Appendix F

Preliminary Water Balance

Bylong Coal Project

Gateway Certificate Application
Supporting Document

0887-01-D2
5 December 2013

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Nathan Cooper
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Dear Nathan,

SUBJECT: BYLONG COAL PROJECT EIS – PRELIMINARY WATER BALANCE

1 OVERVIEW

WRM Water & Environment Pty Ltd was commissioned by Hansen Bailey Environmental Consultants (Hansen Bailey), on behalf of Cockatoo Coal Limited, to undertake a preliminary surface water impact assessment for the Bylong Coal Project (the Project). Cockatoo Coal Limited act as managers of the Project on behalf of KEPCO (Bylong) Australia Pty Ltd (KEPCO).

The preliminary assessment will form part of a Gateway Document being prepared by Hansen Bailey to support a Gateway Application to be lodged under Clause 17F of *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007* (SEPP (Mining)) which will be assessed by the Gateway Panel. This preliminary assessment will inform the preparation of the surface water impact assessment that will form part of an Environmental Impact Statement (EIS) being prepared by Hansen Bailey to support an application for State Significant Development Consent under Division 4.1 of Part 4 of the *Environmental Planning & Assessment Act 1979* (EP&A Act).

The following report provides details of the preliminary water balance assessment for the Project.

2 DRAINAGE NETWORK

The Project is located within the catchment of the Bylong River, a tributary of the Goulburn River, which in turn is a tributary of the Hunter River. The drainage network in the area of interest is shown in Figure 2.1. The Bylong River drains generally northwards, from the south-east, through the Project Boundary. A number of tributaries feed into the Bylong River throughout the Project Boundary, including:

- Reedy Creek,
- Wattle Creek,
- Cousins Creek,
- Lee Creek,
- Growee River,
- Dry Creek, and
- Coggan Creek.

The drainage network in the Bylong Valley, in which the Project is located, varies from steep headwater gullies to wide, flat, alluvial floodplains.

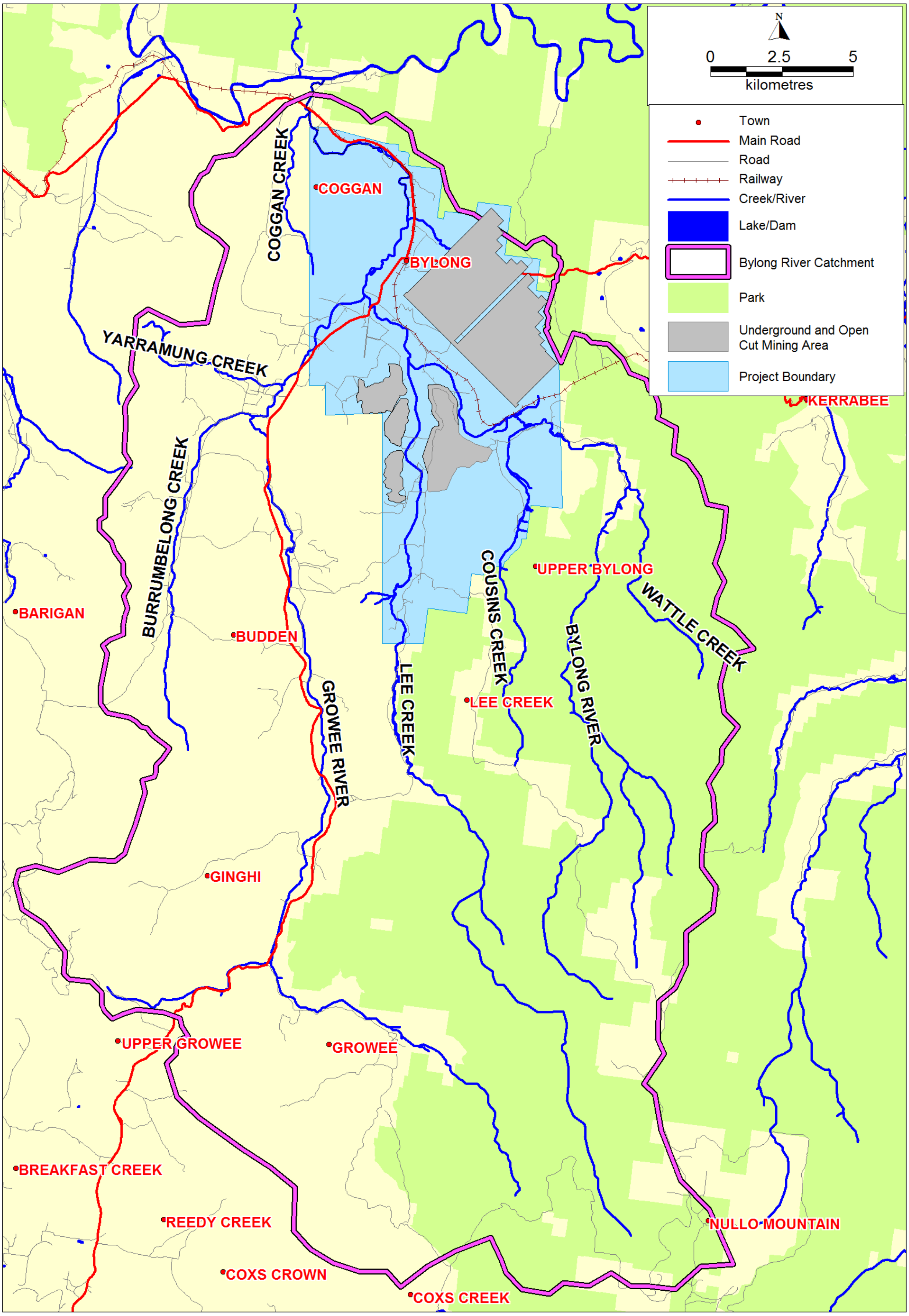

Figure 2.1 Drainage Network

3 WATER MANAGEMENT STRATEGY AND INFRASTRUCTURE

Open cut mining will be undertaken from approximately Year 3 to Year 10 of the 29 year mine life, with underground mining undertaken from approximately Year 8 to Year 29. Construction activities are proposed in the initial 2 years of the Project. Representative mine plans for the Project for Year 3, Year 5, Year 7 and Year 10 are shown in Figure 3.1 to Figure 3.4. At the completion of open cut mining, the southern portion of the eastern open cut mining area will remain open to accommodate disposal of partially dried tailings and rejects material from washing of coal from the underground operations. All sediment dams capturing runoff from rehabilitated overburden emplacement areas will also be rehabilitated. Each stage is expected to have differing operational rules and physical layout, which will reflect variations over time such as catchments, ROM coal production and groundwater seepage.

The water management strategy for the Project is based on the separation of water from different sources based on anticipated water quality. The surface water management strategy has been developed by categorising the surface water runoff into three types as follows:

- 'Clean' – surface runoff from areas where water quality is unaffected by mining operations. Clean water includes runoff from undisturbed areas and any fully rehabilitated areas;
- 'Dirty' – surface runoff from areas that are disturbed by mining operations (including overburden emplacement areas (OEAs)). This runoff is unlikely to come into contact with coal or other carbonaceous material and may contain high sediment loads, but does not contain contaminated material or high salt concentrations. This runoff may be suitable for release off-site after treatment to ensure that water quality is within the adopted water quality compliance criteria;
- 'Mine water' – includes water that has come in contact with coal such as seepage, groundwater and surface runoff within the Open Cut Mining Area or runoff from the CHPP and ROM coal stockpiles. This water may contain elevated concentrations of salt and other contaminants.

The key principles for the management of these three surface water runoff categories are as follows:

- Clean surface water runoff from undisturbed areas will be diverted, wherever possible, around areas disturbed by mining and released from the site, minimising the capture of clean surface water runoff.
- Dirty (sediment-laden) surface runoff from OEAs will be managed through a sediment and erosion control plan with water captured in sediment dams and treated to improve water quality prior to release from the site, or returned to the mine water system for reuse if the water quality is not suitable for release.
- Mine water will be collected in onsite storages and used preferentially to satisfy mine site water demands. It is not proposed to release this water from the site.

Figure 3.1 to Figure 3.4 show preliminary positioning of water management infrastructure, including clean and dirty water drains, in order to achieve the objectives of the water management strategy as detailed above. Proposed water storages include:

- A clean water dam;
- Mine water dams; and
- Sediment dams.

The sizes of all dams will be determined as part of ongoing preliminary design and more detailed assessment of the site water balance.

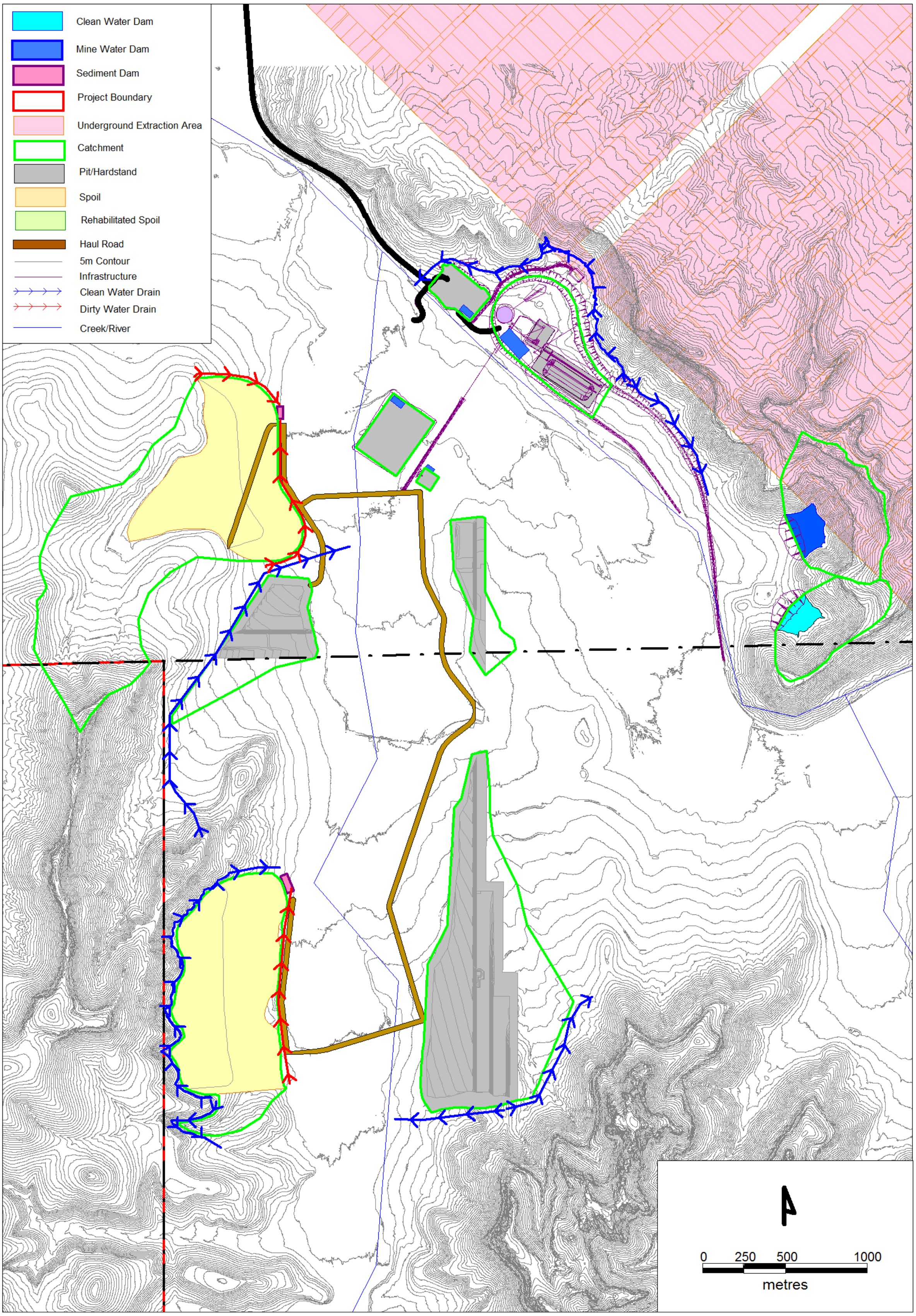

Figure 3.1 Year 3 Mine Plan

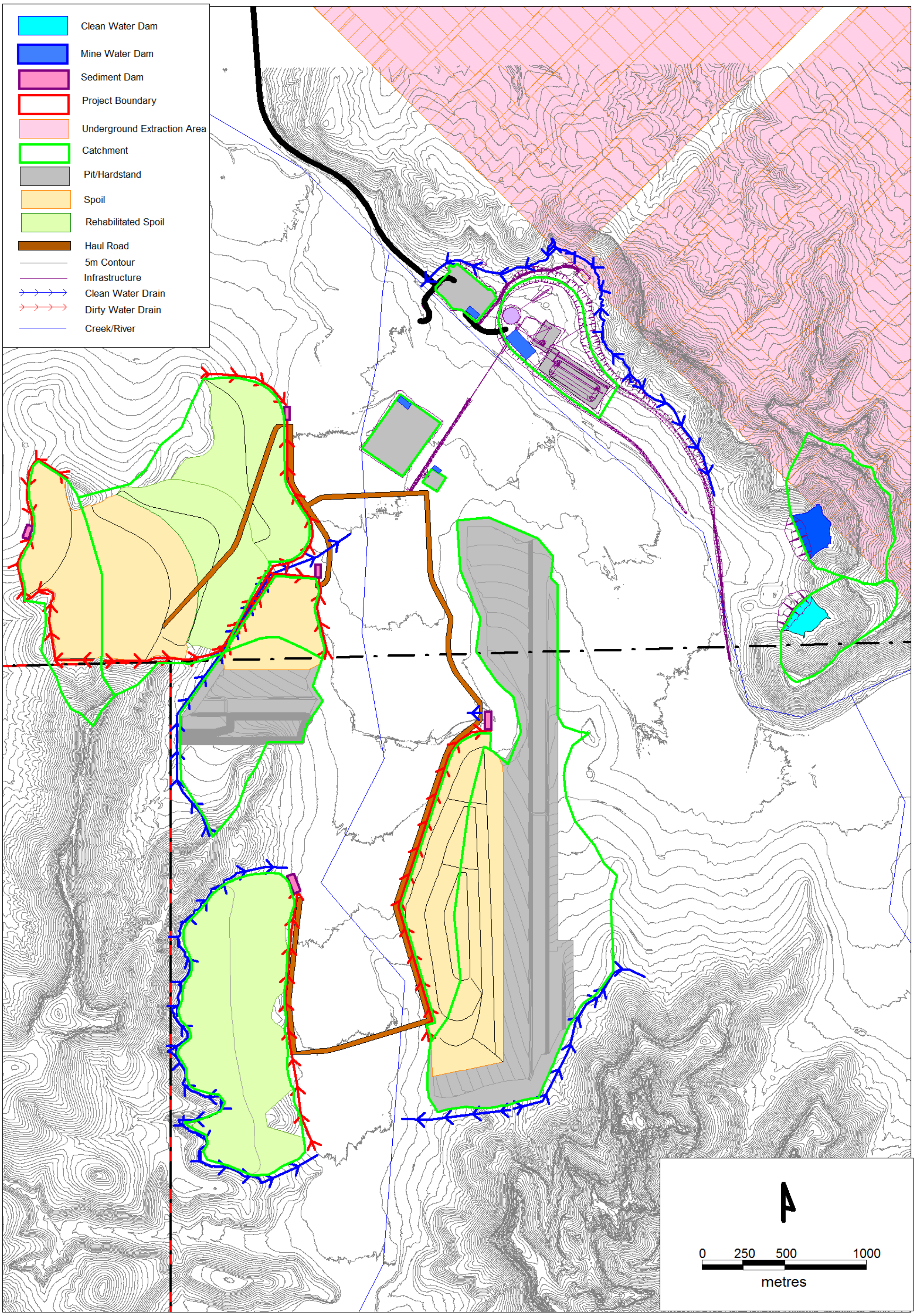

Figure 3.2 Year 5 Mine Plan

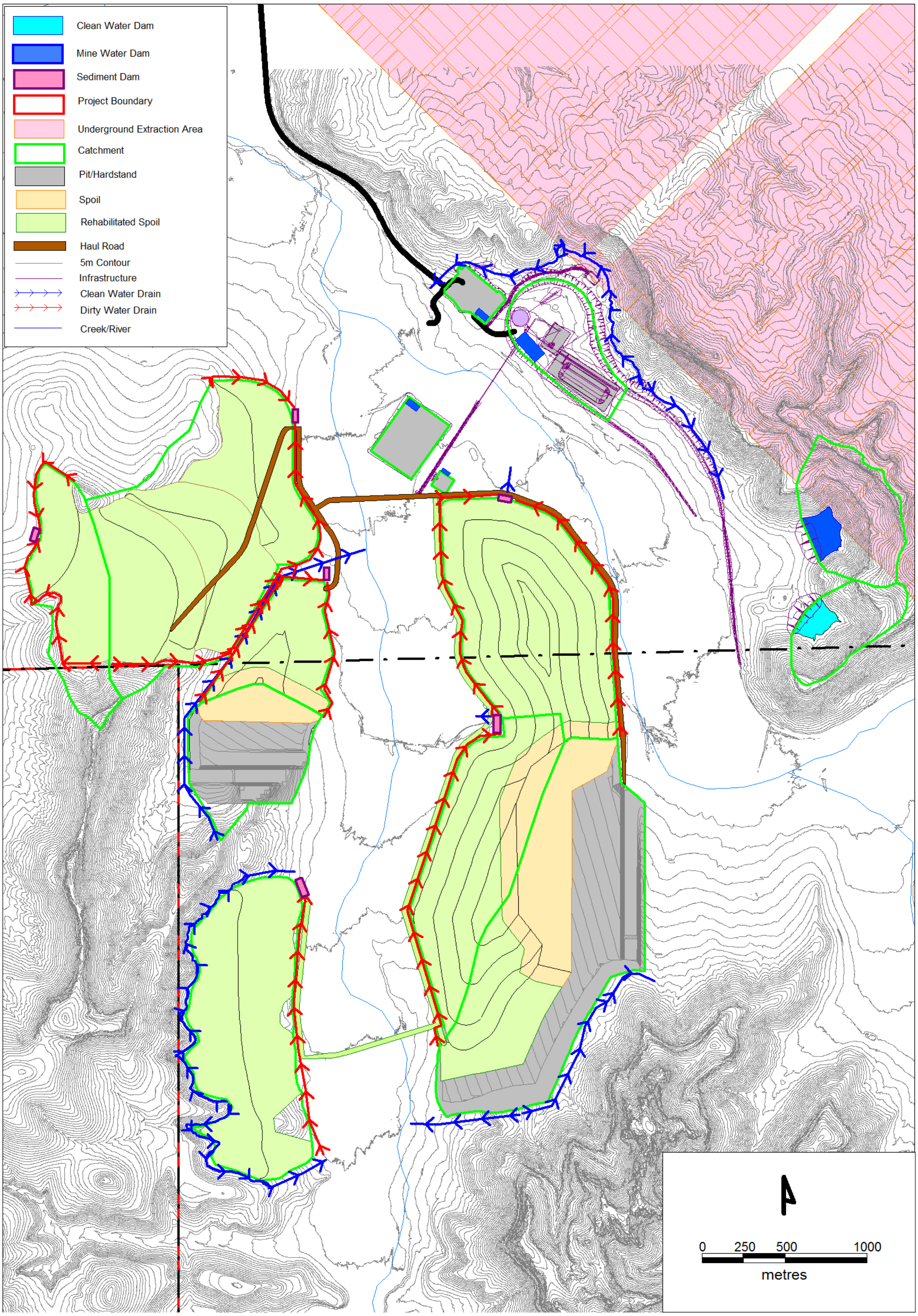

Figure 3.3 Year 7 Mine Plan

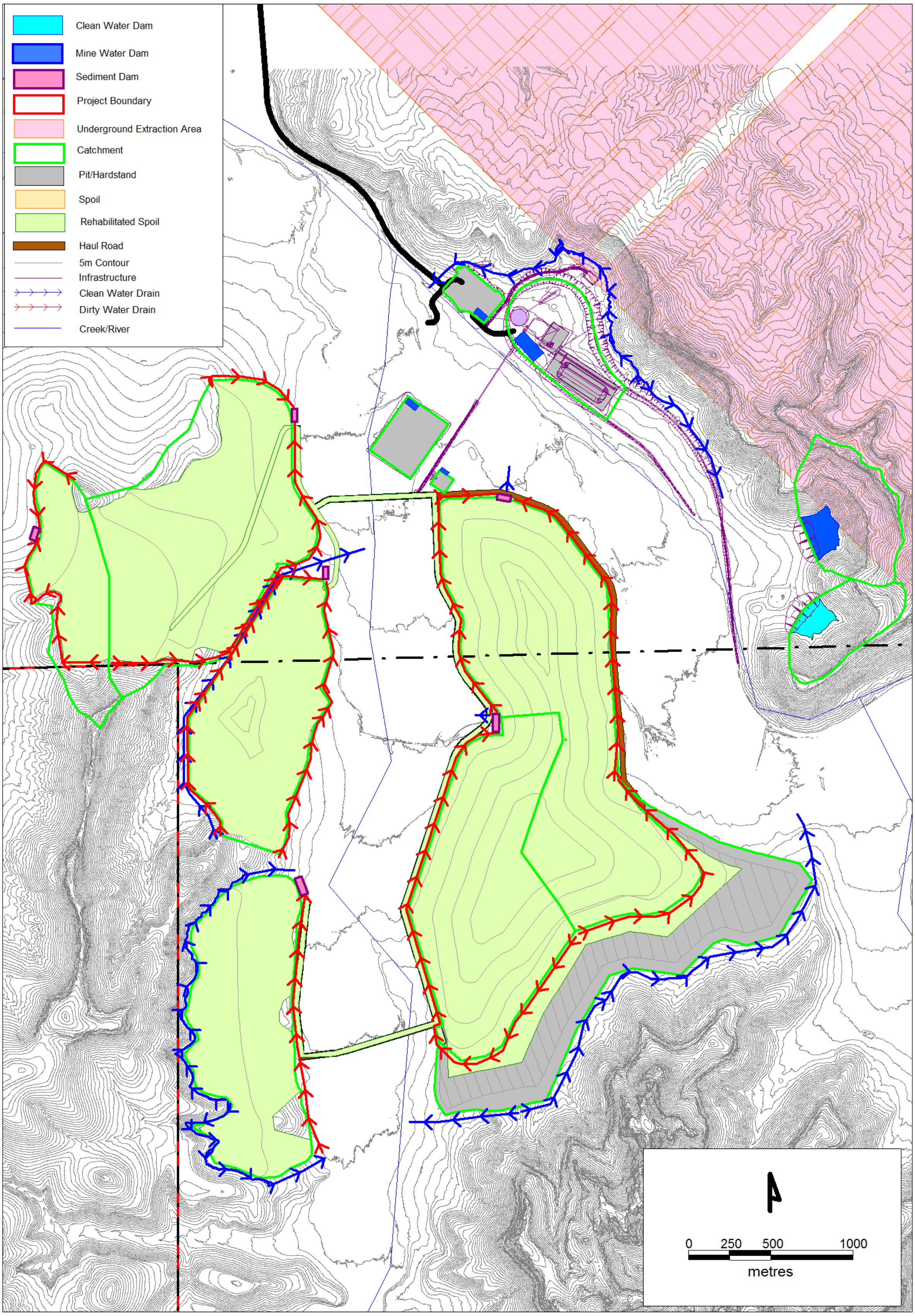

Figure 3.4 Year 10 Mine Plan

4 CLIMATE DATA

Daily rainfall has been recorded at Kerrabee (Murrumbo) (BoM Station No. 062046), about 10 km east of the Project Boundary, since 1951. Table 4.1 shows summary details of the rainfall station. Table 4.2 shows rainfall statistics for the Kerrabee (Murrumbo) Station. Mean annual rainfall is 661.3 mm with the highest monthly rainfalls occurring in the summer. The highest annual rainfall at this station (1,207.8 mm) was recorded in 1990.

The Bylong (Heatherbrae) rainfall station (BoM Station No. 062080) is located to the north of the Project Boundary, however this station only has recorded daily rainfall between 1968 and 2008. Table 4.1 shows summary details of the rainfall station. A comparison of the mean monthly rainfalls for the common period of record at the Bylong (Heatherbrae) and Kerrabee (Murrumbo) rainfall stations is provided in Table 4.3.
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Table 4.1 Rainfall Station Details

Station No.	Station Name	Elevation (m)	Latitude	Longitude	Distance from Site (km)	Opened	Closed
062046	Kerrabee (Murrumbo)	260	32.41° S	150.24° E	10	1951	-
062080	Bylong (Heatherbrae)	230	32.36° S	150.10° E	10	1968	2008

Table 4.2 Monthly Rainfall Statistics, Kerrabee (Murrumbo) (Station No. 062046), 1951-2013

Statistic	Monthly Rainfall (mm)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	86.7	75.5	52	34.7	44	36.8	38.8	44.4	39.3	57.9	59.6	70.5	661.3
Lowest	3	0	0	0	0	0	0	0	0	0	5.1	0	286.1
5th %ile	16.4	1.9	0.5	0	2.1	0.9	4	2.2	2.1	1.3	12.4	8.8	423.8
10th %ile	31.3	6.2	3.4	4.6	6.8	3.2	9.1	7.5	5.8	9.7	14.6	16.3	471.4
Median	65.2	63.6	33.6	25.1	34.4	29.2	33.4	40.1	34.3	57.2	53.2	64.6	668
90th %ile	162.8	137.7	126.8	69.6	107.6	70.9	69.9	83	79	101.6	124.6	136.8	817.3
95th %ile	204.9	206.9	136.1	97.9	119	91.2	81.2	117.1	92.2	106.9	140.8	160.8	887.3
Highest	260.5	388.9	183.4	153.6	162.9	217	150.8	129	102.4	187.6	154.6	266.1	1,207.8

Table 4.3 Rainfall Comparison

Period	Mean Rainfall (mm) 1968-2008	
	Kerrabee (Murrumbo) 062046	Bylong (Heatherbrae) 062080
Jan	89	76
Feb	70	72
Mar	52	49
Apr	35	35
May	46	39
Jun	37	43
Jul	42	40
Aug	44	38
Sep	43	42
Oct	56	63
Nov	64	58
Dec	69	68
Annual	661	627

Figure 4.1 shows the distribution of average annual rainfall over the Bylong River catchment (for the period 1961-1990), based on data obtained from the Bureau of Meteorology (BOM, 2009). Average annual rainfalls are similar across the alluvial plains (of the order of 600 to 700 mm), but are significantly higher across the ranges that form the southern and eastern boundary of the Bylong River catchment. Average annual rainfalls on the ranges to the south and east are approximately 750 – 1,000 mm. Nullo Mountain AWS (BoM Station No. 062100), located at the Bylong River upper catchment boundary as shown in Figure 4.1, has an average annual rainfall of 951.8 mm.

For the preliminary water balance assessment, the mean annual rainfall at Kerrabee of 661 mm was adopted.

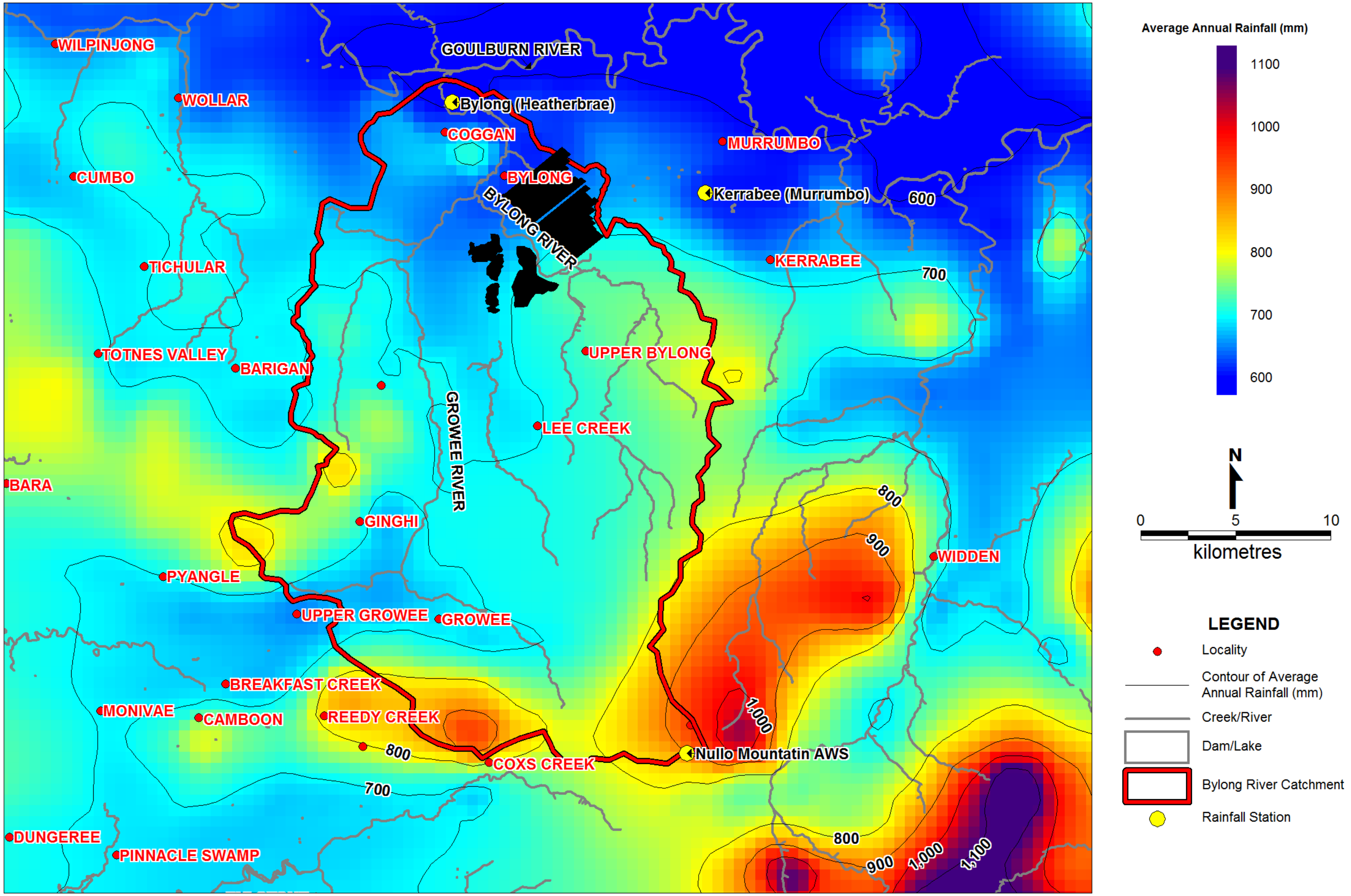

Figure 4.1 Spatial Distribution of Average Annual Rainfall, Bylong River Catchment (Data Source: BOM)

Table 4.4 shows mean monthly evaporation (based on Class A pan evaporation) recorded at Jerrys Plains Post Office (Station No. 061086), located some 75 km to the east of the Project Boundary. Mean annual evaporation is 1,641 mm, which is more than double mean annual rainfall.

Figure 4.2 shows the annual distribution of average monthly rainfall and evaporation. Evaporation is greater than rainfall in all months, but is much greater than rainfall in the warmer months.

Information from BOM (2009) indicates that average annual evaporation in the vicinity of the Project is approximately 1,606 mm (for the period 1961-1990), and 1,310 mm for average annual areal potential evapotranspiration.

For the preliminary water balance assessment, the mean annual evaporation of 1,606 mm will be used to estimate evaporative losses from storages, and the mean annual evapotranspiration rate will be used to estimate dust suppression requirements.

Table 4.4 Mean Monthly Pan Evaporation, Jerrys Plains Post Office, 10 Years of Data

Month	Mean Monthly Pan Evaporation (mm)
January	220.1
February	169.5
March	155
April	120
May	89.9
June	60
July	71.3
August	80.6
September	111
October	164.3
November	195
December	204.6
Total	1,641

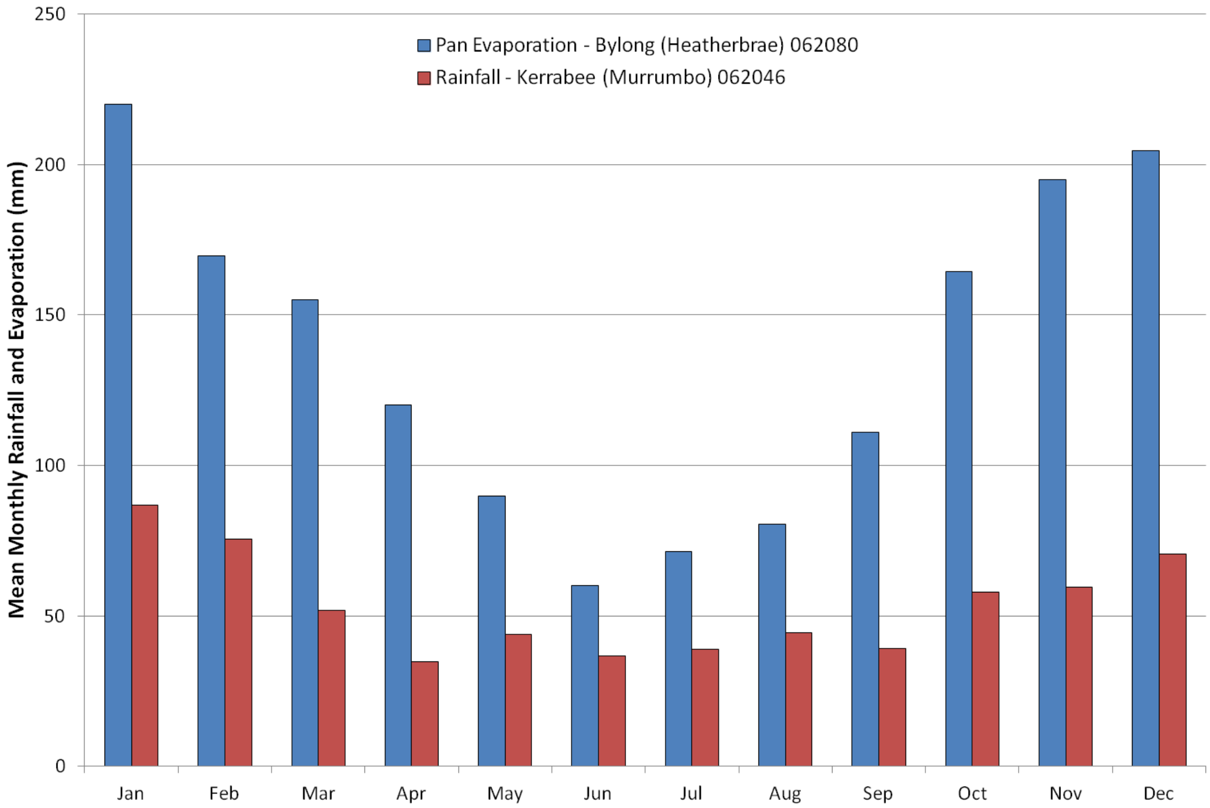

Figure 4.2 Distribution of Monthly Rainfall at Kerrabee (Murrumbo) and Evaporation at Jerrys Plains Post Office (Data Source: BOM)

5 WATER DEMANDS

5.1 General

Cockatoo Coal has estimated the following maximum water demands for the various components of the open cut and underground operations:

- Open cut operations and associated haul roads – 500 ML/yr for two pits;
- Underground operations (including longwall and continuous miner units, dust sprays and ROM coal stockpile) – 500 ML/yr;
- Coal Preparation Plant make-up water – 400 ML/yr;
- Offices, workshops, bathhouse etc in the MIA – 90 ML/yr;
- Accommodation camp – 50 ML/yr;

5.2 Haul Road Dust Suppression

Annual demand for haul road dust suppression was estimated based on the following:

- Approximate lengths were obtained for the active haul roads from the mine plans provided by Hansen Bailey and shown in Figure 3.1 to Figure 3.4;
- A watered road width of 30m was assumed;
- The water balance assessment assumes that on days on which the rainfall depth is greater than 5mm/d, no dust suppression will be required. When daily rainfall is less than 5mm/d, the rate is interpolated linearly with rainfall;

- The available rainfall record at Kerrabee (Murrumbo) (BoM Station No. 062046) was used to determine dust suppression requirements on a daily basis, however average annual demand was used in the preliminary water balance;
- There is on average 333 days per year where rainfall is below 5mm/day (at the Kerrabee rainfall station) and dust suppression will be required;
- The maximum haul road watering rate (on a dry day) was based on the average annual evapotranspiration rate in the vicinity of the Project (1,310 mm/yr, based on data obtained from BOM for the period 1961-1990). This equates to 3.6mm/d, which was adopted as the maximum haul road watering rate on a dry day.

The resulting average annual haul road dust suppression demand adopted for each mine stage is shown in Table 5.1. It is assumed that dust suppression demands will be drawn from the Mine Water Dam.

Table 5.1 Estimated Haul Road Dust Suppression Requirements

Mining Stage	Haul Road Length (km)	Dust Suppression Area (ha)*1	Maximum Daily Dust Suppression (kL/d)*2	Annual Average Dust Suppression (ML/yr)*3
Year 3	8.0	23.9	856	275
Year 5	8.6	25.8	925	297
Year 7	5.9	17.6	632	203
Year 10	2.7	8.1	291	93
Post - Open Cut	2.7	8.1	291	93

*1Based on an assumed width of 30m.
*2 For a non-rainfall (0mm) day.
*3 Based on long-term average, including rainfall days, from Kerrabee (Murrumbo) (BoM Station No. 062046).

5.3 Demand Summary

A summary of the Project demands is presented in Table 5.2 below.

Table 5.2 Summary of Project Demands – Net Usage

Mining Stage (Year)	Haul Road Dust Suppression (ML/yr)	Balance of Open Cut Usage (ML/yr)	CHPP Net Loss (ML/yr)	Office, Workshops & Camp (ML/yr)	Underground Operations (ML/yr)	Total Site Demand (ML/yr)
3	275	200	400	140	-	**1,015**
5	297	200	400	140	-	**1,037**
7	203	200	400	140	-	**943**
10	93	200	400	140	500	**1,333**
POST – OPEN CUT	93	20	400	140	500	**1,153**

6 PIT GROUNDWATER INFLOWS

Preliminary estimates of annual groundwater inflow volumes to the open cut and underground mining areas for the life of the Project are shown in Figure 6.1 (AGE, 2013). For the preliminary water balance assessment, the following groundwater inflows were adopted for the representative mine stages:

- Year 3 = 296 ML/yr
- Year 5 = 536 ML/yr
- Year 7 = 417 ML/yr
- Year 10 = 500 ML/yr
- Post open cut mining = 243 ML/yr (average of Years 11 to 29)

Evaporation of groundwater from the open cut pit walls was taken into account with a loss of 100 ML/yr assumed during Years 2 - 10 when the open cut pit is active, as shown in Figure 6.1.

Figure 6.1 Groundwater Inflows

7 WATER SOURCES

7.1 Catchment Runoff

Catchments across the site have been characterised into the following land use types:

- Natural/Undisturbed
- Un-rehabilitated Spoil
- Rehabilitated Spoil
- Roads/Hardstand (including pit floor & prestrip).

Long-term volumetric runoff coefficients have been selected for each land use type based on experience at other mine sites. The parameters are shown in Table 7.1.

Table 7.1 Adopted Rainfall-Runoff Parameter

Parameter	Long-term Volumetric Runoff Coefficient
Natural/Undisturbed	4%
Un-rehabilitated Spoil	10%
Rehabilitated Spoil	8%
Roads/Hardstand	30%

7.1.1 Catchments

Catchment areas for each of the site storages and pits have been estimated from the available topographic information and conceptual mine plans, as shown in Figure 3.1 to Figure 3.4. The catchment for the eastern mining area at Year 10 is assumed to remain at the completion of open cut mining while the pit is used for the disposal of tailings and rejects from the underground operations. A summary of catchment areas for the current mine configuration is provided in Table 7.2.

Table 7.2 Storage Catchment Area

Stage	Storage	Contributing Catchment (ha)			
		Rehabilitated Spoil	Unrehabilitated Spoil	Roads/ Hardstand	Natural/ Undisturbed
Year 3	East Pit	0	0	93	36
	West Pit	0	0	22	11
	Sed. Dams	0	139	2	108
	Catch Dams	0	0	30	22
	MWD	0	0	0	37
	RWD	0	0	0	23
	TOTAL	**0**	**139**	**147**	**238**
Year 5	East Pit	0	53	144	33
	West Pit	0	9	32	19
	Sed. Dams	182	147	4	39
	Catch Dams	0	0	30	22
	MWD	0	0	0	37
	RWD	0	0	0	23
	TOTAL	**182**	**209**	**210**	**174**
Year 7	East Pit	39	45	83	0
	West Pit	0	12	34	4
	Sed. Dams	475	30	4	39
	Catch Dams	0	0	30	22
	MWD	0	0	0	37
	RWD	0	0	0	23
	TOTAL	**513**	**87**	**151**	**126**
Year 10	East Pit	138	0	29	0
	Sed. Dams	683	0	4	39
	Catch Dams	0	0	30	22
	MWD	0	0	0	37
	RWD	0	0	0	23
	TOTAL	**821**	**0**	**63**	**122**

Stage	Storage	Contributing Catchment (ha)			
		Rehabilitated	Unrehabilitated	Roads/	Natural/
Post Open Cut	East Pit	138	0	29	0
	Catch Dams	0	0	30	22
	MWD	0	0	0	37
	RWD	0	0	0	23
	TOTAL	**138**	**0**	**59**	**82**

7.2 Water Licences

KEPCO has purchased licences to extract approximately 2,000 ML/annum from existing farm bores throughout the site. Where these farm bores are required to supply raw water for the Project, KEPCO will apply for their reclassification as industrial bores (pers. comm, Nathan Cooper, Hansen Bailey).

8 PRELIMINARY OPERATIONAL WATER BALANCE

8.1 Methodology

A static annual water balance was undertaken for each mine stage based on the changing physical layout. This allows for a comparison of inflows and outflows between the different stages. A list of the assumptions and calculation methods for the preliminary water balance is provided below:

- Runoff volume reporting to the site storages was calculated by multiplying the site catchments (Section 7.1.1) by the relevant long term volumetric runoff coefficients (Section 7.1) and the adopted average annual rainfall (Section 4).
- The volume of rain falling direct on storages was estimated based on:
  - the adopted average annual rainfall (Section 4);
  - a combined surface area for the Raw Water Dam and mine water dams of 11 ha (estimated from the provided mine plans) was adopted;
  - the total surface area of the sediment dams was estimated based on an assumed depth of 3m and a total volume based on the total catchment area reporting to the sediment dams during each stage, a 90th percentile 5-day rainfall depth of 35.9mm and a volumetric runoff coefficient of 0.68.
- The volume of evaporation from storages was estimated based on the combined maximum Raw Water Dam and mine water dams surface area (11 ha) multiplied by a factor of 0.6 to account for the variations in surface area with changing dam volume. The sediment dams and other minor mine water storages were assumed to be pumped out immediately to the primary Mine Water Dam, hence no evaporation from the sediment dams was accounted for.
- Groundwater inflows were adopted as per Section 6.
- Operational water demands are as per Section 5.
- For the post-open cut mining water balance (Years 10-29), it was assumed that the open cut mine was completely rehabilitated and only underground operations were occurring.

8.2 Results

Table 8.1 shows the preliminary water balance results. A summary of these results is provided below:

- Catchment runoff provides the largest water input to the water management system during the operation of the open cut pits (Years 3, 5, 7 and 10). At the completion of open cut mining, the largest inflow to the system is from groundwater;

- The largest demands from the water management system include water required for underground operations and CHPP make up water;
- The balance provides an indication of whether there will be a deficit (a negative value) or a surplus (positive value) of water under the proposed operational rules and layout for a given stage. For a water deficit, off-site supplies will be required to meet the operational demands, and for a water surplus, sufficient storage capacity will be required on site to contain excess mine affected water.
- In Year 3, Year 10 and post-open cut mining, there will be a deficit of water of 387 ML/yr, 321 ML/yr and 732 ML/yr, respectively. For each of these stages, the existing groundwater bore licences held by KEPCO will be sufficient to supply the additional water requirement;
- The water balance for Year 5 shows a water surplus of 90 ML/yr under the adopted operating rules and layout for that stage;
- A surplus of 46 ML/yr occurs for Year 7.

Table 8.1 Preliminary Water Balance (ML/yr)

Parameter	Mining Stage				
	Year 3	Year 5	Year 7	Year 10	Post-Open Cut Mining
Water Inputs					
Direct Rainfall	92	101	114	128	73
Catchment Runoff	446	696	663	591	211
Groundwater to open cut pit/underground operations	296	536	417	500	243
Total Inputs	**833**	**1,333**	**1,194**	**1,219**	**527**
Water Outputs					
Net loss from CHPP	400	400	400	400	400
Haul Road Dust Suppression	275	297	203	93	93
Open cut pits and associated dust suppression	200	200	200	200	20
Office/Workshops/accommodation camp	140	140	140	140	140
Underground operations	-	-	-	500	500
Evaporation from storages	106	106	106	106	106
Evaporation of groundwater from pit wall	100	100	100	100	-
Total Outputs	**1,221**	**1,243**	**1,149**	**1,539**	**1,259**
Balance [a]	**-387**	**90**	**46**	**-321**	**-732**

[a] Negative value indicates a water deficit.

9 CONCLUSION

The water balance results presented in this preliminary assessment are based on annual average inflows and outflows and should be considered indicative only. The actual site water balance will vary from year to year depending on climatic conditions.

The preliminary water balance assessment indicates that there may be a water deficit in Year 3, Year 10 and post-open cut mining (Years 11-29). Off-site water supplies may be required to meet operational demands during these stages if insufficient captured surface runoff has been stored for later use in the preceding stages where a surplus exists. The existing groundwater bore licences held by KEPCO would be sufficient to supply the deficit in each of these stages, which ranges from 321 ML/yr to 732 ML/yr.

The greatest surplus water (90 ML/yr) occurs in Year 5 of the Project. During this stage, sufficient storage capacity will be required for the surplus of water, ensuring all mine affected water is contained within the water management system. The sizes of all storages to supply site demands and prevent discharge of mine water will be determined as part of ongoing preliminary design and more detailed assessment of the site water balance.

For and on behalf of
WRM Water & Environment Pty Ltd

David Newton
Director

10 REFERENCES

AGE, 2013 AGE Groundwater & Environmental, *Bylong Coal Project - Gateway Groundwater Study,* Project No. G1606, 19 November 2013.

BOM, 2009 Mean Monthly and Mean Annual Rainfall Data – Gridded Climatological Data, Bureau of Meteorology, 2009, Australia.