendium* provides a detailed review of potential cumulative agricultural impacts. In summary, following a review of the major developments within the Region, as well as the amended Project, it was concluded that the cumulative impacts on regional agricultural lands and enterprises would be minimal, with each development subject to their own agricultural impact assessment and mitigation measures to manage their individual potential agricultural impacts. There are no other known existing or proposed major developments within the locality or Mine Area.

4.16.6 Conclusion

As the amended Project has been designed so that all land disturbed is rehabilitated to the current land and soil capability classes and the final void in the Main Pit is backfilled to overcome potential final void issues, the Applicant considers that the amended Project represents an excellent balance between the use of the land for ongoing agricultural uses and nature conservation and acceptance of mining as being a temporary land use. In particular, the increased productivity observed to date as a consequence of the partnership between the Applicant and the Speldon Partnership in terms of both its dairying and beef cattle enterprises provides a clear example how the Applicant is approaching the development of the amended Project and its co-existence with the local agricultural industry.

In summary, throughout the operational life of the amended Project there would be a marginal reduction in the availability of agricultural land within the Rocky Hill Locality and Region, but with the implementation of the proposed management and mitigation measures, along with the current agreements in place, the amended Project is likely, at worst, to have only minor, short-term adverse impacts on agricultural lands with a long-term positive net benefit on surrounding agricultural resources and enterprises.

4.17 SOCIAL IMPACTS

The social impact assessment of the amended Project was undertaken by Key Insights Pty Ltd. The full assessment is presented in Volume 5 Part 14 of the Specialist Consultant Studies Compendium and is referenced throughout this section as Key Insights (2016), with the relevant information from the assessment summarised in the following subsections. It is noted that the economic impacts of the amended Project have been separately addressed by Deloitte Access Economics Pty Ltd. Their report is presented in full in Volume 5 Part 15 of the Specialist Consultant Studies Compendium and is summarised in Section 4.18.

4.17.1 Introduction

Based on the risk assessment undertaken for the amended Project (Section 3.3.1 and **Appendix 6**), the potential impacts relating to the social and economic setting and their risk rankings after the adoption of standard mitigation measures are as follows.

- Localised negative impacts on land values and housing market (devaluation) due to mining operations (high).
- Localised negative impacts of land values and housing markets leading to rent increases (medium).

- Perception of negative health impacts on community within the surrounding residences / Gloucester LGA (high).
- Equity imbalance in wages and access to resources between miners and other sectors within the Gloucester LGA / Hunter region (medium).
- Community division over support and opposition for the amended Project within the surrounding community (medium).
- Inability of local business to compete with mining wages leading to antagonism towards the amended Project from local businesses (low).
- Stress on local services leading to community disharmony and poor relationships with the Applicant (low).
- Cumulative social impacts within the Gloucester LGA (low).
- Negative impacts on tourism and agriculture within the Gloucester LGA (low).

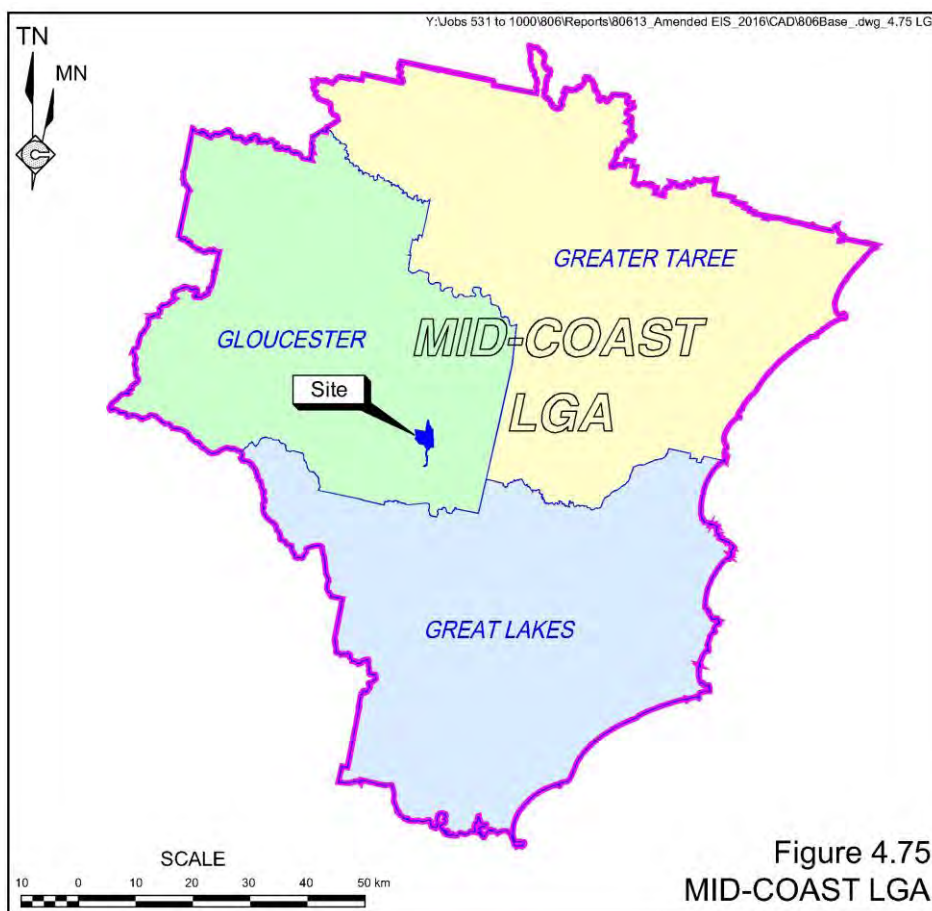
In addition, the Director-General's Requirements issued by the then DP&I (now DPE) identified "Social and Economic" issues as one of the key issues requiring assessment. The principal specific social assessment matters from DP&I include the following.

- Assessment of potential impacts on local and regional communities, including:
 - increased demand for local and regional infrastructure and services (such as housing, childcare, health, education, and emergency services); and
 - impacts on social amenity, particularly those impacts associated with residents of Gloucester, large lot residential estates on Gloucester's outskirts and nearby landowners and residents.
- Provision of a detailed description of the measures that would be implemented to minimise the adverse social impacts of the Project, including any infrastructure improvements or contributions and/or voluntary planning agreement or similar mechanism.

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the DGRs from the former Gloucester Shire Council, NSW Health – Hunter New England Local Health District, and BGSPA. The additional matters identified in the correspondence are generally consistent with the DGRs, although BGSPA requested that the social assessment address physical health, psychological health, social disruptions and property value loss. Each matter raised by the BGSPA has been addressed as part of a balanced assessment which also considers benefits to individuals and the community.

4.17.2 Regional and Local Setting

As noted previously, on 12 May 2016, the Minister for Local Government announced the merger of Gloucester, Great Lakes and Greater Taree LGAs to form the Mid-Coast Local Government Area (**Figure 4.75**). Consistent with the approach adopted in Section 4.16, and given that the social impact assessment primarily pertains to the former Gloucester LGA, the terms "Gloucester LGA" and "Gloucester Shire" have been retained throughout this section to provide a geographical context.



The Gloucester LGA covers an area of 2 918km² with the township of Gloucester being the major commercial and urban centre of the area. The Gloucester LGA also includes a number of small villages such as Barrington, Bundook, Copeland, Craven and Stratford. The Gloucester LGA is located within the Hunter Region, however, it is in a separate valley to the Hunter River and has a strong identity separate from the Hunter.

At the time of European settlement (1830 – 1840), the Gloucester – Stroud area was inhabited by the Kattang speaking peoples of the Gringai, Worimi and Kabook tribes. European settlement commenced in 1826 and had significant impacts on the Aboriginal population between the Barrington Tops and Forster through to Maitland and the Hunter River in the south as the traditional life of the Aboriginal community was replaced by a reliance on the European settlement for food and other resources. Since European settlement, the Gloucester LGA has traditionally been a timber, beef and dairy area and has a long farming history. Agriculture still accounts for approximately 17% of jobs, followed by the Health Care and Social assistance industry (approximately 11%).

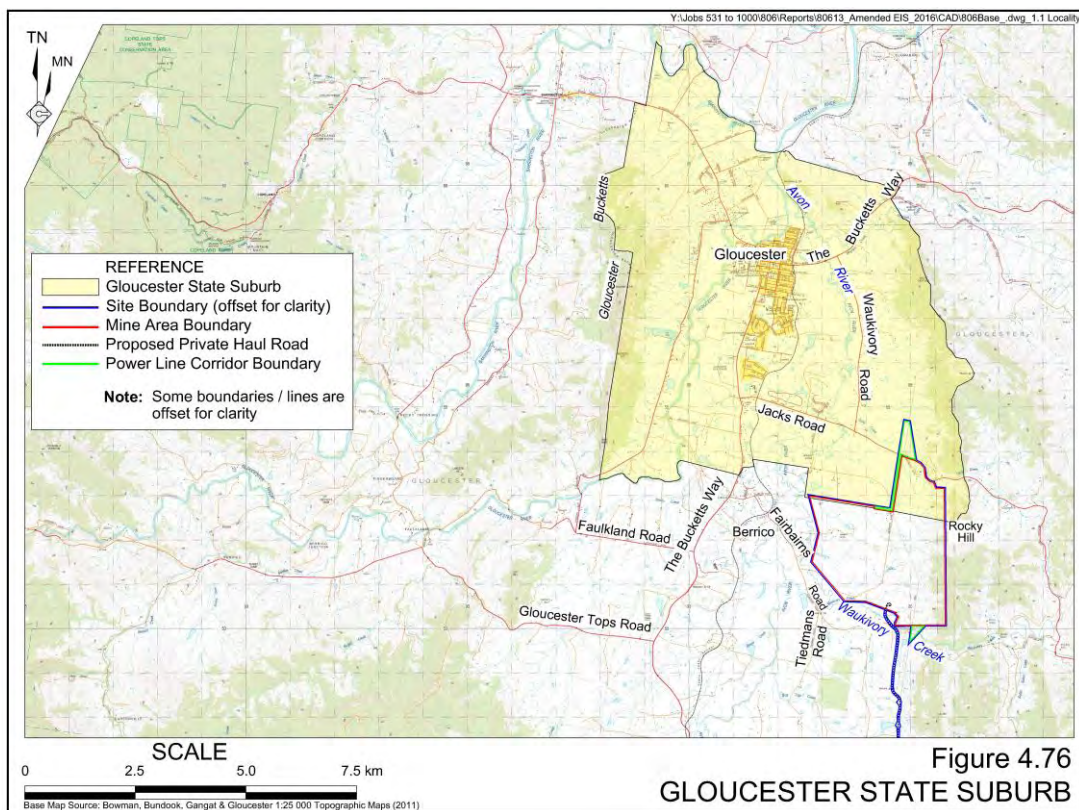
The Gloucester LGA is an area of scenic beauty and rural ambience, and includes several National Parks that attract campers, walkers and adventure tourists. Tourist visitation is strong. Coal mining has been undertaken in the LGA for over 100 years, with the initial mines developed in the Craven area and Gloucester township. In 1995, modern coal mining practices were introduced focusing on the high quality coking coal resources in the Gloucester Valley with the commencement of operations at the Stratford Main Pit. Coal mining has continued in the LGA since that time and contributes to the diversified economy.

The regional setting of the Hunter also exhibits features that attract tourists, a farming tradition, the modern Port city of Newcastle with major health and education facilities (including a University) and a diversified economy. Coal mining continues to form the foundation of the Hunter's economy, generating more than 11 000 direct jobs and around 40 000 indirect jobs, with profound flow-on benefits for the region. Approximately 72% of the coal mined in NSW originates from the Newcastle, Hunter and Northwest areas. In addition, the mining services industry plays an important role in the region, ranging from professional services, education, training and research to general engineering and manufacturing, transport, construction, and OHS and employment services.

4.17.3 Community Profile

4.17.3.1 Introduction

The following demographic data is provided for both the “Gloucester State Suburb” which covers the township of Gloucester⁸ (but does not include Forbesdale Estate), the “Local Government Area” (LGA), being the former Gloucester LGA (prior to the recent Council merger) and NSW. The former Gloucester LGA is displayed in **Figure 4.75** and the Gloucester State Suburb displayed in **Figure 4.76**. The State Suburb is included due to the proximity of the Mine Area to the township. All data has been gathered from the community profile tables and quick data sets from the Australian Bureau of Statistics (ABS) 2006 and 2011 Census data.



⁸ The term “Gloucester” refers to the Gloucester State Suburb while “Gloucester LGA” is used to describe the broader area.

Where available, the statistical data has been updated to the most current figures. These have been variably sourced from the latest REMPLAN⁹ data or publicly available information published by Gloucester Shire Council or NSW Department of Planning and Environment.

Key Insights undertook a program of research between 2012 and 2013 to gauge the issues and concerns that the community had regarding the 2013 Project. The research included a Community Perception Survey and meetings and interviews with key stakeholders. Many aspects of the research program were repeated in 2016 to update community input. It is recognised that many of the issues raised during 2012/2013 in relation to the 2013 Project remain the same for the amended Project. A summary of the community inputs in 2012/2013 and 2016 are presented in Section 3.2.2.2 and Section 4 of Key Insights (2016).

4.17.3.2 Population and Age Characteristics

Tables 4.78 and 4.79 provide a summary of population and age characteristics sourced from the 2006 and 2011 Census.

Table 4.78
2006 and 2011 Population Statistics

	Gloucester LGA		Gloucester State Suburb		NSW	
	2006	2011	2006	2011	2006	2011
Total Population						
Population	4 801	4 877	3 100	2 878	6 549 178	6 917 658
Males	2 353 (49%)	2 430 (49.8%)	1 486 (47.9%)	1 394 (48.4%)	3 228 451 (49.3%)	3 408 878 (49.3%)
Females	2 448 (51%)	2 447 (50.2%)	1 614 (52.1%)	1 484 (51.6%)	3 320 727 (50.7%)	3 508 780 (50.7%)
Aboriginal Population						
Population	171 (3.6%*)	228 (4.7%*)	113 (3.6%*)	172 (6%*)	138 506 (2.1%*)	172 621 (2.5%*)
Males	73 (42.7%)	114 (50%)	44 (38.9%)	84 (48.8%)	68 478 (49.4%)	85 081 (49.3%)
Females	98 (57.3%)	114 (50%)	69 (61.1%)	88 (51.2%)	70 028 (50.6%)	87 539 (50.7%)
Born Overseas Population						
Persons Born Overseas	315 (6.6%*)	373 (7.6%*)	163 (5.3%*)	203 (7.1%*)	1 555 847 (23.8%*)	1 778 550 (25.7%*)
Males	147 (46.6%)	171 (45.8%)	81 (49.7%)	93 (45.8%)	762 117 (49%)	866 978 (48.7%)
Females	163 (51.7%)	202 (54.2%)	82 (50.3%)	110 (54.2%)	793 730 (51%)	911 572 (51.3%)
Family Composition						
Total families	1 393	1 383	872	779	1 716 219	1 829 553
Couple families with children	496 (35.6%)	453 (32.8%)	307 (35.2%)	247 (31.7%)	792 686 (46.2%)	831 850 (45.5%)
Couple families without children	725 (52%)	745 (53.9%)	440 (50.5%)	408 (52.4%)	618 583 (36%)	669 019 (36.6%)
One parent families	157 (11.3%)	165 (12%)	118 (13.5%)	109 (14%)	275 798 (16.1%)	297 904 (16.3%)
Other families	15 (1.1%)	20 (1.4%)	7 (0.8%)	15 (1.9%)	29 152 (1.7%)	30 780 (1.7%)
Source: Key Insights (2016) – Modified after Tables 2, 4 5, and 6					*Of Total Population	

⁹ Gloucester Shire Council has previously contracted REMPLAN for up to date data and analysis based on the latest ABS releases. REMPLAN is a registered trademark and trading name of Compelling Economics Pty Ltd.

Table 4.79
2006 and 2011 Age Distribution

Ages	Gloucester LGA				Gloucester State Suburb				NSW			
	2006		2011		2006		2011		2006		2011	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
0-4	226	4.7%	235	4.8%	148	4.8%	160	5.6%	420 431	6.4%	458 736	6.6%
5-14	644	13.4%	546	11.2%	429	13.8%	312	10.8%	878 483	13.4%	873 776	12.6%
15-19	278	5.8%	285	5.8%	186	6%	167	5.8%	439 863	6.7%	443 416	6.4%
20-24	142	3%	158	3.2%	112	3.6%	107	3.7%	431 854	6.6%	449 685	6.5%
25-34	345	7.2%	335	6.9%	225	7.3%	229	8%	891 040	13.6%	941 496	13.6%
35-44	619	12.9%	544	11.2%	381	12.3%	317	11%	957 842	14.6%	971 626	14.1%
45-54	695	14.5%	689	14.1%	442	14.3%	376	13.1%	904 337	13.8%	950 452	13.8%
55-64	785	16.4%	819	16.8%	424	13.7%	411	14.3%	719 551	11%	810 290	11.7%
65-74	560	11.7%	699	14.3%	355	11.5%	375	13%	465 327	7.1%	541 689	7.8%
75-84	372	7.7%	427	8.8%	283	9.1%	310	10.8%	328 795	5%	336 756	4.9%
84+	134	2.8%	141	2.9%	115	3.7%	114	4%	111 656	1.7%	139 735	2%
Total	4 800		4 878		3 100		2 878		6 549 179		6 917 657	

Source: Key Insights (2016) – Table 3

Population Trends

Table 4.78 shows that, in 2011, the population of the Gloucester LGA was 4 877, of which 2 878 (59%) lived in the township of Gloucester. This represented a population increase of 1.6% across the LGA but a population decrease in the township of 7.2% since the 2006 Census compared with an overall increase in the population of NSW of 5.6%. Australian Bureau of Statistics data, reported through Gloucester Shire Council, identifies that the population of the Gloucester LGA in 2015 was 5 160, an increase of approximately 2.0% from 2014. In 2012 and 2013 the population in the Gloucester LGA declined (-0.9%) but increased in 2014 (1.8%). Gloucester Shire Council has previously forecasted a population growth between 2012 and 2022 at a rate of 1.8% per annum leading to approximately 1 200 new residents in the LGA by that year (GSC, 2012). This is in contrast to a prediction by the Department of Planning and Environment which in the *New South Wales and Local Government Area Population Projections: 2014* predicted a steady population of around 5 000 within the Gloucester LGA to 2021 and a gradual decline through until 2031. The social impact assessment placed greater weight on Gloucester Shire Council's projections. More reliable trend data will be available after the 2016 Census.

In summary, the population of the LGA and the township are relatively stable but growing at a rate slower than the rest of the NSW. There is also an apparent trend of the population moving away from living in the town towards living in the broader LGA.

Age Distribution

Table 4.79 shows that the LGA and State Suburb had a lower proportion of people in all age groups from 0 to 44 years than NSW. However, the proportion of residents in the 55+ age group in both the LGA (42.8%) and the State Suburb (42.1%) was significantly higher than NSW (26.4%).

Furthermore, over the period 2001 to 2011, the median age in the Gloucester LGA increased from 42 to 49 years compared with the NSW median age of 38 in 2011, indicating an aging population.

Other Population Characteristics

Other notable population characteristics are as follows.

- The proportion of the Aboriginal population in the Gloucester LGA (4.7%) and the State Suburb (6%) was significantly higher than in NSW (2.5%).
- The vast majority of Aboriginal people (75%) in the LGA lived in the Gloucester township.
- The proportion of the population in the Gloucester LGA (7.6%) and in the State Suburb (7.1%) that was born overseas was significantly lower than in NSW (25.7%).
- Household size decreased in the Gloucester LGA from 2.5 persons per dwelling in 2001 to 2.3 persons per dwelling in 2011.
- The proportion of couple families with children was significantly less in the LGA (32.8%) and the State Suburb (31.7%) than in NSW (45.5%). However, the proportion of couple families without children was also significantly higher in the LGA (53.9%) and the State Suburb (52.4%) than in NSW (36.6%), a reflection of the higher number of retirees in the Gloucester area.

4.17.3.3 Education

Table 4.80 displays the 2006 and 2011 Census data for post school levels of education.

Table 4.80
Post School Level of Education

	Gloucester LGA		Gloucester State Suburb		NSW	
	2006	2011	2006	2011	2006	2011
Post Graduate Degree	31 (0.6%)	47 (1%)	15 (0.5%)	20 (0.7%)	162 916 (2.5%)	238 851 (3.5%)
Bachelor Degree	256 (5.3%)	309 (6.3%)	143 (4.6%)	164 (5.7%)	635 030 (9.7%)	787 336 (11.4%)
Advanced Dip/Dip	216 (4.5%)	271 (5.6%)	120 (3.9%)	134 (4.7%)	387 652 (5.9%)	462 059 (6.7%)
Grad Dip/Cert	42 (0.9%)	44 (0.9%)	21 (0.7%)	14 (0.5%)	65 832 (1%)	82 617 (1.2%)
Certificate	739 (15.4%)	901 (18.5%)	456 (14.7%)	523 (18.2%)	883 236 (13.5%)	986 704 (14.3%)
Total	1 284 (26.7%)	1 572 (32.2%)	755 (24.4%)	855 (29.7%)	2 134 666 (32.6%)	2 557 567 (37.1%)

Source: Key Insights (2016) – Table 7

The 2011 data shows both the LGA (32.2%) and State Suburb (29.7%) had a lower proportion of people with a tertiary level of education than in NSW (37.1%). The most notable differences were in the areas of Bachelor Degrees (6.3% in the LGA compared to 11.4% in NSW) and Post Graduate Degrees (1% in the LGA compared to 3.5% in NSW). The proportion of people with

Certificates was higher in the LGA (18.5%) and State Suburb (18.2%) than in NSW (14.3%). Similar information can be observed from the 2006 data, however, the proportion of people with a tertiary education has increased from 2006 to 2011 within both the Gloucester LGA and NSW.

4.17.3.4 Employment

The 2011 Census data shows that the proportion of the population that were employed on Census night was lower in both the LGA (40.2%) and the State Suburb (37.8%) than across NSW (45.4%). In 2011, the unemployment rate was similar in both the LGA and State Suburb at 2.2% compared to 2.8% for NSW, but notably, unemployment has decreased in both the LGA and State Suburb from 2.6% in 2006, although unchanged in NSW at 2.8%. Since the 2011 Census, the unemployment rate in the Gloucester LGA has been steadily rising and was at 6.8% for the March 2016 quarter. This compares to a State-wide average of 5.6% (Department of Employment, 2016).

In 2006, the main employment sector in the LGA was Agriculture, Forestry, Fishing (19.5%) followed by Health Care and Social Assistance (10.5%) and Retail Trade (9.8%) with Mining ranking the 10th highest industry of employment (4.3%). In 2011, the main employment sectors remained Agriculture, Forestry, Fishing (15.6%) followed by Health Care and Social Assistance (11.2%) and Retail Trade (10.1%), however, employment in Mining increased to 6.6%, ranking the 7th highest industry of employment. Of the 1 799 people working in the Gloucester LGA, it is estimated that 140 jobs are supported by tourism.

In 2006, a similar trend was recorded for the State Suburb, with the main employment sector being Agriculture, Forestry, Fishing (12.3%) followed by Retail Trade (11.1%) and Health Care and Social Assistance (10.7%). Mining was again ranked the 10th highest industry of employment (4.2%). However, in 2011 the main employment sectors were Retail Trade (12.5%), Health Care and Social Assistance (12%) and Accommodation and Food Services (10.1%). Employment in Mining also increased to 6.3%, ranking the 8th highest industry of employment.

4.17.3.5 Tourism

Tourism was not defined as a separate employment category in the 2006 or 2011 Census data and would have been included in the Accommodation and Food Services and other minor categories. Based on the Upper Hunter Economic Diversification Project, Strategy Report (Buchan Consulting, 2011) the estimated proportion of tourism jobs in the overall employment sector in the Gloucester LGA was 5.4%, while Key Insights (2016) reviewed Australian Bureau of Statistics data from 2012 to 2013 that indicated that at that time, 140 of the 1 799 people working in the Gloucester LGA were working in the tourism industry. This represents approximately 7.8% of total jobs and an increase from 2011. On the basis of the data presented by Destination NSW for the Gloucester LGA, September 2014, the local tourism industry appears relatively strong. In summary, the data indicates that, as at September 2014, and on the basis of annual averages over 2011 to 2014, there were:

- 96 000 domestic overnight visitors;
- 262 000 domestic visitor nights; and
- \$43 million in domestic overnight visitor spending.

These figures show an increase in domestic visitors, and dollars spent, based on a similar report for the three-year average, 2008 to 2011. During that period, there was an annual average of:

- 69 000 domestic overnight visitors;
- 190 000 domestic visitor nights; and
- \$30 million in domestic overnight visitor spend.

This data suggests that on average 700 people are staying in Gloucester township and surrounding areas each night which seems overstated. There is also insufficient data regarding the purpose of visits, as data on business trips is not available. However, proprietors of the larger accommodation establishments in the township of Gloucester have stated that business trips represent between 60 to 75% of their business. An example of the importance of business trips is indicated by the reported decrease in accommodation revenues experienced since the withdrawal of most AGL activities from the Gloucester LGA. International tourists represent only a small percentage of visitors to the region (6.2%).

Regardless of the above, the Destination NSW National Visitor Survey 2011 – 2014 indicates that 59% of visitors to the Gloucester LGA based their visit around experience-based activities like bushwalking and general sightseeing, which is well above the NSW figure of 35%. Eating out at restaurants topped the list of activities for visitors with 40% of the LGA's visitors participating in this activity (58% for NSW). 21% of visitors to the LGA visit National Parks or State Parks (9% for NSW). This indicates that the natural and scenic features continue to attract tourists.

4.17.3.6 Income

Table 4.81 shows the 2006 and 2011 Census data for income. **Table 4.81** shows that, although median income increased over the inter-censal period for individuals, households and families, incomes within the LGA and State Suburb remain significantly lower than for NSW.

Table 4.81
Weekly Income

Income (\$ weekly)	Gloucester LGA		Gloucester State Suburb		NSW	
	2006	2011	2006	2011	2006	2011
Median individual income	\$343	\$422	\$341	\$409	\$461	\$561
Median household Income	\$665	\$810	\$644	\$750	\$1 036	\$1 237
Median family income	\$846	\$971	\$832	\$966	\$1 181	\$1 477
Source: Key Insights (2016) – Table 15						

4.17.3.7 Housing

According to the 2011 Census data, the total number of private dwellings in the LGA was 2 453 and in the State Suburb, 1 397. It is noted that a significant number of private dwellings in the LGA (453) and the State Suburb (195) were identified as unoccupied.

Housing Tenure

The 2011 Census data records that the proportion of full home ownership tenure in the Gloucester LGA (48.8%) and the State Suburb (45.5%) which was significantly higher than NSW (33.2%) while the proportion of those purchasing a home was lower in the LGA (23.2%) and the State Suburb (22.6%) than in NSW (33.4%). The proportion of those renting was also lower in the LGA (24.7%) and the State Suburb (28.7%) than in NSW (30.1%).

Public Housing

The NSW Government maintains a single State-wide waiting list for public and community housing called the NSW Housing Register. In March 2012, the Gloucester LGA was identified as having waiting times of between 2 and 5 years for two bedroom properties and up to 2 years for three and four bedroom properties. No studio or one bedroom properties were listed as available. The relative need for affordable housing in the Gloucester LGA was listed as moderate.

The NSW Local Government Housing Kit (based on the 2011 Census data and subsequent updates) also indicates a slight decrease in public housing stock between 2012 and 2013 in the Gloucester LGA.

According to the 2011 Census data, a very high proportion (86%) of very low income renting households in the Gloucester LGA (of which there were 116) were considered to be in rental stress. A high proportion (75%) of very low income purchasing households (of which there were 54) were also considered to be in home purchase stress. This may have been improved over the period from 2011 to the present time as the Reserve Bank of Australia cash rates have decreased from 4.8% to 1.75%.

The Gloucester Shire Council Community Strategic Plan 2014 – 2024 states that an additional 500 homes (an increase of approximately 20%) would be constructed in the Gloucester LGA by 2022, mainly located in housing estates near Gloucester township and Barrington village, to accommodate the forecast population increase of 1.8% per annum (1 200 persons in total) over the period to 2024.

4.17.3.8 Health

Overview

Key features of the health data drawn from Health Statistics NSW for the Gloucester LGA are as follows.

- High body mass attributable deaths slightly decreased between 1997-1998 (59.7 per 100 000) and 2006-2007 (47.5 per 100 000). This rate has continued to decline into 2012 and 2013 and comparable with the rate for NSW.
- High body mass hospitalisations steadily increased between 1998-2000 (545.5 per 100 000) and 2005-2007 (719.8 per 100 000) before trending down again to 2008-2010 (617.5 per 100 000). As with high body mass attributable deaths, this feature remained stable into 2014.

- Potentially preventable hospitalisations remained fairly constant with up and down movements from year to year (approximately 2200 to 2800 per 100 000 population) between 1989-1991 to 2009-2011. In 2012/2014 the rate was 2 589.5 per 100 000.
- Alcohol attributable hospitalisations from 1998-2000 to 2008-2010 peaked in 2006-08 at 553.1 per 100 000 before trending down to 425.9 per 100 000 in 2008-2010. By 2012-14 the smoothed rate per 100 000 of alcohol attributable hospital admissions was 617.7 (representing approximately 36 actual admissions).
- Smoking attributable hospitalisations from 1998-2000 to 2008-2010 remained fairly constant at approximately 600 per 100 000 population. In 2013, the spatially adjusted rate per 100 000 of smoking attributable deaths in Gloucester LGA was 62.4 compared to 58.4 for NSW.
- Coronary heart disease hospitalisations between 1998 and 2010 peaked at 1 016 per 100 000 population in 2004-2006 before trending down to 737.6 per 100 000 population in 2008-2010. Rates of hospitalisations began rising again between 2012 and 2014. In 2012-2014, the spatially adjusted rate of hospitalisation for coronary heart disease was 670.6 per 100 000 compared to 574 per 100 000 for NSW. The difference between the local hospitalisations and those across NSW may be attributed to the ageing population in the Gloucester LGA.
- From 2012-2014, the spatially adjusted rate per 100 000 for chronic obstructive pulmonary disease deaths in Gloucester LGA was 27.8 compared to 22.2 for NSW. The difference between the local death rate and that across NSW may also be attributed to the ageing population in the Gloucester LGA.

Asthma

The NSW Health data on asthma hospitalisations indicates that asthma related hospitalisations are stable in the Gloucester LGA and not significantly different from the rest of NSW. The hospitalisation rate for 2012-14 was 8.6 admissions, representing a rate of 173.2 per 100 000 population compared to 176.9 per 100 000 for NSW.

A recent NSW Health study on respiratory and cardiovascular diseases and cancer among residents in the Hunter New England Area Health Service (centred on Singleton and Muswellbrook LGAs) found that rates of children diagnosed with asthma in Hunter New England Area Health Services were higher at 39.8% than Rural NSW at 33.2% (NSW Health, 2010). The study also found that prescription rates for the whole of the Hunter Region for asthma preventatives were higher than the rest of non-metropolitan NSW (NSW Health, 2010). The results of the study are not directly relevant to the Gloucester area given the considerable number and size of coal mines in the Singleton and Muswellbrook LGAs. Furthermore, the study does not comprehensively establish adverse health effects are attributable to air pollution relating to open cut coal mining. However, the results indicate that the outcomes of further studies should be monitored and recommendations considered for the amended Project, where relevant.

Mental Health

NSW Health Statistics does not publish LGA specific data and there is no data available locally to understand the nature and magnitude of stress and mental health in the community. In general, the prevalence of mental health conditions in rural and remote Australia has been estimated as equivalent to levels in major cities.

However, rural Australians face greater challenges as a result of such conditions due both to the difficulty of accessing the support needed for mental illness and to the greater visibility attached to mental health in a smaller community. Anecdotally, some Gloucester LGA residents report high levels of stress and mental health issues in the community.

Available data from NSW on intentional self-harm hospitalisations and the gender of those admitted indicates that the Gloucester LGA is consistent with trends across NSW for these matters. However, the Australian Institute of Health and Welfare reports that rates of completed suicide in regional and remote areas are 1.2 to 2.4 times higher than those in major cities.

In addition, natural disasters such as drought, cyclones, floods, bushfire and pest infestations are contributors to mental illnesses and have a direct impact on income and wellbeing for rural Australians.

4.17.3.9 Crime and Safety

The Gloucester LGA is a low crime area when compared to other LGAs across NSW. The NSW Bureau of Crime Statistics and Research (BOCSAR) data for the period from January to December 2015 show that crime rates remain very low for the area.

The Gloucester LGA has more incidents per 100 000 people than the rest of NSW for domestic assault (alcohol and non-alcohol related), sexual offences, malicious damage to property, disorderly conduct, harassment, threatening behaviour and private nuisance incidents, disorderly conduct, and prohibited and regulated weapons offences incidents. Mostly the differences in rates are quite small. There are, however some significant differences in rates where the Gloucester LGA is well below the NSW rate such as theft and liquor offences. During 2015, there were no incidents of assaults of police, homicide or robbery.

4.17.3.10 Socio Economic Indexes for Areas (SEIFA)

SEIFA is a suite of four summary measures that have been derived from Census information. For each index, every geographic area in Australia is given a SEIFA number which shows how disadvantaged that area is compared with other areas in Australia. Each index contains a relative measure between 1 to 10 where the 1st decile represents the 10% of most disadvantaged areas in the State and the 10th decile represents the 10% of least disadvantaged areas.

The index of socio-economic disadvantage is derived from Census variables related to disadvantage such as low income, low educational attainment, unemployment, and dwellings without motor vehicles.

In 2006, the Gloucester LGA was in the 5th decile for the index of Relative Socio-economic Disadvantage and moved downwards to the 4th decile in 2011. This means that from 2006 to 2011 the level of socio-economic disadvantage in the Gloucester LGA has increased relative to the rest of Australia and to NSW.

4.17.4 Community Facilities and Social Infrastructure

4.17.4.1 Introduction

From their research, Key Insights (2016) concluded that the Gloucester LGA is an area with a high degree of social capital. Consultation with the community has indicated that there are perceived strengths in health, aged care, education and training. There is also a range of services and infrastructure in the Gloucester LGA and a strong network of community organisations.

A summary of existing community facilities and social infrastructure is provided in the following subsections.

4.17.4.2 Childcare

There are two pre-schools in the Gloucester township, namely Gloucester Pre-School (3 to 5 year olds) and Barrington St Pre-School and Long Day Care Centre (0 to 6 year olds). The Gloucester Pre-School currently has 45 children, and the Barrington Centre has 29 places for children.

There are also three Family Day Care Centres catering for children from 6 weeks old to 12 years. They can each take 4 to 5 children at a time.

4.17.4.3 Healthcare

The Gloucester LGA has a public hospital operated by NSW Health Hunter New England called Gloucester Soldiers Memorial Hospital. The hospital is an 80-bed facility which consists of a 20-bed acute ward, 15-bed aged care transitional ward, 25-bed nursing home and a 20-bed hostel. Services offered include:

- 24-hour emergency department, medical, surgical, palliative care, limited obstetrics, limited paediatrics, x-ray and physiotherapy.
- Minor general surgery and ophthalmic (eye) surgery is also undertaken at Gloucester Hospital.

The Gloucester-Stroud Medical Practice has surgeries in Gloucester and Stroud and provides the emergency doctors for the hospital and care within aged care facilities. The practice also hosts other visiting health providers including a general surgeon, a general physician, ophthalmologists, a psychiatrist, psychologists, a dietician, podiatrists, and has ultrasound, echocardiography and audiology capabilities.

The Gloucester LGA also has a wide range of allied health providers or services including dentists, optometrists, chiropractors, physiotherapy, massage therapy, Bowen therapy, naturopathy, home nursing, occupational health and safety, health food supplier(s), and a local chemist.

4.17.4.4 Education

There are four Primary Schools in the Gloucester LGA, two in Gloucester township – St Joseph’s Primary and Gloucester Primary, one in Stratford and one in Barrington. Gloucester also has one High School, namely Gloucester High School.

NSW TAFE does not provide any courses in the Gloucester LGA, however, the school bus service operated by Fishers Bus Service (Taree) travels every weekday between Gloucester and Taree and enables students to participate in the Taree TAFE Campus programs. The University of the Third Age offers courses in Gloucester.

The Gloucester Shire Library also offers a wide range of services to the community including:

- access to informative, educational and recreational resources in a wide range of formats;
- free access to the internet and email facilities;
- community space for meetings, exhibitions and events;
- children’s programs, including story time, Library and school visits;
- resources for the hearing and sight impaired; and
- research and homework assistance.

4.17.4.5 Legal and Emergency Services

The Gloucester LGA is currently serviced by the following legal and emergency services.

- A local court that is open on Wednesdays and three private solicitor firms located in the town.
- Fire and Rescue NSW, NSW Rural Fire Service, Avon Bush Fire Brigade, Barrington Bush Fire Brigade and Gangat Rural Fire Brigade. There are 24 Rural Fire Service buildings within the LGA.
- Gloucester Shire SES - responsible for responding to emergencies during floods and storms and is also the primary rescue group for the LGA and surrounding area.
- An ambulance station at each of Gloucester and Stroud.
- A Police Station in Gloucester.

It is noted that the ambulance and police stations are not staffed on a 24 hour basis. The Gloucester ambulance station is staffed during the day shift only with staff rostered “on call” for hours outside the day shift. The Police Area Command in Taree reports that the Gloucester Police Station runs on rotating shifts with no regular opening hours.

4.17.4.6 Recreational and Cultural Facilities

The Gloucester LGA has a wide range of sport and recreation clubs including archery, bowling, croquet, cricket, tennis, golf, gymnastics, basketball, hockey, fishing, athletics, netball, soccer, squash, swimming, rugby union and rugby league. The Gloucester LGA also has 45 parks and reserves, 12 sports fields/facilities, two public swimming pools and four community halls.

Cultural facilities include the Gloucester Arts and Cultural Council Inc. (GACCI) which organises events and activities such as plays, concerts, bus trips, youth talent quests, photography competitions and workshops, and generally works towards enriching Gloucester's cultural life. GAACI also manages the Gloucester Gallery - a community exhibition space in the Gloucester township.

4.17.4.7 Other Community Facilities and Groups

The Gloucester LGA has a wide range of service organisations including a Masonic Lodge and CWA, and Quota, Apex, Rotary, Lions and View Clubs. There are also a number of churches located in the Gloucester LGA including Anglican, Catholic, Presbyterian, Baptist, Uniting, Christian Outreach, Jehovah's Witness and Seventh Day Adventist.

Gloucester Shire Council's Community Directory lists 85 Community Organisations including the Senior Citizens Centre, Youth Centre, Art Society, Australia Day Committee, Bucketts Ball Committee, Friends of the Library, Gloucester Bookworms, Gloucester Community Markets, Gloucester Historical Society, Tidy Towns Committee, Gloucester Pipes and Drums, Ladies Craft Connection, The Cottage, The Gloucester Project (a sustainable community-developed economic growth project focused on food production), and the Men's Shed. The Men's Shed is supported by the Applicant by way of the provision of land and a building on one of its properties adjacent to Fairbairns Road.

4.17.5 Company Contributions, Management and Recommendations

Extensive consultation was undertaken during preparation of the social impact assessment for the 2013 Project and continued throughout the Gloucester LGA and beyond during preparation of the impact assessments for the amended Project. Throughout this period, the Applicant has identified the benefits that could be achieved through pro-actively introducing a suite of management and mitigation measures to benefit the local community. A range of recommendations has been provided by Key Insights (2016) drawing together a number of those previously identified by the Applicant, together with those arising from Key Insights' independent and structured assessment of the social impact issues relating to both the 2013 Project and the amended Project.

One of the key management measures previously announced to the local community by the Applicant relates to a Community Grants Program designed to provide both direct and indirect benefits to the local community during and beyond the life of the amended Project. The Community Grants Program comprises:

- an annual donation at a rate of 50 cents per tonne of product coal sold;
- sponsorship of up to three tertiary education scholarships annually in fields such as mining, engineering, agriculture and environmental science;
- assistance in the provision of enhanced medical services and facilities to the local area, with details of this assistance package to be determined in consultation with local health professionals;
- provision of trade apprenticeships for local youth at the Rocky Hill Coal Project;

- provision of competency training and certification on mining-related equipment to assist local men and women gain employment in mining or other related fields; and
- provision of local training and employment for local people through the Applicant's farming enterprises or on farming enterprises on the Applicant's land.

The annual production-related donation, which would equate to a contribution to the community of approximately \$6.5 million over the life of the amended Project at an average of approximately \$400 000 per annum, would be managed through either a new or existing charitable trust using a corporate trustee including highly respected members of the community with the requisite knowledge and skills, and administered by a small committee operating in accordance with a written policy and guidelines for investment and distribution of the accumulated funds. The guidelines would reflect the areas of priority need identified in Key Insights (2016), including health infrastructure and healthy lifestyle initiatives, low-cost housing initiatives, youth education/training and employment (including indigenous projects), local amenity and community-building initiatives such as events and support initiatives and activities or those arising from the development consent, which are important to the community as a whole.

The Applicant proposes to adopt the following recommendations provided by Key Insights (2016) to minimise any potential adverse socio-economic impacts including:

- facilitating the establishment of a Rocky Hill Coal Project Community Consultative Committee following the disbanding of, or transition from, the Gloucester Exploration Project CCC;
- formalising existing stakeholder engagement and strategies in a detailed Stakeholder Engagement Plan;
- investigating the most appropriate methods to provide the community with access to up-to-date information regarding the amended Project in conjunction with preparation of the Stakeholder Engagement Plan, including a Rocky Hill Coal Project Shop Front, if this is deemed feasible and useful;
- setting a target for 50% of employees and contractors living locally (within the LGA and surrounding area) in the first two years, with a target of 75% by the end of Year 3;
- investigating development of joint recruitment operations with existing organisations to attract families to live in Gloucester;
- investigating an incentive package to encourage employees to re-locate to Gloucester;
- promoting job opportunities for local school leavers through school visits and information packages;
- development of an Aboriginal Employment Strategy to target local Aboriginal people for employment;
- implementing a preferred supplier policy that utilises local suppliers as far as commercially practicable;

- preferential contracts with suppliers who employ local people;
- investigating the possibility of partnering with other stakeholders to provide relocation incentives to suppliers prepared to establish their businesses in Gloucester and employ local people;
- investigating the use of a local voucher system for rewards and incentives for employees;
- participation in the Chamber of Commerce and other business and agricultural networks to promote local business and events that attract people to Gloucester;
- monitoring the flow of employees from local commerce and agriculture into mining;
- planning for joint training and employment strategies to assist suppliers retain local staff;
- developing and promoting a database of local rentals, including rooms and board to employees;
- exploring options for temporary and short term accommodation for employees not relocating full time to Gloucester;
- monitoring of health studies undertaken by the Hunter New England Area Health Service in the Upper Hunter Region and, where appropriate, implementing actions in response to study findings;
- development of a pastoral plan to manage the ongoing use of GRL-owned agricultural land in the vicinity of the Site; and
- consideration of an annual joint meeting between resource company CCCs to review cumulative impacts and monitoring, coordinate community funding priorities and improve knowledge of operations and future directions for resources companies, suppliers and Council.

4.17.6 Assessment of Impacts

4.17.6.1 Introduction

The assessment of social impacts has been made against the background of social information compiled by Key Insights (2016) through a review of existing data and studies, together with community input received through both structured and informal interaction as part of the investigations for the 2013 Project and the further research undertaken in 2016. Relevant Gloucester Shire Council planning documents and the literature were also reviewed.

The information gathered by Key Insights for the 2013 Project has, in most cases, been brought forward as it remains relevant to the amended Project. Some stakeholders contacted in 2016 to follow up their previous input from 2013 stated that they had nothing further to add as their earlier input remained unchanged, while other stakeholders provided additional input as detailed in Section 4.2 of Key Insights (2016).

As part of their overall research, Key Insights held meetings and/or interviews with a wide cross-section of the community including the following.

Key Stakeholders

- Director of Planning, Gloucester Shire Council
- Executive Officer, Gloucester District Health Service and members of the Senior Management Team
- The Health Services Manager of Gloucester Hospital and other senior management members.
- Gloucester Chamber of Commerce
- Gloucester Exploration Project Community Consultative Committee and members
- Gloucester Residents in Partnership (GRIP) were consulted in 2013 but in 2016, with the disbanding of GRIP, were consulted as the 'Rocky Hill Division' of Groundswell Gloucester.
- A group of residents from the Forbesdale area
- Real Estate Agents
- Gloucester Visitor Information Centre
- Coordinator, Bucketts Way Neighbourhood Group
- Forbesdale residents
- Gloucester Community Relations Manager, AGL
- Regional Asset Planner, North Coast Region, NSW Department of Education and Communities
- Practice Manager, Gloucester-Stroud Medical Centre
- Taree Community Health
- Emergency Services
- Taree TAFE
- Advance Gloucester

Tourism Operators and Clubs

- Country Comfort Motel Management
- Barrington Outdoor Adventure Centre
- Online Accommodation Distribution Organisation
- Bucketts Way Motel
- Gloucester Golf Club
- Gloucester Aero Club

Key Insights also facilitated two focus groups with young adults less than 30 years of age from Gloucester, attended two public meetings organised by Gloucester Shire Council and spent time in Gloucester talking to local people by way of casual intercept.

The assessment of potential social impacts has been divided into the following key areas.

- Health Impacts – including psychological impacts.
- Social Infrastructure Capacity.
- Community Sense of Place and Amenity.
- Social Cohesion.

- Employment.
- Housing.
- Cumulative Impacts.
- Changes in predicted impacts associated with the amended Project.

4.17.6.2 Health Impacts

In the Community Perception Survey undertaken as part of the investigations for the 2013 Project, there was a high level of concern recorded regarding health impacts associated with dust (raised as an area of concern by 79% of respondents) and noise (raised as an area of concern by 76% of respondents). More recent research has recorded growing concerns about mental health impacts.

Air Quality

There is growing community concern generally about the impacts of coal mining and power stations on the population's health, particularly in relation to respiratory disease and cancer.

The air quality and health risk assessment for the amended Project presented in Section 4.4 and Pacific Environment (2016a and 2016b) has concluded that, with the implementation of the proposed management measures and safeguards, the proposed activities would be compliant with all health-based criteria at all privately-owned residences within the vicinity of the Mine Area. It is noted that this view is also supported by Associate Professor David McKenzie, Respiratory and Sleep Physician at the Prince of Wales Private Hospital and Medical Director of Medicine and Integrated Care at the Prince of Wales Hospital, Randwick, NSW. His peer review of the Health Risk Assessment is presented in Volume 1 Part 2C of the *Specialist Consultant Studies Compendium*. In addition to the air quality management measures and monitoring outlined within Section 4.4, the Applicant proposes to monitor the outcomes from the Upper Hunter Air Quality Monitoring Network and from associated studies conducted by the HNEAHS and respond accordingly.

Noise and Light

As there are no planned mining operations during the night-time period and no coal haulage outside the hours of 7:00am to 6:00pm Monday to Saturday, there would be limited potential for adverse impact of noise and after dusk lighting on sleep disturbance at residences within the vicinity of the Mine Area and private haul road. Management measures that would mitigate potential impacts resulting from noise and after dusk light are described in Section 4.2.5 and 4.5.5.5 respectively.

The SLR (2016) assessment of potential noise impacts on amenity indicates that a total of three privately-owned residences are predicted to receive noise levels exceeding the project-specific noise level by 1 to 2dB(A) (two residences) and 3 to 5dB(A) (one residence), during one or more years of operations. Noise would be managed through community engagement, real-time continuous noise monitoring, predictive meteorological systems and site management procedures.

Mental Health

The qualitative research presented in Key Insights (2016) reveals that some local people have identified heightened levels of stress associated with the amended Project and therefore there are concerns about mental health. Environmentally induced distress is increasingly being recognised as an impact associated with change in communities. Research into the relatively new concept of solastalgia (the distress that is produced by environmental change impacting on people while they are directly connected to their home environment and exacerbated by a sense of powerlessness or lack of control over the unfolding change process) has found evidence of this type of distress associated with persistent drought in rural communities and open cut coal mining in the Upper Hunter Valley of NSW. Local data is not available to make conclusions about mental health trends within the Gloucester LGA. However, Key Insights (2016) report that the observed evidence of distress amongst some members of the local community is indisputable.

Due to the difficulty in quantifying solastalgia as a whole and its relationship to a mining operation such as proposed for the amended Project, the Applicant considers that whether or not solastalgia is experienced by some members of the local community; the fact that the proposed mining operations are a relatively short-term land use (with the Mine Area returning to a similar landform and agricultural land use), and the proposed management measures outlined in this document, the concept of solastalgia is likely to only apply to a small proportion of the population within the former Gloucester LGA. In reality, the Applicant expects the extent of solastalgia in the surrounding community would decrease after the amended Project commences operation, given the surrounding residents would recognise the impacts are more consistent with those predicted in the EIS and not those promoted by the opponents to the amended Project.

The Applicant acknowledges that uncertainty surrounding the amended Project is a factor in the distress evident in the local community. The Applicant has always maintained an ‘open door policy’ regarding community consultation and has been transparent in its plans regarding potential land acquisition and impacts upon local residents. Once the EIS is placed on exhibition, a shop front would be established to maintain a presence in the community and enable residents to make enquiries and seek further information.

It should also be noted that the positive mental health outcomes associated with increased employment and training opportunities and enhanced economic development associated with a project of this scale would provide a balance to the potential negative impacts. The qualitative research reveals that many young people leave town for work and study and that those who remain are often trapped in unemployment or underemployment, with the negative mental health impacts of long-term unemployment being well documented. While many retirees have taken advantage of a “tree change” to the rural area of the Gloucester LGA, so too mine workers who are currently in fly-in/fly-out or drive-in/drive-out positions elsewhere in the Hunter Valley or in more remote parts of the country, including individuals and families who have moved from Gloucester seeking work in the mining industry elsewhere, have identified that they would take advantage of the more balanced lifestyle that Gloucester has to offer to their families. This would be an obvious benefit to those moving or returning to the area. For these employees, the opportunity for employment in the Gloucester LGA may reduce personal stress levels associated with their current work situation.

4.17.6.3 Social Infrastructure Capacity

It is important to understand the capacity of community services and facilities to be able to meet the projected increase in population associated with the amended Project should it proceed. Key Insights (2016) have recommended, and the Applicant has accepted a 50% local resident rate target by the end of Year 2 of operations and 75% local resident rate target by the end of Year 3 of operations, recognising that the achievement of these rates would be unlikely at commencement of operations. Achieving the target of 75% by the end of the third year of operations, would also minimise the potential impacts in the longer term as the community slowly adapts to the gradual population increase. Key Insights (2016) reviewed social infrastructure capacity based on the following three conservative scenarios and the target local resident rate of 75%:

- a low resident rate where only 20% of employees would live in Gloucester during construction and operations;
- a medium resident rate where 30% of employees would live in Gloucester during construction and operations;
- a high resident rate where 40% of employees would live in Gloucester during construction and operations; and
- the target resident rate where 75% of employees would live in Gloucester by the end of Year 3 of operations;

This resident rate refers to existing persons living in the Gloucester LGA as well as new persons (and their families) that re-locate to the Gloucester LGA.

The Applicant has received over 300 enquiries relating to employment opportunities through the Rocky Hill website and information hub since it was established in August 2011. Given this, the response to the Applicant's advertised Expressions of Interest for employment undertaken through the Gloucester Advocate on two occasions in 2012 and experience in other communities, the Applicant expects to far exceed Key Insight's assumed high resident rate of 40% and is confident that the 75% target would be readily achieved.

An assessment of impacts on key social infrastructure under these scenarios is provided as follows. This social infrastructure assessment is summarised from Section 5.3 of Key Insights (2016) and assumes that locally resident employees include a component of existing residents as well as those that relocate with their families to the Gloucester LGA. Table 22 of Key Insights (2016) provides a breakdown of the existing and new residents based on the 2011 Census data for family composition in the Gloucester LGA and assuming that half of those people relocating to Gloucester bring another adult with them.

Childcare

Two pre-schools and three family day care centres are operational in the Gloucester LGA. Based on the low, medium and high scenarios relating to the increase of families in the area, as a result of the approval of the amended Project, there would potentially be up to eight new children aged between 0 and 4 years that may require some form of childcare. By the end of Year 3 of operations when the 75% target rate is expected to be reached, there may be up to 20 additional children aged between 0 and 4 years.

Both pre-schools had waiting lists when contacted in 2016. This indicates that the capacity of existing childcare services may be stretched to meet demands of population growth associated with the target rate of 75% of employees living in the Gloucester LGA with their families. The result may be a need for a new preschool, or additional Family Day Care or related service. Local preschools have previously indicated that they prepared to increase capacity subject to financial viability.

Healthcare

Key Insights (2016) have assessed that the healthcare system in the Gloucester LGA has the capacity to cope with the increased population associated with the operation of the mine at the target rate (75% of employees living in the Gloucester LGA). However, it is noted the service system has many of the challenges of rural healthcare including distances and patient transport, meeting the needs of the ageing population, mental health services, and availability of GPs, attracting qualified staff and purchasing major equipment.

Part of the Community Grants Program announced by the Applicant in March 2012 was a commitment to assist with the provision of improved medical services and facilities in the area. In line with this commitment, in August 2012, the Directors of GRL donated \$10 000 to the Gloucester Hospital which was used for target areas of immediate need, including medication/procedural trolleys, a mobile finger oximeter and a glucometer unit.

Key Insights (2016) noted that should the amended Project be approved, provision of respiratory monitoring equipment would contribute to addressing community concerns relating to dust and associated health impacts and there was also a need identified in the qualitative research to attract appropriately experienced local hospital staff. A strong partnership with the local health system will also lead to the identification of appropriate community programs for funding from the Community Trust.

Mental health is also a concern for a proportion of the local community and the hospital management reports a lack of generalist services in this area, particularly for families with children. Key Insights (2016) recommends that HNEAHS research should be monitored and responded to appropriately by the Applicant.

Education

Based on the locally resident employee population scenarios of 20% to 40%, it was identified that there might be a requirement for an extra 5 to 28 new primary school places and an extra 3 to 20 new high school places should the amended Project be approved. Based on previous consultation with the NSW Department of Education and Training, it has been confirmed that the current school facilities in the Gloucester LGA have the capacity to meet these potential increases. The number of enrolments at all schools has remained stable between 2013 and 2016.

At the target rate of 75% of employees living locally, the increase in necessary primary school positions required would likely be approximately 38, an increase which may be enough to establish a new class or at least secure the positions of existing teachers. Similarly, there may be up to 20 additional students of high school age which is considered to be within existing capacity.

Vocational education programs are currently limited and the Gloucester LGA is underserved in this area. The Applicant has made a commitment to supporting apprenticeships, tertiary education and training/upskilling. This commitment would assist in minimising the potential impacts from the amended Project and provide a benefit to the broader community, particularly to young people.

Emergency Services

It is unlikely that the police services would be impacted due to the generally low crime rate, while consultation with the local ambulance service suggested the service is confident of delivering the necessary level of service.

The Applicant would also address emergency service issues for its operations and employees in its own Emergency Plans.

It is also noted that mine employees and their families moving to and living in the Gloucester LGA would provide an increase of potential volunteers for community services such as the SES and the Rural Fire Service. The Applicant would adopt policies that encourage employee volunteering in local organisations.

4.17.6.4 Community Sense of Place and Amenity

The Gloucester Community has a strong “sense of place” and people highly value the amenity of the area. This was a theme in much of the research undertaken by Key Insights in 2012/2013 and again in 2016.

When talking with local organisations and people, an often-mentioned desire was: “We don’t want to change from being a town with a mine to a mining town.” To a degree, the existing mining at Stratford and Duralie has been accepted. However, the former AGL Gloucester Gas Project and the 2013 Project were seen by a broad component of the community as being significant threats to the character and amenity of the Gloucester LGA. In part, this view is driven by environmental concerns but the most significant driver of this impression for these projects was the proximity to the Gloucester township and its perceived potential impacts on amenity and the rural character of the township.

People interviewed for the research undertaken by Key Insights in 2012/2013 and in 2016 who were supportive of the 2013 Project and amended Project respectively, and related benefits for Gloucester, still desired balance. They welcomed change, but not change at the expense of the amenity of the town. While wanting to see change in terms of economic activity and opportunities, they also wanted to see the township maintain its diverse economic base and rural ambience. They were able to support the 2013 Project and the amended Project because they believe that balance is possible and, in general, they trust in the environmental standards and monitoring that would be applied.

The former Gloucester Shire Council opposed the 2013 Rocky Hill Coal Project primarily because of its proximity to the township and the fact that some of the proposed mine would be on land that has been zoned E3, Environmental Management and, though recognising the value of mining to the local economy, did not want a mine in this zoning and in this proximity to the township of Gloucester.

The Visual Impacts Assessment (RLA 2016a) has identified that short-term visual impacts would occur during the construction of the western and northern amenity barrier after which the activities within the Mine Area would be shielded behind the vegetated barriers for most of the operational life of the amended Project. The Applicant recognises that most residents in Forbesdale Estate do not want to overlook a mine and accordingly the method of construction and progressive revegetation of the western and northern amenity barrier would be expedited to limit visual impacts, even during its construction.

Key Insights (2016) consider that the reduced scale of the amended Project, the shift of the major processing components and product despatch to the Stratford Mining Complex, and the limitation of the operations to the day and evening periods would reduce the potential impact on the township but that the important economic benefits would remain. Agriculture, government services and projects like The Gloucester Project would still be able to contribute to the sense of place with which people identify and would provide continuity of identity during a time of change.

The balance between the economic and social benefits of the amended Project and environmental and amenity impacts would be managed through the implementation of environmental management measures including those related to potential impacts to visual amenity.

Key Insights (2016) also concludes that the continued use of GRL-owned land for agricultural activity will be a balancing attribute of the presence of GRL in the Gloucester LGA.

4.17.6.5 Social Cohesion

The Gloucester community is already a community divided over mining, with AGL's Gloucester Gas Project, the extension to Stratford Coal Mine, and the 2013 Project and amended Project having all generated varying degrees of passionate reactions within the Gloucester LGA. There are a number of variables that determine peoples' positions such as whether they already benefit or have benefitted from mining either through employment or land sales; whether they stand to benefit from mining in the future through business activity, and whether they are at risk of being impacted by living very close to the Site.

It is the observation of Key Insights (2016) that existing tensions have not ruptured the town socially and that, overall, people act as a community in harmony. Furthermore, Key Insights (2016) are of the opinion that most of the existing tensions would subside when the amended Project is either approved or rejected. After the decision is made, residents and businesses would have certainty and continue to act as a cohesive community with either outcome. Gloucester is an area of high social capital and as such a place where people would want to live. The Applicant intends to implement a wide range of recommendations presented by Key Insights (2016) that would enhance the social fabric of the township once they have been implemented.

If the amended Project is approved, it may result in further social disruption for those already feeling stressed about the approval process and this would be particularly true for those that feel they would have to re-locate if the amended Project is approved. Conversely, if the amended Project was to be refused, there would be those who would be disappointed about the lost opportunities and the need to re-locate to obtain training and/or work. There is evidence of this response following the withdrawal of AGL from the Gloucester LGA (acknowledging however

that the amended Project differs from the AGL project in terms of the perceived potential impacts and related community concerns), with some community members feel a sense of relief, while others are distressed about the lost business and employment opportunities.

The Gloucester LGA is a relatively low crime area and significant increases in crime would impact on social cohesion. Recent research indicates that some of the social costs of the mining boom related to new patterns of crime and violence, particularly in the large fly-in fly-out camps. Although the Applicant has no intention of building work camps, this research emphasises the importance of committing to a policy of recruiting and maintaining employees who live locally. Key Insights (2016) also considers it is important for the Applicant to have policies that address gender balance in the workforce to avoid the subtle masculinisation of the workforce over time, that is, an increased number of jobs for males without similar growth in female employment.

The other consideration in relation to social cohesion is the potential impact of an increase of miners and/or an increased number of existing residents on higher wages. While there is a range of incomes in the Gloucester LGA at present, the mining sector has traditionally paid higher wages on average than other sectors. If a group of people have much stronger buying power than other sectors in town, this can lead to resentment and impact negatively on social cohesion. This has previously been referred to as a “two tier” economy which is present in many regional communities due to the divide between those that are limited by employment opportunities and difficulties in creating sustainable businesses and those that are in semi-retirement or run businesses that require tourist or other external participation rather than local trade. It should be made very clear that the emergence of “tiers” in local economies is as much about the aging of the population, out migration, disparate skill levels, falling agricultural prices and the impacts of “tree changers” as it is about mining and resources. The Applicant notes that it will be extremely important that the social and economic benefits arising from the Community Grants Program and managed through a Community Trust are distributed equitably throughout the entire community. The Applicant would also continue to participate in community-building activities and community networks, such as the current contributions to the Gloucester Men’s Shed.

4.17.6.6 Employment

Employment benefits for the Gloucester LGA and the Hunter Region delivered by the amended Project would be significant. These social benefits would include the following.

- Increased population leading to increase viability of local institutions, services and businesses.
- Increased value in the property market due to increased demand for local housing.
- More potential members for community organisations and clubs with increased volunteer capacity.
- Increased ability to attract training providers and courses to Gloucester.
- Improvements to the local skill base.
- Increased economic activity in all sectors.
- Enhanced diversity within the community, including more families with young children.
- Enhanced training and career path opportunities for existing local people.

The social benefits associated with employment would be maximised for the local area if a high percentage of workers live in the Gloucester LGA. Previous studies indicate that social benefits are strongest for projects where 75% or more employees are a resident workforce but that benefits diminish significantly and are very weak for projects with a resident workforce of less than 25%.

As discussed in Section 4.17.5, the Applicant is targeting a resident workforce of 75%, therefore maximising the social benefits from the amended Project. Key Insights (2016) consider that this is a desirable target. The potential success of reaching this target is supported by a high level of relevant local skills and experience identified through the employment Expression of Interest placed in the Gloucester Advocate newspaper and the Applicant's website, which also indicated a strong interest shown by those living outside the LGA to relocate to Gloucester, and the Applicant's experience elsewhere in rural NSW.

There are, however, social risks associated with increased population and of increased employment opportunities, including the following.

- Wage inequity leading to lack of social cohesion.
- Stress on capacity of some social infrastructure to meet demands of the new population.
- Upward pressure on the rental market and housing prices to the detriment of low income earners.
- Ongoing loss of workers from other industries to mining.
- Worker fatigue and traffic impacts if new employees drive in and drive out as opposed to residing locally.

Previous studies have also indicated that the use of block rosters can result in a range of negative social outcomes including fatigue-related injuries and accidents; greater abuses of alcohol and drugs; family violence and break-ups; parenting problems; mental health problems; and other issues. The Applicant does not propose to use block rosters and intends to utilise shifts arrangement which reduce these potential impacts.

The Applicant acknowledges comments made during consultation regarding the difficulty that some existing businesses within the Gloucester township have in finding skilled employees. This is indicative of the challenges facing all parts of rural NSW. If young people don't see employment opportunities, they are reluctant to stay. However, they may return when they wish to start to establish a family. Without perceived opportunities they would not look to return. The approval of the amended Project would increase the size of the local population and economic activity in the area, increasing the size of the workforce pool and attracting more businesses across the sector. One of the recommendations made by Key Insights (2016), and supported by the Applicant, is for joint recruitment operations which, if successfully implemented, may attract young couples with a variety of skills to the area.

The economic impacts of employment for the Gloucester LGA and other parts of the NSW are detailed in Section 4.18 and Volume 5 Part 15 of the *Specialist Consultant Studies Compendium*.

4.17.6.7 Tourism

While it is accepted that some local residents and tourism operators may perceive a negative impact from the operation of the amended Project, it is not accepted that mining and tourism cannot coexist and flourish. Areas such as Mudgee, Cessnock and Gunnedah in NSW, and Carnarvon Gorge and Arcadia Valley in Queensland, have recorded strong and sustained growth in visitor numbers in parallel with growth in mining and mining employment.

Essential Solutions considered impacts to agribusiness and tourism in its Agricultural Impact Assessment (see Section 2.9.3 and Section 6.3.8 of Volume 5 Part 13 of the *Specialist Consultant Studies Compendium*). Essential Solutions consulted with tourist operators in Mudgee who reported average annual business growth of approximately 2.5% over a time when mining in the region was also growing. Similarly data from the Gunnedah/Boggabri region and specifically the Gunnedah Visitor Centre (see **Figure 4.77**) indicates that tourist visitation did not decline when mining activity significantly increased between 2005 and 2013, a period that has seen mining growth in that region. Essential Solutions has also consulted with experience-based tourism operators, some of which indicated that mining employees were a large proportion of their customers.



Similar data to that presented in **Figure 4.77** is not currently available for Gloucester. However Key Insights (2016) research suggests that accommodation providers welcome the potential increase in business visitors, while recreational tourism operators remain concerned at amenity impacts that may translate to their business.

The Applicant's has committed to mitigate potential visual impacts associated with the amended Project, and other potential impacts to amenity such as those associated with noise and air quality would also be mitigated and/or managed. It is therefore considered that on the basis of successful coexisting tourism and mining businesses in other regions, that no adverse impacts to tourism in Gloucester and surrounding areas can be expected as a result of the amended Project.

4.17.6.8 Housing

Increased population as a result of employment of large numbers of workers relocating to an area is likely to have both positive and negative impacts on the housing market. The increase in demand for housing would affect aspects such as house prices, rent and local construction activity.

While some impact from the additional employment and new residents is likely and beneficial for existing home and property owners, the extent to which inflationary impacts occur could be managed through increasing the local availability of land and housing stock. Community project proposals that address housing stress for local people which have the potential to mitigate the impact on the most vulnerable low income earners in the community could be one area for consideration by the committee administering the Community Trust. It is noted however, that according to local Real Estate Agents, there is ample land available for new housing projects and development of this land would be market driven. Key Insights (2016) has observed that the property market in 2016 is stable and that there is rental availability, especially in the lower end of the market.

It should be noted that the Applicant owns several blocks of land with existing houses, which may be made available to employees seeking long-term rental arrangements within the Gloucester LGA. The Applicant would also maintain a database of local rentals and options for interim and short term accommodation for employees not living in the Gloucester LGA which would also assist in reducing the potential inflationary impacts.

The Applicant acknowledges the uncertainty concerning the potential impact to local land values and rental rates as a result of the amended Project. This has previously been raised with the Applicant as an issue of particular concern for property owners within the Forbesdale Estate. The amended Project has been carefully designed so as to minimise any resultant short and longer-term direct or indirect impacts including the construction of the western and northern amenity barrier and tree screening that has been implemented. Key Insights (2016) consulted with local real estate agents who commented that the main issue is not property prices but saleability of properties (see Section 4.1.2.7 of Key Insights (2016)).

It should be noted that there are a wide range of economic factors that influence house prices and saleability. Factors relevant to Gloucester include the Tree Change migration to the region which has artificially pushed up house prices, particularly for small lot rural residential zones, larger higher value residential lots and small acre lifestyle lots, as these are the key targets of the new residents. Broader changes in the economic climate, such as the Global Financial Crisis and more recently the slow down in the resources sector and in China and the Australian economy in general and the associated economic uncertainties are all factors that have in the past, or are currently influencing house prices.

Key Insights (2016) indicates that potential positive impacts for current home owners include a general increase in property values and rental returns as a result of new residents that move to Gloucester. These impacts need to be considered with the potential negative impacts to house saleability for those properties in close proximity to the Site and the potential rise in rental rates for some properties. Concerns regarding saleability (in the event the amended Project proceeds) would diminish given the experience of property sales within the Singleton Heights, Retreat Road and McDougalls Hill areas of Singleton, each of which lies within 1km to 2km of existing open cut coal mine developments.

4.17.6.9 Social Impacts of Economic Benefits and Costs

The economic assessment presented in Section 4.18 and Deloitte Access Economics (2016) has assessed the expected benefits and costs associated with the amended Project to the NSW community through a cost benefit analysis and at a local scale through a local effects analysis. The assessment concluded that benefits would outweigh costs for both the NSW community and at a local scale.

In addition to the benefits associated with direct employment, incremental wage differences and non-labour spending, the investment in the local community proposed by the Applicant would result in social benefits that in effect ‘flow-on’ from the direct investment and indirectly benefit the local community. These social benefits are difficult to quantify. Further benefits would arise from the contributions made by the Applicant through the Community Grants Program. The social benefits are therefore considered qualitatively and summarised as follows.

- The focus on attracting a larger working age population to reside within the Gloucester LGA would improve the dependency ratio and offset the imbalance created by an ageing population.
- The changes in population associated with locally resident employees and their families would improve the viability of services and may result in employment growth directly from population growth. Where a joint recruitment program is successful, improvements may result for issues such as the aging cohort of health services staff.
- The research undertaken by Key Insights (2016) identified that local farmers have previously taken advantage of the mining industry through various forms of employment, access arrangements and land sales to enhance the viability of their businesses. This may also result from the presence of the amended Project.
- Tourism operators are expected to benefit from the increased business travel expenditure and locally resident employees, which will add to the viability of tourist attractions such as outdoor adventure-related businesses.
- Greater employment opportunities in the local community would reduce the out-migration of the working age population to larger employment centres.
- The increased population and skill requirements may encourage tertiary and other training providers to establish centres or courses within the Gloucester township, an area that Key Insights (2016) considered was under-supplied in Gloucester.

The social impacts associated with environmental, social and transport economic costs have been addressed in Section 4.18.3.3, and relate principally to the impacts relating to Aboriginal cultural heritage, historic heritage and visual amenity that are acknowledged but difficult to quantify.

4.17.6.10 Cumulative Impacts

There is concern in the community about cumulative impacts associated with the amended Project and the Stratford Coal Mine Extension Project. It is, however, acknowledged that the decision by AGL not to proceed with its Gloucester Gas Project removed some potential

cumulative impacts. The Stratford Mining Complex has been operating at reduced levels since mid-2014 and plans to commence activities under the Stratford Extension Project in 2018, while the Duralie Mine is projected to close in 2017. Both of these changes would occur prior to the commencement of the amended Project. Regardless of this, the community has identified cumulative impacts to air quality and water resources as primary concerns. These issues are addressed in Sections 4.4 and 4.6.

Cumulative social impacts are primarily related to population increase and the increased presence of mining and mine employees in the Gloucester township and the nearby villages. Key Insights (2016) considered cumulative impacts associated with population growth to be unlikely given the withdrawal AGL, the temporary reduction in activity at the Stratford Mining Complex and the projected closure of the Duralie Mine.

It is accepted that the presence of several large projects increases the stress for some people, particularly those who desire minimal change for the area. However, there is no hard data available yet to test if this stress converts to mental health hospital admissions or other indicators.

The potential for positive cumulative impacts should also be noted. It is likely that the amended Project would positively contribute to the Gloucester LGA through added diversity of the local population, the provision of critical mass to support important services; attraction of education providers and changes to supply chain business opportunities. This would all contribute to the social character of the Gloucester township and to a positive economic climate.

In 2016, there remains some concern about both the proximity of the amended Project to the township and the cumulative effect of an increase in overall mining shifting the character of the Gloucester LGA from rural to mining centred. Key Insights (2016) considers that the amended Project would not adversely affect other industry sectors such as tourism and agriculture and would contribute to the viability of local supply businesses. There are many businesses within Gloucester that are small in scale, generational, operated solely by owners and/or that rely on the natural environment. Adverse changes to the operating environment can be significant for these businesses. However, it is not true that the operation of the amended Project and these or other businesses within the former Gloucester LGA are mutually exclusive. The assessment of environmental, social and economic impacts of the amended Project has concluded that the amended Project achieves a sustainable outcome for the local and wider environment. In addition, the Applicant has made a series of commitments that will enhance the employment and other direct economic benefits of the amended Project and provides education and training opportunities to encourage a diverse economic base for the area.

4.17.7 Conclusion

Consideration of potential social risks and social benefits associated with the amended Project indicates that the majority of issues that were raised in regard to the 2013 Project remain relevant in 2016. Key Insights (2016) assessed a range of potential social risks and social benefits using input collected through a comprehensive research program. It is evident that some parts of the community are distressed by the prospect of approval of the amended Project and some are distressed by the prospect that the amended Project may be rejected. Other community members are seeking a balance through environmental management commitments, contributions and local employment. Notably, some parts of the community report being tired

and over-consulted on the issue of mining in the Gloucester LGA. However, Key Insights (2016) considered that the existing strong social cohesion within the Gloucester community would remain whether the amended Project is approved or rejected.

The Applicant supports the recommendations made in the Key Insights (2016) assessment and acknowledges the residual environmental impacts may have subsequent social impacts. Commitments to significant contributions through a Community Grants Program and other community focused management and mitigation measures would balance the social risks and social benefits for the community and contribute to positive economic benefits as discussed in Section 4.18.

4.18 ECONOMIC IMPACT ASSESSMENT

The economic impact assessment of the amended Project was undertaken by Deloitte Access Economics Pty Ltd. The full assessment is presented in Volume 5 Part 15 of the Specialist Consultant Studies Compendium and is referenced throughout this section as Deloitte Access Economics (2016), with the relevant information from the assessment summarised in the following subsections.

4.18.1 Introduction

The risk assessment undertaken for the amended Project (Section 3.3.1 and **Appendix 6**) focussed upon the potential impacts relating to the “socio-economic” setting and their risk rankings given the reference in the DGRs to “social and economic” issues. The bulk of the issues addressed in the risk assessment focussed upon social issues and as such are not re-addressed in this subsection. The social impacts of the amended Project are addressed in Volume 5 Part 14 of the *Specialist Consultant Studies Compendium* and Section 4.17 of this document.

The specific matters relating to economic issues within the Director-General’s Requirements issued by the then DP&I (now DPE) are as follows.

- Assessment of potential direct and indirect economic benefits of the Project for local and regional communities and the State.
- Provision of a detailed description of the measures that would be implemented to minimise the adverse economic impacts of the Project, including any infrastructure improvements or contributions and/or voluntary planning agreement or similar mechanism.
- Provision of a detailed assessment of the costs and benefits of the development as a whole, and whether it would result in a net benefit for the NSW community.

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the DGRs from the former Gloucester Shire Council, NSW Health – Hunter New England Local Health District and BGSPA. These further matters identified in the additional correspondence are generally consistent with the DGRs, although BGSPA requested that the consequences for the local economy be specifically addressed.

The objective of an economic impact assessment is to use a structured approach to assess whether a Project is likely to result in overall benefits for the NSW community. Deloitte Access Economics (2016) has undertaken a cost benefit analysis (CBA) and local effects analysis (LEA) in accordance with the *NSW Government Guidelines for the economic assessment of mining and coal seam gas proposals, 2015* (the 2015 guidelines), with the CBA also drawing on *NSW Treasury Government Guidelines for Economic Appraisal, 2007* (the Treasury guidelines). The 2015 guidelines require assessment of the estimated incremental change in costs and benefits of the amended Project, relative to a baseline or ‘no mining’ case. For example, the Applicant has estimated average annual wage payments would be in the vicinity of approximately \$9.0 million. However, for the economic assessment prepared in accordance with the above guidelines, Deloitte Access Economics (2016) use an average incremental increase of approximately \$1.0 million per year based on publicly available data for the mining industry and all other industries within the local area.

It should be noted that the 2015 Guidelines are not referred to in the DGRs and therefore are not strictly required to be applied to the amended Project. Notwithstanding, the 2015 guidelines have been applied by Deloitte Access Economics (2016) in preparing the CBA and LEA for the amended Project to ensure that the economic assessment is based on current policies and guidelines.

A conservative approach has been assumed when assessing costs and benefits relevant in the analysis.

4.18.2 Actual Financial Payments and Net Present Values

In accordance with the 2015 guidelines, values estimated in the assessment are presented as ‘net present values’ using a 7% discount rate and are therefore reported in 2016 dollars. The 7% discount rate is nominated in the 2015 guidelines, the NSW Treasury guidelines and is consistent with international best practice. It should therefore be noted that the values used in the Deloitte Access Economics (2016) assessment do not represent the ‘actual financial payments’ that would be transacted under the amended Project, but the value of the costs and benefits in ‘net present value’ (NPV) terms for the purpose of assessment. For example, the following costs and benefits have been included in the assessment.

- The net benefit to NSW is assessed as \$89.5 million over the life of the amended Project, in NPV terms. However actual financial payments made within NSW would be higher and would exceed \$200 million.
- Local government rates are assessed as an incremental benefit of \$2.7 million in NPV terms over the life of the amended Project, where the undiscounted value over the same period would be approximately \$5.6 million.
- Royalty payments are assessed as an incremental benefit of \$63.4 million in NPV terms over the life of the amended Project, where the undiscounted value over the same period is approximately \$144.0 million.
- Company taxes are assessed as an incremental benefit of \$59.8 million in NPV terms over the life of the amended Project, where the undiscounted value over the same period is approximately \$146.0 million.

- Company tax share to NSW received through Federal funding of infrastructure, health and education services is valued as an incremental benefit of \$19.1 million in NPV terms over the life of the amended Project, where the undiscounted value over the same period is approximately \$46.7 million.
- Funds to be contributed to the Community Grants Program are assessed as an incremental benefit \$2.9 million in NPV terms over the life of the amended Project, where the undiscounted value over the same period is \$6.5 million.
- External costs associated with residual environmental impacts are assessed as an incremental cost of \$9.9 million in NPV terms over the life of the amended Project, where the undiscounted value over the same period is approximately \$24.0 million.

The use of a 'net present value' in the assessment accounts for differences in the value of costs and benefits spread over time or in other words the change in value of the 'actual financial payments' over time. The undiscounted dollar values are not suitable for assessment purposes and have not been used by Deloitte Access Economics (2016) or in this EIS. However, these figures represent the 'actual financial payments' that, in the example of royalty payments above, would have been paid by the Applicant to the NSW Government by the end of coal extraction activities.

All dollar values presented in the remainder of this section are presented in terms of net present value, that is, a 7% discount rate has been applied to discount all values to 2016 price terms.

4.18.3 Cost Benefit Analysis (NSW)

4.18.3.1 Methodology

The methodology for the CBA has been drawn from the high level framework provided in the Government Guidelines for Economic Appraisal 2007 prepared by the NSW Treasury and the 2015 guidelines which provide a framework specific for the application of a CBA (and LEA) for mining developments. The 2015 guidelines identify the type of information and analysis required by the NSW Government to inform its assessment process for the economic assessment of the amended Project. The CBA assesses the public interest by estimating the net present value of the amended Project to the NSW community. The LEA (Section 4.18.4) assesses the likely impacts of the amended Project in the locality.

In summary, the following steps have been followed by Deloitte Access Economics in preparing the CBA.

- Establishing a Base Case against which to assess the economic and other impacts arising from the amended Project.
- Defining the scope of the assessment by considering the inputs required to meet the objectives of the amended Project.
- Quantifying changes resulting from the amended Project relative to the Base Case, including:
 - economic benefits such as revenues from the coal output and royalties;
 - economic resource costs such as capital expenditure and operating costs; and
 - externalities including environmental and social impacts.

- Estimation of the monetary value of these changes using market prices, where available, otherwise using imputed prices or a qualitative assessment.
- Estimating the net present value (NPV) of the amended Project's future net benefits by applying an appropriate discount rate.
- Undertaking a sensitivity analysis on the key variables to address uncertainties related to specific benefits and costs.
- Assessing the distribution of benefits and costs across different groups and geographic levels.
- Reporting results that incorporate unquantified impacts, so that all material that may be relevant to the decision maker is included.

Table 4.82 identifies the costs and benefits considered by Deloitte Access Economics in their analysis.

Table 4.82
Benefit and Cost Items Included in the Cost Benefit Analysis

Item	Benefit components	Cost components
Net producer surplus	Gross mining revenue Residual value of land Residual value of capital	Operating costs Capital costs Decommissioning costs Environmental mitigation costs Transport management costs Rehabilitation expenses Purchase costs for land Local contributions Taxes (Australian, state and local) Royalties
Royalties	Royalties payable to NSW Government	
Company income tax	Company income tax payable to the Australian Government	
Local government rates	Council rates payable to NSW local governments	
Economic benefit to existing landholders	Payments to existing landholders	Opportunity cost of land
Economic benefit to workers	Wages paid to workers	Reservation wage for workers in the mining sector
Economic benefit to suppliers	Revenue paid to suppliers	Opportunity cost of supplier goods and services
Net environmental, social and transport-related costs		Greenhouse gas emissions Air quality Ambient noise Traffic and transport* Biodiversity* Groundwater* Surface Water* Aboriginal heritage* Non-Aboriginal heritage* Visual amenity*
Net public infrastructure costs	Local contributions	Incremental costs for Government associated with provision of public infrastructure, net of payments made by the Applicant
* Qualitative values only were assessed for these items		
Source: Deloitte Access Economics (2016) – Table 4.1		

4.18.3.2 Scope

The Base Case for the economic assessment represents a ‘business as usual’ or ‘do nothing’ scenario against which to assess the potential economic, social and environmental changes due to the amended Project. Deloitte Access Economics (2016) refer to the land and soil capability and agricultural setting presented in Section 4.8.5.1 and Section 4.16.2 respectively to establish the Base Case that assumes continued minor grazing activity and native vegetation conservation in perpetuity on land largely identified as of classes 4 and 5 according the NSW Office of Environment and Heritage land and soil capability assessment scheme. Though the existing interaction with the Speldon Partnership (Speldon) has resulted in an additional 1 130ha of land within and in the vicinity of the Site being leased to Speldon for the purposes of grazing cattle and fodder production, it has been conservatively assumed that this land would have remained under lease for the Base Case and therefore no additional revenue is attributed to the lease agreement.

The case for the amended Project is based on the scope of the Project as presented in Section 2 and assumes a close interaction with the Stratford Mining Complex.

4.18.3.3 Results

The following summary of results presents the NPV of benefits and costs associated with the amended Project to the NSW community. Values have been assessed by quantifying, where possible, the incremental costs and benefits compared to the Base Case. The share of these costs and benefits attributable to NSW is also presented below. Where it was difficult to quantify the costs or benefits of the amended Project, a qualitative analysis was undertaken.

Deloitte Access Economics (2016) estimated that the amended Project would deliver the following economic benefits to the NSW community.

- A net producer surplus attributable to NSW of \$4.6 million.
- Royalties payable to the NSW Government of \$63.4 million.
- Company income tax attributable to NSW of \$19.1 million.
- Local government rates of \$2.7 million
- Local contributions of \$2.9 million.

Once the estimated environmental, social and transport costs of \$3.3 million over the life of the amended Project have been accounted for, the net economic benefit to NSW is estimated to be approximately \$89.5 million in net present value terms.

Net Producer Surplus Attributable to NSW

Deloitte Access Economics (2016) has estimated that the net producer surplus of the Base Case scenario is negative \$0.8 million based on the payments of local Council rates for the continued use of the land for rural residential and farming purposes.

The total net producer surplus of the amended Project is estimated at \$79.4 million in present value terms, calculated as total revenue net of all direct costs, taxes and royalty payments. Overall, the amended Project would generate \$80.1 million in additional value, relative to the Base Case.

Table 4.83 provides a summary of values applied by Deloitte Access Economics (2016) to establish the net producer surplus.

Table 4.83
Calculation of Net Producer Surplus

Item	Base Case (\$m, NPV)	Project Case (\$m, NPV)	Incremental (\$m, NPV)
Revenue			
Gross mining revenue	-	793.6	793.6
Residual value of land	-	-	-
Residual value of capital ^a	-	-	-
Subtotal	-	793.6	793.6
Costs			
Operating costs	-	490.6	490.6
Capital costs	-	81.4	81.4
Decommissioning costs ^b	-	-	-
Environmental mitigation costs	-	0.7	0.7
Transport management costs ^c	-	-	-
Purchase costs for land	-	8.0	8.0
Local contributions	-	2.9	2.9
Subtotal	-	583.6	583.6
Taxes			
Corporate income tax	-	59.8	59.8
Payroll tax	-	3.9	3.9
Local government rates	0.8	3.5	2.7
Subtotal	0.8	67.2	66.4
Royalties			
Ad valorem coal royalties	-	63.4	63.4
Subtotal	-	63.4	63.4
Net producer surplus	-0.8	79.3	79.3
Note: a and b - Decommissioning costs are assumed to be completely offset by the residual value of capital.			
c – These costs are included in ongoing capital cost estimates and have not been separately itemised.			
Source: Deloitte Access Economics (2016) – Table 4.2			

Details of the methods and assumptions used for calculating the revenues and costs detailed in **Table 4.83** are provided in Section 4.3 of Deloitte Access Economics (2016).

In accordance with the 2015 guidelines, to establish a net producer surplus attributable to NSW, Deloitte Access Economics (2016) applied the share of the total net producer surplus based on the Australian ownership of the amended Project (18.3%) and the NSW share of the Australian population (32%). The net producer surplus attributable to NSW is therefore estimated at \$4.6 million.

It is noted the 2015 guidelines require that the benefits to NSW associated with payment of payroll tax (\$3.9 million NPV) and local government rates (\$2.7 million NPV) are included in the net producer surplus rather than considering these as stand-alone benefits to NSW. The payment is then split by foreign/local ownership and the share of the benefit to NSW is derived based on population weighting and included as part of net producer surplus. In reality, these payments would be made directly to either the NSW government or Mid-Coast Council, respectively.

Environmental mitigation costs relate principally to \$0.7 million in net present value terms (\$0.9 million in undiscounted terms) for the establishment and management of the 267ha Biodiversity Offset Area (see Section 2.16.9).

It should be noted, however, that net producer surplus is only one component of the benefits to NSW of the amended Project and is essentially income generated by owners of the amended Project. This benefit represents additional income that is retained in NSW for the owners of the amended Project and does not represent benefits that accrue directly to the State of NSW, nor does it consider that it is likely that some of the net producer surplus which would flow to foreign owners is likely to re-enter the State in the form of investments to other projects.

Royalties

Royalties payable to the State of NSW were calculated using the open cut coal rate of 8.2% of revenue after the allowable deductions for the full cycle washing of the product coal, but excluding other potential deductions, e.g. levies, insurance etc. due to the variability in such payments and the difficulty in forecasting them accurately over time.

Royalties contribute the greatest overall incremental benefit to NSW as 100% is paid to the State of NSW.

Total additional royalties payable to the State of NSW under the amended Project are estimated to be approximately \$63.4 million.

Company Income Tax

The company income tax payable is estimated at approximately \$59.8 million for the amended Project, additional to the Base Case.

Deloitte Access Economics (2016) determined this value by applying a 30% corporate tax rate to an estimate of taxable income in each year, where taxable income was estimated from gross mining revenue, less total costs, royalties and depreciation.

On the basis that NSW accounts for 32% of the Australian population, the share of company income tax attributable to NSW is estimated to be approximately \$19.1 million for the amended Project.

Local Government Rates

Local government rates were estimated at \$0.8 million in the Base Case and \$3.5 million in the Project Case in present value terms.

On the basis that the Council rates relevant for the Project Case are collected by the NSW local governments, all of the local government rates payable are attributable to NSW.

Benefits to Existing Landholders, Workers and Suppliers

For the purposes of the assessment, and under the definitions provided in the 2015 guidelines, Deloitte Access Economics (2016) assumed no additional benefits to existing landholders, workers and suppliers.

An additional 130ha of land would be purchased in the event the amended Project is approved as this land is held under an option to purchase. However, the analysis has conservatively assumed that any acquisitions are made at market value such that there is no additional surplus for existing landholders.

While all employment generated from the amended Project is expected to be from NSW, the analysis conservatively assumed that workers employed for the amended Project would not receive a wage premium and that any additional wage payment would be compensation for changes in working conditions (i.e. relocation or costs associated with travel) and not a premium. It should be noted that this assumes that alternative employment within the mining industry is readily available. Should this not be the case, and employment must otherwise be taken in an alternative industry, a benefit to NSW would result from the employment proposed under the amended Project. For the purposes of the assessment, it is assumed that a job is readily available, hence it is a conservative underestimate of benefits to the NSW community.

Although the amended Project generates additional demand for services to suppliers in NSW, additional producer surplus is difficult to measure. Accordingly, Deloitte Access Economics (2016) has conservatively assumed that suppliers to the amended Project will earn similar margins relative to what they could have received from other sources under the Base Case. As a result, no additional benefits to suppliers in NSW have been considered. Similar to consideration of benefits to employees, the assessment undertaken by Deloitte Access Economics has assumed that alternative sales would be readily available to suppliers, i.e. it does not take into account market conditions for these suppliers and, where the supply of goods and services may otherwise be limited by existing market conditions, the amended Project would result in a benefit to these suppliers. Hence, this approach represents a conservative underestimate of benefits to the NSW community.

Net Environmental, Social and Transport Costs

Net environmental, social and transport costs are summarised in **Table 4.84**, including the costs attributable to NSW. Of these costs, an estimated \$3.3 million is attributable to NSW.

Table 4.84
Environmental, Social and Transport Costs

Item	Base Case (\$m, NPV)	Project Case (\$m, NPV)	Incremental Change (\$m, NPV)	NSW community share (%)	Net cost to NSW (\$m, NPV)
Aboriginal heritage	-	-	-	-	-
Air quality	-	0.140	0.140	100%	0.140
Ambient noise	-	0.002	0.002	100%	0.002
Biodiversity	-	-	-	100%	-
GHG	-	9.725	9.725	32%	3.128
Water	-	-	-	100%	-
Historic heritage	-	-	-	100%	-
Traffic and transport	-	-	-	100%	-
Visual amenity	-	-	-	100%	-
Net costs	-	9.867	9.867	-	3.270

Source: Deloitte Access Economics (2016) – Modified after Table 4.5 and Table 4.6

The assumptions and calculations applied or the approach adopted for each item considered in terms of environmental, social and transport costs is provided in Section 4.3.7 of Deloitte Access Economics (2016), with the following aspects were assessed quantitatively.

- Costs associated with greenhouse gas emissions were calculated for ‘Scope 1’ and ‘Scope 2’ emissions based on forecasted European Union Emissions Allowance Units price from December 2014 converted to Australian dollars and scaled up to 2016 prices using the CPI.
- Air quality costs were assessed based on an estimated cost per tonne of PM_{2.5} emissions. Deloitte Access Economics (2016) estimated the cost per tonne of PM_{2.5} emissions using unit damage costs as recommended in PAE Holmes (2013), adjusted to 2016 values. The most relevant cost for the locality presented in PAE Holmes (2013) (‘Not in any Significant Urban Area’) was adjusted upwards to account for the higher population density of the former Gloucester LGA.
- Consideration of aggregated noise pollution conservatively assessed those cases where noise would exceed the intrusiveness criteria by 1dB(A) or more. Costs were estimated at a value of \$63.89 per dB(A) per household per year based on the upper limit of the range recommended by Navrud (2002), converted to 2016 Australian dollars.

Where environmental, social and transport costs have been assessed to be negligible or where residual impacts were difficult to quantify, costs were attributed qualitatively in accordance with the 2015 guidelines. Qualitative costs were assessed and/or acknowledged for the following aspects.

- Based on the findings of the Transport Assessment (see Section 4.9 and Constructive Solutions (2016)), the costs associated with mine-related traffic on the public roads surrounding the Site are considered to be negligible as the proposed implementation of traffic management measures would likely mitigate against any traffic impacts as a consequence of the amended Project, relative to the Base Case.
- Based on the findings of the Terrestrial Biodiversity Assessment (see Section 4.12 and Biosis (2016)), residual impacts to biodiversity associated with the amended Project would be relatively short term in nature and appropriately offset in perpetuity within the proposed Biodiversity Offset Area. The costs of implementing the biodiversity offset strategy are included in the environmental mitigation costs in **Table 4.83**.
- Based on the findings presented in the Groundwater Assessment (see Section 4.6 and AGE (2016)), the costs associated with potential impacts to local groundwater users, base groundwater flow to the Avon River and Waukivory Creek, groundwater recharge to the alluvium and identified groundwater dependent ecosystems assessed to be negligible as the amended Project is not likely to have a significant impact on water users or the environment. Investment in a water treatment plant would allow for the groundwater, treated to achieve a quality equivalent to that within the Avon River, to be used for irrigation, with releases to the Avon River during periods when irrigation is not possible.

- Based on the findings presented in the Surface Water Assessment (see Section 4.7 and WRM (2016)), the installation of a water treatment plant under the amended Project is expected to mitigate impacts on surface water runoff. The amended Project would not significantly impact on the availability of water to downstream users, and increases or decreases in flows, to the Avon River and Waukivory and Oaky Creeks would be minimal.
- Based on the findings of the Aboriginal Cultural Heritage Assessment (see Section 4.10 and ASR (2016)), the environmental and social costs associated with the salvage of identified sites are acknowledged qualitatively as these sites would effectively be destroyed as a result of the salvage of the identified artefacts. As these artefacts are not considered to be rare or significant, their salvage would preserve them for future educational purposes.
- Based on the findings of the Historic Heritage Assessment (see Section 4.11 and RLA (2016b)), no impacts would occur to State and locally listed sites with statutory protection; the landscape is not rare or uncommon and the views are not heritage views. The social cost associated with a change to the landscape resulting from the amended Project that may be felt by those with a cultural or historical connection to the area, cannot be quantified.
- Based on the findings of the Visual Impact Assessment (see Section 4.5 and RLA (2016a)), the amended Project is expected to have temporary visual impacts that would decline after the third year of operations. As it is difficult to apply appropriate monetary values to quantify the short term visual impacts of the amended Project, the potential social costs as a result of visual impacts associated with the amended Project are acknowledged only.

While economic costs have not been directly estimated for these potential environmental, social and transport impacts, Deloitte Access Economics (2016) concluded that these costs would need to total approximately \$12 million per year (in real terms) from 2018 to 2034 in order to fully offset the net benefits of the amended Project to the NSW community (discussed in Section 4.18.3.4).

Net Public Infrastructure Costs

Deloitte Access Economics (2016) considered it unlikely that the amended Project would generate any additional public infrastructure costs for any level of government, compared to the Base Case: the Applicant would bear the cost of all proposed infrastructure construction required for the amended Project and has also committed to the payment of a contribution for public road maintenance commensurate with the use of these roads by the heavy vehicles travelling to and from the Site.

In addition, over the life of the amended Project, the Applicant has agreed to provide ongoing local contributions to a community trust, estimated at approximately \$6.5 million. For the purposes of the cost benefit analysis, Deloitte Access Economics (2016) applied a 7% discount rate for these contributions and included a NPV of \$2.9 million under the net public infrastructure benefits to NSW.

4.18.3.4 Net Benefit to NSW

Based on the results summarised in Section 4.18.3.3, Deloitte Access Economics (2016) estimates that the amended Project will deliver a net economic benefit to the NSW community of approximately \$89.5 million, in 2016 price terms. This estimate was calculated using a 7% discount rate to present net present value, in accordance with the 2015 guidelines. The value is effectively discounted back to the start of 2016.

Royalties to the NSW Government are the main incremental benefit to NSW in comparison with the Base Case, with the key incremental costs of the amended Project being the additional external environmental costs.

Though Deloitte Access Economics (2016) undertook a qualitative analysis where it was difficult to quantify a particular cost or benefit arising from the amended Project, it was concluded that those non-quantified externalities would need to generate costs to NSW of around \$12 million annually (in real terms) for NSW from 2019 to 2034 to fully offset the net benefits of the amended Project. Deloitte Access Economics (2016) considered this outcome to be unlikely in view of the nature and scale of impacts from the amended Project as determined through the various independent studies underpinning the EIS.

4.18.3.5 Sensitivity Analysis

In accordance with the 2015 guidelines, a sensitivity analysis was undertaken that considered:

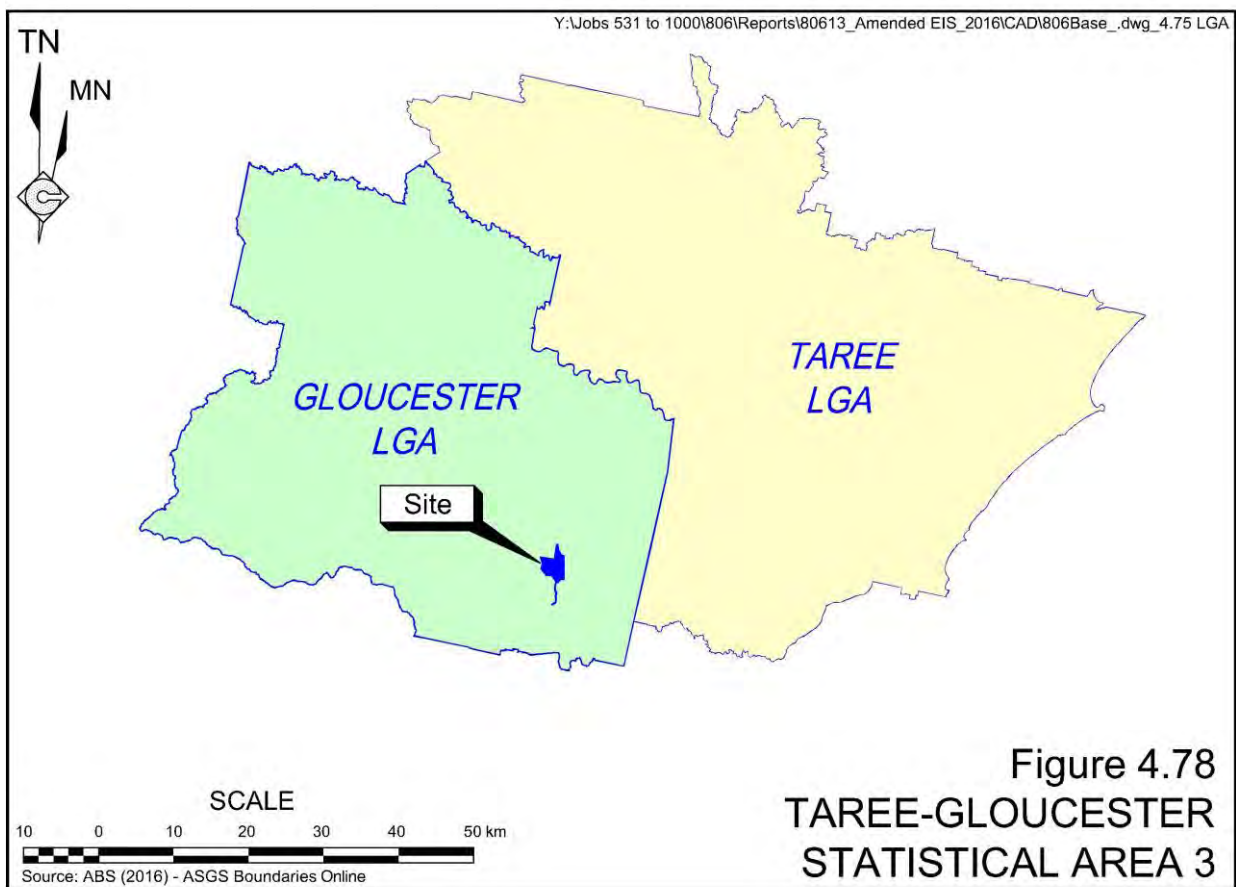
- alternative discount rates of 4% and 10%;
- variations to the following inputs to the CBA:
 - export coal price forecasts (+54% and -9%),
 - incremental royalties ($\pm 25\%$),
 - Project case company tax ($\pm 50\%$); and
- Pricing the cost of carbon according to alternative prices used in the Australian Treasury Clean Energy Future Policy Scenarios (+288% on average) and the US EPA Social Cost of Carbon estimates (5% discount rate scenario) (+87% on average).

The specific outcomes from the sensitivity analysis are provided in Section 4.5 of Deloitte Access Economics (2016). For example, in considering the potential for significantly lower coal prices over the operating period (i.e. prices in the 16th percentile of historical prices) the net economic benefits of the amended Project to NSW are estimated at \$74.1 million. In each scenario, the amended Project is estimated to deliver a net benefit for the NSW community, that is, the benefits for NSW are estimated to exceed the costs of the amended Project borne by NSW, including the quantifiable externality costs.

4.18.4 Local Effects Analysis

4.18.4.1 Methodology

Under the 2015 guidelines, a local effects analysis (LEA) is required in order to address the local economic impacts of the amended Project, specifically as they relate to local employment. The LEA is complementary to the CBA and largely translates the effects at a State level presented in the CBA to the effects at a local level, defined as the Taree-Gloucester Statistical Area 3 (SA3) (see **Figure 4.78**) as defined by the Australian Bureau of Statistics and required in accordance with the 2015 guidelines.



In accordance with the 2015 guidelines, the following steps have been followed by Deloitte Access Economics (2016) in preparing the LEA for the amended Project.

- Defining the spatial area and considering available statistical information relating to the population groups to be analysed.
- Quantitatively and qualitatively analysing the local effects relating to:
 - local employment effects, as well as the expenditure of additional labour earnings by both local and non-local workers in the local economy;
 - local non-labour expenditure effects, such as purchases made in the locality relating to the construction and operational activities;

- impacts to other local industries, such as agriculture or tourism in the local area, and potential temporary impacts on food and housing markets for local residents; and
- the positive and negative environmental and social externalities.
- Analysis of any flow-on effects such as price movements or changes in labour demand and supply that may change the local cost of living.

There are a number of important points when considering the results of the LEA.

- Firstly, the results of the LEA are not additional to those in the State level CBA. Rather, the results are largely already covered in the CBA.
- Secondly, it is not intended that the components of an LEA can be added together to provide a single summary measure – each item reported presents a different local effect.
- Finally, the LEA does not measure economic welfare outcomes.

The following subsections provide a summary of the LEA assessment presented in Section 5 of Deloitte Access Economics (2016).

4.18.4.2 Local Employment Effects

Deloitte Access Economics (2016) have estimated that the amended Project would directly employ an average additional 43 full time equivalent people during the site establishment and construction stage and an average 97 full time equivalent people during ongoing operations, incremental to the Base Case. For the purposes of the LEA, the local share of employment is assumed to be 75% based on the Applicant's commitment to this local resident target rate for employment by end of Year 3 of operations.

The relatively high percentage of locally resident employees would boost net income in the locality. Deloitte Access Economics (2016) estimated that the additional income would be approximately \$13,243 per person per annum, conservatively assuming that these individuals would earn the average wage in the locality (across all industries) of \$60,698 if they were not employed at the amended Project. The income estimates relate to net income (i.e. post-tax) and were developed by Deloitte Access Economics using the Australian Tax Office tax tables for 2016 (ATO, 2016).

4.18.4.3 Non-Labour Expenditure Effects

Expenditure made within the local area on other, non-labour, inputs such as fuel, tyres, water and professional services generates local economic activity.

The amended Project would result in an estimated \$31.0 million spent directly during the 10 month site establishment and construction stage and \$65.0 million each year on average during ongoing operations on non-labour operating expenditure. The local share of expenditure would be around 74% during both stages.

However, Deloitte Access Economics (2016) note that this is likely to be an underestimate of the local share of operating expenditure and does not account for the expenditure effects associated with capital expenditure (estimated to be approximately \$81.4 million (NPV) see **Table 4.83**) which, in the absence of information on its geographical distribution, can only be acknowledged qualitatively.

Effects on other Local Industries

The development (or extension) of a mining project can have direct effects on other local industries, even where there are no direct monetary links between that project and the local economy, e.g. through the purchase of goods and services or through generation of additional labour earnings. Deloitte Access Economics (2016) assessed effects on local industries as a consequence of the amended Project qualitatively, with the conclusions summarised as follows.

- The amended Project would result in a reduction in land available for other land uses. The area available to agricultural use will vary throughout the life of the amended Project with a maximum of approximately 450ha of land within the Site and 267ha within the proposed Biodiversity Offset Area removed from productive use at any time during the life of the amended Project. Both the Biodiversity Offset Area and the land that is rehabilitated post-mining to create wildlife corridors would be permanently removed from agricultural use.
- It is likely that carrying capacity, agricultural productivity and agricultural employment would increase for land that would be leased to the Speldon Partnership as a result of the amended Project. It is, however, acknowledged that this could potentially occur if the amended Project does not proceed.
- The amended Project is not expected to result in a significant change to the supply or demand on tourism or business travel nor on tourism or business travel services in the locality.
- Deloitte Access Economics (2016) anticipate that the amended Project will not result in significant constraints to local businesses as a result of supply or demand pressures from the amended Project and, consequently, that there will not be any demand-related adjustments in the cost of living for local residents.

It should be noted that the Social Impact Assessment (see Section 4.17.6.3) identified that existing social infrastructure capacity such as for child care and education may be impacted within Gloucester, however this is expected to be sufficiently managed through service planning. The Social Impact Assessment also notes the potential for housing stress and effects from potential wage imbalances and makes recommendations to mitigate and manage these impacts that have been accepted by the Applicant.

4.18.4.4 Environmental, Social and Transport Effects

Externalities (both positive and negative) are a major way in which the locality and, in particular the area in the vicinity of the amended Project, is affected by its development. For example, much of the noise and dust generated will affect those normally residing in the locality, as will the benefits arising from infrastructure investment. **Table 4.85** provides a summary of the local environmental and social effects for which a quantifiable value could be

estimated. Air quality impacts are expected to account for the majority of quantifiable local effects with the annual value of all external effects estimated to be approximately \$23,000 per year over the life of the amended Project.

Table 4.85
Incremental Change in Estimated Annual Average Local Externality Effects

	Site Establishment and Construction Stage		Ongoing Operations	
	In locality (\$m)	Outside locality (\$m)	In locality (\$m)	Outside locality (\$m)
Air quality	<0.001	-	0.020	-
Ambient noise	0.001	0.001	0.000	-
Greenhouse gas emissions	-	-	0.003	1.391
Total	0.001	0.001	0.023	1.391
Source: Deloitte Access Economics (2016) – Table 5.5				

As with the CBA, the majority of environmental and social effects were assessed qualitatively (as they were assessed to be minor or not readily quantifiable). The qualitative assessment of local costs associated with environmental, transport and social effects reflects the assessment presented in Section 4.18.3.3 at a local level. The assessment is summarised as follows.

- Any environmental or social cost associated with the destruction of a site and the salvage and removal of artefacts of Aboriginal Cultural Heritage significance, would principally occur locally and are largely predicted to be borne by the local Aboriginal community. However, these costs may be more broadly spread among individuals who feel a cultural or historical connection to the affected sites.
- The residual impacts to biodiversity associated with the amended Project would be relatively short term in nature and appropriately offset by the proposed Biodiversity Offset Strategy, which would be secured in perpetuity. The costs of implementing the biodiversity offset strategy would be borne by the Applicant and therefore no local cost is attributed to effects to biodiversity.
- The contributions to be made by the Applicant relative to road use and the proposed implementation of management measures would effectively mitigate traffic impacts associated with the amended Project. As a result, no local cost is attributed to traffic and transportation.
- While the amended Project would have some effects on water resources, these will not be significant in a downstream context in regards to surface water, and not likely to have a significant impact on water users or the environment in terms of groundwater. Investment in water treatment equipment will allow for the groundwater, treated to achieve a quality equivalent to that within the Avon River, to be used for irrigation, with releases to the Avon River during periods when irrigation is not possible. In this sense, it is unlikely that there will be significant costs borne by the locality.
- Any social cost associated with historic heritage would principally occur locally and may be felt more broadly by those with a cultural or historical connection to the area. However, these costs are difficult to quantify and the Historic Heritage

Assessment (see Section 4.11 and RLA (2016b)) concluded that no impact would occur to statutorily listed sites, that the landscape is not rare or uncommon and that the views are not heritage views.

- Although non-quantifiable, the visual amenity effects are predominantly borne by those living with the locality. However, the amended Project is expected to only have temporary visual impacts that will decline beyond Year 3.

4.18.4.5 Results

The estimated local effects are presented in **Table 4.86**. In summary, local benefits through employment and non-labour expenditure would increase as the amended Project moves from the construction and establishment stage to operations. Local economic benefits would significantly exceed local external costs resulting from environmental and social effects. In addition, GRL have committed to an estimated \$6.5 million (included in Deloitte Access Economics (2016) as \$2.9 million, NPV) in local contributions over the life of the amended Project which would be spent entirely locally.

Table 4.86
Estimated Local Effects

		Site Establishment and Construction Stage			Ongoing Operations		
		Project Direct (total)	Project Direct (local)	Net Local Effects	Project Direct (total)	Project Direct (local)	Net Local Effects
Employment	Average Annual Full Time Equivalent	42	32	7	97	73	16
	Incremental Change to Annual Income (\$million)	N/A	N/A	0.4	N/A	N/A	1.0
Annual Non-Labour Expenditure (\$million)		31	23	N/A	65	48	N/A
Annual Local Externalities (\$million)		0.001	0.001	N/A	1.414	0.023	N/A
N/A = Not Applicable							
Source: Deloitte Access Economics (2016) – Modified after Table 5.6 and Table 5.7							

4.18.5 Second Round and Flow-on Effects

Second round and flow-on effects may be estimated through various modelling or analyses (for example Computable General Equilibrium modelling or Input-Output analysis). However, these values are often difficult to accurately value and the 2015 guidelines suggest that a qualitative assessment of these effects may be the most appropriate approach to assessment. Deloitte Access Economics (2016) considered second round and flow-on effects in this manner with some of the assessed outcomes summarised as follows.

- The employment of 73 full time equivalent employees from the local area may generate an additional \$16.0 million in income within the locality (based on an average annual incremental income increase of \$1.0 million over 16 years). Some of this would in turn be spent locally on groceries, housing and entertainment and generate income and employment throughout the community.

- Capital expenditure for the amended Project may create profit opportunities for new and existing suppliers or may mean other mining operations have to pay more for their inputs due to competition for available services or products.
- The amended Project may reduce the incentive for out-migration of workers from the locality and attract new working age population to the locality.
- The amended Project may benefit the sustainability of local services or draw new services to the area, such as tertiary education services, through population influenced growth.

Overall, the analysis of the economy of the locality indicates that household income is lower than the state-wide average, that it has been growing more slowly than the state-wide average and that unemployment rates in the locality are higher than the state-wide average. This indicates that the economy in the locality would benefit and be able to expand given the inputs expected from employment, spending and contributions associated with the amended Project.

4.18.6 Conclusion

The results of the cost benefit analysis, including a comprehensive sensitivity analysis, conclude that the amended Project is estimated to deliver a net benefit for the NSW community.

In addition, the local effects analysis has considered the costs assessed in the cost benefit analysis at a local scale and confirmed that the local benefits resulting from employment and other spending would far outweigh external costs associated with assessed residual impacts.

The potential flow-on effects associated with the amended Project have been recognised and the economic benefits associated with employment, expenditure and contributions acknowledged qualitatively. Social benefits for the Gloucester community that may result from economic inputs are described in Section 4.17.6.9, however, in summary relate to benefits that may help to balance age distribution address the dependency ratio and therefore impacts of an ageing population, as well as improving the viability of local businesses and essential services.