4.6.6 Management and Mitigation Measures

The following Aboriginal heritage mitigation measures and management procedures would be implemented throughout the life of the Project.

- Sites GT OS1 & GT OS2 would be re-identified in the field with the assistance of a suitably qualified archaeologist and community representative(s). An appropriate fence on all sides of the site would be erected, access to the fenced area would be restricted and appropriate signage would be displayed.
- All other sites would be identified on plans held by the Environmental Manager and Mine Surveyor and activities in the vicinity of those sites would be prohibited. Those sites would not be fenced to limit the potential for inappropriate identification and disturbance of the sites.
- If items of suspected Aboriginal heritage significance are identified throughout the life of the Project, the following procedures would be implemented.
  - **Step 1** - No further earth disturbing works would be undertaken in the vicinity of the suspected item of Aboriginal heritage significance.
  - **Step 2** - A buffer of 20m x 20m would be established around the suspected item of Aboriginal heritage significance. No unauthorised entry or earth disturbance would be allowed with this buffer zone until the area has been assessed.
  - **Step 3** - A qualified archaeologist or the DECCW would be contacted to make an assessment of the discovery. Mitigation procedures would then be developed and implemented based on the assessment.
- If, throughout the life of the Project, suspected human remains are identified, the following procedures would be implemented.
  - **Step 1 -** the suspected skeletal remains would not be touched or disturbed.
  - **Step 2** - A buffer zone of 50m x 50m would be established around the suspected remains and all work in the vicinity of the suspected remains would be suspended until the area has been assessed.
  - **Step 3** - The NSW Police and the DECCW would be contacted to make an assessment of the discovery. If appropriate, mitigation procedures would then be developed in consultation with the registered stakeholders.

4.6.7 Impact Assessment

The likelihood of adverse Project-related impacts on Aboriginal sites or items of cultural heritage significance within the Project Site is considered to be negligible for the following reasons.

- The field survey did not identify any Aboriginal sites or items of cultural heritage significance within sections of the Project Site that would be disturbed.
- The mitigation measures and management procedures identified in Section 4.6.6 would ensure that any identified Aboriginal sites or items of cultural heritage significance would be appropriately protected.

As indicated in Section 4.6.2.2 the registered stakeholders were provided with a draft of ASR (2010a) on 2 August 2010 and were requested to respond to the draft by 1 September 2010. Responses were received from three organisations. The responses indicated that each group agree with the recommendations of the ASR (2010a). In addition, the following recommendations/comments were made.

- Should additional sites be identified then the relevant stakeholders should be consulted prior to any ground disturbing activities. The Proponent agrees with this recommendation.
- The Buru Ngunawal Aboriginal Corporation requested that subsurface testing should be undertaken at sites to be disturbed. As none of the identified sites would be disturbed, the Proponent contends that there is no requirement for subsurface test work.
- The Buru Ngunawal Aboriginal Corporation requested that sites officers be present during or prior to any ground disturbing activities. Given the density of sites identified, the Proponent contends that this is not justified.

4.7 NON-ABORIGINAL HERITAGE

4.7.1 Introduction

The DGRs issued by the Department of Planning require that the *Environmental Assessment* include an assessment of "***Heritage** – both Aboriginal and non-Aboriginal*".

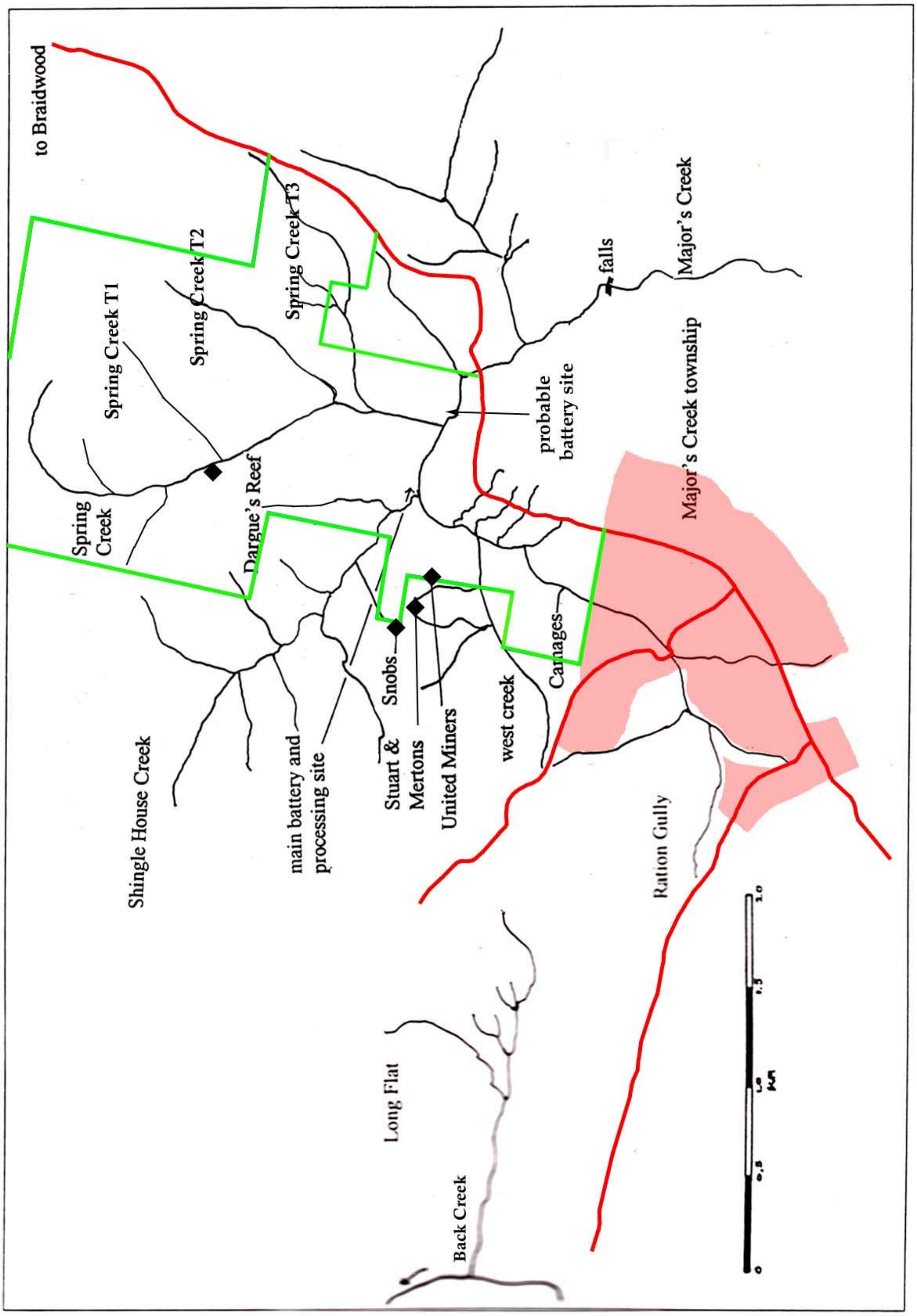
Based on the risk assessment undertaken for the Project (see Section 3.3), specific non-Aboriginal heritage-related impacts that may result as a consequence of the Project (<u>without the implementation of the safeguards, controls and mitigation measures presented in this section</u>) include loss or destruction of items of heritage significance.

A non-Aboriginal Heritage Impact Assessment has been completed by Mr John Appleton (BA (Hons)) of Archaeological Surveys & Reports Pty Ltd to address the DGRs and assess the impact of the Project on items of non-Aboriginal heritage significance. That report, which is referred to hereafter as ASR (2010b) is presented in full as Part 5b (Volume 2) of the *Specialist Consultant Studies Compendium*. This section of the *Environmental Assessment* provides a summary of that report. It is noted that Mr Appleton also undertook the Aboriginal Heritage Assessment (ASR, 2010a) which is discussed in detail in Section 4.6.

4.7.2 Recorded History of the Project Site

Section 3 of ASR (2010b) presents a summary of the background to the discovery of gold in Australia and more specifically in the vicinity of the Project Site. In addition, that section also provides a detailed chronology of the non-Aboriginal history of the Majors Creek Goldfield. **Table 4.27** provides a brief overview of that chronology. It is noted that in establishing the chronology, ASR (2010b) relied heavily on Dunshea (1997), McGowan (2000), McGowan (undated) and Pearson and McGowan (undated).

It is noted that the term "Majors Creek Goldfield" is a collective name for the area in which a number of mining operations were undertaken over a period of over eighty years from 1851 to the late 1930s. During that time, the number of operations, style of mining undertaken and population within the vicinity of the Project Site varied depending on availability of water, changes in mining technology and economic circumstances. **Figure 4.30** presents a plan showing the approximate location of a number of the historic mining operations.



Source: ASR (2010b) – **Figure 5**

Figure 4.30
Historic Mining Areas – Majors Creek Goldfield

Table 4.27
Majors Creek Goldfield Chronology Summary

Date	Majors Creek Population	Event
Feb 1851	?	First payable gold in Australia discovered at Ophir.
Oct 1851	600-700	Gold is found by Mrs Baxter of "Irish Corner". By the end of 1851, there were between 600 and 700 people living in Majors Creek.
Feb 1853	?	Dry diggings towards head of the Majors Creek with several deep shafts and tunnelling. Panning and cradling principal mining methods.
1854 to 1856	123 to 250	Rain and cold weather resulted in reduced mining activity.
1857 to 1861	?	Chinese miners arrive. Increased mining activity, principally using panning, cradling, sluices, long toms (a 3m to 5m long cradle) and puddling (a circular drum or hole in the ground used to mix water and alluvial ore).
1865-1866	200	Pillar Company dug 30m tunnel with tramway into Red Hill. Focus of mining activity moves to Araluen.
1869 to 1872	?	Start of hard rock mining, with crusher batteries installed in Majors Creek and shafts dug in a number of locations. Some issues with refractory ore (ore that is not amenable to processing using gravity methods). Alluvial mining principally undertaken by Chinese. Hard rock mining largely abandoned by 1872.
1877	171	Dargues Reef worked by a party of 24 working shareholders, plus 8 or 10 hired hands. Sluicing and limited hard rock mining only mining activities.
1880	?	A crushing mill, furnaces and arastras (large rock used to crush smaller rocks) constructed. Processing operations not successful.
1883	66	Limited mining operations, with only two miners extracting hard rock ore.
1888 to 1890	?	A stone cracker, centrifugal roller, quartz mill, two Frue vanners concentrators (a gravity-type concentrator) and a steam engine installed at Dargues Reef and 600 tons of ore extracted. A chlorination plant to refine refractory ore was also constructed but the site was closed by 1890.
1893 to 1900	?	Limited mining operations, principally sluicing.
1901 to 1905	?	Hard rock mining operations undertaken at Dargues Reef, United Miners and Thompsons Blow. There is a suggestion that cyanide leaching was undertaken.
1906 to 1916	?	Gradual decline in hard rock mining.
1916 to 1926	?	Limited alluvial mining.
1930's	?	Government subsidies encourages limited alluvial and hard rock mining. Mining operations ceased by 1940s.
Source: ASR (2010b) – After Section 3.		

4.7.3 Registered Sites of Heritage Significance

Searches of the following were made on 26 June 2010 to identify registered sites of heritage significance.

- *Tallaganda Local Environment Plan 1991* – Schedule 1.
- NSW Heritage Branch - State Heritage Inventory listing of places of heritage significance.
- National Trust listing of places of heritage interest.

No registered sites were identified within the Project Site.

4.7.4 Survey Methodology

Items of heritage significance were originally identified during the Aboriginal heritage assessment and their location identified for later follow up. Mr Appleton returned to the identified sites following completion of the Aboriginal heritage survey to photograph and assess the structures, items and places for their heritage significance.

4.7.5 Survey Results

Section 5 of ASR (2010b) presents a detailed description of the artefacts, including photographs, identified during the non-Aboriginal heritage survey. The following presents an overview of that description.

- Ceramic fragments – two ceramic and other glass fragments were identified in the vicinity of Gamage's claim (**Figure 4.30**). These could not be placed into a historical context.
- Dargues Reef railway – ore material was transported from the Dargues Reef Mine to stamp batteries in Majors Creek by rail. A second rail line transported ore from Snobs Mine to Majors Creek, joining the Dargues Reef line. These lines are now preserved as a series of shallow cuttings, depressions and eroding causeways. A rail-truck bogie was identified in the vicinity of the rail line, as were two twisted lengths of track protruding from rabbit warrens. Measurements from the rail bogie indicate that the rail line had an indicative inner track width of approximately 60cm.
- Stamp battery – the foundations and a shoe from a stamp battery were located adjacent to piles of uncrushed ore near the junction of Spring and Majors Creeks.
- Dredge shelves or buckets– three dredge shelves were located midway between the confluence of Majors and Spring Creeks and the Majors Creek Road bridge. ASR (2010b) note that McGowan (2000 and undated) do not mention the use of dredges at Majors Creek.
- Puddling holes – ASR (2010b) states that a number of depressions observed within the Project Site may be associated with puddling, particularly by Chinese miners.
- Magazine – A small explosives magazine was constructed in the western bank of a tributary to Spring Creek.
- Shaft cage – A shaft cage was identified in the vicinity of the Dargues Reef shaft.
- Water Races – Finally, ASR (2010b) notes that water races are a common feature of the landscape within the Project Site. These races may have been constructed by small scale or larger miners to divert surface water flows to the active mining areas. Alternatively, some may have been constructed or converted to support agricultural operations.

4.7.6 Management and Mitigation Measures

As noted in Section 4.7.7, ASR (2010b) note that the Project would not result in disturbance to any of the identified artefacts. As a result, the Proponent would implement the following management and mitigation measures to minimise the potential for inadvertent impacts to items of potential heritage significance.

- Identify on plans held by the Environmental Manager and Mine Surveyor, where relevant, all identified sites and ensure that activities in the vicinity of those sites are appropriately managed.
- If items of suspected non-Aboriginal heritage significance are identified throughout the life of the Project, the following procedures would be implemented.
  - **Step 1** - No further earth disturbing works would be undertaken in the vicinity of the suspected item of non-Aboriginal heritage significance.
  - **Step 2** - A buffer of 20m x 20m would be established around the suspected artefact. No unauthorised entry or earth disturbance would be allowed with this buffer zone until the area has been assessed.
  - **Step 3** - A qualified archaeologist would be contacted to make an assessment of the discovery. Mitigation procedures would then be developed and implemented based on the assessment.

4.7.7 Impact Assessment

ASR (2010b) undertook an assessment of the significance of the identified artefacts in accordance with the NSW Heritage Council criteria for heritage assessment. These are as follows.

- Criterion (a) an item is important in the course, or pattern, of NSW's Cultural or natural history (or the local area).
- Criterion (b) an item has strong or special association with the life or works of a person, or group of persons, of importance in NSW's cultural or natural history (or the local area).
- Criterion (c) an item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW (or the local area).
- Criterion (d) an item has strong or special association with a particular community or cultural group in NSW for social, cultural or spiritual reasons (or the local area).
- Criterion (e) an item has potential to yield information that will contribute to an understanding of NSW's cultural or natural history (or the local area).
- Criterion (f) an item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history (or the local area).
- Criterion (g) an item is important in demonstrating the principal characteristics of a class of NSW's cultural or natural places or cultural or natural environments (or the local area).

ASR (2010b), based on Pearson and McGowan (undated), state that the following attributes are likely to result in an alluvial or hard rock mining site having historical significance. These are consistent with the NSW Heritage Council-identified criteria above.

- Clear evidence of mine workings.
- Clear evidence of machinery and equipment.
- Clear evidence of a processing site with substantial evidence.
- Clear evidence of settlement or habitation.
- Evidence of ethnicity.

ASR (2010b) notes that the Majors Creek Goldfield has witnessed over eighty years of mining, including simple pan and cradle sluicing, Long Toms, puddling, hydraulic sluicing, reef mining, and possibly dredging. However, very little remains of any one clearly identifiable discrete mining activity or of datable layers of mining activities or temporal markers. As a consequence, while there is widespread evidence of the combined activities and impacts from mining, there are very few artefacts that may be temporally placed in context with the recorded history of Project Site.

ASR (2010b) notes that, while the Project Site does have clear evidence of mine workings, it does not have clear evidence of machinery or equipment, a processing site, habitation or ethnicity of those work worked within the Project Site. In addition, the mine workings visible today represent a overlay of many mining events overprinted one over the top of another, with no clear evidence of activities at a particular point in time. As a result, ASR (2010b) states that the Project Site does not have the attributes that warrant its assessment as being of heritage significance.

Finally, with the exception of a number of water races within the footprint of the tailings storage facility and the Processing Plant, the proposed activities would not disturb the identified items of heritage significance. The water races that would be disturbed are not considered to be significant and extensive examples of such races would remain within the Project Site.

As a consequence, ASR (2010b) conclude that the Project Site contains no structures, relics or items of heritage significance and, as a result, the Project would not result in any significant adverse impacts on items of non-Aboriginal heritage significance.

4.8 BUSHFIRE

4.8.1 Introduction

Based on the risk assessment undertaken for the Project (see Section 3.3), specific bushfire related impacts that may result as a consequence of the Project (without the implementation of the safeguards, controls and mitigation measures presented in this section) include the following.

- Initiation of fire leading to impacts on the Project Site.
- Initiation of fire leading to impacts beyond the Project Site.

This section identifies the dominant vegetation type(s) within the Project Site and surrounding landholdings in order to determine the potential bushfire hazard associated with the Project. In identifying the bushfire hazard, the document "*Planning for Bushfire Protection*" produced by NSW Rural Fire Service in consultation with the then Planning NSW (now Department of Planning) in 2001 (RFS, 2001). RFS (2001) forms the basis of the identification of bushfire hazard. It is noted that information required for this assessment was drawn from the Ecology Assessment (Gaia, 2010).

The Bushfire Assessment was prepared by R.W. Corkery & Co. Pty Ltd based, in part, on information provided in Gaia (2010).

4.8.2 Existing Environment – Assessment of Bushfire Hazard

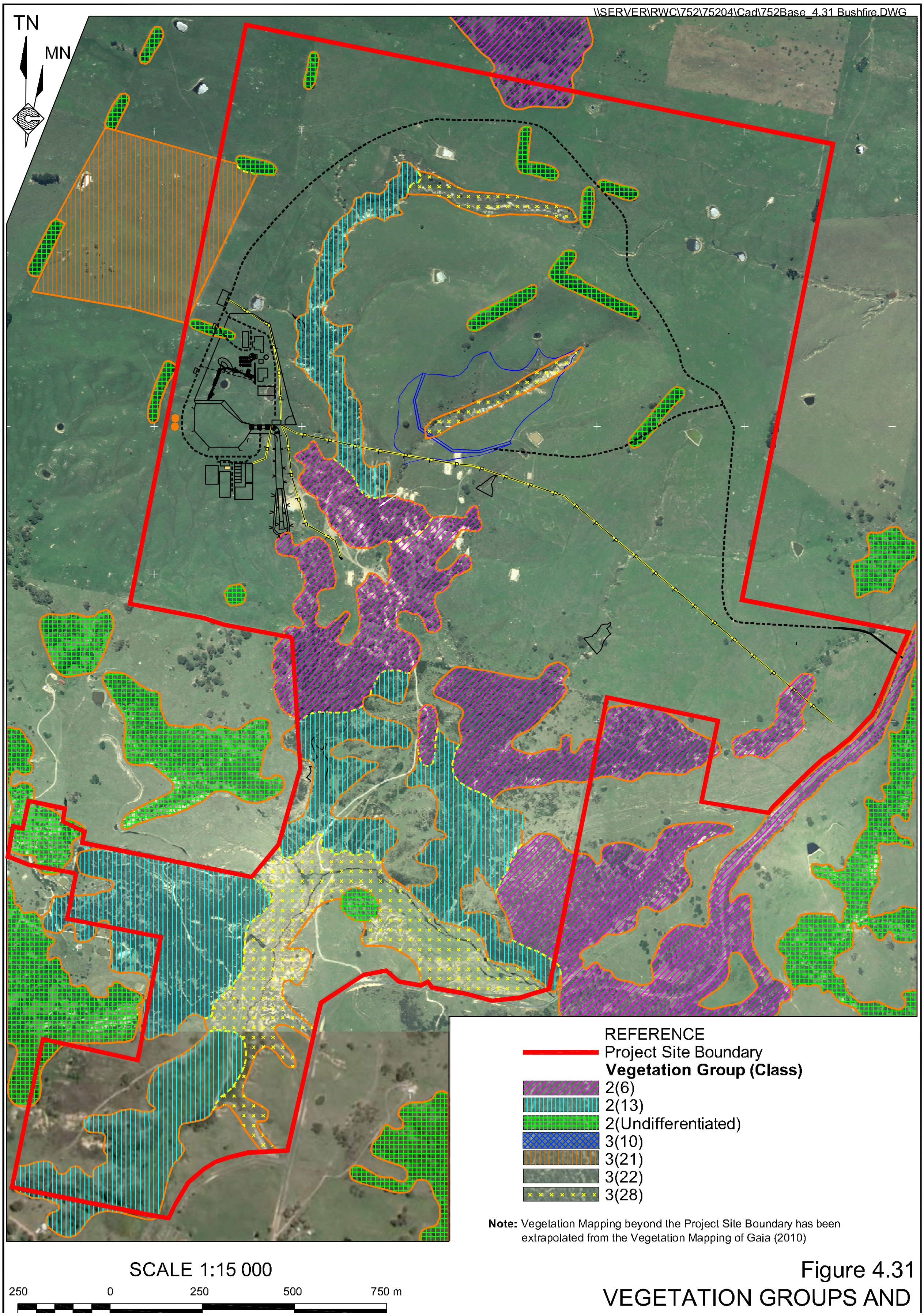
4.8.2.1 Vegetation

As identified in Section 4.3, significant sections of the Project Site have been cleared of large trees and shrubs, with those areas now supporting grasslands, regenerating wattles, woody weeds or limited vegetation. Vegetated areas that remain are, predominantly along Spring Majors Creeks and their tributaries. **Figure 4.31** provides an interpretation of the vegetation within and surrounding the Project Site and surrounding land based on the classifications provided by RFS (2001). The classifications of RFS (2001) have been designated to provide some indication of flammability and therefore bushfire hazard and are broadly grouped, from most flammable to least, as follows.

- Group 1 - forest;
- Group 2 - woodlands and heath; and
- Group 3 - rainforests, shrubland, open woodlands, mallee, grassland.

Within each group, RFS (2001) assigns classes to describe the various vegetation types within these broader groups. The Project Site vegetation is classified as follows (see **Figure 4.31**).

- Group 2, Class 6. Categorised as woodland with trees of 10m to 30m high, foliage cover of 10% to 30% and understorey of low trees, tall shrubs and/or grasses. This classification includes Communities 1 and 2 of Gaia (2010) (see Section 4.3.4.3). A maximum fuel load of 25t/ha is assigned to this vegetation type by RFS (2001).
- Group 2, Class 13. Categorised as open scrub with trees of greater than 2m in height, foliage cover of 10% to 30% and a mixed understorey. This classification includes Communities 3 and 4 of Gaia (2010) (Section 4.3.4.3). A maximum fuel load of 15t/ha is assigned to this vegetation type by RFS (2001).
- Group 2 (no class). Categorised as exotic tree plantation. This classification includes Community 5 as described in Gaia (2010) (see Section 4.3.4.3). A maximum fuel load of 15t/ha is assigned to this vegetation type by RFS (2001).



Base Photo Source: Geo-spectrum (Australia) Pty Ltd - Date of Photo: 20 February 2010
Vegetation Mapping Source: Modified after Gaia (2010) - Figure 5

Figure 4.31
VEGETATION GROUPS AND CLASSES OF THE PROJECT SITE

- Group 3, Class 26. Categorised as native grassland where environmental factors prevent the growth of trees and shrubs. This classification includes Community 6 as described in Gaia (2010) (see Section 4.3.4.3). A maximum fuel load of 3t/ha is assigned to this vegetation type by RFS (2001).
- Group 3, Class 22. Categorised as native dominated pasture. This classification includes Community 7 as described in Gaia (2010) and (see Section 4.3.4.3). A maximum fuel load of 6t/ha is assigned to this vegetation type by RFS (2001).
- Group 3, Class 21. Categorised as exotic dominated pasture. This classification includes Community 8 as described in Gaia (2010) (see Section 4.3.4.3). A maximum fuel load of 6t/ha is assigned to this vegetation type by RFS (2001).
- Group 3, Class 28. Categorised as largely disturbed land with some grass coverage. This classification includes Community 9 as described in Gaia (2010) (see Section 4.3.4.3). A maximum fuel load of 3t/ha is assigned to this vegetation type by RFS (2001).

The vegetation of the landholdings surrounding the Project Site are similar to within the Project Site, that is, the surrounding area is dominated by cleared agricultural land interspersed with woodland and open forest vegetation, predominantly along drainage lines, elevated land or areas with greater topographic relief. Approximately 5km south of the Project Site is a large area of woodland and dry sclerophyll forest (Group 1, Class 5) which occupies a steep valley between the settlements of Majors Creek and Araluen.

4.8.2.2 Slope Classification

Slopes within the Project Site are typically between 5^o and 10^o.

4.8.2.3 Hazard Assessment

The bushfire hazard assessment takes into account not only the vegetation and associated bushfire hazard within the Project Site, but the vegetation immediately surrounding the Project Site and the local area generally.

For the purpose of the bushfire hazard assessment, parameters associated with the Group 3 grassland and pasture dominated vegetation and Group 2 woodland / open forest vegetation have been used to assess the hazard associated with the Project. **Table 4.28** presents the parameters for each assessment which were then compared to RFS (2001) to determine bushfire hazard (referred to as bushfire attack category in RFS (2001)).

Table 4.28
Bushfire Hazard Assessment

Assessment	Vegetation Classification	Slope	Distance to Activities	Category of Bushfire Attack
Group 2	Woodland and Open Forest	$>5^o$ to 10^o	>30m, <50m	High
Group 3	Grassland	$>5^o$ to 10^o	<20m	Low
Sourced: Based on Appendix 3.3 of RFS (2001)				

A high category of bushfire attack describes a site or asset where

> *"attack by burning debris is significant with radiant heat levels and flame threatening some building elements (screened glass)."*

Specific construction requirements (Level 2 construction in accordance with Section 3 of Australian Standard (AS) 3959 – 1999) should be considered.

A low category of bushfire attack describes a site or asset where

> *"minimal attack from radiant heat and flame due to the distance of the site from the vegetation, although some attack by burning debris is possible. There is insufficient threat to warrant specific construction requirements."*

Based on the above bushfire attack categories, the Project Site could be affected by bushfire and precautionary measures should be developed for implementation in the event of a significant bushfire event locally.

4.8.3 Safeguards and Controls

4.8.3.1 Management of a Local Bushfire Event

Acknowledging the 'High' bushfire attack category associated with the woodland / open forest vegetation within and surrounding the Project Site, the construction of buildings within the Project Site should consider the Level 2 requirements of AS 3959 – 1999. Notably, the entire length of the access road would traverse grassland / pasture vegetation which has a low bushfire attack categorisation. As such, an immediate method of egress from the Project Site would be available to Project personnel in the event of bushfire attack on the Project Site.

In the event of a local bushfire event threatening the Project Site, mine management would follow all instructions provided by the NSW Rural Fire Service (RFS) or police. Access to all Project Site water storages would be provided to the RFS and any reasonable assistance offered to RFS or police personnel.

4.8.3.2 Management of Project Site Operations

The Project Site operations that may increase the risk of bushfire, and the controls proposed to limit the risk posed by these are presented in **Table 4.29**.

4.8.4 Assessment of Impact

The Project Site operations would increase the number and type of ignition sources in the local area. The proposed controls and safeguards, in conjunction with general clearing activities associated with the Project would, however, ensure that a lowered bushfire hazard was maintained within the Project Site.

Table 4.29
Bushfire Hazard – Activities and Controls

Activity	Possible Ignition Source	Safeguards and/or Controls
Refuelling	• Spilt fuel ignited by spark	• Refuelling undertaken within designated fuel bays or within cleared area of the Project Site. • Vehicles to be turned off during refuelling. • No smoking policy to be enforced in designated areas of the Project Site. • Fire extinguishers maintained within site vehicles and refuelling areas.
General Activities	• Cigarette • Rubbish, eg. glass, metal.	• No smoking policy to be enforced in designated areas of the Project Site. • Focus on housekeeping to be maintained by mine management. • Water cart available to assist in extinguishing any fire ignited. • Site vehicles to carry a fire extinguisher.

4.9 TRAFFIC AND TRANSPORTATION

4.9.1 Introduction

The DGRs issued by the Department of Planning require that the *Environmental Assessment* include an assessment of "**Traffic**" – *including a detailed description of the measures that would be implemented during construction and operation to minimise the impacts on Majors Creek road and Araluen Road*. The DGRs specify that the Environmental Assessment include "*a detailed description of the measures that would be implemented during construction and operation to minimise impacts on Majors Creek Road and Araluen Road.*" Both the NSW Roads and Traffic Authority (RTA) and Palerang Shire Council identified key issues to be assessed in relation to traffic and the impact of Project-related transport on the local road network (see **Appendix 2**).

Based on the risk assessment undertaken for the Project (see Section 3.3), specific traffic-related impacts that may result as a consequence of the Project (<u>without the implementation of the safeguards, controls and mitigation measures presented in this section</u>) include the following.

- Temporary inconvenience to commuters if stopped for road works.
- Increased traffic congestion.
- Elevated risk of accident/incident on local roads.
- Accelerated road pavement deterioration.

The DGRs require that the traffic assessment take into account the *Guide to Traffic Generating Development* (RTA, 2002) and *Road Design Guide* (RTA, 1999).

A Traffic Impact Assessment has been completed by Mr Terry Lawrence (M.Urb.Plan) of Transport and Urban Planning (TUP) to address the DGRs and assess the impact of the Project on local traffic and roads. This section of the *Environmental Assessment* provides a summary of the assessment report, which is presented in full as Part 6 (Volume 2) of the *Specialist Consultant Studies Compendium* and is referred to hereafter as TUP (2010). The assessment considers existing traffic levels and road conditions, the proposed changes to traffic levels resultant from the Project and the likely impact on the road network, road users and land uses.

4.9.2 Existing Environment

4.9.2.1 Principal Road Network

The roads that would be affected by traffic generated by the Project are as follows.

- Majors Creek Road.
- Araluen Road.
- Captains Flat Road.
- Coghill Street.
- Wallace Street.

Figure 4.32 identifies each of these roads, all of which form part of the main road network of the Palerang local government area. Captains Flat Road, Coghill Street and Wallace Street (to Lascelles Street) are regional roads, ie. public roads of secondary importance within the state-wide context. Regional roads comprise both classified roads that are not State roads and some important but not classified council roads. Councils exercise roads authority powers, have financial asset management responsibility and determine road works priorities for regional roads.

Araluen Road and Majors Creek Road are local roads. Local roads are any unclassified public road for which Council is the road authority and which are not either state or regional roads. Councils exercise roads authority powers and have financial responsibility for local roads.

It is noted that those heavy vehicles that would travel through Braidwood to destinations further afield would do so via the Kings Highway, a State road. In addition, the Proponent anticipates that all heavy vehicles using the Kings Highway would utilise that section of the highway to the north of Braidwood. The Proponent does not anticipate that any Project-related heavy vehicles would travel on the Kings Highway to the east of Braidwood.

4.9.2.2 Traffic Volumes

Traffic volume and classification counts were undertaken on the road network between 12 and 19 February 2010. **Figure 4.33** and **Table 4.30** present the annual average daily traffic (AADT) traffic volumes on the identified roads for an average weekday (5 day average) and full week (7 day average / AADT) including the number and proportion of heavy vehicles.

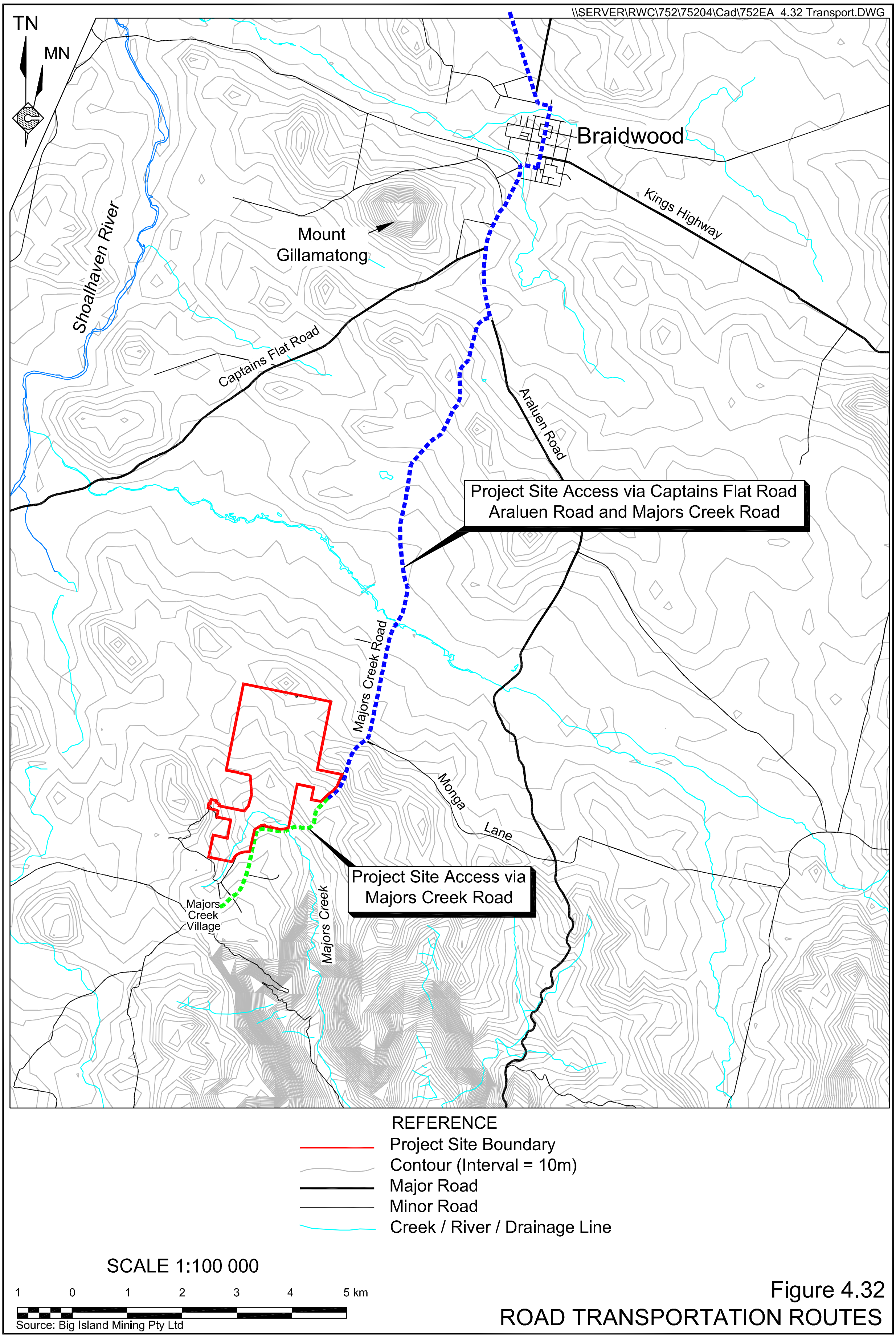
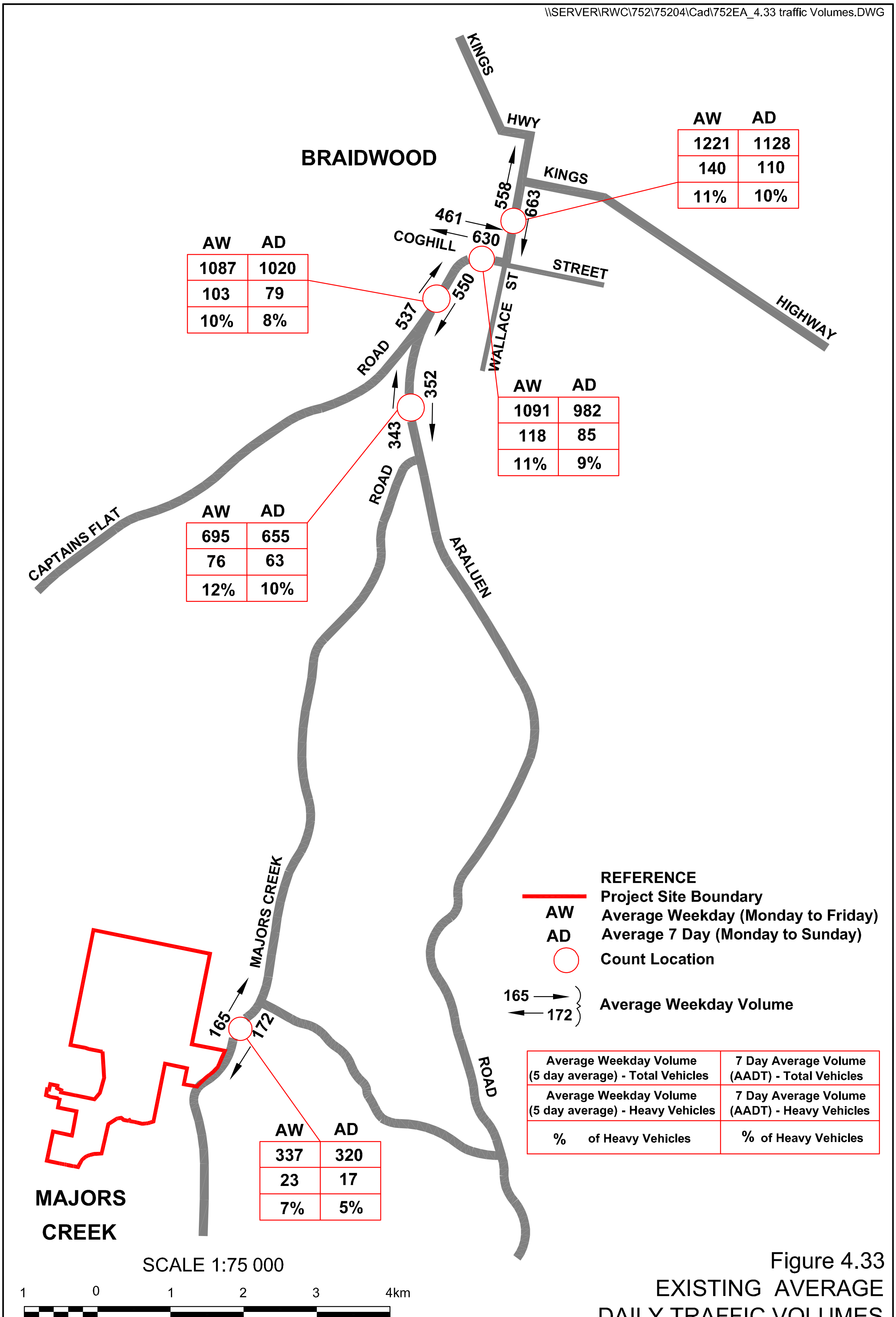


Figure 4.32
ROAD TRANSPORTATION ROUTES



Source: TUPA (2010) - Figure 5

Figure 4.33
EXISTING AVERAGE DAILY TRAFFIC VOLUMES

Table 4.30
Two Way Daily Traffic Volumes Including Heavy Vehicles

Road	5 Day Average (Weekday)			7 Day Average (AADT)		
	Light Vehicles (%)	Heavy Vehicles (%)	Total (%)	Light Vehicles (%)	Heavy Vehicles (%)	Total (%)
Majors Creek Road	314 (93%)	23 (7%)	337 (100%)	303 (95%)	17 (5%)	320 (100%)
Araluen Road	619 (88%)	76 (12%)	695 (100%)	592 (90%)	63 (10%)	655 (100%)
Captains Flat Road	984 (90%)	103 (10%)	1087 (100%)	941 (92%)	79 (8%)	1020 (100%)
Coghill Street	973 (89%)	118 (11%)	1091 (100%)	893 (91%)	85 (9%)	982 (100%)
Wallace Street	1081 (89%)	140 (11%)	1221 (100%)	1018 (90%)	110 (10%)	1128 (100%)
Source: Traffic Counts 12 – 19 February 2010. Modified after TUP (2010) – Table 3.2						

4.9.2.3 Maximum Hourly Traffic Volumes and Traffic Conditions

Table 4.31 presents the maximum two-way hourly traffic volumes for various periods during the average weekday as recorded in the traffic counts between 12 and 19 February 2010.

Table 4.31
Maximum Hourly Two Way Traffic Volumes Using

Road	Time Period				
	6am-9am	9am-3pm	3pm-7pm	7pm-10pm	10pm-6am
Majors Creek Road	28	24	34	12	7
Araluen Road	67	52	66	13	8
Captains Flat Road	97	79	100	35	13
Coghill Road	73	81	105	36	13
Wallace Street	88	93	115	43	4
Source: Traffic Counts 12 – 19 February 2010. Modified after TUP (2010) – Table 3.3					

4.9.2.4 Relevant Road Standards

Rural Roads

The Roads & Traffic Authority's *"Road Design Guide"* (RTA, 1999) is the primary road design reference for NSW roads. **Tables 4.32** and **4.33** provide the Road Design Guide recommended lane and shoulder widths for different traffic flows.

Table 4.32
Lane Widths for Two Lane Two Way Rural Roads

AADT (vehicles/day)	No. of Lanes	Lane Width (m)
1-150	1	3.5
150-500	2	3.0
500-2000	2	3.0-3.5
> 2000	2	3.5
Source: RTA Road Design Guide		

Table 4.33
Shoulder Widths for Two Lane Two Way Rural Roads

AADT (vehicles/day)	Shoulder Width (m)
1-500	1.0-1.5
500-1000	1.0-2.0
Over 1000	2.0-3.0
Adjacent to barrier lines	3.0
Source: RTA Road Design Guide	

Shoulder sealing of 0.5m from the edge of the travel lane is recommended when the AADT is less than 2 000 vehicles per day (vpd) and 1.0m when the AADT is greater than 2 000vpd. It should be noted that most council/local rural roads including regional roads, do not have sealed shoulders and typically use gravel shoulders.

Standards for Town Roads in Rural Areas

There is no particular road width standard for town roads in rural areas which have lower speed limits of 60km/hr or less. Travel lane widths on two way, two lane town roads are typically 3.0 to 3.5 metres wide depending on AADT traffic volumes. Shoulder areas which can be used for parking or as a pull off area and can be 2.0m to 3.0m wide or more and may or may not be sealed. Kerb and gutter may or may not be provided depending on a range of factors.

Level of Service

Level of Service (LOS) is used as a performance standard for roads (and intersections). Level of Service is a qualitative assessment of the quantitative effect of factors such as speed, volume of traffic, geometric features, traffic interruptions, delays and freedom to manoeuvre. There are six Levels of Service for roads. The following descriptions are for roads with interrupted traffic streams, such as rural roads.

- LOS A: this, the top level is a condition of free flow.
- LOS B: this level is in the zone of stable flow and drivers still have reasonable freedom to select their desired speed and to manoeuvre within the traffic stream.
- LOS C: this service level is also in the zone of stable flow, but most drivers are restricted to some extent in their freedom to select their desired speed and to manoeuvre in the traffic stream.
- LOS D: this level is close to the limit of stable flow but is approaching unstable flow. All drivers are severely restricted in their freedom to select their desired speed and to manoeuvre within the traffic stream.
- LOS E: this occurs when traffic volumes are at or close to capacity and there is virtually no freedom to select desired speeds or to manoeuvre within the traffic stream.
- LOS F: this service level is in the zone of forced flow. With it the amount of traffic approaching the point under consideration exceeds that which can pass it. Flow breakdown occurs and queuing and delays result. In short the traffic demand exceeds the capacity of the road or lane.

The desirable Level of Service for rural roads is Level of Service C or above, ie. A, B or C.

Table 4.5 of the RTA's "*Guide to Traffic Generating Developments*" defines maximum (peak) hour Levels of Service Volume Thresholds for 2 lane rural roads. For rural roads with rolling terrain and where heavy vehicles comprise 10% to 15% of the total volumes, Level of Service A occurs when two way traffic volumes are less than 310 to 360 vehicles per hour (vph). For rural roads with level terrain and the same proportion of heavy vehicles, Level of Service A occurs when two way traffic volumes are less than 530 to 560vph.

4.9.2.5 Existing Road Conditions

Majors Creek Road

- Majors Creek Road is a two lane, sealed rural road that connects the village of Majors Creek to Araluen Road (a distance of approximately 11.85km).
- Majors Creek Road typically has a sealed pavement generally 5.8m wide with gravel shoulder on both sides of between 1.0m and 1.5m. Currently Majors Creek Road does not meet the minimum pavement width requirement of the Road Design Guide for the AADT flows of 150 to 500, namely 2 x 3m lane width.
- The maximum two way traffic volume is 34vph. Therefore, as the percentage of heavy vehicles is 5% (7 day AADT), Majors Creek Road currently operates with a LOS A.

Araluen Flat Road

- Araluen Road is a two lane, sealed rural road. The distance between Majors Creek Road and Captains Flat Road is approximately 1km.
- Araluen Road is 6.2m wide with a sealed pavement and gravel shoulders of between 1.5m and 2.0m. Araluen Road is considered to meet the minimum pavement width requirement of the Road Design Guide for the AADT flows of 500 to 2000 vehicles, namely 2 x 3m or 3.5m lane width. The shoulder arrangement of Araluen Road does not meet the Road Design recommendation.
- The maximum two way traffic volume is 66vph. Therefore, as the percentage of heavy vehicles is 10% (7 day AADT), Araluen Road currently operates with a LOS A.

Captains Flat Road

- Captains Flat Road is a two lane, sealed rural road. The distance between Araluen Road and Coghill Street is approximately 2km.
- Captains Flat Road maintains a 7.0m wide sealed pavement with gravel shoulders of variable widths. Captains Flat Road is considered to meet the minimum pavement width requirement of the Road Design Guide for the AADT flows of 500 to 2000 vehicles, namely 2 x 3m or 3.5m lane width. The shoulder arrangement of Captains Flat Road does not meet the Road Design recommendation.
- The maximum two way traffic volume is 100vph. Therefore, as the percentage of heavy vehicles is 8% (7 day AADT), Captains Flat Road currently operates with a LOS A.

Coghill Street / Wallace Street

- Coghill and Wallace Streets are town roads within the Braidwood township with 50km/hr speed limits. Both streets form part of a regional road that connects to the Kings Highway at Lascelles Street and form part of the school bus route to Captains Flat Road, Araluen Road and Majors Creek Road.
- Coghill Street between Bombay Street and Wallace Street provides a sealed road pavement for two (2) lanes of traffic and wide shoulders. Both roads provide the pavement width and wide shoulders nominated as standard for rural town roads.
- The maximum hourly two way traffic volumes on both roads is relatively low (105vph and 115vph respectively). Both Coghill and Wallace Streets provide LOS A.

4.9.2.6 Road Safety

Three year accident statistics from April 2006 to March 2009, the road network between Lascelles Street, Braidwood and the Project Site were obtained from the RTA. There was a total of four accidents during this period, including 2 injury accidents and one fatality on the road network. This included two run off the road accidents on Araluen Road and one run off the road accident on Majors Creek Road. Only one of these accidents involved a truck, with there being no particular pattern with regard to the accidents (TUP, 2010).

4.9.2.7 Bus Routes

A daily bus service is operated between Batemans Bay and Canberra via Braidwood by Murrays Coaches. These buses use the Kings Highway through Braidwood at 8.55am and 4.05pm.

There are five school bus services that use sections of the road network between Braidwood and the Project Site. These buses operate between 7.00am and 8.30am in the morning and 3.00pm and 5.00pm in the afternoon on school days. There are also several school bus routes that use sections of the Kings Highway between Braidwood and Bungendore, Goulburn and Nerriga.

4.9.2.8 Local Weather Conditions

It is understood that the area around Majors Creek experiences low level cloud and fog on occasions throughout the year. It is noted that Majors Creek Road has long sections of road where no centreline is provided. Centreline road marking generally assists drivers when conditions are foggy.

4.9.3 Project-related Roadworks and Traffic

4.9.3.1 Vehicle Access

As noted in Section 2.2.3 and illustrated on **Figure 2.2**, a new intersection with Majors Creek Road would be constructed to provide vehicle access to the Project Site. This would be a sealed intersection based on an RTA basic (BA) right turn (R) and left turn (L)_rural intersection type (BAR and BAL) (as specified in *Guide to Traffic Engineering Practice — Part 5: Intersections at Grade* [Austroads, 2005]).

4.9.3.2 Internal Road

As also described in Section 2.2 and illustrated on **Figure 2.1**, the Proponent would construct a site access road from Majors Creek Road to the proposed processing operations of the Project Site. The site access road would have a sealed 7.0m wide pavement with sealed shoulder, for the initial 50m from Majors Creek Road, The remainder of the road would be a 6.0m wide gravel road, with 1.0 metre wide shoulders.

4.9.3.3 Traffic Generation

Site Establishment Phase

Construction of Project Site infrastructure, including the proposed new intersection with Majors Creek Road, is expected take approximately 5 months to complete.

Traffic travelling to and from the Project Site each day would include low loaders, semi-trailers, truck and dog trailers, other smaller trucks including concrete agitator vehicles and light vehicles. The majority of these vehicles would be drawn from the local and regional area around Braidwood.

Table 4.34 presents the average traffic levels that would be generated during the Project's construction phase.

Table 4.34
Site Establishment Phase Traffic Generation

Source of Traffic	Daily Traffic Movements (Average)		
	Light Vehicles	Heavy Vehicles	Total Vehicles
Majors Creek Road – North of Site Entrance	24	6	30
Majors Creek Road – South of Site Entrance	6	0	6
Total	**30**	**6**	**36**
Source: Mining Plus Pty Ltd			

Operations Phase

The Proponent proposes to use a small (20 seater) bus to take the shift mine workers to and from work each day. Two shifts are proposed which will involve up to four bus movements, ie. 2 arrivals and 2 departures each day. Additional light vehicle movements will be associated with the movement of other staff and visitors to and from the Project Site.

Heavy vehicles coming to the Project Site will include delivery vehicles for consumables which will typically be large rigid trucks and 19 metre semi-trailers, as well as product (concentrate) trucks which will be 19 metre semi-trailers.

Table 4.35 presents the average daily traffic levels that would be generated during the site operations phase (at maximum production).

Table 4.35
Operations Phase Traffic Generation

Source of Traffic	Daily Traffic Movements (Average)		
	Light Vehicles	Heavy Vehicles	Total Vehicles
Majors Creek Road – North of Site Entrance	16	18	34
Majors Creek Road – South of Site Entrance	4	0	4
Total	**20**	**18**	**38**
Source: Mining Plus Pty Ltd			

Product (concentrate) delivery trucks are expected to transport the concentrate to port at Wollongong, Sydney or Newcastle or to customers within Australia via the Kings Highway to the north of Braidwood.

4.9.4 Environmental Controls and Management

4.9.4.1 Design Features

Project Site Entrance

The treatment for the proposed site access road intersection with Majors Creek Road has been based on the recommendations of TUP (2010), and the requirements of the *Road Design Guide* (RTA, 1999) and "*Part 5: Intersections at Grade*" of the Austroads Guide to Traffic Engineering Practice series (Austroads, 2005).

The intersection would have adequate sight distance in Majors Creek Road to meet safe intersection sight distance requirements for the posted speed limit and the recorded 85th percentile vehicle speed at this location which are 100km/hr and 97km/hr respectively (TUP, 2010). Allowing for the 5% upgrade south to north in Majors Creek Road, the required sight distance at the intersection is 215m to the south and 235m to the north. TUP (2010) confirms that the available sight distance at the proposed location exceeds these requirements. The Proponent would regularly inspect and clear long grass and bushes that grow in the road shoulder to maintain the maximum possible sight distance.

Site Access Road

The site access road would incorporate the following features.

- Horizontal alignment complying with the maximum grades and changes of grade outlined in the *Australian Standards for Off-Street Commercial Vehicle Facilities*. Maximum vertical grades would be approximately 10%.
- The gravel surface of the road would be graded treated with chemical suppressants to minimise dust generation.
- The road layout would ensure that all vehicles would enter and exit the site in a forward direction.

In addition, the on-site maximum vehicle speed would be signposted and restricted to 40km/hr.

4.9.4.2 Operational Controls

The operational controls to be employed as part of the Project would include the following.

- All heavy vehicles transporting concentrate would be loaded using a front-end loader fitted with a bucket load indicator. All vehicles would be loaded in a manner that would ensure that they were not overloaded.
- A speed limit of 40km/hr on the site access road and 20km/hr in the operational sections of the Project Site.

- All regular heavy vehicle movements associated with the Project would be scheduled for between 7:00am and 6:00pm, where practicable. Furthermore, the movement of heavy vehicles to and from the Project Site would, where practicable be avoided during the hours of 7.00am to 8.30am and 3.00pm to 5.00pm on school days to avoid potential conflict with the local school bus services.
- A Code of Conduct for all drivers would be developed and enforced for all heavy vehicles that travel to and from the Project Site regularly. The Code of Conduct would stipulate safe driving practices must be maintained at all times and nominate the maximum vehicle speed on Majors Creek Road of 80km/hr for heavy vehicles travelling to and from the Project Site. The code would also include specific requirements for practices to be adopted during periods of fog, such as the use of headlights / fog lights and adopting vehicle speeds appropriate to the conditions as required.
- Any complaints received would be immediately investigated and substantiated incidents acted on decisively, which could include the banning the offending driver(s) from the Project Site.

In addition, the Proponent would manage traffic during the construction of the new intersection in accordance with a works specific Traffic Management Plan and the relevant Australian Standards. All safety procedures to be adopted during intersection construction works would be incorporated into a Section 138 Permit sought under the *Roads Act 1993*.

4.9.4.3 Contribution to Ongoing Road Maintenance and Upgrades

The Proponent recognises that the additional heavy vehicle movement generated by the Project may result in some pavement deterioration on Majors Creek Road, change to traffic conditions for local road users. In recognition of this, the Proponent has negotiated an arrangement with Palerang Council to provide for a range of up-front road upgrades (focussed on improving road safety features) and ongoing Section 94 contributions to road maintenance throughout the life of the Project. The commitments made with respect to road upgrade and maintenance (and agreed to in principle by Palerang Council) are as follows.

Road Upgrades

- Provide centreline road marking along the full length of Majors Creek Road between the Araluen Road and Majors Creek immediately, irrespective of whether project approval is granted. This will assist drivers using Majors Creek Road to drive on the left of the centreline at all times, particularly those times of low visibility, and will assist in maintaining road safety.
- Provide signage/delineation and appropriate barriers such as guardrails at the culverts on Majors Creek Road at 4.4km and 4.9km from the intersection of Majors Creek Road and Araluen Road, as well as at the bridge structure over Honeysuckle Creek. The Proponent has committed to completing this road upgrade prior to the commencement of the operational phase of transport operations.

- Provide pavement widening on curves and crests on Majors Creek Road at the following chainages, as measured from the intersection of Majors Creek road and Araluen Road.
  - Reverse curve between 2.4km and 2.7km.
  - Curve at 3.25km.
  - Crest at 3.8km.
  - Curve at 4.3km.
  - Curve at 4.5km.
  - Curve and crest near Morgans Lane at 5.3km and 5.5km.
  - Crest at 6.9km.
  - Crest at 7.75km.
  - Crest at 8.2km.

  The noted road pavement widening would be undertaken in lieu of Section 94 Contributions during the initial 12 months of the operations phase of transport operations. No significant environmental impacts associated with these works are anticipated.

Road Maintenance

- The Proponent would formalise a Section 94 Contributions Plan with Palerang Council following the granting of project approval.
- Road pavement widening works would be undertaken in lieu of Section 94 contributions during the initial 12 months of the operations phase of transport operations.

4.9.5 Assessment of Impacts

4.9.5.1 Intersection Suitability

The proposed new intersection for the Project Site would be designed and constructed to RTA standards for a Basic Rural intersection incorporating BAL and BAR treatments for the left turn and right turn into the Project Site. The intersection would be able to accommodate articulated vehicles, such as semi-trailers, turning right into and left out of the Project Site. The Proponent does not anticipate that articulated vehicles would be required to travel to the south of the access road intersection. Suitable environmental controls, including a 50m sealed section of the site access road, would be provided near the entrance to prevent dust. from being carried into Majors Creek Road.

As noted in Section 4.9.4.1, the intersection would provide for safe intersection sight distance requirements for the posted speed limit and this would be maintained through clearing of vegetation as necessary.

TUP (2010) has confirmed, through reference to the warrants for Rural Turn Lanes provided by the RTA *Road Design Guide*, that due to the low volume of traffic using Majors Creek Road and the small number of heavy vehicle movements generated by the Project, the provision of a left turn acceleration lane for heavy vehicles leaving the Project Site is not warranted.

4.9.5.2 Traffic Conditions

Tables 4.36 and **Figure 4.34** compare the existing traffic volumes on the roads for an average weekday (5 day average) with the predicted traffic levels when traffic generated by the Project is included.

Table 4.36
5 Day Average (Weekday) Two Way Daily Traffic Volumes

Road	Existing			Predicted (Construction)		
	Light Vehicles (%)	Heavy Vehicles (%)	Total	Light Vehicles (%)	Heavy Vehicles (%)	Total
Construction Phase						
Majors Creek Road	314 (93%)	23 (7%)	337	344 (92%)	29 (8%)	373
Araluen Road	619 (88%)	76 (12%)	695	649 (89%)	82 (11%)	731
Captains Flat Road	984 (90%)	103 (10%)	1087	1 014 (90%)	109 (10%)	1 123
Coghill Street	973 (89%)	118 (11%)	1 091	1 003 (89%)	124 (11%)	1 127
Wallace Street	1 081 (89%)	140 (11%)	1 221	1 111 (88%)	146 (12%)	1 257
Operational Phase						
Majors Creek Road	314 (93%)	23 (7%)	337	334 (88%)	41 (12%)	375
Araluen Road	619 (88%)	76 (12%)	695	639 (87%)	94 (13%)	733
Captains Flat Road	984 (90%)	103 (10%)	1087	1 004 (89%)	121 (11%)	1 125
Coghill Street	973 (89%)	118 11%	1 091	993 (88%)	136 (12%)	1 129
Wallace Street	1 081 (89%)	140 (11%)	1 221	1 101 (88%)	158 (12%)	1 259
Source: Traffic Counts 12 – 19 February 2010. Modified after TUP (2010) – Table 4.1						

It is notable that the predicted traffic generation from the Project would not increase the traffic volume on any road significantly, with no road moving from a lower Road Design Guide AADT class to a higher class. (see **Table 4.32**).

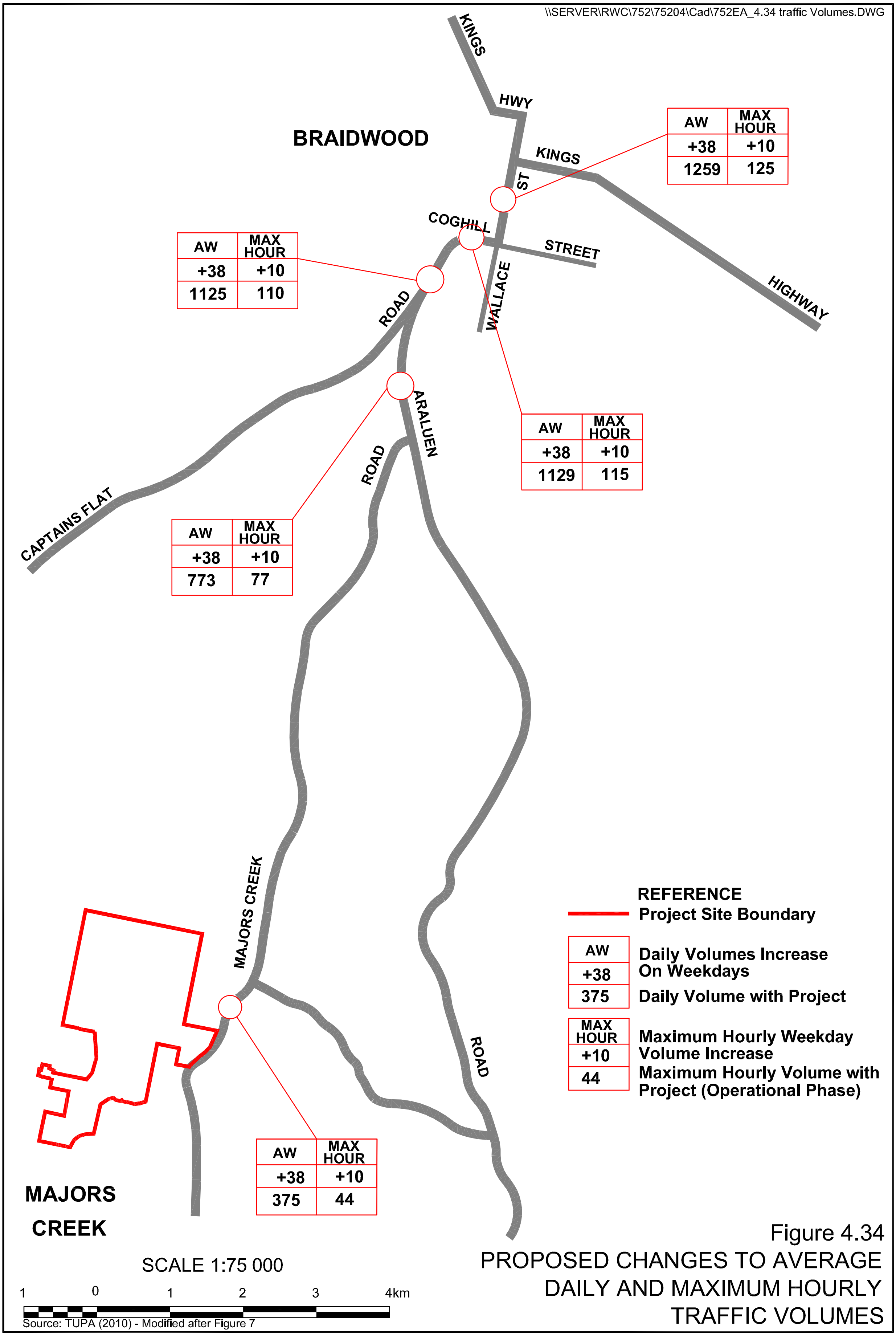


Figure 4.34
PROPOSED CHANGES TO AVERAGE DAILY AND MAXIMUM HOURLY TRAFFIC VOLUMES

A review of **Table 4.36** illustrates the following.

- Over most of the road network, the increase in total traffic volumes due to the Project would range between 3.1% and 5.6%. While on Majors Creek Road, the increase in total traffic volume would be greater (11.3%). However, it is noted that Majors Creek Road also carries relatively low total traffic volume (337vpd on a weekday) than the other roads on the transportation route.
- The proportion of heavy vehicles using the road network would increase by 1% on most sections of the road network, when compared to the existing 2010 traffic volumes. Once again the proportional increase on Majors Creek Road would be comparatively larger (5%) given the relatively low traffic volumes carried by this road. In all cases, the proportion of heavy vehicles proposed to use these roads would remain between 8% (on Majors Creek Road during construction) and 13% (on Araluen Road at maximum production).

Tables 4.37 and **Figure 4.32** identify the traffic volume increase due to Project-related traffic during the busiest hour on a weekday (typically between 6.00am and 9.00am and/or between 3.00pm and 7.00pm).

Table 4.37
Maximum Hourly Two Way Traffic Volumes on the Road Network with the Project

Road	Existing Maximum Hourly Volumes		Additional Maximum Hourly Volumes from Project	Total Volumes with Project	
	6am-9am	3pm-7pm		6am-9am	3pm-7pm
Majors Creek Road	28	34	+10	38	44
Araluen Road	67	66	+10	77	77
Captains Flat Road	97	100	+10	107	110
Coghill Road	73	105	+10	83	115
Wallace Street	88	115	+10	98	125
Source: Traffic Counts 12 – 19 February 2010. Modified after TUP (2010) – Table 4.2					

TUP (2010) considers the Project-related increase in the maximum one hour period of 10vph on the road network to be small in real terms and would have a very minor impact on existing traffic conditions on these roads. A range of between 38vph to 110vph for the rural roads remains consistent with a Level of Service A operation (see Section 4.9.2.4). Similarly, maximum hourly two way traffic volumes with the Project on Coghill and Wallace Streets (town roads) (115vph and 125vph) are also relatively low and representative of good traffic conditions (Level of Service A).

TUP (2010) notes that the proposed increase in hourly traffic movements would not have any measurable impact on intersection capacity and or vehicle delay.

4.9.5.3 Road Conditions

While small, the additional heavy vehicle movements generated by the Project would contribute to limited pavement deterioration on sections of the local road network, in particular those sections of the road network that do not currently comply with the *RTA Road Design Guidelines*. In particular the longer articulated vehicles, ie. 19 metre semi-trailers, may accelerate damage to road edges on the narrower roads such as Majors Creek Road. Majors Creek Road, which has a sealed pavement of (on average) 5.8m wide, is expected to experience some damage to the edge of the sealed pavement particularly on curves and bends, from the increased number of articulated vehicles travelling to and from the Project Site. The Proponent has committed to contributing to the ongoing maintenance of Majors Creek Road through the establishment of a Section 94 Contributions Plan with Palerang Council. The Proponent anticipates that these contributions would be allocated to remediation and preventative maintenance on those sections of the transport route most susceptible to heavy vehicle damage.

Given Wallace Street, Coghill Street, Captains Flat Road and Araluen Road generally have sealed pavements between 6.2m and 7.0m wide and satisfy *RTA Road Design Guidelines* regarding pavement width for the anticipated traffic volumes with the project, the potential for Project-related traffic to contribute significantly or noticeably to pavement deterioration is considered very small.

4.9.5.4 Road Safety

Considering the relatively minor changes to traffic volumes using the local road network, and the proposed operational controls and safeguards to be implemented (such as road upgrades, speed limit restrictions and the implementation of a Driver Code of Conduct), TUP (2010) does not consider the Project-related traffic would result in a significant reduction in local road safety. If anything, the proposed operational controls and safeguards would improve road safety conditions locally. In addition, no reduction in existing level of service is expected as a result of the Project.

4.10 AIR QUALITY AND ENERGY

4.10.1 Introduction

The DGRs issued by the Department of Planning require that the *Environmental Assessment* include an assessment of "**Air Quality**" and "**Energy**". The DGRs specify that in assessing "Energy", the Environmental Assessment must "*Calculate the scope 1, 2 and 3 emissions of the mining operations and describe what measures would be implemented to ensure these operations are energy efficient.*"

Based on the risk assessment undertaken for the Project (see Section 3.3), specific air quality-related impacts that may result as a consequence of the Project (<u>without the implementation of the safeguards, controls and mitigation measures presented in this section</u>) include the following.

- Dust generation resulting in potential nuisance dust impacts (moderate to high risk).

- Dust generation resulting in potential health impacts.
- Dust generation resulting in impacts on biota.
- Greenhouse Gas Emission.

The DGRs also require that the assessment of air quality refer to *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC, 2005) and *Approved Methods for Sampling and Analysis of Air Pollutants in NSW* (DEC, 2007).

An Air Quality and Greenhouse Gas Assessment was undertaken by PAEHolmes (PAEH) to address the DGRs and assess the impact of the Project on local air quality. The assessment was completed by Ms Judith Cox (B.Eng. (Hons) and Ms Francine Triffett (BA) of PAEH. This section of the *Environmental Assessment* provides a summary of the assessment report which is presented in full as Part 7 (Volume 2) of the *Specialist Consultant Studies Compendium* and referred to hereafter as "PAEH (2010)". The following sub-sections describe and assess the existing air quality environment, identify the air quality management issues and the proposed air quality controls, safeguards and mitigation measures. Additionally, the assessment of the residual impacts upon the air quality following the implementation of these safeguards and mitigation measures is also presented.

4.10.2 Existing Environment

4.10.2.1 Introduction

Air quality guidelines and goals refer to levels of “pollutants” in air which include both existing and operational sources. In order to fully assess impacts against all the relevant air quality guidelines and goals, it is therefore necessary to compile information or estimates on the existing concentration of airborne particulates, dust deposition and gases, including those contributing to climate change (“greenhouse gases”). In the absence of site-specific air quality data for some "pollutants", background levels are described through reference to monitoring undertaken at the closest available location.

4.10.2.2 Particulate Matter, Total Suspended Particulates and Deposited Dust

The generation of ‘dust’ would be one of the main air quality issues relevant to the Project. Depending upon the size and concentration of particles in the air and their composition, airborne dust has the potential to affect human health as well as contribute to the general degradation of the environment. The term *“particulate matter”* refers to a category of airborne particles typically less than 50µm in aerodynamic diameter and ranging down to 0.1µm in size. The human respiratory system has a built-in defensive system that prevents particles greater than 10µm in diameter from reaching sensitive areas of the respiratory system. As a result particles less than 10µm (PM_{10}) and 2.5µm ($PM_{2.5}$), if in high enough concentration, may adversely affect human health.

As particles larger than 10µm can also contribute to environmental degradation, the air quality assessment also considers the total mass of particles suspended in the air, ie. Total Suspended Particulates (TSP). Particles that have an aerodynamic sufficiently large so as not to be suspended in air (typically >35µm) are referred to as deposited dust.

No air quality monitoring data is available within or in the vicinity of the Project Site. However, it is noted that the Project Site is situated in a rural area with no major sources of air pollution. As a result the local air quality is likely to be good and concentrations of pollutants are unlikely to exceed any of the air quality criteria.

Particulate Matter

DECCW collects PM_{10} data in the rural areas of Albury, Bathurst and Wagga Wagga using a TEOM (Tapered Element Oscillating Microbalance) to provide continuous recordings of PM_{10} concentrations. **Table 4.38** presents a summary of recent PM_{10} data collected by DECCW in these locations. The annual average PM_{10} concentrations at all three locations are within the DECCW criteria of 30µg/m^3. The average PM_{10} concentration over all sites and all years is 21µg/m^3. PAEH (2010) considers it likely that many of the air quality exceedances experienced at the three sites are due to significant weather events such as bushfires and dust storms or agricultural activities such as when broad acre cultivation and/or the preparation of land for cropping takes place.

TSP and Dust Deposition

While data for local TSP concentration and dust deposition is not available, PAEH (2010) notes that there is an approximate relationship between annual dust deposition and TSP concentrations that can be applied in areas where road traffic is not the dominant source of particulate matter. Areas experiencing 4g/m^2/month typically experience annual TSP concentrations of 90µg/m^3. PAEH (2010) also note that in locations such as that of the Project Site, 40% of TSP will typically be in the PM_{10} size range. To estimate background TSP and dust deposition, these approximate relationships have been applied.

$$TSP = \frac{PM_{10}}{0.4} = 53\mu g/m^3$$

$$\text{Dust deposition} = \frac{53}{90} \times 4.0 = 2.4 g/m^2/\text{month}$$

Summary of Existing Air Quality

Taking into account PM_{10} data collected at rural monitoring sites and the approximate relationships between PM_{10}, TSP and dust deposition in locations where traffic is not the dominant source of particulate matter, PAEH (2010) has assumed the following background dust and particulate matter concentrations for the local area.

- Annual average TSP: 53µg/m^3.
- Annual average PM_{10}: 21µg/m^3.
- 24 hour maximum PM_{10}: daily varying[5].
- Dust deposition: 2.4g/m^2/month.

[5] As the background 24 hour PM_{10} concentration will vary each day, the assessment of PAEH (2010) has adopted the approach that the predicted 24-hour average PM_{10} concentration (increment attributable to the Project) should not exceed 50µg/m^3 at the nearest residences.

Table 4.38
PM_{10} Monitoring Data from DECCW Rural Monitoring Sites

	Albury		Bathurst		Wagga Wagga	
	Monthly Average	Maximum 24-hour Average	Monthly Average	Maximum 24-hour Average	Monthly Average	Maximum 24-hour Average
Month	**2007**					
January	46	**198**	24	**66**	36	**105**
February	23	49	17	37	42	86
March	27	101	15	25	31	76
April	33	95	20	40	37	69
May	18	32	14	47	26	59
June	11	16	9	14	17	30
July	11	20	9	21	15	29
August	13	24	12	20	18	35
September	15	22	17	31	20	37
October	20	36	28	33	33	68
November	14	30	13	49	19	31
December	*15*	*28*	*12*	*21*	*19*	*56*
Annual average	*21*	-	*16*	-	*26*	-
Month	**2008**					
January	21.7	37.2	16.3	27.1	25.0	64.3
February	18.2	56.1	13.3	40.5	14.7	53.6
March	27.3	54.2	17.1	31.2	36.5	64.6
April	32.1	**124.8**	14.8	41.9	2.1	**294.9**
May	-	-	-	-	24.1	49.9
June	11.8	22.5	9.2	22.1	18.2	35.0
July	9.9	36.1	11.3	41.7	15.9	53.6
August	10.0	18.2	10.3	40.6	15.1	28.5
September	18.5	105.1	16.3	**63.0**	30.9	245.9
October	18.9	40.6	15.7	33.7	30.1	59.0
November	13.3	24.0	13.1	27.2	19.2	48.3
December	14.8	124.2	15.9	30.9	21.4	68.6
Annual average	*18*	-	*14*	-	*21*	-
Month	**2009**					
January	21.7	128.9	17.3	26.9	34.3	88.2
February	45.3	**249.7**	18.7	52.4	58.1	224.0
March	23.7	65.7	23.9	51.5	40.3	100.3
April	23.6	105.7	24.3	224.4	-	-
May	17.1	27.0	13.6	24.4	30.1	56.2
June	9.6	16.1	8.4	29.2	11.7	33.9
July	11.1	15.6	8.3	19.8	14.3	26.9
August	12.7	21.0	14.2	31.6	17.0	30.5
September	13.3	26.5	92.9	**2114.4**	27.7	162.2
October	13.3	29.4	14.4	42.4	17.8	53.8
November	27.5	143.4	27.2	96.6	44.6	**297.4**
December	15.8	58.5	19.1	61.4	23.8	120.9
Annual average	*20*	-	*24*	-	*29*	-
Month	**2010**					
January	20.8	53.9	18.1	**43.3**	27.9	52.0
February	11.8	24.1	10.2	19.9	16.8	43.5
March	19.1	**60.8**	14.6	39.4	23.8	**64.9**
April	14.8	26.1	12.3	28.1	17.8	39.3
Annual average	*17*	-	*14*	-	*22*	-
Average (All Years)	***19***		***18***		***25***	
Average (All Years and Sites)	***21***					
Bold identifies maximum 24-hour average concentration each year						
Source: Modified after PAEH (2010) – Table 5.1						

4.10.2.3 Greenhouse Gases

Greenhouse gases would be produced as a consequence of the Project through the use of fuel to power mobile equipment within and to and from the Project Site. The effects of greenhouse gas emissions on global temperatures, now referred to as "climate change", are well documented and an assessment of greenhouse gas emissions has been included in this assessment. In accordance with global reporting protocols, emissions of greenhouse gases are reported as CO_2 equivalent (CO_2-e).

For assessment and reporting purposes, background greenhouse gas emissions are considered to be those reported by the Department of Climate Change (DCC) for NSW in 2007 (DCC, 2009), namely 162.7Mt CO_2-e.

4.10.3 Potential Sources of Air Contaminants

4.10.3.1 Particulate Emissions

The main sources of particulate emissions (dust) that would be generated by the Project would include:

- vegetation clearing, soil stripping, soil stockpiling and soil replacement;
- excavation, haulage and use of overburden as part of box cut development, infrastructure establishment, tailings storage facility construction and construction of other hardstand areas;
- road construction and delivery of road construction materials;
- ore crushing and screening;
- wind erosion off exposed surfaces and stockpiles; and
- general movement of heavy vehicles on unsealed roads within the Project Site.

4.10.3.2 Greenhouse Gas and Other Gas Emissions

The primary source of greenhouse gas emissions from the Project would be a result of the combustion of fuel by diesel-powered equipment and vehicles, including front-end loaders, excavators, bulldozers, graders, drill rigs and haul trucks. Additional greenhouse gas emissions would be generated by electricity purchased to power the processing plant and offices.

Although carbon dioxide (CO_2) would be the principal gas produced, greenhouse gases emitted as a result of the Project would also include limited amounts of carbon monoxide (CO), methane (CH_4), oxides of nitrogen (NO_X), sulphur dioxide (SO_2) and non-methane volatile organic compounds (NMVOCs). All greenhouse gas levels, however, are expressed as CO_2-e units.

4.10.4 Assessment Criteria

4.10.4.1 Particulate Matter, Total Suspended Particulates and Dust Deposition

Goals Applicable to PM_{10} and $PM_{2.5}$

Emissions of PM_{10} and $PM_{2.5}$ particles are considered important pollutants in terms of impacts due to their ability to penetrate into the respiratory system.

The DECCW PM_{10} assessment goals as expressed in the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, (DEC 2005) are:

- a 24-hour maximum of 50µg/m^3; and
- an annual average of 30µg/m^3.

The National Environment Protection Council (NEPC) has also developed a set of advisory reporting standards goals for $PM_{2.5}$ which are:

- a 24-hour maximum of 25µg/m^3; and
- an annual average of 8µg/m^3.

The NEPM goals for $PM_{2.5}$ have not been adopted in NSW for assessment of projects and hence are not considered further in this assessment.

Goal Applicable to Total Suspended Particulates

The annual goal for TSP is given as 90µg/m^3, as recommended by the National Health and Medical Research Council (NHMRC). This goal was developed before the more recent results of epidemiological studies suggested a relationship between health impacts and exposure to PM_{10} concentrations.

Goals Applicable to Deposited Dust

In NSW, accepted practice regarding the nuisance impact of dust is that dust-related nuisance can be expected to impact on residential areas when annual average dust deposition levels exceed 4g/m^2/month. **Table 4.39** presents the allowable increase in dust deposition relative to the ambient levels.

Table 4.39
DECC Goals for Dust Deposition

Averaging Period	Maximum Increase in Deposited Dust Level	Maximum Total Deposited Dust Level
Annual	2g/m^2/month	4g/m^2/month
Source: Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, (DEC 2005)		

4.10.4.2 Greenhouse Gas Emissions

There are no specific guidelines are provided for maximum emissions of greenhouse gases. It is noted, however, that Australia is a signatory to the Kyoto Protocol which requires developed countries to meet national targets for greenhouse gas emissions over the five year period from 2008 to 2012. Australia's annual target is 108% of the 1990 emissions.

4.10.5 Assessment Methodology

4.10.5.1 Particulate Matter Emissions

PAEH (2010) has assessed the potential particulate matter-related impacts of the Project, in accordance with the DECCW published guidelines for the assessment of air pollution sources using dispersion models (DEC, 2005), using a modified version of the US EPA ISCST3 model (ISCMOD). The model incorporates mathematical algorithms to estimate dispersion of a plume of dust, taking into account the location of emission sources and volume of dust produced at each location, as well as the effects of wind and topography on the estimated dust plume. This model has been accepted by DECCW for assessing the dispersion of dust in the atmosphere.

Particle-size Categories and Plume Dispersion Modelling

The modelling has been based on the use of three particle-size categories, namely 0μm to 2.5μm – $PM_{2.5}$, 2.5μm to 10μm – PM_{10} and 10μm to 30μm - PM_{10-30}. The distribution of particles has been derived from measurements published by the SPCC (SPCC, 1986) which is as follows.

- $PM_{2.5}$ is 4.7% of the TSP.
- $PM_{2.5-10}$ is 34.4% of TSP.
- PM_{10-30} is 60.9% of TSP.

The ISCST3 model attempts to estimate the dispersion of a plume of dust using actual meteorological data, including wind speed and direction, each hour over the modelling period, and calculating the relevant dust concentration and deposition rate at specified locations. In the present case, the co-ordinates of surrounding residences were entered into the model as point receptors (**Figure 4.7**). The data for each residence was then averaged over each 24-hour period and for the entire year, with the maximum 24-hour values for PM_{10} and deposited dust representing the highest concentration or amount deposited at that location in any 24-hour period during the year.

Meteorological Conditions

As noted in Section 4.1.3.5, wind speed, wind direction and sigma-theta (a measure of the fluctuation of the horizontal wind direction) data have been collected from the Project Site meteorological station. DECCW have listed requirements for meteorological data that are used for air dispersion modelling in the document "*Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW*" (DEC, 2005). The requirements, and review of data collected from the Project Site meteorological station, are as follows.

- Data must span at least one year. The data used during modelling spans 12 months from March 2009 to March 2010.
- Data must be at least 90% complete. The data contains 8 209 usable hourly records, or 94.4% of the potentially available data.
- Data must be representative of the area in which emissions are modelled. The data was collected within the Project Site.

As noted in Section 4.1.3.5, the onsite meteorological data from March 2009 to March 2010 was used by PAEH (2010) to calculate the proportional occurrences of Pasquill Gifford Stability Classes (see **Table 4.2**). A review of **Table 4.2** identifies that the most common stability class for the Project Site is Class D (59.7%), indicating that the dispersion conditions are such that dust emissions disperse rapidly for a significant proportion of the time. The frequency of E and F class conditions (slow dispersal conditions) are much lower at 23% (combined).

Particulate Matter Emissions (Dust Inventory)

Particulate matter emitting activities were represented by a series of volume sources positioned according to the location of activities during Year 3 of the Project (the year during which the greatest level of production and waste rock movement is scheduled). **Figure 4.35** provides an illustration of the locations of dust generating activities within the Project Site during Year 3 of mining operations. The locations of these activities have been placed where they would be likely to generate the highest concentration of particulate matter at residences surrounding the Project Site and represent the following concurrent activities.

- Stripping topsoil from the tailings storage facility (Locations 1 & 2).
- Placement of topsoil in stockpiles surrounding the tailings storage facility (Locations 3, & 5).
- Operation of a grader on the tailings storage facility access road (Location 4).
- Wind erosion from soil stockpiles (Locations 6 to 8).
- Haulage of ore from the underground to the ROM pad and waste rock from the temporary Waste Rock Emplacement back underground (Locations 9 to 12).
- Tipping of ore on the ROM pad and loading of ore to the ROM hopper (Location 13).
- Haulage of topsoil to the Waste Rock Emplacement and spreading of soil over the final landform (Location 14).
- Operation of the primary crusher and ball mill (Location 15).
- Loading of processed material (concentrate) to stockpile (Location 16).
- Vehicle movements on the site access road (Locations 17 to 32).

The quantity of dust generated by each activity has been established through reference to emission factors developed, both locally and by the US EPA. These emission factors applied are considered to be the most up-to-date methods for determining dust generation rates. **Table 4.40** presents the estimated dust emissions for the modelled worst-case dust generation scenario. It is noted that the estimates presented in **Table 4.40** assume the implementation of the operational controls presented in Section 4.10.6.

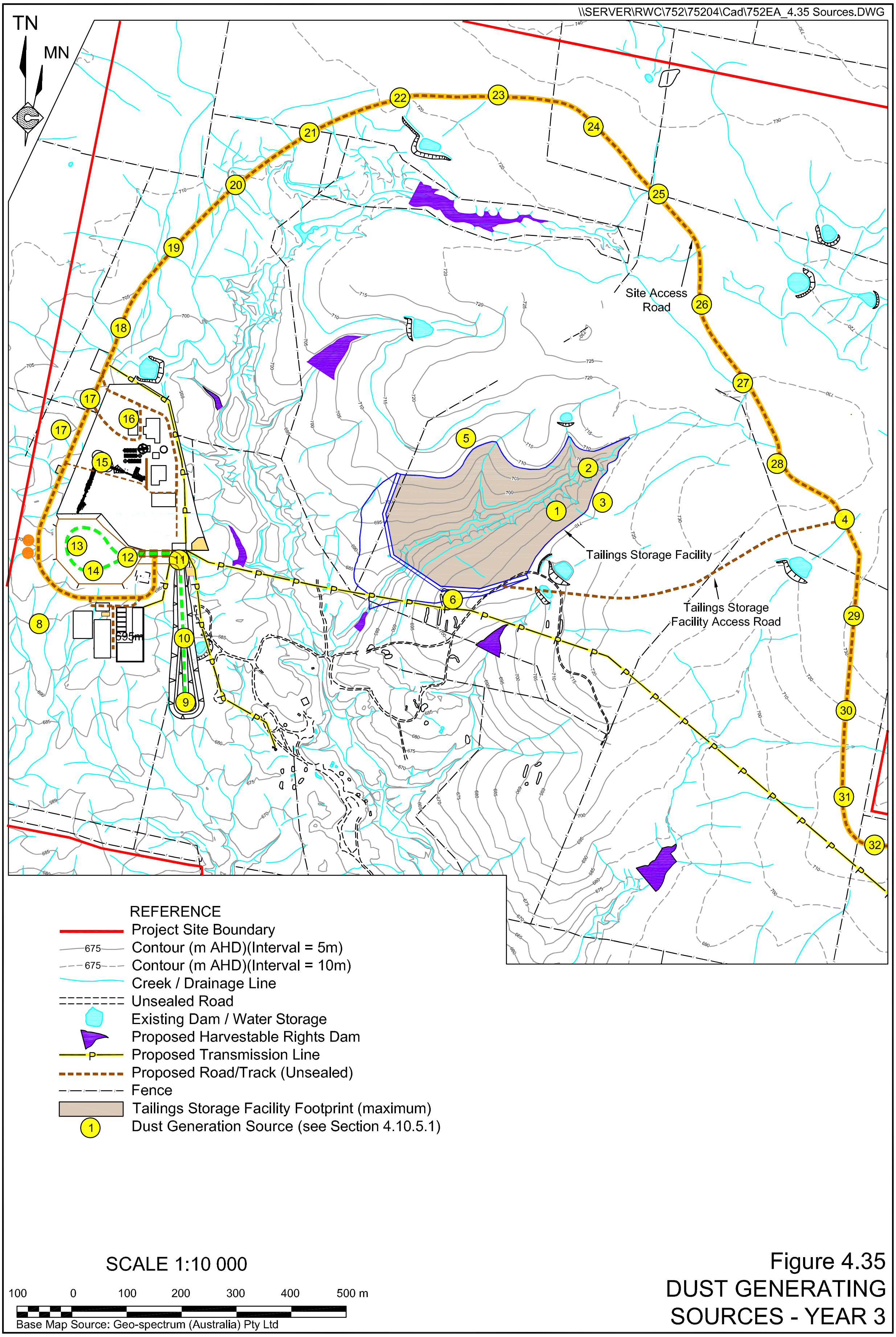


Figure 4.35
DUST GENERATING SOURCES - YEAR 3

Table 4.40
Estimated Dust Emissions of the Project (Year 3)

ACTIVITY	TSP Emission (kg/yr)
Topsoil Management	
Dozers/excavators stripping topsoil	179
Wheeled loader loading topsoil from tailings storage facility	53
Emplacing topsoil at stockpile near to Waste Rock Emplacement	53
Loading topsoil from stockpile near Waste Rock Emplacement to trucks	1
Hauling topsoil to Waste Rock Emplacement	11
Tipping/respreading topsoil at Waste Rock Emplacement	1
Waste Rock Management	
Loading rock from Waste Rock Emplacement to trucks	21
Hauling from Waste Rock Emplacement to underground	696
Ore Management	
Hauling to ROM pad	5,940
Unloading ROM to stockpile	453
Wheeled loader rehandle ore to ROM bin	453
Primary crushing	66,000
Ball milling	-
Screening	26,400
Unloading of crushed / processed ore (concentrate) to stockpile	6
Wheeled loader loading from concentrate stockpile to vehicles	12
Hauling concentrate off-site	5,360
Stockpile Management	
Wind erosion from the Waste Rock Emplacement and ROM pad	3,154
Wind erosion from soil stockpile areas	17,170
Wind erosion from concentrate stockpile	876
Other	
Grading roads	43,132
Total	**169,969**
Source: PAEH (2010) – Table 7.1	

4.10.5.2 Greenhouse Gas Emissions

The primary source of greenhouse gas emissions from the Project would be from the combustion of fuel by diesel-powered equipment and vehicles within the Project Site and along the transportation route. The use of purchased electricity within the Project Site would also be a source of greenhouse gas emissions. In order to assess greenhouse gas emissions, the various greenhouse gas emitting activities were identified and, through the use of established National Greenhouse Accounts (NGA) Factors, published by the DCC (DCC, 2009b), annual CO_2-equivalent emissions were calculated.

The DCC defines the following three 'scopes' (or emission categories) of greenhouse gas emitting sources.

- **Scope 1 Emissions**

  These are the direct emissions from sources within the boundary of the Project Site such as the combustion of fuel by diesel-powered equipment and vehicles.

- **Scope 2 Emissions**

  These are the indirect emissions from the consumption of purchased electricity, steam or heat produced by another organisation.

- **Scope 3 Emissions**

  These emissions are defined as all other indirect emissions that are a consequence of an organisation's activities but are not from sources owned, or controlled, by the organisation. In the case of the Project, this includes:

  – the emissions which arise as a result of the procession and production of the diesel and transport to the Project Site; and

  – the emissions arising from electricity lost through the transmission of purchased electricity.

4.10.6 Management and Mitigation Measures

4.10.6.1 Dust Management and Mitigation Measures

The Proponent has committed to implementing "best practice" management for pollution control. "Best practice" management for the control of particulate emissions is defined by Environment Australia (1998) as follows.

> *"Best Practice can be defined as the most practical and effective methodology that is currently in use or otherwise available. Best practice dust management can be achieved by appropriate planning in the case of new or expanding mining operations and by identifying and controlling dust sources during the active phases of all mining operations."*

Table 4.41 identify the mine design, wind-blown and mining-generated dust sources and proposed controls. These have been incorporated in the analysis, where relevant.

4.10.6.2 Energy Reduction Measures

The Proponent has and would continue to would implement the following measures to minimise the emisions of greenhouse gases during the life of the Project.

- Optimise the underground mine design to minimise:
  – development metres;
  – travel distances for mining equipment; and
  – rehandle of waste and ore material.
- Use mining equipment which is regularly maintained and serviced to maximise efficiency.
- Use Euro 4 compliant engines wherever practicable.
- Minimise the mine footprint to reduce land disturbance and travel distances for mobile plant.
- Optimise the design Process Plant to:
  – maximise the use of gravity to move material through the Process Plant reducing the need for pumping; and
  – maximise the use of energy efficient motors in major pieces of plant

Table 4.41
Proposed Dust Management Controls

Source	**Control Procedures**
Mine Design	
Transportation of ore	• Operate the largest practical truck size to reduce the number of movements necessary to transport the ore. • Use the shortest route possible. • Use conveyors within the processing plant. • Establish and use water sprays on key transfer points within the processing plant.
Waste Rock Emplacement	• Orient the Waste Rock Emplacement to minimise profile exposure to receptors. • Profile all surfaces to reduce velocity of overland winds. • Contour the final landform shape to avoid strong wind flows and smooth gradients to reduce turbulence at surface.
Revegetation	• Apply vegetative cover to non-operational exposed surfaces, eg. tailings storage facility Wall, ROM pad batters, as soon as practical after disturbance. • Apply vegetation as widely as practical.
Wind-blown Dust	
Areas Disturbed by Mining	• Limit disturbance to the minimum area necessary for mining and associated activities. • Reshape, topsoil and rehabilitate completed waste rock emplacement areas as soon as practicable after the completion of waste rock tipping. (As the Waste Rock Emplacement of the Project is to be a temporary structure, reshaping, topsoiling and rehabilitation activities of the remaining structure (ROM pad batter) would be undertaken as soon as practical after the excavation and haulage of the waste rock is complete.)
Ore Handling Areas/Stockpiles	• Maintain ore handling areas / stockpiles in a moist condition by using water carts to water down areas affected by wind-blown and traffic-generated dust.
Stockpiles	• Water stockpiles to maintain moisture content and minimise the generation of dust.
Mine-generated Dust	
Haul Road Dust	• Apply water to all roads and trafficked areas using water trucks to minimise the generation of dust. • Clearly define all haul roads edges with marker posts or equivalent to control their locations, especially when crossing large areas of non-descript disturbance. • Close, rip and revegetate all obsolete roads.
Minor Roads	• Limit the development of minor roads and clearly define the locations of these. • Apply water to all minor roads used regularly for access. • Close, rip and revegetate all obsolete roads.
Topsoil Stripping	• Apply water to all access tracks used by topsoil stripping equipment during their loading and unloading cycle.
Topsoil Stockpiling	• Establish vegetative cover over all long term topsoil stockpiles not regularly used.
Processing	• Establish and use water sprays on key transfer points within the processing plant. • Minimise drop heights from the ROM bin to the primary crusher.
Source: PAEH (2010) After Tables 9.1 to 9.3.	

- Maximise the recovery of recyclable materials where practicable, including:
  - waste hydrocarbons;
  - polyethylene; and
  - scrap metals.

- Minimise waste sent to landfill through the development of appropriate purchasing and waste management plans.
- Progressively review and implement energy efficiency measures during the life of the Project.

4.10.7 Assessment of Impacts

4.10.7.1 Particulate Matter and Deposited Dust Impacts

Table 4.42 summarises the predicted PM_{10}, TSP and deposited dust concentrations at each of the residential receptors attributable to the Project. Emission concentrations are provided both as those attributable to the Project alone, as well as cumulative emissions of the Project and other background sources (based on the background emission concentrations estimated in Section 4.9.2.2). The following compares the maximum incremental contribution for PM_{10}, TSP and deposited dust and assesses each against the Project goals identified in Section 4.10.4.1.

Annual Average PM_{10}

The most potentially affected non-project related residence (Residence R27) is predicted to experience annual average PM_{10} concentration of 1.1µg/m^3 from the Project alone and a cumulative concentration of approximately 22µg/m^3. This is below the NSW DECC goal of 30µg/m^3. **Figure 4.36** provides the predicted cumulative dispersion contours for annual average PM_{10} concentrations.

Maximum 24-hour Average PM_{10}

PAEH (2010) note that where contemporaneous and continuous monitoring data are not available in the vicinity of a Project, it is difficult to establish a reliable background for short-term PM_{10} effects. Notwithstanding the lack of a contemporaneous dataset for comparison to the Project generated PM_{10} increment, it is notable that the predicted 24-hour PM_{10} concentrations at the sensitive receptors surrounding the Project Site are very low. In fact the highest prediction from operations at the Project alone is 9µg/m^3 which represents 18% of the assessment criteria. **Figure 4.36** provides the predicted dispersion contours for Project generated PM_{10} concentrations.

As the Project Site is situated in a rural area with no major sources of air pollution, the local air quality is likely to be good and therefore on all but extreme condition days, eg. when bushfires or dust storms are occurring, cumulative emissions would comply with 50µg/m^3 criterion.

Annual Average TSP

The maximum predicted concentration at surrounding non-project related residences from the Project alone is 1.3µg/m^3 (Residence R27) and a cumulative concentration of approximately 54µg/m^3. This is below the NHMRC goal of 90µg/m^3. **Figure 4.37** provides the predicted cumulative dispersion contours for annual average TSP concentrations.

Dust Deposition

Dust deposition levels at all surrounding residences are predicted to be less than 0.2g/m^2/month. Compliance with the NSW DECC goal of 4g/m^2/month would be anticipated with the existing dust deposition of 2.4g/m^2/month. **Figure 4.37** provides the predicted cumulative dispersion contours for annual average dust deposition levels.

Table 4.42
Predicted Particulate Matter Emissions[1]

Receiver[1]	Project Only				Cumulative Emissions		
	PM_{10} (µg/m³)		TSP (µg/m³)	Dust Deposition (g/m²/month)	PM_{10} (µg/m³)	TSP (µg/m³)	Dust Deposition (g/m²/month)
	24-hour	Annual	Annual	Annual	Annual	Annual	Annual
	Assessment Criteria						
	50	***N/A***	***N/A***	***2***	***30***	***90***	***4***
R1	6	0.3	0.4	0.03	21	53	2.4
R2	4	0.4	0.4	0.03	21	53	2.4
R6	4	0.4	0.4	0.03	21	53	2.4
R7	4	0.4	0.4	0.03	21	53	2.4
R8	4	0.4	0.4	0.03	21	53	2.4
R9	5	0.3	0.4	0.03	21	53	2.4
R10	4	0.4	0.5	0.04	21	53	2.4
R11	5	0.4	0.4	0.03	21	53	2.4
R12	6	0.3	0.3	0.02	21	53	2.4
R13	5	0.3	0.3	0.02	21	53	2.4
R14	5	0.3	0.3	0.02	21	53	2.4
R15	2	0.2	0.2	0.02	21	53	2.4
R16	4	0.5	0.6	0.04	21	54	2.4
R17	4	0.5	0.6	0.05	21	54	2.4
R18	4	0.5	0.6	0.05	22	54	2.5
R19	4	0.5	0.6	0.05	21	54	2.4
R20	4	0.6	0.7	0.05	22	54	2.5
R21	4	0.6	0.7	0.05	22	54	2.5
R22	4	0.6	0.7	0.05	22	54	2.5
R23	4	0.6	0.7	0.06	22	54	2.5
R24	6	0.8	0.9	0.07	22	54	2.5
R25	6	0.7	0.9	0.07	22	54	2.5
R26	6	0.8	0.9	0.07	22	54	2.5
R27	**8**	**1.1**	**1.3**	**0.11**	**22**	**54**	**2.5**
R28	6	0.8	1.0	0.07	22	54	2.5
R29	8	0.7	0.9	0.07	22	54	2.5
R30	9	0.6	0.7	0.05	22	54	2.5
R31	8	0.7	0.9	0.07	22	54	2.5
R34	4	0.1	0.1	0.01	21	53	2.4
R53	4	0.5	0.6	0.04	22	54	2.4
R54	4	0.5	0.6	0.04	22	54	2.4
R55	4	0.6	0.6	0.05	22	54	2.4
R56	4	0.5	0.6	0.04	22	54	2.4
R58	5	0.6	0.7	0.05	22	54	2.5
R59	5	0.6	0.7	0.05	22	54	2.5
R60	4	0.5	0.6	0.04	21	54	2.4
R70	4	0.4	0.5	0.04	21	53	2.4
R71	4	0.6	0.7	0.05	22	54	2.5
R72	5	0.6	0.7	0.05	22	54	2.5
R93	4	0.3	0.4	0.03	21	53	2.4
R94	4	0.3	0.3	0.03	21	53	2.4
R107	4	0.3	0.3	0.02	21	53	2.4

Note 1: see **Figure 4.7** for residence locations.
Note 2: Only residences predicted to receive maximum 24-hour PM_{10} concentrations of 4µg/m³ or more are shown. The results for all residences are shown in Table 8.1 of PEAH (2010)

Source: Modified after PAEH (2010) – Table 8.1

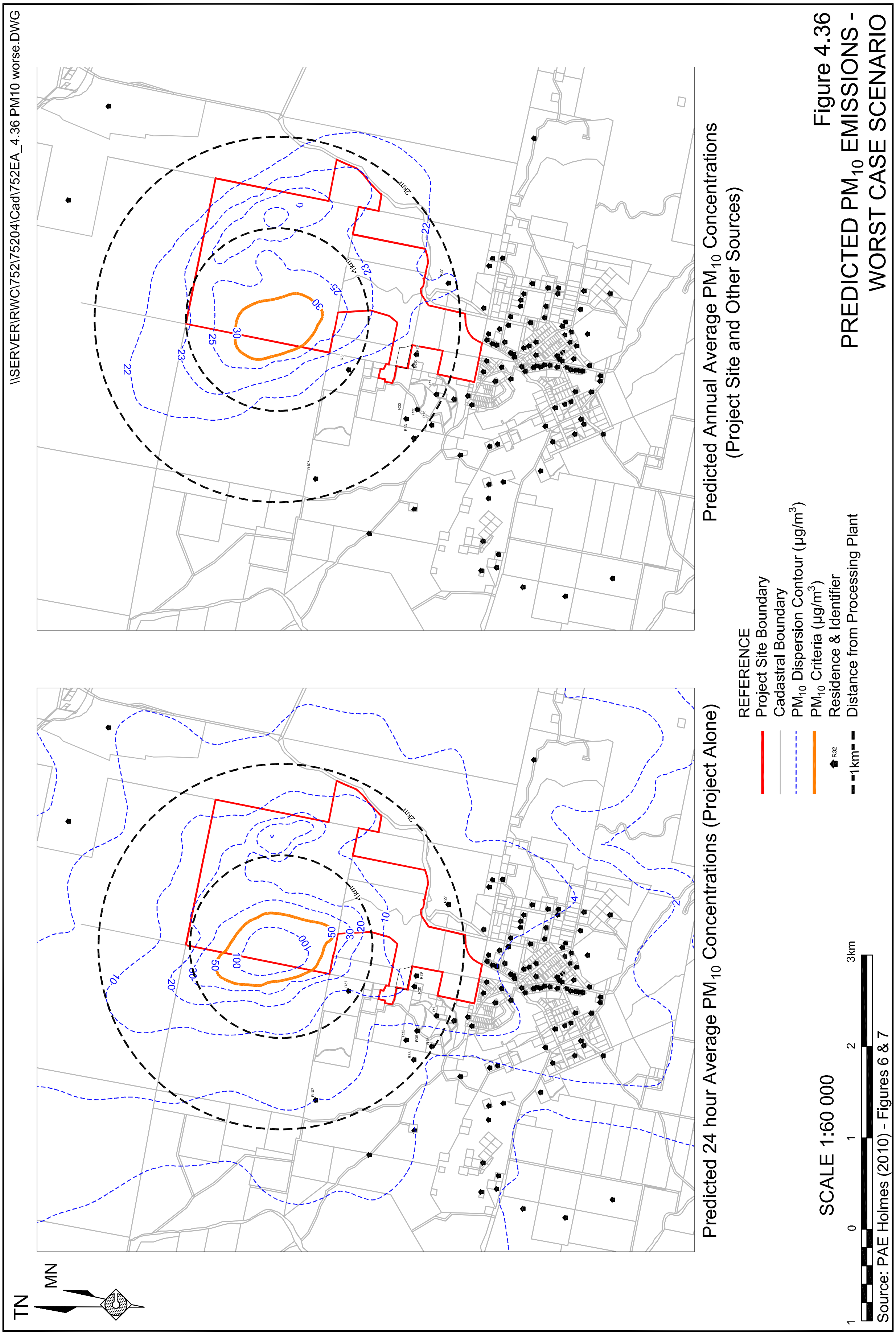


Figure 4.36
PREDICTED PM_{10} EMISSIONS - WORST CASE SCENARIO

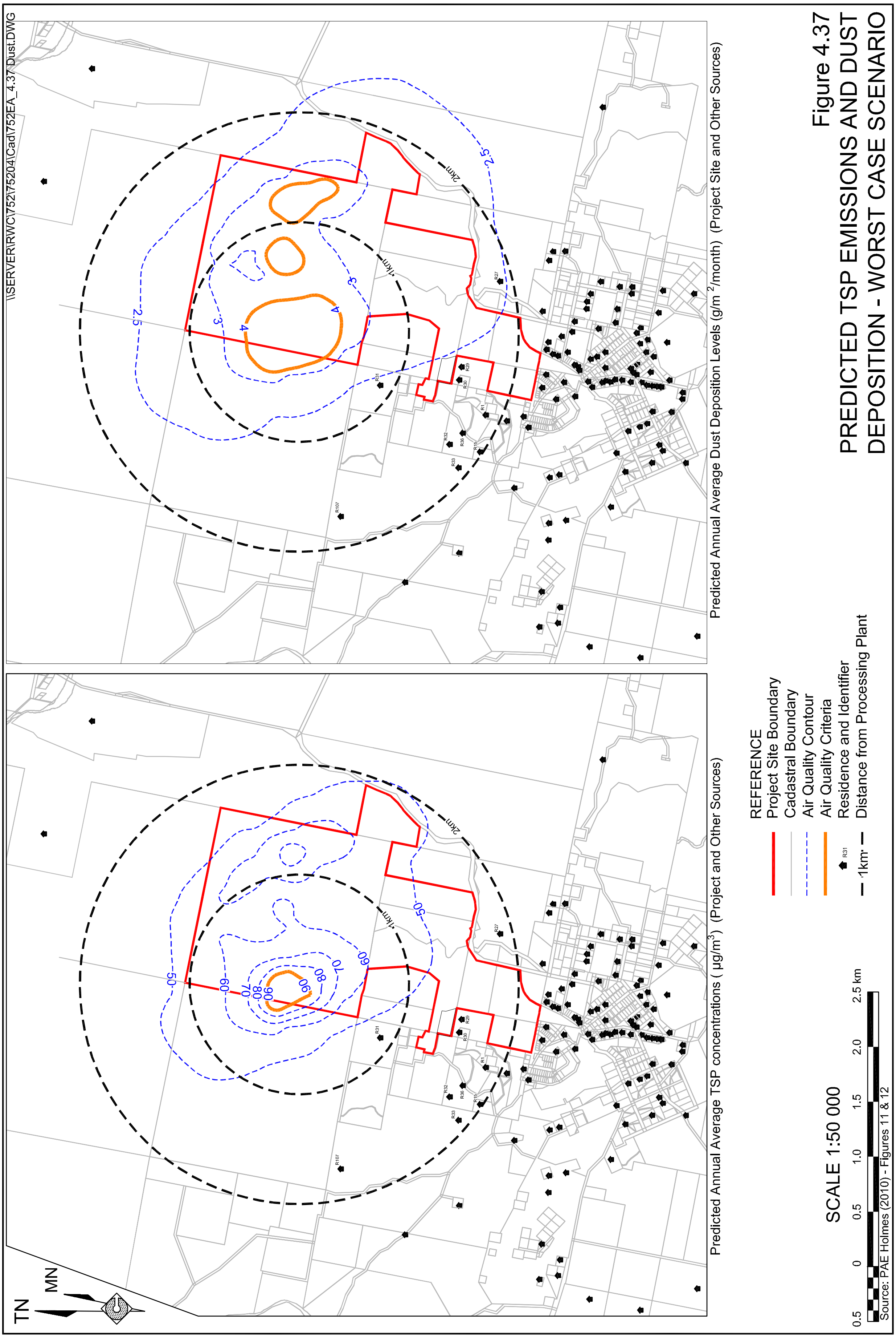


Figure 4.37
PREDICTED TSP EMISSIONS AND DUST DEPOSITION - WORST CASE SCENARIO

The minimal incremental increases in deposited dust (<0.2g/m^2/month) are considered extremely unlikely to have any influence on the growth of vegetation surrounding the Project Site, including native vegetation, pasture and nursery stock. An illustration of the tolerance of vegetation to dust accumulation is provided by Hunt (1999) who considered the accumulation of dust at a rate equivalent to 8g/m^2/day (at least 240 times the maximum predicted incremental increase to dust deposition predicted for residences surrounding the Project Site) on pasture palatability and production. Hunt (1999) concluded that the addition of the elevated rates of dust deposition had no effect on palatability or production.

4.10.7.2 Greenhouse Gas Emissions

Scope 1 Emissions (Diesel Fuel Consumption)

The following formula (DCC, 2009b) was used to estimate the Scope 1 greenhouse gas emissions from fuel usage.

$$GHG\ Emissions\ (tCO_2 - e) = \frac{Q \times EC \times EF}{1000} \qquad \text{Equation 1}$$

Where:

EC = energy content of the fuel in GJ/kL = 38.6GJ/kL (DCC, 2009b)

EF = relevant emission factor in kg CO_2-e/GJ = 69.5kg CO_2-e/GJ (DCC, 2009b)

Q = quantity of fuel in tonnes or thousands of litres

Table 4.43 provides the estimated diesel fuel consumption per year (Q) for the Project and the associated CO_2-e Emissions.

Table 4.43
Summary of Scope 1 Emissions

Operational Year	Diesel Usage per Year (L)	CO_2-e Emissions (t CO_2-e/y)
Year 1	1 117 314	2 997
Year 2	1 473 228	3 952
Year 3	1 475 820	3 959
Year 4	955 800	2 564
Year 5	635 607	1 705
Total (L)	**5 657 769**	**15 178**
Source: Modified after PAEH (2010) – Tables 10.2 & 10.3		

Scope 2 Emissions (Purchased Electricity)

To calculate emissions from electricity usage, the following equation was used:

$$GHG\ Emissions\ (tCO_2 - e) = Q \times \frac{EF}{1000} \qquad \text{Equation 2}$$

Where:

EF = relevant emission factor in kg CO2-e/GJ = 0.89kg CO2-e/kWh

Q = electricity consumed in kWH