

## 9 AQUATIC FLORA AND FAUNA

The aquatic habitats, water quality and/or biota in surface watercourses of Cordeaux and Avon Dam catchments have been previously surveyed for the original Dendrobium coal project in 2001. A further study on the aquatic ecological features has been commissioned for the proposed Area 3 footprint modification. The study was prepared by Ecology Lab who has undertaken field investigations during 2007. Summary of the findings is provided below. The full assessment is provided in **Attachment E**.

### 9.1 EXISTING ENVIRONMENT

#### 9.1.1 Aquatic Habitats

Aquatic ecological studies in watercourses of the Cordeaux and Avon Dam catchments have been undertaken previously in relation to the Dendrobium coal project and mining of longwalls at the nearby Elouera Colliery. The aquatic habitats in Sandy Creek, streams LC6 and LC7 to the east of Dendrobium Area 3, and the Upper Wongawilli Catchment to the south of Dendrobium Area 3 have been described. A qualitative assessment of aquatic habitats that Macquarie Perch may use for spawning has also been conducted in numerous waterways that flow into Lake Cordeaux. Water quality data is available for sites in the Sandy, Wongawilli, Native Dog and Donalds Castle Creek catchments. Native Dog and Wongawilli Creeks both have quantitative data to describe the geochemical effects resulting from past mining by the Elouera Colliery. This data shows that water quality impacts have improved over time.

Aquatic ecological studies in watercourses of the Cordeaux and Avon Dam catchments have been undertaken previously in relation to the Dendrobium coal project and mining of longwalls at Elouera Colliery.

#### 9.1.2 Aquatic Plants and Macroinvertebrate

No information was identified in relation to aquatic plants in the creek systems flowing into Lake Cordeaux and Lake Avon. Aquatic macroinvertebrate surveys have been conducted in Wongawilli, Native Dog, Donalds Castle, Sandy, Banksia and Cascade Creeks and in several un-named creeks draining into the Cordeaux River. The macroinvertebrate fauna at the sites within Dendrobium Area 3 was generally similar to the AUSRIVAS reference condition, but on some occasions was found to be either significantly impaired or richer than reference condition. The fauna at sites above or in the vicinity of Elouera Colliery was generally in a poorer condition.

#### 9.1.3 Fish

Aquatic ecological studies in watercourses of the Cordeaux and Avon Dam catchments have been undertaken previously in relation to the Dendrobium coal project and mining of longwalls at the nearby Elouera Colliery.

Eight surveys were conducted as part of Area 1 baseline investigations which were undertaken from Spring 2003 to Autumn 2004 (The Ecology Lab, 2005). These surveys used backpack electrofishing techniques and were conducted in Kembla, Goondarin and Kentish Creeks, all of which flow to Lake Cordeaux. A further five surveys within these

creeks were undertaken during, and following the mining of Area 1 (The Ecology Lab, report in progress). Fish and crayfish species found during these surveys included: Mountain galaxid (*Galaxias olidus*); Australian smelt (*Retropinna semoni*); longfinned eel (*Anguilla reinhardtii*); shortfinned eel (*Anguilla australis*); lamprey (*Mordacia sp.*); and freshwater crayfish (*Euastacus sp.*).

Investigations undertaken for Dendrobium Mine Area 2 have included fish surveys (electrofishing and traps in autumn 2005 and traps in spring 2005) within Sandy Creek and some of its tributaries (The Ecology Lab, 2006b). These surveys have incorporated reaches of Sandy Creek, Cascade Creek and Banksia Creek which are part of the study area for Area 3A. Techniques included backpack electrofishing and bait trapping. Only one fish species (mountain galaxid) and freshwater crayfish were found within these watercourses.

This lack of diversity is considered to be due to the presence of the large waterfall on Sandy Creek just upstream of the Sandy Creek arm of the Lake Cordeaux that would effectively prevent access to this habitat by most fish species. Observations of the listed threatened species; Macquarie perch (*Macquaria australasica*), participating in apparent spawning behaviour were made by The Ecology Lab in October of 2006 within the Sandy Creek arm of Lake Cordeaux.

Wongawilli Creek is the major watercourse draining Dendrobium Mine Area 3, and contains extensive fish habitat. Fish surveys in this creek using backpack electrofishing techniques were undertaken on 16th and 17th August 2001 (The Ecology Lab 2001c). Macquarie perch were found in a pool just upstream of the fire trail 6 crossing. Other species found included: Australian smelt; freshwater eel; mountain galaxid; climbing galaxid (*Galaxias brevipinnna*); and freshwater crayfish. Observations have since been made of Macquarie Perch within the same reach of the creek by The Ecology Lab in 2005 and 2007. An intensive fish survey of Wongawilli Creek using electrofishing techniques, specifically targeting Macquarie Perch is planned to be undertaken in late 2007.

## 9.2 IMPACT ASSESSMENT OF AQUATIC HABITAT

Further qualitative field investigations were undertaken to survey the aquatic habitat within the Wongawilli, Sandy, Donalds Castle and Native Dog Creek catchments overlying Dendrobium Area 3 between 16 to 20 July 2007. The assessment of aquatic habitats in Sandy Creek is based on the ongoing monitoring undertaken in relation to Dendrobium Area 2. The findings of the survey is summarised below. The habitats are shown in **Figure 9.1**.

### 9.2.1 Wongawilli Creek Catchment

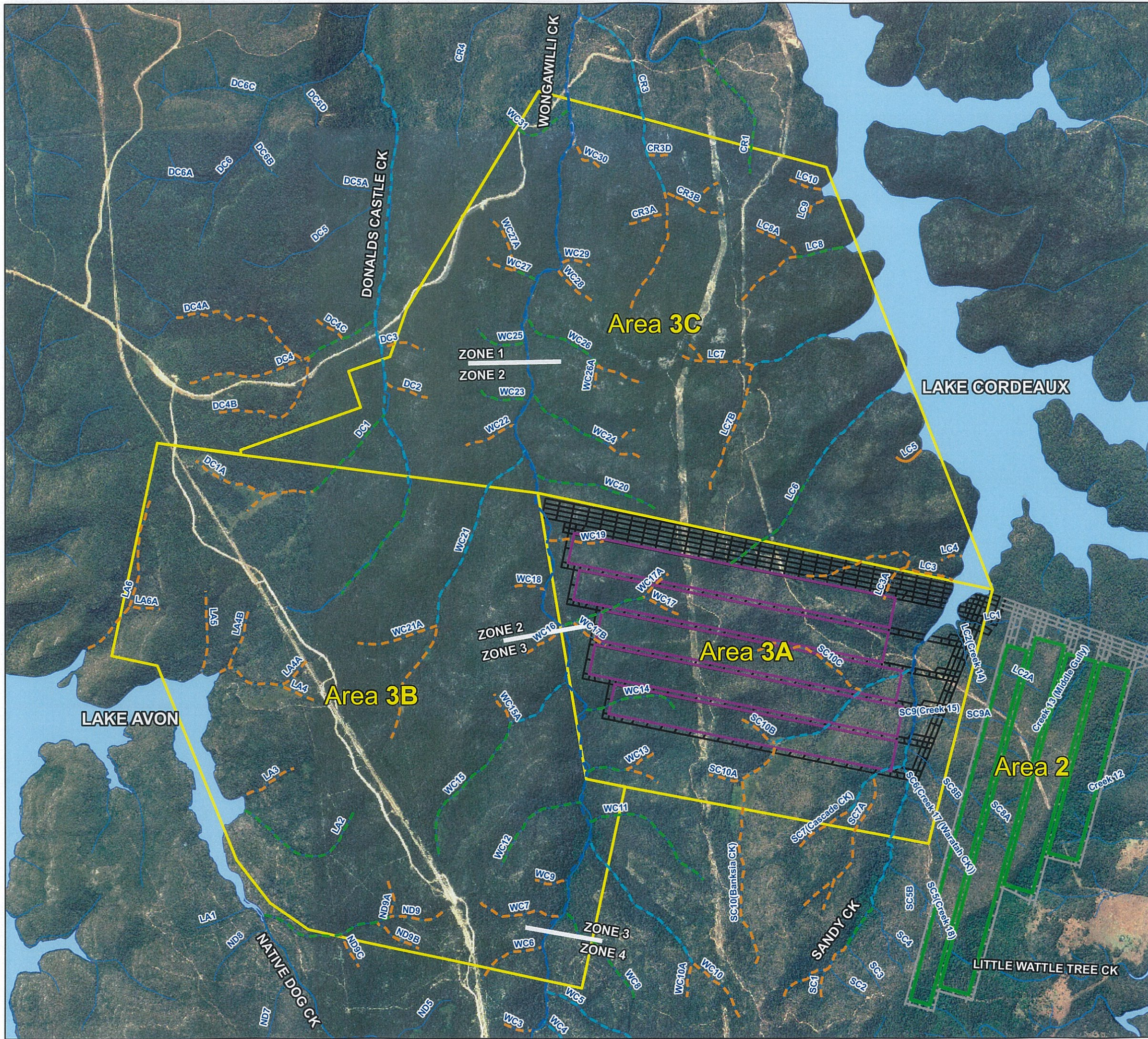
This is the largest creek within Area 3. For the purposes of habitat description, this catchment has been further divided into four major habitat zones. The conditions of the aquatic habitats within each zone is described below.

#### Zone 1 – Cordeaux River Confluence to Site No. 30

- Zone 1 is located within and downstream of the maximum footprint for mining area 3C, includes the main channel of Wongawilli Creek between its confluence with the Cordeaux River and the rock bar at Site No. 30 and tributaries WC25 – WC31.
- The main creek channel is characterized by large deep pools separated by sandstone rock bars and a substratum composed of either sandstone bedrock or a mixture of sand, with significant areas of bedrock and boulder. The channel contains numerous instream



**Aquatic Habitat  
 DENDROBIUM AREA 3**



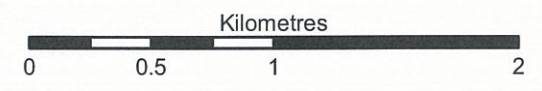
**Legend**

- - - Unlikely Habitat
- - - Minimal Habitat
- - - Moderate Habitat
- - - Significant Habitat
- Minor Streams
- Rivers & Creeks (LPI)
- Lakes (LPI)
- Proposed Area 3 Footprint
- Proposed Longwall Layout
- Existing Longwall Layout



**FIGURE 9.1**

Scale 1:30,000 (at A3)





habitat features and diverse range of aquatic habitats and is therefore considered to be significant aquatic habitat.

- The main channel contains three significant barriers to fish passage: a 15 m high rockbar-waterfall just upstream of its confluence with the Cordeaux River and two smaller rockbars upstream of Fire Road 6.
- The lower reaches of tributaries WC25-WC27 and WC31 contain “minimal” aquatic habitat, and the other tributaries are considered “unlikely” aquatic habitat.

#### **Zone 2 – Site No. 30 to WC 15**

- Zone 2 is located within the maximum footprint for mining areas 3A, 3B and 3C and includes the reach of Wongawilli Creek extending from the rock bar at Site No. 30 upstream to the inflow of tributary WC15 and tributaries WC18-24.
- The channel contains numerous instream habitat features and a diverse range of aquatic habitats and is therefore considered to be significant aquatic habitat. There are no significant barriers to fish passage present within the main channel, hence this reach may provide potential habitat for Macquarie Perch if they can negotiate the barriers downstream in zone 1.
- Tributary WC21 is characterised by a moderate-sized, permanent pool at the base of a large sandstone cascade and is considered “moderate” aquatic habitat. The cascade consists of a series of sandstone steps up to 4 m high and has a total change in elevation of 20 m over a horizontal distance of 70 m making it an effective barrier to passage of Macquarie Perch upstream within this tributary. The lower reaches of tributaries WC17, WC20, WC23 and WC24 contain “minimal” aquatic habitat, but the remaining tributaries are considered “unlikely” aquatic habitat.

#### **Zone 3 – WC15 to Waterfall (Site No. 4)**

- Zone 3 is located within the maximum footprint for mining areas 3A and 3B and includes the reach of Wongawilli Creek extending from its confluence with tributary WC15 upstream to a large waterfall at Site No. 4.
- The channel contains numerous instream habitat features and diverse range of aquatic habitats and is therefore considered to be significant aquatic habitat. There are no significant barriers to fish passage within the main channel, hence this reach may provide potential habitat for Macquarie Perch if they can negotiate the barriers downstream in zone 1.
- The waterfall at Site No. 4 is 25 m high and has a single vertical drop that would prevent passage of Macquarie Perch upstream into zone 4, but may be negotiable by galaxiid fish and freshwater eels.
- Tributaries WC15 and WC10 contain “moderate” aquatic habitat. WC15 flows out of swamp 14 and is characterised by a series of permanent pools amongst sandstone boulders and small waterfalls, which would be an effective barrier to upstream passage of Macquarie Perch. WC10 has a well defined channel with a substratum of gravel, pebbles and cobbles and there are likely to be permanent pools upstream that would provide habitat for some fish and aquatic invertebrates.
- The lower reaches of WC8, WC11, WC12, WC13 and WC14 contain “minimal” aquatic habitat. The other tributaries in this zone are considered as “unlikely” aquatic habitat.

#### **Zone 4 – Upstream of Waterfall (Site No. 4)**

- Zone 4 includes the main channel of Wongawilli Creek extending upstream from the waterfall at Site No. 4 to the upper reaches of Wongawilli Creek and tributaries WC1-WC6. Only the most downstream 400m reach of the creek and tributary WC6 falls within the maximum footprint for the mining area.
- The main channel of the creek between the waterfall and its confluence with WC2 contain “significant” aquatic habitat, whereas that further upstream is considered to be “moderate” aquatic habitat. The steps associated with the sandstone rockbars could be potential barriers to fish passage for some species; but not for freshwater eels or galaxids.
- Tributaries WC4 and WC5 contained small permanent pools in their lower reaches and are therefore categorized as “moderate” aquatic habitat. Tributaries WC6 and WC3, the only other tributaries inspected, are considered to be “unlikely” aquatic habitat.

#### **9.2.2 Sandy Creek Catchment**

- Reach of Sandy Creek near the Fire Road 6C crossing is characterised by a series of long shallow pools, short deep pools and alternating short riffles. A 25 m high waterfall exists approximately 100m below the crossing, which constitutes a substantial barrier to fish passage into Sandy Creek from Lake Cordeaux and an absolute barrier to the passage of Macquarie Perch into Area 3A.
- The creek bed below the waterfall is characterised by a moderate slope with large boulders and sandbars to the high water mark of the dam. The reach of Sandy Creek between its confluences with Banksia and Cascade Creeks is characterised by alternating riffles with sand and gravel bars and moderate size pools.
- Sandy Creek has extensive and diverse aquatic habitat in the mid to lower reaches and is therefore considered as “significant” aquatic habitat. The flow further upstream in the main channel of Sandy Creek is greatly reduced and while there are still some small permanent pools, this reach contains only “moderate” aquatic habitat.
- Banksia Creek adjoins Sandy Creek approximately 50m upstream of the Fire Road 6C. The reach of the creek downstream of swamp15A is characterised by long, permanent pools separated by small sandstone rockbars with short drops (< 2 m) and is considered to be “moderate” aquatic habitat. The creek bed consists of a mixture of bedrock, boulder, sand and detritus.
- Cascade Creek adjoins Sandy Creek approximately 700m upstream of the Fire Road 6C crossing. The substratum of the creek consists of sandstone bedrock with some sand and gravel bars. Approximately 200m upstream of its confluence with Sandy Creek there is a series of cascades over bedrock with a boulder filled pool at the base. The reach of Cascade Creek within the General SMP Area is considered to be “moderate” aquatic habitat.

#### **9.2.3 Donalds Castle Creek**

The main channel of the upper reach of Donalds Castle Creek consists of a series of relatively small, permanent pools with a mainly sand substratum that are connected by narrow channels with a mainly sand substratum, small sections of gravel riffles and sandstone rockbars with small cascades (≤1m high). The reach of Donalds Castle Creek upstream as far as Swamp 5 is considered “moderate” aquatic habitat.

#### 9.2.4 Native Dog Creek

This watercourse contains very limited aquatic habitat apart from some small, semi-permanent pools and is thus considered to be “minimal” aquatic habitat.

- Tributaries CR1 and CR2 flow into the Cordeaux River downstream of the dam wall from within the northern section of the maximum proposed footprint of Dendrobium Area 3. The reach of CR1 to the north of the footprint contains “minimal” aquatic habitat, whereas that of CR2 just downstream of the footprint contains “moderate” aquatic habitat in its lower reach.
- Eight small to moderate size watercourses, LC1-LC8, that flow into Lake Cordeaux lie within the north-east of the maximum proposed footprint for Dendrobium Area 3. The two largest (LC4 and LC5) contain small pools in their lower reaches that may persist through extended dry periods and hence are considered to contain limited “moderate” aquatic habitat. The other watercourses have small steep drainage lines and are therefore likely to contain either “minimal” or “unlikely” aquatic habitat.
- Five small watercourses (LA2 – LA6) that flow to the Native Dog Creek arm of Lake Avon lie within the south-west of the maximum proposed footprint for Dendrobium Area 3. These watercourses also have small steep drainage lines and are therefore unlikely to have aquatic habitat.

### 9.3 IMPACT ASSESSMENT OF SUBSIDENCE-INDUCED IMPACTS

The assessment of potential impacts of longwall mining on aquatic habitat and biota is based on predictions of mine subsidence provided by Mine Subsidence Engineering Consultants (MSEC 2007) and of impacts on water quality within surface watercourses provided by Ecoengineers (2007).

#### 9.3.1 Impacts on Aquatic Habitat

The mine subsidence predictions indicate that there is unlikely to be any significant fracturing of sandstone bedrock or surface water diversions within these creeks. The extraction of longwalls could, however, cause localised, minor fracturing of bedrock within Wongawilli and Sandy Creeks which may extend up to 400 m away from the longwalls. This fracturing is not expected to cause any significant diversion of surface flows, but could cause minor, localised reductions in the availability of aquatic habitat. Predictions about potential impacts in the reaches of Donalds Castle Creek which flow through Areas 3B and 3C are likely to be similar to those for Area 3A (MSEC 2007).

The ephemeral drainage lines located across the Study Area are expected to experience a variety of systematic subsidence and valley-related movements when the longwalls are extracted. Levels of ponding, flooding and scouring are not expected to change significantly along tributary WC 17 (Drainage Line 1), but there may be increased ponding and flooding adjacent to longwall tailgates and increased scouring adjacent to longwall maingates along Banksia Creek (Drainage Line 2). These changes would lead to a temporary increase in the availability of aquatic habitat adjacent to the longwall tailgates and a transient reduction in quality of aquatic habitat in the vicinity of the longwall maingates due to increased turbidity. Cracking of bedrock is also expected to occur along the drainage lines, with that along the lower reaches resulting in some diversion of surface flows into underlying strata and drainage of pools. Changes of this type will cause a localised reduction in the availability of aquatic habitats, which are already ephemeral in nature. The extraction of the proposed and

future longwalls is not expected to have any significant systematic subsidence impacts in Lakes Avon or Cordeaux, however, there is a possibility that it will cause localised, minor cracking in the lake bed. This is unlikely to result in any loss of water or changes in the availability of aquatic habitat.

### 9.3.2 Impacts on Water Quality

The fracturing of bedrock and diversion of sub-surface flows into pools can lead to weathering and leaching of minerals which, in turn, can have a localised impact on the quality of water in rivers and creeks, particularly during low flow conditions. The deposition of sediments mobilised by subsidence-induced erosion events may cause a short term increase in turbidity levels within watercourses. Ecoengineers have concluded that mining of Area 3 is unlikely to have significant geochemical effects on Wongawilli, Sandy or Donalds Castle Creeks. Minor fracturing could lead to changes in water quality in Banksia Creek in the vicinity of Longwall maingate 10 and tailgate 9, in the longer, incised, high gradient tributaries of Wongawilli Creek in Areas 3B and 3C and in creeks LC6 and LC7 in Area 3C. Mining could also lead to the development of ferruginous springs on the slopes of the south-west draining catchments over Area 3B. Minor erosion may occur on the steep slopes along the main channel and tributaries of Wongawilli Creek in Area 3A, on the steep slopes draining the western side of Area 3B to the Native Dog Creek Arm of Lake Avon and on the eastern side of Area 3C draining to Lake Cordeaux. These events are expected to have only minor, localised, short-term impacts on the lower sections of creeks and shorelines of Lakes Cordeaux and Avon.

### 9.3.3 Impacts on Aquatic Biota

Any sudden drainage of pools and rapid drops in surface flow due to subsidence are likely to have localised impacts on aquatic biota, particularly if they are left stranded in air or unable to move to areas that are damp or submerged. The survival of mobile organisms is difficult to predict, because it depends on their tolerance and response to desiccation and rapid changes in water level, ability to move, weather conditions, the underlying substratum and duration of exposure.

## 9.4 THREATENED SPECIES / POPULATIONS AND ECOLOGICAL COMMUNITIES

### 9.4.1 Existing Environment

Searches on the threatened species websites of the Department of Primary Industries website and the BIONET and EPBC databases revealed that four listed aquatic threatened species could potentially occur in the study area including:

- Sydney Hawk Dragonfly (*Austrocordulia leonardi*).
- Adams Emerald Dragonfly (*Archaeophya adamsi*),
- Macquarie Perch (*Macquaria australasica*).
- Australian grayling (*Prototroctes maraena*).

#### 9.4.1.1 Sydney Hawk and Adams Emerald Dragonflies

Potential suitable habitat for the Sydney Hawk and Adams Emerald dragonflies exists within Wongawilli and Sandy Creeks.

#### 9.4.1.2 Macquarie perch

Macquarie perch is the only threatened species that has actually been recorded in the area, having been caught in Wongawilli Creek, the lower arm of Sandy Creek and Lake Cordeaux. The only tributaries draining to Lake Cordeaux from the proposed maximum footprint that contain "moderate" or "significant" aquatic habitat suitable for Macquarie Perch also have large waterfalls and rock-bar cascades which are potential barriers to the upstream passage of this species. Recent field observations in Wongawilli Creek indicate that Macquarie perch may be able to migrate upstream of existing barriers under extreme high-flow conditions. There is consequently a possibility that this species may be able to access the entire reach of Wongawilli Creek that overlies all three sub areas of Dendrobium Area 3. Suitable spawning areas for this species have also been identified within Wongawilli Creek, including within the General SMP Area of Area 3A.

#### 9.4.1.3 Australian Grayling

The Australian grayling is a migratory species and unlikely to occur in the study area, because of the lack of provision for fish passage in the upper Nepean System.

### 9.4.2 Impact Assessment

Seven Part Tests have been undertaken for the three listed threatened species that have been identified as potentially occurring within Area 3, include: Macquarie Perch, Sydney Hawk Dragonfly and Adams Emerald Dragonfly.

The Tests conclude that:

- *Macquarie Perch*

Deep, permanent pools in the reach of Wongawilli Creek from Cordeaux River confluence upstream to the large waterfall are likely to be important habitat areas for Macquarie Perch within various stages of the life cycle of this species. These large deep pool habitats are unlikely to be removed, modified, fragmented or isolated within Wongawilli Creek as a consequence of mine subsidence. The proposed longwall mining of Area 3 does not pose a significant threat to the local viable population of Macquarie Perch and as such a Species Impact Statement as prescribed under the EP&A Act is not required. Further monitoring of the Macquarie Perch population has been incorporated into the monitoring plan as a precautionary measure.

- *Sydney Hawk Dragonfly*

It is unlikely that a viable population of Sydney Hawk Dragonfly exists within Area 3. The aquatic macroinvertebrate monitoring has incorporated a procedure for the identification of family, genus and species of dragonfly larvae as a precautionary measure.

- *Adams Emerald Dragonfly*

It is unlikely that a viable population of Adams Emerald Dragonfly exists within Area 3. The aquatic macroinvertebrate monitoring has incorporated a procedure for the identification of family, genus and species of dragonfly larvae as a precautionary measure.



All Seven Part Tests indicate that the proposed longwall mining does not pose a significant threat, provided that the future longwall layouts for Areas 3B and 3C are offset from the main channel of Wongawilli Creek at a similar distance to those proposed in Area 3A.

## 9.5 MITIGATION MEASURES

### 9.5.1 Aquatic Monitoring Plan

A comprehensive, phased monitoring plan has been designed to assess the potential impacts of mine subsidence on aquatic habitat and biota within watercourses overlying Dendrobium Area 3. The monitoring plan is intended to comply with the Dendrobium conditions of consent and Director General's (DoP) requirements to assess potential impacts on habitats, biodiversity and threatened species.

The proposed monitoring plan incorporates baseline sampling to be undertaken in impact and control locations four times within a 12 months period prior to the commencement of longwall mining within each sub-area, and be repeated during and after extraction to determine the extent and nature of any impacts and recovery should these occur. Monitoring will be undertaken to watercourses rated as containing "significant" and "moderate" aquatic habitats. Potential sampling locations have been identified within Zones 1-4 Wongawilli Creek, Donalds Castle Creek, tributaries LC4 and LC7 of Lake Cordeaux and tributary CR3 of the Cordeaux River. Monitoring will be continued at the locations within the main channel of Sandy Creek, Banksia Creek and Cascade Creek that are currently being used to assess impacts on Dendrobium Area 2. Potential control locations have been identified within the catchments of Loddon Creek (Cataract River Catchment) and O'Hares Creek (Georges River Catchment). At each location, habitat features and water quality will be assessed, the abundance and distribution of aquatic macrophytes will be recorded and samples of fish and macroinvertebrates will be collected using standardised procedures. Larvae of the dragonfly genera *Austrocorduliidae* and *Gomphomacromiidae* will be identified to genus and species level to confirm whether or not the threatened Adams Emerald Dragonfly and Sydney Hawk Dragonfly occur within the study area.

An intensive fish survey of the full reach of Wongawilli Creek from the confluence of the Cordeaux River upstream to the large waterfall will be undertaken during spring 2008 to coincide with possible spawning activity of Macquarie Perch. The aim of this survey is to determine if Macquarie Perch are able to access and utilise aquatic habitat within the proposed Area 3 footprint for spawning.

This survey is specifically designed to gather further information about the distribution of Macquarie Perch within Wongawilli Creek. It is distinct from the ongoing monitoring of fish proposed at selected sites within Area 3 and control locations.

### 9.5.2 Management Measures

The detection of primary impacts, such as rockbar fractures resulting in water loss in a pool within an area of 'significant' or 'moderate' aquatic habitat or significant changes in water chemistry within such areas, would trigger investigations into potential impacts on aquatic ecology. Observations of fish/crayfish kills or die-off of macrophyte beds would trigger a rapid response aquatic monitoring plan to determine the nature and extent of secondary impacts on aquatic ecology. The level of impact found would determine the type of response. It could, for example, include rehabilitation of aquatic habitat being undertaken in conjunction with mitigation works, such as grouting, followed by monitoring to assess

recovery. Significant changes in aquatic biota detected 'during mining' monitoring events would also provide triggers for further investigation.

### **9.5.3 Compensatory Measures**

Longwalls within Dendrobium Area 3A, and the commitments proposed for the longwalls in Areas 3B & 3C, have been designed to avoid or minimise significant impacts to major creeks and the biota therein. Comprehensive management and monitoring programs have been proposed to rapidly evaluate and remediate any significant impact to the natural features within Area 3.

It has been predicted that any mining induced impacts will be of a minor nature and at a local scale. Given the predicted low level of impact, coupled with the avoidance/minimisation of impacts to major creeks that have been achieved at significant loss of minable resource via substantial longwall set backs from these natural features within Area 3, no compensatory measures in addition to detailed monitoring, management and rehabilitation commitments are proposed.

As outlined in the monitoring and management plans, considerable amounts of data, interpretation and analysis of many aspects of the environment will be generated and made available through this proposal. This will assist land and conservation managers better understand the nature and function of this landscape and the environmental values therein.



## 10 ARCHAEOLOGICAL AND CULTURAL HERITAGE

Biosis Research Pty Ltd was commissioned to undertake an archaeological and cultural heritage assessment of the proposed Area 3.

The cultural heritage investigation identifies, records and assesses the value of Aboriginal or historical archaeological sites within the study area. An assessment of the potential impacts on these sites and the broader cultural heritage values of the study area from the proposed underground mining are also included. The archaeological assessment includes environmental and archaeological background research; consultation with the Aboriginal community as per the DECC's *Part 6 Consultation Requirements Guidelines*; an extensive field survey investigating previously recorded sites and discovering new sites; the modelling of subsidence effects for sites where detailed mine plans exist; and, the assessment of risk for sites outside of the current subsidence modelling areas where detailed mine plans do not exist.

The full report is provided in **Attachment G**. This section summarises the key findings of the assessment.

### 10.1 OUTCOMES OF ARCHAEOLOGICAL SURVEY

A total of 65 Aboriginal archaeological sites were identified within the study area, with 56 sites being within Area 3 (14 sites in Area 3A, 24 sites in Area 3B and 18 sites in Area 3C). 9 more sites are located within the study area but outside the boundary of Area 3.

The sites comprise the following site types: shelter with art; shelter with deposit; shelter with art and deposit; stone artefact scatter or isolated occurrences; axe grinding grooves; and, a suspected stone arrangement. Of the 65 sites within the general study area, 50 had been previously recorded. The current field survey relocated 40 of the previously recorded Aboriginal archaeological sites within the current study area. Within Area 3, a total of 15 new Aboriginal archaeological sites were identified within the Area 3.

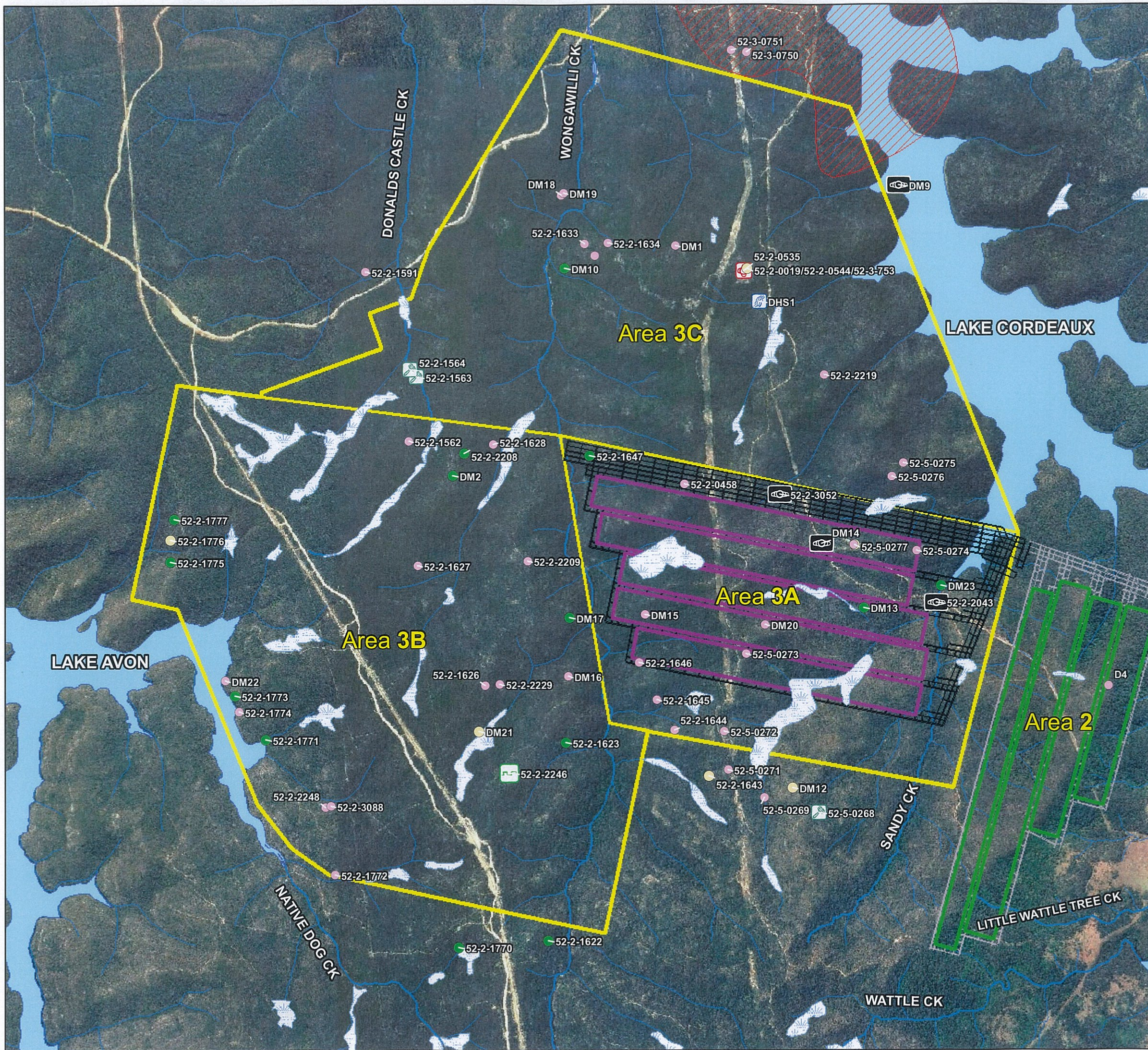
**Table 10.1** lists the Aboriginal archaeological sites and their site type in Area 3. **Figure 10.1** shows the locations of these sites.

Lake Cordeaux dam is listed on the State Heritage Register and is located in proximity to the study area and mine footprint (**Figure 10.1**).

A small timber bridge, apparently constructed ad hoc from recycled power/telegraph poles, is identified as an item of historic heritage during the survey (**Figure 10.1**).



**Archaeological  
 Sites Plan**  
**DENDROBIUM AREA 3**



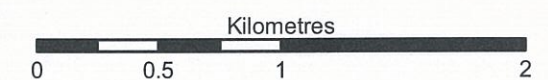
**Legend**

- Shelter with Deposit
- Shelter with Art; Shelter with Deposit
- Shelter with Art
- Stone Arrangement
- Timber Bridge
- Isolated Artefact
- Stone Artefacts
- Axe Grinding Groove
- Cordeaux Dam Heritage Curtilage
- Minor Streams
- Rivers & Creeks (LPI)
- Swamps
- Lakes (LPI)
- Proposed Area 3 Footprint
- Proposed Longwall Layout
- Existing Longwall Layout



**FIGURE 10.1**

Scale 1:30,000 (at A3)





**Table 10.1 – Aboriginal archaeological sites in Area 3**

<b>SITE NUMBER</b>	<b>SITE NAME</b>	<b>SITE TYPE</b>
<b>Dendrobium Area 3A</b>		
52-2-0458	Browns Road Site 33	Shelter with Art
52-2-1646	Browns Road Site 32	Shelter with Art
52-2-1647	Browns Road Site 20	Shelter with Deposit
52-5-0273	Sandy Creek Road 21	Shelter with Art
52-5-0274	Sandy Creek Road 22	Shelter with Art; Shelter with Deposit
52-5-0277	Sandy Creek Road 25	Shelter with Art; Shelter with Deposit
52-5-0278	Sandy Creek Road 26	Shelter with Art
52-2-2043	Sandy Creek Road 28	Stone Artefact
52-2-3052	SCA Special Area Fire Trail 6C	Stone Artefact
NEW RECORD	DM13	Shelter with deposit
NEW RECORD	DM14	Stone artefact
NEW RECORD	DM15	Shelter with art
NEW RECORD	DM20	Shelter with art
NEW RECORD	DM23	Shelter with deposit
<b>Dendrobium Area 3B</b>		
52-2-1562	Donald Castle Creek 1	Shelter with Art
52-2-1622	Browns Road Site 7	Shelter with Deposit
52-2-1623	Browns Road Site 8	Shelter with Deposit
52-2-1626	Browns Road Site 11	Shelter with Art
52-2-1627	Browns Road Site 12	Shelter with Art
52-2-1628	Browns Road Site 13	Shelter with Art
52-2-1770	Upper Avon 34	Shelter with Deposit
52-2-1771	Upper Avon 35	Shelter with Deposit
52-2-1772	Upper Avon 36	Shelter with Art
52-2-1773	Upper Avon 37	Shelter with Deposit
52-2-1774	Upper Avon 38	Shelter with Art
52-2-1775	Upper Avon 39	Shelter with Deposit
52-2-1776	Upper Avon 40	Shelter with Art; Shelter with Deposit
52-2-1777	Upper Avon 41	Shelter with Deposit
52-2-2208	Dendrobium 1	Stone artefact
52-2-2209	Dendrobium 2	Stone artefact
52-2-2229	Site 1 - DB 1	Shelter with Art
52-2-2246	Dendrobium 6	Stone Artefact
52-2-2248	Dendrobium 7	Shelter with Art
52-2-3088	Dendrobium 8	Shelter with Art
NEW RECORD	DM2	Stone Artefact
NEW RECORD	DM16	Shelter with art
NEW RECORD	DM17	Shelter with deposit
NEW RECORD	DM22	Shelter with art
NEW RECORD	DM21	Shelter with art
<b>Dendrobium Area 3C</b>		
52-2-0019, 0544, 0753	Sandy Creek Road 2	Shelter with Art, Shelter with Deposit
52-2-0571	Sandy Creek Road 3	Shelter with Art
52-2-0570	Sandy Creek Road 4	Shelter with Art
52-2-0535	Sandy Creek Stone Arrangement	Stone Arrangement

52-2-0275	Sandy Creek Road 23	Shelter with Art
52-5-0276	Sandy Creek Road 24	Shelter with Art
52-2-1563	Donald Castle Creek 2	Axe Grinding Groove
52-2-1564	Donald Castle Creek 3	Axe Grinding Groove
52-2-1591	Donald Castle Creek 30	Shelter with Art
52-2-1632	Browns Road Site 17	Shelter with Art
52-2-1633	Browns Road Site 18	Shelter with Art
52-2-1634	Browns Road Site 19	Shelter with Art
52-2-2219	Dendrobium 3	Shelter with Art
NEW RECORD	DM1	Shelter with Art
NEW RECORD	DM10	Shelter with Deposit
NEW RECORD	DM18	Shelter with Art
NEW RECORD	Dm19	Shelter with Art
<b>Outside SMP Area but within Study Area</b>		
52-2-1643	Browns Road Site 29	Shelter with Art
52-2-1644	Browns Road Site 30	Shelter with Art
52-2-1645	Browns Road Site 31	Shelter with Art
52-5-0271	Sandy Creek Road 19	Shelter with Art
52-5-0272	Sandy Creek Road 20	Shelter with Art
52-5-0268	Sandy Creek Road 16	Shelter with Art
52-5-0269	Sandy Creek Road 17	Shelter with Art
NEW RECORD	DM 12	Shelter with art; Shelter with deposit
NEW RECORD	DM9	Stone Artefact

## 10.2 IMPACT ASSESSMENT

Impact assessment has been carried out for each sub area of Area 3. Outcomes of these assessments are summarised in the following sections.

### 10.2.1 Area 3A

The cultural landscape of Area 3A contains a dense and diverse range of archaeological sites in a bushland environment that should not be significantly impacted by the proposed longwall mining. There is a low level of predicted and potential impact to the archaeological sites, and similarly a low level of expected impact to the surrounding environment within which they are contained. This being the case the principle nexus of value contributing to the cultural landscape - the relationship between the cultural sites and the natural environment which create a strong sense of place, both at individual sites and for the area as a whole - will not be at risk of significant impact from the proposal.

There are 14 Aboriginal archaeological sites within or near the Area 3A. The sites consist of shelters with art ( $n=8$ ); shelters with artefacts/deposit ( $n=3$ ); and open sites with artefacts ( $n=3$ ). There are a further 7 sites within the study area of Area 3A, but these are not in the boundary of the proposed Area 3A.

Previous studies have shown that stone artefact sites in an open context are not affected by subsidence movements, so there will be no impact to the three open sites from the proposed mining of longwalls in the proposed Area 3A.



Sandstone shelter sites, with art or deposit, have been demonstrated to be susceptible to damage from subsidence movements. If a shelter is situated directly over a longwall or pillar, there is a high risk of impact, as these areas are subject to the greatest subsidence movements.

There are 7 sandstone shelter sites located directly over longwalls in the proposed Area 3A, and 3 shelters in close proximity to the longwalls. There is a risk of impact on these shelters, either through cracking of rock surfaces, sheering or movement on bedding planes and joints, or block fall. Generally large shelters are more likely to be affected by subsidence movements, as these are naturally more unstable.

**Table 10.2** summarises the risk of impacts to the individual sites within Area 3A. It also provides summarises the significance level of each site. Detailed impact assessment for each site is provided in **Attachment G**.

Monitoring programs have shown that only shelters with internal volumes of greater than 50m<sup>3</sup>, which are also situated directly over a longwall, have suffered impacts from subsidence related movements. Shelter collapse has not been observed during previous monitoring programs of subsidence impacts, and it is unlikely that any of these shelters would collapse. Of the 10 sites directly above, or in close proximity to the longwall layout, 6 have volumes greater than 50m<sup>3</sup>, suggesting that the risk of impact to the other sites is very low. Impact assessments on these 6 sites with volumes greater than 50m<sup>3</sup> are summarised in **Table 10.3**.

There are 6 sites with either negligible or very low risk of impact from the proposed mining, including the only site assessed to have high archaeological significance in Area 3A. There are 4 sites that have a low risk of impact, including 2 shelters with deposit; of these 4 sites 2 have moderate archaeological significance and 2 have low archaeological significance. The highest risk category – moderate – contains 4 archaeological sites; these are all shelters with art and/or archaeological deposit, however all these sites have been assessed as having low archaeological significance.

**Table 10.2 - Summary of Risk of Impacts Area 3A**

<b>Site Number</b>	<b>Site Name</b>	<b>Site Type</b>	<b>Significance</b>	<b>Risk of Impact</b>
52-2-0458	Browns Road Site 33	Shelter with Art	Low	Very Low
52-2-1646	Browns Road Site 32	Shelter with Art	High	Very Low
52-2-1647	Browns Road Site 20	Shelter with deposit	Low	Very Low
52-2-2043	Sandy Creek Road 28	Stone Artefacts	Moderate	Negligible
52-2-3052	SCA Special Area Fire Trail 6C	Stone Artefacts	Low	Negligible
52-5-0273	Sandy Creek Road 21	Shelter with art and deposit	Low	Moderate
52-5-0274	Sandy Creek Road 22	Shelter with art	Low	Low
52-5-0277	Sandy Creek Road 25	Shelter with art and deposit	Moderate	Low
52-5-0278	Sandy Creek Road 26	Shelter with art	Low	Moderate
NEW RECORD	DM13	Shelter with deposit	Low	Low
NEW RECORD	DM14	Stone artefacts	Low	Negligible
NEW RECORD	DM15	Shelter with art	Low	Moderate
NEW RECORD	DM20	Shelter with art	Low	Moderate
NEW RECORD	DM23	Shelter with deposit	Moderate	Low

**Table 10.3 – Site Specific Assessments for Sites with Volumes Larger than 50m<sup>3</sup>**

<b>Browns Road Site 32</b>	<b>52-2-1646</b>	<b>Shelter with Art</b>
<p>This site has very low predicted systematic tensile strains, and is not located over a goaf area. The site's volume is 202m<sup>3</sup>, which places it in the risk category of larger sites. However, rock falls, fracturing of strata and shear movements near the surface are very rare outside of goaf areas. The risk of impact at this site is very low.</p>		
<b>Browns Road Site 20</b>	<b>52-2-1647</b>	<b>Shelter with Deposit</b>
<p>This site has very low predicted systematic tensile strains, and is not located over a goaf area. The site's volume is 160m<sup>3</sup>, which places it in the risk category of larger sites. However, rock falls, fracturing of strata and shear movements near the surface are very rare outside of goaf areas. The risk of impact at this site is very low.</p>		
<b>Sandy Creek Road 21</b>	<b>52-5-0273</b>	<b>Shelter with Art and Deposit</b>
<p>This site has moderate predicted systematic tensile strains, as it is located directly over a goaf. The site's volume is 59m<sup>3</sup>, which places it just in the risk category of larger sites. Fracturing and shear movements of strata, and rock falls associated with cliffs have been reported in similar situations. Hence, the risk of impact to this site is moderate.</p>		
<b>DM13</b>	<b>NEW RECORD</b>	<b>Shelter with Deposit</b>
<p>This site has very high predicted systematic tensile strains, as it is located directly over a goaf. The site's volume is 490m<sup>3</sup>, which places it in the risk category of larger sites. Fracturing and shear movements of strata, and rock falls associated with cliffs have been reported in similar situations. There is a low risk of impact to the archaeological deposit at this site.</p>		



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**DM20**

**NEW RECORD**

**Shelter with Art**

This site has moderate predicted systematic tensile strains, as it is located directly over a goaf. The site's volume is 53m<sup>3</sup>, which places it just in the risk category of larger sites. Fracturing and shear movements of strata, and rock falls associated with cliffs have been reported in similar situations. Hence, there a moderate risk of impact to this site.

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**DM23**

**NEW RECORD**

**Shelter with Deposit**

This site has very low predicted systematic tensile strains, and is situated well outside the goaf area. The site is a very large overhang with a volume of 19,200m<sup>3</sup>. Although a very large and a highly weathered, inherently unstable shelter the shelter is not likely to be impacted as it is outside of the zone where rock falls have been previously observed. The shelter is a shelter with deposit, and impacts are not likely to occur to the archaeological deposit. Overall the risk of impact to the shelter is low.

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### 10.2.2 Areas 3B and 3C

Detailed subsidence predictions for sites within Areas 3B and 3C will not be available until mine layouts are finalised. The sites present in Area 3B and Area 3C are widely distributed, and thus are likely to be subjected to a full range of predicted systematic subsidence movements. It is reasonable to expect that longwall widths and extraction heights for Area 3B and Area 3C will be similar to those currently proposed for Area 3A. Hence, the magnitude and range of systematic subsidence movements will be similar in Area 3B and Area 3C to those predicted for Area 3A.

General observations have been assessed for the sites in Area 3B and Area 3C and are presented in **Table 10.4**, with sites that have a higher likelihood of impact being shaded.

Of the 42 sites remaining in Areas 3B and 3C, 15 fall into the category of having a relatively higher likelihood of being at risk of impact from future longwalls. Of these 15 sites: 10 are of low archaeological significance; 2 are of moderate archaeological significance; and 3 are of high archaeological significance.

Detail assessment on the impacts to archaeological sites in Areas 3A and 3C cannot be made without a detailed mine plan and specific subsidence predictions. However at a broad scale the potential impacts are likely to be the same low order of magnitude that has been assessed for Area 3A. It is also argued that the proposed longwall mining did not pose a significant threat of impact to the cultural landscape, and this observation holds for the entire Dendrobium area should mine planning and extraction methods be similar to those suggested for Area 3A.

**Table 10.4 – General Risk Observation in Areas 3B and 3C**

Site Name	Site No.	Site Type	Volume	Reason
<b>Dendrobium Area 3B</b>				
Donald Castle Creek 1	52-2-1562	Shelter with Art	14	<50m <sup>3</sup>
Browns Road Site 7	52-2-1622	Shelter with Deposit	45	<50m <sup>3</sup> , and near edge of area
Browns Road Site 8	52-2-1623	Shelter with Deposit	65	>50m <sup>3</sup>
Browns Road Site 11	52-2-1626	Shelter with Art	32	<50m <sup>3</sup>
Browns Road Site 12	52-2-1627	Shelter with Art	89	>50m <sup>3</sup>
Browns Road Site 13	52-2-1628	Shelter with Art	74	>50m <sup>3</sup>
Upper Avon 35	52-2-1771	Shelter with Deposit	236	>50m <sup>3</sup> , but near edge of area
Upper Avon 36	52-2-1772	Shelter with Art	1221	>50m <sup>3</sup> , but near edge of area
Upper Avon 37	52-2-1773	Shelter with Deposit	22	<50m <sup>3</sup> , and near edge of area
Upper Avon 38	52-2-1774	Shelter with Art	108	>50m <sup>3</sup> , but near edge of area
Upper Avon 39	52-2-1775	Shelter with Deposit	132	>50m <sup>3</sup> , but near edge of area
Upper Avon 40	52-2-1776	Shelter with Art and Deposit	117	>50m <sup>3</sup> , but near edge of area
Upper Avon 41	52-2-1777	Shelter with Deposit	216	>50m <sup>3</sup> , but near edge of area
Dendrobium 1	52-2-2208	Shelter with Deposit	76	>50m <sup>3</sup>
Dendrobium 2	52-2-2209	Shelter with Art	38	<50m <sup>3</sup>
Site 1 - DB 1	52-2-2229	Shelter with Art	11	<50m <sup>3</sup>
Dendrobium 6	52-2-2246	Stone Artefact	-	Open site
Dendrobium 7	52-2-2248	Shelter with Art	48	<50m <sup>3</sup>
Dendrobium 8	52-2-3088	Shelter with Art	13	<50m <sup>3</sup>
DM16	DM16	Shelter with art	100	>50m <sup>3</sup>
DM17	DM17	Shelter with Deposit	68	>50m <sup>3</sup>
DM2	DM2	Stone Artefact	-	Open site
DM21	DM21	Shelter with Art and Deposit	50	>50m <sup>3</sup>
DM22	DM22	Shelter with art	17	<50m <sup>3</sup> , and near edge of area
<b>Dendrobium Area 3C</b>				
Sandy Creek Road 2	52-2-0019 52-2-0544 52-3-753	Shelter with Art and Deposit	210	>50m <sup>3</sup>
Sandy Creek Stone Arrangement	52-2-0535	Stone Arrangement	-	Located on large rock outcrop
Donald Castle Creek 2	52-2-1563	Axe Grinding Groove	-	Located on rock bar
Donald Castle Creek 3	52-2-1564	Axe Grinding Groove	-	Located on rock bar
Donald Castle Creek 30	52-2-1591	Shelter with Art	108	>50m <sup>3</sup> , but near edge of area
Browns Road Site 17	52-2-1632	Shelter with Art	3	<50m <sup>3</sup>
Browns Road Site 18	52-2-1633	Shelter with Art	45	<50m <sup>3</sup>
Browns Road Site 19	52-2-1634	Shelter with Art	65	>50m <sup>3</sup>
Dendrobium 3	52-2-2219	Shelter with Art	75	>50m <sup>3</sup>
Sandy Creek Site 4	52-3-0750	Shelter with Art	30	<50m <sup>3</sup> , and near edge of area
Sandy Creek Site 3	52-3-0751	Shelter with Art	4	<50m <sup>3</sup> , and near edge of area
Sandy Creek Road 23	52-5-0275	Shelter with Art	10	<50m <sup>3</sup>
Sandy Creek Road 24	52-5-0276	Shelter with Art	93	>50m <sup>3</sup>
DM1	DM1	Shelter with Art	18	<50m <sup>3</sup>
DM10	DM10	Shelter with Deposit	42	<50m <sup>3</sup>
DM18	DM18	Shelter with Art	112	>50m <sup>3</sup>
DM19	DM19	Shelter with art	15	<50m <sup>3</sup>
DM9	DM9	Stone Artefact	-	Open site



## 10.3 HISTORICAL ARCHAEOLOGICAL AND HERITAGE SITES

### 10.3.1 Timber Bridge DHS1

Timber bridge DHS1 is located on a tributary of the Cordeaux River. It is located on an earlier road alignment of Fire Trail 6C and is orientated north – south and appears to be constructed with recycled telegraph poles.

The subsidence related impacts on DHS1 has been assessed by MSEC, which concluded that it is unlikely for the bridge to be subjected to any significant systematic subsidence, valley related, or far-field horizontal movements resulting from the extraction of the proposed and future longwalls in Areas 3A and 3B. The impacts on the bridge as a result of future longwalls in Area 3C depend on the final longwall layout in that area and will be assessed as a component of the SMP approval for Area 3C (refer **Section 5.3.19**).

### 10.3.2 Cordeaux Dam Heritage Curtilage

There is no heritage fabric associated with the heritage curtilage of Cordeaux Dam located within the current study area. The portion of the curtilage within the study area has been identified in order to preserve significant views to the dam wall. The Conservation Management Plan for Cordeaux Dam states that “significant views within the Dam site (heritage curtilage area) should be conserved”.

The longwalls are subsurface workings and hence the proposed extraction of coal within Dendrobium Area 3 will have no impact on views to the dam wall from within the heritage curtilage.

## 10.4 MITIGATION MEASURES

Based on the subsidence predictions provided by MSEC (2007), and the nature of the shelters there is some potential for impacts to occur to the archaeological sites resulting from the proposed longwall mining, the following mitigation measures will be implemented:

A program of archaeological monitoring will be designed and implemented for the sites potentially affected by subsidence movements. The program replicate and develop where possible the methods already established by Sefton (2000) and those employed in Dendrobium Areas 1 and 2. This program is provided in the SMP.

Section 90 applications will be sought as part of the SMP process for Aboriginal archaeological sites that have some potential, however unlikely, to be impacted by the proposed longwall mining. For Area 3A s90 Consent to Destroy / Damage / Deface should be sought for the following sites:

- 52-2-0458 (Shelter with Art)
- 52-2-1646 (Shelter with Art)
- 52-2-1647 (Shelter with Deposit)
- 52-2-0273 (Shelter with Art)
- 52-2-0274 (Shelter with Art)
- 52-2-0277 (Shelter with Art and Deposit)

- 52-2-0278 (Shelter with Art)
- DM13 (Shelter with Deposit)
- DM15 (Shelter with Art)
- DM20 (Shelter with Art)
- DM23 (Shelter with Deposit)

The management and monitoring of potentially impacted sites will be developed and implemented in conjunction with relevant Aboriginal stakeholders. Comprehensive site recording will be undertaken for all potentially impacted sites prior to the commencement of mining.

## 11 AIR

Ventilation of the mine will be carried out in accord with the existing established engineering and operational systems, which were approved in 2001. Ventilation of Area 3 will be via Dendrobium No. 2, and No.3 Shafts.

Dendrobium No. 2 and No. 3 Shafts are located together, approximately 6.5 km northwest of the Dendrobium Pit Top and approximately 500 m east of Area 3. Construction of No. 2 and No. 3 shafts (incl. fans) is expected to be completed in September 2008. It is expected that these ventilation shafts will be sufficient to service the mining of Area 3 and no additional ventilation shafts are planned.

Dust monitoring of the No. 1 vent shaft shows low levels of dust (mean of <math><2.5\text{g}/\text{m}^2/\text{month}</math> for 2006) well under the relevant EPA criteria (). As no other surface infrastructure (except exploration bores) is currently proposed in Area 3, it is not expected that the proposed modification to the Area 3 footprint will result in any significant dust emissions, or any other air quality impacts in the Area.

Underground mining can result in the emission of fugitive methane gas which is expelled via the ventilation shafts. An estimation of the likely emissions of fugitive methane gas associated with the mining of Area 3 has been included in the greenhouse gas assessment which is provided in **Section 13** of this report.

## 12 NOISE

The proposed project will be carried out using the existing engineering and operational systems. It is unlikely to generate additional noise impacts on the local residents of Mount Kembla Village.



## 13 GREENHOUSE GAS

### 13.1 INTRODUCTION

This Green House Gas (GHG) Assessment has been prepared in accord with the methodology outlined in the Australian Greenhouse Office (AGO) Factors and Methods Workbook (AGOFMW) (2006) and industry best practice.

The proposed modified Dendrobium Area 3 (including Area 3A, 3B, and 3C) is estimated to produce up to a total of approximately 80 Mt of ROM coal and have a project life of approximately 20 years (based on an annual extraction of ROM coal of 4 Mtpa). The major sources of GHG emissions associated with the project are fugitive mining emissions, combustion of fuels during mining and transportation of materials, indirect emissions associated with the consumption of purchased electricity used onsite for mining and coal processing, and emissions from end use of product coal for steel manufacturing and energy generation (coking and combustion of coal).

The types of emissions, methodology used in the assessment, results, and analysis of impacts are described in detail in the following sections.

### 13.2 SCOPE OF EMISSIONS INVENTORY

The AGOFMW (2006) defines three scopes of GHG emissions for a project. These include Scope 1, Scope 2, and Scope 3 emissions, each of which is defined below.

- **Scope 1** – Scope 1 Emissions include direct emissions from sources within the boundary of an organisation such as fuel combustion and manufacturing processes.
- **Scope 2** – Scope 2 Emissions include indirect emissions from the consumption of purchased electricity, steam or heat produced by another organisation. Scope 2 emissions result from the combustion of fuel to generate electricity, steam, or heat and do not include emissions associated with the production of fuel. Scopes 1 and 2 are carefully defined to ensure that two or more organisations do not report the same emissions in the same scope.
- **Scope 3** – Scope 3 Emissions include all other indirect emissions that are a consequence of an organisation's activities but are not from sources owned or controlled by the organisation. Examples of Scope 3 emissions include indirect emissions associated with the extraction/production of fuels used onsite (i.e., emissions from the provider of the fuels), fuel extraction and line loss associated with the consumed electricity, transport of product outside the organisation, and emissions associated with end use of product.

For the purposes of this assessment, IC operational activities have been defined as all activities carried out directly by IC at or between facilities owned or controlled by IC. These activities include mining, coal processing, disposal of coal wash, and transportation of materials between IC facilities (ie, Dendrobium Colliery, Dendrobium Coal Preparation Plant (DCPP), Port Kembla Coal Terminal (PKCT), and West Cliff Emplacement). All point source emissions associated with these IC operational activities have been considered as occurring within the boundary of the organisation and as such have been defined as Scope 1 emissions in this assessment.

Scope 2 emissions defined in this assessment include direct point source combustion generation emissions associated with the generation of purchased electricity used at IC sites, namely Dendrobium Colliery and DCPD.

Scope 3 emissions defined in this assessment include indirect extraction emissions associated with the generation of purchased electricity used at IC sites (these emissions occur during the extraction of coal/fuels used for generation of electricity); indirect fuel extraction emissions associated with consumption of diesel fuel used by IC onsite and for transportation of materials between IC facilities (these emissions occur during the extraction of fuels used onsite); full fuel cycle emissions associated with transportation of product coal offshore to customers in China, Japan, Africa, and Europe; and combustion emissions associated with end use of clean coal for steel manufacturing (coking coal) and energy generation (energy coal).

The various Scope 1, 2, and 3 GHG emissions associated with the project and included in this GHG assessment are summarised in **Table 13.1**. **Figure 13.1** shows the possible sources of the GHG emissions associated with Dendrobium Area 3.

**Table 13.1 – Scope 1, 2, & 3 Emissions from Dendrobium Area 3 Project**

Scope 1 Emissions	Scope 2 Emissions	Scope 3 Emissions
<ul style="list-style-type: none"> <li>• Fugitive emissions during mining (coal seam methane gas).</li> <li>• Diesel consumption during mining (direct combustion).</li> <li>• Diesel consumption during IC transportation of materials (direct combustion). This includes transportation of:               <ol style="list-style-type: none"> <li>1. ROM coal from Kemira Valley to DCPD (via rail).</li> <li>2. Coal wash from DCPD to West Cliff Emplacement (via road).</li> <li>3. Clean coal from DCPD to PKCT (via road).</li> </ol> </li> <li>• Diesel consumption during emplacement of coal wash (direct combustion).</li> <li>• Non fuel combustion emissions associated with the emplacement of coal wash at West Cliff Emplacement.</li> </ul>	<ul style="list-style-type: none"> <li>• Consumption of purchased electricity at Dendrobium Colliery (combustion generation).</li> <li>• Consumption of purchased electricity at DCPD (combustion generation).</li> </ul>	<ul style="list-style-type: none"> <li>• Diesel consumption during mining (indirect extraction).</li> <li>• Diesel consumption during IC transportation of materials (indirect extraction). This includes transportation of:               <ol style="list-style-type: none"> <li>1. ROM coal from Kemira Valley to DCPD (via rail).</li> <li>2. Coal wash from DCPD to West Cliff Emplacement (via road).</li> <li>3. Clean coal from DCPD to PKCT (via road).</li> </ol> </li> <li>• Diesel consumption during emplacement of coal wash (indirect extraction).</li> <li>• Fuel consumption during transportation of clean coal to customers offshore (full fuel cycle).</li> <li>• Consumption of purchased electricity at Dendrobium Colliery (fuel extraction and line loss).</li> <li>• Consumption of purchased electricity at DCPD (fuel extraction and line loss).</li> <li>• Clean coal end use for steel manufacturing (direct/point source emission).</li> <li>• Clean coal end use for energy generation (direct/point source emission).</li> </ul>

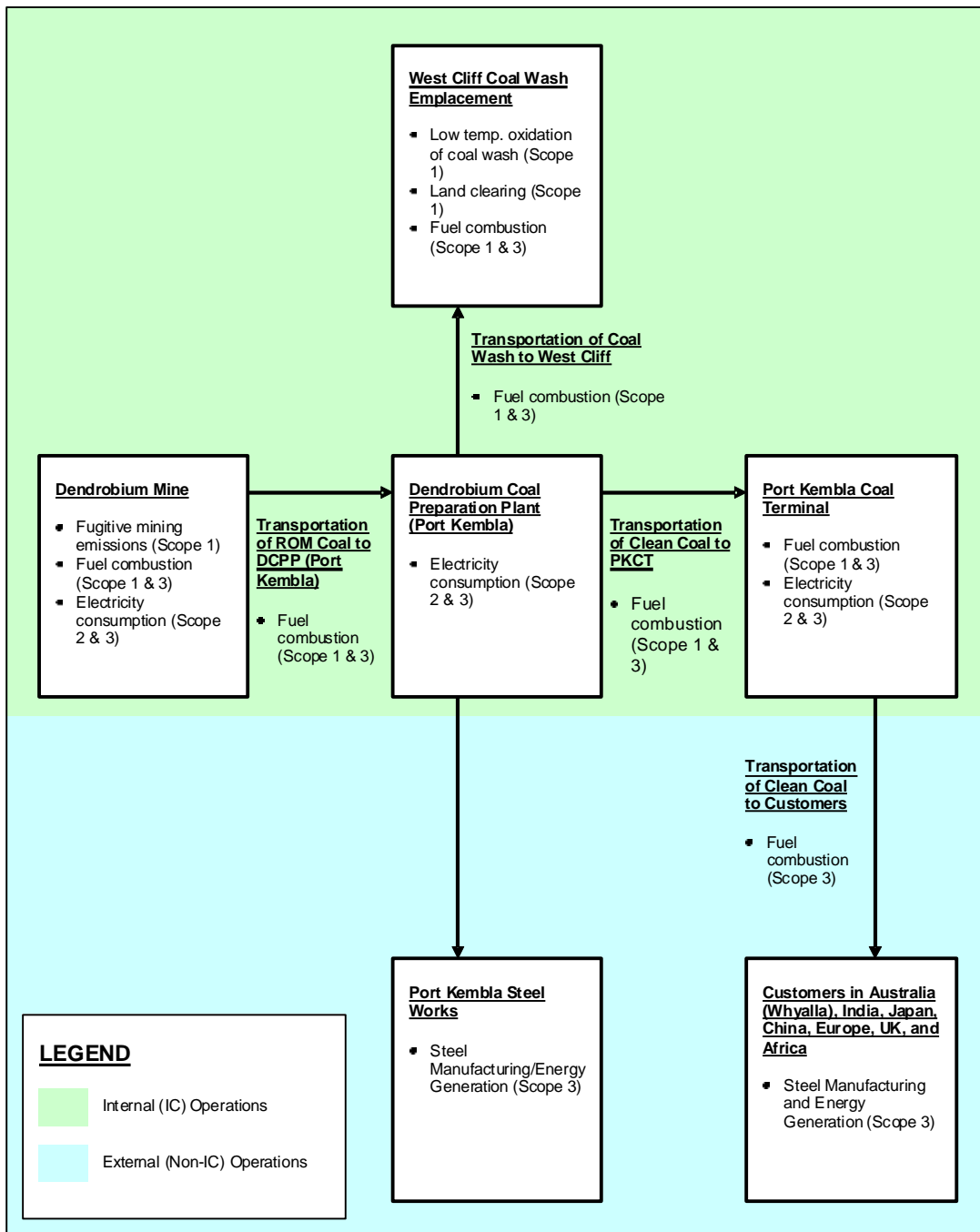


Figure 13.1 – Sources of GHG Emissions Associated with Dendrobium Area 3



### 13.3 METHODOLOGY

All methodology used in this assessment for the estimation of GHG emissions has been in accord with the AGOFMW in the first instance and/or in accord with sound scientific and engineering principles where the AGO Factors and Methods Workbook has not provided a methodology. The specific methodologies used in each calculation are given in the following sections.

There are several recognised greenhouse gases and the contribution of greenhouse gas emissions to global warming varies for each different greenhouse gas. The Intergovernmental Panel on Climate Change (IPCC) has defined the Global Warming Potential for a number of greenhouse gases and these are given in Appendix 3 of the AGOFMW (2006). For example, the IPCC Global Warming Potential for carbon dioxide (CO<sub>2</sub>) is 1 and for methane (CH<sub>4</sub>) is 21. To allow a quantitative comparison between the emissions of different types of greenhouse gases it is necessary to convert all emissions to a universally comparable unit. The methodology adapted by the AGOFMW (2006) and used in this assessment converts all emissions for non-carbon dioxide gases to a carbon dioxide equivalent (CO<sub>2-e</sub>). Emissions from non-carbon dioxide gases are converted to t CO<sub>2-e</sub> by multiplying the emission of each non-carbon dioxide gas by its Global Warming Potential (e.g., 1 t CH<sub>4</sub> = 21 t CO<sub>2-e</sub>).

#### 13.3.1 Estimation of ROM Coal Production from Area 3

The estimated mass of ROM coal to be mined from Dendrobium Area 3 was provided to CFR by IC. The estimated ROM coal production for Areas 3A, 3B, and 3C were 20 Mt, 30 Mt, and 30 Mt, respectively. This equates to a total of 80 Mt of ROM coal extraction for Area 3.

The estimated ROM coal extraction rate for Area 3 used in the GHG Assessment was 4 Mtpa. This was conservatively estimated to be somewhere between the 2007 financial year ROM coal production of 2.54 Mtpa and the maximum allowable ROM coal production of 5.2 Mtpa (as per the Dendrobium Consent). This extraction rate equates to an estimated mine life for Area 3 of approximately 20 years.

#### 13.3.2 Estimation of Clean Coal & Coal Wash Production from Area 3

The total amounts of clean coal and coal wash that will be produced as a result of processing ROM coal mined from Dendrobium Area 3 was estimated based on ROM coal and clean coal processing/production data for the 2007 financial year supplied to CFR by IC's Logistics division.

Over the 2007 financial year the average yield of clean coal from ROM coal was 66%. Applying this yield to the estimated mass of ROM coal to be mined it was estimated that the total amounts of clean coal and coal wash that will be produced as a result of Dendrobium Area 3 operations are 52.8 Mt and 27.2 Mt respectively.

#### 13.3.3 Estimation of Fugitive Mining Emissions (Coal Seam Methane Gas)

Fugitive emissions during mining were calculated using the following equation, which is given in Section 1.4 of the AGOFMW (Extraction and distribution of coal, gas and petroleum):

$$\text{GHG Emission (tCO}_2\text{-e)} = Q_{\text{ROM}} \times \text{EF} / 1000$$

Where,

$Q_{\text{ROM}}$  = the mass of raw (ROM) coal produced (t).  
EF = the relevant Scope 1 Emission Factor from Table 6 of the AGOFMW (kgCO<sub>2</sub>-e/tROM coal produced).

The emission factor chosen from Table 6 of the AGOFMW was 8.4 kgCO<sub>2</sub>-e/t ROM coal produced for non-gassy mines.

The results from these estimates are provided in **Section 13.6**.

### 13.3.4 Estimation of Emissions from Diesel Fuel Combustion

Emissions from diesel fuel combustion onsite and during transportation of materials were calculated using the following equation given in Section 1.2 of the AGOFMW (Transport Fuels):

$$\text{GHG Emission (tCO}_2\text{-e)} = Q \times \text{EF}$$

Where,

Q = the volume of fuel consumed (kL).  
EF = the relevant Emission Factor from Table 3 of the AGOFMW (kgCO<sub>2</sub>-e/kL fuel consumed).

The volume of diesel consumption due to Dendrobium Area 3 operations was estimated based on fuel consumption and production data for the 2007 financial year supplied to CFR by IC.

The emission factors chosen from Table 3 of the AGOFMW were 2.7 tCO<sub>2</sub>-e/kL fuel consumed (Scope 1) and 0.3 tCO<sub>2</sub>-e/kL fuel consumed (Scope 2) for automotive diesel fuel.

The results from these estimates are provided in **Section 13.6**.

### 13.3.5 Emissions from Low Temperature Oxidation & Land Clearing Associated with Emplacement of Coal Wash

The AGOFMW does not provide methodology for the estimation of emissions from this source. In this assessment, GHG emissions associated with the emplacement of coal wash were estimated based on the methodology used in the Application for Further Approval of West Cliff Emplacement Stage 3 (CFR 2007).

The Application for Further Approval of West Cliff Emplacement Stage 3 (CFR 2007) estimated the total emission of CO<sub>2</sub> associated with low temperature oxidation of coal wash and land clearing due to Stage 3 of the West Cliff Emplacement. The methodology used to estimate these emissions was based on studies by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) under the Australian Coal Association Research Program (ACARP).

The estimation of CO<sub>2</sub> associated with low temperature oxidation of coal wash was estimated based on a relationship derived in ACARP Study C8059 (2000). The ACARP (2000) study found that the effects of CO<sub>2</sub> emission from low temperature oxidation of coal material are generally low in the absence of spontaneous combustion. It is noted that spontaneous

combustion is not a risk in emplaced coal wash at West Cliff as discussed in the Application for Further Approval of West Cliff Emplacement Stage 3 (CFR 2007). Based on the data obtained in the ACARP (2000) study, the following relationship was developed for estimating the emission of CO<sub>2</sub> from stockpiled coal waste material.

$$E_{CO_2} = FC_c^{0.49}$$

Where,

- $E_{CO_2}$  = Emission rate of CO<sub>2</sub> (mg/s/m<sup>2</sup>).
- $F$  = Constant (0.0227) derived from data.
- $C_c$  = Carbon content of coal material (expressed in %).

This equation was applied to the proposed Stage 3 Emplacement using data obtained from specifications for West Cliff and Dendrobium coal wash given in the 2006 Report to the Waste Task Force (BHPBIC 2006). It was estimated that the total emission of CO<sub>2</sub> from Stage 3 of the West Cliff Emplacement resulting from low temperature oxidation of coal wash will be approximately 9,558 tonnes.

Emissions resulting from land clearing associated with the West Cliff emplacement were estimated based on data given in ACARP Study C14081 (2006). This study assessed the emission of CO<sub>2</sub> due to land clearing in NSW and QLD. Rates for CO<sub>2</sub> emissions used in the study vary between 99 t CO<sub>2</sub>/ha to 165 t CO<sub>2</sub>/ha. The ACARP project derives a rate for eucalypt woodland (same vegetation type to West Cliff Mine Site) based on previous studies by Burrow et al. (2000) of 129 t CO<sub>2</sub>/ha. When this rate was applied to the areas proposed to be cleared for the West Cliff Stage 3 Emplacement, a total CO<sub>2</sub> emission due to land clearing of 7,805 tonnes was calculated. It is noted that the estimated greenhouse emissions from land clearing for the Stage 3 emplacement do not take into consideration any carbon sequestration associated with the rehabilitation of the emplacement with native vegetation.

The total CO<sub>2</sub> emission estimated to occur from the two point sources of low temperature oxidation and land clearing associated with Stage 3 of the West Cliff Emplacement is approximately 17,351 tonnes. The total capacity of Stage 3 of the emplacement is estimated to be approximately 33.5 Mt. This equates to a rate of approximately 518 tCO<sub>2</sub>/Mt coal wash emplaced.

This emission rate of 518 tCO<sub>2</sub>/Mt of coal wash produced was applied to the estimated tonnage of coal wash to be produced from Dendrobium Area 3 operations to estimate the total GHG emission from coal wash emplacement associated with Dendrobium Area 3 operations.

The results from these estimates are provided in **Section 13.6**.

### 13.3.6 Emissions Associated with Electricity Consumption

Emissions from the consumption of purchased electricity were calculated using the following equation given in Section 1.3 of the AGOFMW (Indirect emissions (electricity end use)):

$$\text{GHG Emission (tCO}_2\text{-e)} = Q \times EF / 1000$$

Where,

- $Q$  = the amount of electricity consumed (kWh).
- $EF$  = the relevant Emission Factor from Table 5 of the AGOFMW (kgCO<sub>2</sub>-e/kWh electricity consumed).



The amount of electricity to be consumed due to Dendrobium Area 3 operations was estimated based on electricity consumption and production data for the 2007 financial year supplied to CFR by IC.

The results from these estimates are provided in **Section 13.6**.

### 13.3.7 Emissions Associated with Shipping of Product Coal to Customers

A preliminary estimate of GHG emissions from sea transport of product coal was undertaken using similar methodology to that used in the Anvil Hill Coal Project GHG Assessment Addendum Report to the Director-General Department of Planning (Independent Hearing and Assessment Panel for the Anvil Hill Coal Project, 2007). The assessment makes the following assumptions:

1. The percentage of clean coal produced that will be transported by sea to customers will be the same as the average over the 2007 and 2008 financial years for the duration of Area 3 operations. These percentages are as follows:
  - 36% – India/Japan/China
  - 8% – Europe/UK/Africa
  - 25% – Domestic (assumed Whyalla, South Australia)
2. Cargo ship carrying capacity 75,000 tonnes.
3. Freight shipping energy efficiency is equal to 4.16 tkm/MJ.
4. Shipping distances are as follows:
  - 12,000 km to India/Japan/China
  - 20,000 km to Europe/UK/Africa
  - 1,000 km to Whyalla (South Australia)
5. Ships are assumed to burn heavy fuel oil.
6. All trips are assumed one way as it is likely that ships would carry other goods elsewhere upon unloading trip.

The calculations for the preliminary estimation of GHG emissions associated with shipping of clean coal are provided in **Table 13.2**.

**Table 13.2 – Preliminary Estimation of GHG Emissions Assoc. with Shipping**

<b>End User Location</b>	<b>India / Japan / China</b>	<b>Europe / UK / Africa</b>	<b>Domestic</b>	<b>TOTAL</b>
Avg. % of Total Clean Coal Production (FY2007 & FY2008)	36	8	25	<b>69</b>
Avg. Shipping Distance (km)	12,000	20,000	1,000	
Carrying Capacity of Ship (tonnes)	75,000	75,000	75,000	
Amount to be Shipped from Area 3 to Destination (tonnes)	18,948,162	4,204,989	13,408,517	<b>36,561,668</b>
Number of Ship Movements Required	253	56	179	<b>487</b>

Total Shipping (Mtkm)	227,378	84,100	13,409	<b>324,886</b>
Energy Efficiency (tkm/MJ)	4.16	4.16	4.16	
Energy Consumption (GJ)	54,658,159	20,216,294	3,223,201	<b>78,097,654</b>
Full Fuel Cycle Emission Factor (kgCO <sub>2</sub> -e / GJ)	82	82	82	
<b>Total Emission (tCO<sub>2</sub>-e)</b>	<b>4,481,969</b>	<b>1,657,736</b>	<b>264,303</b>	<b>6,404,008</b>

**NOTES:**

1. Assumed average shipping distance from Australia to China/Japan/India is 12,000km.
2. Assumed average shipping distance from Australia to Europe/UK/Africa is 20,000km.
3. Assumed average shipping distance to domestic customers in Australia is 1,000km (approx. distance to SA).

### 13.3.8 Final Use of Coal for Steel Manufacturing & Energy Generation

Emissions from the combustion of clean coal for steel manufacturing (coking coal) and energy generation (energy coal) were calculated using the following equation given in Section 1.1 of the AGOFMW (Stationary energy emissions (non-transport)):

$$\text{GHG Emission (tCO}_2\text{-e)} = Q \times \text{EC} \times \text{EF} / 1000$$

Where,

- Q = the quantity of fuel consumed (t).
- EC = the energy content of the fuel (GJ/t)
- EF = the relevant Emission Factor from Table 1 of the AGOFMW (kgCO<sub>2</sub>-e/GJ energy burnt)

The amount of clean coal to be consumed for steel manufacturing and energy generation due to Dendrobium Area 3 operations was estimated based on marketing data showing the percentage of clean coal going to customers for energy generation and coke manufacturing over the 2007 and 2008 financial year. This data was supplied to CFR by IC.

The results from these estimates are provided in **Section 13.6**.

### 13.4 SOURCE DATA

The majority of data used in the estimation of Greenhouse emissions was sourced from production/logistical data for the 2007 financial year supplied to CFR by IC. A summary of data sources is given in **Table 13.3**.

**Table 13.3 – Source Data for GHG Assessment**

<b>Data</b>	<b>Source</b>
Dendrobium Area 3 Coal Production ( $Q_{ROM}$ )	Estimated ROM coal production supplied to CFR by IC.
Yield of Clean Coal from ROM Coal ( $Y\%$ )	FY2007 DCPD ROM feed / clean coal production data supplied by IC.
Dendrobium Area 3 Clean Coal Production ( $Q_{CC}$ )	$Q_{ROM} \times Y\%$
Dendrobium Area 3 Coal Wash Production ( $Q_{CW}$ )	$Q_{ROM} - Q_{CC}$
Diesel Fuel Consumption Dendrobium Colliery	FY2007 fuel consumption data supplied by IC.
Diesel Fuel Consumption West Cliff Emplacement	Monthly fuel consumption figures for WC Emplacement operations (haul trucks and other plant) supplied by Bertuccio Haulage and Simpson Earth Moving (both contracted by BHPBIC for emplacement works).
Diesel Fuel Consumption PKCT	FY2007 fuel consumption data supplied by IC (PKCT), factored to account for Dendrobium throughput fraction.
Diesel Fuel Consumption ROM Coal Dendrobium Colliery → DCPD (Rail)	FY2007 fuel consumption data supplied by IC (Processing & Logistics).
Diesel Fuel Consumption Clean Coal DCPD → PKCT (Truck)	FY2007 fuel consumption data supplied by IC (Processing & Logistics).
Diesel Fuel Consumption Coal Wash DCPD → West Cliff (Truck)	FY2007 fuel consumption data supplied by IC (Processing & Logistics).
Electricity Consumption Dendrobium Colliery	FY2007 electricity consumption data supplied by IC.
Electricity Consumption DCPD	FY2007 electricity consumption data supplied by IC (Processing & Logistics).
Electricity Consumption PKCT	FY2007 electricity consumption data supplied by IC (PKCT), factored to account for Dendrobium throughput fraction.

### 13.5 EMISSIONS NOT INCLUDED IN ASSESSMENT

The following possible emission sources were not considered in this assessment:

- Disposal (end life) of product sold.
- Employee business travel.
- Employees commuting to and from work.
- Extraction, production, and transport of other purchased materials and goods.
- Out sourced activities.
- Transportation of clean coal via conveyor from DCPD to Port Kembla Steel Works.

It is thought that these minor emissions are insignificant in magnitude compared with the major emissions included in the assessment.



## 13.6 RESULTS

The results of the GHG assessment are summarised in **Table 13.4** and displayed graphically in **Figures 13.2 to 13.5**.

The total of all emissions associated with project (incl. Scope 1, 2, and 3 GHG emissions) is estimated to be approx. 147.66 MtCO<sub>2</sub>-e (approx. 1.846 tCO<sub>2</sub>-e/t ROM coal mined).

A breakdown of emissions by source is given in **Figure 13.2**. The Scope 1 and 2 emissions (approx. 1.7% of all emissions) associated with the project is small compared with the Scope 3 emissions (approx. 98.3% of total emissions). This would be expected as the Scope 1 and 2 emissions are associated primarily with production of coal and Scope 3 emissions are associated primarily with combustion of coal.

A breakdown of estimated Scope 1 emissions is given in **Figure 13.3**. The total of all Scope 1 emissions associated with the project is approx. 1.02 MtCO<sub>2</sub>-e (approx. 0.013 tCO<sub>2</sub>-e/t ROM coal mined). The major sources of Scope 1 emissions are fugitive mining emissions (total approx. 65.68%), and emissions associated with transportation of materials between IC facilities (total approx. 24.82%).

A breakdown of estimated Scope 2 emissions is given in **Figure 13.4**. The total of all Scope 2 emissions associated with the project is approx. 1.49 MtCO<sub>2</sub>-e (approx. 0.019 tCO<sub>2</sub>-e/t ROM coal mined). Electricity consumption at Dendrobium Colliery and DCPD makes up the majority of the estimated Scope 2 emissions associated with the project (approx. 50.86% and 46.16% respectively).

A breakdown of Scope 3 emissions is given in **Figure 13.5**. The total of all scope 3 emissions associated with the project is 145.15 MtCO<sub>2</sub>-e (approx. 1.814 tCO<sub>2</sub>-e/t ROM coal mined). The major Scope 3 emissions are combustion of coal for steel manufacturing, energy generation and transportation to customers offshore by sea. These three sources make up approximately 97.77 % of all Scope 3 emissions and other Scope 3 emission sources are insignificant compared with these three sources.

Further analysis of these results including impacts is given in the following sections.

**Table 13.4 – Estimated GHG Emissions Assoc. with Dendrobium Area 3 Operations**

<b>Emission Source</b>	<b>Estimated Emission Rate Per Tonne (tCO<sub>2</sub>-e / Mt ROM Mined)</b>	<b>*Estimated Emission Rate Per Year of Mining (tCO<sub>2</sub>-e / yr)</b>	<b>**Maximum Emission Rate Per Year of Mining (tCO<sub>2</sub>-e / yr)</b>	<b>Area 3A Emission (tCO<sub>2</sub>-e)</b>	<b>Area 3B Emission (tCO<sub>2</sub>-e)</b>	<b>Area 3C Emission (tCO<sub>2</sub>-e)</b>	<b>Total Area 3 Emission (tCO<sub>2</sub>-e)</b>
<b>ROM Coal Production (Mt)</b>	80	4.0	5.2	20	30	30	<b>80</b>
	(Total)			(Area 3A)	(Area 3B)	(Area 3C)	<b>(Total)</b>
<b>Scope 1 Emissions</b>							
Fugitive Emissions During Mining	8,400	33,600	43,680	168,000	252,000	252,000	<b>672,000</b>
Combustion of Fuels at Dendrobium Colliery (Direct Fuel Combustion)	683	2,732	3,552	13,662	20,493	20,493	<b>54,648</b>
Combustion of Fuels at West Cliff Emplacement (Direct Fuel Combustion)	345	1,379	1,793	6,897	10,346	10,346	<b>27,590</b>
Combustion of Fuels at PKCT (Direct Fuel Combustion)	11	44	57	18	326	326	<b>870</b>

Emission Source	Estimated Emission Rate Per Tonne ROM Mined (tCO <sub>2</sub> -e / Mt)	*Estimated Emission Rate Per Year of Mining (tCO <sub>2</sub> -e / yr)	**Maximum Emission Rate Per Year of Mining (tCO <sub>2</sub> -e / yr)	Area 3A Emission (tCO <sub>2</sub> -e)	Area 3B Emission (tCO <sub>2</sub> -e)	Area 3B Emission (tCO <sub>2</sub> -e)	Total Area 3 Emission (tCO <sub>2</sub> -e)
<b>Combustion of Fuels During IC Transportation (Direct Fuel Combustion):</b>							
ROM Coal Kemira Valley to DCPD	2,041	8,162	10,611	40,810	61,215	61,215	<b>163,240</b>
Coal Wash DCPD to WC Emplacement	748	2,993	3,891	14,964	22,446	22,446	<b>59,855</b>
Clean Coal DCPD to PKCT	385	1,542	2,004	7,709	11,563	11,563	<b>30,834</b>
Non-Fuel Combustion Emissions Associated with Emplacement of Coal Wash	176	704	916	3,522	5,284	5,284	<b>14,090</b>
<b>Scope 1 Emissions Total</b>	<b>12,789</b>	<b>51,156</b>	<b>66,503</b>	<b>255,782</b>	<b>383,673</b>	<b>383,673</b>	<b>1,023,127</b>
<b>Scope 2 Emissions</b>							
Electricity Consumption at Dendrobium Colliery (Combustion Generation)	9,457	37,827	49,176	189,137	283,706	283,706	<b>756,550</b>
Electricity Consumption at DCPD (Combustion Generation)	8,582	34,327	44,625	171,635	257,452	257,452	<b>686,538</b>
Electricity Consumption at PKCT (Combustion Generation)	554	2,217	2,881	11,083	16,624	16,624	<b>44,330</b>
<b>Scope 2 Emissions Total</b>	<b>18,593</b>	<b>74,371</b>	<b>96,682</b>	<b>371,855</b>	<b>557,782</b>	<b>557,782</b>	<b>1,487,418</b>
<b>Scope 3 Emissions</b>							
Combustion of Fuels at Dendrobium Colliery (Direct Fuel Combustion)	76	304	395	1,518	2,277	2,277	<b>6,072</b>
Combustion of Fuels at West Cliff Emplacement (Direct Fuel Combustion)	38	153	199	766	1,150	1,150	<b>3,066</b>
Combustion of Fuels at PKCT (Direct Fuel Combustion)	1	5	6	24	36	36	<b>97</b>
<b>Combustion of Fuels During IC Transportation (Direct Fuel Combustion):</b>							
ROM Coal Kemira Valley to DCPD	227	907	1,179	4,534	6,802	6,802	<b>18,138</b>
Coal Wash DCPD to WC Emplacement	83	333	432	1,663	2,494	2,494	<b>6,651</b>
Clean Coal DCPD to PKCT	43	171	223	857	1,285	1,285	<b>3,426</b>
<b>Combustion of Fuels During Customer Transportation:</b>							
Clean Coal PKCT to Customers Offshore	80,050	320,200	416,260	1,601,002	2,401,503	2,401,503	<b>6,404,008</b>
Electricity Consumption at Dendrobium Colliery (Fuel Extraction and Line Loss)	1,864	7,455	9,692	37,277	55,915	55,915	<b>149,107</b>
Electricity Consumption at DCPD (Fuel Extraction and Line Loss)	1,691	6,765	8,795	33,827	50,741	50,741	<b>135,309</b>
Electricity Consumption at PKCT (Fuel Extraction and Line Loss)	109	437	568	2,184	3,276	3,276	<b>8,737</b>
Clean Coal End Use Steel Industry (70%)	1,250,172	5,000,688	6,500,894	25,003,440	37,505,160	37,505,160	<b>100,013,760</b>

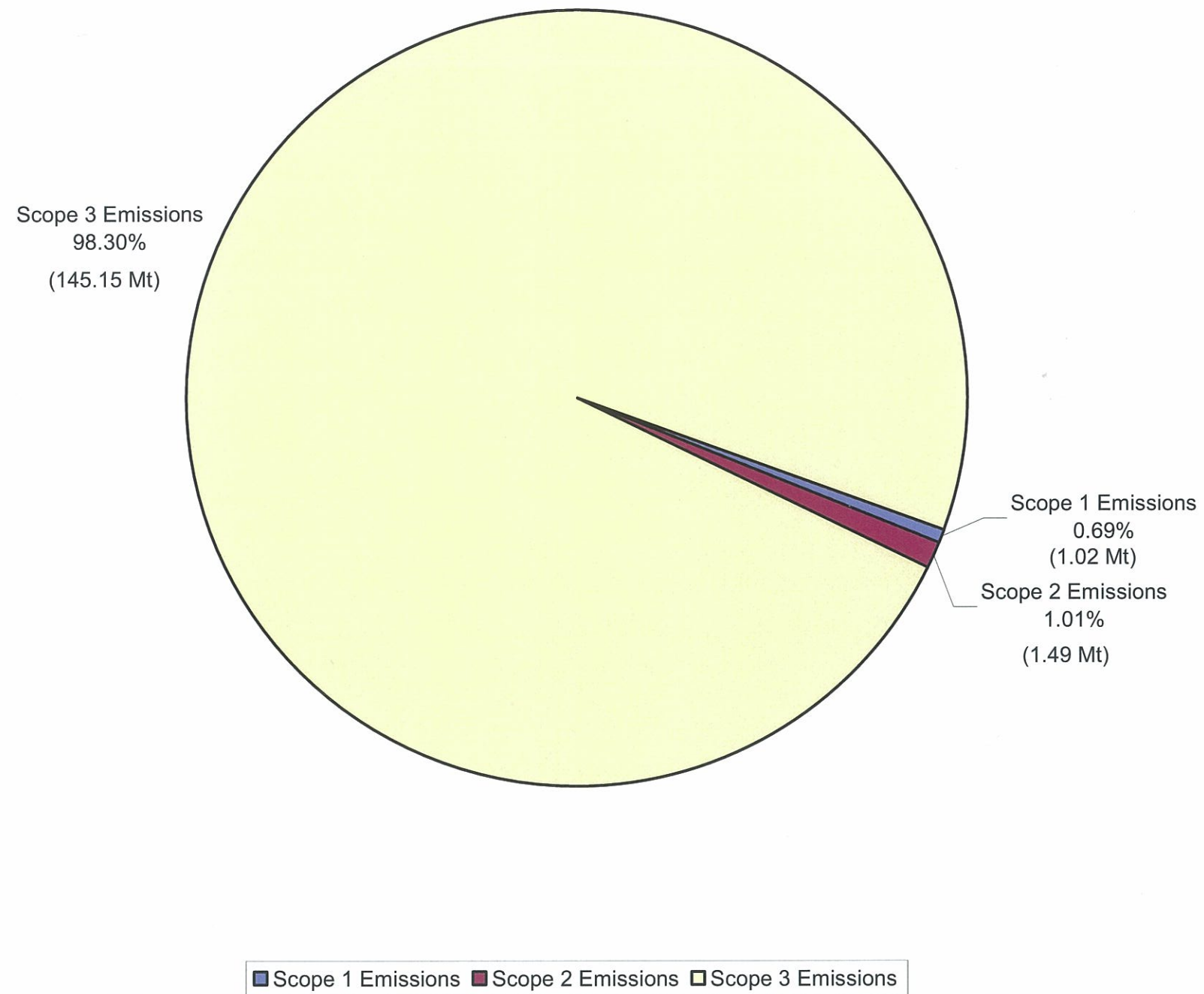
<b>Emission Source</b>	<b>Estimated Emission Rate Per Tonne ROM Mined (tCO<sub>2</sub>-e / Mt)</b>	<b>*Estimated Emission Rate Per Year of Mining (tCO<sub>2</sub>-e / yr)</b>	<b>**Maximum Emission Rate Per Year of Mining (tCO<sub>2</sub>-e / yr)</b>	<b>Area 3A Emission (tCO<sub>2</sub>-e)</b>	<b>Area 3B Emission (tCO<sub>2</sub>-e)</b>	<b>Area 3B Emission (tCO<sub>2</sub>-e)</b>	<b>Total Area 3 Emission (tCO<sub>2</sub>-e)</b>
Clean Coal End Use Energy Generation (30%)	480,071	1,920,283	2,496,368	9,601,416	14,402,124	14,402,124	<b>38,405,664</b>
Scope 3 Emissions Total	<b>1,814,425</b>	<b>7,257,702</b>	<b>9,435,012</b>	<b>36,288,508</b>	<b>54,432,762</b>	<b>54,432,762</b>	<b>145,154,033</b>
<b>TOTAL GHG EMISSIONS</b>	<b>1,845,807</b>	<b>7,383,229</b>	<b>9,598,198</b>	<b>36,916,145</b>	<b>55,374,217</b>	<b>55,374,217</b>	<b>147,664,579</b>

*\*Assumes ROM coal production of 4.0 Mt which was conservatively estimated to be somewhere between the ROM coal production figure for FY2007 of 2.54Mt of and the maximum allowable production as per the Dendrobium Consent of 5.2 Mtpa.*

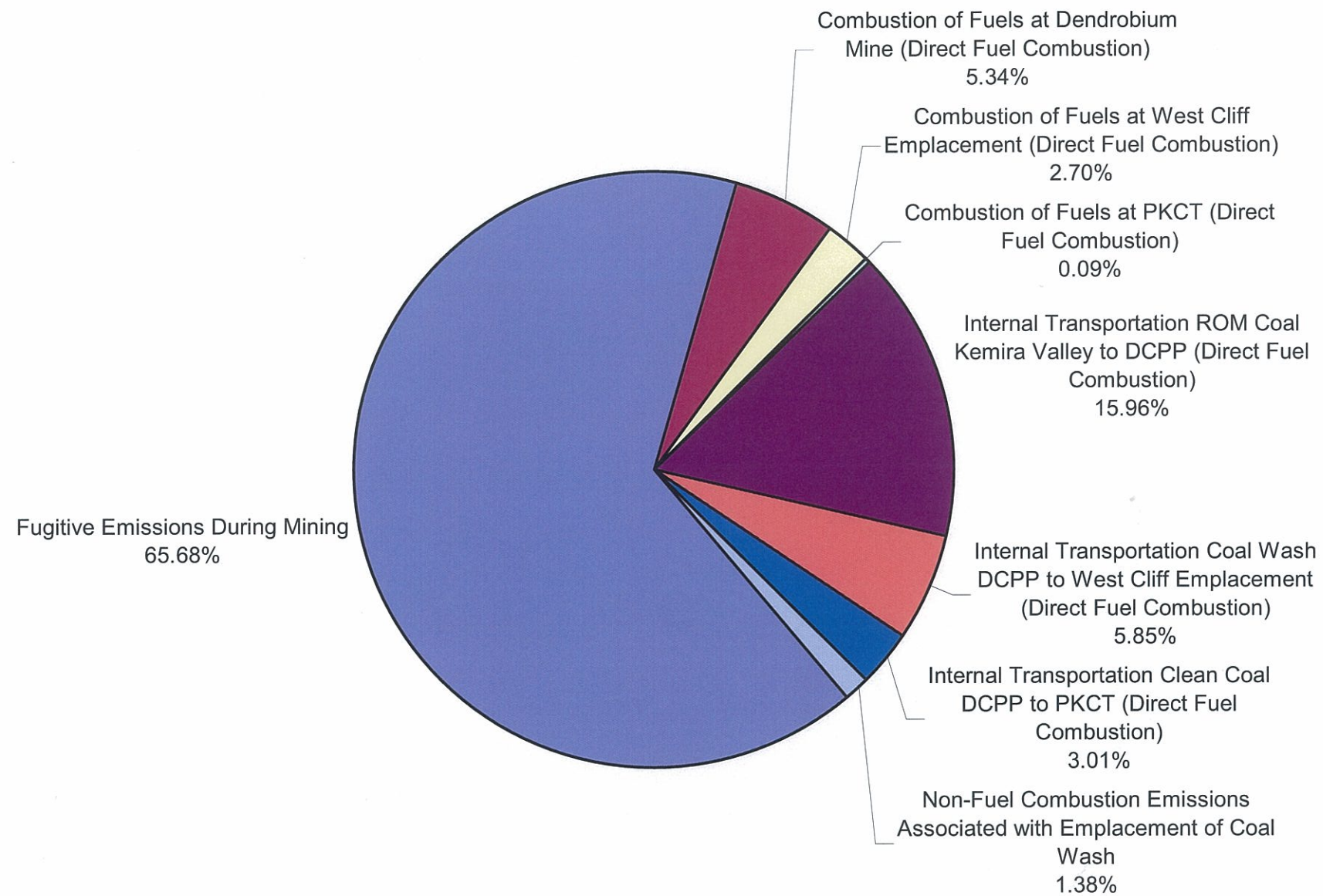
*\*\*Maximum coal production 5.2Mtpa as per Dendrobium Consent.*



Figure 13.2 – Breakdown of Scope 1, 2 and 3 Emissions from Dendrobium Area 3 Operations



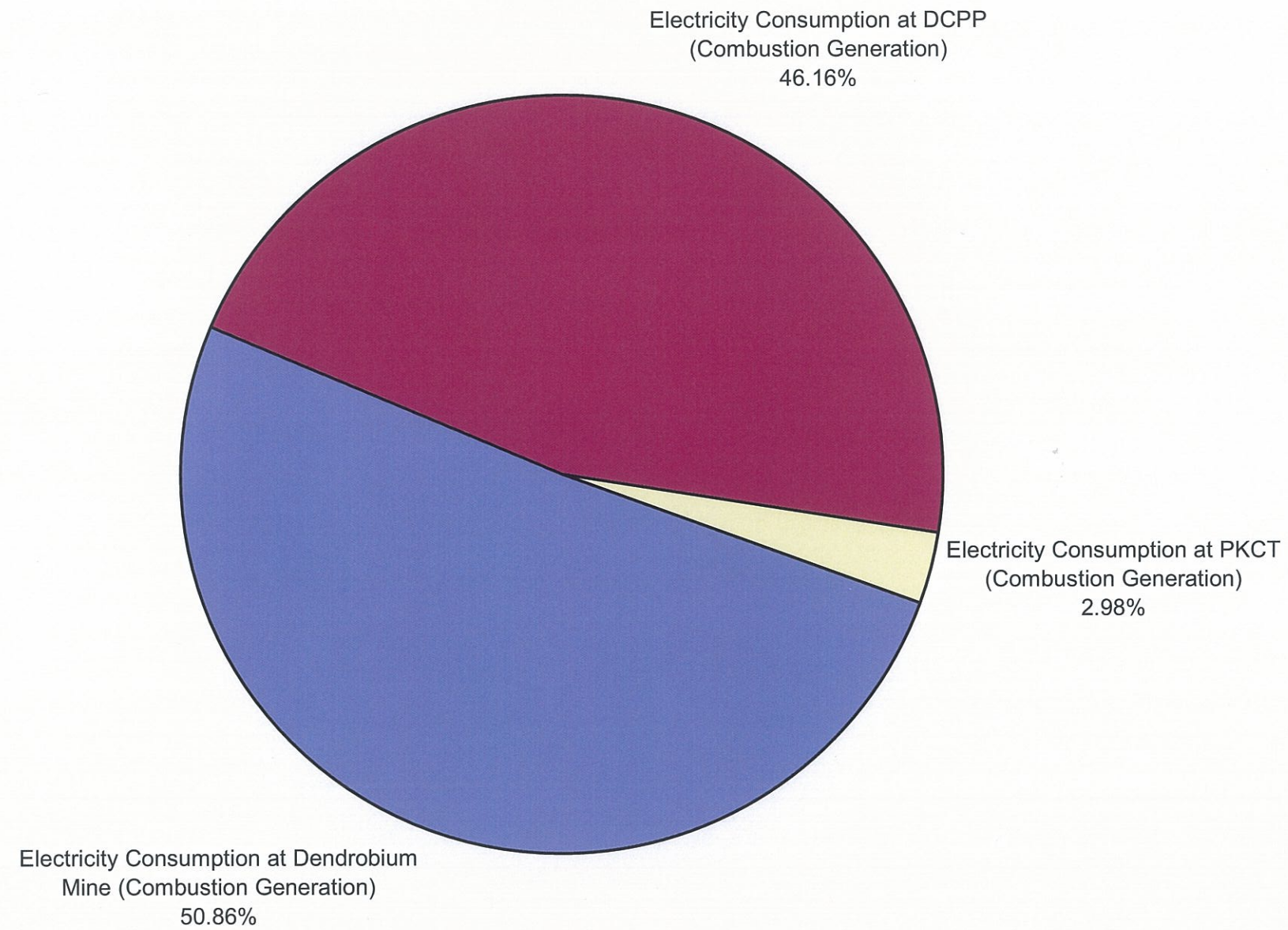
**Figure 13.3 – Breakdown of Scope 1 Emissions from Dendrobium Area 3 Operations**



- |  |  |
|--|--|
| ■ Fugitive Emissions During Mining   | ■ Combustion of Fuels at Dendrobium Mine (Direct Fuel Combustion)                          |
| ■ Combustion of Fuels at West Cliff Emplacement (Direct Fuel Combustion)         | ■ Combustion of Fuels at PKCT (Direct Fuel Combustion)                                     |
| ■ Internal Transportation ROM Coal Kemira Valley to DCP (Direct Fuel Combustion) | ■ Internal Transportation Coal Wash DCP to West Cliff Emplacement (Direct Fuel Combustion) |
| ■ Internal Transportation Clean Coal DCP to PKCT (Direct Fuel Combustion)        | ■ Non-Fuel Combustion Emissions Associated with Emplacement of Coal Wash                   |



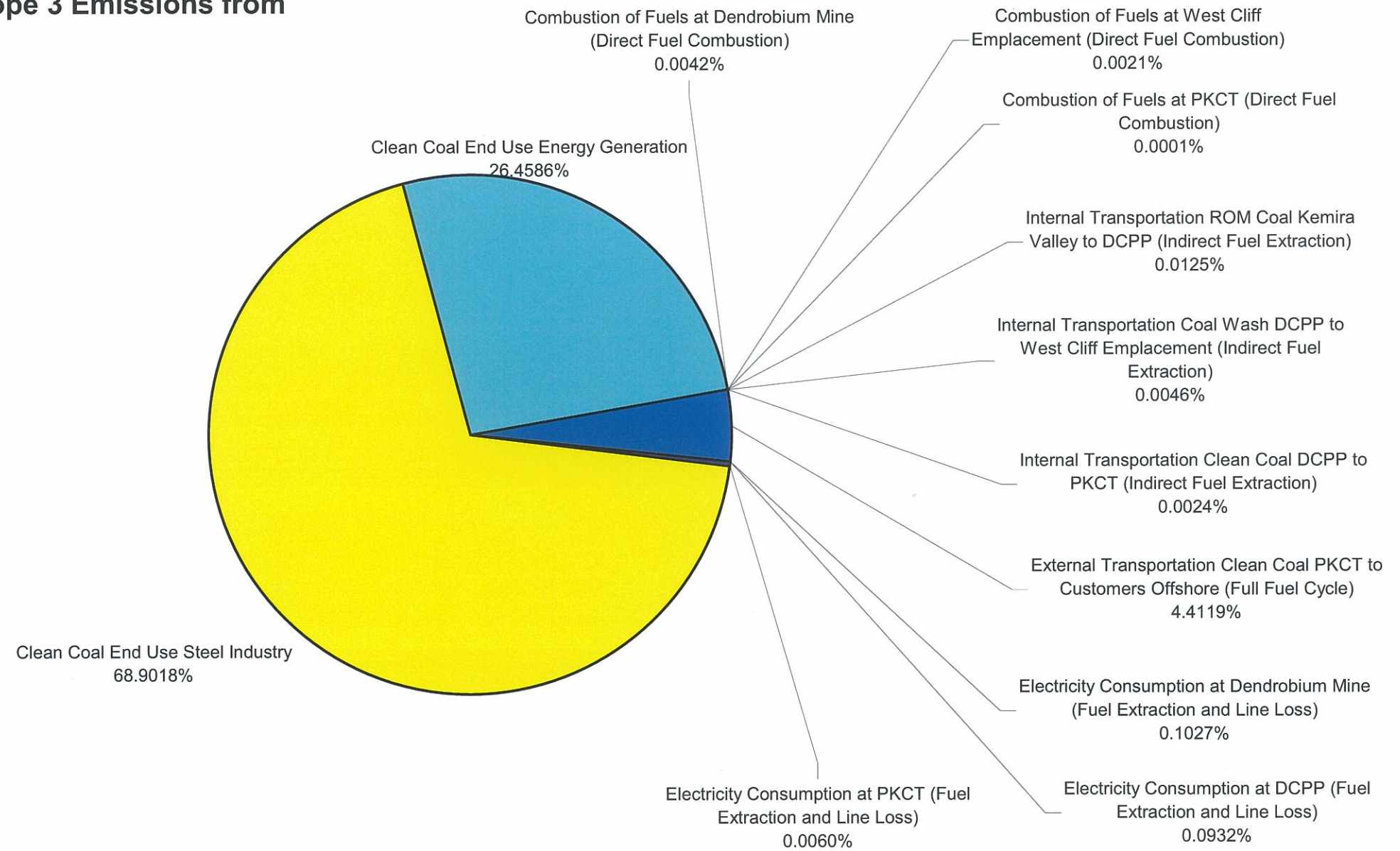
**Figure 13.4 – Breakdown of Scope 2 Emissions from Dendrobium Area 3 Operations**



■ Electricity Consumption at Dendrobium Mine (Combustion Generation) ■ Electricity Consumption at DCPD (Combustion Generation) □ Electricity Consumption at PKCT (Combustion Generation)



**Figure 13.5 – Breakdown of Scope 3 Emissions from Dendrobium Area 3 Operations**



- |  |  |
|--|--|
| ■ Combustion of Fuels at Dendrobium Mine (Direct Fuel Combustion)                            | ■ Combustion of Fuels at West Cliff Emplacement (Direct Fuel Combustion)           |
| ■ Combustion of Fuels at PKCT (Direct Fuel Combustion)                                       | ■ Internal Transportation ROM Coal Kemira Valley to DCP (Indirect Fuel Extraction) |
| ■ Internal Transportation Coal Wash DCP to West Cliff Emplacement (Indirect Fuel Extraction) | ■ Internal Transportation Clean Coal DCP to PKCT (Indirect Fuel Extraction)        |
| ■ External Transportation Clean Coal PKCT to Customers Offshore (Full Fuel Cycle)            | ■ Electricity Consumption at Dendrobium Mine (Fuel Extraction and Line Loss)       |
| ■ Electricity Consumption at DCP (Fuel Extraction and Line Loss)                             | ■ Electricity Consumption at PKCT (Fuel Extraction and Line Loss)                  |
| ■ Clean Coal End Use Steel Industry  | ■ Clean Coal End Use Energy Generation   |



## 13.7 COMPARISON WITH GLOBAL AND NATIONAL EMISSIONS

### 13.7.1 National and Global Emissions Comparison

The AGO's Australian Greenhouse Emissions Information System (AGO 2007) reports that the Total Kyoto emissions for 2005 was 559,074,490 tCO<sub>2-e</sub>. The estimated average annual emission associated with the Dendrobium Area 3 project (incl. Scope 1, 2, and 3 emissions) is 7,383,229 tCO<sub>2-e</sub>. This has been calculated based on an estimated average annual ROM coal production of 4.0 Mt. This average annual emission represents approximately 1.32% of the national Total Kyoto emissions for 2005. It is noted that approximately 98.3% of these emissions are Scope 3 emissions, the vast majority of which are associated with combustion of product coal for energy generation and steel manufacturing, and most of which take place in other countries.

The total estimated annual average for Scope 1 and 2 emissions only is 125,527 tCO<sub>2-e</sub>, which equates to approximately 0.02% of the national Total Kyoto emissions for 2005. As a comparison the Anvil Hill Coal Project (average production 7 Mtpa) was estimated to produce approximately 219,904 MtCO<sub>2-e</sub>/year (excluding Scope 3 emissions), which represents approximately 0.04% of the national Total Kyoto emissions for 2005.

The estimated maximum annual emission associated with the Dendrobium Area 3 Project (maximum production 5.2 Mtpa) is 9,598,198 tCO<sub>2-e</sub>. This represents approximately 1.72% of national Total Kyoto emissions for 2005. As a comparison, the total full fuel cycle GHG emission associated with the Anvil Hill Coal Project (maximum production 10.5 Mtpa) was 18,606,060 tCO<sub>2-e</sub>/year, which represents approximately 3.33% of the national Total Kyoto emissions for 2005.

Assuming that Australia contributes to approximately 1.4% of global GHG emissions, the estimated global emission for 2005 is approximately 39,933,892,140 tCO<sub>2-e</sub>. The estimated annual emission associated with Dendrobium Area 3 (including Scope 1, 2, and 3 emissions) is approximately 0.02% of the estimated global total for 2005. It is noted that the estimated total Scope 1 and 2 emissions associated with Dendrobium Area 3 represents approximately 0.0003% of estimated global annual emissions for 2005.

### 13.7.2 Relative Contribution of Project Global Coal Combustion GHG Emissions

Global proven coal reserves of black coal are at approximately 478.7 Gt (BP 2006). As discussed in **Section 13.3.1**, the Dendrobium Area 3 project coal reserve is estimated to be approximately 80 Mt of ROM coal. This represents approximately 0.017% of global proven coal reserves. However, the reserves of prime hard coking coal similar to that mined at Dendrobium are significantly less than 478.7 Gt.

Global annual production of coal is over 4.973 Gt (IEA 2006). World black coal consumption is projected to increase by 47% between 2002 and 2030 to reach 7.029 billion tonnes in 2030 (IEA 2006).

Annual production of ROM coal from the Dendrobium Area 3 project will be less than the approved maximum of 5.2 Mt per annum. This equates to approximately 3.4 Mt of clean saleable coal per annum. This equates to approximately 0.07% of annual global coal production in 2006 and 0.05% of projected annual global coal production in 2030.

## 13.8 IMPACT ASSESSMENT

Climatic change involves complex interactions between climatic, biophysical, social, economic, institutional, and technological processes. There is a strong general consensus among the scientific community that the world is warming due to the release of emissions of carbon dioxide and other GHG's from human activities including industrial processes, fossil fuel combustion, and changes in land use, such as deforestation (Pew Center on Global Climate Change 2007). The Fourth Assessment Report of the Intergovernmental Panel on Climate Change published in 2007 stated that most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the observed increase in (human produced) greenhouse gas concentrations (IPCC 2007).

### 13.8.1 Global and National Climate

Global temperatures have increased since the earliest reliable data measurements began in the late 1800's (AGO 2007). During the past 100 years, average global surface temperatures have increased by 0.7°C and evidence suggests that 11 of the past 12 years were the warmest since 1860 (AGO 2007).

Scientists believe that the Earth's average temperature will rise by 1.1 to 6.4°C from 1990 to 2100 if nations around the world do not act to control greenhouse emissions (AGO 2007).

Australia is vulnerable to changes in temperature and precipitation and Australia's vulnerability to climate change is intensified by already being a generally dry continent and experiencing high natural climate variability from year to year (Commonwealth Minister for Environment and Heritage Dr David Kemp 2003).

A few degrees of global warming will lead to more heat waves and fewer frosts. In Australia, the projected average warming of 0.4 to 2.0°C by the year 2030 would lead to a 10–50 per cent increase in days over 35°C at many places, and a 10–80 per cent decrease in frosts (AGO 2007).

### 13.8.2 Global and National Sea Level

Sea levels in Australia are naturally variable, although records indicate that sea levels have been rising by an increasing rate over the past 130 years. Records indicate that sea level has risen by approximately 1-2mm per year over the past 50 years and in the first half of the 19<sup>th</sup> century global sea levels were about 200 mm below the present levels (AGO Climate Trends 2007).

Sea level is likely to rise by 18 to 59 cm by 2100, but this does not include possible changes in big ice sheets such as Greenland and the Antarctic that could lead to more rapid sea level rise. Low-lying coastal areas and islands may be inundated more often by storm surges (IPCC 2007).

Impacts of sea level rises may include increased intensity and frequency of storm surges, increased erosion, loss of important wetlands and mangroves, impact on coastal ecosystems (i.e., coral reefs), and impact on human settlements (CSIRO Marine Research 2007). Low lying coastal terrain may become inundated resulting in beaches being eroded, infrastructure being damaged or destroyed, and people being injured or killed. Sea level rises may have impacts on soft sediment shorelines and intertidal ecosystems, which will especially be vulnerable to change with additional impacts from extreme events.

### 13.8.3 NSW Impacts

Possible impacts of climate change in Australia are addressed on the AGO webpage (AGO Climate Change Impacts 2007). Projected impacts listed for NSW include:

- New South Wales is expected to become warmer with more hot days and less cold nights.
- By 2030 the annual average number of days over 35°C in Sydney could grow from the current 3 to 4-7 days, in Canberra from 5 to 6-12 days and in Cobar from 41 to 45-65 days.
- Growth in peak summer energy demand is likely, due to air-conditioning use, which may increase the risk of blackouts.
- Warmer temperatures and population growth are likely to cause a rise in heat-related illness and death for those over 65; increasing in Canberra from the current 14 deaths annually to 37-41 by 2020 and 62-92 by 2050. In Sydney increases are projected in annual deaths from the current 176 to 364-417 by 2020 and 717-1,312 by 2050.
- Warmer conditions may also help spread vector-borne, water-borne and food-borne disease further south. These health issues could increase pressure on medical and hospital services.
- Urban water security may be threatened by projected increases in demand and climate-driven reductions in water supply.
- Little change in annual rainfall and higher evaporation would likely lead to less runoff in rivers in many catchments by 2030. Run-off across the Murray-Darling Basin may decrease 10-25 percent by 2050.
- More frequent and severe droughts, with greater fire risk, are likely.
- By 2020 the annual number of days with very high or extreme fire danger could average 13-14 in Richmond (now 11.5), 26-29 in Canberra (now 23) and 53-57 in Wagga Wagga (now 50).
- By 2020 a 10-40 percent reduction in snow cover is likely with potentially significant consequences for alpine tourism and ecosystems.
- Some agricultural crops may benefit from higher CO<sub>2</sub> concentrations however protein content is likely to decline.
- Frost-sensitive crops, such as wheat, may respond well to some warming however more hot days and less rainfall may reduce yields.
- Adverse effects for agriculture include reduced stone fruit yields in warmer winters, livestock stress and an increased prevalence of plant diseases, weeds and pests.
- CO<sub>2</sub> benefits experienced by forestry may be offset by a decline in rainfall, more bushfires and changes in pests. Centres dependent upon agriculture and forestry may be adversely affected.
- Increases in extreme storm events are expected to cause more flash flooding affecting industry and infrastructure, including water, sewerage and stormwater, transport and communications, and may challenge emergency services.
- In coastal areas infrastructure is vulnerable to sea level rise and inundation.

## 13.9 ABATEMENT MEASURES

Illawarra Coal abates approximately 2.2-2.5 Mt CO<sub>2</sub>-e/year through utilisation of methane for energy generation. Illawarra Coal is one of NSW's largest green house gas abaters and has a proud history of developing and implementing technological innovations to reduce emissions.

### 13.9.1 WestVAMP

West Cliff Ventilation Air Methane Project (WestVAMP) is a major project that will substantially reduce greenhouse gas emissions from IC's West Cliff Colliery. The WestVAMP project is the final step in proving a technology, first piloted at IC's Appin Colliery in 2001. The technology is capable of mitigating the bulk of the company's remaining greenhouse gas emissions, while producing electricity as a product.

IC has built a \$13 million electricity plant at West Cliff that burns waste coal mine gas that would otherwise be vented into the atmosphere and contribute to global warming. The West Cliff Ventilation Air Methane Project (WestVAMP) will construct and operate the plant utilising 20% cent of West Cliff's available mine ventilation air.

WestVAMP will use VOCSIDIZER™ technology, which converts low concentration methane to carbon dioxide and water vapour through a flameless combustion process. High efficiency heat exchangers will recover large levels of thermal energy to produce steam. This steam will be used to drive a conventional turbine to produce 6 MW of electricity that will be used by the West Cliff Colliery.

The outcome of the project will be a reduction in greenhouse gas emissions of up to 200,000 tCO<sub>2</sub>-e/year. This is equivalent to producing enough electricity for 20,000 homes, or removing emissions from 45,000 cars from the environment each year.

### 13.9.2 Energy Developments Limited – Appin Power Station

Coal seam methane from IC's Appin/Appin-West and West Cliff Collieries is supplied to a 94MW gas fired power station operated by Energy Developments Limited (EDL) at Appin. The electricity generated is supplied to Integral Energy and is sufficient to supply all Illawarra Coal's electricity consumption and that of approximately 90,000 homes. The power station abated greenhouse gas emissions by up to 2.2-2.5 Mt CO<sub>2</sub>-e/year.

### 13.9.3 Energy Savings Plans

All Illawarra Coal mines have developed and are now implementing Energy Savings Plans. Opportunities for reduced energy consumption have been identified and will contribute to reduced greenhouse gas emissions.



## **14 COMMUNITY AND STAKEHOLDER CONSULTATION**

### **14.1 INTRODUCTION**

Consultation has been undertaken with relevant stakeholders since the initial application for the construction of the Dendrobium mine. This chapter summarises the consultation events conducted in the past and the specific consultation program that was undertaken for this project.

### **14.2 HISTORY OF CONSULTATION**

There was a history of stakeholder consultation for various stages of the Dendrobium Mine project. For Area 1, consultation has been undertaken since IC commenced the development of the management and monitoring programs. During this process, IC has been involved in the consultation with the Dendrobium Community Consultative Committee (DCCC), Sydney Catchment Authority (SCA), DoP, NSW Fisheries, Dam Safety Committee (DSC), DPI and DECC.

For Area 2, the SMP was subject to external review by numerous agencies and stakeholders, including DECC (formerly DEC and NPWS), MSB, DPI, NSW Fisheries, DoP, Dam Safety Committee, SCA, Wollongong City Council, Integral Energy and Dendrobium Community Consultative Committee. A Longwall Mining Community Communication and Consultation Plan (LCCCP) was prepared and implemented for Area 2. The Plan outlined the general basis for communicating to stakeholders regarding the longwall mining process and environmental aspects.

For Area 3, broad communication and consultation with stakeholders and the community have been carried out throughout the longwall design process, through:

- Regular meetings with the Dendrobium Community Consultative Committee.
- Annual Environmental Management Report (AEMP) which is publicly available.
- The Independent Expert Review Panel (IERP) and associated reporting process.

The outcomes of these consultations are provided in the following sections.

### **14.3 RELEVANT STAKEHOLDERS AND CONSULTATION PROCESS**

Stakeholders who have an interest in the modified footprint in Area 3 include:

- DCCC.
- SCA.
- DECC.
- DPI.
- TransGrid.
- Integral Energy.
- Wollongong City Council.

- Wollondilly Shire Council.
- NSW Heritage Council.
- Mines Subsidence Board.
- relevant Aboriginal stakeholders (see section 14.8)

Consultation undertaken has involved:

- Advertising in Local and State newspapers.
- Specific meetings with relevant Government agencies.
- A Risk Assessment process.
- Community consultation via the Dendrobium Community Consultative Committee (DCCC).
- Aboriginal consultation during the baseline archaeological survey.

#### 14.4 ADVERTISING THE PROJECT

Pre-lodgement advertisements have been placed in both State and local newspapers advising that SMP is being prepared to cover the extraction of Area 3A, which will be submitted to the Department of Primary Industries when completed. The advertisements included a map which clearly showed the planned extraction area in relation to the existing workings as well as information about where submissions could be sent.

The dates of the advertisements were:

- Illawarra Mercury (Local) – on 15 September 2007.
- Wollongong Advertiser (Local) – on 19 September 2007.
- The Land (State) – on 19 September 2007.

Post-lodgement advertisements will also be placed in both State and local newspapers and the Department of Planning's website advising that the application at Dendrobium Mine has been submitted. This advertisement will detail a month long exhibition period including where the EA can be viewed and details of how submissions can be made. The advertisement is provided in **Attachment I**.

#### 14.5 MEETINGS WITH GOVERNMENT AGENCIES

A meeting was held between IC and DoP on 5 February 2007 to discuss the approval process for a modification to the Area 3 footprint and mine layout. DoP confirmed that the application to modify Area 3 footprint will be assessed under Part 3A of the EP&A Act and the modification falls under S75W of the Act. A letter from IC was sent to DoP on 8 February 2007 confirming the outcomes of the meeting. This letter is provided in **Attachment I**.

A letter from IC and a Preliminary Environmental Assessment were then submitted to the DoP on 11 April 2007 requesting that the Director General to provide the requirements for the preparation of an Environmental Assessment for the application.

Upon receipt of the Preliminary EA, the DoP distributed the report to all relevant agencies, including:

- NSW Department of Environment and Climate Change (DECC).
- NSW Department of Primary Industries (DPI).
- Wollongong City Council (WCC).
- Wollondilly Shire Council (WDSC).
- Sydney Catchment Authority (SCA).
- NSW Department of Water and Energy (DWE).
- NSW Dams Safety Committee (DSC).

These agencies responded to the DoP with their specific requirements for an Environmental Assessment associated with the proposed modification to the Dendrobium Area 3 footprint. A set of Director General's Requirements (DGR's) for the proposal was issued to IC on 11 July 2007.

A further meeting was held between IC and DoP on 11 September 2007 to seek confirmation on IC's approach to the EA, and to discuss the need to rationalise the current Dendrobium consent, and obtain DoP feedback on the scope of the EA. The minutes of the meeting are provided in **Attachment I**.

Outcomes of the meeting are summarised below:

- The extent of the modified footprint has been confirmed.
- The EA should discuss:
  - the risk of water loss from pools.
  - the pertinent features parameters that determine the design of the mine plan.
  - alternative mine plan variations that have been considered in the design process.
  - clear justification on the needs of the modification and the rationalisation of development consent.
- The subsidence avoidance model should be incorporated up in the SMP and EA.
- The EA will include a polygon showing the preliminary concept maximum mining layout for clarity to the community. Issues relating to the flexibility to change the layout post approval were discussed. DoP confirmed that the preliminary layout will not be referred to in the approvals.

#### 14.6 RISK ASSESSMENT

Risk Assessment has been undertaken by AXYS on 24 August 2007 to specifically assess risks relating to the proposed Area 3A longwalls. Details of the assessment are provided in the Section 12 of Area 3A SMP (Part A) that accompanies this application.



#### 14.7 DENDROBIUM COMMUNITY CONSULTATION COMMITTEE

IC has undertaken a comprehensive and ongoing consultation program with the DCCC since the commencement of the initial design and development of the Dendrobium mine. During the meetings, IC has been providing consistent updates on the environmental monitoring programs to the members.

In relation to the proposed Area 3 modification, a meeting with the DCCC was carried out on 23 August 2007 to discuss the following agenda:

- Review documents, including the Environmental Management Strategy and associated Environmental Management Plan.
- Allow the community and environmental groups to raise issues concerning the Dendrobium program.
- Give members a 'feel' for the project and how things are done.

The outcomes of the meeting were as follows:

- The Committee was informed that IC has requested a modification of development consent for the footprint of Area 3. The outline of the footprint was shown to the Committee, along with the current configuration of longwall blocks in Area 3A.
- A map outlining the Subsidence predictions for Dendrobium Area 3A was shown to the group along with predicted valley related movements for both Sandy Creek and Wongawilli Creek. A slide show was presented to the committee showing the subsidence predictions and valley related movements for Area 3A.
- The committee was informed that IC will concurrently submit an Environmental Assessment for the whole of Area 3 and the SMP for Area 3A and that this is likely to occur in September 2007 with a 30 day exhibition period following the submission.

The minutes of the meeting are provided in **Attachment I**.

#### 14.8 ABORIGINAL COMMUNITY

In accordance with the DECC's *Part 6 Approvals – Interim Community Consultation Requirements for Applicants*, Biosis Research notified the following bodies regarding the Dendrobium Area 3 Longwall Mine Area:

- Illawarra Local Aboriginal Land Council.
- The Registrar of Aboriginal Owners.
- Native Title Services.
- The Wollondilly Shire Council.
- The NSW Department of Environment and Conservation.

Public notifications following the DECC *Interim Community Consultation Requirements for Applicants* were made in The Illawarra Mercury in March 2007 (see **Attachment I**).

A register for interested parties was opened on 9 March 2007 and registrations were received by Biosis Research until 23 March 2007. Written responses to the notifications were received from the following parties:

- Illawarra Local Aboriginal Land Council (Sharralyn Robinson).
- The Wadi Wadi Coomaditchie Aboriginal Corporation (Peter Carriage).
- Northern Illawarra Aboriginal Collective (NIAC – Chris Illert).
- Korewal Elouera Jerrungarugh (KEJ – Reuben Brown).
- Cubbitch Barta Native Title Claimants Aboriginal Corporation (Glenda Chalker).
- Aboriginal and Historic Archaeological Solutions (Scott Franks).

Additional responses to the project were received from:

- Bellambi Aboriginal Tent Embassy (Kim Moran).
- Gary Caines.
- Kullilla Welfare and Housing Aboriginal Corporation (Maria Maher).

In accordance with the DECC's *Part 6 Approvals – Interim Community Consultation Requirements for Applicants*, stakeholders were provided with a methodology for the proposed cultural assessment and given 21 days to review the methodology and provide feedback. No formal response to the methodology was received.

Meetings to discuss broad cultural heritage issues with the project, and the general approach were held with the following organisations:

- Illawarra Local Aboriginal Land Council.
- The Wadi Wadi Coomaditchie Aboriginal Corporation.
- Bellambi Aboriginal Tent Embassy.
- Korewal Elouera Jerrungarugh.
- Cubbitch Barta Native Title Claimants Aboriginal Corporation.
- Aboriginal and Historic Archaeological Solutions.

Representatives from the following organisations participated in the fieldwork:

- Cubbitch Barta Native Title Claimants Aboriginal Corporation.
- Illawarra Local Aboriginal Land Council.
- Korewal Elouera Jerrungarugh.

## 15 STATEMENT OF COMMITMENTS

### 15.1 COMMITMENT TO AVOID IMPACT ON MAJOR NATURAL FEATURES

IC is committed to adopt the hierarchy of avoid/minimise/mitigate in their mine operation. IC is committed to avoid significant impacts by employing longwall set backs from Wongawilli and Sandy Creeks and Cordeaux and Avon Reservoirs, and by undertaking appropriate management measures and monitoring program to minimise potential impacts on these features.

### 15.2 LONGWALL LAYOUTS IN AREAS 3B AND 3C

- IC is committed to employ the optimisation process as described in Section 2.3 of this EA in the future design of the longwall layouts in Areas 3B and 3C in respect of Wongawilli Creek, and Cordeaux and Avon Reservoirs.
- Longwalls in Areas 3B and 3C will be situated within the general boundary of the preliminary mining domain (**Figures 1.8 and 1.9**).
- Individual SMPs will be submitted for in Areas 3B and 3C at the appropriate time when proposed mine plans are finalised.

### 15.3 SUBSIDENCE MANAGEMENT REMEDIATION MEASURES

- IC will implement the approved Subsidence Management Plan to ensure that the impacts of subsidence are managed to an agreed standard. In particular, the SMP will consider the impacts of the following items within the overall management strategy:
  - Wongawilli, Sandy and Donalds Castle Creeks.
  - Drainage Lines.
  - Lake Cordeaux and Lake Avon.
  - Cliffs and rock outcrops.
  - Steep slopes.
  - Swamps.
  - Fire trails and four wheel drive tracks.
  - TransGrid 330kV transmission line.
  - Integral Energy 33kV powerline.
  - Cordeaux Dam and Upper Cordeaux No. 2 Dam.
  - Archaeological sites.
  - Survey control marks.
- IC will undertake ground monitoring program in Area 3 to:
  - Provide information on the magnitude and extent of subsidence over the longwalls.
  - Compare actual ground movements with predicted ground movements.
  - Monitor ground movements at or near surface infrastructure at greater risk.



- Provide an indication of any non-systematic movements within the subsidence zone, however, given the low density of surface features above the longwalls, the risk of adverse impacts by non-systematic movements, ie: anomalies, is very low. If the density was high, the purpose would be to provide early detection.
- Satisfy the objectives of the subsidence management strategies.
- Satisfy the objectives of agreed management plans between IC and infrastructure owners.
- Meet the expectations of the community with regard to monitoring subsidence.

IC is committed to the locations and methodology of the ground monitoring in Area 3A as detailed in the SMP. The specific locations of ground monitoring in Areas 3B and 3C will be provided in the future SMPs for these areas.

#### **15.4 WATER MONITORING PROGRAMS**

IC will conduct water monitoring before, during and after mining of Area 3. These studies will provide catchment hydrologic and waterway geochemical assessments before and over the lifetime of Area 3. The program includes:

- A pre-mining baseline and post-mining stream hydro graphic monitoring, hydrologic modelling and assessment program.
- Establishment of networks of shallow piezometers in those upland areas where a significant unified hill slope aquifer, potentially susceptible to subsidence effects is believed to occur and where large Type 2 swamps or families of such swamps also occur.
- A pre-mining baseline and post-mining field water quality monitoring and laboratory analysis program based on extension of the existing long term study of water quality conducted in the Native Dog, Wongawilli and Donald's Castle Creeks since late 2001 and extensively reported-on.

Details of the program are provided in the SMP. IC is committed to the program as detailed in the SMP.

#### **15.5 GROUND MONITORING PROGRAMS**

The groundwater-monitoring program has been developed from the baseline study in accordance with the Dendrobium Consent and in consultation with relevant stakeholders. The aim of the monitoring program is to:

- Monitor groundwater levels and quality, commencing at least one year prior to mining affecting the groundwater system.
- Projection of potential groundwater changes during mining (short term) and post-mining (long term) with particular attention given to the affect of changes to groundwater quality and mobilisation of salts.
- Identify hydraulic characteristics of overlying and intercepted groundwater systems, and determine changes to groundwater systems due to coal extraction and dewatering operations.

- Report any pumping tests and groundwater/surface water simulation studies.
- Collect water level data from all agreed groundwater-monitoring locations.

Details of the program are provided in the SMP. IC is committed to the program as detailed in the SMP.

## 15.6 TERRESTRIAL FAUNA AND FLORA

- Where appropriate and agreed with stakeholders (such as SCA, DPIM, DECC), IC will employ remediation works where subsidence-related fracturing or dilation has induced pool water loss or diversion of flows. Where remediation works are to take place in or near waterways, appropriate care will be taken to avoid the infection or spread of Chytrid Fungus, following NPWS's guidelines.
- Where appropriate and agreed with stakeholders (such as SCA, DPIM, DECC), IC will repair fracturing as soon as feasible in order to minimise the impact on frog recruitment, although it is acknowledged that the timing of any remediation techniques needs to account for the cessation of active subsidence.
- Where appropriate and agreed with stakeholders (such as SCA, DPIM, DECC), IC will assess surface cracks that occur within general woodland and/or forest areas as soon as feasible to assess the potential for fauna entrapment. Mitigation measures such as temporary fencing of cracks and/or placement of fauna egress points will be implemented where they are deemed necessary and are practical.
- Prior to any remediation works, advice will be sought from an ecologist regarding the potential impacts of such remediation works on plant and animal populations within the area and further assessment should be conducted as required.
- IC will undertake ongoing monitoring of impacts of the project on plant and animal populations within the Study Area. Methodologies for ongoing monitoring are to be finalised in discussions between IC and DECC, and will be included in the SMPs. The monitoring program methodology is expected to be similar to the current monitoring program within Dendrobium Area 1 and Area 2.
- IC will undertake specific targeted surveys and monitoring of known populations for three animal species (Littlejohn's Tree Frog, Red-crowned Toadlet and Giant Dragonfly). These surveys will be carried out when access to the study area is provided by the SCA.

## 15.7 AQUATIC FAUNA AND FLORA MONITORING PLAN

The monitoring plan will assess the potential impacts of mine subsidence on aquatic habitat and biota within watercourses of the Area 3 mine area. Baseline sampling will be conducted in impact and control locations four times within a 12 month period prior to the commencement of longwall mining. During extraction and post extraction monitoring will be undertaken at the same seasonal periods to determine the extent and nature of any impacts and recovery should this occur.

IC will also undertake specific fish survey at Wongawilli Creek to target the threatened species, Macquarie Perch. The monitoring program is detailed in the SMP of Area 3A.

## 15.8 ARCHAEOLOGICAL MONITORING AND MANAGEMENT MEASURES

IC is committed to undertake a program of archaeological monitoring for the sites potentially affected by subsidence movements. The program aims to replicate and where possible develop the recording methods and action triggers already established by Sefton (2000) and those employed in Dendrobium Areas 1 and 2 (Biosis Research 2006). The management measures implemented for the sites will be coordinated in the first instance through a monitoring program of the shelter sites. The monitoring program will:

- Identify impacts associated with subsidence movements through detailed observation of structural features and, if present, rock art at the sites.
- Include detailed baseline and archival recording of rock art at the sites.
- For consistency include recording of principal components used in previous monitoring programs.
- Include a series of triggers for appropriate management responses if impacts are recognised and documented.

Details of the monitoring program are provided in the SMP.

Section 90 applications will be sought as part of the SMP process for Aboriginal archaeological sites that have some potential, however unlikely, to be impacted by the proposed longwall mining. For the Dendrobium Area 3A SMP, Area s90 Consent to Destroy / Damage / Deface will be sought for the following sites:

- 52-2-0458 (Shelter with Art).
- 52-2-1646 (Shelter with Art).
- 52-2-1647 (Shelter with Deposit).
- 52-2-0273 (Shelter with Art).
- 52-2-0274 (Shelter with Art).
- 52-2-0277 (Shelter with Art and Deposit).
- 52-2-0278 (Shelter with Art).
- DM13 (Shelter with Deposit).
- DM15 (Shelter with Art).
- DM20 (Shelter with Art).
- DM23 (Shelter with Deposit).

## 15.9 GREENHOUSE GAS ABATEMENT MEASURES

IC will continue to operate the recently commissioned WestVAMP project and the EDL gas fired power stations at Appin to reduce greenhouse gas emissions from IC's mine operations (**Section 13**). All IC mines have Energy Management Plans that aim to reduce energy consumption.



## 16 CONCLUSION

This Environmental Assessment (EA) supports an application by IC to modify the existing development consent to modify the footprint of Dendrobium Area 3. The proposed footprint for Area 3 is larger than the originally approved footprint and this partially compensates for the sterilisation of coal in Areas 1, 2 and 3 resulting from a number of risk management mechanisms (eg. set backs from creeks) and geological constraints.

This EA is prepared in accordance with the Director General's Requirements issued to IC upon the assessment of the Preliminary Environmental Assessment and consultation with the relevant agencies, which was undertaken and coordinated by the Department of Planning between April to July 2007.

The proposed modification to the footprint of Area 3 is needed to continue IC's underground coal mining operations at Dendrobium. We have demonstrated in this report that the modified footprint is necessary to deliver an efficient mining operation with due consideration of the environmental and geological constraints of the Area, and other mine planning requirements that restricted extraction in specific locations. We have also shown in this report that total mining area pursuant to this modification is comparable to the original approved area in the 2001 consent.

The modified footprint of Area 3 and longwall layout in Area 3A represent the optimal outcomes that achieve the following objectives:

- Avoid significant impacts on the major natural features, including Wongawilli Creek, Sandy Creek and the waterfall where Sandy Creek flows into Lake Cordeaux.
- Minimise volume of sterilised coal which could be efficiently extracted within the mining and environmental constraints of the area.

IC's optimisation process for designing longwall layout adopts the hierarchy of avoid/minimise/mitigate as requested by DoP during consultation with IC, and by DECC in their comments to DoP during the preparation of the DGR's.

As a result of the optimisation process, the longwalls in Area 3A are setback from Wongawilli and Sandy Creeks to avoid significant impacts. It is proposed that the longwall layouts in Areas 3B and 3C will be developed using the same process in order to minimise significant impacts to Wongawilli Creek. Further SMPs will be prepared for Areas 3B and 3C when proposed longwall layouts of these areas are finalised.

A range of potential impacts as a result of the proposal has been assessed in this EA, including subsidence predictions of all surface features and assessments of the subsidence induced impacts to all major creeks, tributaries and natural features, impacts on terrestrial and aquatic flora and fauna, surface water quality, hydrogeology and greenhouse gas emission. This EA has demonstrated that underground mining can be undertaken without significant impacts on these features. Potential impacts will be managed by implementing appropriate management strategies and be monitored through various monitoring programs. These are outlined in the Statement of Commitment and detailed in the Area 3A SMP.

The proposed modification of the Area 3 footprint is vital to IC's business as minimal reserves of such high quality coking coal exist. It represents continuing significant capital and operating investments in the Southern Coalfield of New South Wales. Continuing

benefits will occur through continuity of employment, expendable income, export earnings and government revenue.

This EA has demonstrated that the project is consistent with the objectives and controls of the EP&A Act and other relevant legislations and planning instruments. Consultation has been undertaken by IC to address the issues raised by the relevant stakeholders and affected parties. This EA supports the modification and seeks approval for the project.

Prepared by  
for and on behalf of  
**CARDNO FORBES RIGBY PTY LTD**

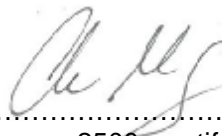


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