YANCOAL
兖煤澳大利亚有限公司

Moolarben Coal Project
Stage 1 Optimisation Modification

Environmental Assessment

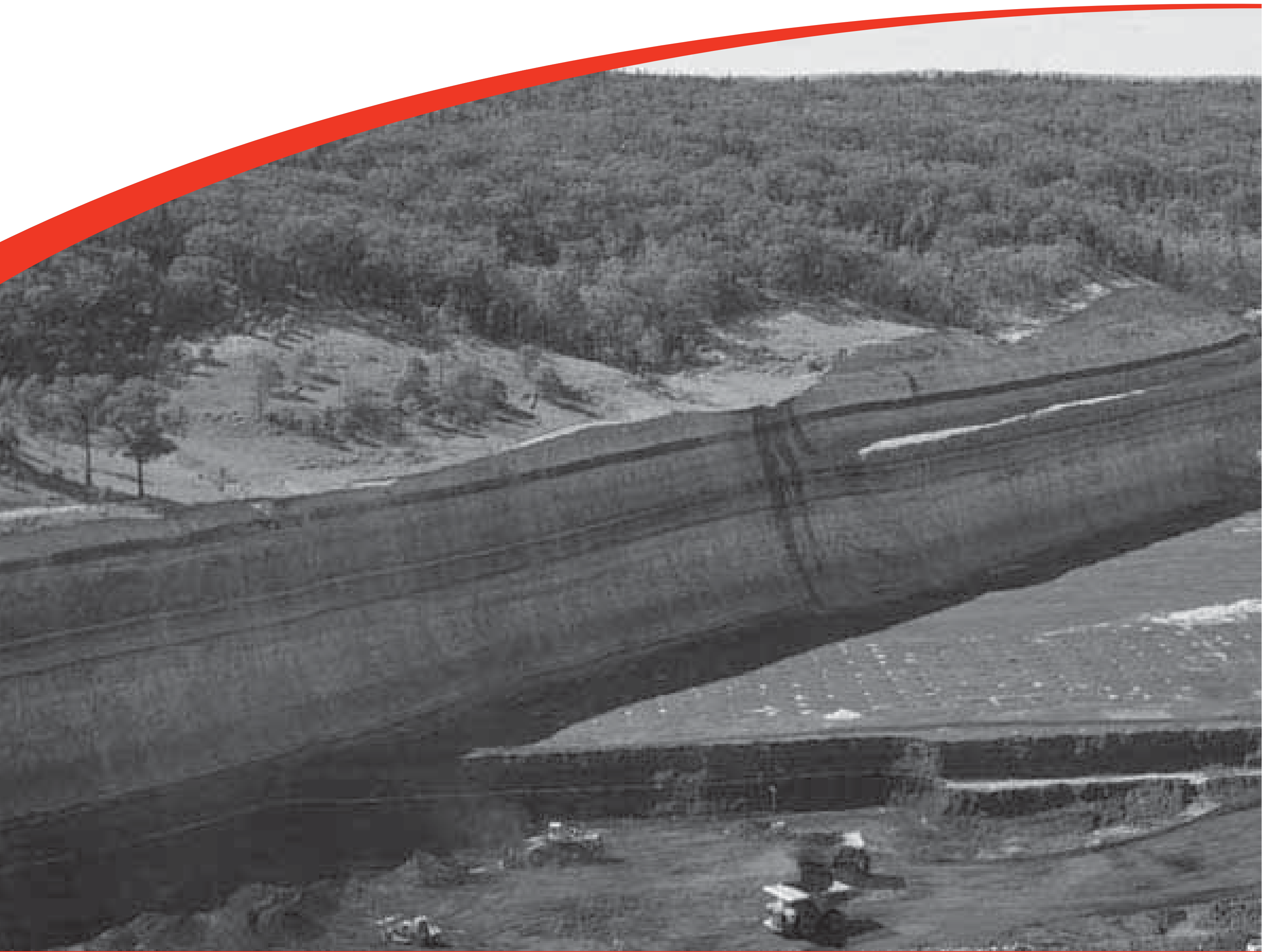
Prepared for Moolarben Coal Operations Pty Limited | May 2013

Volume 4 – Supporting Appendices

MOOLARBENCOAL
PART OF THE YANCOAL AUSTRALIA GROUP

EMM
EMGA Mitchell McLennan

Appendix H – Visual impact assessment
Appendix I – Surface water impact assessment
Appendix J – Groundwater impact assessment
Appendix K – Soils and agricultural impact assessment
Appendix L – Economic impact assessment



Moolarben Coal Project Stage 1 Optimisation Modification, Environmental Assessment – May 2013

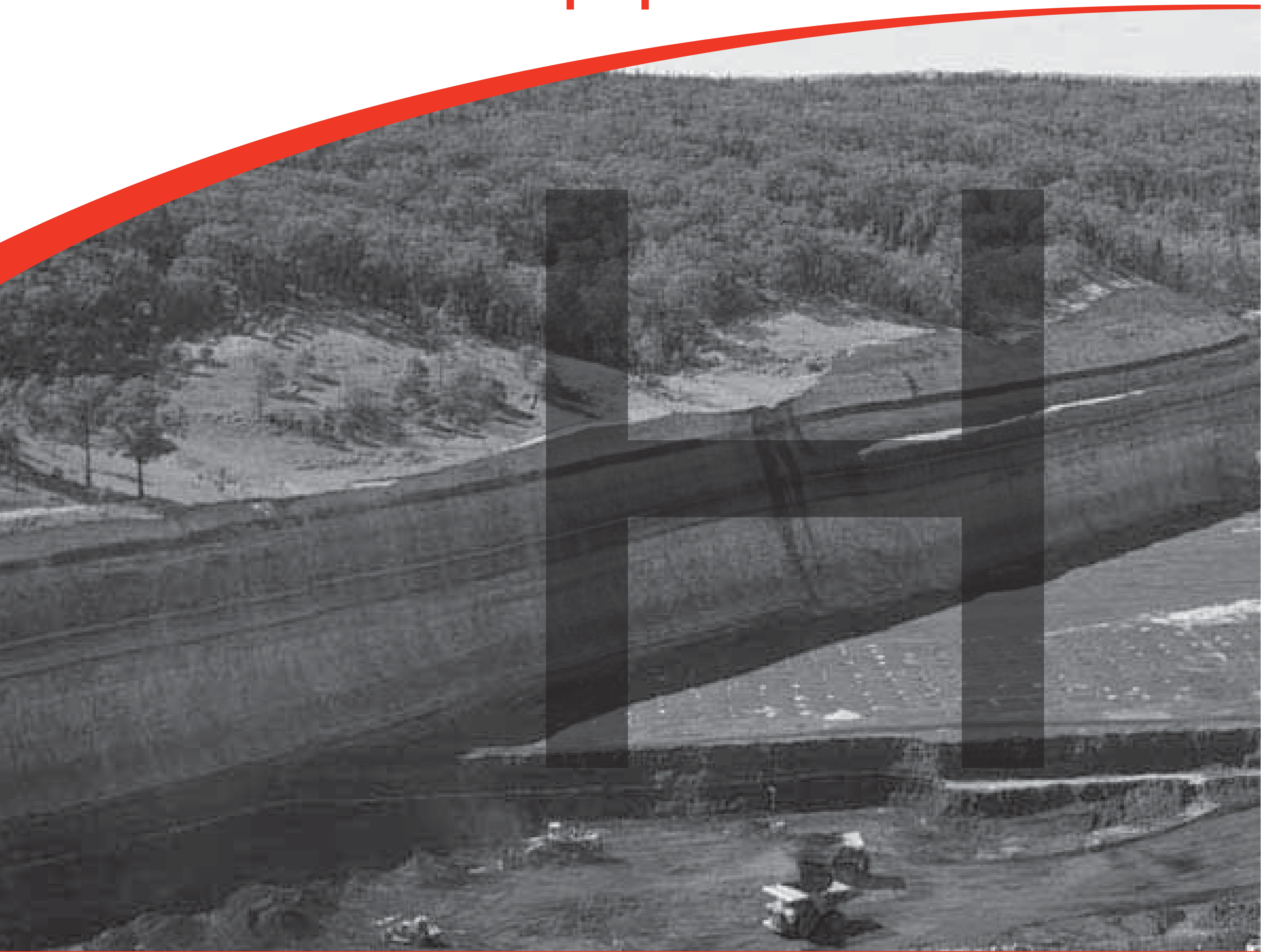
Volume 4 – Supporting Appendices

MOOLARBENCOAL
PART OF THE YANCOAL AUSTRALIA GROUP

EMM
EMGA Mitchell McLennan

www.moolarbencoal.com.au

Appendix H



Visual impact assessment

Moolarben Coal Project Stage 1 Optimisation Modification, Environmental Assessment – May 2013

MOOLARBEN COAL
PART OF THE YANCOAL AUSTRALIA GROUP

EMM
EMGA Mitchell McLennan

Visual Impact Assessment

Moolarben Coal Project – Stage 1 Optimisation Modification

Prepared for Moolarben Coal Operations Pty Limited | 7 May 2013

Ground Floor, Suite 01, 20 Chandos Street
St Leonards, NSW, 2065

T +61 2 9493 9500
F +61 2 9493 9599
E info@emgamm.com

emgamm.com

Visual Impact Assessment

Final

Report J12090RP1 | Prepared for Moolarben Coal Operations Pty Limited | 7 May 2013

Prepared by	**David Kelly**	Approved by	**Luke Stewart**
Position	Senior Environmental Planner	Position	Director
Signature		Signature	
Date	7 May 2013	Date	7 May 2013

This report has been prepared in accordance with the brief provided by the client and has relied upon the information collected at or under the times and conditions specified in the report. All findings, conclusions or recommendations contained in the report are based on the aforementioned circumstances. The report is for the use of the client and no responsibility will be taken for its use by other parties. The client may, at its discretion, use the report to inform regulators and the public.

Document Control

Version	Date	Prepared by	Reviewed by
1	07 May 2013	David Kelly	Luke Stewart

EMM
EMGA Mitchell McLennan

T +61 (0)2 9493 9500 | F +61 (0)2 9493 9599

Ground Floor | Suite 01 | 20 Chandos Street | St Leonards | New South Wales | 2065 | Australia

emgamm.com

Table of Contents

Table of Contents *(Cont'd)*

Tables

Figures

Figures

1 Introduction

1.1 Background

The Moolarben Coal Project (MCP) is an approved open cut and underground coal mine in the Western Coalfields of NSW, approximately 40 km north-east of Mudgee (Figure 1.1). EMGA Mitchell McLennan (EMM) was engaged by Moolarben Coal Operations Pty Limited (MCO) to undertake a visual impact assessment for the Moolarben Coal Project – Stage 1 Optimisation Modification (proposed modification).

The MCP Stage 1 Major Project approval 05_0117 (MP 05_0117) was approved under Part 3A of the Environmental Planning and Assessment Act 1979 (EP&A Act) in 2007. Since gaining approval, MP 05_0117 has been modified on seven occasions to make administrative changes, minor changes to infrastructure areas and allow the construction of a borefield. The main components of the MCP Stage 1, as modified, comprise:

- three open cut pits, referred to as Open Cuts 1, 2 and 3, which have an approved combined maximum extraction rate of 8 million tonnes per annum (Mtpa) of run of mine (ROM) coal;
- one underground mine, referred to as Underground 4, which has an approved maximum extraction rate of 4 Mtpa of ROM coal;
- coal handling, processing, rail loop, load-out and water management infrastructure; and
- associated facilities including offices, bathhouses, workshops and fuel storages.

To date, mining has occurred within Open Cut 1 only, commencing at the south-western perimeter and progressing in a north-easterly direction.

The current disturbance limit granted under MP 05_0117 is restricting the extraction of large quantities of the deposit which are economically viable in today’s market. The proposed modification will extend the disturbance boundary enabling increased resource utilisation, a longer life for Open Cuts 1 and 2 and promote the continuity of Stage 1 operations. All of the elements of the proposed modification are described in Section 1.2.

The MCP is bordered by the Goulburn River to the north-west; privately owned grazing land to the north; Goulburn River National Park, Wilpinjong Coal Mine and Munghorn Gap Nature Reserve to the east; privately-owned grazing land to the south; and privately-owned grazing land, Ulan settlement and Ulan Coal Mine to the west.

1.2 Overview of proposed modification

The elements of the proposed modification to MP 05_0117 comprise:

- the extension of mining within Open Cuts 1 and 2;
- the construction and operation of additional water management infrastructure;
- a minor change to the rehabilitation sequencing and final landform; and

The project approval period will be extended to accommodate the proposed modification.

No others changes are proposed under the modification.

The proposed modification elements are shown in Figure 1.2. They are all within the Stage 1 project approval boundary, which forms the 'project area' for the proposed modification. Within the project area, Open Cut 1 and 2 extension areas are referred to collectively as the 'proposed extension areas'. It is noted that proposed extension areas include a disturbance buffer of up to 50 m that will enable the development of a services road and infrastructure if required, such as water pipelines. This ensures that all potential impacts associated with the proposed extension to mining have been assessed. The proposed extension area footprints ensure that a minimum 40 m barrier exists between coal from the proposed and approved open cut and underground mining areas.

1.3 Relationship to other projects

A Major Project Application for Stage 2 of the MCP, MP 08_0135, is currently being assessed by the Department of Planning and Infrastructure (DP&I). If approved, Stage 2 will consist of one open cut pit, Open Cut 4, and two underground mines, Undergrounds 1 and 2, and associated additional infrastructure.

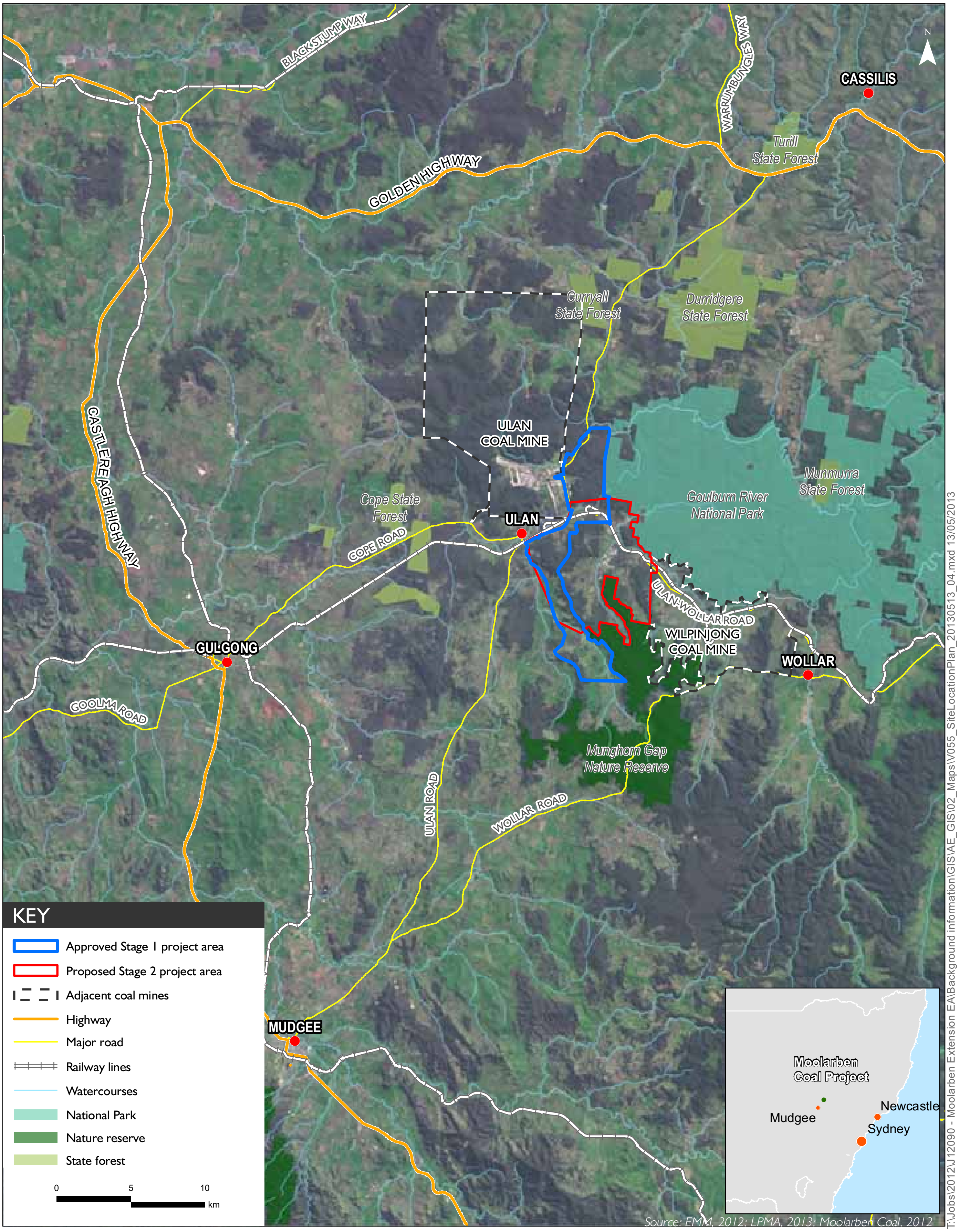
1.4 Study purpose

The purpose of this report is to provide an assessment of the impacts of the proposed modification on the visual landscape. This VIA accompanies the EA for the proposed modification. The VIA makes an assessment of likely additional or cumulative impacts resulting from the proposed modification and the assessment results have been used to determine mitigation measures to minimise visual impacts.

1.5 Report structure

This report is structured as follows:

- Chapter 2 provides an outline of the visual impact methodology used in the preparation of this report;
- Chapter 3 describes the project area and the proposed modification, including the visual components of the modification, the staging of the mine plan and the impact it has on the changing landforms;
- Chapter 4 describes the impacts of the proposed modification from representative viewpoints surrounding the project area;
- Chapter 5 provides measures necessary to mitigate visual impacts of the proposed modification; and
- Chapter 6 provides conclusions.

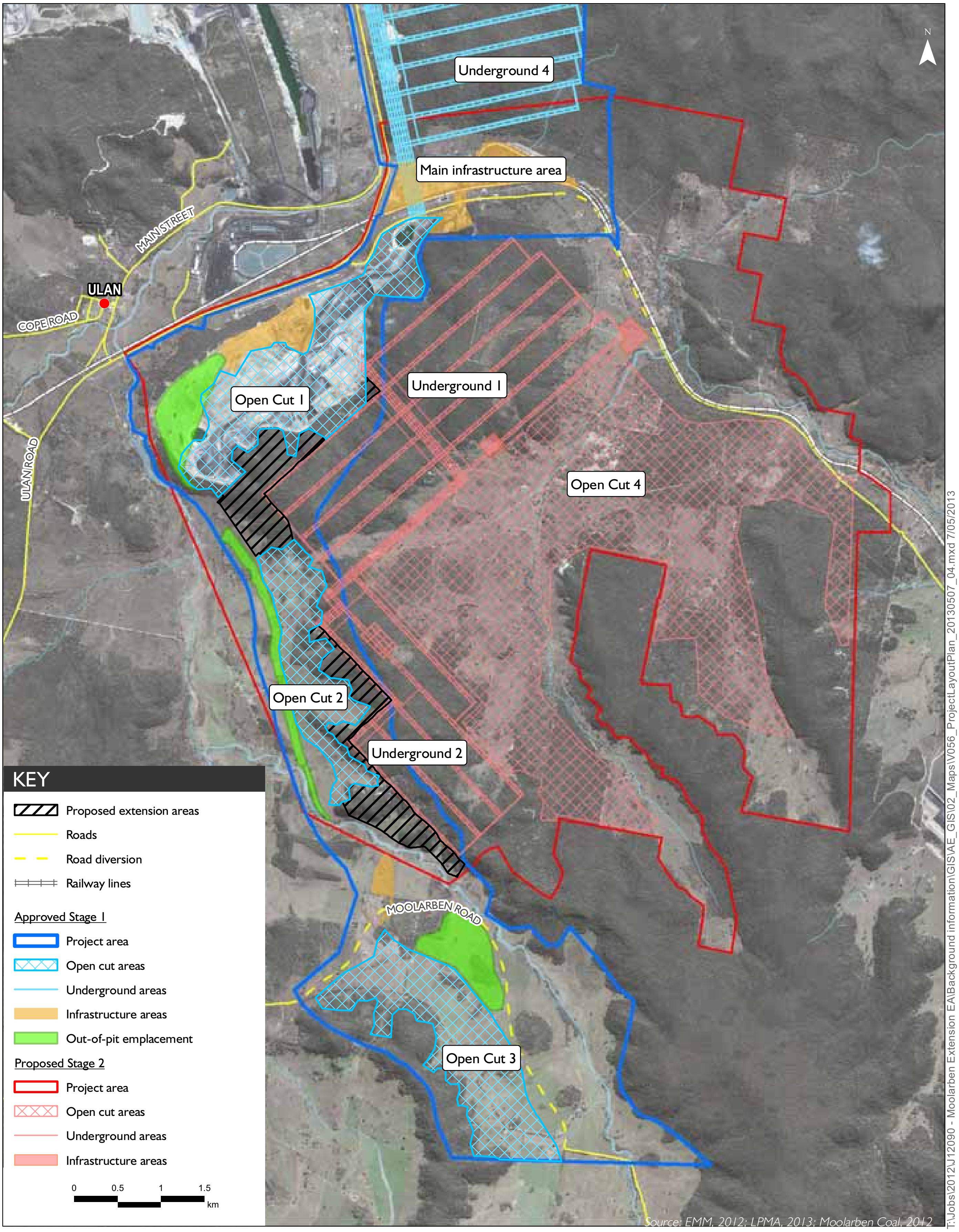


MCP location plan

Moolarben Coal Project - Stage 1 Optimisation Modification

Visual impact assessment

Figure 1.1



EMM
MOOLARBEN COAL

Proposed modification layout plan

Moolarben Coal Project - Stage 1 Optimisation Modification

Visual impact assessment

Figure 1.2

2 Methodology

2.1 Overview

This VIA is based on a qualitative analysis of viewpoints which are considered to have potential to be impacted by the proposed modification, or are considered to be representative of views of mining activities at the MCP from private residences or public roads in the surrounding areas.

The methodology used in the visual assessment included:

- a desktop review of the viewpoints identified in previous visual assessments for operations at MCP for relevance in respect of the proposed modification;
- a visual survey involving a line of site analysis from each viewpoint to assess view type/context and determine visual absorption capacity;
- an assessment of the significance of the visual impact of the proposed modification from each of the identified viewpoints; and
- a review of mitigation measures previously employed in the original approval and subsequent modifications to determine their adequacy and whether additional measures are considered necessary.

2.1.1 Study area and viewpoints

As part of the original project application and subsequent modifications to the project approval, a number of visual assessments have been undertaken. In each instance these assessments have provided a qualitative assessment of visual impacts of the original project and subsequent modifications.

Previous visual assessments undertaken comprise:

- Visual & Lighting Impact Assessment Moolarben Coal Project prepared by O'Hanlon Design Pty Ltd (O'Hanlon) (2006). This report was prepared as part of the Stage 1 EA for the MCP; and
- Visual & Lighting Impact Assessment Stage 2 Moolarben Coal Project prepared by O'Hanlon (2008). This report was prepared as part of the Stage 2 EA for the MCP.

The O'Hanlon (2006) visual assessment prepared with the original EA, selected 11 viewpoints considered to be representative of views to the mine activities from a particular area and /or due to the potential impact on a specific receiver. Selection of the viewpoints had regard for landscape, sensitivity of viewer location and the nature of mine activities visible from a given point.

To ensure consistency and ease of comparison between the visual impacts of the approved Stage 1 project, as modified, and subsequent modifications to the project approval, this VIA has utilised the same visual receptor locations, where still relevant to the proposed modification, identified in the previous assessments.

Each of the viewpoints is illustrated and described in Chapter 4.

2.1.2 Visual survey

Following the desktop analysis, a visual survey was undertaken on Monday 17 and Tuesday 18 December, 2012. It was determined from the visual survey that two of the previously assessed viewpoints (VP10 - Moolarben Road at Moolarben Creek crossing and VP11 - Wollar Road in O'Hanlon, 2006) were not relevant to the proposed modification and, therefore, not considered relevant to the current assessment. It was considered necessary through discussions with MCO, however, to include an additional viewpoint for consideration, being Cope Road which connects Ulan through to Gulgong. This viewpoint, located to the west of the Ulan settlement, was selected for assessment due to its potential for direct visual and lighting impacts from the proposed modification.

2.1.3 Viewpoint photomontages

Following desktop analysis, visual survey and viewpoint analysis, three locations were chosen to have photomontages prepared. These three locations were chosen as they are considered to have the greatest potential visual impact due to exposure to active mining areas, active overburden emplacement or rehabilitation of mined areas and were accessible from public roads. Additionally, these locations are representative of likely visual impact on surrounding private residential landowners or potential exposure to the proposed modification for motorists travelling in the vicinity of the mine.

2.2 Viewpoint assessment methodology

2.2.1 View type and context

View type and context describes the existing landscape character, the built environment, topography and screening provided by existing vegetation or other landforms. The context is a primary factor in the visual sensitivity of the view. Generally sites within higher contrasting landscapes have greater ability to absorb change, whereas sites within a uniform or highly ordered landscape have lower sensitivity.

2.2.2 Magnitude of change

The magnitude of change on the visual landscape is an important factor in determining the significance of visual impacts of a proposal. In accordance with *The Landscape Institute of Environmental Management and Assessment (2002): Guidelines for Landscape and Visual Impact Assessment,* this VIA has considered the following criteria in determining the magnitude of change on a receptor:

- whether the impact is temporary or permanent – impacts that are for a limited duration are considered less significant than those which occur for an extended period or are permanent;
- scale of change – the loss or addition of features in the view and changes in the proportion of the view affected by the proposal;
- degree of contrast – level of integration of new features with existing or remaining landscape elements, having regard to form, scale, height, colour, and texture;
- distance of the viewer from the altered elements in the landscape – close proximity to an altered landscape will increase the significance for private residences. In the case of motorists, mid ground changes can be greater than foreground elements as they can result in longer viewing times;
- viewing direction – whether the change is to the primary view from the receptor;

- extent of view affected – impacts that are visible over a greater portion of a view are more significant than those where only a part of the view is impacted. Intervening topography and vegetation will also affect the magnitude of change; and

- length of viewing time – views from a residence are constant whereas some views from roadways as experienced by motorists may be brief dependent upon speed and viewing direction.

2.2.3 Visual sensitivity

Visual sensitivity is a measure of the landscape's ability to absorb development without a significant change in the character. It is a function of the view type and context. In this assessment, the major factor influencing visual sensitivity is the level of contrast between the mining activities and the rural landscape setting in which they sit.

Visual sensitivity is rated on a scale of high, moderate, or low. The physical characteristics of the landscape, including existing development features, are integral components in determining the visual sensitivity. For example, a low visual sensitivity would enable a modification or addition to be made to the landscape which would only cause minimal contrast and result in a high level of integration with the surrounding landscape. Similarly, a high visual sensitivity would mean the same modification or addition to the surrounding landscape would cause high contrast to the surrounding landscape.

In accordance with *The Landscape Institute of Environmental Management and Assessment (2002): Guidelines for Landscape and Visual Impact Assessment*, the visual sensitivity of a receptor has been assessed based on the following criteria:

- importance of the view – changes to views from private residents or main tourist roads are considered more sensitive than from secondary roads;

- receptor viewer expectation – communities where development results in changes in the landscape setting or valued views; and

- location and context of the viewpoint – natural and modified elements that make up the visual landscape and contribute to the composition, and hence sensitivity of a visual landscape.

2.2.4 Evaluation of significance

The significance of a change in the landscape is a function of the magnitude of that change when considered against the view type/context and the sensitivity of a receptor. Typically, a noticeable change in the landscape in an unmodified rural or natural landscape would be considered to be significant, whereas a change in an already heavily modified landscape would be considered slight or moderate.

Table 2.1 illustrates how the magnitude of a change in the landscape is assessed, and its significance rated, against the sensitivity of a receptor.

Table 2.1 Evaluation of significance matrix

Magnitude of change	Visual sensitivity		
	High	Moderate	Low
High	Substantial	Moderate/ Substantial	Moderate
Medium	Moderate/ Substantial	Moderate	Slight/ Moderate
Low	Moderate	Slight/ Moderate	Slight
Negligible	Slight	Slight/ Moderate	Negligible
Key:	Significant (red)	Not significant (green)	

2.3 Mitigation

The final step in the assessment process is to determine measures that can be incorporated into the design of the proposal to ameliorate, or, where possible, eliminate the visual impact of the proposed activity.

Mitigation measures can be in several forms including:

- design of mine infrastructure to reduce the contrast with the surrounding environment;
- use of visual buffers and screening by planting vegetation; and
- designing waste emplacements to screen mining operations and lighting.

Mitigation measures are given in Chapter 5 of this report.

3 Project area and proposed modification

3.1 Overview

Elements of the proposed modification that have the potential to impact visual amenity, comprise:

- views of highwalls and mobile mine machinery working in active mining areas;
- views of out-of-pit overburden emplacement workings;
- views of rehabilitation works involving reshaping of out-of-pit overburden emplacement areas; and
- lighting spill and skyglow from mobile mine machinery and mobile lighting structures.

Each of these elements is discussed in the following sub-section.

3.1.1 Visual elements and mine plan staging

The proposed extension of mining in Open Cuts 1 and 2 will result in extraction of resource in areas additional to those which is currently approved. The extent of the additional extraction area is illustrated in Figure 1.2.

The proposed conceptual mine plan layouts for Years 2, 6, 11, 16 and 21 are illustrated in Figures 3.1 to 3.5 and described briefly below. The conceptual final landform (Year 22) is shown in Figure 3.6. The timing of the staged mine plans are indicative worst case only and have been included for assessment purposes and may vary due to the ultimate production levels achieved during the life of the mine.

The following provides a description of the mine planning stages associated with the proposed modification:

- Indicative Year 2 –mining in the proposed Open Cut 1 extension area is a continuation of mining the existing Open Cut 1 area. Disturbance up to approximately 527 m AHD will be visible to motorists travelling south on the Ulan Road at Viewpoint (VP) 2. No mining has occurred within Open Cut 2 at this stage;
- Indicative Year 6 –mining within the proposed Open Cut 1 extension area has continued in a south-westerly direction and has broken through the ridge, to expose workings to private residences to the west. Disturbance up to approximately 529 m AHD will be visible to Ridge Road and Winchester Crescent in the vicinity of VP6 and VP7. No mining has occurred within Open Cut 2 at this stage;
- Indicative Year 11 – active mining within the proposed Open Cut 1 extension area has been completed in Open Cut 1 and the majority of the area rehabilitated to its final landform. Coal extraction has extended into the north part of the approved Open Cut 2 as a continuation of Open Cut 1. Active mining within the Open Cut 2 extension area to straighten up the ridge has not commenced at this stage;
- Indicative Year 16 –mining within the proposed Open Cut 2 extension area continues, extending south-east to include the straightening up of the highwall. Active mining and overburden emplacement areas will be visible from some private residence at the northern end of Ridge Road. Views of active mining will not be possible for residents further south on Ridge Road and no residences on Winchester Crescent, as views are obscured by Dexter Mountain; and

- Indicative Year 21 -the sequencing of mining for Open Cut 3 will be the same as that shown in the approved Stage 1 EA. All mining in Open Cut 2 has finished and mining in Open Cut 3 is close to completion, with active mining occurring only in the southern tip and the remaining area rehabilitated. Rehabilitation will be occurring to a height of approximately 560 m AHD and views of these areas will be possible from private residences along the southern end of Ridge Road. Rehabilitation activities may become visible to some private residents from behind Dexter Mountain as works progress south-east.

The proposed modificatoin will not require additional plant and equipment to be utilised in the recovery of coal, as this can be achieved with the existing Stage 1 fleet. This equipment is referred to as mobile mine machinery for the purposes of this VIA. Operational requirements may vary from time to time due to constraints such as weather conditions, and would also depend on maintenance and repair works.

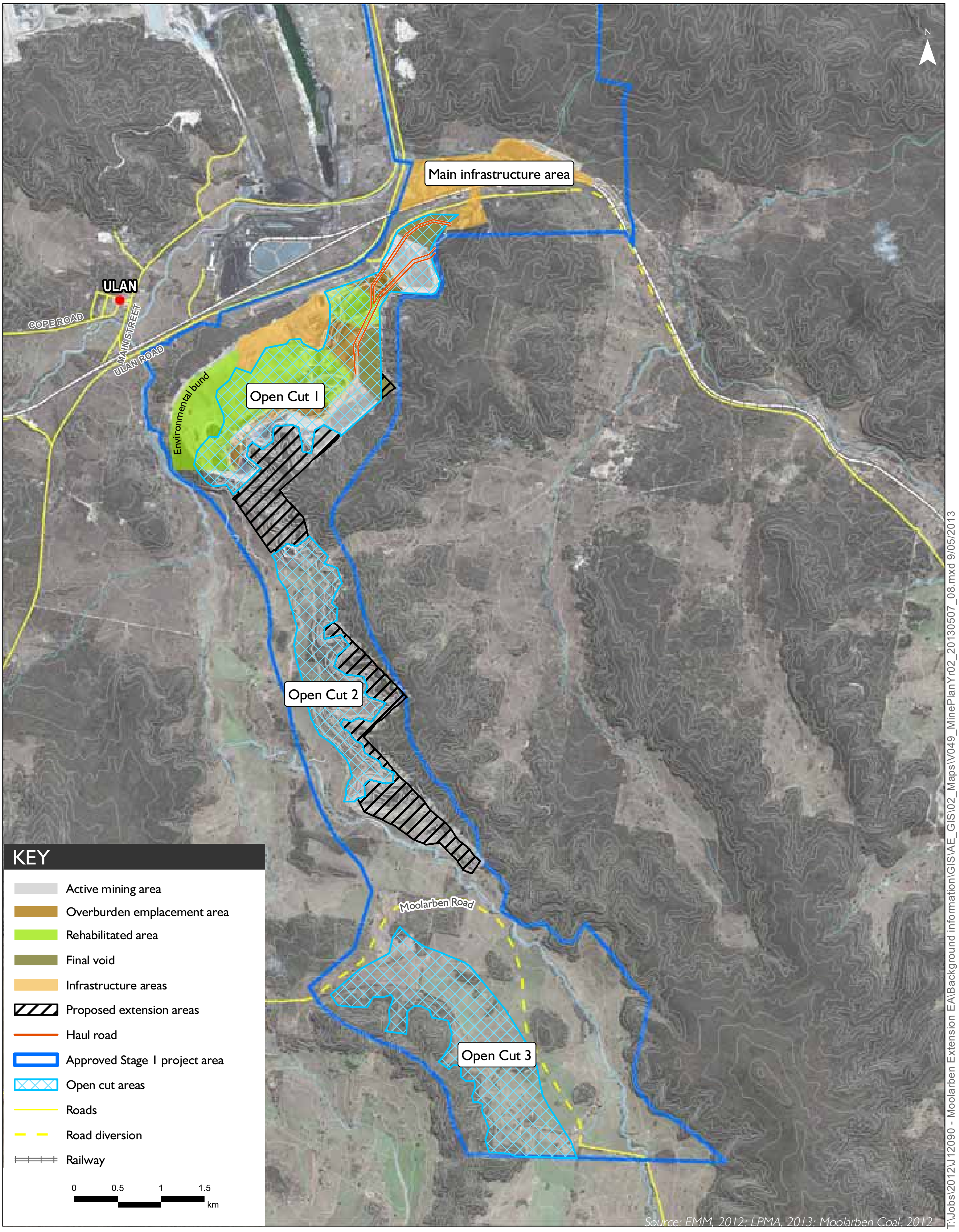
Although the proposed modification can be accommodated with the existing fleet, it may be that more equipment may be operating in a given mine area at any given time. This has potential to impose additional temporary visual impacts when viewed from surrounding areas. The proposed modification will alter the mine staging and, therefore, the potential time period that a viewpoint will be exposed to various active mining areas, overburden emplacement and rehabilitation work, as compared to the approved project. The potential visual impacts associated with the changes described above have been assessed from each viewpoint in Chapter 4.

3.1.2 Changes to coal handling and processing

There will be no change to the existing coal handling and processing methods, which will utilise existing Stage 1 infrastructure, plant and equipment.

Open cut mining at MCP is undertaken by truck and shovel operation. Overburden and coal is blasted and removed with excavators and rear dump trucks. Overburden is hauled to out-of-pit emplacement areas, and coal is hauled to the ROM Coal Hopper. The washed product is then stored on the product coal stockpile at the CHPP and later fed to the rail load out bin by conveyors. Product is transported off site by rail via a rail load out facility and dedicated rail loop that ties into the Gulgong- Sandy Hollow rail line.

ROM coal from Open Cut 2 will be transported to the Open Cut 1 facilities by trucks on internal haul roads. The haul roads are fully bunded to reduce noise and visual impacts of truck movements.

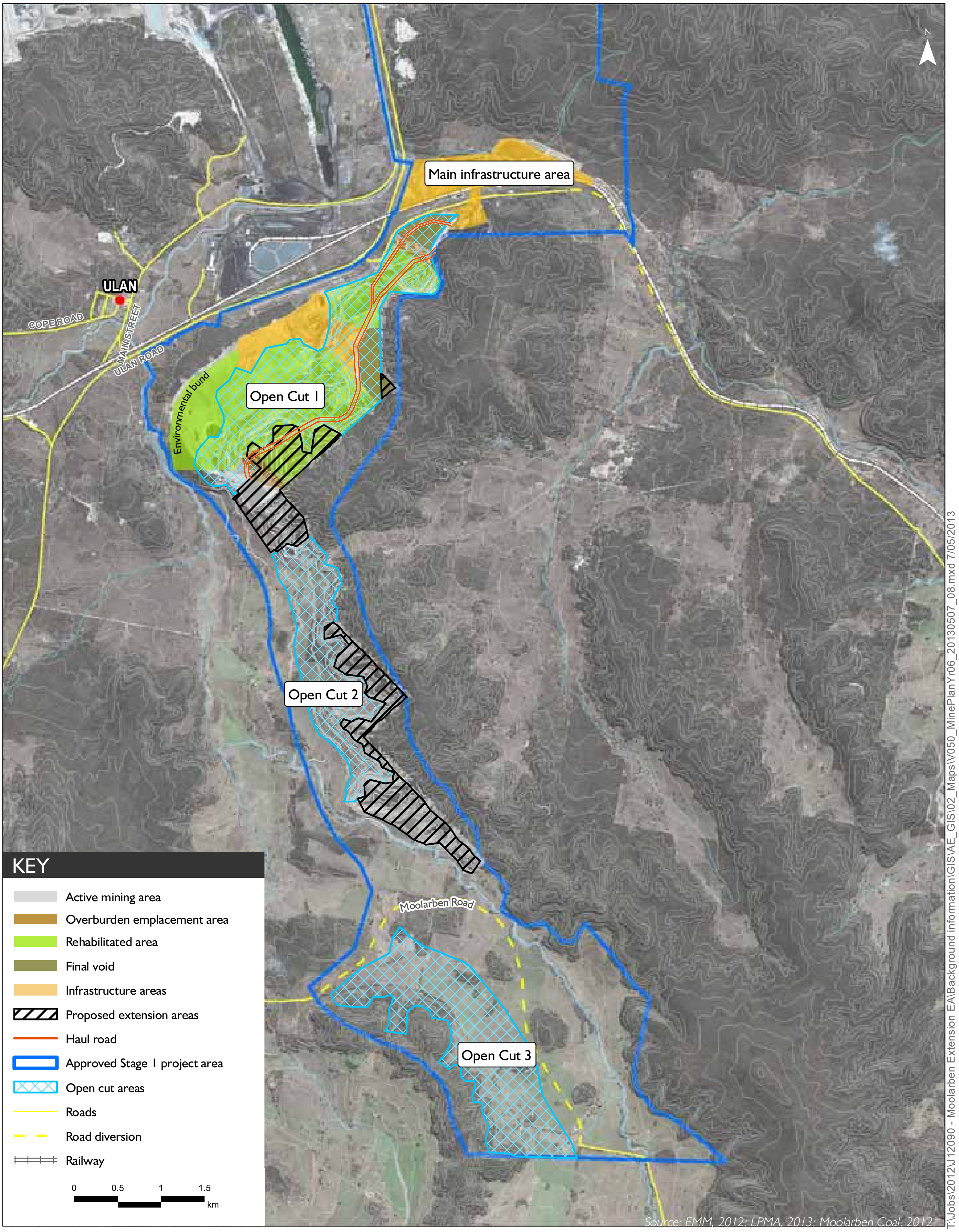


Indicative mine plan - Year 2

Moolarben Coal Project - Stage 1 Optimisation Modification

Visual impact assessment

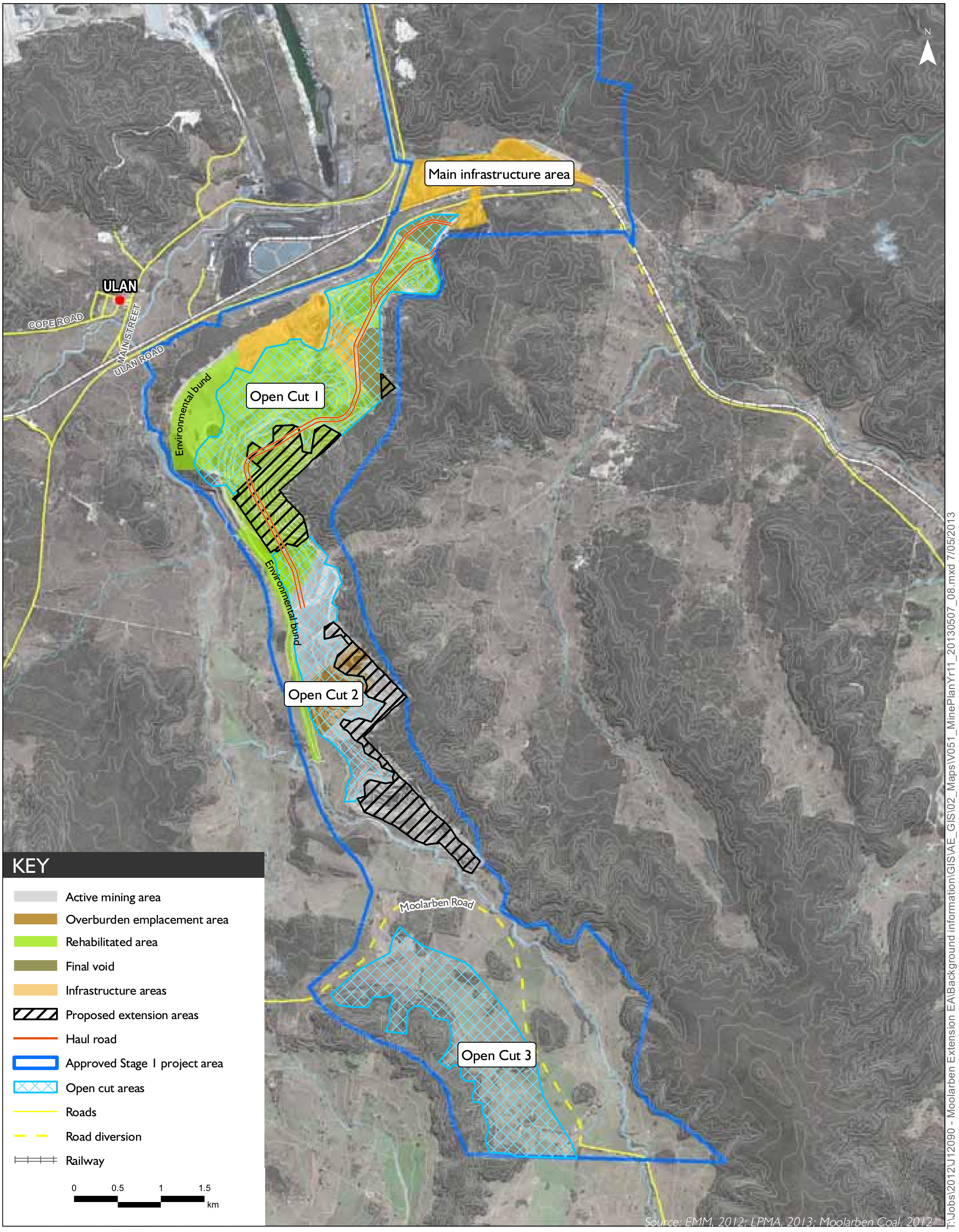
Figure 3.1



Indicative mine plan - Year 6

Moolarben Coal Project - Stage 1 Optimisation Modification
Visual impact assessment

Figure 3.2

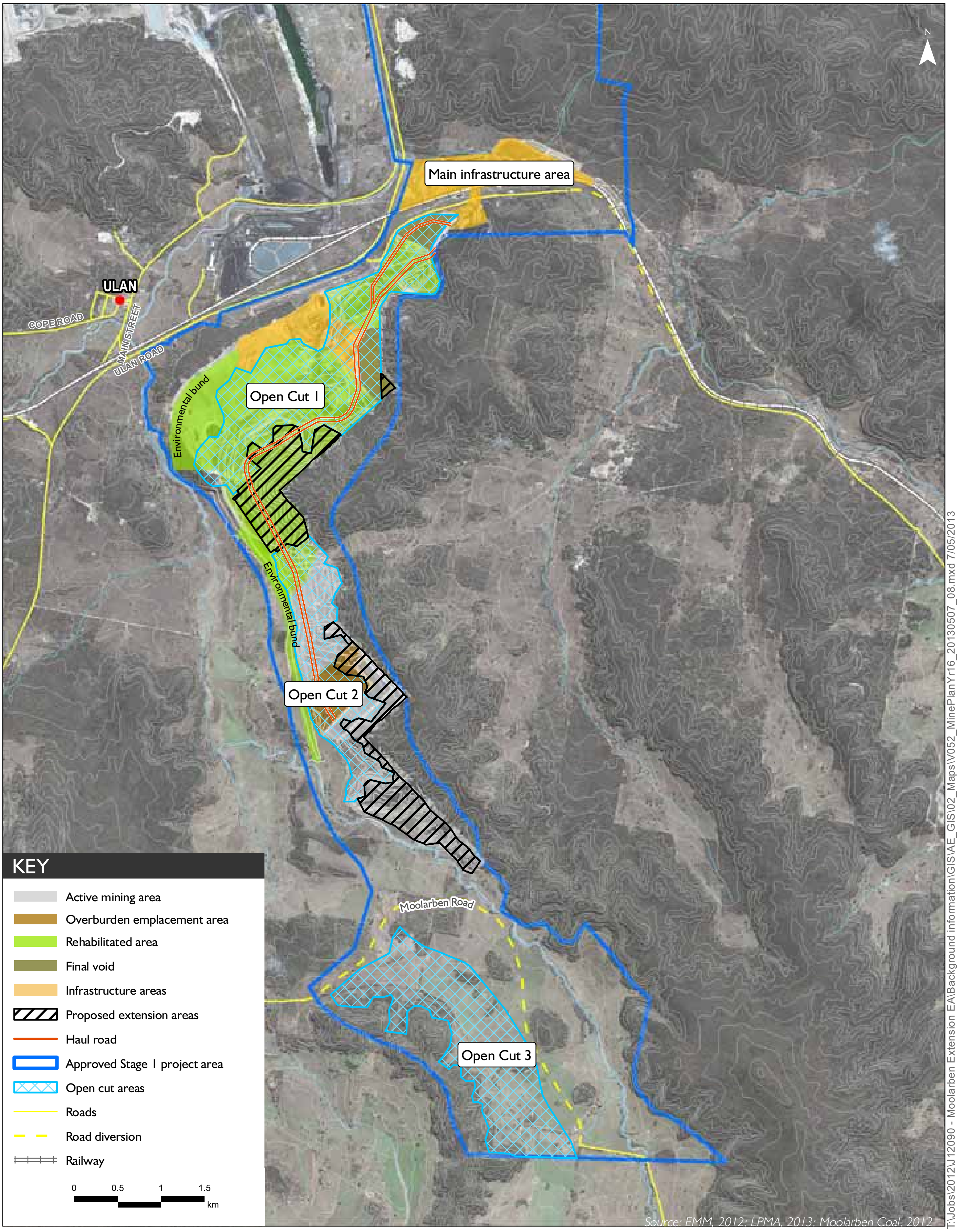


Indicative mine plan - Year 11

Moolarben Coal Project - Stage 1 Optimisation Modification

Visual impact assessment

Figure 3.3

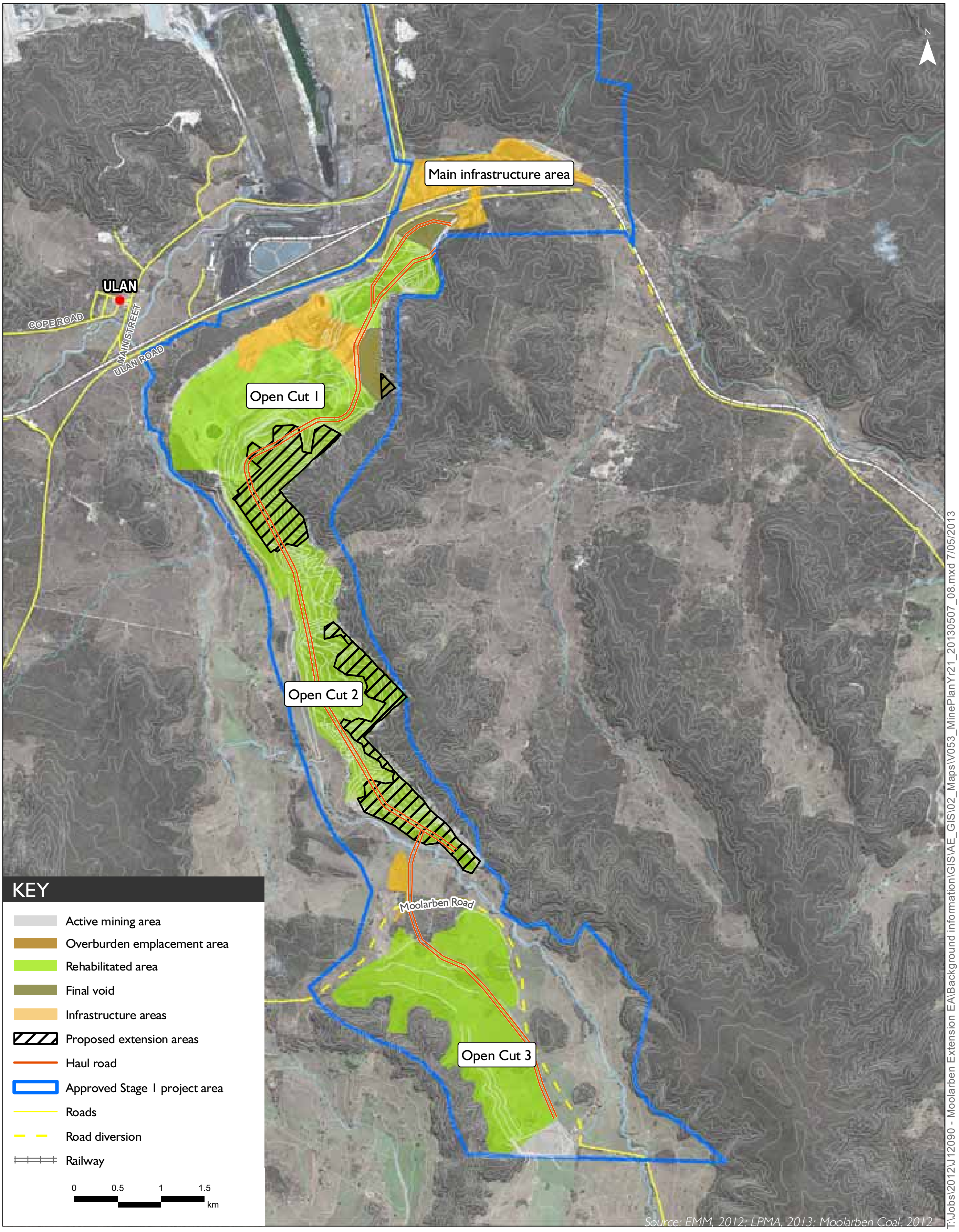


Indicative OC mine plan - Year 16

Moolarben Coal Project - Stage 1 Optimisation Modification

Visual impact assessment

Figure 3.4

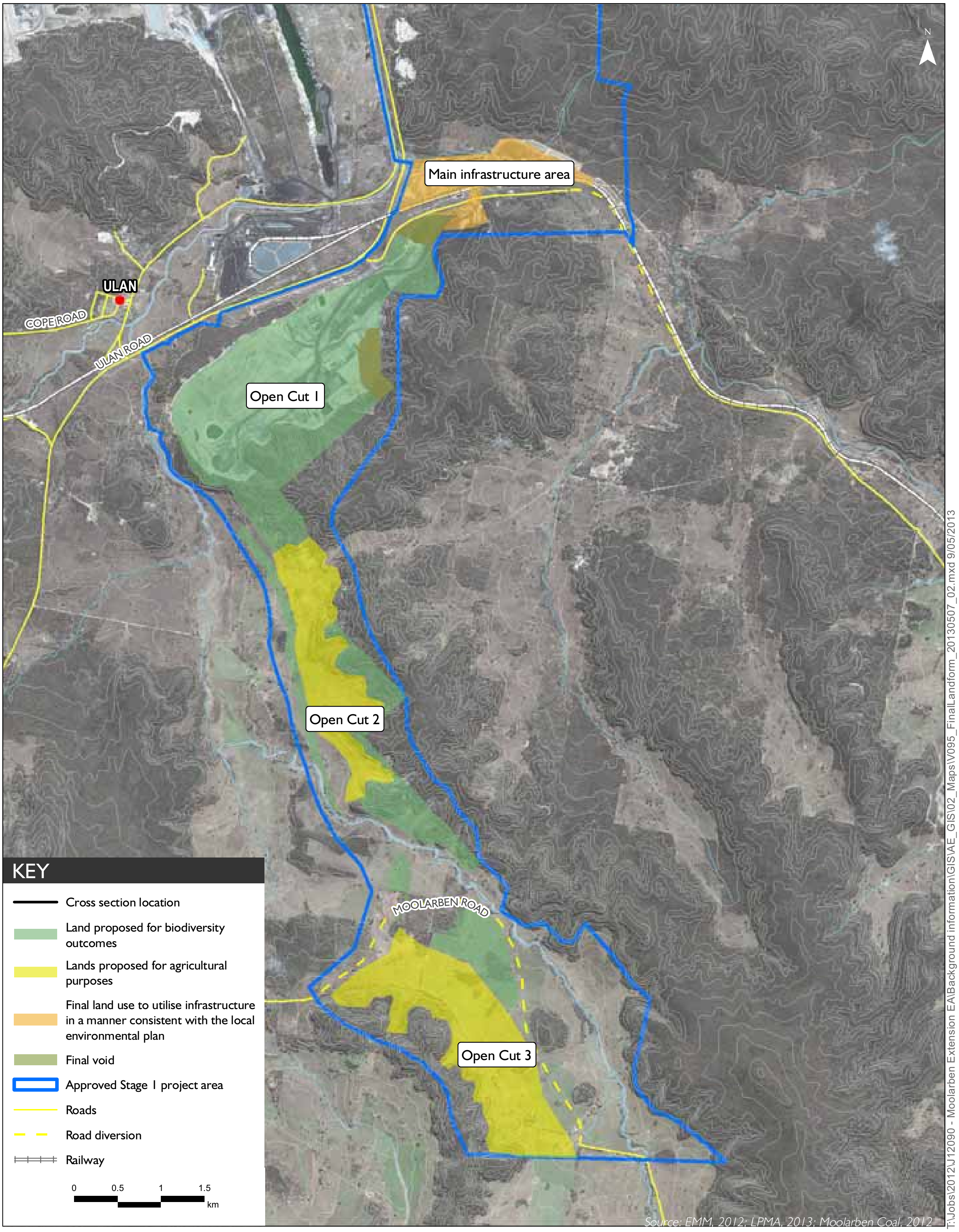


Indicative mine plan - Year 21

Moolarben Coal Project - Stage 1 Optimisation Modification

Visual impact assessment

Figure 3.5



Indicative final landform plan

Moolarben Coal Project - Stage 1 Optimisation Modification

Visual impact assessment

Figure 3.6

3.1.3 Proposed changes to final landform

The approved project disturbance would continue to be progressively rehabilitated in accordance with the project approval, as soon as practicable following disturbance, as shown on the conceptual mine plans for Years 2, 6, 11, 16, 21 and 22 (final landform) (refer to Figures 3.1 to 3.6). Rehabilitation of the disturbance area would continue to be undertaken progressively.

MCO is committed to returning areas disturbed by mining operations to their pre-mining landuse. Accordingly, Open Cut 1 will be rehabilitated for biodiversity outcomes, and Open Cuts 2, including for agricultural use.

Rehabilitation at MCO is undertaken in accordance with a Mining Operations Plans (MOP) and the Landscape Management Plan (LMP). To date, a MOP has been prepared for Open Cut 1 only, the current mining area. The approach to achieving its rehabilitation objectives, information on assessment criteria and monitoring program are detailed in the LMP and reinforced in the MOP.

The design of the post mining landform is based on four main factors:

- landform stability;
- erosion minimisation;
- landform compatibility with the surrounding environment; and
- cost of earthworks.

This will involve the reshaping with large dozers of the majority of overburden emplacement and incorporation of contour-graded banks to reduce erosion risks. The spacing and ultimate dimensions of these structures will be a function of the final slope and catchment area and, consequently, these design details will be provided in the mine's rehabilitation plan.

Open Cut 1 will be principally rehabilitated to create a mixture of native woodland and forest. The Open Cut 1 extension area will be seeded with a combination of native grasses, shrubs and woodland species consistent with those species found in the local area.

Open Cut 2 will be principally reinstated to agricultural land following mining. However, given the majority of the Open Cut 2 extension area is vegetated, the majority of the extension area will be rehabilitated with native vegetation similar to the existing undisturbed environment. An area in the south-western section will be restored to agricultural land.

Rehabilitation has been designed to mirror, as practicable as possible, the pre mining landform with mined areas being filled back up to the disturbance line in the ridges of Open Cut 1 and 2, to ensure no scarring of the ridgeline is visible in the final landform.

4 Viewpoint assessment

4.1 Critical viewpoints

As previously outlined, this VIA has considered the viewpoints used in each of the previous visual assessments that have accompanied the Stage 1 and Stage 2 EAs. The location of each of these viewpoints is shown in Figure 4.2.

Each of the viewpoints are described and illustrated below. The VIA has analysed the likely visual and lighting impacts as a result of the proposed modification on the viewpoints.

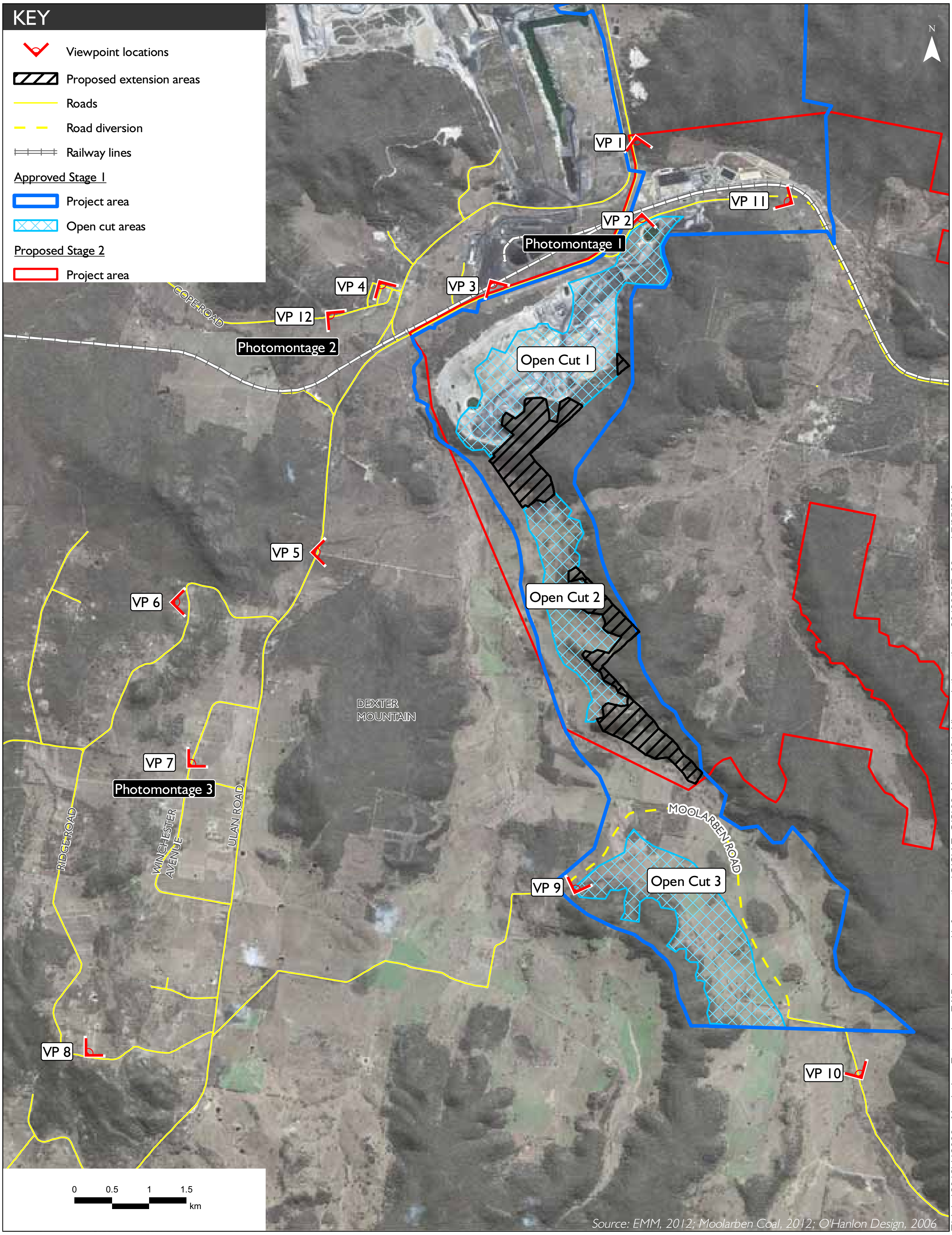
4.2 Assessment of visual impacts

4.2.1 VP1 - Ulan Road

i Viewpoint type and context

The relevant viewing direction from VP1 to the project area is to the south as shown in Figure 4.2. The existing view is shown in Figure 4.1. Viewers from this location would typically be motorists travelling south along Ulan Road. Views of road pavement and cutting are present in the foreground, MCP administrative offices and minor mine infrastructure in the mid-ground, and a background of vegetated foothills and ridgelines define the horizon.

Figure 4.1 Views to MCP administration buildings from VP1



T:\Jobs\2012\J12090 - Moolarben Extension EA\Background information\GIS\AE_GIS\02_Maps\V031_ViewpointLocations_20130507_08.mxd 7/05/2013

EMM
MOOLARBENCOAL

Viewpoint locations

Moolarben Coal Project - Stage 1 Optimisation Modification

Visual impact assessment

Figure 4.2

Views from this location represent a modified landscape with power lines, lighting structures, MCP administration and infrastructure, signage and road cutting all visible. A vegetated ridgeline in the background remains the only natural element in the landscape. The viewpoint is considered to have a **low** visual sensitivity given its modified nature.

ii Visual impacts of modification

Due to intervening topography, namely the cutting in the foreground of the viewpoint, views to the additional Open Cut extension areas are considered to be limited. Some filtered views of the upper ridgelines may be possible in the early years of mining within the Open Cut 1 extension area.

Views of the Open Cut 2 extension area are not possible from this viewpoint.

The magnitude of change from the proposed modification, given the heavily modified landscape within which this viewpoint sits, is considered to be **low**.

iii Lighting impacts of modification

Viewers at this location may be sporadically exposed to lighting from activities on top of the active mining area and out-of-pit overburden emplacement areas within the upper ridgeline areas of Open Cut 1 in the initial years of mining. Viewers are exposed to lighting sources under approved operations within Open Cut 1, however, the more elevated operations under the proposed modification has the potential to result in some increase in light spill to motorists. Unmitigated, temporary lighting structures and lighting from mobile mine equipment working on batters and the edge of dumps may be visible to motorists.

Sky glow from mobile mine machinery are similarly likely to be present, although the impact on viewers from this location is likely to be no more significant than under the approved Stage 1 operations given the intervening distance. However, light spill from works on top of the out-of-pit overburden emplacement areas has the potential to be a distraction to motorists travelling along the Ulan Road. These impacts could be reduced by ensuring workings on out-of-pit emplacements benches are staged so that outer embankments are created first around the perimeter, providing a visual screen while work is undertaken in the central part of the emplacement. The outer perimeter should be to a height sufficient to conceal direct light spill from the mobile equipment. These measures will be formulated into protocols to be used as part of operations at the MCP.

The magnitude of change as a result of lighting associated with the proposed modification is considered to be **negligible**.

iv Duration and significance of impacts

Any limited views of Open Cut 1 extension area will commence in the initial years and progressively decrease over the subsequent few years. Under the conceptual mine plan, the north-eastern face of the ridgeline to be extracted in Open Cut 1 is planned to have been fully rehabilitated within six years. With implementation of the mitigation measures outlined above (implementation of operational procedures for mobile mine machinery and, where possible, construction of the outer edge of active dumps first to act as a visual barrier at night) the visual impacts will be acceptable.

Based on the above assessment, the significance of the impact of the proposed modification on VP1 is evaluated as **slight**.

4.2.2 VP2 and Photomontage 1 - Ulan to Cassilis Road - rail overpass

i Viewpoint type and context

This viewpoint is located on the Ulan Road taken from the rail overpass. The relevant viewing direction from VP2 to the project area is to the south as shown in Figure 4.2. The existing view is shown in Figure 4.3. Viewers from this location would typically be motorists travelling south along Ulan Road. Views of road pavement, powerlines, and mine infrastructure are present in the foreground. Active mining and overburden emplacement, and rehabilitated overburden areas are visible in the mid-ground, and a background of vegetated foothills and ridgelines defines the horizon.

Views from this location represent a heavily modified landscape with unimpeded views to MCP operations as well as the nearby Ulan Coal Mine to the north. Aside from vegetated ridgeline in the background, the vast majority of the viewpoint has been modified. The viewpoint is considered to have a **low** visual sensitivity given its modified nature.

Figure 4.3 Unimpeded views to project area from VP2

ii Visual impacts of modification

From this viewpoint, Open Cut 1, including the additional extraction area proposed in this modification will be a dominant visual element. The additional extraction will result in the permanent removal of a portion of the ridgeline which defines the horizon from this viewpoint. This is illustrated in Figures 4.4 to 4.6 which show the existing view, modelled Year 6, and the final landform. Although the removal of this section of ridgeline is not considered significant in the context of this visual landscape, it is important, given that this new element defines the horizon that careful consideration is given in the mine plan to contouring this slope to appear as natural as possible. This is necessary to ensure it does not present as an artificial straight line.

Views to Open Cut 2 are not possible from this viewpoint.

Although the visual landscape is heavily modified from operations at MCP and the nearby Ulan Coal Mine, the proposed modification will result in temporary changes to the landscape during active mining in the higher reaches of the ridgeline. The removal of a part of the ridgeline, which is visually prominent from this viewpoint, will permanently alter the visual landscape following completion of mining operations. For these reasons the magnitude of change from the proposed modification is considered to be **medium**.

iii Lighting impacts of modification

Viewers at this location will be exposed to lighting from activities on top of the active mining area and dumps within the upper ridgeline areas of Open Cut 1 in the initial years of mining under the proposed modification. As with VP1, unmitigated, temporary lighting structures and lighting from mobile mine equipment working on batters and the edge of out-of-pit overburden emplacements areas will be directly in the line of site of motorists.

Sky glow from mobile mine machinery are similarly likely to be present, although the impact on viewers from this location is likely to be no more significant than under the approved operations. However, light spill from works at higher elevations has the potential to be a distraction to motorists travelling along the Ulan Road. These impacts could be reduced by ensuring workings on out-of-pit emplacements benches are staged so that outer embankments are created first around the perimeter, providing a visual screen while work is undertaken in the central part of the emplacement. The outer perimeter should be to a height sufficient to conceal direct light spill from the mobile equipment. These measures will be formulated into protocols to be used as part of operations at the MCP.

The magnitude of change as a result of lighting associated with the proposed modification is considered to be **medium**.

iv Duration and significance of impacts

The proposed modification will result in a permanent change to the ridgeline as viewed from VP2. This additional extraction when viewed against the undisturbed ridgeline which forms a backdrop to this active mining area will be visually prominent from this viewpoint. Given the highly modified landscape within which it will sit, the cumulative impact of the additional extraction area is considered to be **slight** (visual) to **moderate** (lighting)**.** The impact of the modification on this viewpoint is considered acceptable, provided the mitigation measures identified above are implemented.

Photomontage 1: Existing (Ulan Road - rail overpass)

Moolarben Coal Project - Stage 1 Optimisation Modification
Visual impact assessment

Figure 4.4

Photomontage 1: Indicative Year 6 (Ulan Road - rail overpass)

Moolarben Coal Project - Stage 1 Optimisation Modification

Visual impact assessment

Figure 4.5

Photomontage 1: Indicative final landform (Ulan Road - rail overpass)

Moolarben Coal Project - Stage 1 Optimisation Modification
Visual impact assessment

Figure 4.6

KEY

Approved disturbance area

Proposed modification disturbance area

Comparison of approved vs proposed disturbance areas (Ulan Road - rail overpass)

Moolarben Coal Project - Stage 1 Optimisation Modification
Visual impact assessment

Figure 4.7

4.2.3 VP3 - Ulan Road adjacent to Ulan Stockpiles

i Viewpoint type and context

This viewpoint is taken from Ulan Road adjacent to the Ulan stockpiles. The relevant viewing direction to the project area from VP3 is to the north east as shown in Figure 4.2. The existing view is shown in Figure 4.8. Viewers from this location would typically be motorists travelling north-east along Ulan Road. Views of road pavement, powerlines, disturbed earth and the environmental bund are present in the foreground. Active mining, overburden emplacement, and rehabilitated overburden areas are visible in the mid-ground, and a background of vegetated foothills and ridgelines defines the horizon.

Views from this location represent a heavily modified landscape with unimpeded views to MCP operations as well as the nearby Ulan Coal Mine to the north-west. Aside from the vegetated ridgeline in the background, the viewpoint is considered to have a **low** visual sensitivity given its heavily modified nature.

Figure 4.8 Views to Open Cut 1 from VP3

ii Visual impacts of modification

Viewers travelling north-east along Ulan Road at the Ulan stockpiles are currently partially screened from views of Open Cut 1 by the environmental bund and existing roadside vegetation. Partial views of Open Cut 1 and existing overburden emplacement areas are possible from this viewpoint, however, no views of the Open Cut 1 extension area are considered possible from this location. The additional impacts of the proposal from this viewpoint are therefore considered to be **negligible**.

Views to the Open Cut 2 proposed modification area are not possible from this viewpoint.

iii Lighting impacts of modification

The impact of sky glow on viewers from this location is assessed to be no more significant than under the approved operations. Mitigation measures identified for VP1 and VP2 would assist in minimising the level of sky glow from MCP as seen by motorists along Ulan Road.

The magnitude of change as a result of lighting associated with the proposed modification is considered to be **negligible.**

iv Duration and significance of impacts

The environmental bund and other intervening vegetation will block any views of the proposed Open Cut 1 extension area from this viewpoint. The low visual sensitivity of this location, along with the negligible change in the visual landscape, will result in a **negligible** visual impact.

4.2.4 VP4 – Ulan settlement

i Viewpoint type and context

This viewpoint is taken from Mackay Street within the Ulan settlement. The relevant viewing direction to the project area from VP4 is to the east south-east as shown in Figure 4.2. The existing view is shown in Figure 4.9. Viewers from this location would typically be motorists travelling east along Mackay Street, however, this viewpoint is also representative of the typical view to the project area which would be experienced by residents of the Ulan settlement. It is noted that there are no private residences within Ulan, with all properties having been purchased by either MCO or the Ulan Coal Mine.

Foreground views are typical of a rural residential landscape with a number of dwellings, sheds and other structures such as water tanks all present. A rehabilitated overburden area is visible in the mid-ground which currently provides a visual barrier to active mining operations in Open Cut 1. A background of vegetated ridgeline defines the horizon.

Figure 4.9 Views to Open Cut 1 from VP4 currently obscured by rehabilitated overburden emplacement area

Views from this location represent a moderate to heavily modified landscape with unimpeded views to the rehabilitated overburden emplacement area and several highwalls of Open Cut 1 are evident, dependent upon viewer location around the settlement. The viewpoint is considered to have a **moderate** visual sensitivity.

ii Visual impacts of modification

Although highwalls on the ridgeline in Open Cut 1 are evident from this viewpoint, the rehabilitated overburden emplacement area present in the mid-ground of this visual landscape creates an effective visual barrier to active mine operations and truck movement. The proposed Open Cut 1 extension area will result in the mining of the ridgeline which appears above the rehabilitated area from Year 2 for a period of approximately six years when mining of the upper ridgeline, as seen from VP4, will be completed and rehabilitated.

Initially, viewers at the location will see the removal of vegetation to allow for removal of overburden and then active mining of the ridgeline as it moves in a south-westerly direction, before sweeping around the ridge and heading in a south-east direction, away from the viewpoint.

The Open Cut 1 extension area will remove approximately 750 m of ridgeline, which will alter the permanent visual landscape as viewed from this location. However, as the entire ridgeline is not proposed to be removed, the post mining landscape will continue to exhibit a vegetated ridgeline which defines the horizon in the background of this view, albeit at a greater distance than present. As a consequence, it is considered that the magnitude of change in the visual landscape will be **medium**.

iii Lighting impacts of modification

Viewers at this location will be exposed to lighting from activities on top of the active mining area and out-of-pit overburden emplacement areas within the upper ridgeline areas of Open Cut 1 in the first six years of mining. As with VP1 and VP2, unmitigated, temporary lighting structures and lighting from mobile mine equipment working on batters and the edge of out-of-pit overburden emplacement areas will be directly in the line of site of motorists and areas in Ulan.

The impact of sky glow on viewers from this location is likely to be more significant than under the approved operations, due to the relatively close viewing distance and the lack of any intervening topography or vegetation to help filter the views to the night sky.

As with previous viewpoints, light spill from works at higher elevations has the greatest potential to be a distraction to motorists and residents around the Ulan settlement. These impacts could be reduced by maintaining a strip of vegetation along the leading face of the ridgeline, where possible, for as long as practical, to provide a visual screen to workings behind and thereby limiting the time viewers will be exposed to workings on the ridgeline. Where possible, workings on out-of-pit emplacements benches should be staged so that the outer embankments are created first around the perimeter, providing a visual screen while work is undertaken in the central part of the emplacement. The outer perimeter should be to a height sufficient to conceal direct light spill from the mobile equipment. These measures will be formulated into protocols to be used as part of operations at the MCP.

The magnitude of change as a result of lighting associated with the proposed modification is considered to be **medium.**

iv Duration and significance of impacts

Views to active mining and overburden emplacement activities will be present from Year 2 for a period of approximately 6 years, at a relatively short viewing distance. Given the elevation at which mining activities are proposed, there is no practical way in which a visual screen can be implemented to obscure views to mining operations from this viewpoint.

Provided the recommended mitigation measures are implemented, it is considered that visual and lighting impacts of the proposed modification can be managed to an acceptable level from this viewpoint. Based on the above assessment the significance of the impact of the proposed modification on this viewpoint is evaluated to be **moderate**.

4.2.5 VP5 Ulan Road - Moolarben Road to Lagoons Road

i Viewpoint type and context

This viewpoint is located on the Ulan Road taken at the intersection with Lagoons Road. The relevant viewing directions from VP5 to the project area are to the east as shown in Figure 4.2. The existing view is shown in Figure 4.10. Viewers from this location would typically be motorists travelling north or south along the Ulan Road. Views of rural roads, vegetation, powerlines and fencelines dominate the foreground. Grazing lands, rural homesteads, agricultural outbuildings and stands of vegetation are present in the mid-ground. A background of vegetated foothills and ridgelines define the horizon.

Views from this location represent a low to moderately modified landscape with no existing views to mining operations at MCP currently possible. The viewpoint is considered to have a **moderate** visual sensitivity given its relatively rural dominated nature.

Figure 4.10 Ulan Road at Lagoons Road intersection looking east to the project area

ii Visual impacts of modification

Viewers travelling along Ulan Road between Toole Road and Moolarben Road have primary views along the road alignment, due to the heavily vegetated edges which allow for only intermittent glimpses through the treeline. Consequently, viewers are likely to have only sporadic views of active mining within Open Cut 1 and Open Cut 2 extension areas, at a viewing distance of greater than 2 km to the Open Cut 1 extension area and 3.5 km to the Open Cut 2 extension area.

Through breaks in the vegetation, views would be of active mining, overburden emplacement and rehabilitation works on the higher ridgelines associated with the proposed extension areas. These breaks are primarily restricted to intersections and driveways. Given the distance and vegetative buffer present, the cumulative impacts of the proposed extension areas are considered to be minor in nature.

Rehabilitation of the extension areas will, as far as possible, return the landform to its pre mining state, with the exception of part of the ridgeline in Open Cut 1 which will be permanently removed from the landscape. A view to this area of ridgeline is not possible from most locations along this section of Ulan Road. Where it is possible, it will be intermittent only due to intervening topography. Therefore, the impact on the visual landscape from this change is considered **low**.

iii Lighting impacts of modification

Light spill from mobile mine machinery working on the higher ridgeline has the potential to create a distraction for motorists as a result of either light spill from headlights of machinery or badly established lighting plant. The significant level of vegetation that exists along the road corridor will act as a visual buffer to motorists and as an effective filter to night lighting from the project area. This vegetation, and the distance between this viewpoint and the proposed Open Cut 1 and 2 extension areas is in excess of 2 km and therefore lighting impacts in this area are considered minimal. Introduction of lighting protocols, as recommended in Chapter 5, will further ensure lighting impacts are well mitigated.

Sky glow is not anticipated to be significantly different to that which will occur under the current approved mining plan.

The magnitude of change as a result of lighting associated with the proposed modification is considered to be **low**.

iv Duration and significance of impacts

Views to the workings in the proposed Open Cut 1 extension area would be present for approximately three years until rehabilitation of this area was complete. Mining in the Open Cut 2 extension area would commence after approximately 11 years and as mining progresses in a south-east direction and away from Ulan Road. It is anticipated that any views from this viewpoint to mining activities would be limited to around three years.

Given the significant vegetative screening along Ulan Road in the vicinity of the viewpoint and the significant viewing distance, it is considered that the visual and lighting impacts of the proposal on motorists in this area are **slight**.

4.2.6 VP6 - Ridge Road (north)

i Viewpoint type and context

This viewpoint is located at the northern end of Ridge Road. The relevant viewing direction from VP6 to the project area is to the east as shown in Figure 4.2. The existing view is shown in Figure 4.11. Viewers from this location would typically be motorists travelling north along Ridge Road and private residences sited on the eastern side of Ridge Road. Views of rural roads, vegetation, and fencelines dominate the foreground. Rural residential dwellings, agricultural outbuildings and stands of vegetation are present in the mid-ground. Dependent upon viewer location, panoramic views of vegetated ridgelines, agricultural lands and Dexter Mountain are present in this landscape.

The view from private residences along Ridge Road varies according to the siting of each dwelling in relation to the ridgeline which runs through the land holdings on the eastern side of the roadway. As a consequence, some properties on this side of Ridge Road have views only to the west, away from the project area. Other properties, however, located on the eastern side of the ridge, have unimpeded views to project area, and the proposed extension areas. Access to individual properties was not possible during the site survey and therefore the assessment of impact is relevant only to those properties which have views to the project area from the dwelling.

Views from this location represent a relatively natural rural residential landscape with no existing views to MCP mining operations currently possible, although it is noted that views to operations within Open Cut 2 will be possible in the future under the current approval. Private residences in the vicinity of this viewpoint are considered to have a **high** visual sensitivity given the rural setting and natural panoramic views.

Figure 4.11 View from VP6 looking east toward MCP

ii Visual impacts of modification

Due to the superior viewing elevation of these private receptors, unimpeded views of the majority of the proposed extension areas will be present from certain properties along Ridge Road. Views to Open Cut 1 under the approved mine plan were largely obscured by the ridgeline that is now proposed to be mined under the modification. Views of mining at elevated heights will now be possible in Open Cut 1 under the modification. The Open Cut 1 extension area will join to the northern end of Open Cut 2, which will have a cumulative impact by creating a continuous disturbance area and increasing the length of time viewers will be exposed to mining activities from this viewpoint. At a distance of approximately 6 km from these properties on Ridge Road to Open Cut 1, views to mining operations will be distant, albeit unimpeded.

Visual impacts will similarly be increased for views to Open Cut 2 from this viewpoint. The approved disturbance footprint for Open Cut 2 was generally contained to lower laying agricultural lands which ceased at the base of the foothills and will now be mined under the proposed modification. Viewers will be exposed to mining operations at higher elevations, up to 560 m AHD, compared to a maximum height of around 525 m AHD under the approved mine plan. Viewers will be exposed to mobile mine machinery working in the active mine, overburden, and rehabilitation areas of Open Cut 2 and will be exposed to views of highwalls on the ridgeline until rehabilitation works to reshape the land can be undertaken.

Dexter Mountain provides a visual buffer to areas of Open Cut 2 towards the south of Ridge Road and provides an effective screen to works in Open Cut 2 in this area. This landform will be progressively effective as a buffer and earlier screening feature for properties moving south along Ridge Road.

The magnitude of change as a result of visual impacts associated with the proposed modification is considered to be **medium**.

iii Lighting impacts of modification

Viewers at this location will be exposed to lighting from activities on top of the active mining areas and out-of-pit overburden emplacement areas within the upper ridgeline areas of Open Cut 1 and Open Cut 2 extension areas. Unmitigated, temporary lighting structures and lighting from mobile mine equipment working in active mining areas and on batters and the edge of out-of-pit overburden emplacement areas will be directly in the line of site of some viewers at VP6.

The impact of sky glow on viewers from this location is likely to be no more significant than under the approved operations.

As with previous viewpoints, light spill from works at higher elevations has the greatest potential to have an impact on private residences. These impacts would be reduced by staging work so that outer embankments are created first around the perimeter, providing a visual screen while work is undertaken in the central part of the emplacement. The outer perimeter should be to a height sufficient to conceal direct light spill from the mobile equipment. In addition, operational protocols for the erection of mobile lighting plant will assist in ensuring lighting spill to private residences is minimised. These measures will be formulated into protocols to be used as part of operations at the MCP.

The magnitude of change as a result of lighting associated with the proposed modification is considered to be **high** for private residences where unimpeded views to Open Cut 1 and Open Cut 2 are possible.

iv Duration and significance of impacts

The most significant visual impacts from the proposed extension area will be experienced by some residents along Ridge Road due to more direct views from this location and, with the exception of Dexter

Mountain, there are no topographical or vegetative elements to help screen the proposed mining activities from the viewpoint.

As a consequence, viewers are likely to be exposed to workings in Open Cut 1 for a period of approximately six years. Views of mining within the proposed extension areas of Open Cut 2 extension area will be present for approximately ten years for the worst effected properties. The visual impacts of mining within the extension of Open Cut 2 will progressively reduce as mining will be continually be moving away from Ridge Road and Dexter Mountain will increasingly provide a visual barrier for private residents.

Given the potential exposure to the proposed modification and cumulative impacts for some private residents along Ridge Road, it is considered that the visual and lighting impacts of the proposal from on those properties are **moderate/substantial.**

Mitigation proposed for other viewpoints should also be implemented for VP6. Additional mitigation may be required at some residences along Ridge Road due to the length of time these viewers may be exposed to mining within the extension areas and the cumulative impacts that could be experienced. It is not possible for the mine plan to provide a buffer to screen operation at the elevated areas to be mined and, therefore, it is considered that in cases where dwellings have unimpeded views to the Open Cut 1 and Open Cut 2 proposed extension areas, MCO seek to investigate the feasibility of targeted vegetative screening, which will minimise the visual and lighting impacts on those properties.

4.2.7 VP7 - Winchester Crescent

i Viewpoint type and context

This viewpoint is located on Winchester Crescent which is located below Ridge Road, to the east. The relevant viewing directions from VP7 to the project area are to the east and north-east as shown in Figure 4.2. The existing view is shown in Figure 4.12. Views from this location are rural and scenic, with the foreground dominated by large areas of open grazing land, extensive stands of vegetation in the mid-ground and a background exhibiting undulating foothills and ridgelines which defines the horizon.

Modifications in this area are limited to an unsealed roadway, fences, rural dwellings and cleared agricultural grazing land. Viewers from this location would typically be private residents and motorists travelling north along Winchester Crescent. Due to the relatively unmodified landscape and attractive rural setting, the visual sensitivity of this viewpoint is considered to be **moderate**.

Figure 4.12 Views toward the project area from VP7

ii Visual impacts of modification

Views to the extended Open Cut 1 extension area will be similar to the experience from VP6, albeit from an inferior viewing height. As with VP6, views to Open Cut 1 under the approved mine plan were largely obscured by the ridgeline that is now proposed to be mined under the proposed modification. Views of mining at elevated heights will now be possible in Open Cut 1 under the proposed modification. The mid-ground vegetation will offer some effective visual screening to operations at lower levels, however, screening of the upper ridgelines would be difficult to achieve. Targeted vegetative screening could be investigated where unimpeded views to Open Cut 1 are experienced by most affected private residents along Winchester Crescent. However, as the mining of the extended Open Cut 1 extension area will be completed by approximately Year 11, the establishment of vegetation sufficient to offer a useful screen would only occur in the latter years of mining in this area. Similarly, as views to Open Cut 2 extension areas will not be possible, visual impacts to properties on Winchester Crescent are not considered to be as significant as those on Ridge Road under the proposed modification.

Photomontages have been prepared for this viewpoint to assist in demonstrating the difference between the existing visual landscape (Figure 4.13), the worst case visual impact during mining (Figure 4.14) and the final landform (Figure 4.15). A comparison of the existing and final landform illustrates the permanent removal of a section of the upper ridgeline. Although the removal of this section of ridgeline is not considered significant in the context of this visual landscape, it is important, given that this new element defines the horizon, that careful consideration be given in the mine plan to contouring this slope to appear as natural as possible. This is necessary to ensure it does not present as an artificial straight line.

Due to the presence of Dexter Mountain, views to Open Cut 2 extension area will not be possible. This is demonstrated in Figure 14.6, which illustrates the comparison between mining operations visible under the approved mine plan and proposed modification.

Based on the above assessment, the magnitude of change in the visual landscape from this viewpoint is considered to be **medium**.

iii Lighting impacts of modification

Viewers at this location will be exposed to lighting from activities on top of the active mining area and dumps within the upper ridgeline areas of Open Cut 1 extension area from approximately Year 4. As with other viewpoints, unmitigated, temporary lighting structures and lighting from mobile mine equipment working on batters and the edge of dumps will be directly in the line of site of motorists.

Sky glow from mobile mine machinery are similarly likely to be present, particularly once mining through the ridge occurs and active mining moves to the south-east. However, light spill from works at higher elevations has the potential to be more of a distraction to private residents. As previously outlined, these impacts could be reduced by ensuring workings on out-of-pit emplacements are designed in such a way as to screen the movement of machinery as far as possible and implementing operational procedures for the set up of temporary lighting structures. Removal of vegetation that will assist to screen operations from this viewpoint should be delayed as long as possible.

The magnitude of change as a result of lighting associated with the proposed modification is considered to be **medium.**

iv Duration and significance of impacts

Views to the Open Cut 1 extension area will be present for approximately seven years from approximately the fourth year of mining. Views of mining activities on the higher ridgelines will be visible during this period and screening through planting of vegetative buffers is unlikely to be effective given the time period required to establish an effective screen.

It is considered more appropriate that the mitigation measures identified above to screen mining operations and lighting structures to viewers at VP7 be implemented to manage and mitigate the potential visual and lighting impacts. Should these measures be effectively implemented, the significance of the impacts on private residents at this location is considered to be **moderate**.

Photomontage 2: Existing (Winchester Crescent)

Moolarben Coal Project - Stage 1 Optimisation Modification
Visual impact assessment

Figure 4.13

Photomontage 2: Indicative Year 11 (Winchester Crescent)

Moolarben Coal Project - Stage 1 Optimisation Modification
Visual impact assessment

Figure 4.14

Photomontage 2: Indicative final landform (Winchester Crescent)

Moolarben Coal Project - Stage 1 Optimisation Modification
Visual impact assessment

Figure 4.15

KEY

Approved disturbance area

Proposed modification disturbance area

Comparison of approved vs proposed disturbance areas (Winchester Crescent)

Moolarben Coal Project - Stage 1 Optimisation Modification
Visual impact assessment

Figure 4.16

4.2.8 VP8 - Ridge Road (south)

i Viewpoint type and context

This viewpoint is located at the southern end of Ridge Road. The relevant viewing direction from VP8 to project area is to the north-east as shown in Figure 4.2. The existing view is shown in Figure 4.17. Views from this location are rural and scenic, with the foreground dominated by large areas of open grazing land, extensive bands of vegetation in the mid-ground and a background characterised by undulating foothills and ridgelines. Dexter Mountain is also a prominent landform for many viewers in this area. Modifications in this area are limited to roadways, fences, rural dwellings and cleared agricultural grazing land. Viewers from this location would typically be private residents and motorists travelling north along Ridge Road. Due to the relatively unmodified landscape and attractive rural setting, the visual sensitivity of this viewpoint is considered to be **moderate**.

Figure 4.17 Views toward the project area from VP8

ii Visual impacts of modification

Visual and lighting impacts on private residents and motorists at VP8 are considered to be minor due to distance from the MCP and intervening topography. At a viewing distance of greater than 7.5 km to Open Cut 2 and 8.5 km to Open Cut 1, views to any mining activities will be almost indiscernible in daylight hours. Dexter Mountain which dominates the landscape in this area will act as a visual buffer to Open Cut 1 and the majority of Open Cut 2. As a consequence, the magnitude of change in the landscape from VP8 as a result of the proposed modification is considered to be **negligible**.

iii Lighting impacts of modification

At a viewing distance of greater than 7.5 km to the nearest lighting source, lighting impacts are considered to be negligible.

The impact of sky glow on viewers from this location is assessed to be no more significant than under the approved operations. Therefore, no additional mitigation measures due to the proposed modification, is warranted.

The magnitude of change as a result of lighting associated with the proposed modification is considered to be **negligible**.

iv Duration and significance of impacts

Due to distance and the presence of Dexter Mountain between this viewpoint and the project area, views of the mining in Open Cut 1 extension area will not be possible and views of mining in Open Cut 2 would only potentially be for a small number of properties at the southern end of Ridge Road, for approximately the last five years of the Project. Given the distance, the significance of any impacts from the proposal at VP8 is considered to be **slight**.

4.2.9 VP9 - Moolarben Road

i Viewpoint type and context

This viewpoint is located on the Moolarben Road. The relevant viewing directions from VP9 to the project area are to the north-east as shown in Figure 4.2. The existing view is shown in Figure 4.18. Viewers from this location would typically be motorists travelling east along the Moolarben Road. There are currently only two private residences on Moolarben Road, and being a no through road, traffic volumes are minimal. Views of rural roads, vegetation, and fencelines dominate the foreground. Grazing lands, agricultural outbuildings and bands of vegetation are present in the mid-ground. A background of vegetated foothills and ridgelines defines the horizon.

Views from this location represent a low to moderately modified landscape with no existing views to mining operations at MCP currently possible. The viewpoint is considered to have a **moderate** visual sensitivity given its low traffic usage.

Figure 4.18 Views from Moolarben Road (VP9) toward Open Cut 2

ii Visual impacts of modification

Visual and lighting impacts on motorists at VP9 are considered to be minor due to the distance from the project area and intervening topography and minimal traffic volumes. At a viewing distance of greater than 4.5 km to Open Cut 2 and 6.5 km to Open Cut 1, views to any mining activities would be unlikely to cause any distraction to drivers along Moolarben Road. As a consequence, the magnitude of change in the landscape form VP9 as a result of the proposed modification is considered to be **negligible.**

iii Lighting impacts of modification

At a viewing distance of greater than 4.5 km to the nearest lighting source, lighting impacts are considered to be negligible. The mitigation measures recommended to mitigate the impacts to nearer viewpoints will ensure that there are no significant lighting impacts to this viewpoint.

The impact of sky glow on viewers from this location is assessed to be no more significant than under the approved operations.

The magnitude of change as a result of lighting associated with the proposed modification is considered to be **negligible**.

iv Duration and significance of impacts

Due to distance, between 4.5 km and 6.5 km, and intervening vegetation, views of the mining in the extended Open Cut 1 and Open Cut 2 would be possible at selected locations along Moolarben Road for approximately 10 years. Given the intervening distance, the significance of any impacts from the proposal at VP9 is considered to be **slight.**

4.2.10 VP10 - Moolarben Road at Moolarben Creek crossing

VP10 was selected for assessment in previous VIA's due to its proximity to MCP's Open Cut 3 and the presence of a number of private residences in the vicinity of this viewpoint. MCO have subsequently purchased a number of these properties and there is currently only one private residence in this vicinity. Furthermore, as the proposed modification does not relate to Open Cut 3, this location has not been considered further in this VIA.

4.2.11 VP11 - Wollar Road

Access to this viewpoint is no longer possible, due to the realignment of the road at this viewpoint. The project area can no longer be seen by motorists from this viewpoint, and therefore this location has not been considered further in this VIA.

4.2.12 VP12 and Photomontage 3 - Cope Road

i Viewpoint type and context

This viewpoint is located on Cope Road, west of the Ulan settlement. The relevant viewing directions from VP12 to the project, is to the east and south-east as shown in Figure 4.2. The existing view is shown in Figure 4.19. Viewers from this location would typically be motorists travelling west along Cope Road. Views of road pavement, high voltage powerlines and cleared former agricultural land, are present in the foreground. The previously mined ridgeline and rehabilitated emplacement areas are visible in the mid-ground and vegetated ridgelines define the horizon.

Views from this location represent a heavily modified landscape with unimpeded views of power lines, overburden and highwalls. With the exception of the vegetated ridgeline in the background, the vast majority of the viewpoint has been modified. The viewpoint is considered to have a **low** visual sensitivity given its heavily modified nature.

Figure 4.19 Views to MCP experienced by motorists heading west on Cope Road

ii Visual impacts of modification

Visual impacts of the proposed modification are consistent with those approved and currently experienced at VP4. Although some disturbance of the ridgeline in Open Cut 1 is evident from this viewpoint, the rehabilitated overburden emplacement area present in the mid-ground of this visual landscape creates an effective visual barrier to current active mine operations and truck movements behind.

The proposed Open Cut 1 extension area will result in the ridgeline, which appears above the rehabilitated area, being partially extracted. Views to active mining from Year 2 will be present from this viewpoint for approximately six years until mining of the upper ridge line, as seen from VP12, will be completed and rehabilitated.

Initially, viewers at the location will see the removal of vegetation to allow for overburden stripping and then active mining of the ridgeline as it moves in a south-westerly direction, before moving around the ridge and heading in a south-easterly direction, away from the viewpoint. At this point, around Year 4, views directly into the active mining area will be exposed due to a gap in mid ground vegetation which has been cleared along the high voltage power line corridor. This is demonstrated in Figure 4.21 which illustrates the comparison between mining operations visible under the approved mine plan and proposed modification.

The Open Cut 1 extension area will result in the removal of the band of around 750 m of ridgeline, that will alter the permanent visual landscape as viewed from this location. However, as the entire ridgeline is not proposed to be removed, the post mining landscape will continue to exhibit a vegetated ridgeline which defines the horizon in the background of this view, albeit at a greater distance than present. Figures 4.20 and 4.22, which illustrate the existing and final landform, demonstrate that the proposed modification will not materially alter the visual landscape as seen from this viewpoint. As a consequence, it considered that the magnitude of change in the visual landscape will be **moderate**.

iii Lighting impacts of modification

Viewers at this location will be exposed to lighting from activities on top of the active mining area and out-of-pit overburden emplacements areas within the upper ridgeline areas of Open Cut 1 from Year 2 for a period of approximately four years. As with VP1 and VP2, unmitigated, temporary lighting structures and lighting from mobile mine equipment working on batters and the edge of out-of-pit overburden emplacements areas will be directly in the line of site of motorists and areas in Ulan.

The impact of sky glow on viewers from this location is likely to be more significant than under the approved operations, due to the relatively close viewing distance and the lack of any intervening topography or vegetation to help filter the views to the night sky.

As with previous viewpoints, light spill from works at higher elevations has the greatest potential to be a distraction to motorists heading east along Cope Road.

These impacts could be reduced by maintaining a strip of vegetation along the leading face of the ridgeline for as long as practical, to provide a visual screen to workings behind and thereby limiting the time viewers will be exposed to workings on the ridgeline. Where possible, workings on out-of-pit emplacement benches should be staged so that outer embankments are created first around the perimeter, providing a visual screen while work is undertaken in the central part of the emplacement. The outer perimeter should be to a height sufficient to conceal direct light spill from the mobile equipment. These measures will be formulated into protocols to be used as part of operations at the MCP.

The magnitude of change as a result of lighting associated with the proposed modification is considered to be **high**.

iv Duration and significance of impacts

Views of the active mining and overburden emplacement activities will be present from Year 2 for a period of approximately six years, at a relatively short viewing distance. An unimpeded view to Open Cut 1 mining in the upper ridgeline and potential for light spill is considered to be a potential hazard to motorists given the lack of any screening between the roadway and the project area. Given the direct exposure to drivers, it is considered appropriate that a vegetative buffer be created along the south-eastern edge of the roadway to establish an effective screen to help filter visual and lighting impacts of operations to motorists using Cope Road. A site survey would be required, in consultation and agreement with the custodian of the road easement, to target and quantify the extent of the screen necessary to address traffic safety issues. Given that the mining of Open Cut 1 would result in impacts to this viewpoint in the early years, planting would need to include some semi-mature plantings (minimum of 2 m) to ensure an instant effect in screening.

Provided the recommended mitigation measures are implemented, it is considered that visual and lighting impacts of the proposed modification can be managed to an acceptable level from this viewpoint. Based on the above assessment the significance of the impact of the proposal on this viewpoint is evaluated to be **moderate**.

Photomontage 3: Existing (Cope Road)

Moolarben Coal Project - Stage 1 Optimisation Modification
Visual impact assessment

Figure 4.20

Photomontage 3: Indicative Year 6 (Cope Road)

Moolarben Coal Project - Stage 1 Optimisation Modification
Visual impact assessment

Figure 4.21

Photomontage 3: Final landform (Cope Road)

Moolarben Coal Project - Stage 1 Optimisation Modification
Visual impact assessment

Figure 4.22

KEY

- Approved disturbance area
- Proposed modification disturbance area

EMM

EMGA Mitchell McLennan

Comparison of approved vs proposed disturbance areas (Cope Road)

Moolarben Coal Project - Stage 1 Optimisation Modification

Visual impact assessment

Figure 4.23

4.3 Summary of results

The following table provides a summary of the assessed level of visual and light impact of each viewpoint as a result of the proposed modification, prior to the implementation of suggested mitigation measures as outlined in Chapter 5.

Table 4.1 Assessment of significance

Viewpoint	Viewer Type	Visual sensitivity	Magnitude of change	Significance of impact
VP1 – Visual impact	Motorists	Low	Low	Slight
VP1 – Lighting impact	Motorists	Low	Negligible	Negligible
VP2 – Visual impact	Motorists	Low	Medium	Slight
VP2 – Lighting impact	Motorists	Low	Medium	Moderate
VP3 - Visual impact	Motorists	Low	Negligible	Negligible
VP3 – Lighting impact	Motorists	Low	Negligible	Negligible
VP4 – Visual impact	Residents/ motorists	Moderate	Medium	Moderate
VP4 – Lighting impact	Residents/ motorists	Moderate	Medium	Moderate
VP5 – Visual impact	Motorists	Moderate	Low	Slight
VP5 – Lighting impact	Motorists	Moderate	Low	Slight
VP6 – Visual impact	Residents	High	Medium	Moderate/ substantial
VP6 – Lighting impact	Residents	High	Medium	Moderate/ substantial
VP7 – Visual impact	Residents/ motorists	Moderate	Medium	Moderate
VP7 – Lighting impact	Residents/ motorists	Moderate	Medium	Moderate
VP8 – Visual impact	Residents/ motorists	Moderate	Negligible	Slight
VP8 – Lighting impact	Residents/ motorists	Moderate	Negligible	Slight
VP9 – Visual impact	Motorists	Moderate	Negligible	Slight
VP9 – Lighting impact	Motorists	Moderate	Negligible	Slight
VP10 – Visual impact	N/A	N/A	N/A	N/A
VP10 – Lighting impact	N/A	N/A	N/A	N/A
VP11 – Visual impact	N/A	N/A	N/A	N/A
VP11 – Lighting impact	N/A	N/A	N/A	N/A
VP12 – Visual impact	Motorists	Low	Medium	Moderate
VP12 – Lighting impact	Motorists	Low	High	Moderate
Key:		Significant		Not significant

5 Management and monitoring measures

Although mine planning design and staging has had consideration for minimising visual impacts of the modification on private receptors, changes in the landscape and some visual impacts are unavoidable, especially in the early phases of mining prior to the commencement of rehabilitation.

Various mitigation measures have been developed to address impacts both generally and from specific viewpoints surrounding the project area as described in Chapter 4. These are consolidated below and are considered to be generally consistent with requirements and commitments associated with previous Stage 1 approvals.

Activities will be scheduled to give priority to the establishment of the most exposed faces of overburden emplacements, so that they can be stabilised and then rehabilitated as soon as practical.

5.1.1 Progressive rehabilitation

Early and progressive rehabilitation of disturbed areas is generally the most effective way of minimising visual impacts. MCO has proven through existing activities that it is committed to undertaking rehabilitation as an integral component of mining operations. MCO's approach to rehabilitation is outlined in Section 3.1.3.

5.1.2 Visual screening

Screening in the form of foreground and mid-ground tree and shrub planting is an effective way of reducing exposure of a receptor to various aspects of the mine operation and/or infrastructure. Once established, such planting provides a permanent and natural screen to the various elements of the mine from either roadways or private landholdings.

Vegetative screens should consist of species that are common to the ecological community into which they are to be planted. Planting should be undertaken as soon as practicable following approval. This will maximise the time available for establishment of the trees and plants, thereby ensuring the effectiveness of the screening as early as possible.

The specific areas where screen planting is recommended to occur, subject to landowner consent, are along the southern edge of Cope Road, where views of Open Cut 1 mining will be possible. Quantification of the extent of planting should be confirmed on site, however, given the timing of the impacts, planting should include semi-mature trees with a planted height of at least 2 m.

Where properties on Ridge Road will have direct views from the residence to both the proposed Open Cut 1 and Open Cut 2 extension areas, MCO will investigate the feasibility of targeted vegetative planting for affected properties along Ridge Road, to mitigate the visual and lighting impacts of the proposed modification.

5.1.3 Operational screening procedures

Operational measures implemented by MCO to limit external viewers exposure to mine operations and lighting is the most effective way to minimise impacts associated with the proposed modification. Where possible the following measures will be implemented:

- out-of-pit embankments should be built up first so that continued operation are obscured by the embankment. Outer faces of the embankments should be seeded and grassed as soon as possible to soften the view to exposed workings;

- workings on out-of-pit emplacements benches should be staged so that outer embankments are created first around the perimeter, providing a visual screen while work is undertaken in the central part of the emplacement. The outer perimeter should be to a height sufficient to conceal direct light spill from mobile equipment; and

- MCO will, wherever possible, maintain a strip of vegetation along the leading face of the ridgeline associated with the proposed Open Cut 1 extension area for as long as practical, to provide a visual screen to workings behind and thereby limiting the time viewers will be exposed to workings and lighting in this area. This will be undertaken wherever it can be accommodated without affecting efficient mining sequencing which would have the effect of slowing extraction and thereby prolonging visual impacts.

5.1.4 Night lighting

Operational measures should be adopted to reduce light spill generally and provide shielding from exposed work areas in the form of protocols for the use of mobile lighting plant and lighting associated with mobile mine machinery. The protocols should meet the requirements of *AS 4282 – Control of Obtrusive Effects of Outdoor Lighting* and *AS/NZS 1158 – Lighting for Roads and Public Spaces*, unless such compliance is practically impossible. In the unlikely event that any requirement cannot be met, special measures will need to be implemented in consultation with affected parties.

Lighting protocols should be developed which adopt the following principles:

- establish operational protocols for setting up of mobile lighting plant such that lighting is directed away from external private receptors;

- establish design and operational protocols such that lighting sources are directed below the horizontal to minimise potential light spill;

- design light systems that minimise wastage; and

- avoid lighting of light coloured surfaces which have greater reflectivity.

In addition to the above, the following commitments made for Stage 1 approval will be adopted within the operational lighting protocols for the modification, including:

- All floodlights will be shielded in the open cut area to the maximum extent practicable; and

- Lighting will be screened to viewers where possible but will always be selected to initially meet safe working practices.

6 Conclusion

The mine design considered, amongst other factors, potential visual impacts, with amelioration included, where possible. Despite this, the proposed modification will result in both temporary and permanent changes in the visual landscape. Changes will be more prevalent in the early stages prior to the full re-establishment of rehabilitated areas and maturation of screen landscaping. Such changes will be noticeable to viewers and generally perceived as intruding into a rural landscape, albeit one in which mining operations are currently approved. Where these impacts are considered significant, a number of commitments have been made within this document, which when implemented by MCO will reduce the impacts down to a level that is considered acceptable.

Where operational mitigations are considered inadequate to reduce impacts to an acceptable level, it is recommended that MCO investigate the feasibility of targeted vegetation planting to screen visual and lighting impacts on privately-owned properties along Ridge Road that have an unimpeded lines of sight to the Open Cut 1 and 2 extension areas. Where vegetative screening is deemed appropriate and implemented, impacts will be of a short to medium term in nature, until vegetative screening is established. Once an effective visual screen is established, the significance of impacts in these instances will reduce to negligible.

This report has assessed visual impacts from all representative locations around the project area. In some instances, distance combined with intervening topography and vegetation means that impacts will be minimised. Elsewhere, measures have been proposed to reduce exposure to mine elements at viewer locations, and/or minimise the contrast between the element concerned and the surrounding landscape. Some of these measures, particularly vegetation screening, will take time to become established and fully effective but, once established, the measures will mitigate visual impacts.

The operational lighting protocols to be prepared for mobile mine machinery and mobile lighting structures will be prepared to ensure the Project's compliance with *AS 4282 – Control of Obtrusive Effects of Outdoor Lighting* and *AS/NZS 1158 – Lighting for Roads and Public Spaces*.

Provided the recommended mitigation measures are implemented, the proposed modification is not predicted to significantly impact the visual amenity of the area.

Acronyms

ABS	Australian Bureau of Statistics
AHD	Australian Height Datum
DP&I	Department of Planning and Infrastructure
EA	environmental assessment
EMM	EMGA Mitchell McLennan Pty Ltd
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
km	kilometre
LMP	landscape management plan
Mtpa	million tonnes per annum
MCO	Moolarben Coal Operations Pty Limited
MCP	Moolarben Coal Project
ROM	run of mine
VIA	visual impact assessment
VP	viewpoint

References

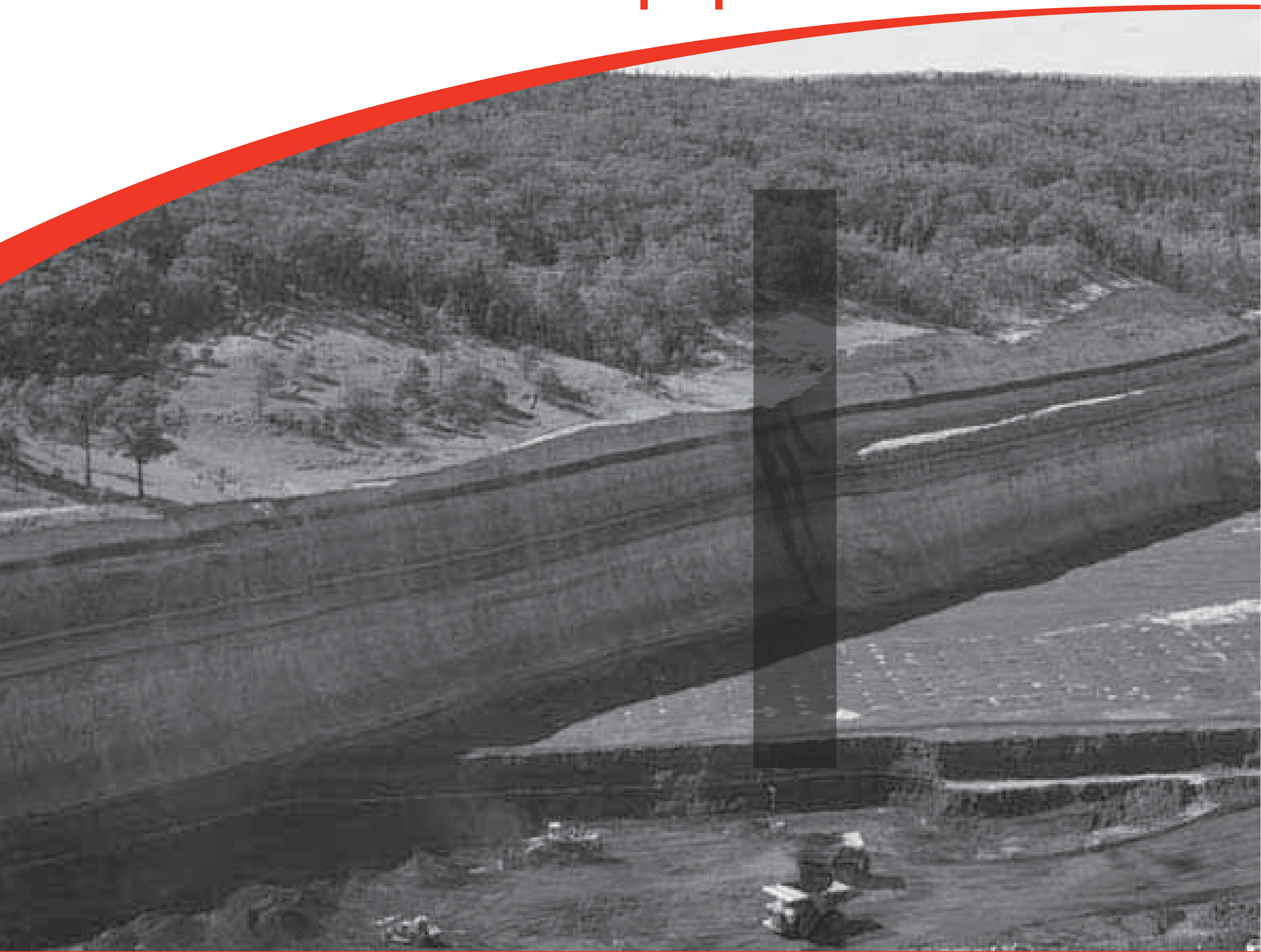
O'Hanlon Design Pty Ltd (2006) *Visual & Lighting Impact Assessment Moolarben Coal Project* prepared as part of the original EA for MCP; and

O'Hanlon Design Pty Ltd (2008) *Visual & Lighting Impact Assessment Stage 2 Moolarben Coal Project* prepared as part of Stage 2 EA for MCP.

Standards Australia, 1997 *Control of the Obtrusive Effects of Outdoor Lighting* (AS 4282 – 1997).

The Landscape Institute of Environmental Management and Assessment 2002*: Guidelines for Landscape and Visual Impact Assessment (Second Edition).*

Appendix I



Surface water impact assessment

Moolarben Coal Project Stage 1 Optimisation Modification, Environmental Assessment — May 2013

MOOLARBEN COAL
PART OF THE YANCOAL AUSTRALIA GROUP

EMM
EMGA Mitchell McLennan

MOOLARBEN COAL PROJECT STAGE 1 OPTIMISATION MODIFICATION – SURFACE WATER IMPACT ASSESSMENT

EMGA Mitchell McLennan Pty Limited

May 2013

WRM Water & Environment Pty Ltd
ABN: 96 107 404 544 ACN: 107 404 544
Level 9, 135 Wickham Tce, Spring Hill
PO Box 10703
Brisbane Adelaide St QLD 4000
tel +61 7 3225 0200 fax +61 7 3225 0299
www.wrmwater.com.au

REPORT TITLE: Moolarben Coal Project, Stage 1 Optimisation Modification, Surface Water Impact Assessment

CLIENT: EMGA Mitchell McLennan Pty Ltd

REPORT NUMBER: 0926-01-C_FINAL

Revision Number	Report Date	Report Author	Reviewer
FINAL	8 May 2013	MGB / AN / DN	MJB

For and on behalf of
WRM Water & Environment Pty Ltd

David Newton
Principal Engineer

EXECUTIVE SUMMARY

The Moolarben Coal Project (MCP) is an approved open cut and underground coal mine in the Western Coalfields of NSW, approximately 40km north-east of Mudgee. WRM Water & Environment Pty Ltd (WRM) was engaged by EMGA Mitchell McLennan Pty Limited (EMM) on behalf of Moolarben Coal Operations Pty Limited (MCO) to undertake a surface water impact assessment for the Moolarben Coal Project – Stage 1 Optimisation Modification (proposed modification).

The MCP Stage 1 Major Project approval 05_0117 (MP 05_0117) was approved under Part 3A of the Environmental Planning and Assessment Act 1979 (EP&A Act) in 2007. Since gaining approval, MP 05_0117 has been modified on seven occasions to make administrative changes, changes to infrastructure and allow the construction of a borefield. The main components of the MCP Stage 1, as modified, comprise:

- three open cut pits, referred to as Open Cuts 1, 2 and 3, which have an approved combined maximum extraction rate of 8 million tonnes per annum (Mtpa) of run of mine (ROM) coal;
- one underground mine, referred to as Underground 4, which has an approved maximum extraction rate of 4 Mtpa of ROM coal;
- coal handling, processing, rail loop, load-out and water management infrastructure; and
- associated facilities including offices, bathhouses, workshops and fuel storages.

To date, mining has occurred within Open Cut 1 only, commencing at the south-western perimeter and progressing in a north-easterly direction.

The current disturbance limit granted under MP 05_0117 is restricting the extraction of large quantities of the deposit which are economically viable in today's market. The proposed modification will extend the disturbance boundary enabling increased resource utilisation, a longer life for Open Cut 1 and 2 and promote continuity of Stage 1 operations.

The elements of the proposed modification to MP05_0117 comprise:

- the extension of mining within Open Cuts 1 and 2;
- the construction and operation of additional water management infrastructure; and
- a minor change to the rehabilitation sequencing and final landform.

A Major Project Application for Stage 2 of the MCP, MCP 08_0135, is currently being assessed by the Department of Planning and Infrastructure (DP&I). If approved, Stage 2 will consist of one open cut pit, Open Cut 4, and two underground mines, Undergrounds 1 and 2, and associated additional infrastructure. This surface water assessment is based on the assumption that Stage 2 of the MCP will be approved, enabling potential worst case impacts to be assessed.

The surface water impact assessment has considered the potential impacts of the proposed modification on surface water resources, including:

- Impacts on imported water requirements from external sources to meet additional operational water requirements of mining operations;
- Adverse impacts on the quality of surface runoff draining from the disturbance area to the various receiving waters surrounding the project area;
- Adverse impacts on downstream water quality associated with possible overflows from the mine water dams;

- Loss of catchment area draining to Moolarben Creek due to capture of runoff within onsite storages and the open cut pits; and
- Interference with flood flows along Moolarben Creek.

A detailed daily water balance model has been developed to simulate the behaviour of the mine site water management system over the life of the mine, with and without the proposed modification. The increase in haul road dust suppression associated with the proposed modification will increase site water demand by up to 280ML/a (depending on the mining phase). However, the increase in disturbance area will result in additional surface runoff inflows to the mine water management system. The results of the water balance model show that an average 200ML/a (depending on climatic conditions) of additional imported water is required to sustain site demands, as a result of the proposed modification.

The maximum annual imported water requirement, taking into account the additional demands associated with the proposed modification, is around 1,940ML/a. This maximum external water requirement can be satisfied from current water sources (UWSA and Northern Borefields) and MCO have the ability to access additional water under the UWSA, if required. Water required from external sources will be obtained under appropriate Water Access Licences and will be accessed in accordance with the requirements of existing Water Sharing Plans, including adherence to total daily extraction limits. This will ensure no adverse impacts on water availability for other licensed water users.

The mine water management system will be operated to preferentially reuse mine water collected on the site to meet minesite demands. The results of the mine water balance modelling show that under the full range of historical rainfall conditions, the proposed mine water management system will have sufficient capacity to contain all mine water on the site without uncontrolled releases, when operated in accordance with the proposed release conditions specified in the MCO Environmental Protection Licence (EPL). The proposed mine site water management strategy and infrastructure will ensure that the proposed modification has a negligible impact on the quality of surface runoff and receiving waters. The existing receiving water quality data indicates that the current operation has had no measurable impact on receiving water quality.

The additional disturbance area associated with the proposed modification removes a small area of catchment draining to Moolarben Creek. The proposed modification only results in a 1.1% reduction in Moolarben Creek catchment area. This small reduction in catchment area will have a negligible impact on the flow characteristics of Moolarben Creek.

The modification pit footprint is outside the 100 year ARI extent of flooding for Moolarben Creek. Hence, the proposed modification will have no additional impact on flood behaviour in Moolarben Creek up to the 100 year ARI flood event.

The potential impacts which result from the proposed modification will be managed under the existing surface water management system and in accordance with the WMP. The WMP and relevant sub-plans will be reviewed and updated as required to accommodate the proposed modification.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

1.1 BACKGROUND

The Moolarben Coal Project (MCP) is an approved open cut and underground coal mine in the Western Coalfields of NSW, approximately 40km north-east of Mudgee. WRM Water & Environment Pty Ltd (WRM) was engaged by EMGA Mitchell McLennan Pty Limited (EMM) on behalf of Moolarben Coal Operations Pty Limited (MCO) to undertake a surface water impact assessment for the Moolarben Coal Project – Stage 1 Optimisation Modification (proposed modification).

The MCP Stage 1 Major Project approval 05_0117 (MP 05_0117) was approved under Part 3A of the Environmental Planning and Assessment Act 1979 (EP&A Act) in 2007. Since gaining approval, MP 05_0117 has been modified on seven occasions to make administrative changes, changes to infrastructure and allow the construction of a borefield. The main components of the MCP Stage 1, as modified, comprise:

- three open cut pits, referred to as Open Cuts 1, 2 and 3, which have an approved combined maximum extraction rate of 8 million tonnes per annum (Mtpa) of run of mine (ROM) coal;
- one underground mine, referred to as Underground 4, which has an approved maximum extraction rate of 4 Mtpa of ROM coal;
- coal handling, processing, rail loop, load-out and water management infrastructure; and
- associated facilities including offices, bathhouses, workshops and fuel storages.

To date, mining has occurred within Open Cut 1 only, commencing at the south-western perimeter and progressing in a north-easterly direction.

The current disturbance limit granted under MP 05_0117 is restricting the extraction of large quantities of the deposit which are economically viable in today's market. The proposed modification will extend the disturbance boundary enabling increased resource utilisation, a longer life for Open Cut 1 and 2 and promote continuity of Stage 1 operations.

The MCP is bordered by the Goulburn River to the north-west; privately owned grazing land to the north; Goulburn River National Park, Wilpinjong Coal Mine and Munghorn Gap Nature Reserve to the east; privately-owned grazing land to the south; and privately-owned grazing land, Ulan village and Ulan Coal Mine to the west.

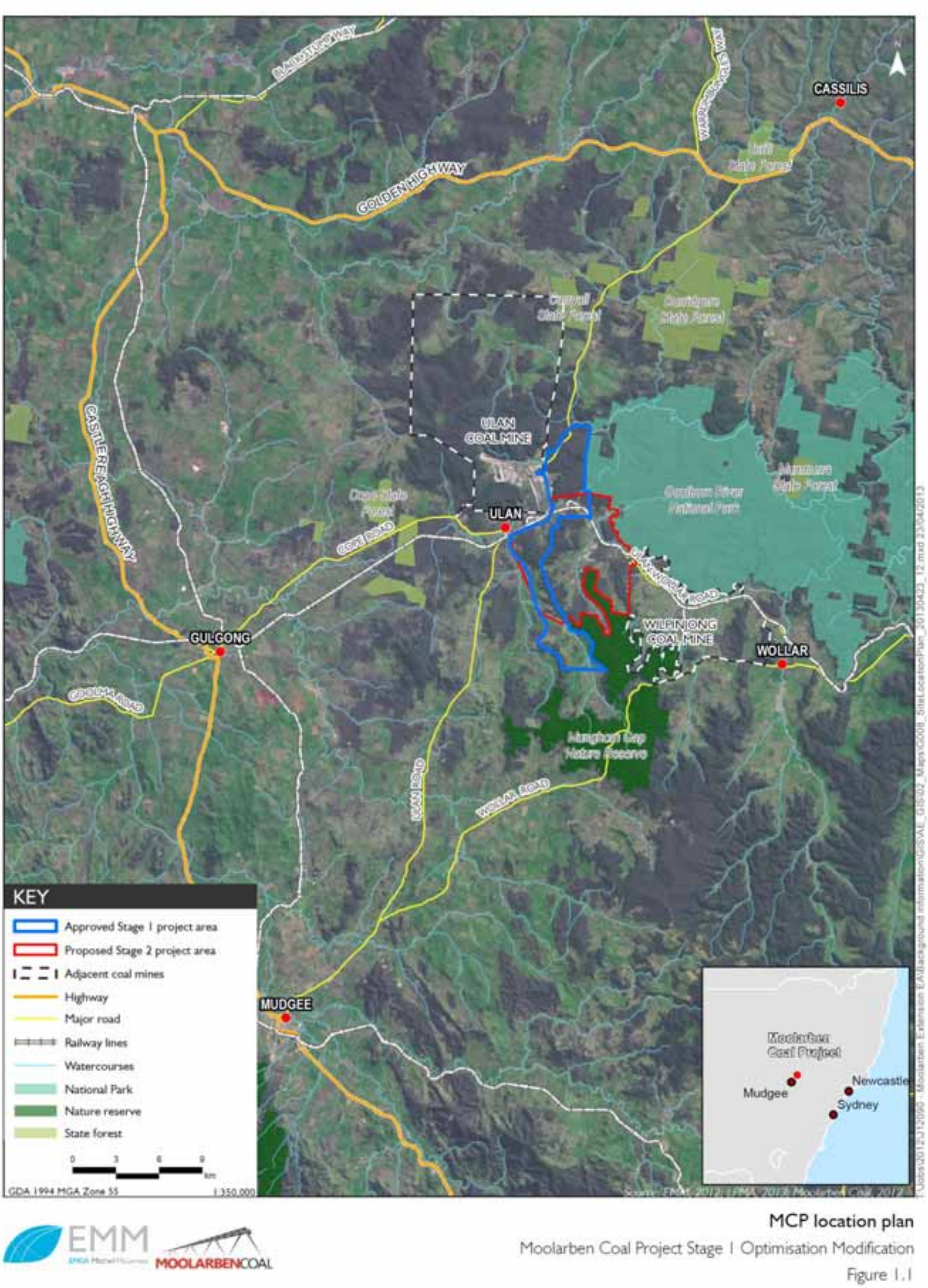


Figure 1.1 Moolarben Coal Project, Locality Plan

1.2 OVERVIEW OF PROPOSED MODIFICATION

The elements of the proposed modification to MP05_0117 comprise:

- the extension of open cut mining within Open Cuts 1 and 2;
- the construction and operation of additional water management infrastructure; and
- a minor change to the rehabilitation sequencing and final landform.

The project approval period will be extended to accommodate the proposed modification.

The proposed modification elements are shown on Figure 1.2. They are all within the Stage 1 project approval boundary, which forms the 'project area' for the proposed modification. Within the project area, Open Cut 1 and 2 extension areas are referred to collectively as the 'proposed extension areas'. It is noted that proposed extension areas include a disturbance buffer of up to 50m that will enable the development of a services road and infrastructure if required, such as water pipelines. This ensures that all potential impacts associated with the proposed extension to mining have been assessed.

It is noted that surface water considerations were factored into the mine optimisation process for the proposed modification. An outcome of this process was the revision of the mine design to ensure no impact to Moolarben Creek, the closest creek to the proposed extension areas, or its floodplain.

1.3 RELATIONSHIP TO OTHER PROJECTS

A Major Project Application for Stage 2 of the MCP, MCP 08_0135, is currently being assessed by the Department of Planning and Infrastructure (DP&I). If approved, Stage 2 will consist of one open cut pit, Open Cut 4, and two underground mines, Undergrounds 1 and 2, and associated additional infrastructure. This surface water assessment is based on the assumption that Stage 2 of the MCP will be approved, enabling potential worst case impacts to be assessed.

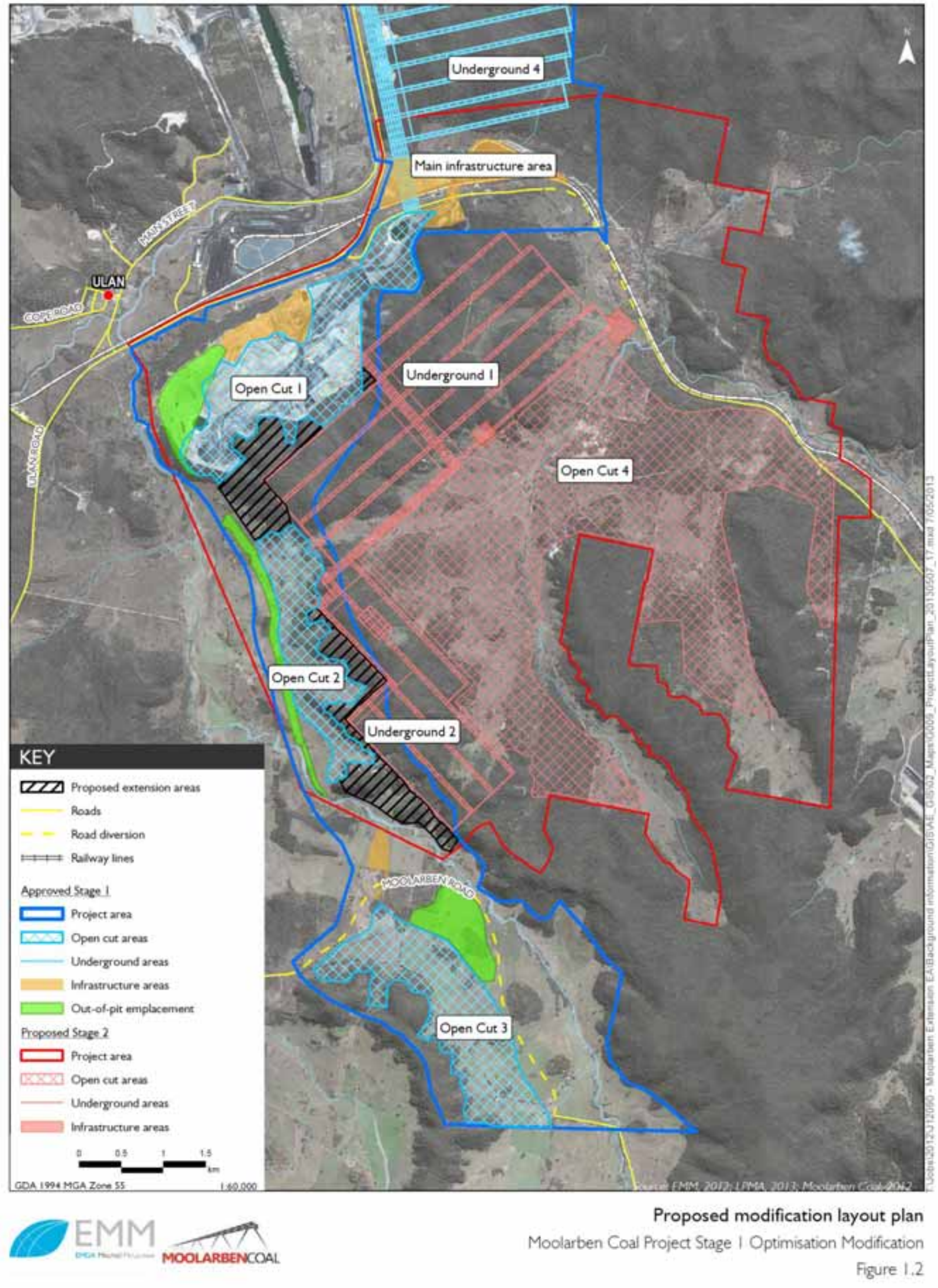


Figure 1.2 Elements of Stage 1 Optimisation Modification

1.4 STUDY METHODOLOGY AND DOCUMENT STRUCTURE

This study has been prepared to assess the potential surface water impacts from the proposed modification and to develop measures that would avoid, minimise and monitor potential impacts.

A key potential impact of the proposed modification is an increase in site water demand due to the proposed increase in site water demands from open cut operations. Previous investigations of the site water balance have been undertaken using several different methodologies and models. For this investigation, a new site water balance model has been developed using the OPSIM software. The OPSIM model provides a high level of flexibility in assessing the behaviour of the site water management system under a wide range of climatic conditions.

Two separate models (with and without the modification) were developed to assess the impacts of the proposed modification on the surface water system. In order to accurately represent the overall performance of the water management system, both models included mining development and infrastructure associated with the Stage 2 proposal.

This report contains a further six sections:

- Section 2 provides a description of the existing surface water environment;
- Section 3 provides an overview of the existing site water management system;
- Section 4 presents the assessment of potential surface water impacts of the proposed modification;
- Section 5 presents the assessment of potential surface water impacts of the proposed modification;
- Section 6 details the proposed management and monitoring strategy for the proposed modification;
- Section 7 presents a summary of the findings of the surface water impact assessment; and
- Section 8 is a list of references.

2 EXISTING SURFACE WATER ENVIRONMENT

2.1 REGIONAL DRAINAGE NETWORK

The MCP is within the Upper Goulburn river catchment. The upper Goulburn River has a catchment area of approximately 2,455 km^2 to the Ulan-Cassilis Road Bridge. Moolarben Creek is the primary tributary of the upper Goulburn River catchment. Moolarben Creek flows in a northerly direction along the western project area boundary and joins Sportsmans Hollow Creek at the village of Ulan to form the headwater of the Goulburn River. Moolarben Dam is located on Moolarben Creek, approximately 1.5km upstream of the Sportsman Hollow Creek confluence.

Wilpinjong Creek drains in a south-easterly direction along the eastern project area boundary and joins Wollar creek, before joining the Goulburn River approximately 26km downstream of the project area. The Goulburn River flows in an easterly direction, eventually joining the Hunter River approximately 150km downstream of the project area.

2.2 LOCAL DRAINAGE NETWORK

The local drainage network in the vicinity of the project area is shown in Figure 2.1. The majority of Stage 1 mining operations, including Open Cuts 1, 2 and 3, are located within the Moolarben Creek catchment. The Moolarben Creek catchment has an area of about 126 km^2 to the Ulan-Cassilis Road near Ulan. Moolarben Creek is located between 100 m to 1 km from the edge of the proposed extension to mining.

The upper reaches of the Moolarben Creek catchment are characterised by steep, heavily forested slopes of up to 20%, draining into a cleared and relatively flat floodplain. The Moolarben Creek catchment to the Ulan-Cassilis road includes the Moolarben Dam, constructed in 1957 to supply water to the Ulan Power Station (decommissioned in 1968). The dam has a catchment area of about 109 km^2 and a surface area of about 6ha. This dam is considered to provide limited flow attenuation during large floods.

The majority of the Stage 1 infrastructure area including the Coal Handling and Preparation Plan (CHPP), product stockpile pad and the rail loop are located within the Bora Creek Catchment. Bora Creek is a small tributary of the Goulburn River with a catchment area of about 6.7 km^2 to the Ulan-Cassilis Road. Bora Creek drains in a westerly direction along the northern boundary of the CHPP area.

The majority of the proposed Stage 2 mining operations including Open Cut 4 are located within the Murragamba and Eastern Creek catchments. Murragamba and Eastern Creeks have a combined catchment area of about 31.5km^2. Both creeks drain in a north-easterly direction across the proposed Stage 2 project boundary, eventually joining Wilpinjong Creek to the east of the project area. The Murragamba and Eastern Creek catchments are typically characterised by steep and heavily forested valley sides, draining into a flat and mostly cleared floodplain.

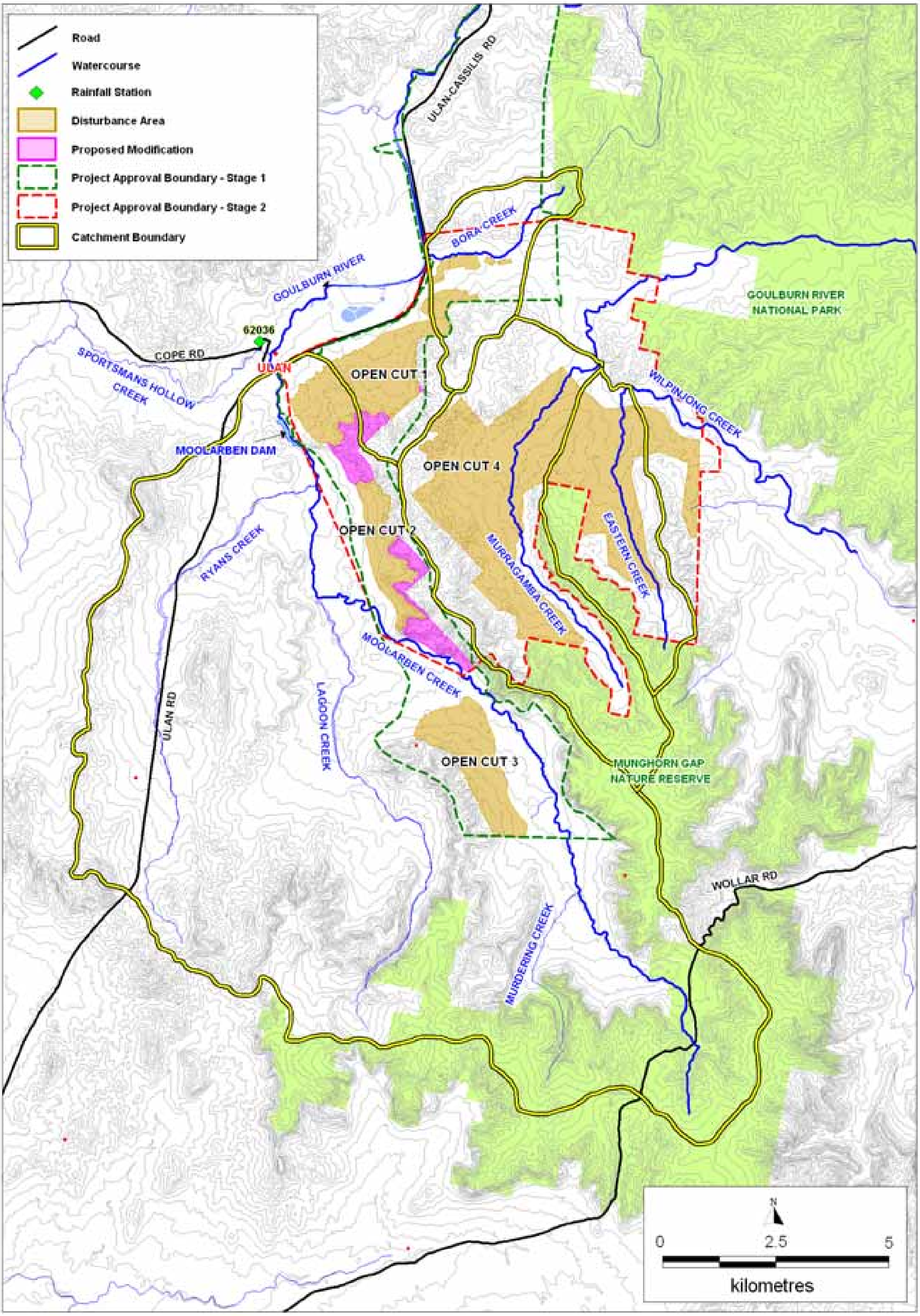


Figure 2.1 Local Drainage Network

2.3 RAINFALL AND EVAPORATION

Daily rainfalls have been recorded at the "Ulan Water" rainfall station located at the Ulan Post Office (Bureau of Meteorology (BOM) Station No. 062036), about 1km from the project area, since 1906. Table 2.1 shows summary details of the rainfall station. Table 2.2 shows mean monthly rainfalls for the Ulan Water rainfall station. The mean annual rainfall is 638mm, with the highest monthly rainfalls occurring during the summer months.

Table 2.1 Rainfall Station Details

Station No.	Station Name	Elevation (m)	Easting	Northing	Distance from Site (km)	Opened	Closed
062036	Ulan Water	420	758,153	6,425,151	1	1906	-

(BoM, 2012)

In order to extend the rainfall dataset for the water balance calculations, a synthetic rainfall dataset was also obtained for nearest available co-ordinate near the project area from the Queensland Department of Science, Information Technology, Innovation and the Arts (DSITIA's) Data Drill service (Jeffrey et al. 2001). The Data Drill "*accesses grids of data derived by interpolating the Bureau of Meteorology's station records. Interpolations are calculated by splining and kriging techniques. The data in the Data Drill are all synthetic; there are no original meteorological station data left in the calculated grid fields. However, the Data Drill does have the advantage of being available for any set of coordinates in Australia*". The Data Drill service accesses data stored in the enhanced climate data bank. The key advantage of adopting the Data Drill data is that it has been adjusted to remove accumulated totals over multiple days and to fill periods of missing data using rainfall from nearby stations.

A comparison of mean monthly rainfalls for Data Drill and BoM (Ulan Water) rainfall station is presented in Table 2.2.

Figure 2.2 shows the annual distribution of average monthly rainfall and evaporation in the local area. Mean evaporation is similar to mean rainfall in the winter months, but substantially exceeds rainfall for the remainder of the year. Note that only Data Drill evaporation was used, are there are no BOM stations near the project area which record evaporation

Table 2.2 Mean Monthly Rainfall and Evaporation

Month	Mean Monthly Rainfall (mm)		Mean Monthly Pan Evaporation (mm)
	Ulan Water 062036 (BOM) [1906 - 2012]	Data Drill [1889 – 2012]	Data Drill [1889 – 2012]
Jan	73.9	69.2	199
Feb	61.7	64.6	162
Mar	52.7	53.5	141
Apr	41.8	41.6	93
May	46.2	44.7	58
Jun	44.7	46.9	39
Jul	47.7	46.6	46
Aug	48.7	45.5	69
Sep	43.3	44.2	101
Oct	55.8	55.6	144
Nov	56.2	57.4	171
Dec	66.6	63.2	198
Total	**639**	**633**	**1,421**

(Australian Government Bureau of Meteorology, 2012)
(Jeffrey et al., 2001)

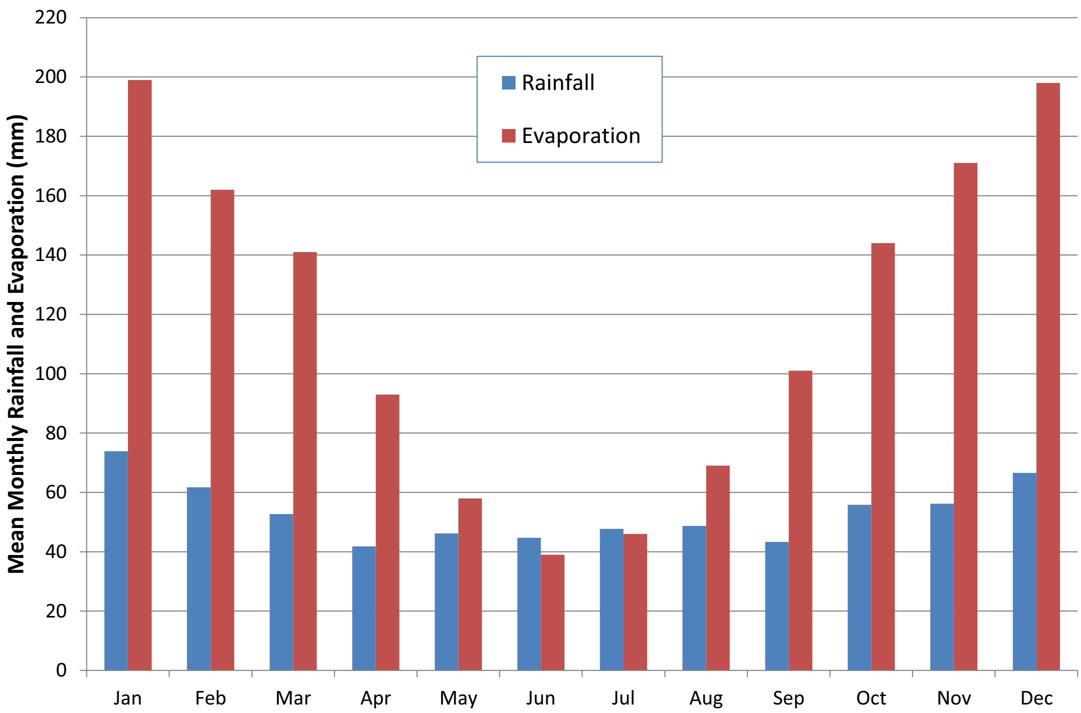


Figure 2.2 Distribution of Monthly Rainfall at Ulan Water (BOM, 2005) and Data Drill Evaporation (DSITA, 2012)

2.4 STREAMFLOW

The nearest streamflow gauging station is NSW Office of Water's (NOW) Goulburn River at Coggan (gauge no. 210006) located approximately 70km downstream of the project area.

MCO has collected streamflow data between February and October 2010 at three monitoring sites. Streamflow monitoring has also been conducted at Moolarben Dam with data available from October 2011. Table 2.3 shows details of the streamflow monitoring sites. The monitoring locations are shown in Figure 2.7. The recorded flow data at each location is presented in Figure 2.3 to Figure 2.6.

Table 2.3 Moolarben Stream Flow Monitoring Sites

Monitoring Site	Description	Easting	Northing	Frequency	Period of Record
		MCO Monitoring Sites			
SW05*	Moolarben Creek at Ulan-Cassilis Road	758,483	6,424,620	Sub-daily	Feb - Sep 2010
SW11*	Bora Creek at Ulan-Cassilis Road	761,496	6,426,927	Sub-daily	Feb - Sep 2010
SW15	Wilpinjong Creek at Red Hill	764,653	6,425,304	Sub-daily	Feb - Sep 2010
		Ulan Coal Monitoring Sites			
Moolarben Dam	Moolarben Creek at Moolarben Dam	758,587	6,423,638	Sub-daily	Oct 2011 – Sep 2012

* Also functions as a water quality monitoring site

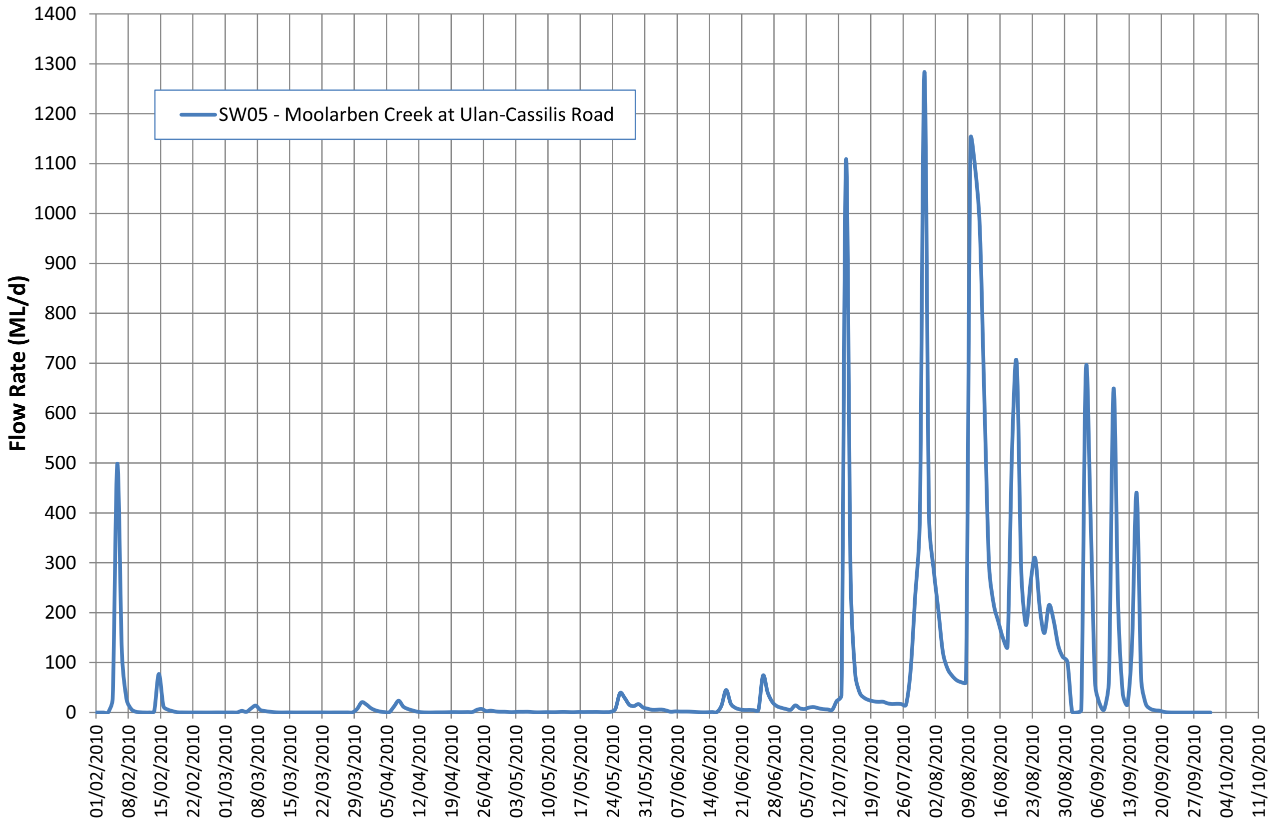


Figure 2.3 Recorded Streamflow Data, Moolarben Creek at Ulan-Cassilis Road (SW05)

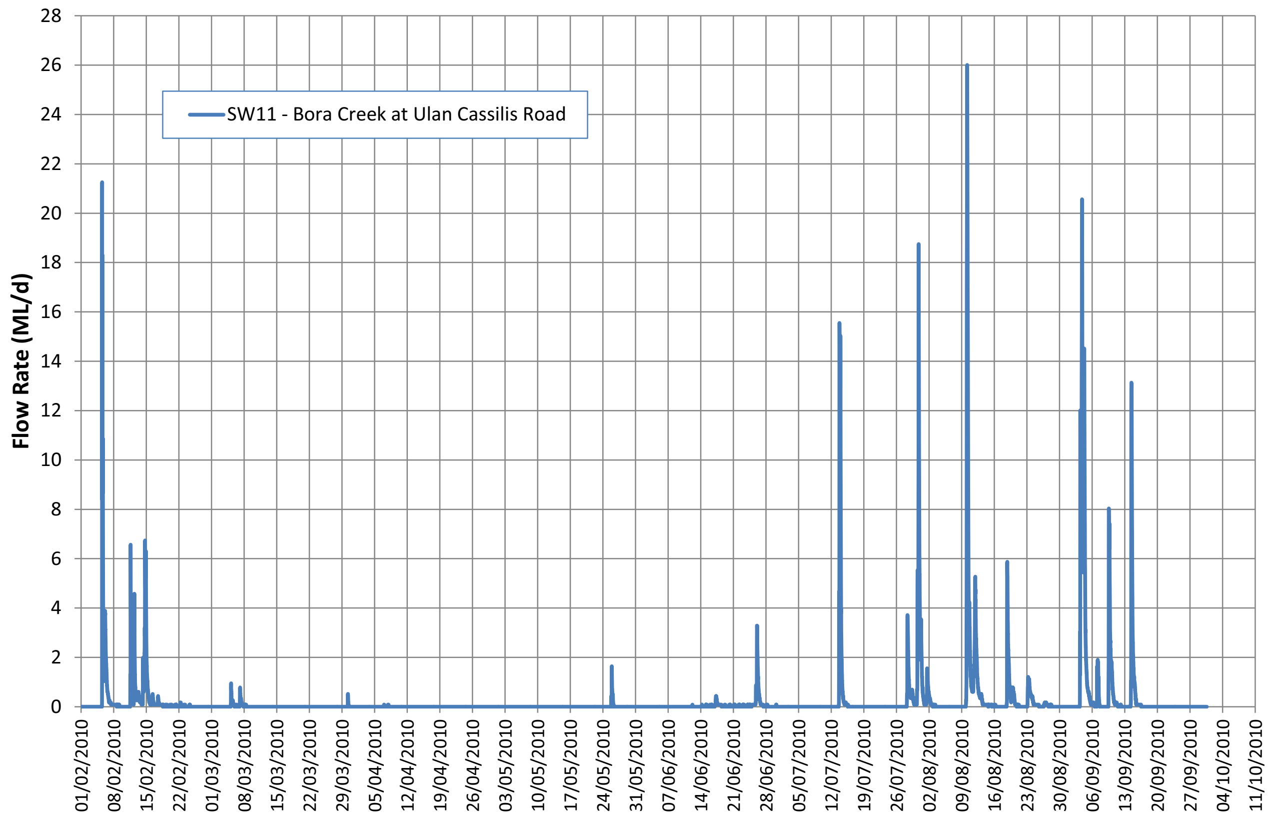


Figure 2.4 Recorded Streamflow Data, Bora Creek at Ulan Cassilis Road (SW11)

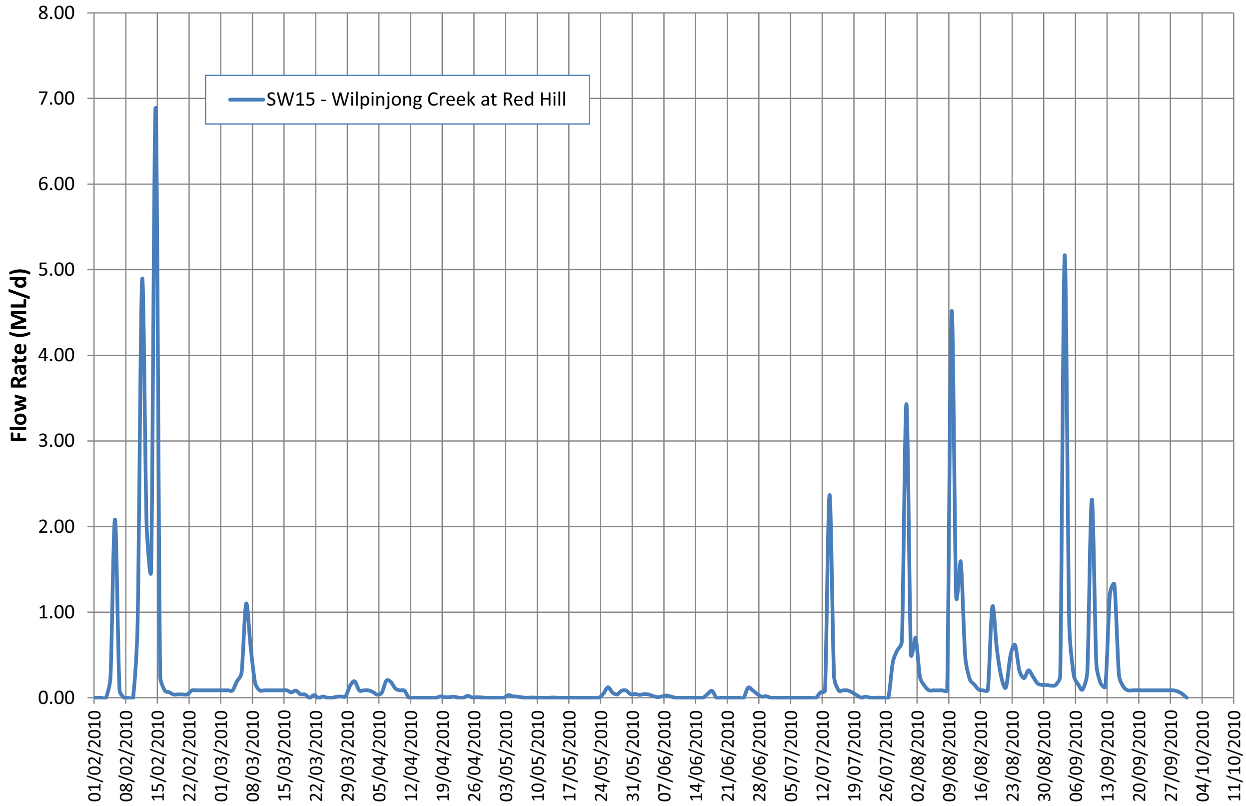


Figure 2.5 Recorded Streamflow Data, Wilpinjong Creek at Red Hill (SW15)

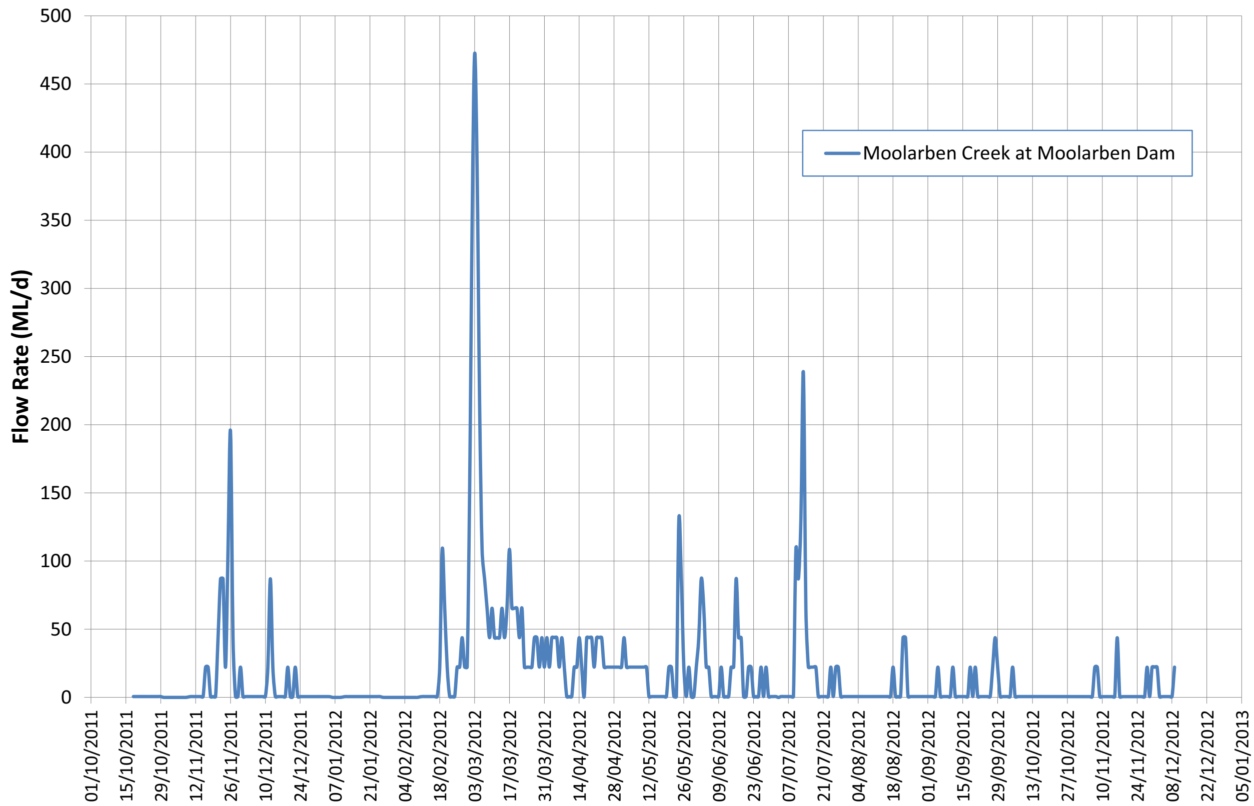


Figure 2.6 Recorded Streamflow Data, Moolarben Creek at Moolarben Dam

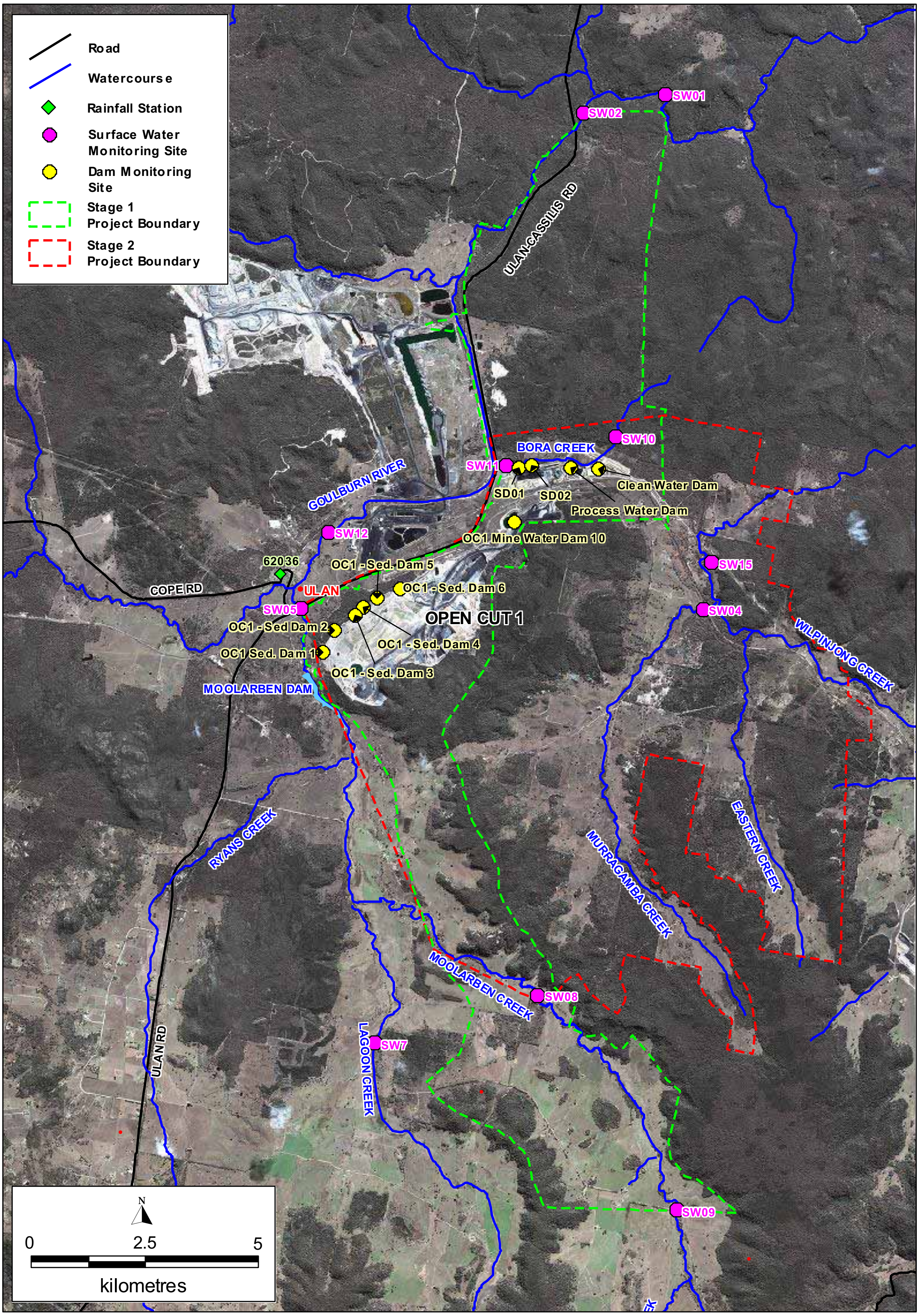


Figure 2.7 Surface Water Monitoring Locations

2.5 SURFACE WATER QUALITY

2.5.1 Overview

MCO has undertaken a water quality monitoring program since 2005 at various locations, including on-site dams and receiving waters. A summary of the water quality sampling results for dams and receiving waters is presented in the following sections.

2.5.2 On-site Dams

Water quality sampling is conducted on a monthly basis at 11 sites across the project area, at the location shown on Figure 2.7. A summary of the water sampling results is provided in Table 2.4.

The dams at MCP are generally classified as mine water dams or sediment dams. Mine water dams hold mine affected water, including pit water and tailings return water. Sediment dams capture runoff from disturbed areas such as spoil dumps and rehabilitation, but not mine affected water. This is reflected in the water quality observed in each of the two storage types.

The mine water dams include Clean Water Dam, Process Water Dam and Mine Water Dam 10, amongst others. The sediment dams include SD01, SD02 and Sediment Dams 1-6.

Review of Table 2.4 indicates the following:

- Mine water dams
  - pH readings range between 3.6 and 8.5, with average readings between 5.3 and 7.1;
  - Electrical Conductivity (EC) readings range between 70 and 2,420 μs/cm, with average readings between 500 and 1,700 μs/cm; and
  - Total Suspended Solids (TSS) readings range between 2 and 140 mg/L, with average readings between 5 and 34 mg/L.
- Sediment dams
  - pH readings range between 5.3 and 7.3, with average readings between 5.3 and 7.2;
  - Electrical Conductivity (EC) readings range between 95 and 890 μs/cm, with average readings between 180 and 890 μs/cm; and
  - Total Suspended Solids (TSS) readings range between 5 and 11,310 mg/L, with average readings between 16 and 8,474 mg/L.

Note that average readings relate to the readings at a given dam, so a range of averages gives the spectrum of averages across the dams that were monitored.

Table 2.4 On-site Storage Water Quality Characteristics for MCP

Monitoring Site	Sampling Date	Value	pH	Electrical Conductivity (µS/cm)	Total Suspended Solids (mg/L)
Clean Water Dam	Between Aug 2010 - Sep 2012	No. of Samples	63	63	63
		Min	6.2	70	2
		Max	8.5	2420	140
		Ave	6.9	500	34
Process Water Dam	Between Feb 2011 - Sep 2012	No. of Samples	21	21	13
		Min	6.5	900	2
		Max	7.9	2240	9
		Ave	7.1	1699	5
OC1 Mine Water Dam 10	Between Jul 2010 - Sep 2012	No. of Samples	30	30	21
		Min	3.6	700	2
		Max	7.2	1730	58
		Ave	5.3	1226	17
SD01	Between Dec 2010 - Mar 2012	No. of Samples	3	3	3
		Min	5.3	315	24
		Max	6.9	515	578
		Ave	6.0	430	221
SD02	Mar-12	No. of Samples	1	1	1
		Min	7.2	890	16
		Max	7.2	890	16
		Ave	7.2	890	16
OC1 - Sed. Dam 1	Mar-12	No. of Samples	2	2	2
		Min	5.9	95	368
		Max	5.9	265	548
		Ave	5.9	180	458
OC1 - Sed. Dam 2	Between Dec 2010 - Mar 2012	No. of Samples	3	3	3
		Min	5.8	105	432
		Max	7.3	575	13110
		Ave	6.4	268	8474
OC1 - Sed. Dam 3	Between Dec 2009 - Mar 2012	No. of Samples	2	2	2
		Min	5.6	110	1130
		Max	5.9	735	6990
		Ave	5.8	423	4060
OC1 - Sed. Dam 4	Mar-12	No. of Samples	1	1	1
		Min	5.3	585	592
		Max	5.3	585	592
		Ave	5.3	585	592
OC1 - Sed. Dam 5	Mar-12	No. of Samples	1	1	1
		Min	6.2	490	108
		Max	6.2	490	108
		Ave	6.2	490	108
OC1 - Sed. Dam 6	Between Mar 2012 - Sep 2012	No. of Samples	8	8	8
		Min	6.2	380	5
		Max	7.1	660	2240
		Ave	6.6	464	425

2.5.3 Receiving Water Quality Monitoring

In accordance with MCO's approved Surface Water Management Plan (MCO, 2010), the pH, EC, TSS and total dissolved solids (TDS) levels in the receiving watercourses are monitored on a monthly basis. Additional samples are also taken from these locations following rainfall events larger than 30mm over a 24-hour period.

Additional parameters: copper (Cu), lead (Pb), zinc (Zn), nickel (Ni), iron (Fe), manganese (Mn), arsenic (As), selenium (Se), cadmium (Cd), chromium (Cr), lithium (Li), barium (Ba), and strontium (Sr) are monitored on a six-monthly basis. Stream water quality monitoring is conducted at 12 sites across the project area. Table 2.5 provides a summary of water quality parameters measured at these sites which include data from February 2005 to September 2012. Table 2.6 provides a summary of the sample readings over the period 2005 to 2012.

Comparison of the recorded baseline monitoring data with ANZECC (2000) trigger values has been undertaken and is discussed below ANZECC (2000) recommends that wherever possible site-specific data is used to define trigger values for physical and chemical factors which can adversely impact the environment. However, the default values provided by ANZECC (2000) can be used where there is insufficient baseline data available.

Trigger values are not regarded as assessment criteria; rather they are used to initiate investigations into the surface water quality as reported by the monitoring program. ANZECC 2000 defines trigger levels as:

> *The guideline trigger values are the concentrations (or loads) of the key performance indicators, below which there is a low risk that adverse biological effects will occur. The physical and chemical trigger values are not designed to be used as 'magic numbers' or threshold values at which an environmental problem is inferred if they are exceeded. Rather they are designed to be used in conjunction with professional judgement, to provide an initial assessment of the state of a water body regarding the issue in question.*

The receiving waterways at the project area are classified as Upland rivers (or streams), as they have an elevation of greater than 150mAHD. The default ANZECC trigger values for key water quality parameters are provided in Table 2.7.

Review of the baseline monitoring data indicates that the receiving waters around the project area have water quality attributes as follows:

- Slightly acidic, with minimum pH readings as low as 4.4, median readings between 6.3 to 7.1, and maximum readings of up to 8.8;
- Generally fresh, with ECs ranging from 10 to 2,520 µS/cm with a median value between 70 and 1,020 µS/cm, with the exception of the upstream monitoring points on Moolarben Creek and Lagoon Creek (SW07, SW08 and SW09). These site have median EC concentration of up to 3,900 µS/cm;
- TDS, calcium, sulphate, sodium, chloride levels mostly below the ANZECC trigger values, with the exception of the upstream locations SW07, SW08 and SW09;
- Magnesium levels below the ANZECC trigger value with the exception of the upstream locations SW07, SW08 and SW09;
- Generally exceeds the turbidity ANZECC trigger values, with the exception of SW7 and SW10;
- Generally exceeds the total nitrogen and total phosphorus ANZECC trigger values.

In general, the water quality parameters are fairly consistent between the upstream and downstream waterway monitoring locations. However, almost all of the water quality parameters at the upstream monitoring locations on Moolarben Creek and Lagoon Creek (SW07, SW08, SW09) are elevated in comparison to the other locations. On this basis, the water quality results indicate that the existing operations are not adversely affecting the quality of receiving waters.

Table 2.5 MCO Stream Water Quality Monitoring Sites

Sample Point ID	Sampling Point Description	Type of Analysis	Frequency
SW01	Goulburn River, downstream of 'The Drip' picnic area	Basic Surface Water Analysis	Monthly and within 24 hours of a rainfall event >30mm
		6 monthly surface water analysis	6 monthly
SW02	Goulburn River, 'The Drip' picnic area	Basic Surface Water Analysis	Monthly and within 24 hours of a rainfall event >30mm
		6 monthly surface water analysis	6 monthly
SW04	Murragamba Creek, near Wilpinjong Creek	Basic Surface Water Analysis	Monthly
		6 monthly surface water analysis	6 monthly
SW05	Goulburn River, Ulan-Cassilis Road Crossing	Basic Surface Water Analysis	Monthly and within 24 hours of a rainfall event >30mm
		6 monthly surface water analysis	6 monthly
SW07	Swampy section of Lagoon Creek	Basic Surface Water Analysis	Monthly
		6 monthly surface water analysis	6 monthly
SW08	Moolarben Creek	Basic Surface Water Analysis	Monthly
		6 monthly surface water analysis	6 monthly
SW09	Moolarben Creek, Moolarben Road	Basic Surface Water Analysis	Monthly
		6 monthly surface water analysis	6 monthly
SW10	Bora Creek, upstream of CHPP operations	Basic Surface Water Analysis	Monthly and within 24 hours of a rainfall event >30mm
		6 monthly surface water analysis	6 monthly
SW11	Bora Creek, downstream of CHPP operations	Basic Surface Water Analysis	Monthly and within 24 hours of a rainfall event >30mm
		6 monthly surface water analysis	6 monthly
SW12	Goulburn River, upstream of Open Cut 1, Underground 4 and CHPP operations	Basic Surface Water Analysis	Monthly and within 24 hours of a rainfall event >30mm
		6 monthly surface water analysis	6 monthly

Basic Surface Water Analysis: pH, EC, TSS, TDS
6-monthly Surface Water Analysis: pH, EC, TSS. TDS, Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd, Cr, Li, Ba, Sr

Table 2.6 Water Quality Characteristics for the MCP *

Monitoring Site	Sampling Date	Value	pH	Electrical Conductivity (uS/cm - field)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Chloride (mg/L)	Sulphates (mg/L)	Alkalinity - Bicarbonate (mg CaCO3/L	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
SW01	Monthly between Feb 2005 – Sep 2012	Count	124	84	99	100	123	124	69	69	69	69	69	69	69	99	91
		Min	5.4	170	4.7	0	172	2	7.5	5	27	3.2	25	18	17	0.05	0.01
		Max	8.4	1680	13.9	780	808	662	49.0	34	130	25.0	138	360	180	4.40	56.00
		Ave	7.0	765	9.3	48	382	37	21.0	16	77	8.1	85	95	93	0.60	0.67
SW02	Monthly between Feb 2005 – Sep 2012	Count	134	85	100	101	124	134	70	70	70	70	70	70	70	100	92
		Min	4.4	200	2.2	0	152	2	5.2	5	25	3.7	25	12	17	0.05	0.01
		Max	8.5	1560	12.4	1400	790	844	54.0	35	130	18.0	149	410	190	2.10	22.00
		Ave	7.0	854	8.5	58	415	36	24.2	18	87	8.9	93	115	103	0.57	0.28
SW04	Monthly between Feb 2005 – Sep 2012	Count	97	76	72	72	96	97	62	62	62	62	62	62	62	72	64
		Min	4.8	60	0.5	0	118	2	1.3	1	5	3.6	7	1	6	0.14	0.01
		Max	8.4	2260	10.4	830	1280	440	36.0	51	300	26.0	600	160	180	2.20	74.00
		Ave	6.8	1017	6.8	128	534	52	16.3	20	100	8.5	191	28	72	0.96	1.25
SW05	Monthly between Feb 2005 – Sep 2012	Count	146	85	100	101	124	136	70	70	70	70	70	70	70	100	92
		Min	5.3	140	3.0	0	142	2	2.9	3	9	2.4	14	1	2	0.04	0.01
		Max	8.0	1590	10.5	4200	860	2600	56.0	39	174	11.0	323	200	656	2.80	9.00
		Ave	6.9	819	7.5	99	457	44	23.6	17	81	5.8	145	49	83	1.10	0.17
SW07	Monthly between Feb 2005 – Sep 2012	Count	100	78	74	74	99	100	65	65	65	65	65	65	65	74	66
		Min	5.3	10	2.0	0	286	2	39.0	22	71	1.1	120	45	19	0.10	0.01
		Max	8.8	6950	14.8	44	4458	64	1800.0	254	736	31.0	1700	892	435	4.90	3.00
		Ave	7.1	3673	9.4	6	2236	9	247.3	146	415	15.7	963	500	223	1.37	0.09

Table 2.6 Water Quality Characteristics for the MCP * (con't)

Monitoring Site	Sampling Date	Value	pH	Electrical Conductivity (uS/cm - field)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Chloride (mg/L)	Sulphates (mg/L)	Alkalinity - Bicarbonate (mg CaCO3/L	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
SW08	Monthly between Feb 2005 - Sep 2012	Count	97	76	72	72	96	97	62	62	62	62	62	62	62	72	64
		Min	4.5	10	0.2	0	246	2	34.0	51	191	8.0	383	91	3	0.02	0.01
		Max	8.0	5910	14.7	420	6400	510	230.0	470	1200	66.0	2600	980	350	24.00	2.00
		Ave	6.6	3754	8.2	48	2068	29	64.2	162	485	20.8	1103	290	93	1.99	0.18
SW09	Monthly between Feb 2005 – Sep 2012	Count	99	78	74	74	98	99	64	64	64	64	64	64	64	73	66
		Min	5.2	250	1.2	0	181	2	11.0	15	53	1.8	92	80	25	0.05	0.01
		Max	8.6	5750	12.5	200	4000	322	150.0	250	716	29.0	1360	1020	295	2.30	9.00
		Ave	6.7	3905	6.2	44	2249	26	98.4	170	533	19.5	1064	515	197	0.61	0.17
SW10	Monthly between Feb 2005 – Sep 2012	Count	40	10	27	28	40	40	3	3	3	3	3	3	3	26	27
		Min	5.6	10	6.9	1	5	2	0.6	0	1	0.7	3	2	3	0.30	0.00
		Max	8.1	120	11.2	43	200	77	1.8	2	9	3.0	14	2	16	1.90	0.34
		Ave	6.4	67	8.6	11	85	9	1.1	1	5	2.2	9	2	10	0.93	0.06
SW11	Monthly between Feb 2005 – Sep 2012	Count	72	30	42	45	67	72	12	12	12	12	12	12	12	43	44
		Min	4.7	30	2.0	0	42	2	1.0	0	3	2.5	4	2	5	0.10	0.01
		Max	7.6	1060	10.6	7400	8285	5040	8.9	10	26	46.0	46	44	108	14.60	68.00
		Ave	6.6	233	7.5	609	559	201	3.1	5	17	11.6	22	17	27	2.05	1.75
SW12	Monthly between Feb 2005 – Sep 2012	Count	79	41	54	55	78	79	24	24	24	24	24	24	24	53	53
		Min	5.4	50	2.3	0	76	2	0.9	0	5	3.1	4	2	2	0.15	0.01
		Max	7.8	1080	10.9	850	628	1020	23.0	18	85	6.6	142	68	118	2.30	0.26
		Ave	6.7	515	7.3	103	313	83	12.3	9	49	5.0	79	19	54	0.97	0.06

* Analyte concentrations below the detection limit were assumed to be at the detection limit for statistical analysis.

Table 2.7 ANZECC (2000) Default Trigger Values for Key Parameters

Water Quality Parameter	Units	Trigger Value for Upland Rivers	MCO Receiving Waters Range
pH range	-	6.5 – 8.0	4.4 – 8.8
Electrical Conductivity (EC)	µS/cm	30 - 350	10 – 6,950
Total Suspended Solids (TSS)	mg/L	50	2 – 5,040
Total Dissolved Solids (TDS)	mg/L	No Trigger Value	5 – 8,285

2.6 ENVIRONMENTAL PROTECTION LICENCE (EPL) - RELEASE CONDITIONS

MCO have recently submitted an application with the Environmental Protection Agency (EPA) to vary the existing EPL (EPA, 2011) for MCO. A summary of the proposed EPL conditions in relation to surface water release conditions are provided below.

Table 2.8 EPL Release Locations

EPA ID No.	Type of Discharge Point	Location Description
1	Discharge to waters; Discharge water quality monitoring	Discharge to Bora Ck from Cockies Dam
2	Discharge to waters; Discharge water quality monitoring	Discharge from Open Cut 1 Sediment Dam 6
24	Stormwater discharge and monitoring point	Sediment dams OC1-1, OC1-2, OC1-3, OC1-4 & OC1-5
26	Stormwater discharge and monitoring point	Sediment dams SD03, SD04, SD05, SD06, SD07, SD08 & SD-14-

Table 2.9 Water Release Concentration Limits – Release Point 1 & 2

Pollutant	Units	Limit/Range
Conductivity	µs/cm	900
Iron	mg/L	5
Oil & Grease	mg/L	10
pH	-	6.5 – 8.5
Total Suspended Solids	mg/L	50
Turbidity	NTU	25
Zinc	mg/l	5

Table 2.10 Water Release Concentration Limits – Release Point 24 & 26

Pollutant	Units	Limit/Range
pH	-	6.5 – 8.5
Total Suspended Solids	mg/L	50
Turbidity	NTU	25

In addition, the combined discharge volume from release points 1 and 2 must not exceed 10ML/day.

However, Condition L2.6 in the proposed EPL states that the limits specified in Table 2.9 and Table 2.10 do not apply when the discharge occurs solely as a result of rainfall measured at the site which exceeds 44mm of rainfall over a consecutive 5-day period.

3 OVERVIEW OF MINE WATER MANAGEMENT SYSTEM

Figure 3.1 shows the locations of existing water storages at MCP. The site water management system includes:

- Sediment dams to collect and settle runoff from disturbed areas,
- Mine water dams to contain groundwater inflows to the open cut pit and runoff potentially impacted by contact with coal, and
- A clean water dam to store water harvested from groundwater bores.

The existing MCP water management system is operated in accordance with the MCP's approved Water Management Plan (WMP) (MCO, 2010) for MCP Stage 1. Key objectives of the surface water management strategy are as follows:

- Ensuring that the water quality leaving the mine site meets the appropriate quality standards;
- To maintain separation of clean water and dirty water;
- Diversion of upslope clean surface water runoff around disturbed areas where feasible;
- Maximising the reuse of treated dirty water onsite; and
- Ensuring that groundwater inflows to the pits are stored and treated on-site and re-used as needed.

The current sources of water supply to MCP include:

- Groundwater inflows to Open Cut 1;
- Water imported from Ulan Coal Mines;
- Runoff captured from the footprint of the mining disturbance area by the water management system; and
- External water supply from groundwater bore fields.

Where practical, surplus mine water from other mines is used in preference to water from the groundwater borefield and clean catchment runoff. MCP has an agreement with the nearby Ulan Coal Mines to be supplied with water from their operations.

Water demands on site include:

- Gross water requirements for the coal handling and preparation plant (CHPP); including water lost to product, coarse rejects and tailings, wash down water and water for stockpile dust suppression;
- Net water used by the CHPP includes water lost with the product and water trapped in tailings;
- Haul road dust suppression;
- Potable water; and
- Evaporation losses.

The CHPP is the primary water demand. Water from the coal handling and preparation process is either lost with the product or coarse reject material.

Further details of the mine water management system and impacts of the proposed modification are provided in Section 4.

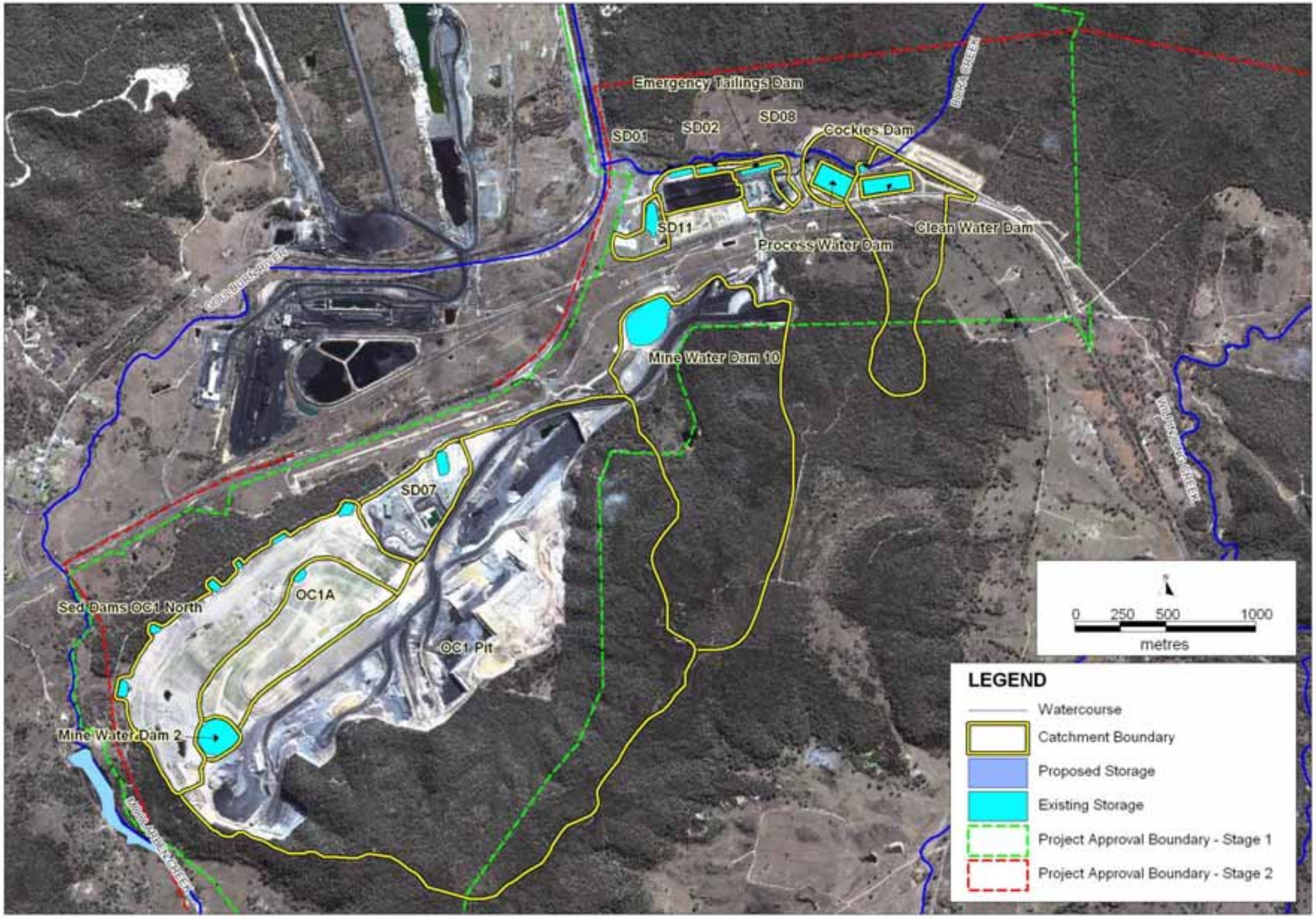


Figure 3.1 Location of Storages, Existing Water Management System

4 IMPACT ASSESSMENT

4.1 POTENTIAL IMPACTS

The potential impacts of the proposed modification on surface water resources include:

- Impacts on imported water requirements from external sources to meet additional operational water requirements of mining operations;
- Adverse impacts on the quality of surface runoff draining from the disturbance area to the various receiving waters surrounding the MCP;
- Adverse impacts on downstream water quality associated with possible overflows from the mine water dams;
- Loss of catchment area draining to Moolarben Creek due to capture of runoff within onsite storages and the open cut pits;
- Interference with flood flows along Moolarben Creek.

An assessment of each of these potential impacts of the proposed modification is provided in the following sections.

4.2 MINE SITE WATER REQUIREMENTS

A detailed daily water balance model has been developed to simulate the behaviour of the mine site water management system over the life of the mine, with and without the proposed modification. Full details of the methodology and results of the water balance modelling are provided in Section 5.

The increase in haul road dust suppression associated with the proposed modification will increase site water demand by up to 280ML/a (depending on the mining phase). However, the increase in disturbance area will result in additional surface runoff inflows to the mine water management system, offsetting some of the increase in demand. The results of the water balance model show that an average 200ML/a (depending on climatic conditions) of additional imported water is required to sustain site demands, as a result of the proposed modification.

The maximum annual imported water requirement, taking into account the additional demands associated with the proposed modification, is around 1,940ML/year. Note that this maximum annual volume include the combined site demands associated with Stage 1, the proposed Stage 1 modification, and the proposed Stage 2 development. MCO currently has access to the following external water sources:

- Surplus mine water from the Ulan Coal Mine through a water sharing agreement (Ulan Water Sharing Agreement - UWSA) – at least 3,000ML/a (no upper limit has been defined)
- Northern Borefields – up to 2,400ML/a; and
- Southern Borefields – up to 450ML/a.

On this basis, the maximum external water requirement can be satisfied from current water sources (UWSA and borefields).

Water required from external sources will be obtained under appropriate Water Access Licences and will be accessed in accordance with the requirements of existing Water Sharing Plans (under the Water Management Act), including adherence to total daily extraction limits. Additional water can be sourced under the UWSA under the current agreement, if required.

Licence allocations on Water Sharing Plan water sources are being finalised for the Stage 2 application. The purchase of a water license for 218 ML/year from the Wollar Creek water source has recently been finalised. MCO is in the process of purchasing a water licence for 9 ML/year from the Goulburn River water source to account for predicted reductions in baseflow as a result of Stage 1 and Stage 2 operations on this water source. Stage 2 modelling simulated an impact on the water source at a maximum of 7 ML/year with the additional 2 ML/year accounting for security of supply and minor increases in baseflow reduction due to the proposed modification.

4.3 SURFACE WATER QUALITY

Water on the mine site will consist of:

- Runoff from undisturbed area (clean runoff),
- Runoff from disturbed areas (sediment-laden runoff), and
- Water that has been affected by contact with coal or other potential contaminants (mine water). This includes groundwater and surface runoff inflows to open cut pits, runoff from coal stockpiles etc.

Wherever possible, clean runoff will be diverted around disturbance areas using diversion drains. This will minimise the volume of water collected in onsite storages and also minimise the impacts on downstream catchments.

Sediment-laden runoff will be collected and settled in sediment dams. If the quality of this water is not suitable for release to receiving waters, it will be pumped back into the mine water management system. This water will only be released from site in accordance with the EPL.

The mine water management system will be operated to fully contain mine water on the mine site and to preferentially reuse this water to meet minesite demands. The results of the mine water balance modelling show that under the full range of historical rainfall conditions, the proposed mine water management system will have sufficient capacity to contain all mine water on the site without uncontrolled releases.

The proposed mine site water management strategy and infrastructure will ensure that the proposed modification has a negligible impact on the quality of surface runoff and receiving waters.

4.4 LOSS OF CATCHMENT AREA

The additional disturbance area associated with the proposed modification removes a small additional area of catchment draining to Moolarben Creek. This removal of catchment has been compared with the overall Moolarben Creek catchment at this location, and is presented in Table 4.1.

Table 4.1 shows that the proposed modification only results in a 1.1% reduction in Moolarben Creek catchment area. This small reduction in catchment area will have a negligible impact on the flow characteristics of Moolarben Creek.

The affected catchment area will be mined through, forming part of the open cut pit. Runoff from the disturbed area will be collected in a sediment dam which is solely for the capture, containment and recirculation of mine affected water consistent with best management practice to prevent the contamination of a water source. Such dams are "excluded works" and are exempt from the requirement for water supply works approvals and Water Access Licences (WALs) under the Water Management Act 2000. For this reason no additional WALs will be required for the capture of surface runoff associated with the proposed modification.

Table 4.1 Catchment Diversion and Loss of Runoff for Modification Only

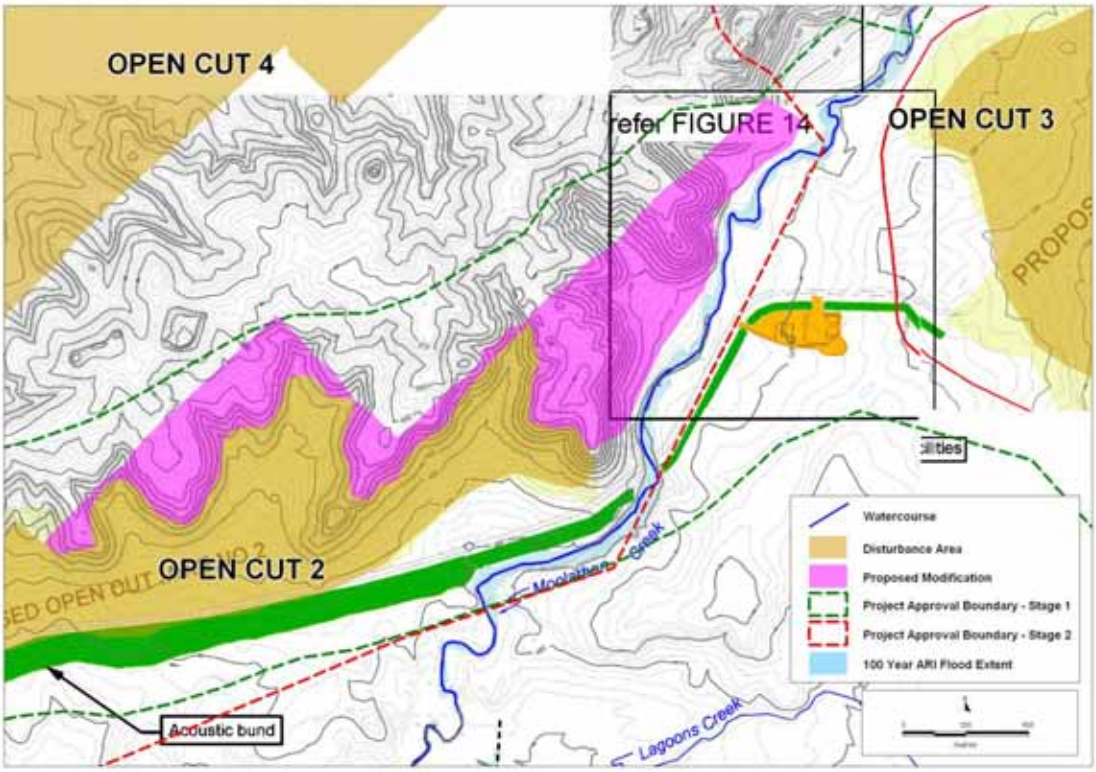
Moolarben Creek Catchment (ha)	Catchment Loss (ha)	Catchment Loss (expressed as a %)	Runoff Loss (expressed as ML/yr)
12,600	140	1.1	35

4.5 IMPACT ON MOOLARBEN CREEK FLOODING

A detailed flood study of Moolarben Creek was undertaken as part of the Stage 1 impact assessment (PB, 2006a). The proposed modification will extend Open Cut 2 to the south, adjacent to the Moolarben Creek floodplain. As stated in Section 1.2, the mine design was modified during its development to ensure no impact to Moolarben Creek or its floodplain. Figure 4.1 shows the modification proposed extension areas as well as the 100 year ARI flood extent for Moolarben Creek. As shown, the proposed extension area is outside the extent of flooding and hence the proposed modification will have no additional impact on flood behaviour in Moolarben Creek up to the 100 year ARI flood event.

Note that the underlying data in Figure 4.1 was sourced from the PB 2006 Flood Study.

(1)



(2)

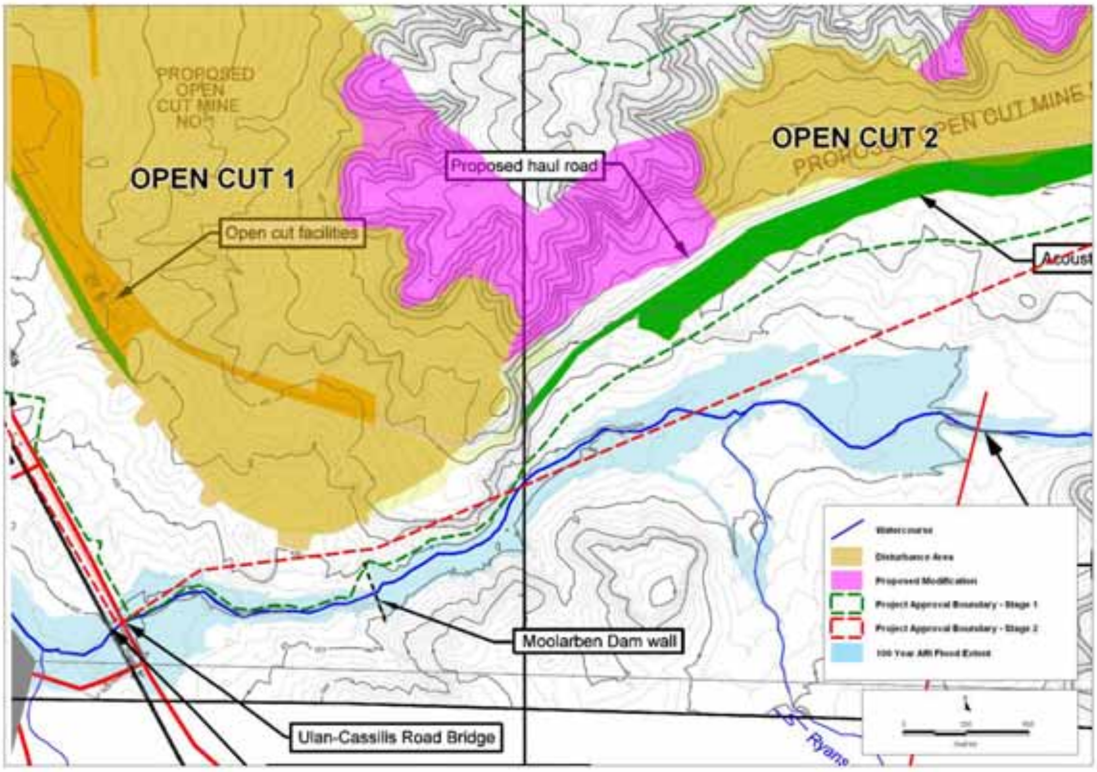


Figure 4.1 Moolarben Creek Flood Extent Showing (1) Upstream and (2) Downstream Reaches (Base Source: PB, 2006a)

5 MANAGEMENT AND MONITORING

Surface water impacts associated with Stage 1 operations are managed under MCO's Water Management Plan (WMP), developed in consultation with the NSW Office of Water (NOW), NSW Office of Environment and Heritage (OEH) and NSW Department of Trade and Investment, Regional Infrastructure and Services (DTIRIS). The primary objectives of the WMP, with respect to surface water, are to:

- Ensure that the water quality leaving the mine site meets the appropriate quality standards under the EPL;
- Define the structures, strategies and procedures to be implemented to ensure that all environmental impacts associated with site water management are minimised;
- Define a program to monitor and assess impacts on surface water;
- Define how the mine will mitigate and respond to potential impacts from mining activities on surface water;
- Divert upslope clean surface water runoff around disturbed areas where feasible;
- Maximise the reuse of treated dirty water onsite;
- Maximise water sharing with other mines; and
- Ensure that groundwater make is stored and treated on-site and re-used as needed.

The WMP includes a Surface Water Monitoring Program and a Surface Water Response Plan that provide guidance on the monitoring and management for the surface water management system, including details of management response actions.

The main potential impact of the proposed modification is the additional imported water requirements, which is primarily associated with the increase in haul road dust suppression. As discussed in Section 4.2, the proposed modification results in an additional imported water requirement of 200ML/a (on average), with a maximum total requirement of around 1,940ML/a. This can currently be supplied with the existing UWSA and borefield supply, and MCO have the ability to access additional water under the UWSA, if required. These existing water supply sources and water sharing agreements should be maintained to ensure that adequate water is available is required.

This key potential impact will be managed under the existing surface water management system and in accordance with the WMP. The WMP and relevant sub-plans will be reviewed and updated as required to accommodate the proposed modification.

6 MINE WATER BALANCE

6.1 BACKGROUND

A water balance assessment was previously undertaken by Worley Parsons (WP, 2008) as part of the Stage 2 Environmental Assessment in November 2008. The water balance model used by Worley Parsons was developed for the water management strategy as part of the Stage 2 proposal, and also formed the basis of the water balance modelling for the Moolarben Stage 2 Preferred Project Report (HB, 2012). As such, it was based on different production rates and site demands than those adopted for the Stage 1 modification.

For the assessment of the impacts of the Stage 1 modification on the site water balance, a new water balance model was developed which incorporated updated information on the configuration of the site water management system, proposed water demands and coal production rates. The water balance model includes the proposed Stage 2 development as documented in the previous Environmental Assessment (WP, 2008).

6.2 ASSESSMENT OVERVIEW

An assessment of the potential impacts of the proposed modification on the MCP Stage 1 water management system was undertaken using the OPSIM water balance simulation software. The assessment considered the following key performance indicators:

- Pit water inventory;
- Out-of-pit water inventory;
- External water requirements;
- Uncontrolled discharges; and
- Annual site water balance.

Separate water balance models were developed to represent the following scenarios:

- *Scenario 1*: No Modification
- *Scenario 2*: Includes the proposed modification to Open Cuts 1 and 2.

Key assumptions associated with the modelling are as follows:

- The proposed modification commences in 2013, or Year 1 of the project phasing; and
- Stage 2 works have been included for both scenarios (with and without the modification), however model results are only been presented for Stage 1 works; and
- Controlled release capabilities have been modelled in accordance with the proposed EPL conditions specified in Section 2.6, for EC only.

Details of the methodology and results of the water balance modelling are provided in the following sections.

6.3 SIMULATION METHODOLOGY

For each scenario, the model was configured to represent the changing characteristics of the conceptual water management system over the 24 year mine life. This included changes in contributing catchment areas draining to the various mine site storages, as well as varying groundwater inflows, coal production rates and site water demand. Six different representative phases of mine life were modelled to reflect variations over time. These modelling phases are summarised in Table 6.1. Although the catchment areas will continuously change as the mining progresses, the adopted approach of modelling discrete stages will provide a reasonable representation of conditions over the 24 year period.

Table 6.1 MCP Model Phases

Representative Mine Phase	Applied Range of Mine Life	Phase Duration
Year 2 (2014)	Year 1-2 (2013-2014)	2 years
Year 7 (2019)	Year 3-7 (2015-2019)	5 years
Year 12 (2024)	Year 8-12 (2020-2024)	5 years
Year 16 (2028)	Year 13-16 (2025-2028)	4 years
Year 19 (2031)	Year 17-19 (2029-2031)	3 years
Year 24 (2036)	Year 20-24 (2032-2036)	5 years

Two kinds of model simulation were used for this assessment, forecast simulation and static simulation.

For a static simulation, a single stage of mine development is modelled separately from the other stages. The model is run for a 123 year period using historical climatic data (1889-2011), using this single mine configuration. This simulation type is useful for providing an indication of the water balance under the specific operating rules adopted for that stage of operation and allows for a comparison of inflows and outflows between the different stages or configurations.

The forecast simulation allows the model configuration to change over the modelled 24 year mine life, reflecting changes in the water management system over time. The operational rules and physical layout for each representative stage of mine progression are applied to the range of years given in Table 6.1 and are then linked in the model to reflect the development of the mine.

The water balance model was run on a daily timestep for the 24 year operating period of the mine. To assess the effects of varying climatic conditions, the model was run for multiple climate sequences, each referred to as a “realisation”. Each realisation is based on a 24 year sequence extracted from the historical rainfall data. The first realisation will be based on rainfall data from 1889 to 1913. The second will use data from 1890 to 1914 and so on. This approach provides the widest possible range of climate scenarios covering the full range of climatic conditions represented in the historical rainfall record. Statistical analysis of the results from all realisations provides a probability distribution of key hydrologic parameters, such as storage and spill volumes.

In interpreting the results of a forecast simulation, it should be noted that this simulation type provides a statistical analysis of the water management system's performance over its 24 year life, based on 99 realisations with different climatic sequences. The results are presented as daily or annual exceedance probability percentile traces. The 1st and 10th percentiles represent wetter conditions and the 90th and 99th percentile results represent dryer conditions. There is an 80% chance that the result will fall within the 10th and 90th percentiles. The 1st and 99th percentile results represent the likely upper and lower bounds of the estimate (i.e. 98% of all results will fall within this range). Importantly, a percentile trace shows the envelope of results at the chosen exceedance probability and does not represent continuous results from a single model realisation e.g. the 50th percentile trace does not represent the model time series for median climatic conditions.

6.4 CLIMATE DATA

Long term daily rainfall and evaporation data for the area from January 1889 to July 2012 (123+ years) obtained from the DSITIA Data Drill service were used for the simulation. This data set is corrected for accumulated daily rainfall totals and missing data and is well suited to use in water balance modelling. This data was verified against recorded rainfall data at the nearby Ulan Water station (no. 062036) (refer to Table 2.2).

6.5 WATER MANAGEMENT SYSTEM CONFIGURATION AND ASSUMPTIONS

Information on existing site storages and operation has been obtained from the site water management plan and information provided by MCO. The site water management system for future development of the mine has been based on information contained in previous environmental assessments (PB 2006a, PB 2006b, WP 2011, HB 2012), with some minor changes to accommodate the proposed modification.

For the proposed dams, an indicative location is shown on Figure 6.1, however the final position of the dams will be confirmed as part of the detailed design process. A summary of the existing and proposed storages (under Stage 1, the Stage 1 Modification and as part of the Stage 2 proposal) are summarised in the following sections.

6.5.1 Existing Storages (Stage 1)

The existing min water management infrastructure is presented in Figure 6.1 and comprises the following:

- Clean Water Dam;
- Process Water Dam;
- Sediment Dam SD01;
- Sediment Dam SD02;
- Sediment Dam SD07;
- Sediment Dam SD08;
- Sediment Dam SD11;
- Cockies Dam;
- Mine Water Dam 10;
- OC1 Mine Water Dam 2;
- Sediment Dam OC1A; and
- Sediment Dams OC1 North.

In the near future, Mine Water Dam 10 will be mined through and removed from the water management system, to be replaced with a dam of similar size and function. This replacement dam has been called “OC1 Mine Water Dam 1” for the purposes of this assessment. The final location of this dam will be confirmed as part of the detailed design process.

6.5.2 Proposed Storages (Stage 1)

The storages proposed under the Stage 1 development include:

- OC1 Mine Water Dam 1 (which replaces Mine Water Dam 10);
- OC2 Mine Water Dam;
- OC3 Mine Water Dam;
- OC2 Sediment Dams (OC2A, OC2B, OC2C, OC2D); and
- OC3 Sediment Dams (OC3A, OC3B, OC3C, OC3D, OC3E).

Note that the locations of these storages on Figure 6.1 are indicative only, and will be confirmed as part of detailed design.

6.5.3 Proposed Storages (Stage 1 Modification)

One additional storage will be required as a result of the proposed modification, OC2E Sediment Dam. This storage captures disturbed area runoff from the southern end of the Open Cut 2 extension. The additional disturbance areas associated with the remainder of the proposed extension will be managed within the proposed Stage 1 storages (see Section 6.5.2).

6.5.4 Proposed Storages (Stage 2)

The storages proposed under the Stage 2 development include:

- OC4 Mine Water Dam; and
- OC4 Sediment Dams (OC4A, OC4B, OC4C, OC4D, OC4E, OC4F, OC4G and OC4H).

Note that the locations of these storages on Figure 6.1 are indicative only, and will be confirmed as part of detailed design.

6.5.5 Concept Sizing of Dams

Adopted sizes areas of the mine site water storages are given in Table 6.2 for Scenario 1 (No Modification) and Table 6.3 for Scenario 2 (With Modification). The key differences between the two tables are as follows:

- Small differences in volumes for the OC2 Sediment Dams; and
- OC2E Sediment Dam only required for Scenario 2.

The assumed periods of operation for the mine site storages are given in Figure 6.2 for Scenario 1 and Figure 6.3 for Scenario 2

6.5.6 Model Schematic & Modelling Assumptions

The water management system schematics are shown in Figure 6.4 for Stage 1 and Figure 6.5 for Stage 2.

Model assumptions are summarised as follows:

- Pump capacity of 50L/s (4.3ML/d) for all pumped transfers.
- Runoff from undisturbed catchments along the southern side of Open Cut 1 currently drains into the pit.

- Overflows from sediment dams along Open Cut 1, 2 and 3 discharge to the Goulburn River via Moolarben Creek or direct flow. Overflows from sediment dams at the CHPP area discharge to the Goulburn River via Bora Creek. Overflows from sediment dams along the boundary of Open Cut 4 discharge to Wilpinjong Creek via Murragamba Creek and Eastern Creek.
- The CHPP water demand is made up from Emergency Tailings Dam Decant Return, SD01 and SD02 treatment ponds (1st priority), OC1 Mine Water Dam 1 (2nd Priority) and Process Water Dam (3rd priority).
- Water pumped from the Ulan Coal Mine under the Ulan Water Sharing Agreement (WP, 2011) is stored in the Process Water Dam.
- Water pumped from the groundwater bores is stored in the clean water dam.
- Mine Water Dam 10 collects runoff and groundwater inflows to the Open Cut 1 pit including groundwater inflows as well as runoff from the ROM pad. This dam functions as the main dirty water storage for Open Cut 1 from Year 0 to Year 2 when it is eventually mined out.
- It is assumed that runoff and groundwater inflows to Open Cut 2, 3, 4 are stored in Mine Water Dams OC2, OC3 and OC4 respectively. Water stored in these mine water storages will be used locally for dust suppression.
- OC1 Mine Water Dam 1 is the proposed replacement for Mine Water Dam 10 in Year 2. Water stored in OC2 Mine Water Dam, OC3 Mine Water Dam and OC4 Mine Water Dam is pumped to OC1 Mine Water Dam 1 to supply CHPP and dust suppression demands.
- OC1 Mine Water Dam 2 functions as secondary dirty water storage for Open Cut 1 and will be in place throughout the life of the mine. This dam also collects runoff from disturbed and undisturbed areas in the later stages of the mine.
- A series of sediment dams along the north-eastern spoil dump of Open Cut 1, referred to collectively as Sediment Dams OC1 North, collect runoff from un-rehabilitated spoil. These sediment dams are pumped to OC1 Mine Water Dam 2 to minimise spills.
- Sediment Dam OC1A collects runoff from un-rehabilitated spoil and also functions as a stilling basin.
- Sediment Dams OC2A to OC2D, referred to collectively as OC2 Sediment Dams, collect runoff from disturbed and undisturbed areas in Open Cut 2. These sediment dams have the ability to pump to the OC2 Mine Water Dam to minimise spills.
- Sediment Dams OC3A to OC3E, referred to collectively as OC3 Sediment Dams, collect runoff from disturbed and undisturbed areas in Open Cut 3. These sediment dams have the ability to pump to the OC3 Mine Water Dam to minimise spills.
- Sediment Dams OC4A to OC4G, referred to collectively as OC4 Sediment Dams, collect runoff from disturbed and undisturbed areas in Open Cut 4. These sediment dams have the ability to pump to the OC4 Mine Water Dam to minimise spills.
- Sediment Dams SD01 and SD02 collect runoff from disturbed areas including the CHPP pad and Product Stockpile Pad. These dams can pump back to the mine water system.
- Sediment Dam SD11 collects runoff from undisturbed catchments. It is assumed that sediment dam SD11 will be decommissioned by Year 3.
- Sediment Dam SD07 collects runoff from disturbed areas including the ROM pads, MIA area and CHPP area. This dam is pumped back into the Process Water Dam.
- Controlled releases from the MCO WMS have been modelled to reflect the release conditions specified in the proposed EPL.
- Potable water is not included as a part of the surface water management system.

6.5.7 Sediment Dam Sizing

The operating rules for the sediment dam collection system are based on the recommendations in the guidelines 'Managing Urban Stormwater Soils and Construction Guideline: Mines and Quarries' (DECCW 2008). The operating rules are as follows:

- Runoff from disturbed areas will be captured in a sediment dam and pumped back to the mine water system;
- Pump capacities will be sized to empty sediment dams in 5 days; and
- Runoff from rehabilitated areas established for more than 2 years will be directed to a sediment dam and released off-site.

The sediment dams have been sized in accordance with current recommended design standards in the following guidelines:

- Managing Urban Stormwater, Soils and Construction (Landcom, 2004); and
- Managing Urban Stormwater, Soils and Construction, Mines and Quarries (DECC, 2008).

The sediment dam volumes have been based on the following design standards and methodology:

- "Type F" sediment basins;
- Total sediment basin volume = settling zone volume + sediment storage volume. The sediment storage volume is the portion of the basin storage volume that progressively fills with sediment until the basin is de-silted. The settling zone is the minimum required free storage capacity that must restored within 5 days after a runoff event;
- Sediment basin settling zone volume based on 90th percentile 5-day duration rainfall (35.6mm) with an adopted volumetric event runoff coefficient for disturbed catchments of 0.5; and
- Sediment storage volume = 50% of settling zone volume.

6.5.8 Clean Water Diversion/Dams

It has been assumed that proposed clean water diversion dams on Murragamba Creek and Eastern Creek will be adequately sized to divert all runoff without overflows into the Stage 2 open cut pits. These works do not directly impact the proposed Modification.

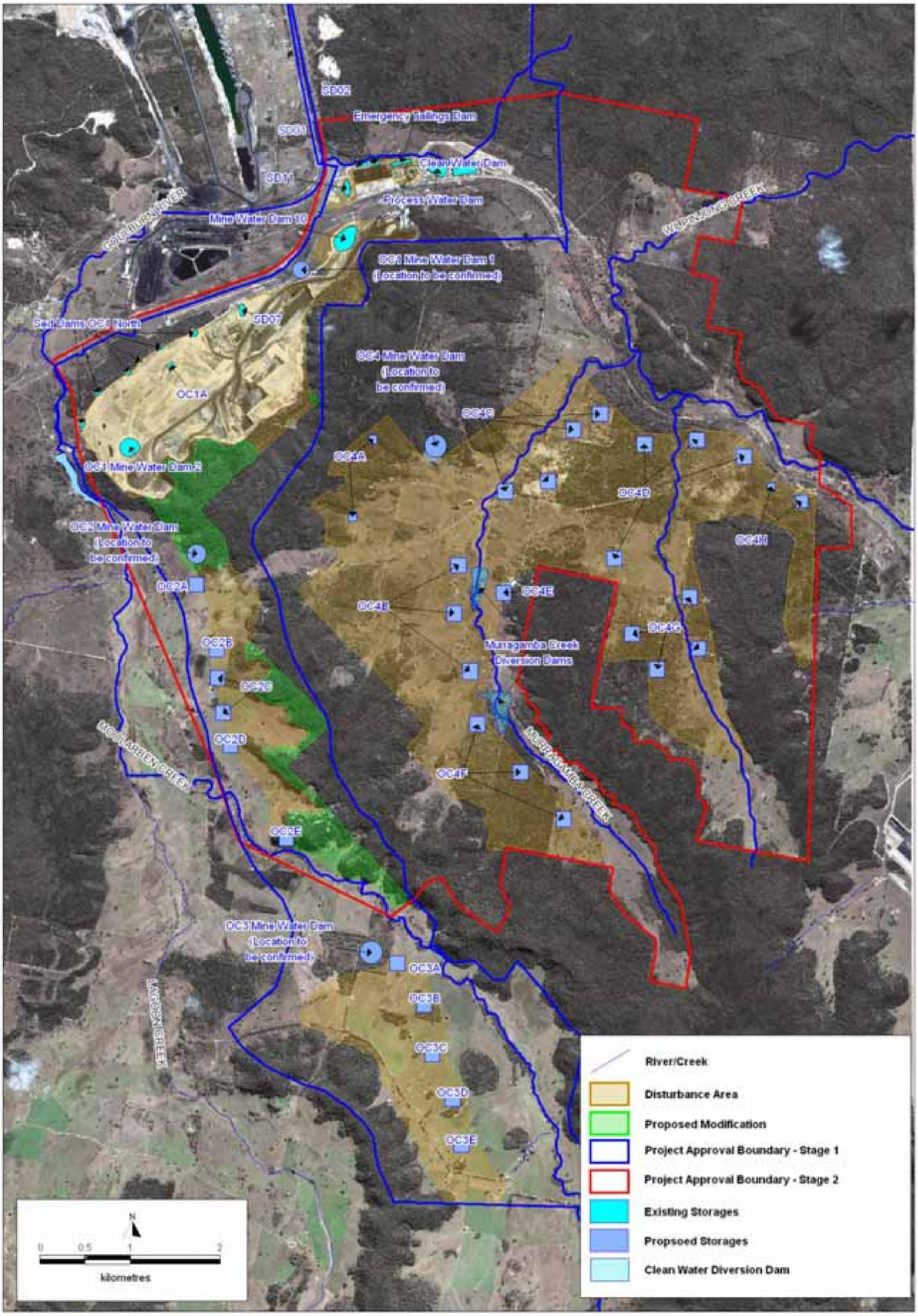


Figure 6.1 Overview of Water Management System Infrastructure

Table 6.2 MCP Storage Summary, Scenario 1

Storage	Total Surface Area (ha)	Total Storage Volume (ML)	Overflows to
Existing Storages			
Mine Water Dam 10	4.00	226	Bora Creek
OC1 Mine Water Dam 2	3.40	220.5	Moolarben Creek
Process Water Dam	2.33	113.2	Bora Creek
Clean Water Dam	2.14	89.4	Bora Creek
Sediment Dam SD01	0.75	15.4	Bora Creek
Sediment Dam SD02	0.35	9.5	Bora Creek
Sediment Dam SD07	0.77	20.8	Goulburn River
Sediment Dam SD08	0.09	0.9	Bora Creek
Sediment Dam SD11	1.05	22.3	Bora Creek
Cockies Dam	0.19	3.7	Bora Creek
Sediment Dams OC1 North	1.80	40.4	Moolarben Creek
Sediment Dam OC1A	0.40	11.9	Moolarben Creek
Emergency Tailings Dam	0.86	23.1	Bora Creek
Proposed Storages (Stage 1)			
OC1 Mine Water Dam 1 (replaces Mine Water Dam 10)	4.00	226	Moolarben Creek
OC2 Mine Water Dam	3.40	220.5	Moolarben Creek
OC3 Mine Water Dam	3.40	220.5	Moolarben Creek
Sediment Dams OC2A	1.08	27.7	Moolarben Creek
Sediment Dams OC2B	0.59	14.8	Moolarben Creek
Sediment Dams OC2C	1.48	37.4	Moolarben Creek
Sediment Dams OC2D	0.84	20.9	Moolarben Creek
Sediment Dams OC3A	1.11	28.1	Moolarben Creek
Sediment Dams OC3B	0.71	17.5	Moolarben Creek
Sediment Dams OC3C	0.52	13.2	Moolarben Creek
Sediment Dams OC3D	0.62	15.6	Moolarben Creek
Sediment Dams OC3E	0.47	11.8	Moolarben Creek
Proposed Storages (Stage 2)			
OC4 Mine Water Dam	3.40	220.5	Wilpinjong Creek
Sediment Dams OC4A	1.68	51.6	Murragamba Creek
Sediment Dams OC4B	3.26	97.7	Murragamba Creek
Sediment Dams OC4C	2.90	84.5	Murragamba Creek
Sediment Dams OC4D	2.79	84.3	Murragamba Creek
Sediment Dams OC4E	1.26	38.2	Wilpinjong Creek
Sediment Dams OC4F	2.61	78.6	Wilpinjong Creek
Sediment Dams OC4G	4.51	135.3	Wilpinjong Creek
Sediment Dams OC4H	0.36	11.3	Eastern Creek

Table 6.3 MCP Storage Summary, Scenario 2

Storage	Total Surface Area (ha)	Total Storage Volume (ML)	Overflows to
Existing Storages			
Mine Water Dam 10	4.00	226	Bora Creek
OC1 Mine Water Dam 2	3.40	220.5	Moolarben Creek
Process Water Dam	2.33	113.2	Bora Creek
Clean Water Dam	2.14	89.4	Bora Creek
Sediment Dam SD01	0.75	15.4	Bora Creek
Sediment Dam SD02	0.35	9.5	Bora Creek
Sediment Dam SD07	0.77	20.8	Goulburn River
Sediment Dam SD08	0.09	0.9	Bora Creek
Sediment Dam SD11	1.05	22.3	Bora Creek
Cockies Dam	0.19	3.7	Bora Creek
Sediment Dams OC1 North	1.80	40.4	Moolarben Creek
Sediment Dam OC1A	0.40	11.9	Moolarben Creek
Emergency Tailings Dam	0.86	23.1	Bora Creek
Proposed Storages (Stage 1)			
OC1 Mine Water Dam 1 (replaces Mine Water Dam 10)	4.00	226	Moolarben Creek
OC2 Mine Water Dam	3.40	220.5	Moolarben Creek
OC3 Mine Water Dam	3.40	220.5	Moolarben Creek
Sediment Dams OC2A	1.27	32.5	Moolarben Creek
Sediment Dams OC2B	0.74	18.5	Moolarben Creek
Sediment Dams OC2C	1.47	36.8	Moolarben Creek
Sediment Dams OC2D	1.32	32.9	Moolarben Creek
Sediment Dams OC3A	1.11	28.1	Moolarben Creek
Sediment Dams OC3B	0.71	17.5	Moolarben Creek
Sediment Dams OC3C	0.52	13.2	Moolarben Creek
Sediment Dams OC3D	0.62	15.6	Moolarben Creek
Sediment Dams OC3E	0.47	11.8	Moolarben Creek
Proposed Storages (Stage 1 Modification)			
Sediment Dams OC2E	1.03	25.9	Moolarben Creek
Proposed Storages (Stage 2)			
OC4 Mine Water Dam	3.40	220.5	Wilpinjong Creek
Sediment Dams OC4A	1.68	51.6	Murragamba Creek
Sediment Dams OC4B	3.26	97.7	Murragamba Creek
Sediment Dams OC4C	2.14	84.3	Murragamba Creek
Sediment Dams OC4D	2.79	86.8	Murragamba Creek
Sediment Dams OC4E	1.26	38.2	Wilpinjong Creek
Sediment Dams OC4F	2.61	78.6	Wilpinjong Creek
Sediment Dams OC4G	4.51	135.3	Wilpinjong Creek
Sediment Dams OC4H	0.36	11.3	Eastern Creek

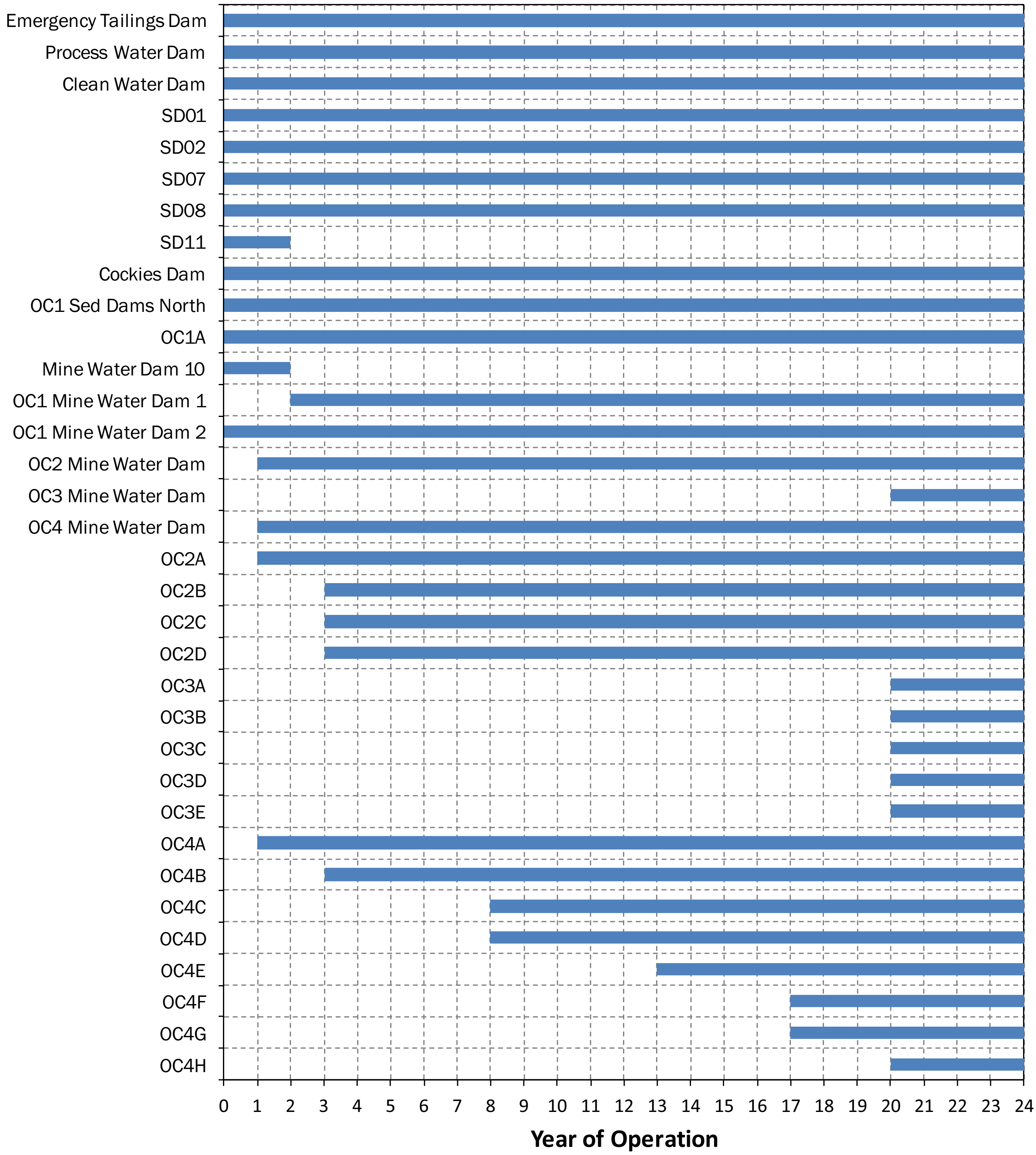


Figure 6.2 Moolarben Storages Periods of Operation, Scenario 1

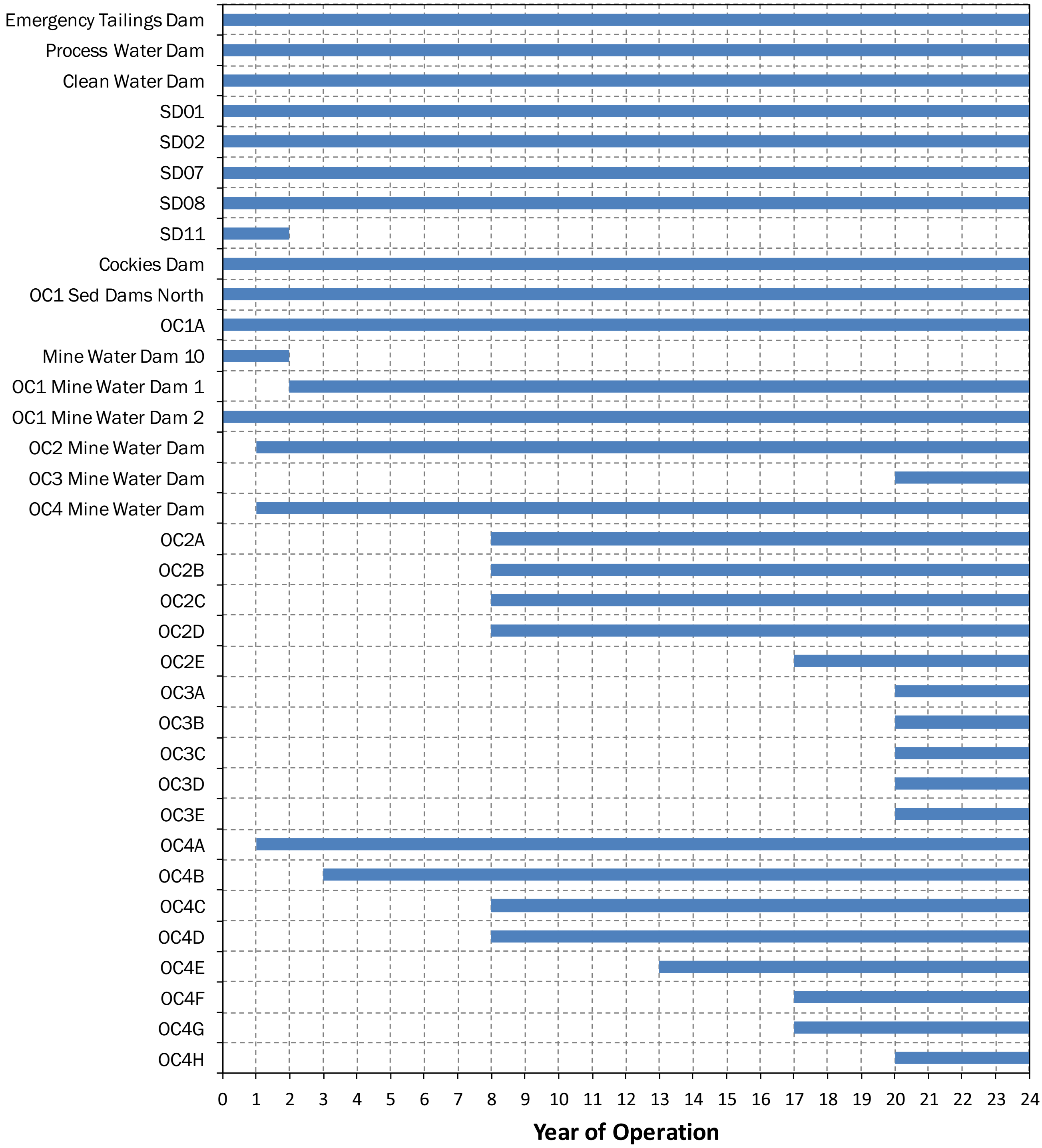


Figure 6.3 Moolarben Storages Periods of Operation, Scenario 2

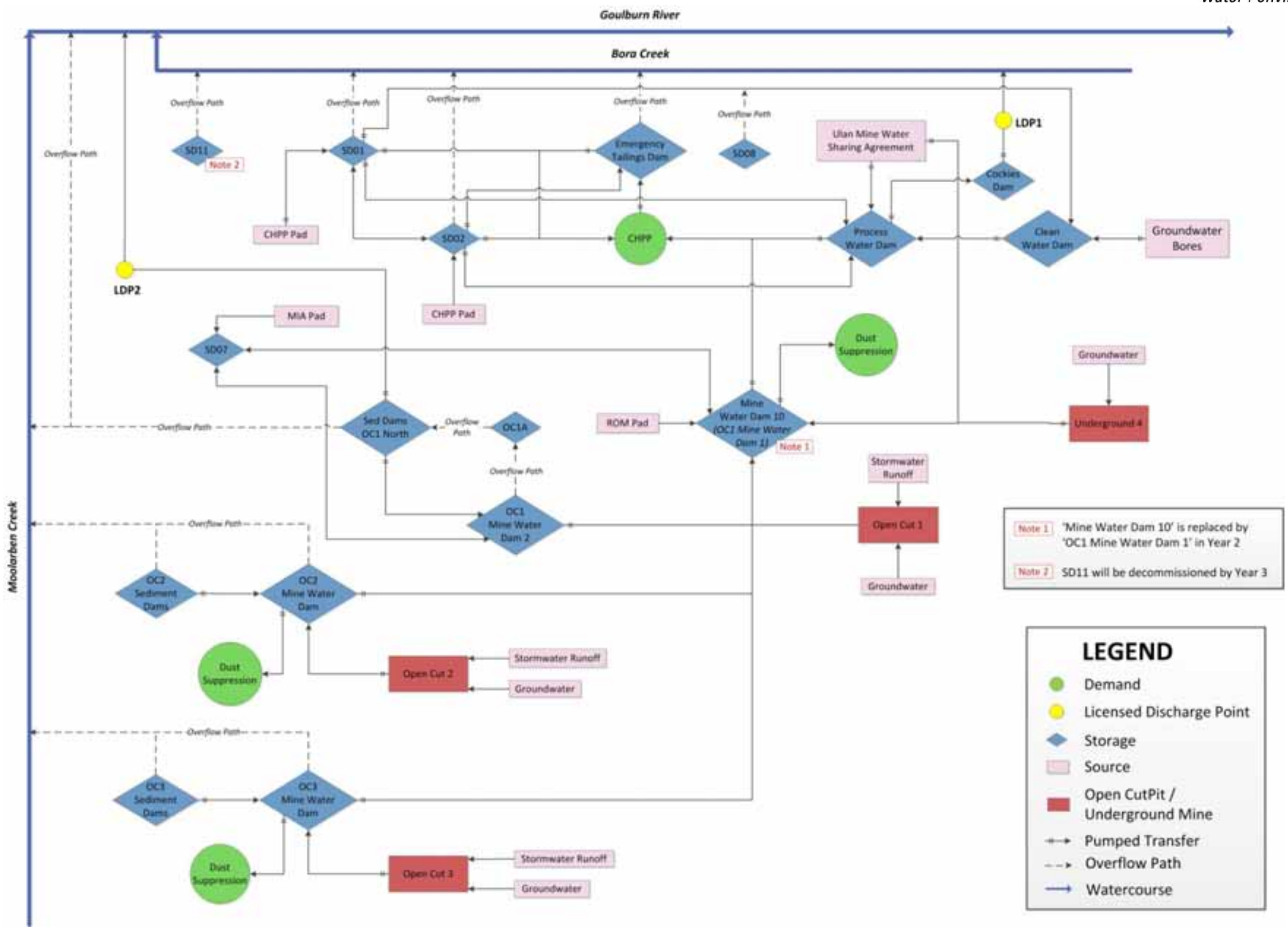


Figure 6.4 Moolarben Water Management System Schematic, Existing Work plus Stage 1

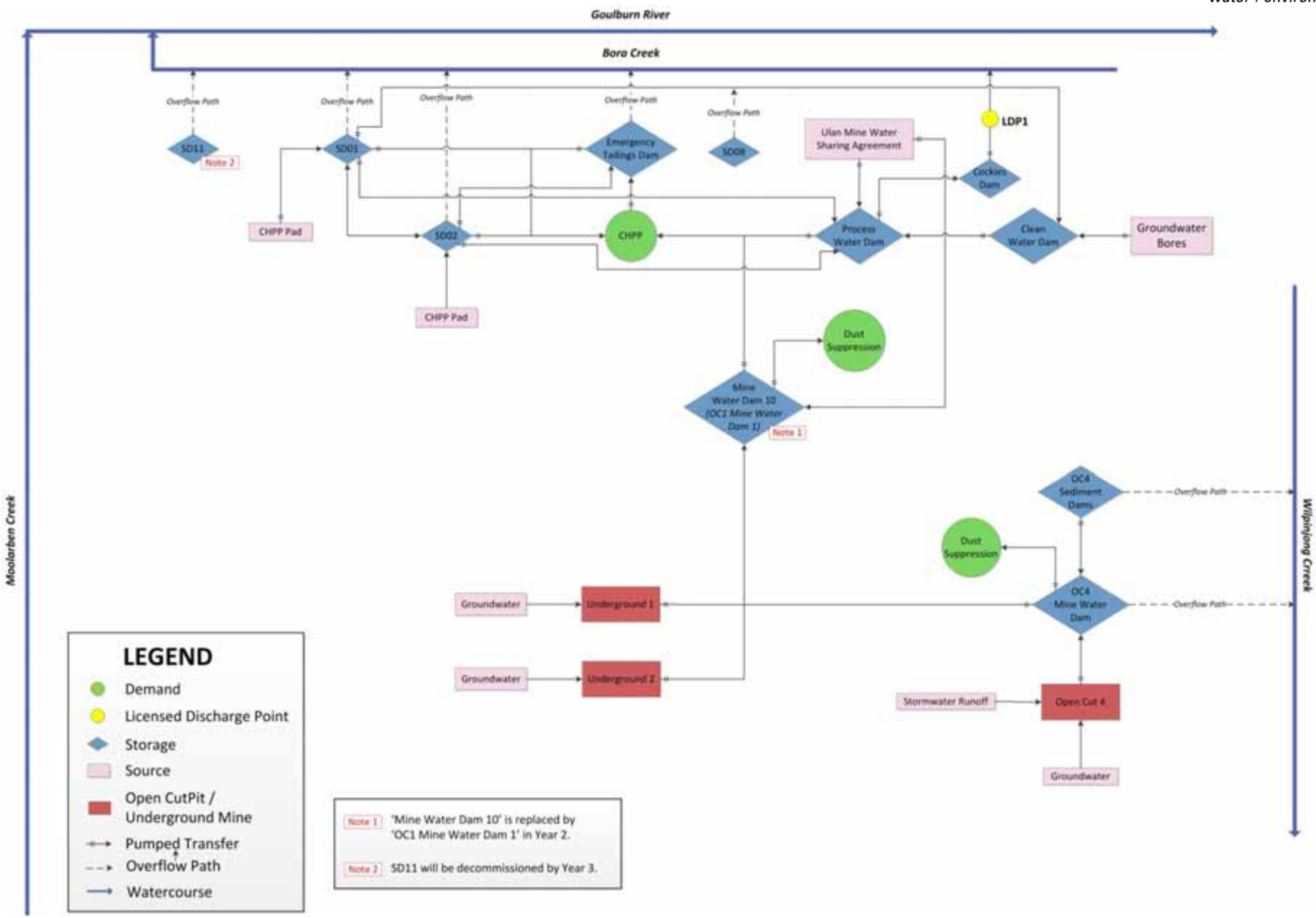


Figure 6.5 Moolarben Water Management System Schematic, Existing Works plus Stage 2

6.6 SIMULATION OF CATCHMENT RUNOFF

Catchment runoff inflows to the mine water management system were modelled using the AWBM rainfall-runoff model. Catchments across the site were characterised into the following land use types:

- Natural/Undisturbed;
- Roads/Industrial/Hardstand;
- Mining Pit;
- Coal Stockpile
- Unrehabilitated Spoil; and
- Rehabilitated Spoil.

The AWBM model for natural/undisturbed catchments (i.e. not disturbed by mining) was calibrated against available stream flow data at the following four locations:

- Moolarben Creek at Moolarben Dam;
- Moolarben Creek at Ulan Road (gauge no. MOOL001);
- Bora Creek at Ulan Road (gauge no. MOOL002);
- Wilpinjong Creek at Red Hill (gauge no. MOOL003);

The calibrated AWBM parameters for the four locations differed significantly. The most suitable parameter set was determined by undertaking a calibration of the OPSIM model against modelled and observed combined site inventory over a six month period. Historical site water inventory data was provided by MCO. The results of the OPSIM model calibration showed that the Bora Creek catchment model parameters produced the best match between modelled and observed combined site inventory. Hence, the Bora Creek catchment model parameters were adopted for natural/undisturbed catchments (shown in Table 6.4). Figure 6.6 and Figure 6.7 show predicted and recorded daily runoff and flow duration curves for Bora Creek at Ulan Road. Figure 6.8 compares modelled and observed combined site inventory using the Bora Creek catchment AWBM parameters.

Table 6.4 Natural Catchment AWBM Parameters, Bora Creek at Ulan Road

AWBM Parameter	Natural/ Undisturbed
A1	0.2
A2	0.2
C1	45
C2	95
C3	150
BFI	0.55
Kb	0.7
Ks	0

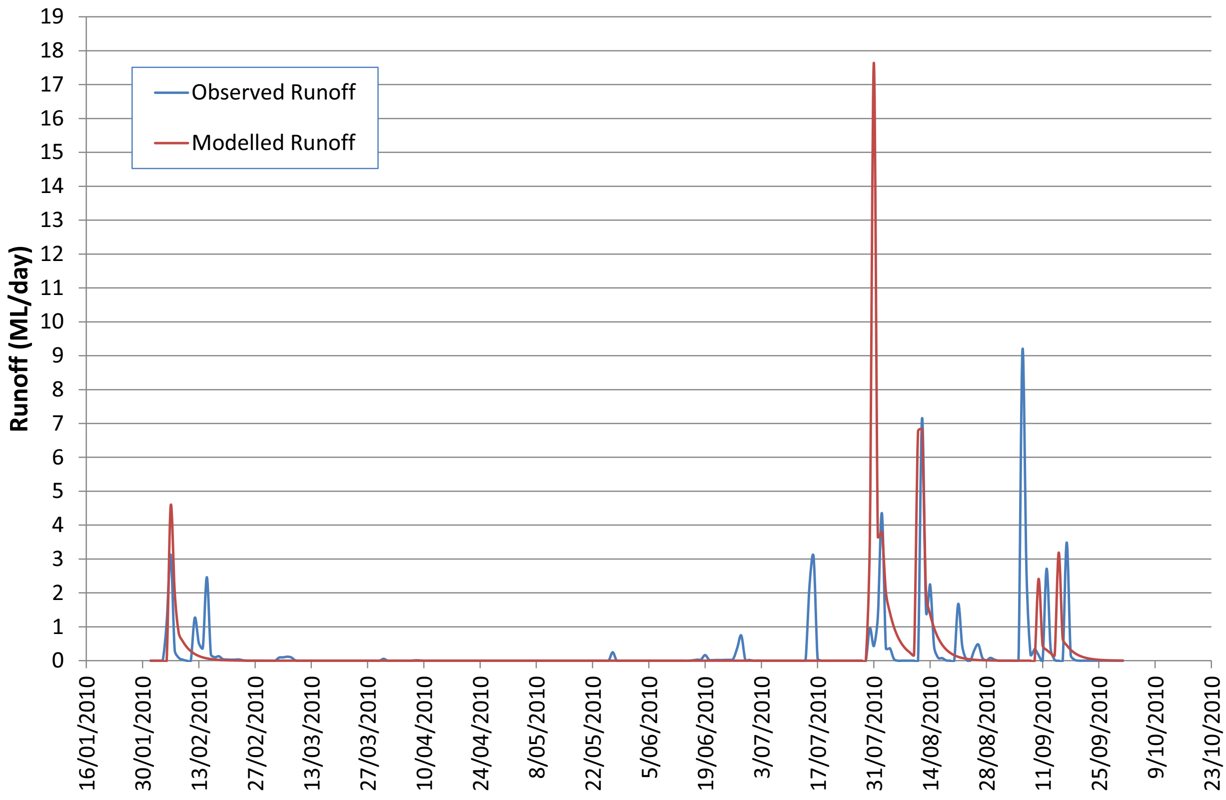


Figure 6.6 Comparison of Modelled and Observed Daily Runoff, Bora Creek at Ulan Road

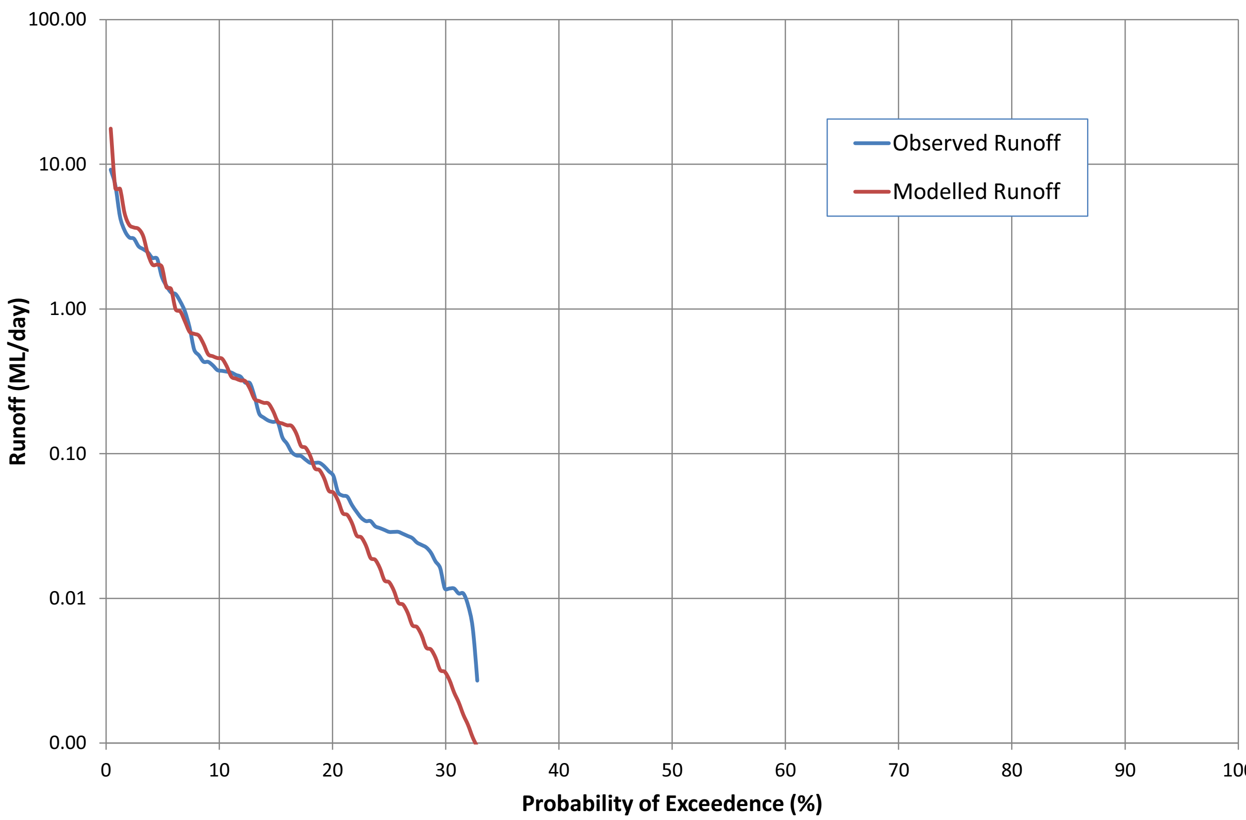


Figure 6.7 Comparison of Modelled and Observed Flow-Duration Curves, Bora Creek at Ulan Road

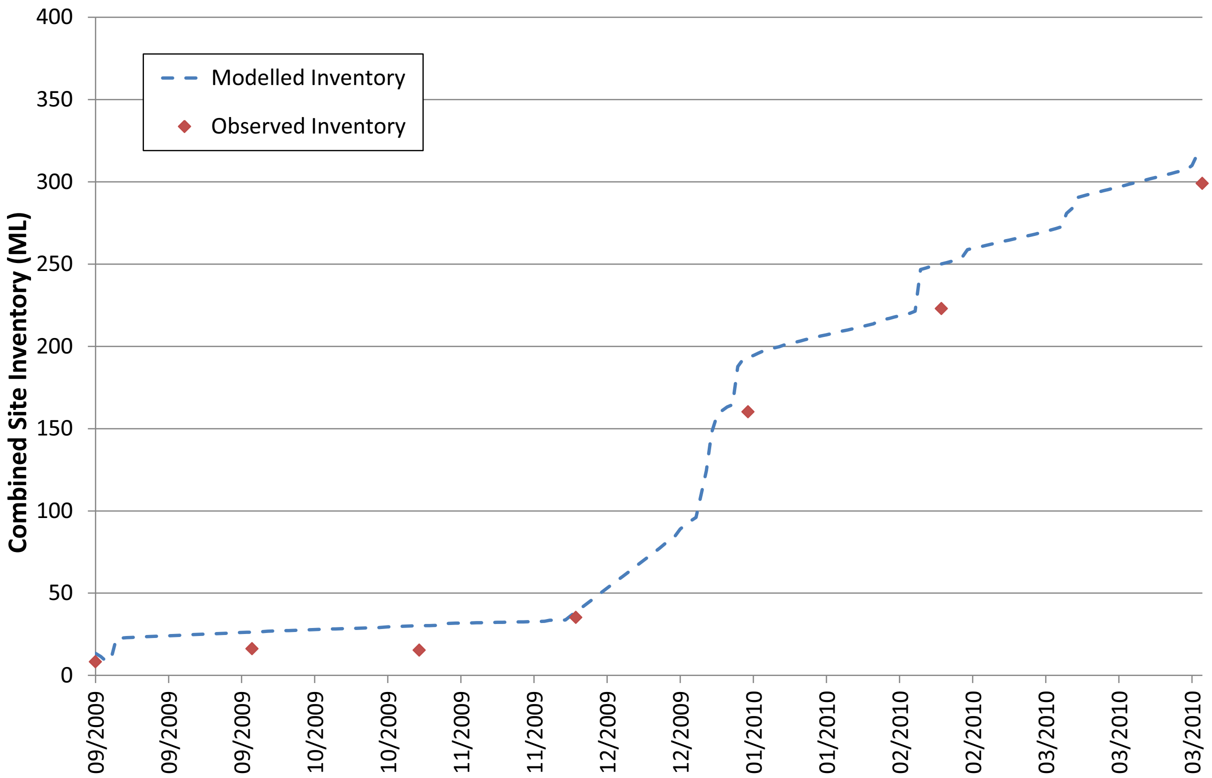


Figure 6.8 Comparison of Modelled and Observed Combined Site Inventory

Model parameters for pit, hardstand and stockpile catchments were adopted based on previous experience with OPSIM modelling on these types of catchments. Model parameters for spoil catchments were adopted from a previous study of runoff from disturbed mine catchments in the Hunter Valley region (ACARP, 2001). Natural/undisturbed catchment AWBM parameters were adopted for rehabilitated spoil catchments. Model parameters for the various catchment types are summarised in Table 6.5.

Table 6.5 AWBM Parameters

Parameter	Natural/ Undisturbed	Roads/ Industrial/ Hardstand	Mining Pit	Unrehabilitated Spoil	Rehabilitated Spoil	Coal Stockpile
A1	0.2	0.1	0.1	0.1	0.2	0.1
A2	0.2	0.9	0.9	0.3	0.2	0.9
C1	45	4	4	15	45	4
C2	95	16	16	50	95	16
C3	150	-	-	110	150	-
BFI	0.55	0	0	0.20	0.55	0
Kb	0.70	0	0	0	0.70	0
Ks	0	0	0	0	0	0

6.7 CATCHMENT AREAS

Catchment types draining to the mine site storages change with mining progression. For Scenario 1, mining progression and associated spoil/rehabilitation footprints at each stage were based on the latest mine plans. Mining progression for Scenario 2 was based on conceptual mine plans for the Stage 1 Modification.

Water balance modelling was undertaken for six discrete phases, as follows:

- Phase 1: Years 1-2 (Represented by Year 2 mine plan)
- Phase 2: Years 3-7 (Represented by Year 7 mine plan)
- Phase 3: Years 8-12 (Represented by Year 12 mine plan)
- Phase 4: Years 13-16 (Represented by Year 16 mine plan)
- Phase 5: Years 17-19 (Represented by Year 19 mine plan)
- Phase 6: Years 20-24 (Represented by Year 24 mine plan)

A summary of catchment areas and types for each mine phase is given in Table 6.6 for Scenario 1 and in Table 6.7 for Scenario 2. A breakdown of catchment areas and catchment types draining into each mine storage for all mine phases are given in Appendix A and illustrated in Figure 6.9 to Figure 6.14 for Scenario 1 and in Figure 6.15 to Figure 6.20 for Scenario 2.

Table 6.6 Catchment Areas, Scenario 1 (No Modification)

Year	Catchment Area (ha)						
	Natural	Pit	Unrehabilitated Spoil	Rehabilitated Spoil	Stockpile	Hardstand	Total
2	740	123	297	128	11	74	1,373
7	770	114	448	409	11	92	1,837
12	927	110	376	893	11	118	2,428
16	1,184	105	257	1,141	11	116	2,813
19	1,380	70	116	1,532	11	111	3,270
24	1,600	85	26	2,048	11	81	3,850

Table 6.7 Catchment Areas, Scenario 2 (With Modification)

Year	Catchment Area (ha)						
	Natural	Pit	Unrehabilitated Spoil	Rehabilitated Spoil	Stockpile	Hardstand	Total
2	687	79	98	236	11	66	1,177
7	544	123	270	447	11	71	1,466
12	955	128	363	913	11	97	2,466
16	1,110	134	311	1,187	11	104	2,856
19	1,308	103	162	1,729	11	102	3,414
24	1,527	99	76	2,189	11	66	3,969

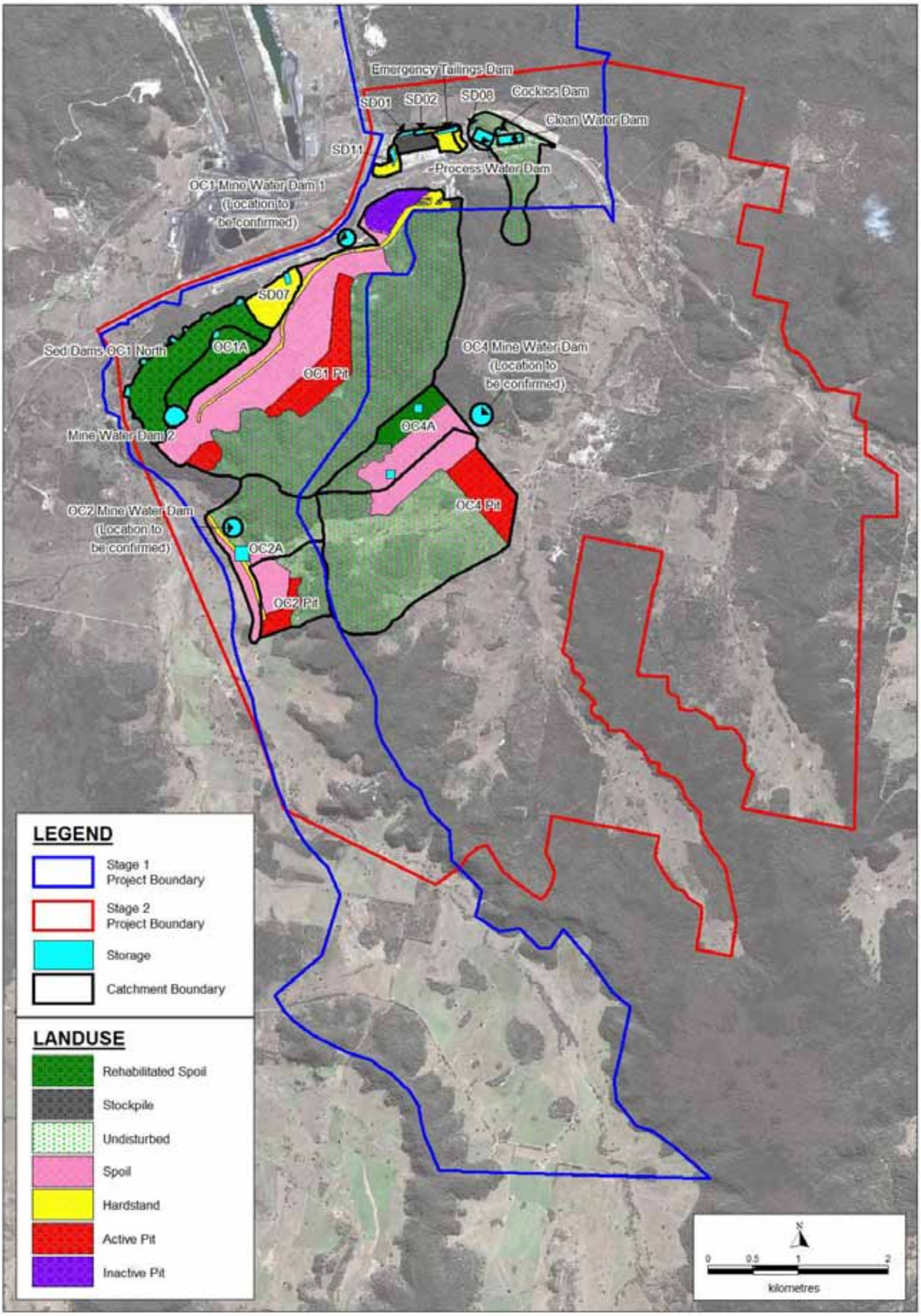


Figure 6.9 Moolarben Project, Scenario 1 Mine Staging, Year 2

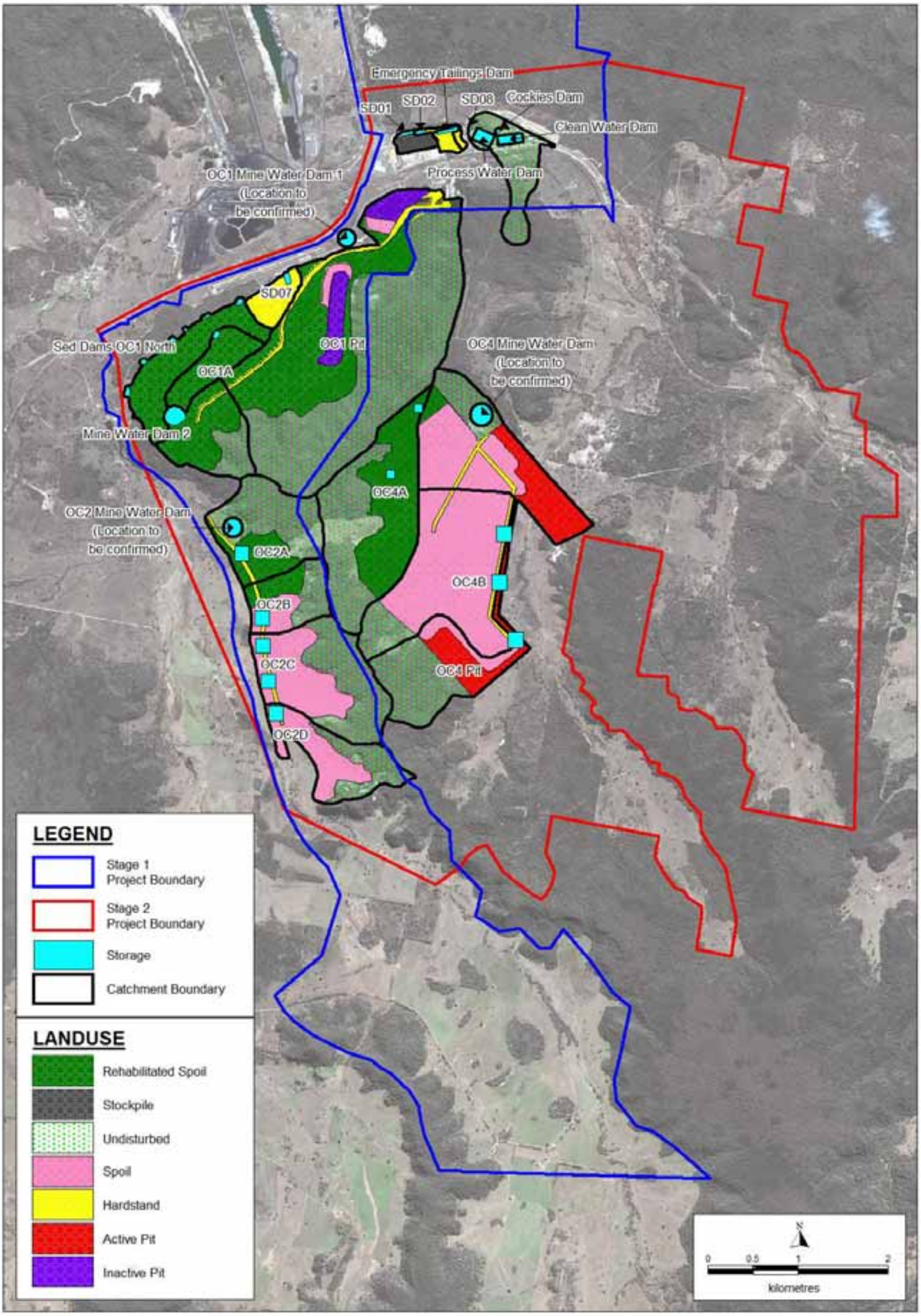


Figure 6.10 Moolarben Project, Scenario 1 Mine Staging, Year 7

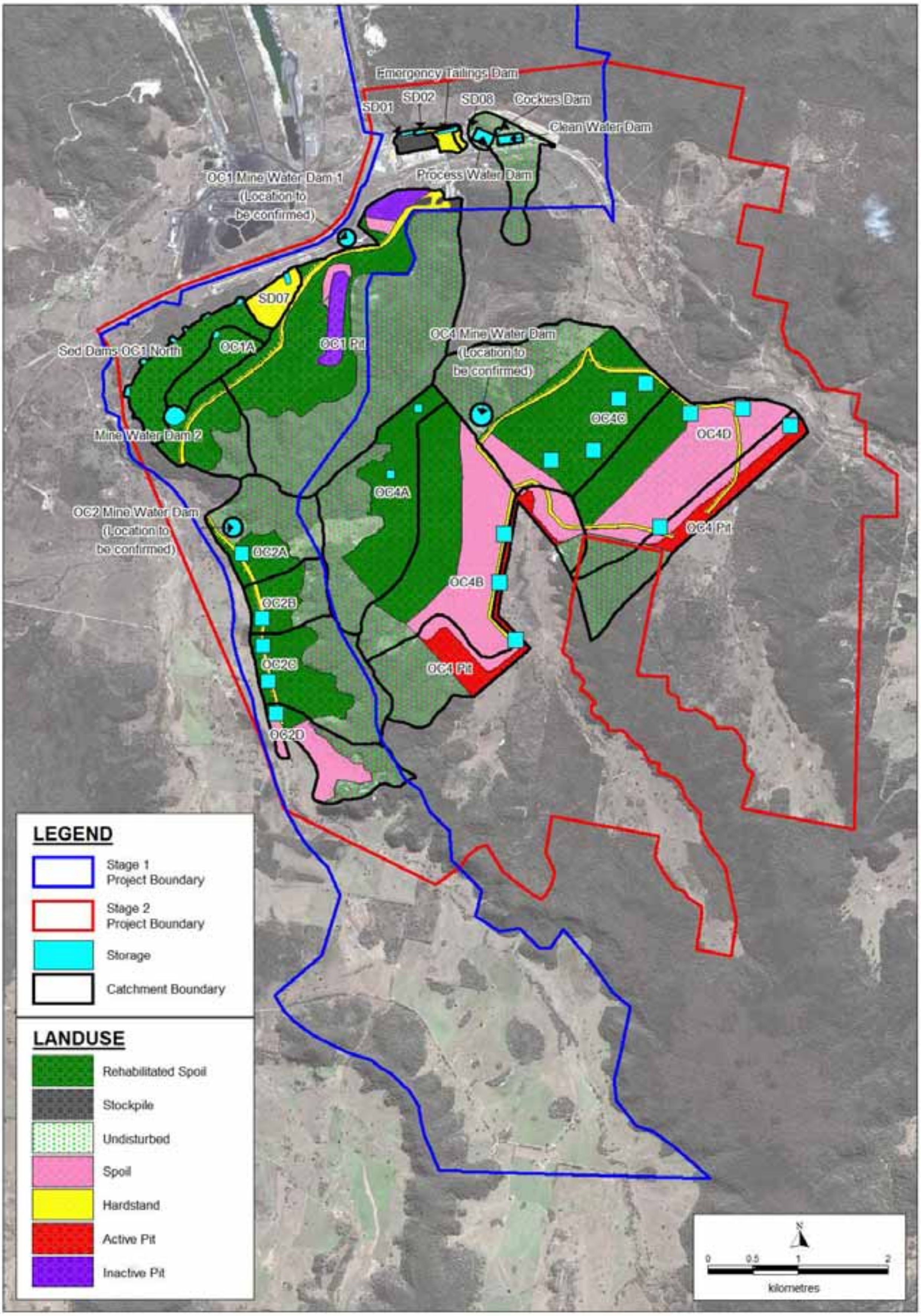


Figure 6.11 Moolarben Project, Scenario 1 Mine Staging, Year 12

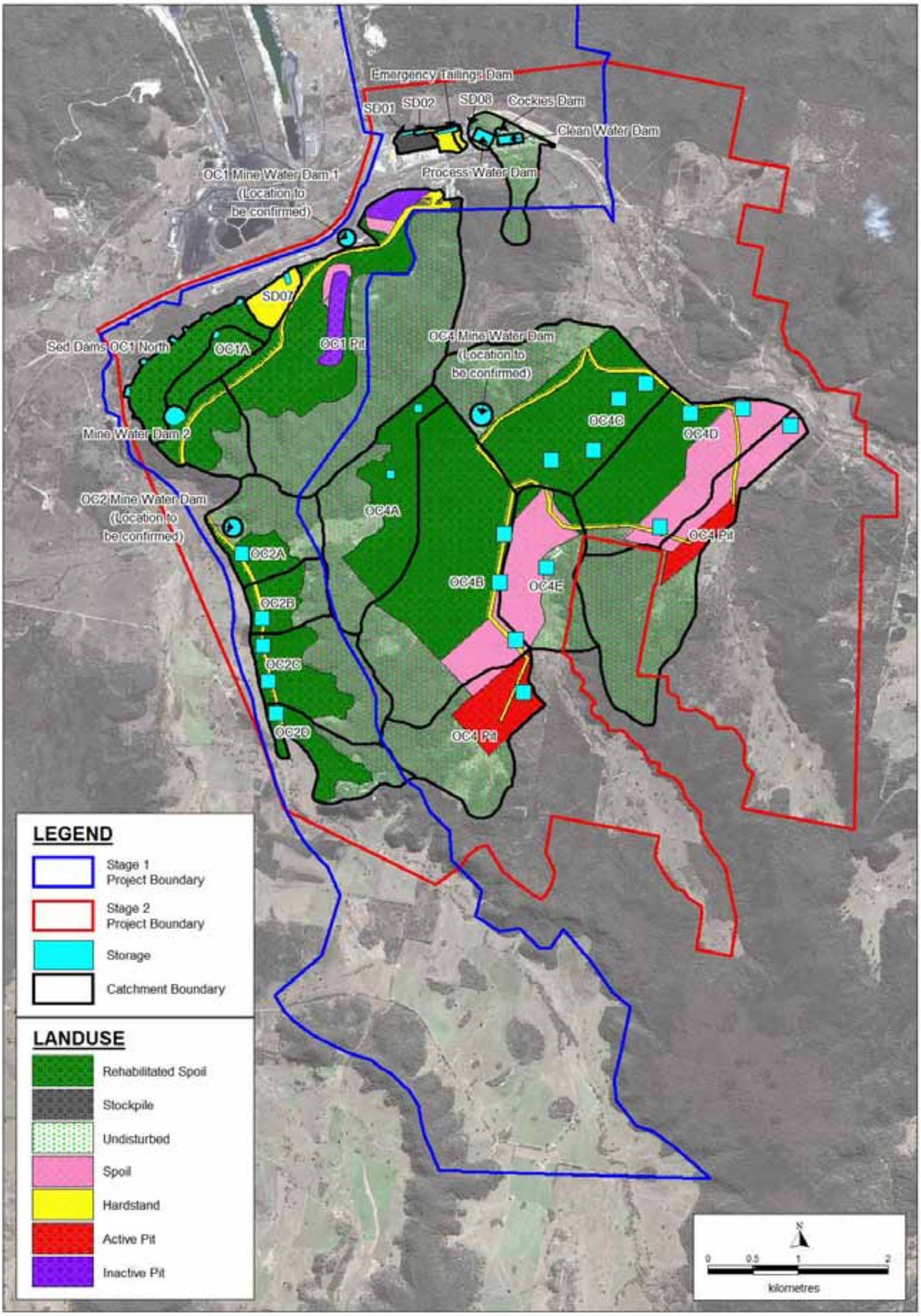


Figure 6.12 Moolarben Project, Scenario 1 Mine Staging, Year 16

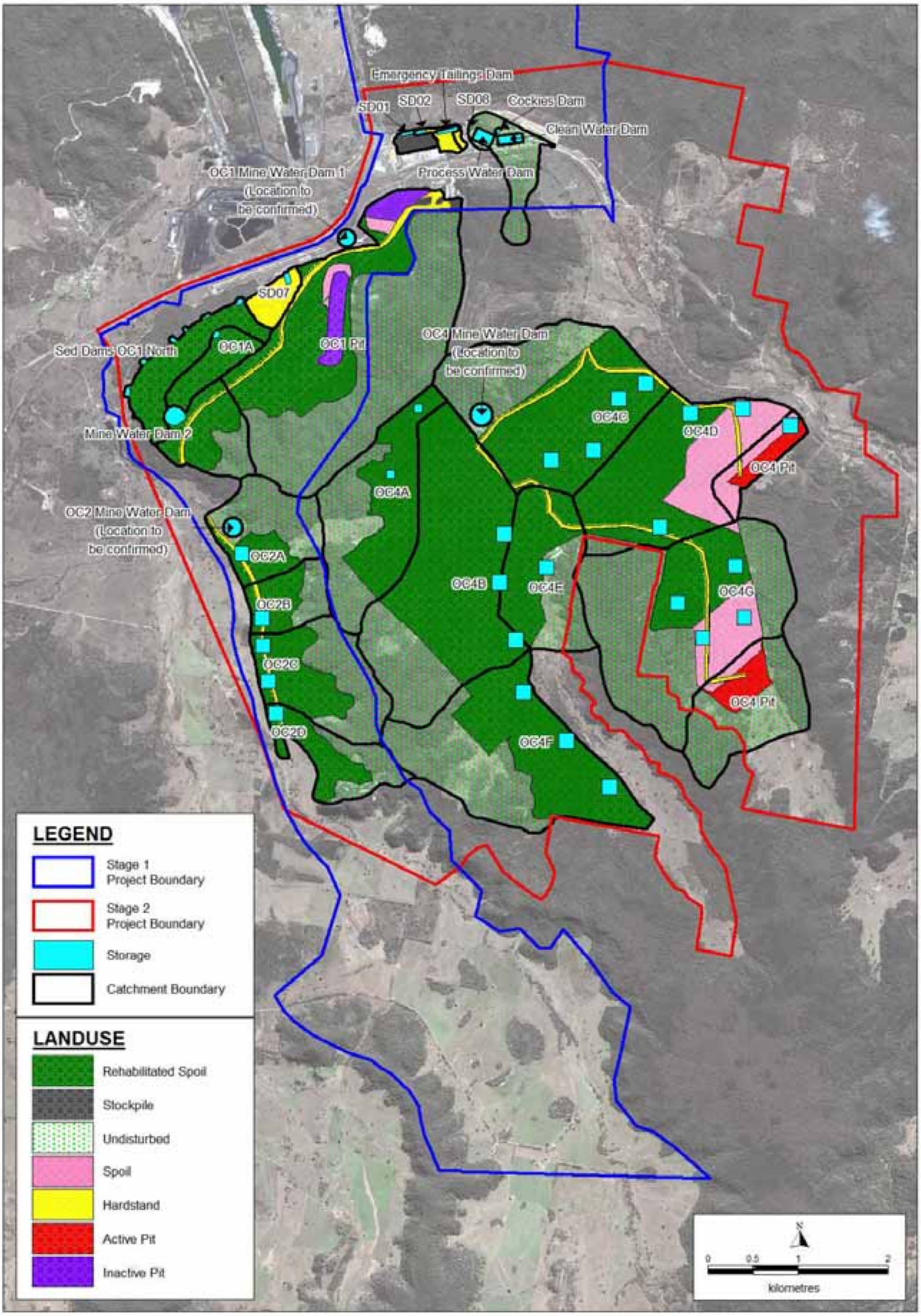


Figure 6.13 Moolarben Project, Scenario 1 Mine Staging, Year 19

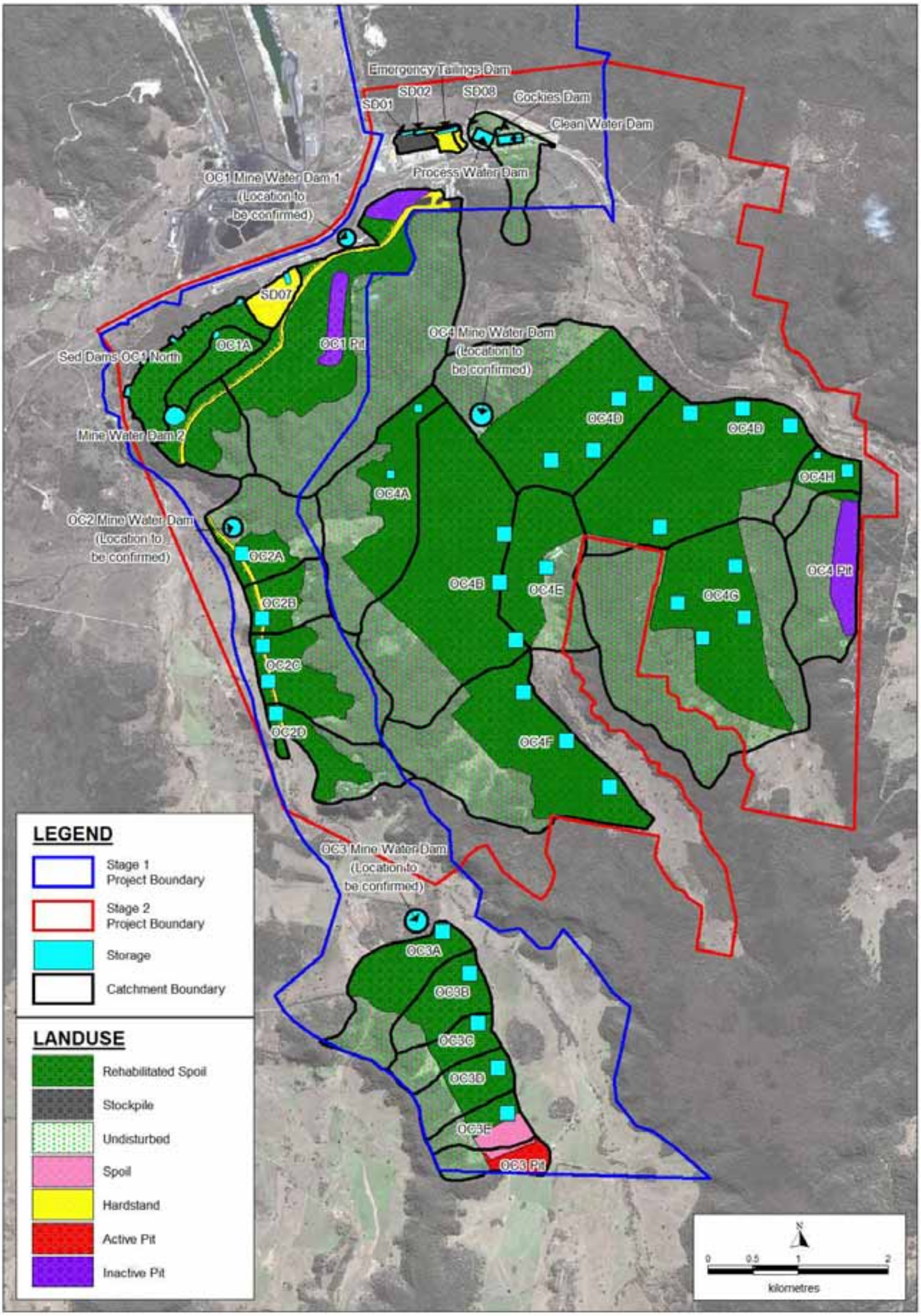


Figure 6.14 Moolarben Project, Scenario 1 Mine Staging, Year 24

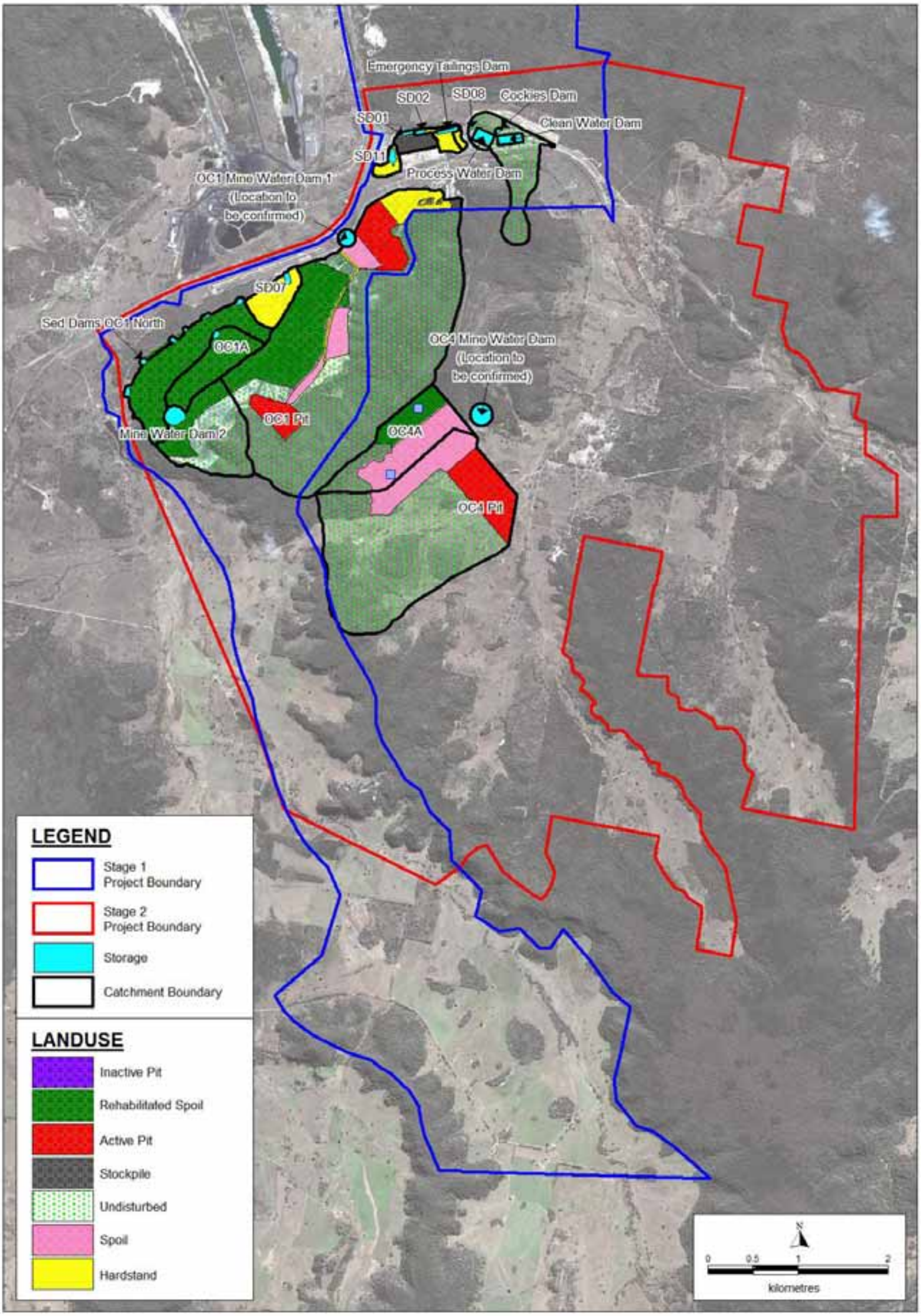


Figure 6.15 Moolarben Project, Scenario 2 Mine Staging, Year 2

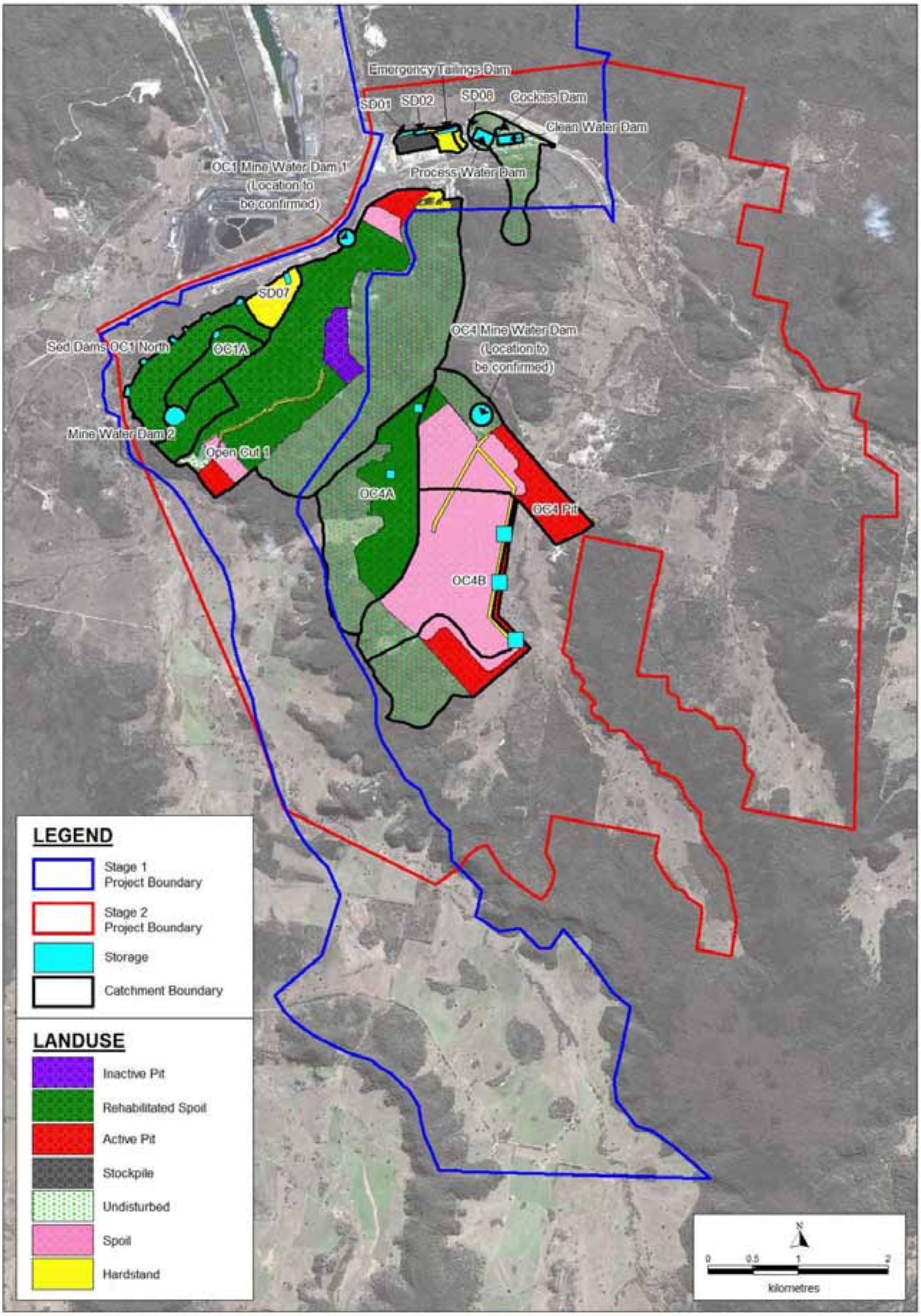


Figure 6.16 Moolarben Project, Scenario 2 Mine Staging, Year 7

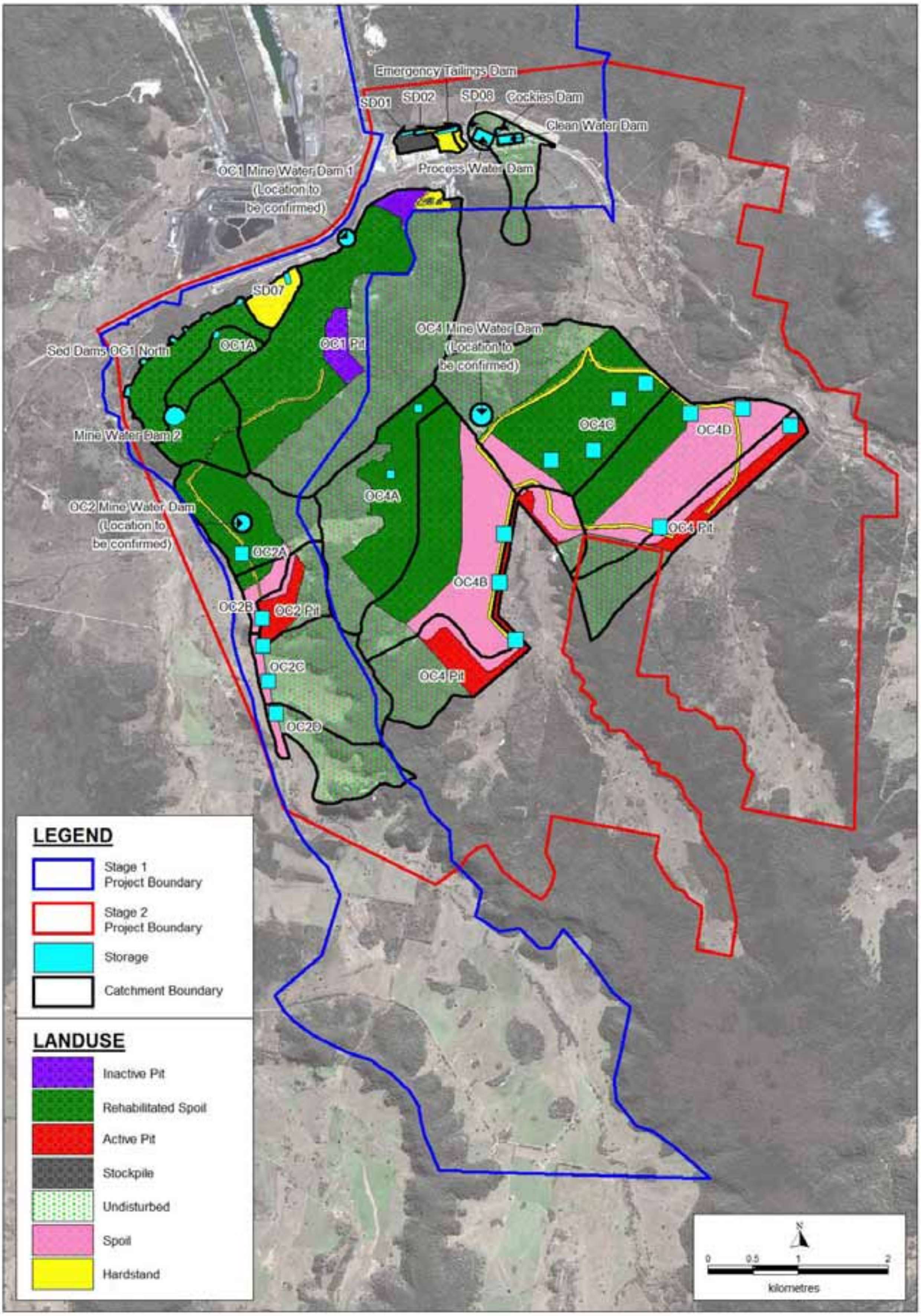


Figure 6.17 Moolarben Project, Scenario 2 Mine Staging, Year 12

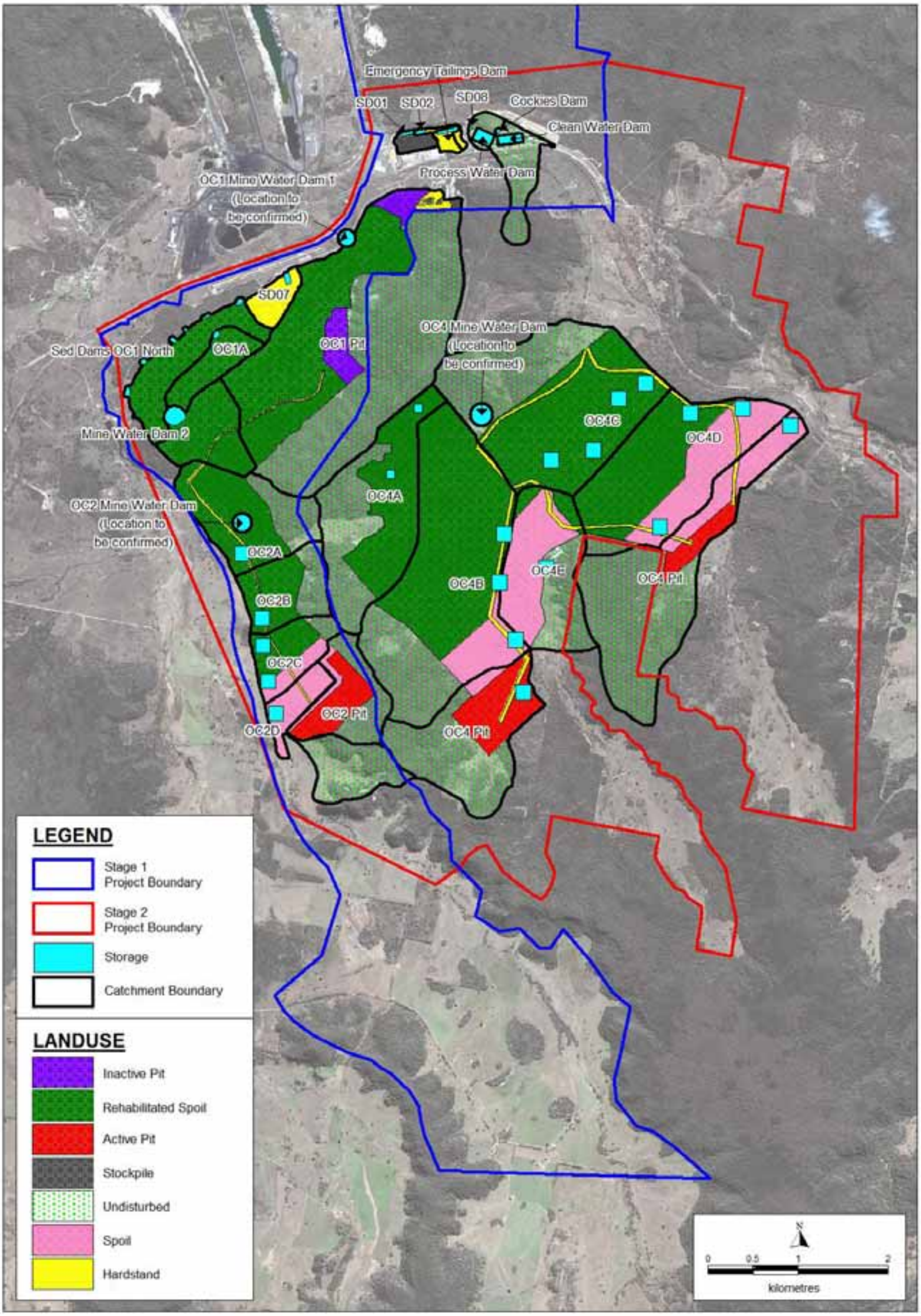


Figure 6.18 Moolarben Project, Scenario 2 Mine Staging, Year 16

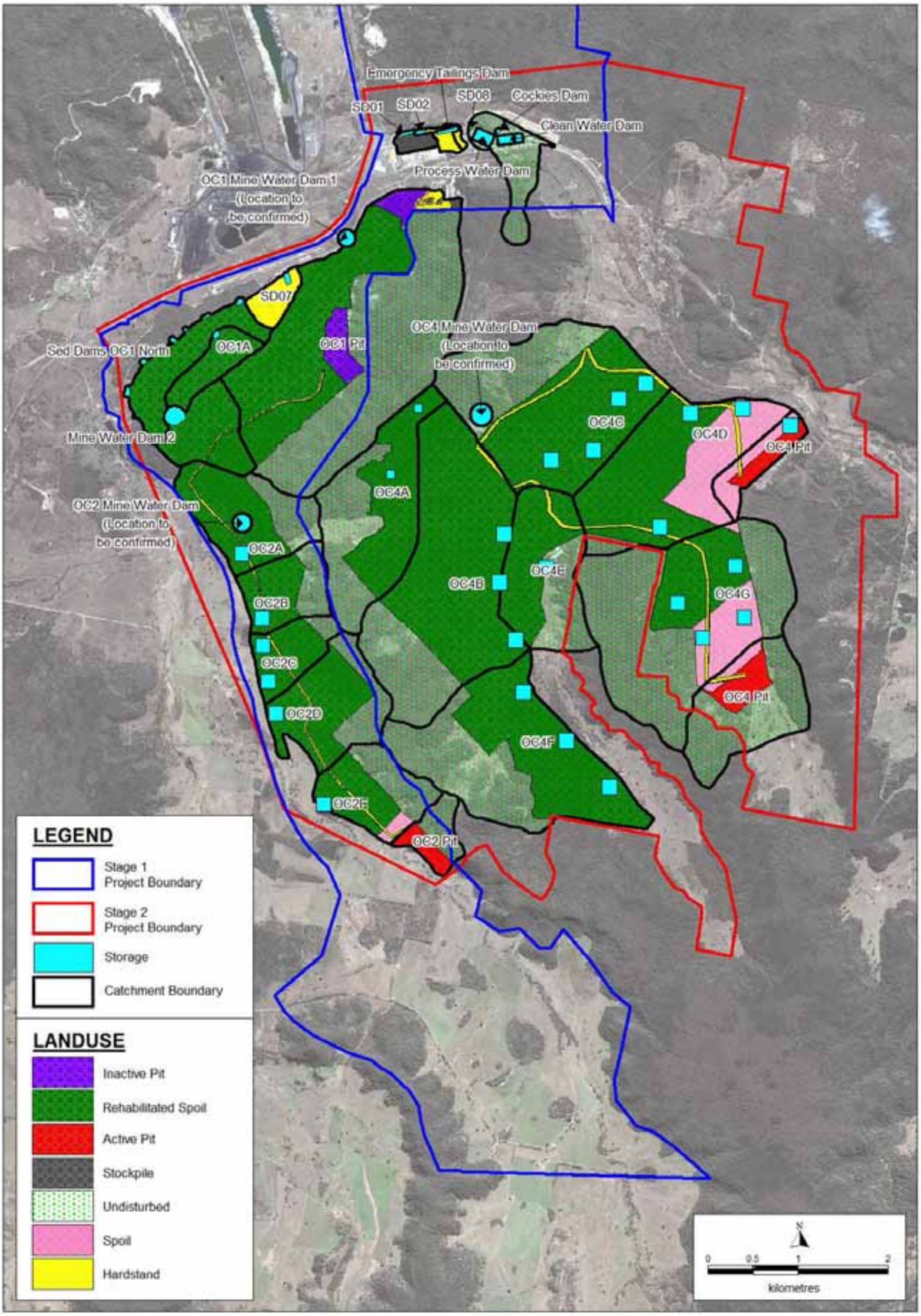


Figure 6.19 Moolarben Project, Scenario 2 Mine Staging, Year 19

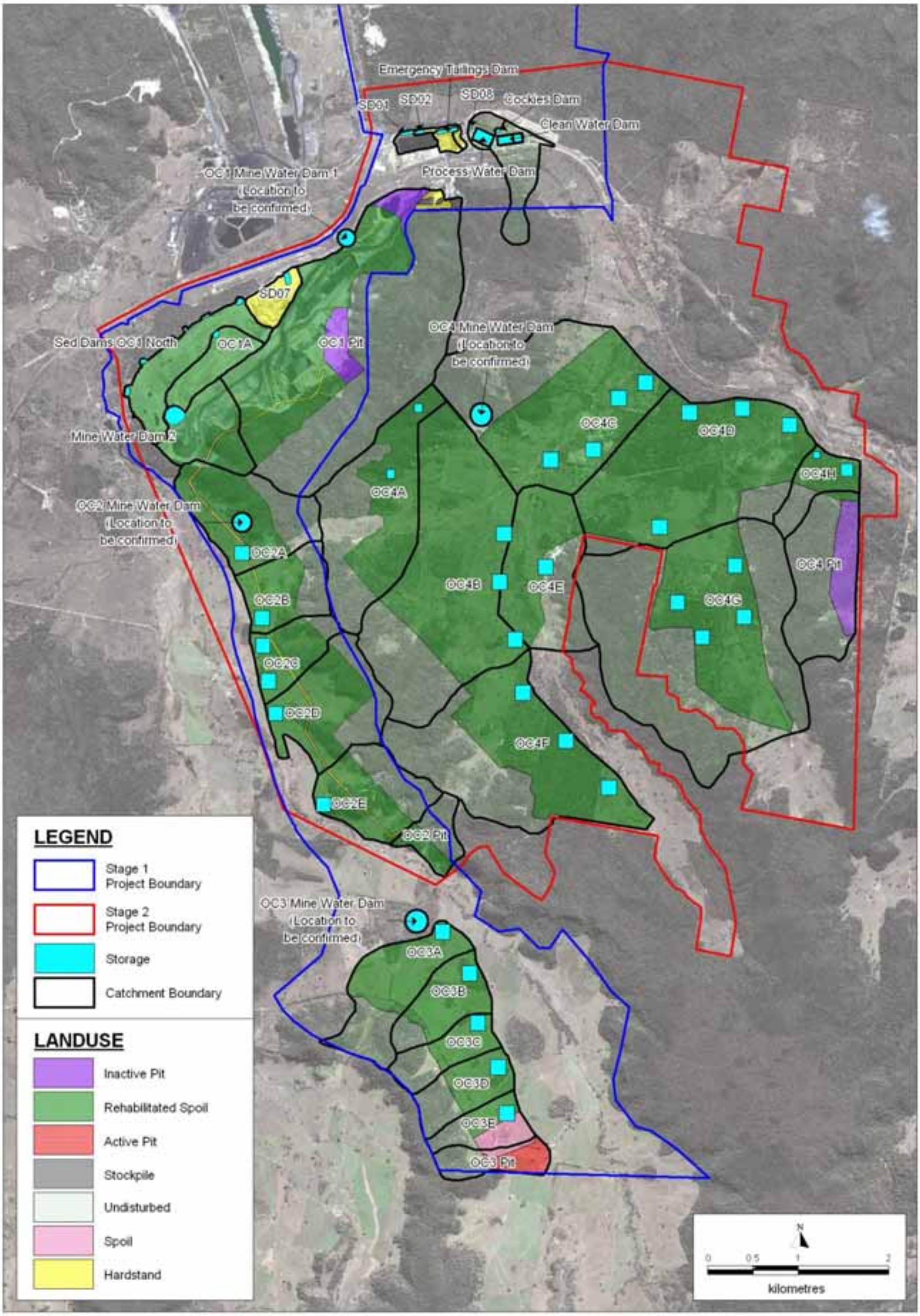


Figure 6.20 Moolarben Project, Scenario 2 Mine Staging, Year 24

6.8 STORAGE OPERATING RULES

Table 6.8 shows the operating rules adopted in the water balance model.

Table 6.8 MCP Water Management System Operating Rules

Item	Node Name	Operating Rules
1.0	Water Supply	
1.1	Ulan Water Sharing Agreement	▪ Supplies water to Process Water Dam from the "East Pit" of the Ulan Mine as part of the UWSA.
1.2	Bore Water Supply	▪ Supplies to Clean Water Dam as required at a maximum yield of 1,146ML/year
2.0	Water Demands	
2.1	CHPP	▪ Supplied from the following locations in order of priority: ▫ SD01 and SD02 Sediment dams ▫ OC1 Mine Water Dam 1 ▫ Process Water Dam
2.2	MIA Usage	▪ Supplied from Clean Water Dam
2.3	Dust Suppression	▪ Supplied from Mine Water Dams 10, OC2, OC3 and OC4
3.0	Open-cut Operations	
3.1	Open Cut 1	▪ Receives groundwater inflows, at a maximum rate of 151ML/yr ▪ Receives stormwater runoff from disturbed and undisturbed areas ▪ Continuous dewatering to Mine Water Dam 10
3.2	Open Cut 2	▪ Receives groundwater inflows, at a maximum rate of 21ML/yr ▪ Receives stormwater runoff from disturbed and undisturbed areas ▪ Continuous dewatering to OC2 Mine Water Dam
3.3	Open Cut 3	▪ Receives groundwater inflows, at a maximum rate of 97ML/yr ▪ Receives stormwater runoff from disturbed and undisturbed areas ▪ Continuous dewatering to OC3 Mine Water Dam
3.4	Open Cut 4	▪ Receives groundwater inflows, at a maximum rate of 664ML/yr ▪ Receives stormwater runoff from disturbed and undisturbed areas ▪ Continuous dewatering to OC4 Mine Water Dam
4.0	Underground Operations	
4.1	Underground 1	▪ Receives groundwater inflows, at a maximum rate of 364ML/yr ▪ Continuous dewatering to OC1 Mine Water Dam 1
4.2	Underground 2	▪ Receives groundwater inflows, at a maximum rate of 9ML/yr ▪ Continuous dewatering to OC1 Mine Water Dam 1
4.3	Underground 4	▪ Receives groundwater inflows, at a maximum rate of 1,177ML/yr ▪ Continuous dewatering to OC1 Mine Water Dam 1
5.0	Water Storages	
5.1	Mine Water Dam 10	▪ Primary mine water storage dam for Open Cut 1 until Year 2 ▪ Pump transfers to Process Water Dam ▪ Receives pumped transfers from the following locations: ▫ Open Cut 1 ▫ OC1 Mine Water Dam 2

Item	Node Name	Operating Rules
5.2	OC1 Mine Water Dam 1	▪ Replaces Mine Water Dam 10 in Year 2 ▪ Pump transfers to Process Water Dam ▪ Receives pumped transfers from the following locations: ▫ Open Cut 1 ▫ OC1 Mine Water Dam 2 ▫ OC2, OC3 and OC4 Mine Water Dams ▫ Undergrounds 1, 2 and 4
5.3	OC1 Mine Water Dam 2	▪ Secondary mine water storage dam for Open Cut 1 ▪ Pump Transfers to Mine Water Dam 10 ▪ Receives pumped transfers from Sediment Dams OC1 North
5.4	OC2 Mine Water Dam	▪ Primary mine water storage dam for Open Cut 2 ▪ Supplies dust suppression demand ▪ Receives pumped transfers from OC2 Sediment Dams
5.5	OC3 Mine Water Dam	▪ Primary mine water storage dam for Open Cut 3 ▪ Supplies dust suppression demand ▪ Receives pumped transfers from OC3 Sediment Dams
5.6	OC4 Mine Water Dam	▪ Primary mine water storage dam for Open Cut 4 ▪ Supplies dust suppression demand ▪ Receives pumped transfers from OC4 Sediment Dams
5.7	Process Water Dam	▪ Supplies to CHPP ▪ Receives pumped transfers from Clean Water Dam
5.8	Clean Water Dam	▪ Pump transfers to Process Water Dam ▪ Receives pumped transfers from the bore water supply
5.9	Sediment Dam SD01	▪ Receives catchment inflows from product stockpile pad ▪ Supplies to the CHPP ▪ Overflows to Bora Creek
5.10	Sediment Dam SD02	▪ Receives catchment inflows from CHPP pad ▪ Supplies to the CHPP ▪ Overflows to Bora Creek
5.11	Sediment Dam SD07	▪ Receives catchment inflows from MIA pad and Administration Area ▪ Pump transfers to OC1 Mine Water Dam 10 ▪ Overflows to Goulburn River
5.12	Sediment Dam SD08	▪ Receives catchment inflows from undisturbed areas ▪ Overflows to Bora Creek
5.13	Sediment Dam SD11	▪ Receives catchment inflows from undisturbed areas ▪ Overflows to Bora Creek
5.14	Cockies Dam	▪ Receives catchment inflows from undisturbed areas ▪ Receives pumped transfers from Process Water Dam ▪ Proposed controlled release point, discharges to Bora Creek ▪ Overflows to Bora Creek Creek
5.15	Sediment Dams OC1 North	▪ Receives catchment inflows from Open Cut 1 rehabilitated spoil areas ▪ Pump transfers to Mine Water Dam 2 ▪ Proposed controlled release point, discharges to Moolarben Creek ▪ Overflows to Moolarben Creek or directly to Goulburn River
5.16	OC2 Sediment Dams	▪ Receives catchment inflows from Open Cut 2 spoil dumps ▪ Pump transfers to OC2 Mine Water Dam ▪ Overflows to Moolarben Creek
5.17	OC3 Sediment Dams	▪ Receives catchment inflows from Open Cut 3 spoil dumps ▪ Pump transfers to OC3 Mine Water Dam ▪ Overflows to Moolarben Creek
5.18	OC4 Sediment Dams	▪ Receives catchment inflows from Open Cut 4 spoil dumps ▪ Pump transfers to OC4 Mine Water Dam ▪ Overflows to Moolarben Creek
5.19	Emergency Tailings Dam	▪ Decant return to the CHPP ▪ Overflows to Bora Creek

Item	Node Name	Operating Rules
6.0	Receiving Waters	
6.1	Moolarben Creek	▪ Receives storage overflows from the following locations: ▫ Sediment Dam OC1A ▫ Sediment Dams OC1 North ▫ OC2 and OC3 Mine Water Dams ▫ OC2 and OC3 Sediment Dams
6.2	Bora Creek	▪ Receives storage overflows from the following locations: ▫ Emergency Tailings Dam ▫ Sediment Dams SD01, SD02 and SD11 ▪ Licensed Discharge Point for the following storages: ▫ Mine Water Dam 10 ▫ Clean Water Dam
6.3	Goulburn River	▪ Receives storage overflows from the following locations: ▫ Sediment Dam OC1A ▫ Sediment Dams OC1 North
6.4	Wilpinjong Creek	▪ Receives storage overflows from the following locations: ▫ OC4 Sediment Dams ▫ OC4 Mine Water Dam

6.9 GROUNDWATER INFLOWS TO MINING PIT

A groundwater impact assessment was previously been completed by RPS Aquaterra in 2011 (Aquaterra, 2011). This previous work has been used by AGE Consultants (AGE) to estimate annual groundwater inflows to the open cut and underground pits for the proposed modification.

AGE have advised that the groundwater inflow estimates include an allowance for coal face evaporation of 150ML/year, and there is no change in inflow estimates between the two scenarios.

Adopted groundwater inflow estimates for all open cut pits and underground mines are provided in Table 6.9.

Table 6.9 Predicted Groundwater Inflows at Different Pits within the Moolarben Mining Area (Aquaterra, 2011)

Year of Mine	Open Cut 1 (ML/yr)	Open Cut 2 (ML/yr)	Open Cut 3 (ML/yr)	Open Cut 4 (ML/yr)	Underground 1 (ML/yr)	Underground 2 (ML/yr)	Underground 4 (ML/yr)	Total Inflow to Pits (ML)
1	0.0	0.0	0.0	29.0	0.0	0.0	0.0	29.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2
4	0.0	0.0	0.0	0.0	218.1	0.0	0.0	218.7
5	0.0	0.0	0.0	0.0	291.6	0.0	0.0	292.2
6	0.0	0.0	0.0	0.0	302.4	0.0	0.0	303.0
7	0.0	0.0	0.0	137.0	281.8	0.0	0.0	418.8
8	0.0	0.0	0.0	140.1	263.6	0.0	0.0	403.7
9	0.0	0.0	0.0	306.9	293.7	0.0	0.0	600.6
10	0.0	0.0	0.0	513.9	229.1	0.0	0.0	743.0
11	0.0	0.0	0.0	366.3	364.3	0.0	0.0	730.6
12	0.0	0.0	0.0	26.72	324.1	0.0	0.0	591.3
13	0.0	0.0	0.0	263.0	321.6	0.0	0.0	584.6
14	0.0	0.0	0.0	210.0	287.1	1.7	155.6	654.4
15	0.0	0.0	0.0	171.1	0.0	8.9	275.0	455.0
16	0.0	0.0	0.0	142.6	0.0	6.6	299.0	448.2
17	0.0	0.0	0.0	345.2	0.0	2.6	360.7	708.5
18	0.0	0.0	0.0	243.1	0.0	0.0	380.4	623.5
19	0.0	0.0	0.0	159.2	0.0	0.0	443.8	603.0
20	0.0	0.0	0.0	277.4	0.0	0.0	439.1	716.5
21	0.0	0.0	0.0	0.0	0.0	0.0	510.0	510.0
22	0.0	0.0	0.0	0.0	0.0	0.0	687.5	687.5
23	0.0	0.0	0.0	0.0	0.0	0.0	1,176.6	1,176.6
24	0.0	0.0	0.0	0.0	0.0	0.0	940.1	940.1

6.10 WATER DEMANDS

6.10.1 Coal Handling and Preparation Plant (CHPP)

Estimates of CHPP requirements were based on a previous water balance study conducted by Worley Parsons in August 2011 (WP, 2011). The following assumptions were made:

- The net water demand of the CHPP is 186ML per Mt of washed product coal;
- Only coal that is extracted from open cut pits will be washed and processed by the CHPP (coal from the underground mine is not washed).

The assumed ROM coal production rate (excluding underground coal) is 8 Mtpa for both Scenario 1 and Scenario 2.

6.10.2 Dust Suppression

Estimates of haul road dust suppression requirements have been based on the following assumptions:

- Dust suppression demand in Year 0 is estimated as 402ML/yr (WP, 2011);
- Haul road length in Year 0 is estimated as 9.3km based on the latest aerial image taken in August 2012; and
- Dust suppression demand for successive mine stages was estimated by factoring the Year 0 demand based on proposed haul road lengths. Haul road lengths for Scenario 1 and Scenario 2 for the various mine stages were estimated from the conceptual mine plans for the proposed Stage 1 Modification.

A summary of the estimated haul road dust suppression requirements is provided in Table 6.10 for Scenario 1 and Table 6.11 for the Scenario 2.

Table 6.10 Estimated Haul Road Dust Suppression Requirements, Scenario 1

Year	Est. Haul Road Length (km)	Annual Demand (ML/yr)	Daily Demand (kL/d)
0	9.3	402	1,101
1	9.3	402	1,101
2	10.8	465	1,274
7	15.7	677	1,853
12	21.0	902	2,472
16	20.9	899	2,463
19	19.8	852	2,334
24	13.3	571	1,566

Table 6.11 Estimated Haul Road Dust Suppression Requirements, Scenario 2

Year	Est. Haul Road Length (km)	Annual Demand (ML/yr)	Daily Demand (kL/d)
0	9.3	402	1,101
1	9.3	402	1,101
2	10.8	465	1,274
7	16.9	726	1,989
12	22.7	980	2,684
16	24.1	1,037	2,842
19	26.2	1,129	3,093
24	16.9	729	1,997

6.10.3 Other Demands

Other water demands for the mine include water for cooling and dust suppression in the underground, as well as vehicle washdown and other miscellaneous water demands. For both scenarios, a water demand of 160ML/year was assumed for the underground and 50ML/year for miscellaneous water demands such as vehicle wash-down and MIA water usage. This estimated demand is based on our experience at other coal operations in NSW.

6.10.4 Demand Summary

A summary of site demands is presented in Table 6.12 for Scenario 1 and Table 6.13 for Scenario 2. Peak demand occurs in Years 12 to 17 for Scenario 1 and Years 15 to 20 for Scenario 2.

Table 6.12 Summary of Moolarben Site Demands, Scenario 1

Year	CHPP Net Demand (ML/a)	Dust Suppression Demand (ML/a)	Miscellaneous Water Demand (ML/a)	U/G Water Demand (ML/a)	Total Site Demand (ML/a)
0	1,042	402	50	0	1,494
1	1,042	402	50	0	1,494
2	1,042	465	50	160	1,717
3	1,042	507	50	160	1,759
4	1,042	550	50	160	1,802
5	1,042	592	50	160	1,844
6	1,042	634	50	160	1,886
7	1,042	676	50	160	1,928
8	1,042	722	50	160	1,974
9	1,042	767	50	160	2,019
10	1,042	812	50	160	2,064
11	1,042	857	50	160	2,109
12	1,042	902	50	160	2,154
13	1,042	901	50	160	2,153
14	1,042	901	50	160	2,153
15	1,042	900	50	160	2,152
16	1,042	899	50	160	2,151
17	1,042	883	50	160	2,135
18	1,042	867	50	160	2,119
19	1,042	852	50	160	2,104
20	1,042	796	50	160	2,048
21	1,042	740	50	160	1,992
22	1,042	684	50	160	1,936
23	1,042	627	50	160	1,879
24	1,042	571	50	160	1,823

Table 6.13 Summary of Moolarben Site Demands, Scenario 2

Year	CHPP Net Demand (ML/a)	Dust Suppression Demand (ML/a)	Miscellaneous Water Demand (ML/a)	U/G Water Demand (ML/a)	Total Site Demand (ML/a)
0	1,042	402	50	0	1,494
1	1,042	402	50	0	1,494
2	1,042	465	50	160	1,717
3	1,042	517	50	160	1,769
4	1,042	569	50	160	1,821
5	1,042	622	50	160	1,874
6	1,042	674	50	160	1,926
7	1,042	726	50	160	1,978
8	1,042	777	50	160	2,029
9	1,042	827	50	160	2,079
10	1,042	878	50	160	2,130
11	1,042	929	50	160	2,181
12	1,042	980	50	160	2,232
13	1,042	994	50	160	2,246
14	1,042	1,008	50	160	2,260
15	1,042	1,023	50	160	2,275
16	1,042	1,037	50	160	2,289
17	1,042	1,068	50	160	2,320
18	1,042	1,098	50	160	2,350
19	1,042	1,129	50	160	2,381
20	1,042	1,049	50	160	2,301
21	1,042	969	50	160	2,221
22	1,042	889	50	160	2,141
23	1,042	809	50	160	2,061
24	1,042	729	50	160	1,981

6.11 WATER BALANCE MODEL RESULTS

6.11.1 Pit Water Inventory

A forecast assessment of predicted pit inventory for the MCP Stage 1 open cut pits has been undertaken for both scenarios (with and without the modification), in order to assess the potential impact of the modification over the mine life. This assessment includes Open Cuts 1, 2 and 3.

Figure 6.21 and Figure 6.22 show the predicted in-pit storage volume for the MCP Stage 1 open cut pits, for the 10th, 50th and 90th percentile confidence limits. The modelling outcomes are summarised as follows:

- Under median (50th percentile) and low (90th percentile) rainfall conditions, there would be no significant build up of water in the open cut pits, for both scenarios;
- Under wet (10th percentile) rainfall conditions, there is a moderate build-up of water in the pits over each wet season, up to a maximum inventory of around 800ML. This occurs for both modelling scenarios; and
- For Scenario 2 (with Modification), elevated pit water inventories occur around five years later than Scenario 1 (without Modification).

There is a small risk that, under very wet conditions, accumulation of excess in-pit water may have some impact on mining, depending on the volume which can be accommodated in-pit before mining is disrupted. Having multiple open cut pits significantly reduces the risk of impacts on mining because, under exceptionally wet conditions, it is possible to transfer water between pits for temporary storage. In addition, mining in Open Cut 1 will be completed in Year 3 for Scenario 1 and Year 8 for Scenario 2, providing the option of temporary storage in this pit to allow continuous mining in the other pits.

The modelling results indicate a reduction in the risk of excess pit inundation as a result of the proposed modification. This is due to the timing of Open Cut 2 development in Scenario 2, as well as higher system water demands for Scenario 2.

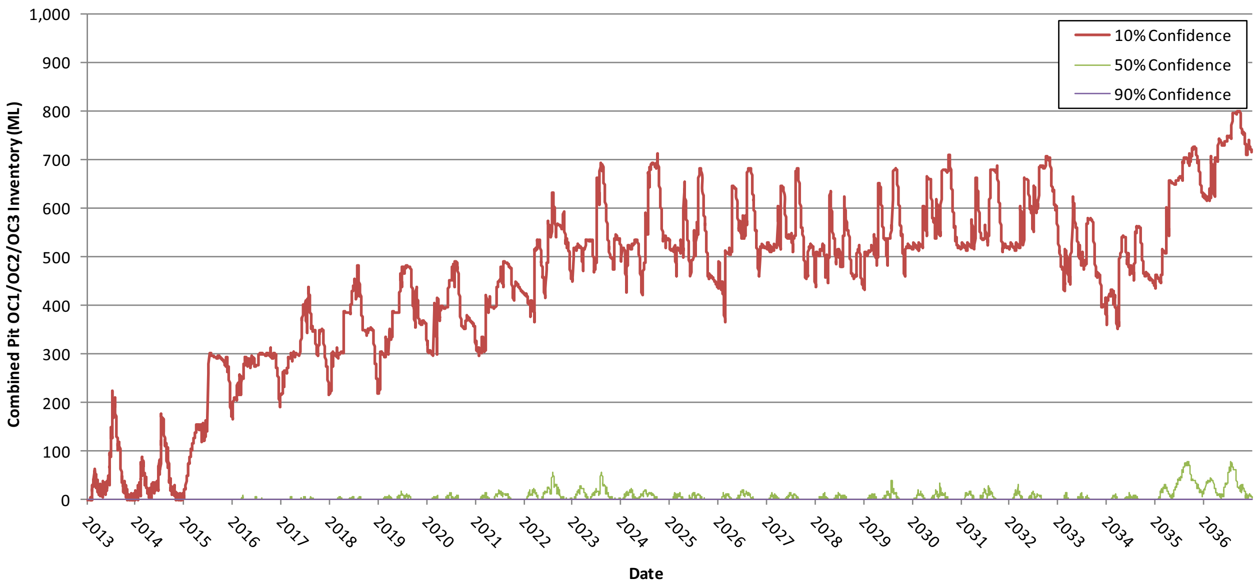


Figure 6.21 Combined Stage 1 Pit Inventory Forecast – No Modification (Scenario 1)

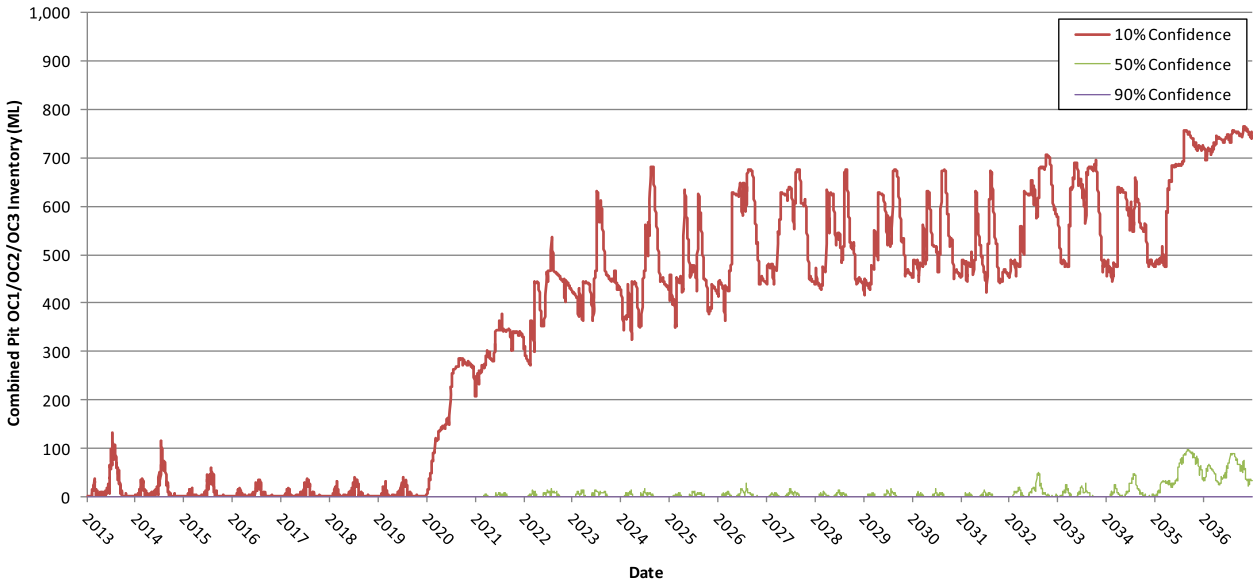


Figure 6.22 Combined Stage 1 Pit Inventory Forecast – With Modification (Scenario 2)

6.11.1 Out-of-Pit Water Inventory

A forecast assessment of out-of-pit inventory for MCP Stage 1 was undertaken for both scenarios. The out-of-pit storages include Process Water Dam, Clean Water Dam, Mine Water Dam 10, OC1A, OC1 Mine Water Dam 1, OC1 Mine Water Dam 2, OC2 Mine Water Dam and OC3 Mine Water Dam. For reference, the combined full supply volume (FSV) of the storages has been included on the plots.

Figure 6.23 and Figure 6.24 show the predicted out-of-pit storage volume for the MCP Stage 1 mine water dams, for the 10^{th}, 50^{th} and 90^{th} percentile confidence limits. The modelling outcomes are summarised as follows:

- Under median (50^{th} percentile) and dry (90^{th} percentile) conditions, the mine water volumes in the water management system WMS are fairly constant over the mine life (at around 200-350ML), with little variation. This is the same for both scenarios;
- Under wet (10^{th} percentile) conditions, the combined inventory is generally elevated, with volumes typically between 450-650ML/a. However the expected out-of-pit inventory does not exceed the combined full supply volume for the mine water dams. This is generally the same for both scenarios; and
- The proposed modification does not significantly impact the expected out-of-pit inventory. This is due to the system being a net water consumer and the limited catchment reporting to the mine water dams. The overall mine water inventory is controlled more by imported water makeup than catchment runoff.

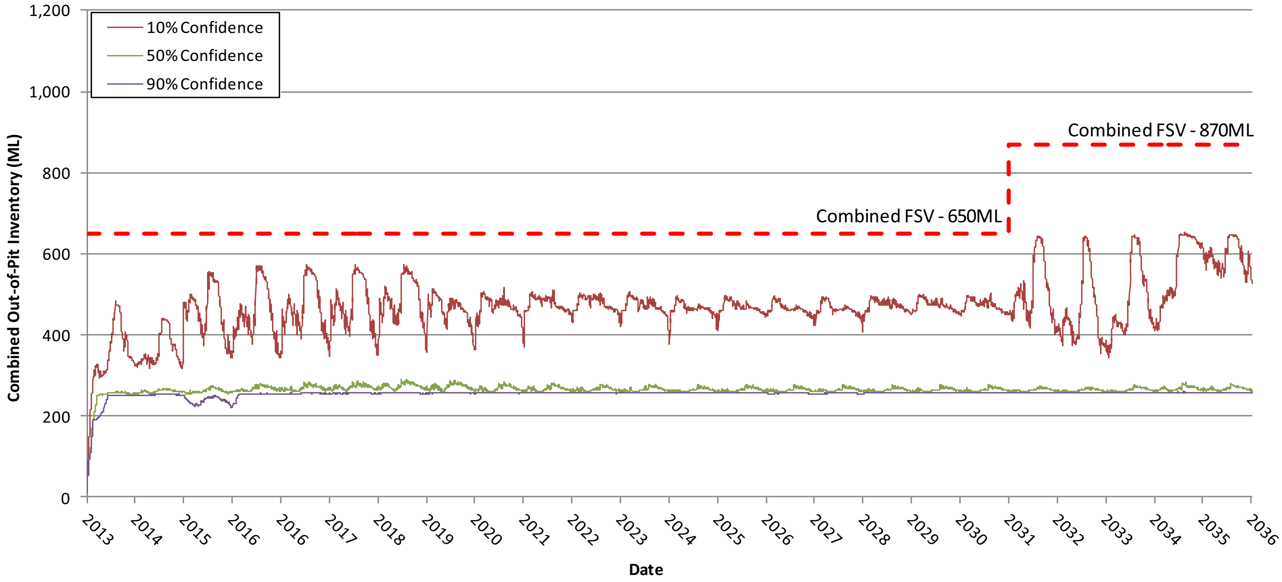


Figure 6.23 Combined Out-of-Pit Inventory Forecast – No Modification (Scenario 1)

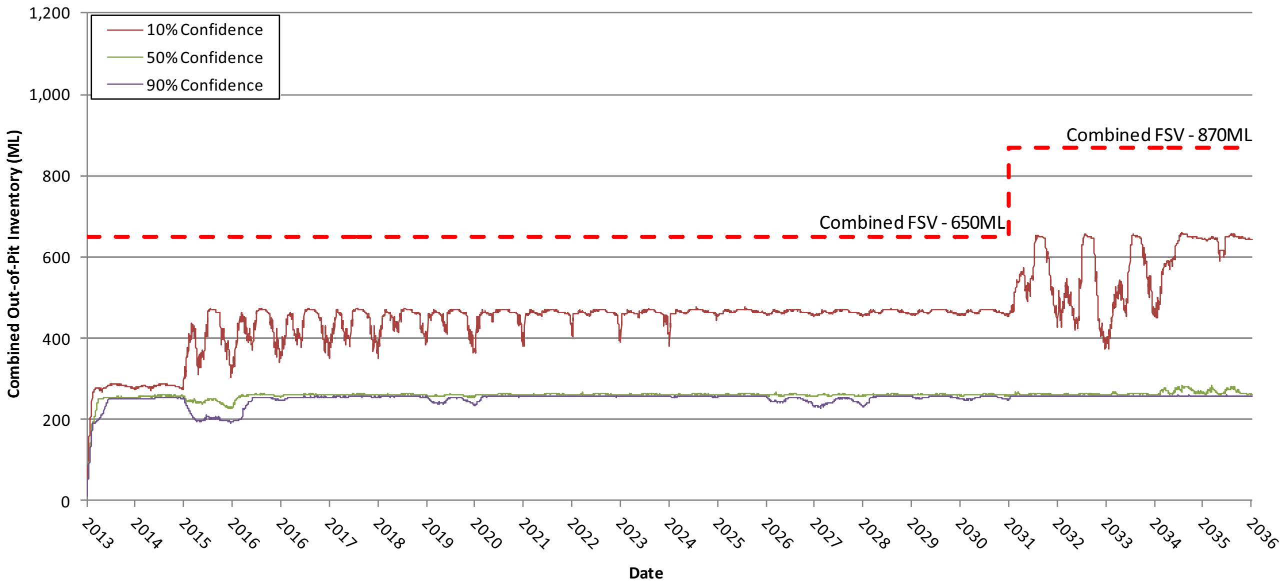


Figure 6.24 Combined Out-of-Pit Inventory Forecast – With Modification (Scenario 2)

6.11.2 Imported Water Requirements

When the water level within Process Water Dam and Clean Water Dam drops below a nominated trigger level, water is demanded from offsite sources, such as the Ulan Water Sharing Agreement (UWSA) and groundwater bores. A forecast assessment of expected imported water requirements has been undertaken for both scenarios.

Figure 6.25 and Figure 6.26 show the predicted annual imported water requirements for both scenarios, for the 10th, 50th and 90th percentile confidence limits. The modelling outcomes are summarised as follows:

- There is a 50% chance that:
  - For Scenario 1 (No Modification), an annual imported water volume of between 330-1,530ML/a will be required to supply operational demand over the life of the mine;
  - For Scenario 2 (With Modification), an annual imported water volume of between 310-1,630ML/a will be required to supply operational demand over the life of the mine.
- There is at least a 10% chance (90th percentile results) that:
  - For Scenario 1 (No Modification), an annual imported water volume of between 680-1,820ML/a will be required to supply operational demand over the life of the mine;
  - For Scenario 2 (With Modification), an annual imported water volume of between 670-1,840ML/a will be required to supply operational demand over the life of the mine.
- There is at least a 90% chance (10th percentile results) that:
  - For Scenario 1 (No Modification), an annual imported water volume of between 65-880ML/a will be required to supply operational demand over the life of the mine;
  - For Scenario 2 (With Modification), an annual imported water volume of between 60-940ML/a will be required to supply operational demand over the life of the mine.
- The maximum annual imported water requirement (around 1,940ML/a) can be satisfied from the current external water sources and licences (UWSA and borefields).

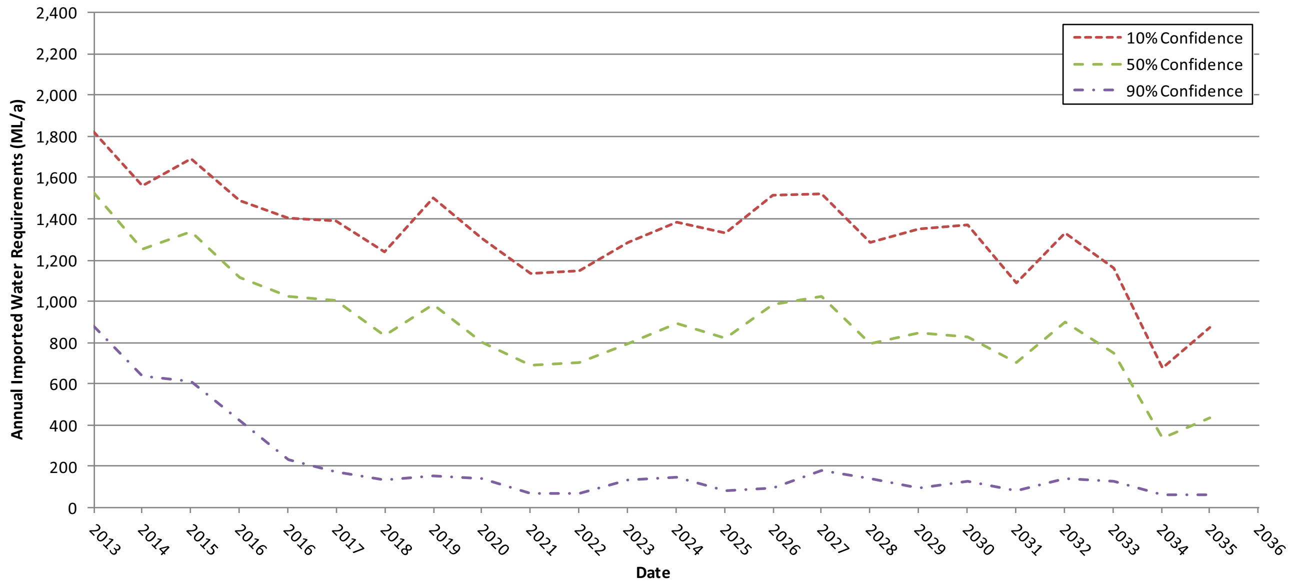


Figure 6.25 Forecast Imported Water Requirements – No Modification (Scenario 1)

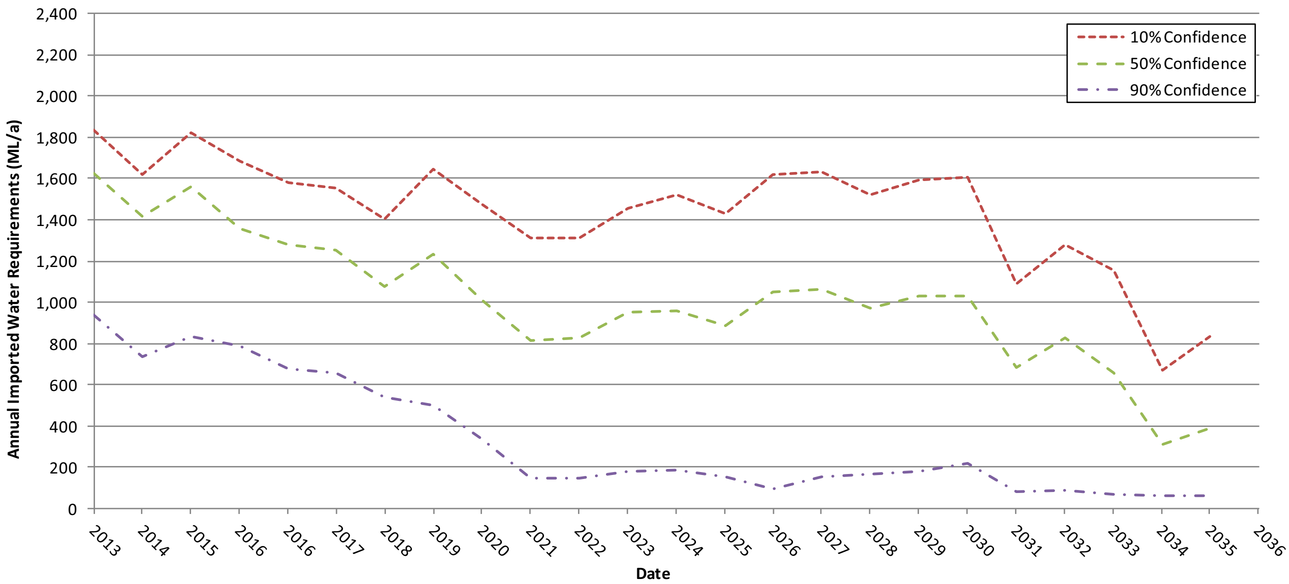


Figure 6.26 Forecast Imported Water Requirements – With Modification (Scenario 2)

6.11.3 Uncontrolled Discharges – Forecast Results

Mine Water Dams

The model of the water management system has been configured to ensure no uncontrolled off-site discharges from mine water storages. The modelled results show no uncontrolled discharges from the mine water dams.

Sediment Dams

Table 6.14 and Table 6.15 show the predicted discharges from the sediment dams over the 24 year period for the median result as well as the 90th and 10th percentile confidence limits. Each of the sediment dams are active for different periods of time during the 24 year mine life (see Table 6.1). Sediment dams have been removed from the active water management system after their catchment has been rehabilitated for a minimum of three years.

Overflows from the sediment dams after this time have not been included in the following results.

The modelling results are summarised as follows:

- The majority of the sediment dams do not discharge for the median and 90th percentile (dry conditions) confidence limits. This is the case for both scenarios.
- In reality, if the sediment dams are not able to be dewatered to the water management system within five days, excess water may be transferred to Open Cut 1 once mining of that pit is completed (Year 3 for Scenario 1, and Year 8 for Scenario 2).
- The proposed modification has no significant impact on the risk of discharge from either the mine water dams or the sediment dams for the MCP Stage 1.

6.11.4 Controlled Releases – Forecast Results

The release of water from the MCO WMS may only occur in accordance release conditions specified in the proposed EPL. Refer to Section 2.6 for a summary of the proposed release conditions.

Modelling of the MCO release capability is based on the following key assumptions:

- The WMS is capable of transferring water to the release points during release opportunities;
- The release infrastructure will immediately release when a release opportunity occurs (i.e. there is no delay in turning on the pumps etc). This is usually only possible for telemetrically controlled systems;
- No allowance for wet weather access issues or infrastructure failure; and
- Controlled releases may be constrained by modelled salinity in the site storages.

The salinity generation rates adopted in the model for the various land types have been based on past experience and the limited water quality data available. These may potentially limit the potential for controlled release if the salinity exceeds the maximum release limits.

This assessment has been undertaken using the maximum release rates as specified in the MCO EPL (i.e. combined 10ML/day from all release points). As such, the modelled controlled release volumes represent the maximum theoretical release.

The assessment results are summarised below:

- For Scenario 1, the average annual controlled release volume is around 20ML per year.
- For Scenario 2, the average annual controlled release volume is around 42ML per year.

The model results indicate a minor increase in controlled release opportunity as a result of the proposed modification. However, the predicted annual release volumes are relatively small. This is due to the following:

- The maximum release volume (10ML/day) is larger than the volume of the release dams (OC1 Sed. Dam 6 and Cockie's Dam). The water balance model runs on a daily timestep, and therefore would underestimate the volume able to be discharged in a day.
- The adopted salinity generation rates for runoff from all land types are higher than the 900µs/cm release limit for electrical conductivity, with the exception of undisturbed and rehabilitation catchments. This would limit the ability of the system to release in accordance with the EPL. Given that the EC in the existing sediment dams is generally below the 900µs/cm EC limit, it is expected that there would be more opportunities to discharge than indicated by the water balance model.

Table 6.14 Predicted Discharges from Sediment Dams – No Modification (Scenario 1)

Sediment Dam	Simulation	Average Spill Days per Year (days)	Average Volume per Spill (ML)
SD02	10%ile 50%ile 90%ile	No modelled discharges	
SD07	10%ile	0.1	4.9
	50%ile	0.0	0.0
	90%ile	0.0	0.0
OC1 North Sed. Dams	10%ile	0.2	17.2
	50%ile	0.1	8.4
	90%ile	0.0	0.0
OC2A	10%ile	0.7	8.1
	50%ile	0.0	0.0
	90%ile	0.0	0.0
OC2B	10%ile	0.6	7.0
	50%ile	0.0	0.0
	90%ile	0.0	0.0
OC2C	10%ile	0.6	22.5
	50%ile	0.0	0.0
	90%ile	0.0	0.0
OC2D	10%ile	1.9	13.6
	50%ile	0.1	2.8
	90%ile	0.0	0.0
OC3A	10%ile	9.4	2.1
	50%ile	0.0	0.0
	90%ile	0.0	0.0
OC3B	10%ile	9.5	1.4
	50%ile	0.0	0.0
	90%ile	0.0	0.0
OC3C	10%ile	9.7	1.0
	50%ile	0.0	0.0
	90%ile	0.0	0.0
OC3D	10%ile	9.7	1.3
	50%ile	0.0	0.0
	90%ile	0.0	0.0
OC3E	10%ile	10.4	1.5
	50%ile	0.2	0.0
	90%ile	0.0	0.0

Table 6.15 Predicted Discharges from Sediment Dams – With Modification (Scenario 2)

Sediment Dam	Simulation	Average Spill Days per Year (days)	Average Volume per Spill (ML)
SD02	10%ile	No modelled discharges	
	50%ile		
	90%ile		
SD07	10%ile	0.1	4.9
	50%ile	0.0	0.0
	90%ile	0.0	0.0
OC1 North Sed. Dams	10%ile	0.1	13.6
	50%ile	0.0	0.0
	90%ile	0.0	0.0
OC2A	10%ile	2.2	9.5
	50%ile	0.0	0.0
	90%ile	0.0	0.0
OC2B	10%ile	0.8	8.5
	50%ile	0.3	2.1
	90%ile	0.0	0.0
OC2C	10%ile	0.5	7.9
	50%ile	0.0	0.0
	90%ile	0.0	0.0
OC2D	10%ile	1.1	16.3
	50%ile	0.4	5.9
	90%ile	0.0	0.0
OC2E	10%ile	1.0	15.3
	50%ile	0.4	4.5
	90%ile	0.0	0.0
OC3A	10%ile	29.7	2.2
	50%ile	1.4	0.7
	90%ile	0.0	0.0
OC3B	10%ile	12.4	1.5
	50%ile	0.0	0.0
	90%ile	0.0	0.0
OC3C	10%ile	12.6	1.2
	50%ile	0.0	0.0
	90%ile	0.0	0.0
OC3D	10%ile	12.6	1.4
	50%ile	0.0	0.0
	90%ile	0.0	0.0
OC3E	10%ile	15.6	1.5
	50%ile	0.4	0.5
	90%ile	0.0	0.0

6.11.5 Annual Site Water Balance

Table 6.16 provides the long term daily average water balance for both Scenario 1 (No Modification) and Scenario 2 (With Modification). The Year 19 model has been adopted for the overall site water balance, as it represents the greatest difference in disturbance as a result of the proposed modification. Table 6.16 shows the following:

- The average annual volume of water required from an external source is around 200ML/a higher due to the proposed modification, primarily associated with increased dust suppression demands, for the Year 19 configuration; and
- The modelled rainfall/runoff yield, evaporation and storage overflows are not significantly affected by the proposed modification, for the Year 19 configuration.

Table 6.16 Average Annual Water Balance – Year 19 Configuration

			Annual Volume (ML/a)	
			No Modification	With Modification
Water Inputs				
	Rainfall/Runoff Yield			
		Mine Water Dams	*129*	*123*
		Open Cut Pits	*356*	*369*
		Sediment Dams	*811*	*828*
		Total Rainfall Yield	1,297	1,304
	Groundwater Inflow to Pit (OC & UG)		639	644
	Imported Water		760	953
	Gross Water Inputs		**2,695**	**2,917**
Water Outputs				
	Evaporation from Storages			
		Mine Water Dams	*137*	*131*
		Open Cut Pits	*56*	*48*
		Sediment Dams	*103*	*61*
		Total Evaporation	296	240
	Storage Overflows (off-site)			
		Mine Water Dams	*0*	*0*
		Open Cut Pits	*0*	*0*
		Sediment Dams	*245*	*226*
		Total Overflows	267	226
	Net Loss from CHPP		1,033	1,042
	Haul Road Dust Suppression		860	1,130
	UG Usage		159	160
	Controlled Releases		26	43
	Miscellaneous Use		50	50
	Gross Water Outputs		**2,690**	**2,891**
Water Retained				
Onsite	Net Inventory			
		Mine Water Dams	*3*	*3*
		Open Cut Pits	*0*	*0*
		Sediment Dams	*1*	*1*
	Gross Water Retained		**4**	**4**
Balance			**-62**	**-23**

The long-term water balance rates provided in Table 6.16 are the average of a 123 year static simulation. These values do not provide an indication of the variability of these components due to historical climatic variability, only the long-term average. It should be noted that some components of the water balance including rainfall runoff, evaporation, imported water requirements and storage overflows can be significantly influenced by climatic variability.

6.12 SUMMARY OF RESULTS

In summary, the results of the water balance modelling show that the proposed modification are predicted to have the following impacts on the performance of the site water management system:

- A slight reduction in the risk of pit inundation;
- A minor increase in controlled release opportunity;
- A slight reduction in out-of-pit water inventory over the life of the mine; and
- An average annual increase in imported water requirements of around 200ML/a.

The changes are primarily associated with the additional haul road dust suppression water demands for the proposed modification.

7 SUMMARY OF FINDINGS

The surface water impact assessment has considered the potential impacts of the proposed modification on surface water resources. A summary of the assessed impacts on the surface water management system are as follows:

- The increase in disturbance area will result in additional surface runoff inflows to the mine water management system.
- The results of the water balance model show that an additional 200ML/a (on average) of imported water is required to sustain site demands, as a result of the proposed modification.
- The maximum annual imported water requirement, taking into account the additional demands associated with the proposed modification, is around 1,940ML/a. This maximum external water requirement can be satisfied from current water sources (UWSA and Northern Borefields) and MCO have the ability to access additional water under the UWSA, if required. Water required from external sources will be obtained under appropriate Water Access Licences and will be accessed in accordance with the requirements of existing Water Sharing Plans, including adherence to total daily extraction limits. This will ensure no adverse impacts on water availability for other licensed water users.
- The results of the mine water balance modelling show that under the full range of historical rainfall conditions, the proposed mine water management system will have sufficient capacity to contain all mine water on the site without uncontrolled releases, when operated in accordance with the proposed release conditions specified in the MCO Environmental Protection Licence (EPL). The proposed mine site water management strategy and infrastructure will ensure that the proposed modification has a negligible impact on the quality of surface runoff and receiving waters. The existing receiving water quality data indicates that the current operation has had no measurable impact on receiving water quality.
- The additional disturbance area associated with the proposed modification removes of small area of catchment draining to Moolarben Creek. The proposed modification only results in a 1.1% reduction in Moolarben Creek catchment area. This small reduction in catchment area will have a negligible impact on the flow characteristics of Moolarben Creek.
- The modification pit footprint is outside the 100 year ARI extent of flooding for Moolarben Creek. Hence, the proposed modification will have no additional impact on flood behaviour in Moolarben Creek up to the 100 year ARI flood event.

The potential impacts which result from the proposed modification will be managed under the existing surface water management system and in accordance with the WMP. The WMP and relevant sub-plans will be reviewed and updated as required to accommodate the proposed modification.

8 REFERENCES

ACARP, 2001	*ACARP Project No. 7007, Water Quality and Discharge Predictions to Final Void and Spoil Catchments*, PPK Environment & Infrastructure, December 2001.
AGE, 2013	*Moolarben Coal Project – Stage 1 Optimisation Modification Groundwater Assessment (DRAFT)*, Report prepared by Australasian Groundwater and Environmental Consultants, January 2013.
ANZECC/ARMCANZ, 2000	*Australian Guidelines for Fresh and Marine Water Quality*, Australian and New Zealand Environment Control Council and Agricultural and Resource Management Council of Australia and New Zealand, Australia.
Aquaterra, 2011	'*Groundwater Impact Assessment – Moolarben Stage 2 PPR*", Report prepared by RPS Aquaterra, 2011.
DECCW, 2008	*Managing Urban Stormwater – Soils and Construction – Volume 2E Mine and Quarries*, Department of Environment and Climate Change NSW, June 2008.
EPA, 2011	*Environmental Protection Licence - Ref. 12932*, Environmental Protection Agency – NSW, October 2011.
HB, 2012	'*Moolarben Coal –Project Stage 2 Preferred Project Report'*, Report prepared by Hansen Bailey for Moolarben Coal Mines Pty Ltd, January 2012.
Jeffrey SJ, Carter JO, Moodie KM & Beswick AR, 2001	Using Spatial Interpolation to Construct a Comprehensive Archive of Australian Climate Data, *Environmental Modelling & Software*, Vole 16/4. Pp 309-330, 2001.
MCO, 2010	*Moolarben Coal Water Management Plan,* Ref. MCO_ENV_PLN_0028, V2, Moolarben Coal Operations, April 2010.
PB, 2006a	*Moolarben Coal Project, Flood Impact Assessment*, Issue 3, Patterson Britton & Partners Pty Ltd, May 2006.
PB, 2006b	*Moolarben Coal Project, Surface Water Management Strategy*, Issue 3, Patterson Britton & Partners Pty Ltd, September 2006.
WP, 2008	*Moolarben Coal Project EA2 – Surface Water Management Strategy,* Issue 4, Worley Parsons, 28 November 2008.
WP, 2011	*Moolarben Coal Project – Stage 2 Preferred Project, Supplementary Surface Water Investigations Including Water Balance Modelling*, Issue 4, Worley Parsons, 30 August 2011.

APPENDIX A

ADOPTED MINE SITE CATCHMENT AREAS

Table A1 Mine Site Storage Catchment Areas and Types, Scenario 1, Year 2

Storage	Catchment Area (ha)						
	Natural	Pit	Unrehabilitated Spoil	Rehabilitated Spoil	Stockpile	Hardstand	Total
Mine Water Dam 10							-
Mine Water Dam 2			41.1			5.0	46.1
Process Water Dam						2.3	2.3
Clean Water Dam						2.1	2.1
Sediment Dam SD01					8.0		8.0
Sediment Dam SD02						3.9	3.9
Sediment Dam SD07						22.1	22.1
Sediment Dam SD08	8.3						8.3
Sediment Dam SD11						5.8	5.8
Cockies Dam	41.2						41.2
Sed Dams OC1 North				68.0		1.8	69.8
Sed Dam OC1A				37.5		0.4	37.9
Emergency Tailings Dam						5.7	5.7
Open Cut 1	341.9	73.9	149.5		2.7	18.6	586.6
OC2A	75.7		16.0			5.2	96.9
OC2B							-
OC2C							-
OC2D							-
Open Cut 2	32.4	11.6	18.4			0.7	63.0
OC3A							-
OC3B							-
OC3C							-
OC3D							-
OC3E							-
Open Cut 3							-
OC4A	17.3		37.8	22.1			77.3
OC4B							-
OC4C							-
OC4D							-
OC4E							-
OC4F							-
OC4G							-
OC4H							-
Open Cut 4	223.0	38.0	34.6				295.6
Total	739.8	123.5	297.3	127.7	10.7	73.6	1372.6

Table A2 Mine Site Storage Catchment Areas and Types, Scenario 1, Year 7

Storage	Catchment Area (ha)						
	Natural	Pit	Unrehabilitated Spoil	Rehabilitated Spoil	Stockpile	Hardstand	Total
Mine Water Dam 10							-
Mine Water Dam 2	20.7		41.1			5.0	66.8
Process Water Dam						2.3	2.3
Clean Water Dam						2.1	2.1
Sediment Dam SD01					8.0		8.0
Sediment Dam SD02						3.9	3.9
Sediment Dam SD07						22.1	22.1
Sediment Dam SD08	8.3						8.3
Sediment Dam SD11							-
Cockies Dam	41.2						41.2
Sed Dams OC1 North				68.0		1.8	69.8
Sed Dam OC1A				37.5		0.4	37.9
Emergency Tailings Dam						5.7	5.7
Open Cut 1	300.5	32.4	10.5	151.8	2.7	18.6	516.5
OC2A	69.6			30.6		3.6	103.8
OC2B	21.1		16.7	15.3			53.0
OC2C	72.4		64.3			3.3	140.0
OC2D	33.8		43.6			1.0	78.4
Open Cut 2							-
OC3A							-
OC3B							-
OC3C							-
OC3D							-
OC3E							-
Open Cut 3							-
OC4A	87.3			100.1			187.4
OC4B	23.6		161.8			10.2	195.5
OC4C							-
OC4D							-
OC4E							-
OC4F							-
OC4G							-
OC4H							-
Open Cut 4	91.2	81.0	86.9			5.9	271.2
Total	769.6	113.5	424.9	403.3	10.7	91.8	1837.1

Table A3 Mine Site Storage Catchment Areas and Types, Scenario 1, Year 12

Storage	Catchment Area (ha)						
	Natural	Pit	Unrehabilitated Spoil	Rehabilitated Spoil	Stockpile	Hardstand	Total
Mine Water Dam 10							-
Mine Water Dam 2	20.7			46.9		7.4	75.1
Process Water Dam						2.3	2.3
Clean Water Dam						2.1	2.1
Sediment Dam SD01					8.0		8.0
Sediment Dam SD02						3.9	3.9
Sediment Dam SD07						22.1	22.1
Sediment Dam SD08	8.3						8.3
Sediment Dam SD11							
Cockies Dam	41.2						41.2
Sed Dams OC1 North				68.0		1.8	69.8
Sed Dam OC1A				37.5		0.4	37.9
Emergency Tailings Dam						5.7	5.7
Open Cut 1	300.5	36.9	10.5	151.8	2.7	18.6	521.0
OC2A	69.6			30.6		3.6	103.8
OC2B	21.1			32.0		2.6	55.6
OC2C	72.4			64.3		3.3	140.0
OC2D	33.8		37.0	6.6		1.0	78.4
Open Cut 2							-
OC3A							-
OC3B							-
OC3C							-
OC3D							-
OC3E							-
Open Cut 3							-
OC4A	85.5			107.7			193.2
OC4B	22.7		114.3	112.9		10.2	260.1
OC4C	113.4		21.0	169.2		12.3	315.9
OC4D	18.1		128.8	65.2		8.3	220.3
OC4E							-
OC4F							-
OC4G							-
OC4H							-
Open Cut 4	119.7	73.3	64.0			6.6	263.6
Total	926.9	110.1	375.6	892.8	10.7	118.0	2428.4

Table A4 Mine Site Storage Catchment Areas and Types, Scenario 1, Year 16

Storage	Catchment Area (ha)						
	Natural	Pit	Unrehabilitated Spoil	Rehabilitated Spoil	Stockpile	Hardstand	Total
Mine Water Dam 10							0.0
Mine Water Dam 2	20.7			46.9		7.4	75.1
Process Water Dam						2.3	2.3
Clean Water Dam						2.1	2.1
Sediment Dam SD01					8.0		8.0
Sediment Dam SD02						3.9	3.9
Sediment Dam SD07						22.1	22.1
Sediment Dam SD08	8.3						8.3
Sediment Dam SD11							
Cockies Dam	41.2						41.2
Sed Dams OC1 North				68.0		1.8	69.8
Sed Dam OC1A				37.5		0.4	37.9
Emergency Tailings Dam						5.7	5.7
Open Cut 1	300.5	32.4	10.5	151.8	2.7	18.6	516.5
OC2A	69.6			30.6		3.6	103.8
OC2B	21.1			32.0		2.6	55.6
OC2C	72.4			64.3		3.3	140.0
OC2D	33.8			43.6		1.0	78.4
Open Cut 2							-
OC3A							-
OC3B							-
OC3C							-
OC3D							-
OC3E							-
Open Cut 3							-
OC4A	85.5			107.7			193.2
OC4B	83.5		37.3	233.6		11.1	365.5
OC4C	113.5			189.9		12.6	316.0
OC4D	9.6		84.0	122.0		8.9	224.5
OC4E	55.5		72.3	12.6		2.9	143.3
OC4F							-
OC4G							-
OC4H							-
Open Cut 4	269.1	72.4	52.6			6.2	400.3
Total	1184.3	104.8	256.6	1140.5	10.7	116.4	2813.4

Table A5 Mine Site Storage Catchment Areas and Types, Scenario 1, Year 19

Storage	Catchment Area (ha)						
	Natural	Pit	Unrehabilitated Spoil	Rehabilitated Spoil	Stockpile	Hardstand	Total
Mine Water Dam 10							-
Mine Water Dam 2	20.7			46.9		7.4	75.1
Process Water Dam						2.3	2.3
Clean Water Dam						2.1	2.1
Sediment Dam SD01					8.0		8.0
Sediment Dam SD02						3.9	3.9
Sediment Dam SD07						22.1	22.1
Sediment Dam SD08	8.3						8.3
Sediment Dam SD11							
Cockies Dam	41.2						41.2
Sed Dams OC1 North				68.0		1.8	69.8
Sed Dam OC1A				37.5		0.4	37.9
Emergency Tailings Dam						5.7	5.7
Open Cut 1	300.5	32.4	10.5	151.8	2.7	18.6	516.5
OC2A	69.6			30.6		3.6	103.8
OC2B	21.1			32.0		2.6	55.6
OC2C	72.4			64.3		3.3	140.0
OC2D	33.8			43.6		1.0	78.4
Open Cut 2							-
OC3A							-
OC3B							-
OC3C							-
OC3D							-
OC3E							-
Open Cut 3							-
OC4A	85.5			107.7			193.2
OC4B	85.1			278.5		2.2	365.9
OC4C	113.5			190.0		12.5	316.0
OC4D	9.6		75.1	146.6		9.4	240.7
OC4E	55.5			84.8		2.9	143.2
OC4F	123.8			170.4			294.2
OC4G	235.8		49.6	79.5			371.3
OC4H							-
Open Cut 4	103.9	37.9	30.8			2.5	175.1
Total	1380.2	70.3	166.0	1532.3	10.7	110.7	3270.2

Table A6 Mine Site Storage Catchment Areas and Types, Scenario 1, Year 24

Storage	Catchment Area (ha)						
	Natural	Pit	Unrehabilitated Spoil	Rehabilitated Spoil	Stockpile	Hardstand	Total
Mine Water Dam 10							-
Mine Water Dam 2	20.7			46.9		7.4	75.1
Process Water Dam						2.3	2.3
Clean Water Dam						2.1	2.1
Sediment Dam SD01					8.0		8.0
Sediment Dam SD02						3.9	3.9
Sediment Dam SD07						22.1	22.1
Sediment Dam SD08	8.3						8.3
Sediment Dam SD11							
Cockies Dam	41.2						41.2
Sed Dams OC1 North				68.0		1.8	69.8
Sed Dam OC1A				37.5		0.4	37.9
Emergency Tailings Dam						5.7	5.7
Open Cut 1	300.5	32.4	6.1	162.3	2.7	18.6	522.6
OC2A	69.6			30.6		3.6	103.8
OC2B	21.1			32.0		2.6	55.6
OC2C	72.4			64.3		3.3	140.0
OC2D	33.8			43.6		1.0	78.4
Open Cut 2							0.0
OC3A	35.1			70.0			105.1
OC3B	11.1			54.5			65.6
OC3C	20.4			28.9			49.3
OC3D	21.8			36.7			58.5
OC3E	12.2		15.7	16.2			44.2
Open Cut 3	18.1	17.3	4.0				39.4
OC4A	85.5			107.7			193.2
OC4B	85.1			280.7			365.8
OC4C	113.5			202.5			316.0
OC4D	27.9			287.8			315.7
OC4E	55.5			87.8			143.3
OC4F	118.7			175.7			294.4
OC4G	322.9			184.0			506.9
OC4H	15.4			27.1			42.4
Open Cut 4	89.2	35.4		3.3			127.9
Total	1599.9	85.1	25.8	2048.1	10.7	80.6	3850.2

Table A7 Mine Site Storage Catchment Areas and Types, Scenario 2, Year 2

Storage	Catchment Area (ha)						
	Natural	Pit	Unrehabilitated Spoil	Rehabilitated Spoil	Stockpile	Hardstand	Total
Mine Water Dam 10							-
Mine Water Dam 2	48.5			22.2		3.4	74.0
Process Water Dam						2.3	2.3
Clean Water Dam						2.1	2.1
Sediment Dam SD01					8.0		8.0
Sediment Dam SD02						3.9	3.9
Sediment Dam SD07						22.1	22.1
Sediment Dam SD08	8.3						8.3
Sediment Dam SD11							
Cockies Dam	41.2						41.2
Sed Dams OC1 North				68.0		1.8	69.8
Sed Dam OC1A				37.5		0.4	37.9
Emergency Tailings Dam						5.7	5.7
Open Cut 1	348.3	41.5	25.7	85.7	2.7	18.9	522.8
OC2A							-
OC2B							-
OC2C							-
OC2D							-
OC2E							-
Open Cut 2							
OC3A							
OC3B							
OC3C							
OC3D							
OC3E							
Open Cut 3							
OC4A	17.3		37.8	22.1			77.3
OC4B							-
OC4C							-
OC4D							-
OC4E							-
OC4F							-
OC4G							-
OC4H							-
Open Cut 4	223.0	38.0	34.6				295.6
Total	686.6	79.5	98.1	235.6	10.7	66.4	1176.8

Table A8 Mine Site Storage Catchment Areas and Types, Scenario 2, Year 7

Storage	Catchment Area (ha)						
	Natural	Pit	Unrehabilitated Spoil	Rehabilitated Spoil	Stockpile	Hardstand	Total
Mine Water Dam 10							-
Mine Water Dam 2				31.3		3.4	34.7
Process Water Dam						2.3	2.3
Clean Water Dam						2.1	2.1
Sediment Dam SD01					8.0		8.0
Sediment Dam SD02						3.9	3.9
Sediment Dam SD07						22.1	22.1
Sediment Dam SD08	8.3						8.3
Sediment Dam SD11							
Cockies Dam	41.2						41.2
Sed Dams OC1 North				68.0		1.8	69.8
Sed Dam OC1A				37.5		0.4	37.9
Emergency Tailings Dam						5.7	5.7
Open Cut 1	292.7	41.7	20.8	203.8	2.7	7.9	569.7
OC2A							0.0
OC2B							0.0
OC2C							0.0
OC2D							0.0
OC2E							0.0
Open Cut 2							0.0
OC3A							0.0
OC3B							0.0
OC3C							0.0
OC3D							0.0
OC3E							0.0
Open Cut 3							0.0
OC4A	87.3			100.1			187.4
OC4B	23.5		162.6			10.0	196.1
OC4C							0.0
OC4D							0.0
OC4E							0.0
OC4F							0.0
OC4G							0.0
OC4H							0.0
Open Cut 4	91.2	81.0	86.9	6.1		5.9	271.2
Total	544.3	122.8	270.3	446.9	10.7	71.4	1466.3

Table A9 Mine Site Storage Catchment Areas and Types, Scenario 2, Year 12

Storage	Catchment Area (ha)						
	Natural	Pit	Unrehabilitated Spoil	Rehabilitated Spoil	Stockpile	Hardstand	Total
Mine Water Dam 10							-
Mine Water Dam 2				61.1		4.6	65.7
Process Water Dam						2.3	2.3
Clean Water Dam						2.1	2.1
Sediment Dam SD01					8.0		8.0
Sediment Dam SD02						3.9	3.9
Sediment Dam SD07						22.1	22.1
Sediment Dam SD08	8.3						8.3
Sediment Dam SD11							
Cockies Dam	41.2						41.2
Sed Dams OC1 North				68.0		1.8	69.8
Sed Dam OC1A				37.5		0.4	37.9
Emergency Tailings Dam						5.7	5.7
Open Cut 1	282.5	32.6		202.5	2.7	7.0	527.4
OC2A	34.4		1.7	82.6		3.0	121.6
OC2B			14.6	5.9		0.7	21.2
OC2C	130.1		7.8				137.9
OC2D	72.1		6.3				78.4
OC2E							-
Open Cut 2	27.1	22.1	4.4				53.5
OC3A							-
OC3B							-
OC3C							-
OC3D							-
OC3E							-
Open Cut 3							-
OC4A	85.5			107.7			193.2
OC4B	22.7		114.3	112.9		10.2	260.1
OC4C	113.4		21.0	169.2		12.3	315.9
OC4D	18.1		128.8	65.2		8.3	220.3
OC4E							-
OC4F							-
OC4G							-
OC4H							-
Open Cut 4	119.7	73.3	64.0			6.6	263.6
Total	955.0	128.0	362.9	912.7	10.7	96.8	2466.1

Table A10 Mine Site Storage Catchment Areas and Types, Scenario 2, Year 16

Storage	Catchment Area (ha)						
	Natural	Pit	Unrehabilitated Spoil	Rehabilitated Spoil	Stockpile	Hardstand	Total
Mine Water Dam 10							-
Mine Water Dam 2				63.3		4.6	67.9
Process Water Dam						2.3	2.3
Clean Water Dam						2.1	2.1
Sediment Dam SD01					8.0		8.0
Sediment Dam SD02						3.9	3.9
Sediment Dam SD07						22.1	22.1
Sediment Dam SD08	8.3						8.3
Sediment Dam SD11							
Cockies Dam	41.2						41.2
Sed Dams OC1 North				68.0		1.8	69.8
Sed Dam OC1A				37.5		0.4	37.9
Emergency Tailings Dam						5.7	5.7
Open Cut 1	282.5	26.6	11.3	195.0	2.7	7.0	525.1
OC2A	34.4			84.3		3.0	121.6
OC2B	24.7			43.1		1.5	69.3
OC2C	7.1		16.0	30.2		1.2	54.5
OC2D	59.0		29.9			0.6	89.5
OC2E							0.0
Open Cut 2	35.8	34.7	7.4				77.9
OC3A							-
OC3B							-
OC3C							-
OC3D							-
OC3E							-
Open Cut 3							-
OC4A	85.5			107.7			193.2
OC4B	83.5		37.3	233.6		11.1	365.5
OC4C	113.5			189.9		12.6	316.0
OC4D	9.6		84.0	122.0		8.9	224.5
OC4E	55.5		72.3	12.6		2.9	143.3
OC4F							-
OC4G							-
OC4H							-
Open Cut 4	269.1	72.4	52.6			6.2	400.3
Total	1109.6	133.7	310.7	1187.2	10.7	103.7	2855.6

Table A11 Mine Site Storage Catchment Areas and Types, Scenario 2, Year 19

Storage	Catchment Area (ha)						
	Natural	Pit	Unrehabilitated Spoil	Rehabilitated Spoil	Stockpile	Hardstand	Total
Mine Water Dam 10							-
Mine Water Dam 2				63.2		4.6	67.8
Process Water Dam						2.3	2.3
Clean Water Dam						2.1	2.1
Sediment Dam SD01					8.0		8.0
Sediment Dam SD02						3.9	3.9
Sediment Dam SD07						22.1	22.1
Sediment Dam SD08	8.3						8.3
Sediment Dam SD11							
Cockies Dam	41.2						41.2
Sed Dams OC1 North				68.0		1.8	69.8
Sed Dam OC1A				37.5		0.4	37.9
Emergency Tailings Dam						5.7	5.7
Open Cut 1	282.5	32.6		200.3	2.7	7.0	525.2
OC2A	34.4			84.3		3.0	121.6
OC2B	24.7			43.1		1.5	69.3
OC2C	7.1			46.2		1.2	54.5
OC2D	37.2			83.9		2.2	123.3
OC2E	37.6		6.1	44.9		2.5	91.0
Open Cut 2	21.9	32.9					54.6
OC3A							-
OC3B							-
OC3C							-
OC3D							-
OC3E							-
Open Cut 3							-
OC4A	85.5			107.7			193.2
OC4B	85.1			278.5		2.2	365.9
OC4C	113.4			190.0		12.5	315.9
OC4D	9.6		75.1	146.6		9.4	240.7
OC4E	55.5			84.8		2.9	143.2
OC4F	123.8			170.4			294.2
OC4G	235.8		49.6	79.5		6.3	371.3
OC4H							-
Open Cut 4	103.9	37.9	30.8			2.5	175.1
Total	1307.6	103.1	161.5	1729.0	10.7	102.0	3414.0

Table A12 Mine Site Storage Catchment Areas and Types, Scenario 2, Year 24

Storage	Catchment Area (ha)						
	Natural	Pit	Unrehabilitated Spoil	Rehabilitated Spoil	Stockpile	Hardstand	Total
Mine Water Dam 10							0.0
Mine Water Dam 2				3.2		4.6	67.8
Process Water Dam						2.3	2.3
Clean Water Dam						2.1	2.1
Sediment Dam SD01					8.0		8.0
Sediment Dam SD02						3.9	3.9
Sediment Dam SD07						22.1	22.1
Sediment Dam SD08	8.3						8.3
Sediment Dam SD11							
Cockies Dam	41.2						41.2
Sed Dams OC1 North				68.0		1.8	69.8
Sed Dam OC1A				37.5		0.4	37.9
Emergency Tailings Dam						5.7	5.7
Open Cut 1	282.5	32.6		200.3	2.7	7.0	525.2
OC2A	34.4			84.3		3.0	121.6
OC2B	24.7			43.1		1.5	69.3
OC2C	7.1			46.2		1.2	54.5
OC2D	37.2			83.9		2.2	123.3
OC2E	37.6		56.8			2.5	96.8
Open Cut 2	21.9	13.9					35.9
OC3A	35.1			70.0			105.1
OC3B	11.1			54.5			65.6
OC3C	20.4			28.9			49.3
OC3D	21.8			36.7			58.5
OC3E	12.2		15.7	16.2			44.2
Open Cut 3	18.1	17.3	4.0				39.4
OC4A	85.5			107.7			193.2
OC4B	85.1			280.7			365.8
OC4C	113.5			202.5			316.0
OC4D	27.9			287.8			315.7
OC4E	55.5			87.8			143.3
OC4F	118.7			175.7			294.4
OC4G	322.9			184.0			506.9
OC4H	15.4			27.1			42.4
Open Cut 4	89.2	35.4		3.3			127.9
Total	1527.3	99.2	76.5	2189.4	10.7	66.1	3969.1