



COWAL

APPENDIX B HYDROLOGICAL ASSESSMENT

COWAL GOLD MINE EXTENSION MODIFICATION

FINAL REPORT

**Cowal Gold Mine Extension Modification
Hydrological Assessment**

Prepared for: **Barrick (Cowal) Limited**

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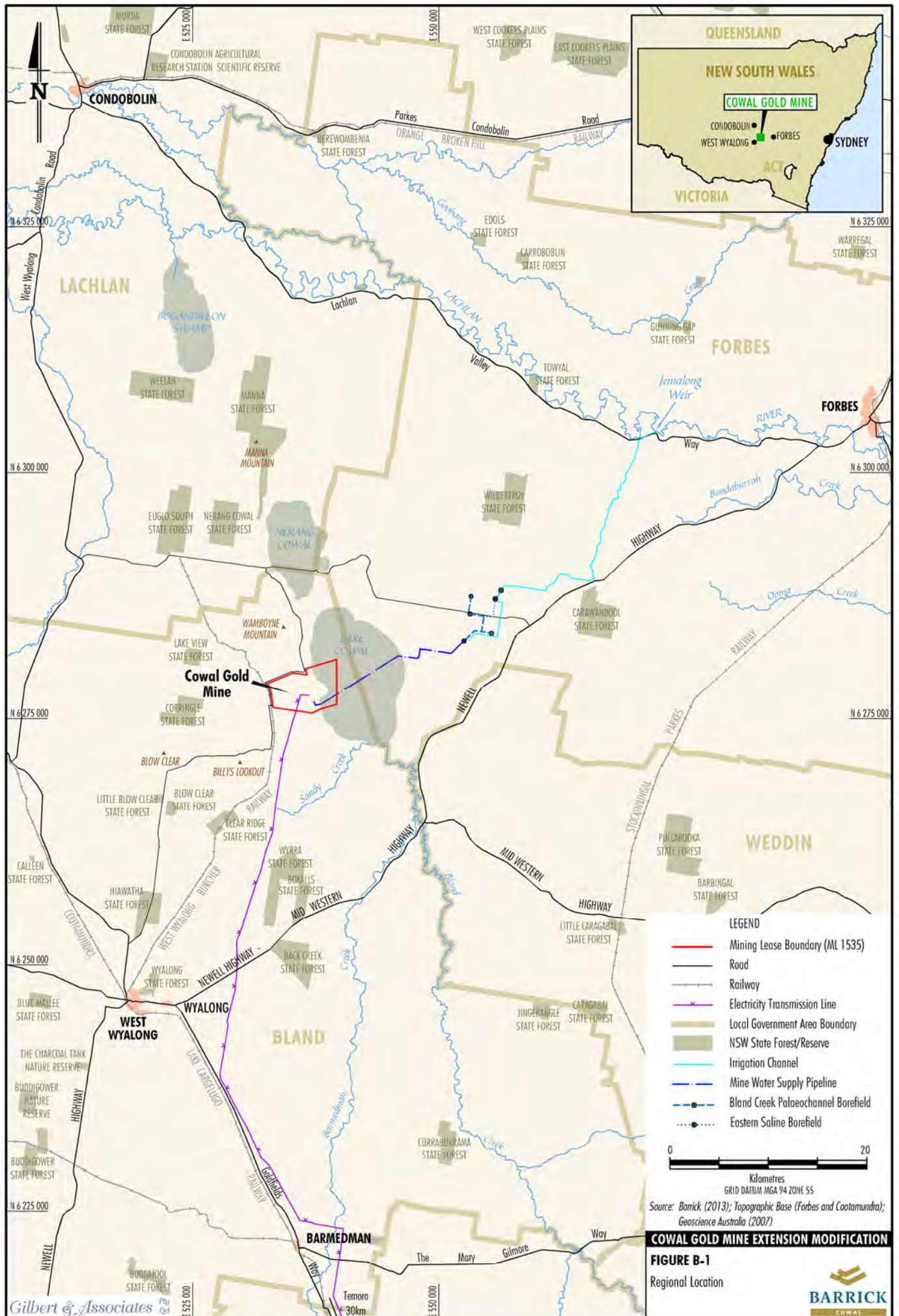
B1.0 INTRODUCTION

B1.1 Existing Mine and Modification Description

Barrick (Cowal) Limited (Barrick) is the owner and operator of the Cowal Gold Mine (CGM). Barrick is a wholly owned subsidiary of Barrick Australia Limited. The CGM is located approximately 38 kilometres (km) north-east of West Wyalong in New South Wales (NSW) (Figure B-1).

Barrick is seeking to modify the Development Consent (DA 14/98) under section 75W of the NSW *Environmental Planning and Assessment Act, 1979* (the CGM Extension Modification [the Modification]). The Modification includes the continuation of open cut mining operations at the CGM for an additional operational life of five years. The main activities associated with the development of the Modification would include:

- extension of the operational life of the CGM by an additional 5 years (i.e. until 2024);
- continued development of open pit mining operations at the CGM, including expansion of the extent and depth of the open pit;
- continued and expanded development of the existing Northern and Southern waste rock emplacements within ML 1535 for placement of mined waste rock over the life of the CGM, including:
 - raising the maximum design height of the northern waste rock emplacement to 308 metres (m) Australian Height Datum [AHD];
 - raising the maximum design height of the southern waste rock emplacement to 283 m AHD; and
 - extension of the northern waste rock emplacement to the west with an additional disturbance area of approximately 39 hectares (ha);
- no change to the existing process plant or its currently installed capacity to continue ore processing at a rate up to 7.5 million tonnes per annum (Mtpa)
- an increase in total gold production to approximately 3.8 million ounces;
- continued use of the existing tailings storage facilities for the deposition of tailings produced over the life of the CGM, including raising the maximum design height of:
 - the northern tailings storage facility (NTSF) to 248 m AHD; and
 - the southern tailings storage facility (STSF) to 255 m AHD;
- no change to the use of cyanide destruction in tailings prior to deposition in tailings storage facilities, with no change to the approved cyanide concentration limits in the aqueous component of the tailings slurry stream specified in the CGM Development Consent (DA 14/98);
- continued and expanded development of soil stockpiles, the relocation of existing soil stockpiles and stockpiling of mineralised material (i.e. potentially commercial ore) within ML 1535);



- no change to the use of currently approved external water supply sources (e.g. Bland Creek Palaeochannel Borefield, Eastern Saline Borefield and Lachlan River water entitlements via the Jemalong Irrigation Channel);
- additional internal surface water management infrastructure, including:
 - modification to the existing contained water storage D5 (including the potential for a new D5A water storage) to maintain the storage capacity of the existing D5; and
 - construction of a new water supply storage D10;
- construction of a new pump station on the eastern side of Lake Cowal to improve capacity/flow of the existing mine water supply pipeline, and associated diesel generator and access track; and
- a revised rehabilitation cover system to reflect the findings of ongoing rehabilitation trials at the CGM.

This hydrological assessment report has been prepared by Gilbert & Associates Pty Ltd in support of the Modification Environmental Assessment (EA) and draws on results of groundwater modelling contained in the report by Coffey Geotechnics (2013) (Appendix A of the EA).

B1.2 Assessment Requirements

This assessment addresses specific issues raised by government agencies during the consultation process for the Modification which are summarised in Section 1 of the Main Report of the EA.

The guidelines used as a basis for assessing impacts in this report are shown below:

| | | |
|----|--|---|
| 1. | National Water Quality Management Strategy: Australian Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000a) | The surface water quality monitoring results from the existing CGM and surrounding areas have been compared to these guidelines where appropriate (Section B2.3). |
| 2. | National Water Quality Management Strategy: Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC/ARMCANZ, 2000b) | The existing surface water quality monitoring would be conducted in accordance with these guidelines (Section B2.3). |
| 3. | National Water Quality Management Strategy: Guidelines for Sewerage Systems – Effluent Management (ANZECC/ARMCANZ, 1997) | The existing sewerage systems at the CGM (with upgrades as required) would continue to be operated in accordance with the <i>Environmental Guidelines: Use of Effluent by Irrigation</i> (DEC, 2004). |

| | | |
|-----|---|--|
| 4. | National Water Quality Management Strategy: Guidelines for Sewerage System – Use of Reclaimed Water (ANZECC/ARMCANZ, 2000c) | The existing sewerage systems at the CGM (with upgrades as required) would continue to be operated in accordance with the <i>Environmental Guidelines: Use of Effluent by Irrigation</i> (DEC, 2004) which makes reference to ANZECC/ARMCANZ (2000c). |
| 5. | Using the ANZECC Guideline and Water Quality Objectives in NSW (DEC, 2006) | The <i>Guidelines for Fresh and Marine Water Quality</i> (ANZECC/ARMCANZ, 2000a) has been applied in accordance with this guideline, including consideration of the NSW Government Water Quality and River Flow Objectives (OEH, 2011). |
| 6. | State Water Management Outcomes Plan | The assessment includes consideration of the policy developed under the State Water Management Outcomes Plan and the <i>Water Management Act, 2000</i> , including the <i>Water Sharing Plan for the Lachlan Unregulated and Alluvial Water Sources 2012</i> and <i>Water Sharing Plan for the Lachlan Regulated River Water Source 2012</i> (refer this section). |
| 7. | NSW Government Water Quality and River Flow Objectives (OEH, 2011) | Where applicable, the Water Quality Objectives for the Lachlan River have been compared to surface water quality monitoring results from the existing CGM and surrounding areas (Section B2.3). |
| 8. | Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (DEC, 2004) | The surface water quality monitoring programme would be conducted in accordance with these guidelines (Section B2.3). |
| 9. | Managing Urban Stormwater: Soils & Construction (Landcom, 2004) and associated Volume 2E: Mines and Quarries (DECCW, 2008) | Existing and planned erosion and sediment controls would be designed in accordance with Landcom (2004) and DECCW (2008) to control suspended solids in runoff (Section B2.3). |
| 10. | Managing Urban Stormwater: Treatment Techniques (EPA, 1997) | Would be considered and applied as relevant to drainage design/management around mine infrastructure area. |
| 11. | Managing Urban Stormwater: Source Control (EPA, 1998) | Would be considered and applied as relevant to drainage design/management in mine infrastructure areas. |
| 12. | Floodplain Development Manual (DIPNR, 2005) | Not considered relevant to this assessment as there are no properties other than those owned by the proponent that could be affected by mine infrastructure in any floodplain. |

| | |
|---|---|
| 13. Floodplain Risk Management Guide (DECCW,[2010]) | Not considered relevant to this assessment as the Modification is outside areas which could be affected by current sea level rise predictions and there are no properties outside those owned by the proponent that could be affected by mine infrastructure in any floodplain. |
| 14. A Rehabilitation Manual for Australian Streams (CRCCH and LWRRDC, 2000) | This guideline would be considered upon approval of the Modification. |
| 15. Technical Guidelines: Bunding & Spill Management | Would be used in design of containment systems for hazardous chemicals and would be incorporated into standard operating procedures for spill response. |
| 16. Environmental Guidelines: Use of Effluent by Irrigation | The surface water quality monitoring results from the existing CGM and surrounding areas have been compared to guidelines set in ANZECC/ARMCANZ (2000a) for use of water as irrigation water where relevant (Section B2.3). |
| 17. Guidelines for Practical Consideration of Climate Change (DECC, 2007) | Considered in the interpretations of post-mine impacts. |

DIPNR = NSW Department of Infrastructure, Planning and Natural Resources.

DECC = NSW Department of Environment and Climate Change.

ANZECC/ARMCANZ = Australian and New Zealand Environment and Conservation Council/ Agriculture and Resource Management Council of Australia and New Zealand.

DEC = NSW Department of Environment and Conservation.

OEH = NSW Office of Environment and Heritage.

DECCW = NSW Department of Environment, Climate Change and Water.

EPA = NSW Environment Protection Authority.

CRCCH and LWRRDC = Cooperative Research Centre for Catchment Hydrology and Land and Water Resources Research and Development Corporation.

The objects of the *NSW Water Management Act, 2000* which is the principal statute governing management of water resources in NSW, were also considered during the assessment. The objects of the *Water Management Act, 2000* include:

...to provide for the sustainable and integrated management of the water sources of the State for the benefit of both present and future generations and, in particular:

- (a) to apply the principles of ecologically sustainable development, and*
- (b) to protect, enhance and restore water sources, their associated ecosystems, ecological processes and biological diversity and their water quality, and*
- (c) to recognise and foster the significant social and economic benefits to the State that result from the sustainable and efficient use of water, including:*
 - (i) benefits to the environment, and*
 - (ii) benefits to urban communities, agriculture, fisheries, industry and recreation, and*
 - (iii) benefits to culture and heritage, and*
 - (iv) benefits to the Aboriginal people in relation to their spiritual, social, customary and economic use of land and water,*

- (d) *to recognise the role of the community, as a partner with government, in resolving issues relating to the management of water sources,*
- (e) *to provide for the orderly, efficient and equitable sharing of water from water sources,*
- (f) *to integrate the management of water sources with the management of other aspects of the environment, including the land, its soil, its native vegetation and its native fauna,*
- (g) *to encourage the sharing of responsibility for the sustainable and efficient use of water between the Government and water users,*
- (h) *to encourage best practice in the management and use of water.*

The groundwater-related components of the assessment are provided separately in the Hydrogeological Assessment prepared by Coffey Geotechnics (Appendix A of the EA). The Hydrogeological Assessment includes a discussion on the NSW Aquifer Interference Policy, 2012 and its implications for the Modification.

Under the *Water Management Act, 2000*, the *Water Sharing Plan for the Lachlan Regulated River Water Source, 2003* commenced on 1 July 2004 however was suspended up until 1 July 2011, when the plan then recommenced. The *Water Sharing Plan for the Lachlan Regulated River Water Source, 2003* covers licensed surface water accessed from the Lachlan River.

The external make-up of water supply at the CGM is provided to the site via the mine borefield pipeline which draws water from the eastern saline borefield, the Bland Creek Palaeochannel Borefield and water extracted from the Lachlan River via the Jemalong Irrigation Channel. Water is extracted from the Lachlan River using regulated flow licences purchased by Barrick on the open market under the *Water Sharing Plan for the Lachlan Regulated River Water Source 2003*. Between approximately 4,000 and 202,000 megalitres (ML) of temporary water has been traded annually since records began in the 2004 to 2005 season.

Under the *Water Management Act, 2000*, the *Water Sharing Plan for the Lachlan Unregulated and Alluvial Water Sources 2012* commenced on 14 September 2012.

The *Water Sharing Plan for the Lachlan Unregulated and Alluvial Water Sources 2012* applies to all unregulated water sources in the Lachlan catchment which occurs naturally on the surface of the ground, and in rivers, lakes and wetlands. The *Water Sharing Plan for the Lachlan Unregulated and Alluvial Water Sources 2012* would apply to any surface water excised from the Lachlan catchment that would otherwise have reported to the Lachlan River.

Within the *Water Sharing Plan for the Lachlan Unregulated and Alluvial Water Sources 2012*, the CGM is located within the Western Bland Creek Water Source, which has a total surface water entitlement of 2,187 megalitres per year (ML/year). Within the Western Bland Creek Water Source, there are currently 56 surface water licences, which account to a share component of 2,177 ML/year (NSW Office of Water [NOW], 2013).

Specific consideration of the objects of the *Water Management Act, 2000* are provided in Attachment 5 (Aquifer Interference Policy Considerations and Water Licensing Addendum) in the Main Report of the EA.

B1.3 Summary of Relevant Findings of Previous Environmental Approvals Documentation

Cowal Gold Project Environmental Impact Statement (EIS) (North, 1998).

- Surface water on the mine site was to be permanently isolated from Lake Cowal by an up-catchment diversion system (UCDS), directing runoff from areas unaffected by mining around the perimeter of the site, and an Internal Catchment Drainage System (ICDS), capturing all site runoff and seepage for re-use in the processing plant. In the longer term the ICDS would direct site runoff to the final void which would become a permanent sink for groundwater and surface runoff.
- The long term final void water balance was such that the final void was predicted to not spill under any conceivable climate conditions.
- The operational water balance prediction was for a moderately negative site water balance. External water supply would be required from the Bland Creek Palaeochannel Borefield.
- Mine waste rock material was predicted to have the potential to generate moderately saline seepage, particularly during the active mining phase. During the active mining phase, all runoff and seepage from the waste rock emplacements would be contained within the ICDS.
- The tailings storages were designed to be able to contain runoff from a 1 in 1,000 year average recurrence interval (ARI) rainfall event. Any spill or seepage would be contained within the ICDS, ultimately reporting to the open cut.
- In the longer term, it was predicted there would be little potential for movement of surface water or groundwater from the waste rock emplacements or of seepage from the tailings storages.

Use of suitable soils and vegetation in rehabilitation of waste rock emplacements and the tailings storages was predicted to result in low salt fluxes in surface waters consistent with regional runoff water quality.

B2.0 HYDROMETEOROLOGICAL SETTING

B2.1 Regional Hydrology

The CGM is located on the western side of Lake Cowal (Figure B-1) and extends into the natural extent of Lake Cowal. Lake Cowal is an ephemeral, fresh water lake that forms part of the Wilbertroy-Cowal Wetlands which are located on the Jemalong Plain. Lake Cowal is in the lower reaches of the Bland Creek catchment. It also receives periodic inflows from the Lachlan River during periods of high flow¹ when flood waters enter Lake Cowal via two main breakout channels from the north-east. Breakout from the Lachlan River to Lake Cowal occurred in late 2010 and in the first half of 2012, but had not occurred prior to this since 1998.

Lake Cowal is a large oval shaped lake which when full occupies an area of some 105 square kilometres (km²) and holds some 150 gegalitres of water and has a depth of approximately 4 m when full. It overflows to Nerang Cowal, a smaller lake to the north. Overflows from Lake Cowal to Nerang Cowal occurred in early 2012. When flows are sufficient, the lakes ultimately overflow and drain into the Lachlan River via Bogandillon Creek. The Lachlan River is the major regional surface drainage, forming part of the Murray-Darling Basin. Flows in the Lachlan River are regulated by releases from Wyangala Dam.

Figure B-2 shows a plot of recent Lake Cowal water levels, regional rainfall and streamflow in the Lachlan River. Lake water level rises in recent years have been caused by local rainfall (e.g. in March 2011), runoff inflows from the Bland Creek catchment and by breakout flows from the Lachlan River (e.g. in December 2010).

The area surrounding the CGM site is drained by ephemeral drainage lines which flow to Lake Cowal. Bland Creek and all other tributaries of Lake Cowal are also ephemeral. Flow records from a gauging station² on Bland Creek indicate that runoff is low, averaging about 5 percent (%) of rainfall.

B2.2 Meteorology

The region experiences a semi-arid climate which is dominated by cool, wetter conditions in winter and hot and relatively dry conditions in summer. Table B-1 summarises regional monthly and annual rainfall totals from Bureau of Meteorology (BoM) stations (Wyalong, Ungarie and Burcher Post Offices [PO]), as well as rainfall recorded at CGM since 2002.

¹ Inflows from the Lachlan River occur when flows at Jemalong Weir exceed 15,000 to 20,000 megalitres per day (ML/day) – North (1998).

² GS 412171 (Bland Creek at Marsden), which operated from 1998 to 2004.

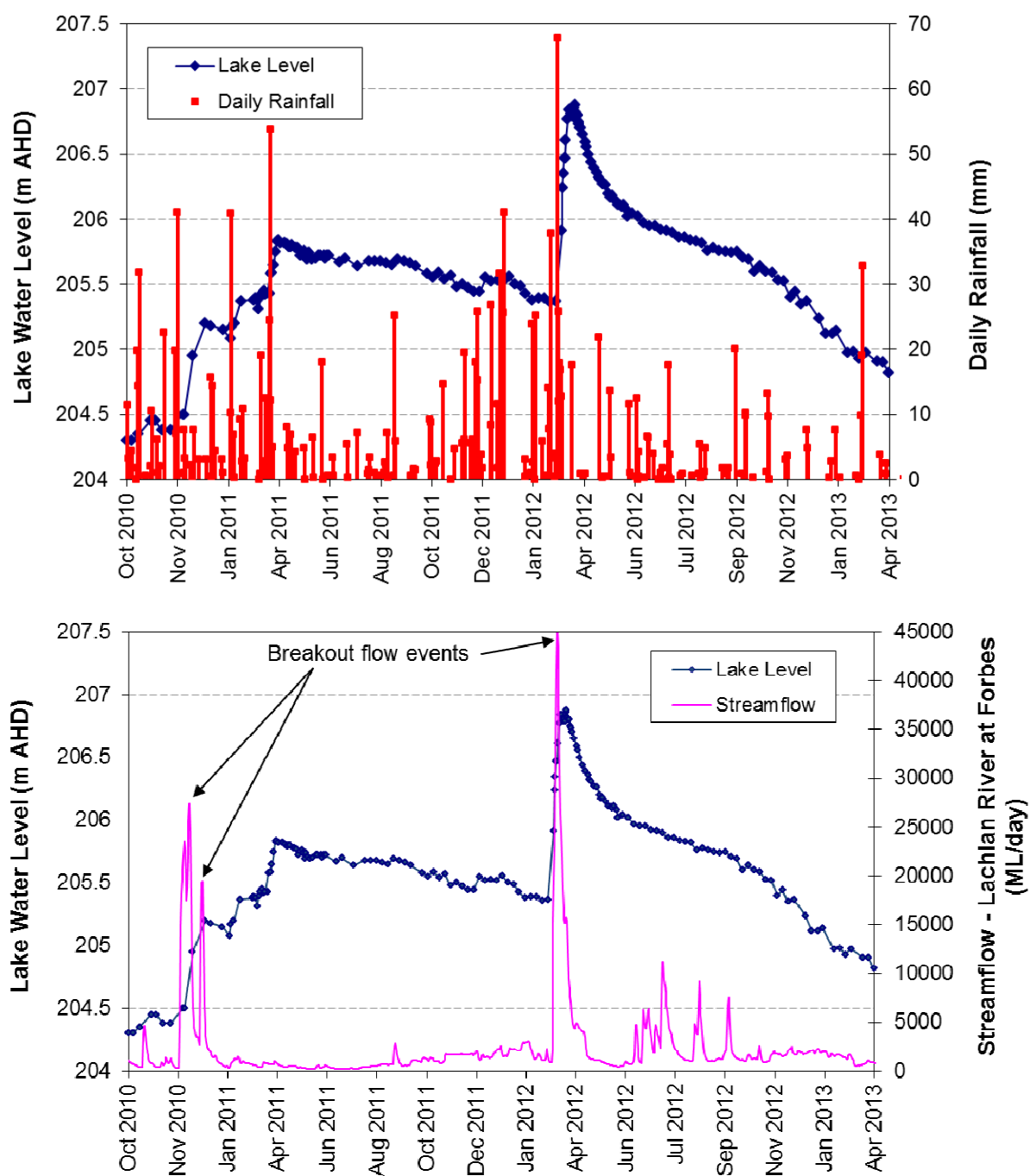


Figure B-2 – Recorded Lake Cowal Water Level, Rainfall and Lachlan River Streamflow

Table B-1
Rainfall Data Summary

| | Wyalong PO (073054*) | | Ungarie PO** (050040) | | Burcher PO (050010) | | Cowal Gold Mine | |
|--------|---------------------------------|------------------------------|----------------------------------|------------------------------|--------------------------------|------------------------------|--------------------------------|------------------------------|
| | 1895 – 2013 | | 1895 – 2012 | | 1937 – 2013 | | 2002 – 2013[†] | |
| | Mean Total (mm) | Mean No. Raindays | Mean Total (mm) | Mean No. Raindays | Mean Total (mm) | Mean No. Raindays | Mean Total (mm) | Mean No. Raindays |
| Jan | 41.7 | 4.8 | 41.6 | 3.7 | 41.5 | 3.9 | 20.6 | 4.4 |
| Feb | 39.2 | 4.6 | 39.7 | 3.8 | 44.7 | 3.9 | 69.9 | 6.9 |
| Mar | 37.9 | 4.6 | 38.2 | 3.7 | 40.6 | 3.8 | 32.9 | 4.6 |
| Apr | 35.0 | 4.8 | 32.5 | 3.8 | 33.0 | 4.0 | 19.7 | 4.0 |
| May | 39.1 | 6.6 | 38.3 | 5.6 | 37.6 | 5.7 | 19.2 | 4.8 |
| Jun | 42.1 | 8.5 | 41.6 | 6.7 | 34.0 | 6.2 | 42.5 | 9.1 |
| Jul | 41.8 | 9.6 | 37.9 | 7.2 | 38.3 | 7.2 | 37.1 | 9.5 |
| Aug | 39.1 | 9.0 | 35.8 | 7.0 | 38.2 | 6.4 | 32.5 | 8.0 |
| Sep | 36.6 | 7.4 | 32.4 | 5.7 | 34.5 | 5.3 | 30.2 | 6.1 |
| Oct | 46.1 | 6.9 | 40.8 | 5.5 | 46.0 | 5.5 | 30.2 | 6.2 |
| Nov | 36.8 | 5.6 | 36.2 | 4.3 | 37.6 | 4.7 | 39.2 | 6.1 |
| Dec | 44.2 | 5.4 | 43.2 | 4.2 | 42.2 | 4.0 | 56.2 | 7.0 |
| Annual | 479.6 | 77.8 | 458.5 | 61.1 | 468.2 | 61.2 | 430.7 | 76.6 |

* BoM Station Number.

** Data contains numerous gaps in recent years and early in the 20th century.

[†] Manual gauge to December 2006, automatic weather station thereafter (to early 2013).

mm = millimetres.

Long-term regional rainfall averages some 470 mm per annum. Average annual rainfall recorded at the CGM from 2002 to early 2013 averages 430 mm, which compares with an annual average of 432 mm recorded at Wyalong PO and 467 mm at Burcher PO for the same period.

Table B-2 summarises regional monthly and annual pan evaporation totals from the nearest BoM pan evaporation stations. The nearest BoM pan evaporation station is located at the Condobolin Agricultural Research Station, approximately 65 km north of CGM.

Table B-2
Evaporation Data Summary

| | Pan evaporation Condobolin Agricultural Research Station (050052*) | Pan evaporation Condobolin Soil Conservation (050102*) | Pan evaporation Cowra Research Station (063023*) |
|--------|---|---|---|
| | 1973 – 2013 | 1971 – 1985 | 1965 – 2011 |
| | Mean Total (mm) | Mean Total (mm) | Mean Total (mm) |
| Jan | 313.1 | 235.6 | 229.4 |
| Feb | 248.6 | 200.6 | 180.8 |
| Mar | 210.8 | 161.2 | 148.8 |
| Apr | 129.0 | 102.0 | 90.0 |
| May | 74.4 | 58.9 | 49.6 |
| Jun | 48.0 | 36.0 | 30.0 |
| Jul | 49.6 | 43.4 | 34.1 |
| Aug | 77.5 | 68.2 | 49.6 |
| Sep | 117.0 | 96.0 | 78.0 |
| Oct | 179.8 | 142.6 | 124.0 |
| Nov | 231.0 | 189.0 | 165.0 |
| Dec | 297.6 | 235.6 | 217.0 |
| Annual | 1,972 | 1,569 | 1,388 |

* BoM Station Number.

B2.3 Water Quality

B2.3.1 Lake Cowal

Baseline water quality reported in the Cowal Gold Project EIS was based on results of an intensive sampling programme conducted between 1991 and 1995 and included 34 monitoring locations along four transects across the Lake. This has been supplemented by an additional monitoring campaign undertaken from November 2010 through to June 2013 which included sampling of lake inflow from Sandy and Bland Creeks. The results of additional monitoring have been summarised in Table B-3 and Table B-4. The following assessment has been conducted using water quality data results obtained from sampling in Lake Cowal over this period (November 2010 to June 2013). Results from this assessment period are compared to relevant guideline values published in ANZECC/ARMCANZ (2000a) and with values obtained from sampling programs conducted in the baseline period prior to commencement of mining operations. Lake water quality monitoring locations are shown on Figure B-3.

Table B-3
Summary of Lake Cowal Water Quality – Generic Parameters

| Parameter (Units as stated) | Default Trigger Values ¹ | | Lake Cowal Baseline Water Quality (1991-1995) | Baseline Data Inflow Sites Only (1991-1992, Dec 93) | Baseline Data Lake Transects (1991-1995) | Lake Cowal Transect Monitoring (Nov 2010-June 2013) | Lake Cowal Inflow Sites (Nov 2010-June 2013) |
|---|--|--|---|--|---|--|--|
| | Protection of Aquatic Ecosystems | Stock Water Protection Low Risk Trigger Value | | | | | |
| Total N (µg/L) | 350 µg/L for SE Aust. Freshwater Lakes and Reservoirs | No trigger values given | Not available | 660 to 2,610 (1,200**) | 61 to 257 (136**) | 10 to 4,950, (765**) | 10 to 2,700 (1,099**) |
| Total P (µg/L) | 10 µg/L for SE Aust. Freshwater Lakes and Reservoirs | No trigger values given | Not available | 29 to 216 (79**) | 970 to 2,640 (1,667**) | 10 to 1,980(348**) | 170 to 1,860 (601*) |
| pH (pH units) - field | 6.5 to 8.0 pH for SE Aust. Freshwater Lakes and Reservoirs | No trigger values given | 8.27 to 8.67 | 7.6 to 8.2 | 7.72 to 9.80 (8.48**) | 5.56 to 11.42 (8.0**) | 5.78 to 9.39 (7.5**) |
| EC (measured in field)/TDS | EC 20-30 µS/cm for SE Aust. Freshwater Lakes and Reservoirs | TDS triggers 2,500 mg/L dairy cattle, 5,000 mg/L sheep | 222 to 1,557 µS/cm | 382 to 1,260 µS/cm (726**) | 160 to 3,130 µS/cm (881**) | 2.1 to 4,222 µS/cm (303**) | 34 to 871 µS/cm (221**) |
| Turbidity (NTU – measured in field)/TSS (mg/L) [^] | 1 to 20 NTU Turbidity Triggers for slightly disturbed ecosystems - lakes | No triggers given | 22 to 224 mg/L | 0.62 to 234 (70.5**) NTU [^] TSS 0.54 to 150 (37.9**) mg/L | 7 to 566 (111**) NTU [^] TSS 13 to 271 (103.4**) mg/L | 7.8 to 2,562 (261**) NTU [^] TSS 5 to 782 mg/L (104**) | 14.9 to 2,819 (411**) NTU [^] TSS 6 to 640 (140.6**) mg/L (**) |

µg/L = micrograms per litre; µS/cm = microSiemens per centimetre; mg/L = milligrams per litre.

EC = electrical conductivity.

TDS = total dissolved solids.

TSS = total suspended solids.

NTU = nephelometric turbidity unit.

[^] Catchments with highly dispersive soils will have high turbidity (ANZECC/ARMCANZ, 2000a).

Conductivity in lakes and reservoirs is generally low, but will vary depending on catchment geology (ANZECC/ARMCANZ, 2000a).

** Average Value.

¹ Trigger values were taken from ANZECC/ARMCANZ (2000a). The NSW Water Quality Objectives do not differ from the ANZECC/ARMCANZ (2000a) guidelines.

Note: pH, turbidity, and EC data was derived from field samples, all other parameters were derived from laboratory analysis.

Table B-4
Summary of Lake Cowal Water Quality – Metals

| Parameter (Units as stated) | Default Trigger Values ¹ | | | | | Lake Cowal Baseline Water Quality (1991-1995) | Baseline Data Inflow Sites Only (1991-1992, Dec 93) | Baseline Data Lake Transects (1991 - 1995) | Lake Cowal Transect Monitoring (Nov 2010-June 2013) | Lake Cowal Inflow Sites (Nov 2010-June 2013) |
|-----------------------------------|---|-------|-------|-------|--------------------------------------|--|---|---|---|--|
| | Protection Levels for Aquatic Ecosystems | | | | Stock Water Protection Level | | | | | |
| | 99% | 95% | 90% | 80% | Low Risk Trigger Value | | | | | |
| As (Total I (µg/L) | 0.8 | 13 | 42 | 140 | 500 µg/L | 2.6** | <0.1 to 3.5 (1.2**) | <0.5 to 3.98 (2.6**) | 2 to 27 (5.3**) | 2 - 26 (5.6**) |
| Cd (Total (µg/L) | 0.06 | 0.2 | 0.4 | 0.8 | 10 µg/L | 0.055** | <0.05 to 0.5 (0.1**) | <0.05 to 0.5 (0.06**) | 0.1 to 1 (0.10**) | All samples less than or equal to the Level of Detection Limit (0.1) |
| Cu (Total µg/L) | 1.0 | 1.4 | 1.8 | 2.5 | 1,000 µg/L cattle, 400 µg/L sheep | 6** | 1.6 to 7.5 (3.5**) | 2.2 to 15.9 (5.8**) | 1 to 31 (8.4) | 2 to 70 (13.6**) |
| Fe (Total µg/L) | No trigger values given | | | | Not sufficiently toxic | - | - | - | 360 to 33,600 (11,361**) | 900 to 180,000 (23,650**) |
| Pb (Total µg/L) | 1 | 3.4 | 5.6 | 9.4 | 100 µg/L | 2.9** | <0.5 to 7.2 (2.3**) | <0.5 to 6.5 (2.7**) | 1 to 15 (4.9**) | 1 to 97 (12.8**) |
| Mn (Total µg/L) | 1,200 | 1,900 | 2,500 | 3,600 | Not sufficiently toxic | - | - | - | 55 to 470 (158.5**) | 137 to 296 |
| Hg (Total µg/L) (inorganic) | 0.06 | 0.6 | 1.9 | 5.4 | 2 µg/L | >50% of samples less than the Level of Detection Limit | <0.1 to 0.4 (0.2**) | <0.1 to 0.4 (0.13**) | All samples less than or equal to the Level of Detection Limit (0.1) | All samples less than or equal to the Level of Detection Limit (0.1) |
| Zn (Total µg/L) | 2.4 | 8 | 15 | 31 | 20,000 µg/L | 12** | <3 to 22 (9.0**) | <3 to 30 (11.7**) | 5 to 79 (20.2**) | 5 to 234 (37.6 **) |
| Ni (Total µg/L) | 8 | 11 | 13 | 17 | 1,000 µg/L | - | - | - | 2 to 26 (10.5**) | 3 to 77 (15.25**) |

As = arsenic.

Cd = cadmium.

Cu = copper.

** Average Value.

Fe = iron.

Pb = lead.

Mn = manganese.

Hg = mercury.

Zn = zinc.

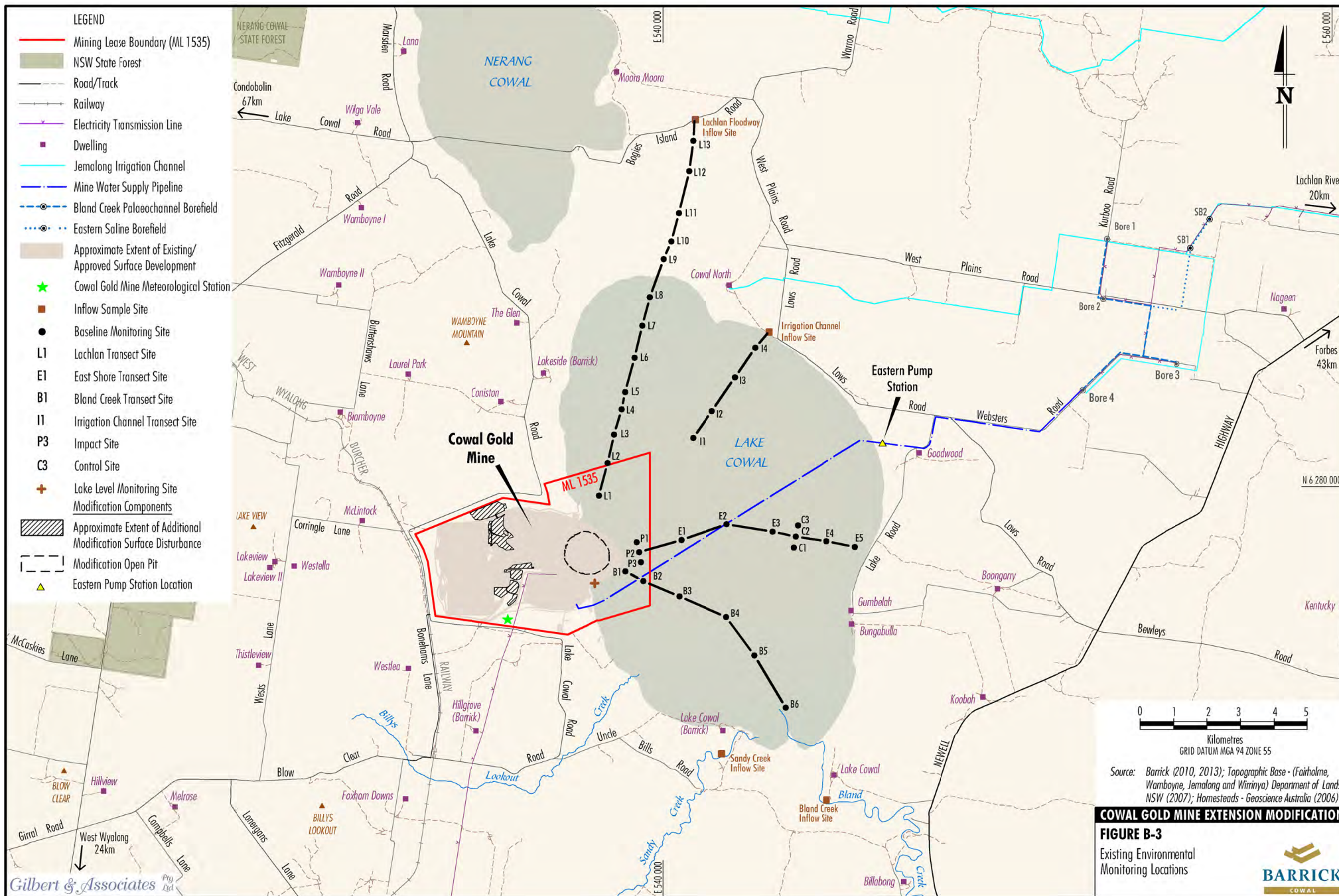
Ni = nickel.

> = greater than.

< = less than.

¹ Trigger values were taken from ANZECC/ARMCANZ (2000a). The NSW Water Quality Objectives to do not differ from the ANZECC/ARMCANZ (2000a) guidelines.

Note: pH, turbidity, and EC data was derived from field samples, all other parameters were derived from laboratory analysis.



Average total nitrogen measured at the lake transect sites was 765 µg/L, which was higher than the maximum level recorded during the baseline period (257 µg/L) and the ANZECC/ARMCANZ (2000a) default trigger value for fresh water lakes (350 µg/L). It was however lower than the average concentration in lake inflows from Bland Creek and Sandy Creek over the assessment period (1,099 µg/L).

Average total phosphorous measured at the lake transect sites was 348 µg/L, which was lower than the baseline data (range 970 to 2,640 µg/L) and lower than the average at the lake inflow sites (Bland Creek and Sandy Creek – 601, µg/L). It was however higher than the ANZECC/ARMCANZ (2000a) default trigger value for fresh water lakes (10 µg/L).

Average pH measured at the lake transect sites was 8.0, which was slightly lower than the average over the baseline period (8.48), but slightly higher than the average at the lake inflow sites (7.5). The range of pH levels recorded at the lake transect sites (5.56 to 11.42)³ was greater than that recorded at the lake inflow sample locations (5.78 to 9.39,) and outside the trigger value range (6.5 to 8) published in ANZECC/ARMCANZ (2000a). The range measured at the lake transects during the baseline period was 7.72 to 9.8 (which is noted to also be outside the upper trigger level published in ANZECC/ARMCANZ).

Average EC (a measure of salinity) in lake water over the assessment period was 303 µS/cm. This is lower than the average EC measured at the lake transect sites during the baseline period (881 µS/cm). The average EC readings in the lake during the assessment period were consistent with the average at the lake inflow sample locations (221 µS/cm) over assessment period. Both the average lake inflows and lake transect readings during the baseline and assessment periods were however well above the ANZECC/ARMCANZ (2000a) default trigger value for fresh water lakes (20 - 30 µS/cm).

Average turbidity levels recorded at lake transect sites during the assessment period was 261 NTU compared to 111 NTU recorded during the baseline period. Average turbidity recorded at Lake transects was lower than the average recorded at the lake inflow sample locations (411 NTU) during the assessment period. The levels recorded during the baseline and assessed period were well above the ANZECC/ARMCANZ (2000a) default trigger level for protection of slightly disturbed ecosystems (1 to 20 NTU).

Laboratory analysis of lake and inflow water quality samples included metals analyses for nine metals (arsenic, cadmium, copper, iron, lead, manganese, mercury, nickel and zinc). Mercury concentrations were at or below laboratory detection level at both lake transect and lake inflow sites during the assessment period. Cadmium concentrations were at or below laboratory detection level at lake inflow sites and one sample returned a concentration above the laboratory detection in the lake transect sites.

³ Two field pH values greater than 10 were recorded in late February 2011. 90% of recorded pH values were less than 8.7.

Average arsenic, manganese and nickel concentrations at the lake transect sites were below ANZECC/ARMCANZ (2000a) default trigger levels for protection of slightly modified aquatic ecosystems (95% protection level). Average lead, copper and zinc concentrations at the lake transect sites were lower than the respective average concentrations measured at the lake inflow sites but above the ANZECC/ARMCANZ (2000a) default triggers (at 95% the protection level). The average lake copper concentration (8.4 µg/L), lead (4.9 µg/L) and zinc (20.2 µg/L) were greater than the baseline values of 5.8, 2.7 and 11.7 µg/L respectively.

Notable results are:

- the range of pH is high relative to ANZECC/ARMCANZ (2000a) default triggers and baseline ranges;
- average copper, lead and zinc concentrations which are high relative to both ANZECC/ARMCANZ (2000a) default triggers and baseline;
- average turbidity was significantly higher (up to 13 times) than the ANZECC/ARMCANZ (2000a) default trigger value and higher than baseline levels); and
- total phosphorous concentrations which are significantly higher (34 times) than the ANZECC/ARMCANZ (2000a) default trigger value for fresh water lakes (it is noted measured total phosphorus is less than the baseline average).

Because runoff and water within the CGM area is fully contained within the ICDS, there is no obvious causal link between the mining operations and the water quality in the lake. Given that groundwater, including any seepage from on-site storages, would flow toward the mine pit (Coffey Geotechnics, 2013), the only plausible links between mining activity at CGM and lake water quality would be overflow from dams D1 and/or D4 (which are outside the ICDS), mine site, dust fall-out onto the lake or runoff/wash-off from the outside batters and inundated parts of the Lake Temporary Isolation Bund. Both D1 and D4 storages are fitted with pump back systems and Barrick has advised⁴ that they have never overflowed.

Samples taken at transect sites P1, P2 and P3 are physically close to the Lake Isolation Bund and therefore more likely to reflect mine-related effects, whilst sites E3 and E4 are on the “opposite” side of the lake – refer Figure B-3. A comparison of the monitored results from these sites for pH, zinc, turbidity and total phosphorous is shown in Figures B-4 to B-9.

⁴ Pers comm., Barrick Australia Limited.

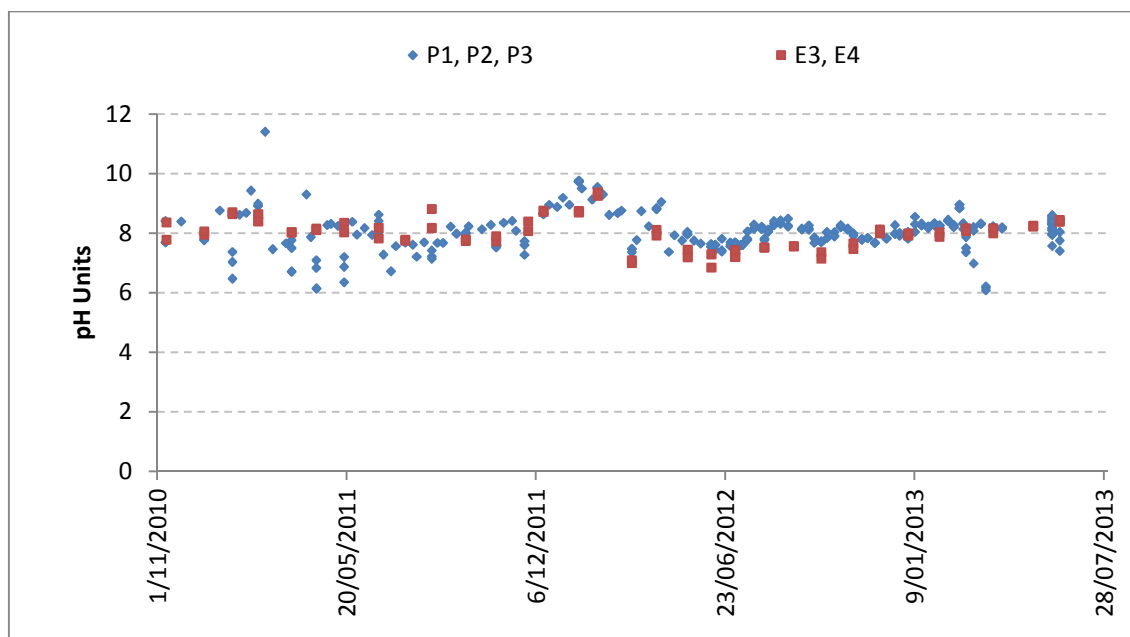


Figure B-4 Field Measurement of pH at Selected Sites – Lake Cowal

The pH values were relatively elevated at lake sites close to CGM (P1, P2, and P3), in February 2011 compared to sites on the opposite side of the Lake. Elevated pH levels were also recorded near the CGM in February 2012 although similar levels were also measured on the opposite side of the lake at that time.

To further assess whether there was a link between the elevated pH levels measured in February 2011 and proximity to CGM, an assessment was conducted on pH levels recorded at all sites considered to be relatively close to the Lake Temporary Isolation Bund (E1, L1, P1, P2, P3, B1 and B2 – refer Figure B-3) and all other sites in the lake during 2011 – refer Figure B-5. This assessment indicates that pH levels were similar at sites close to CGM and at other (more distant) sites. In particular there was a relatively elevated pH value recorded at site C1 (11.05) in February 2011 which suggests that pH has been similarly elevated at sites near and distant from the CGM.

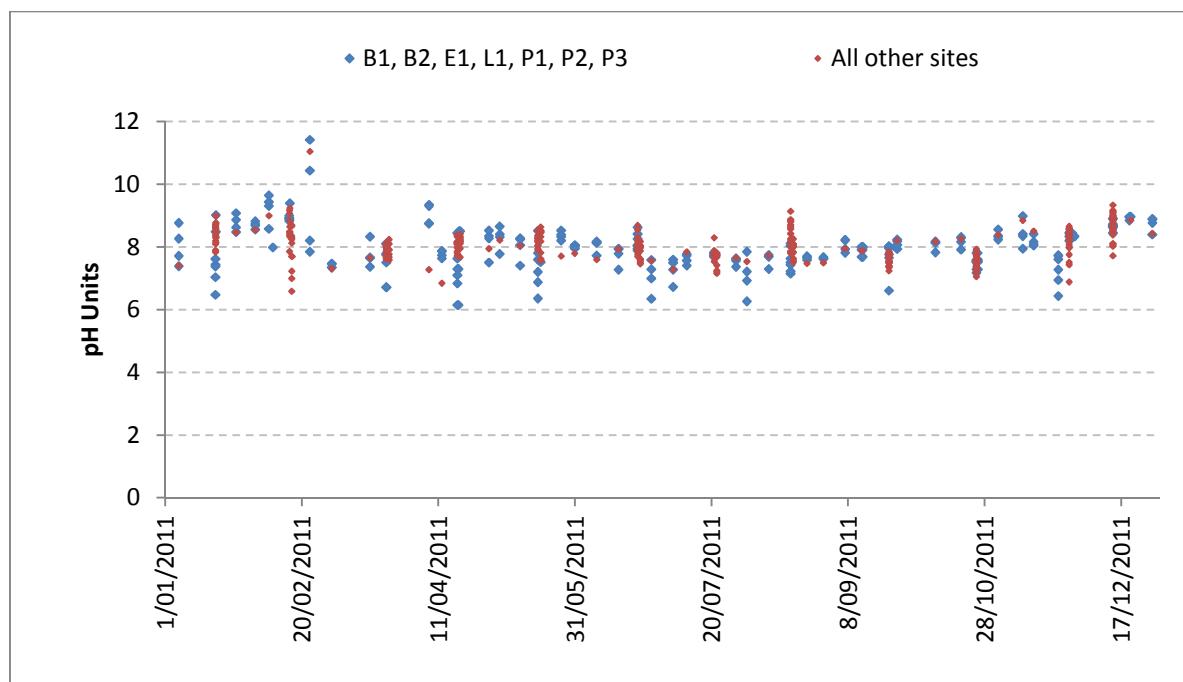


Figure B-5 Field Measurements of pH – Lake Cowal 2011

The assessment of copper concentrations at sites close to CGM and sites on the opposite side of the lake is presented in Figure B-6. Results of this assessment indicate that copper concentrations have been similar at sites close to CGM and at sites on the opposite side of the lake.

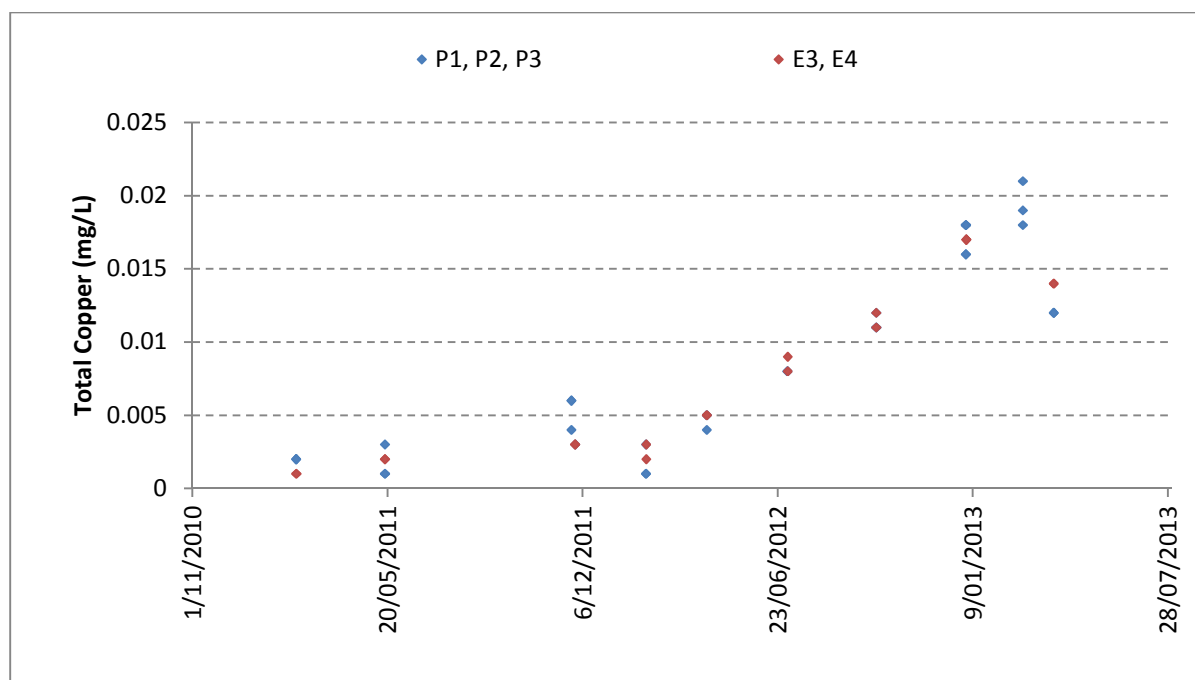


Figure B-6 Recorded Copper Concentrations at Selected Sites – Lake Cowal

The assessment of lead concentrations at sites close to CGM and sites on the opposite side of the lake is presented in Figure B-7. Results of this assessment indicate that lead concentrations have also been similar at sites close to CGM and at sites on the opposite side of the lake.

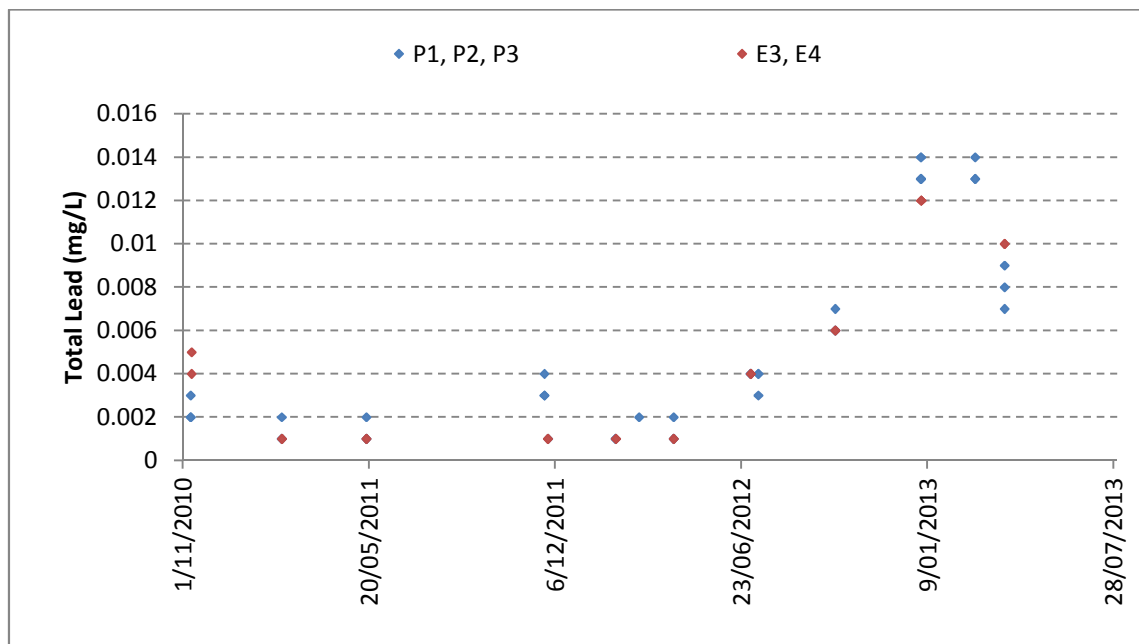


Figure B-7 Recorded Lead Concentrations at Selected Sites – Lake Cowal

The assessment of zinc concentrations at sites close to CGM and sites on the opposite side of the lake is presented in Figure B-8. Results of this assessment indicate that zinc concentrations have also been similar at sites close to CGM and at sites on the opposite side of the lake.

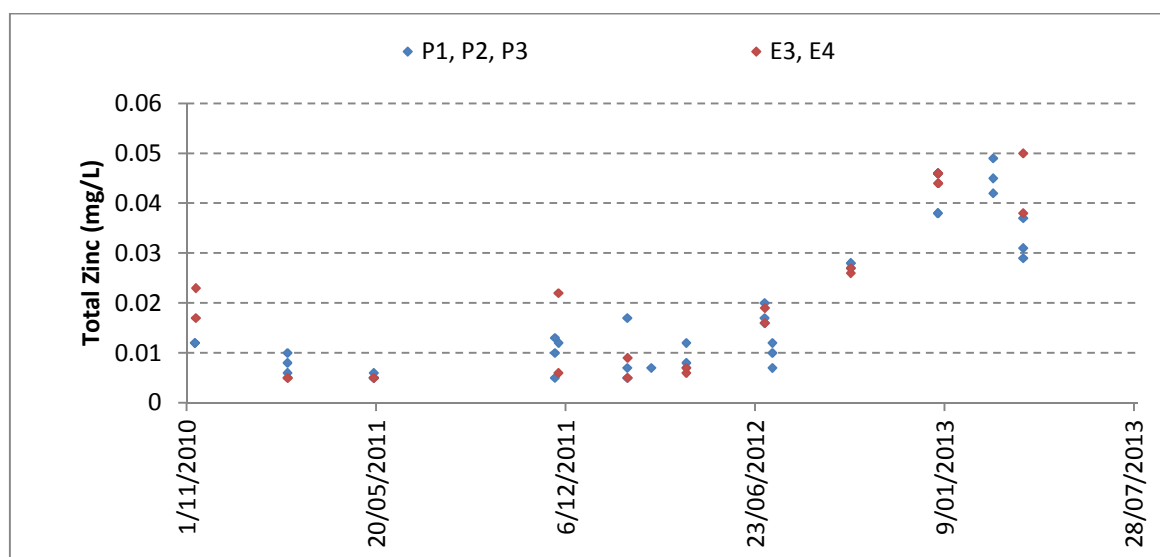


Figure B-8 Recorded Zinc Concentrations at Selected Sites – Lake Cowal

The assessment of lake turbidity levels indicates a consistent trend of increasing turbidity from March to December 2012 at sites both close to CGM and sites on the other side of the lake – refer Figure B-9. It is noted that flood water entered Lake Cowal in March 2012.

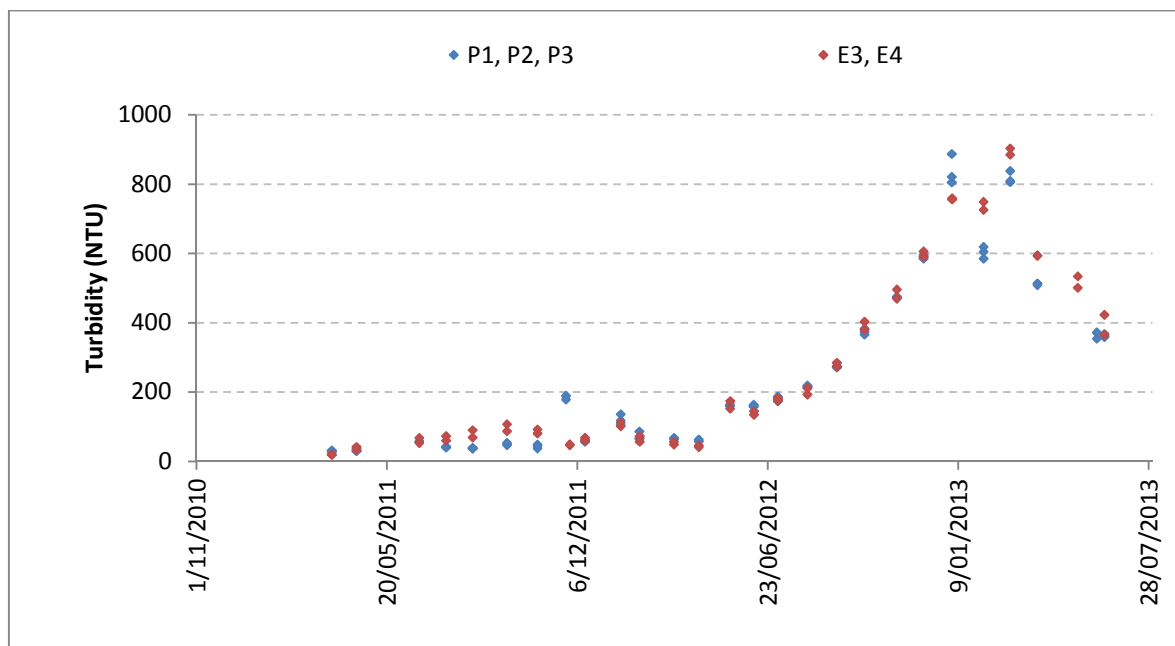


Figure B-9 Field Measurements of Turbidity at Selected Sites – Lake Cowal

An assessment of the concurrent trends in lake turbidity and lake water level indicates the period of increasing turbidity followed by a gradual decline. This has occurred uniformly at sites close to and distant from the CGM.

Assessment of total phosphorous concentrations indicates that concentrations have been similar at sites both close to the CGM and on the other side of the lake (refer Figure B-10).

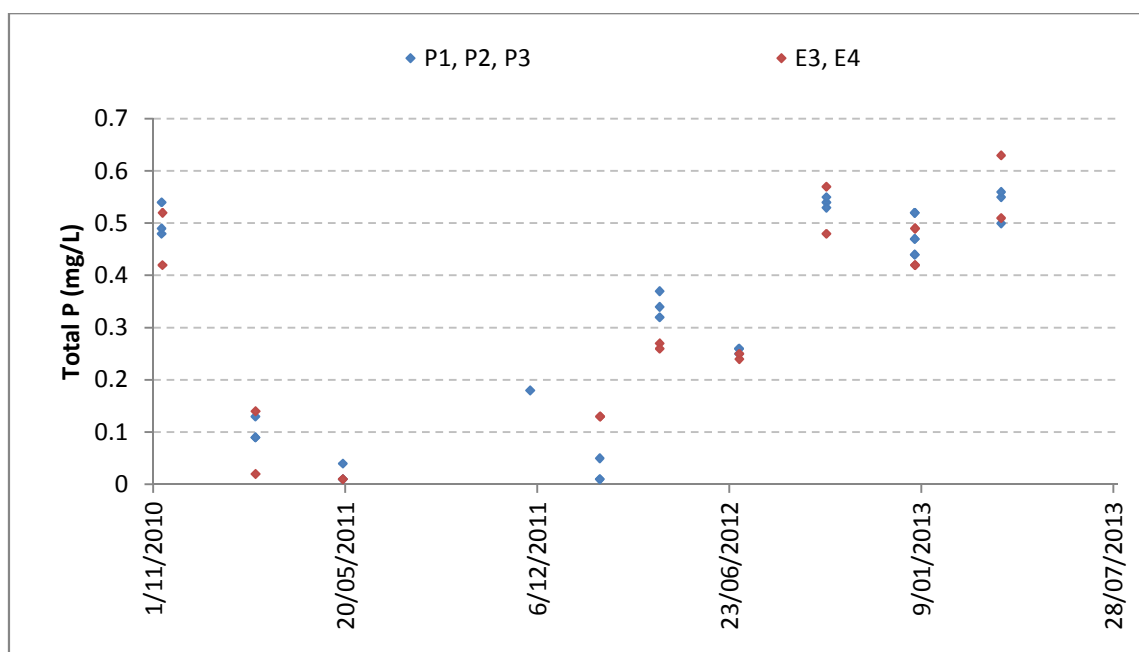


Figure B-10 Recorded Total Phosphorous Concentrations at Selected Lake Sites and Lake Water Level

B2.3.2 Other Water Quality Monitoring

Barrick has monitored pH, EC and TSS concentrations in the UCDS from 2007 to late 2012. Recorded pH ranged from 6.1 to 9.7, EC between 61 and 2,220 $\mu\text{S}/\text{cm}$ and TSS from 4 to 1,300 mg/L.

Barrick has also monitored pH, EC and TSS in site contained water storages and the open pit over a similar period. Ranges of pH in these site storages have been recorded from 4.4 to 10.1, EC between 112 and 142,700 $\mu\text{S}/\text{cm}$ and TSS from 1 to 1,630 mg/L. High recorded EC values reflect, at least in part, the use of water supplied from saline groundwater bores and saline groundwater inflow to the open pit.

B2.4 Harvestable Right

Landholders in most NSW rural areas are allowed to collect a proportion of the rainfall runoff on their property and store it in one or more dams up to a certain size. This is known as a 'harvestable right'. Maximum harvestable right dam capacity is the total dam capacity allowed under the harvestable right for a given property. It is based on 10% of the average regional rainfall runoff and takes into account local evaporation rates and rainfall periods.

The regulations (made under the *NSW Water Management Act, 2000*) relating to harvestable right exclude capture of drainage and/or effluent in accordance with best management practice, and dams constructed to control or prevent soil erosion. None of the storages on-site are used to harvest runoff from land and all storages are used to contain contaminated drainage, mine water or effluent in accordance with best management practice or are used to control soil erosion. It is concluded therefore that all of these storages should be excluded from consideration as a component of the harvestable right calculation.

B2.5 Groundwater

The groundwater levels and water quality in the CGM region are described separately in the Hydrogeological Assessment prepared by Coffey Geotechnics (2013) and is provided in Appendix A of the EA.

B3.0 CURRENT CGM WATER MANAGEMENT AND WATER SUPPLY

B3.1 Description

The CGM currently involves open cut mining and on-site ore processing. On-site ore processing involves crushing and grinding followed by a combined flotation and carbon-in-leach circuits. Tailings produced from the processing plant are deposited in two tailings storage facilities (TSFs). Mine waste rock is placed in waste rock emplacements located to the north and south of the open pit (refer Figure B-11).

The CGM water management system has been designed such that the approved CGM does not impact on the integrity of Lake Cowal. Mine infrastructure and landforms have been constructed within a contained catchment (i.e. the ICDS). The ICDS combines with the UCDS and the lake isolation system to protect Lake Cowal from CGM development activities (refer Figure B-11). The lake isolation system comprises a temporary isolation bund and a permanent isolation bund (i.e. lake protection bund). The lake protection bund comprises a large engineered embankment that provides a permanent barrier between the lake and the open pit. Runoff from areas upslope of the ICDS (i.e. areas undisturbed by mining) is diverted via the UCDS, around the CGM to Lake Cowal.

The main water demand for the approved CGM is for supply to the process plant. Since the commencement of primary ore processing in mid-2007, the CGM processing rate has averaged 7.2 Mtpa and the water demand⁵ (total) has averaged 17.2 ML/day (of which up to approximately 8 ML/day was supplied by on-site recycling of return water and incident rainfall from the TSF decant ponds). Prior to mid-2007, during the initial oxide ore processing phase⁶, the ore processing rate averaged 6.4 Mtpa and the water demand (total) averaged 33.7 ML/day. A higher water demand is required for oxide ore due to the finer, clayey nature of the ore.

The only other significant water demand is for haul road dust suppression. Monitoring data (to late May 2013) indicates that this demand averages 0.65 ML/day.

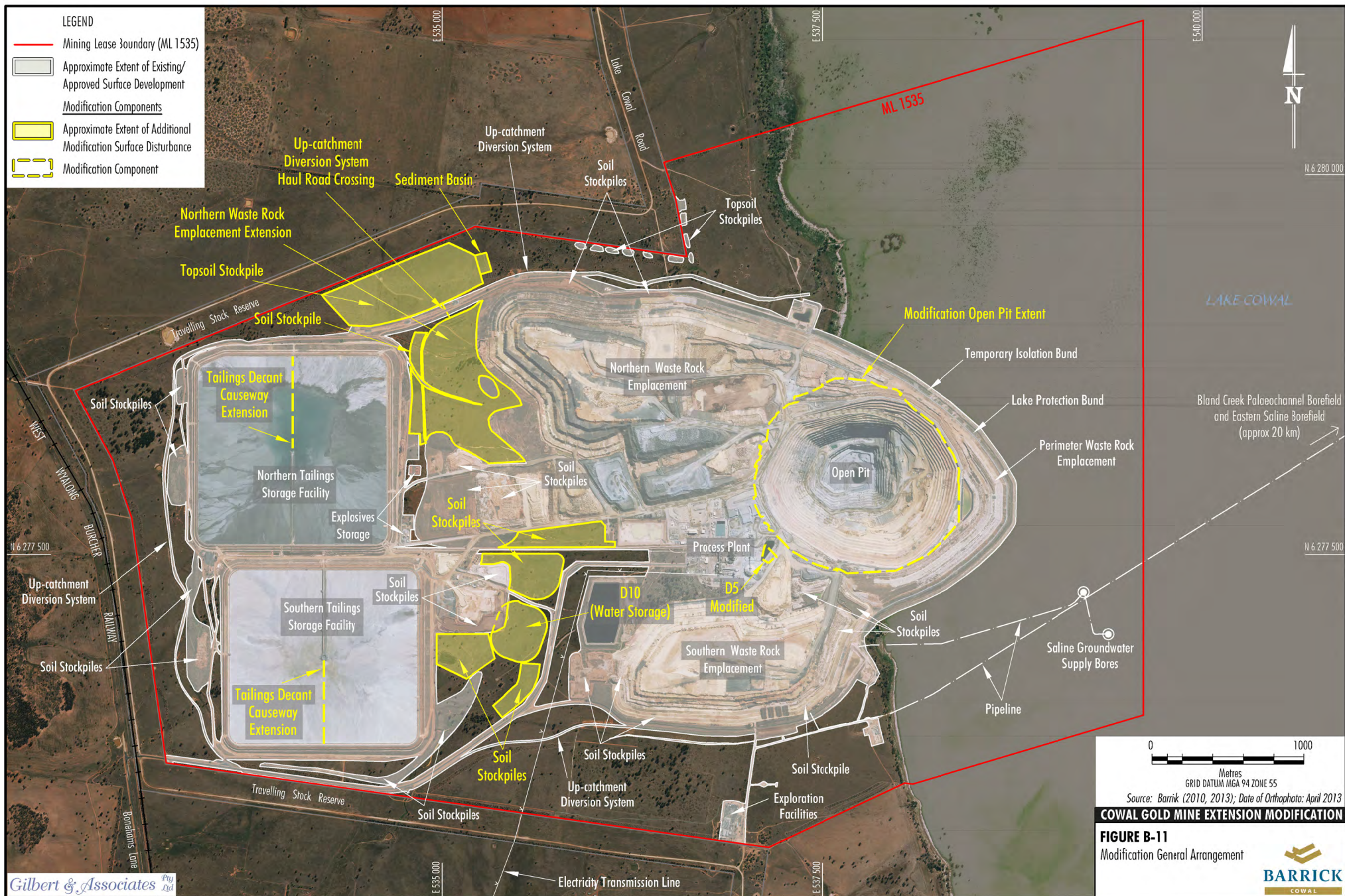
Water supply for the approved CGM involves re-use of mine process water (tailings water reclaim), capture and re-use of runoff from areas within the ICDS, groundwater seepage to the open pit and groundwater sourced from the saline groundwater supply bores within ML1535 when Lake Cowal is dry (refer Figure B-11). Other external make-up water supply is provided to the site via the mine borefield pipeline and is drawn from three sources:

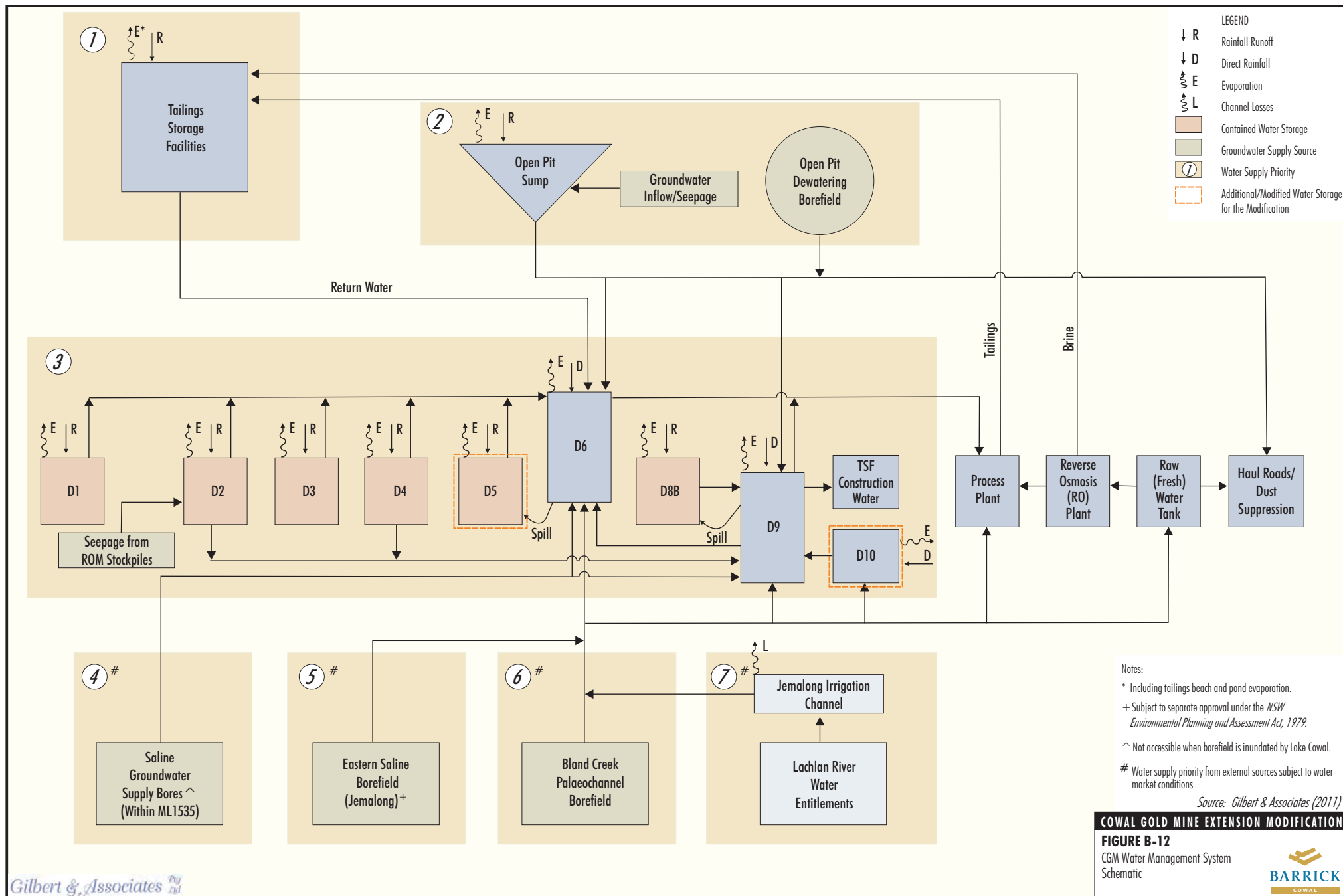
1. The Eastern Saline Borefield.
2. The Bland Creek Palaeochannel Borefield.
3. Water extracted from the Lachlan River via the Jemalong Irrigation Channel (Figure B-1) using regulated flow licences purchased by Barrick on the open market.

The various CGM water management system components and their linkages (via system transfers) are shown in schematic form in Figure B-12.

⁵ Based on data provided by Barrick to mid-April 2013.

⁶ Based on data provided by Barrick from August 2006 to April 2007.





Water management at the CGM is undertaken in accordance with the Site Water Management Plan (Barrick, 2011).

B3.2 Contained Water Storages

The ICDS comprises a series of six internal drainage catchments (each served by a contained water storage for runoff collection) and two water supply storages. Details of the catchment areas and the capacities of the contained water storages are summarised in Table B-5. With the exception of D5, the contained water storages are designed to collect runoff generated from their contributing catchment during a 1 in 100 year ARI rainfall event of 48 hours duration. Contained water storage D5 and water supply storages D6 and D9 are designed to contain runoff and/or incident rainfall from a 1 in 1,000 year ARI rainfall event of 48 hours duration. With the exception of storages D1 and D4, all storages would (in the unlikely event) ultimately spill to the open pit. Storages D1 and D4 are equipped with pumps which facilitate dewatering of these storages such that they are emptied in between rainfall events, as required. Runoff from the outer batters of the perimeter waste rock emplacement ponds against the temporary isolation bund, which has a capacity for at least a 1 in 100 year ARI rainfall event of 48 hours duration. Water that ponds in this area would be pumped to D6 between rainfall events as required.

Table B-5
Summary of Existing Internal Catchments and Contained Water Storages

| Storage | Catchment/Function | Catchment Area (ha)* | Storage Capacity (ML)** |
|---------|--|----------------------|-------------------------|
| D1 | Runoff from northern perimeter of the northern waste rock emplacement. | 95 | 57 |
| D2 | Runoff/seepage from ROM pad, low grade ore stockpile and from the northern waste rock emplacement area. | 343 | 195 |
| D3 | Runoff from perimeter catchment surrounding the open pit and the perimeter waste rock emplacement areas. | 131 | 39 |
| D4 | Runoff from the southern perimeter of the southern waste rock emplacement. | 60 | 69 |
| D5 | Process plant area runoff collection. | 61 | 92 |
| D6 | Process water storage. Main source of process plant make-up. | Incident Area | 10 |
| D8B | Runoff from southern waste rock emplacement and area between STSF and D9. | 199 | 43 |
| D9 | Process water storage and storage for raw water. | Incident area | 726 |

* Estimated from 2010 contour plans provided by Barrick.

** Calculated from as-built plans provided by Barrick or as advised by Barrick.

B3.3 Pit Dewatering

Pit inflows occur via groundwater seepage and rainfall runoff from areas surrounding the open pit. The catchment area draining to the open pit has been restricted to an area of approximately 100 ha. The open pit would also be the final water containment point in the event of overflow from any of the contained water storages (except D1 and D4 which are emptied by pumping) or in the highly unlikely event of a spill from the TSFs.

A network of dewatering bores has been developed around the open pit. Pumping from these bores is directed to D3 and then to storage D6 and reduces groundwater inflows to the open pit. Inflows to the open pit accumulate in a sump in the pit floor and are pumped to storage D6.

Groundwater inflow predictions made as part of the Cowal Gold Project EIS were for quite high groundwater inflow rates. Significantly lower groundwater inflow rates have been encountered in practice as described in the Hydrogeological Assessment prepared by Coffey Geotechnics (2013), provided in Appendix A of the EA.

B3.4 Waste Rock Emplacement Water Management

Mine waste rock from open cut mining operations is placed in three waste rock emplacement areas: the northern, southern and perimeter waste rock emplacements. The northern and southern waste rock emplacements are integral with the perimeter waste rock emplacement which is a component of the permanent lake isolation system. The outside faces of the northern and southern waste rock emplacements form part of the perimeter catchment limits of the approved CGM. The northern waste rock emplacement is the largest of the emplacement areas.

Runoff from the external face of the northern waste rock emplacement reports to the external contained water storage D1 which has been constructed below the external (north-eastern) toe of the northern waste rock emplacement area and is dewatered by pumping to storage D6.

Runoff from the external face of the southern waste rock emplacement reports to the external contained water storage D4 which has been constructed below the external (south-eastern) toe of the southern waste rock emplacement area and is dewatered by pumping to storage D6 or D9.

The perimeter waste rock emplacement area forms part of the permanent lake isolation system. It provides a continuous elevated landform linking the northern and southern waste rock emplacement areas. Runoff from this area would report to the storage which forms between the toe of the perimeter waste rock emplacement and the Temporary Isolation Bund. Water that accumulates in this storage would be returned to D6.

B3.5 Tailings Storage Facility Water Management

Tailings material is deposited into the two TSFs (i.e. NTSF and STSF) as a slurry, normally under sub-aerial conditions. The TSFs comprise confining embankments raised above the surrounding natural surface and, as such, their catchment area comprises only the area inside the confining embankments – estimated to be approximately 163 ha for each TSF⁷. Tailings are discharged to only one TSF at any one time. Once the tailings level has risen to its design level, discharge is switched to the other TSF while the embankment of the first TSF is raised.

Rainfall runoff and free water liberated during settling and consolidation of the tailings accumulate in an internal (central) decant pond. During the switch over from one TSF to the other, water from the decant pond of the inactive TSF may be pumped to contained water storage D6. Water from the decant pond of the active TSF is pumped to storage D6 for re-use in the processing plant. The TSFs have been designed to maintain a minimum freeboard sufficient to store at least the contingency 1 in 1,000 year ARI rainfall event at all times⁸.

⁷ Estimated from 2010 contour plans provided by Barrick.

⁸ 1 in 1,000 year rainfall is calculated using procedures described in Institution of Engineers Australia (1998) by interpolation in between the 1 in 100 year rainfall and the probable maximum precipitation (PMP). The 1 in 100 year rainfall is obtained from the BoM. The PMP is calculated using methods published by BoM (2003).

B4.0 FUTURE CGM WATER MANAGEMENT AND WATER SUPPLY

B4.1 Water Management

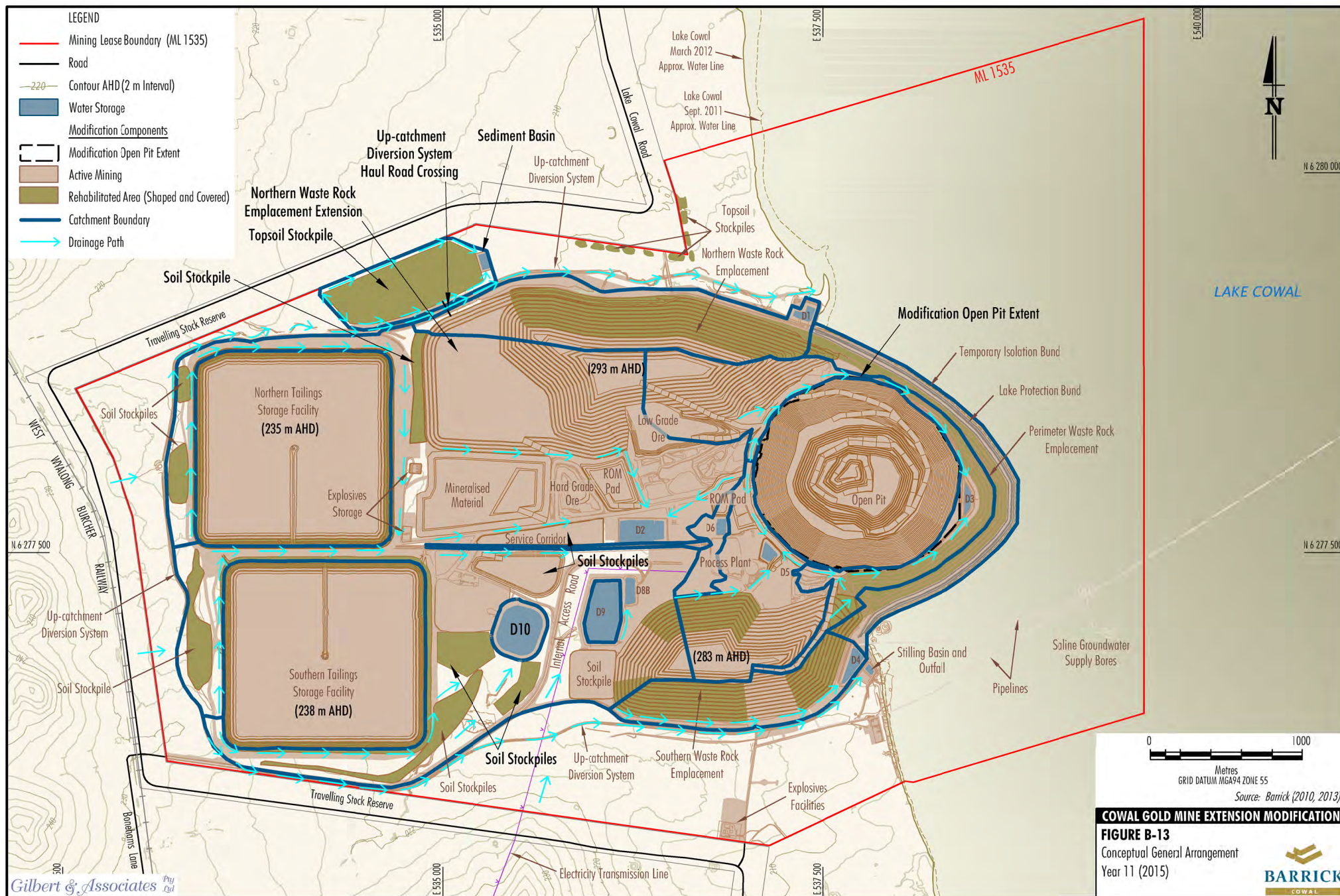
The future development of the CGM surface facilities is shown in a series of snapshot plans (Figures B-13 to B-15) showing the layout of surface facilities and drainage at 2015, 2020 and the end of mining.

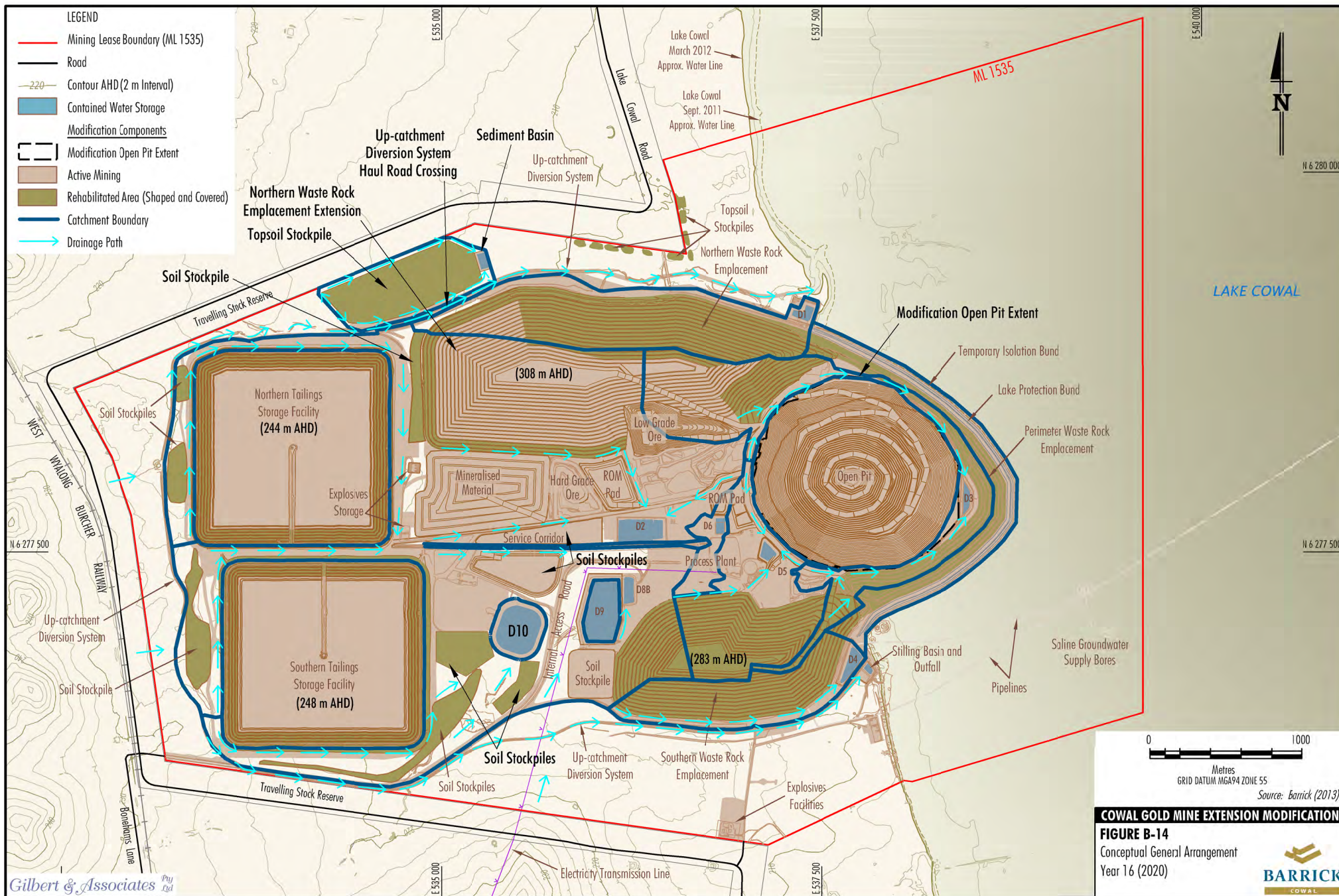
By 2015 (Figure B-13) the northern waste rock emplacement would have expanded westwards towards the NTSF. Topsoil recovered from the foundation of the northern waste rock emplacement would have already been placed in stockpiles west of the northern waste rock emplacement within the ICDS and in a stockpile located in the north of ML 1535 (Figure B-13). Prior to placement of this topsoil material in the stockpile in the north of ML 1535, upslope runoff would be directed around the stockpile area via a system of diversion/drainage bunds. Runoff from the topsoil stockpile area itself would be directed to a sediment basin constructed at the eastern boundary of the stockpile area. The upslope stockpile diversions and the sediment basin would be constructed and maintained in accordance with the guidelines in Landcom (2004) and DECCW (2008). A haul road would be constructed from the foundation of the northern waste rock emplacement to the topsoil stockpile across the UCDS. The UCDS crossing would be constructed to maintain the existing capacity of the UCDS.

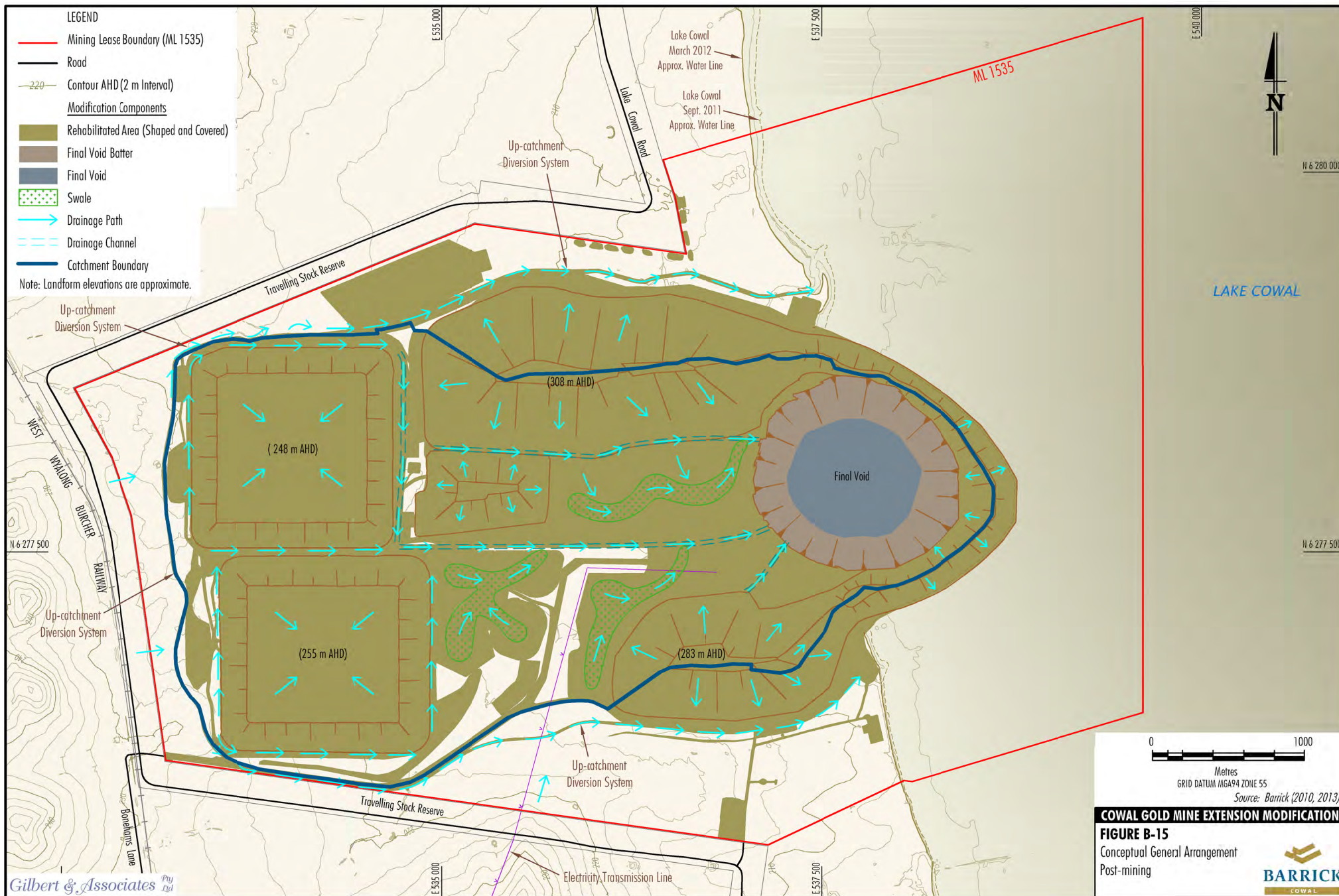
During 2015 the southern waste rock emplacement would have expanded slightly and both waste rock emplacements would have increased in elevation (to 283 m AHD [north] and 258 m AHD [south]). Drainage would be constructed between the NTSF and the northern waste rock emplacement to direct runoff to contained water storage D2, limiting the catchment reporting to D1. Two low grade ore stockpiles would have been developed east of the TSFs, with topsoil recovered from their foundations stockpiled in an area just west of D2. Rehabilitation would have advanced around the perimeters of the waste rock emplacements. The open pit extent would have increased slightly and, as a result, D5 would have been relocated to D5a, which would be constructed with adequate capacity to capture all runoff generated from its contributing catchment during a 1 in 100 year ARI rainfall event of 48 hours duration. Finally storage D10 (new process water storage) would be constructed east of the STSF (refer Section B4.2) with topsoil recovered from its foundation stockpiled in two areas adjacent.

By 2020 (Figure B-14) the waste rock emplacements would have increased in elevation (to 308 m AHD [north] and 283 m AHD [south]), with the northern waste rock emplacement reaching its full plan extent. Rehabilitation would have progressed further around the batters of the waste rock emplacements. The northern of the two low grade ore stockpiles would be developed to its full height (263 m AHD).

Toward the end of the mine life (Figure B-15) the waste rock emplacements would have been completed to their maximum elevation and rehabilitation works would have been well advanced (refer also Section B6.0).







Development of the TSF would continue through the remaining mine life. Tailings discharge would be cycled with discharge planned to occur to one TSF for a year and then to the other TSF for a year and so on. Embankment raising would occur on each TSF while it was inactive. Water for use in embankment construction (for earthfill conditioning and dust suppression) would be sourced from storage D9. Water reclaim from the decant pond of the active TSF to storage D6 would continue to occur, with any accumulated rainfall runoff water in the inactive TSF pumped to the active TSF.

Runoff from waste rock emplacements would continue to be directed to contained water storages. A geochemical assessment has been prepared for the Modification by Geo-Environmental Management (2013) (Appendix C of the EA). The assessment report states that:

Because the waste rock, pit wall rock, low grade ore, ore and tailings are expected to be relatively geochemically similar to those from the current pit configuration no changes to the site water quality monitoring programs for the pit, waste rock emplacements, low grade ore stockpile, ROM ore stockpile, and tailings storage facilities are expected to be necessary. However, it is recommended that these programs be reviewed on a 12 month basis in order to maintain and rationalise these programs.

B4.2 Water Supply

The main water demand for the CGM would continue to be the requirements of the process plant as well as dust suppression (e.g. haul roads) and other potable and non-potable uses. Proposed future ore processing at the CGM is summarised as follows:

- The primary ore processing rate would be maintained at 7.2 to 7.4 Mtpa in 2014 and into 2015.
- In late 2015, a campaign of oxide ore processing would commence for approximately 6 months (into early 2016) with approximately 3.6 million tonnes (Mt) planned to be processed.
- Processing of primary ore would then resume until late 2020 at a rate of approximately 7.4 Mtpa.
- A second campaign of oxide ore processing would then occur for approximately 8 months, with 4.9 Mt planned to be processed.
- Processing of primary ore would then resume at a rate of approximately 7.4 Mtpa until the scheduled end of operations in 2024.

It is estimated that the average process plant demand (total) at the above processing rates would be 18.7 ML/day for primary ore processing, while the average water demand (total) for oxide ore processing would be 35.9 ML/day (refer Section B5.0).

Water supply would continue to be sourced primarily from on-site sources, with make-up from external water supply sources. The order of priority of water supply sources would be:

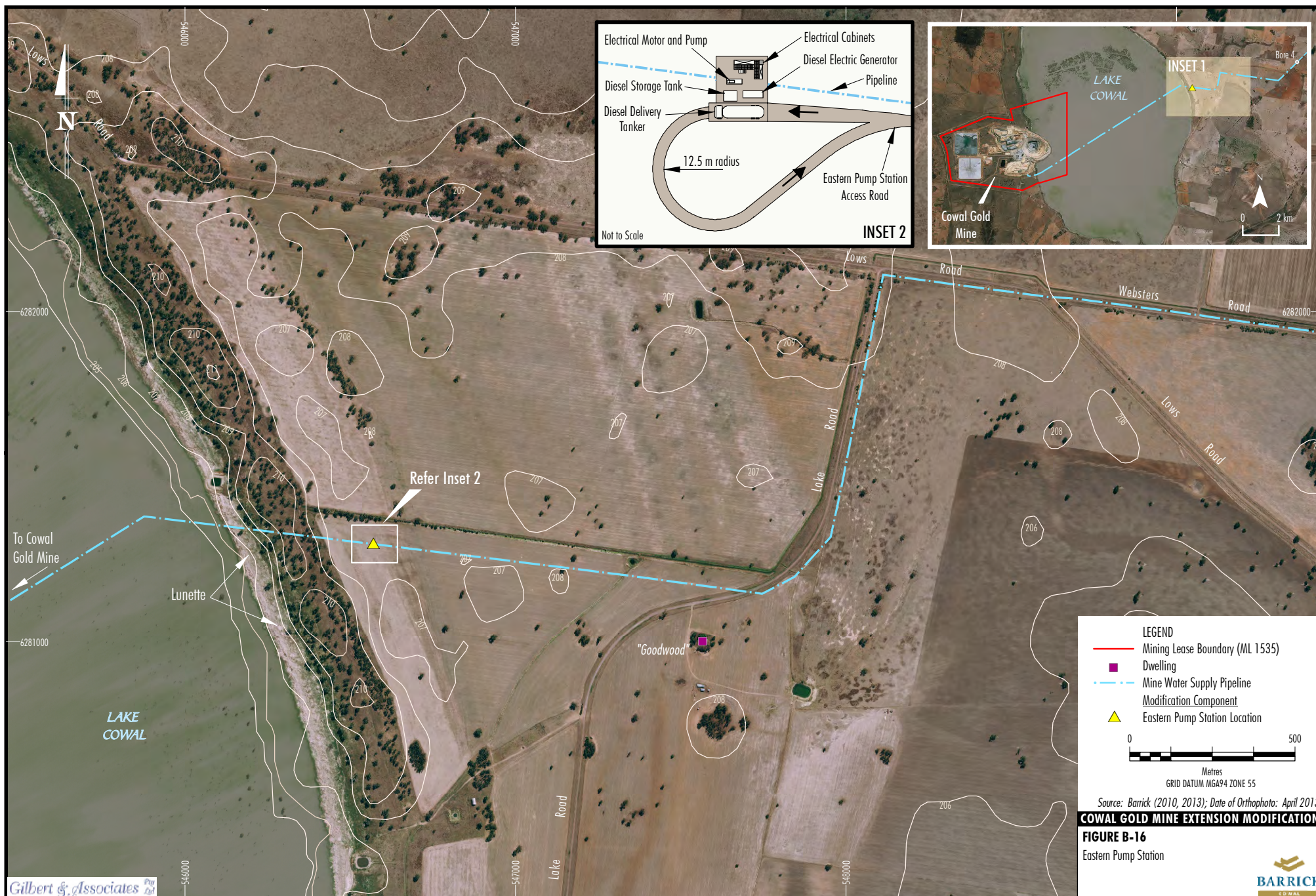
1. Reclaim from the TSF decant ponds.
2. Pumping from the open pit dewatering bores and sump.
3. Water from contained water storages (transferred to either storage D6 or D9 as indicated on Figure B-12).
4. External water sources:
 - Groundwater from the saline groundwater bores located with ML1535 when lake conditions allow.
 - Groundwater from the eastern saline borefield via the mine borefield pipeline.
 - Groundwater from the Bland Creek Palaeochannel borefield via the mine borefield pipeline (consistent with existing licensed limits – refer Section B4.2.3).
 - Water accessed from the Lachlan River via the Jemalong Irrigation Channel using regulated flow licences purchased by Barrick on the open market.

In order to maintain a secure water supply during the oxide ore (higher water demand) processing campaigns, Barrick proposes to undertake the following modifications to the CGM water supply system:

- A. Construction of a new process water storage D10, with a design capacity of 1,500 ML, commissioned in mid-2014.
- B. Increasing the capacity of the external water supply pipeline (across Lake Cowal, supplying water from sources 5, 6 and 7 above) from 11 ML/day to 14 ML/day.

These modifications would be commissioned by 1 July 2014. Storage D10 would effectively act as an enlarged storage D9, with water shared between the storages and used to provide make-up supply to the process plant. The proposed system would be managed such that storages D9 and D10 were as full as possible at the start of the oxide ore processing campaigns (supplied by on-site sources and the increased capacity of the external water supply pipeline). Water balance modelling of the proposed system (Section B5.0) indicates that storages D9 and D10 may draw down during the oxide ore processing campaigns but would be replenished upon resumption of primary ore processing.

The proposed increased capacity of the external pipeline would necessitate construction of another pump station which would be located outside the bounds of the Lake inundation limits and away from drainage paths. The pumping station would be located in a secure fenced area served by a graded road (Figure B-16). The proposed access road would be designed to provide “all weather” access to the pumping station. This would involve construction of a road formation elevated over low lying sections. The access road would have a similar vertical alignment design specifications to Lake Road. The construction of the access road has the potential to modify overland flow patterns and to cause increased inundation in areas upslope to the road formation. The extent of these effects can however be managed by appropriate detailing during final design by incorporating effective culvert crossing in low areas where the road formation is elevated relative to the surrounding natural ground surface.



LEGEND

- Mining Lease Boundary (ML 1535)
- Dwelling
- Mine Water Supply Pipeline
- Modification Component
- Eastern Pump Station Location

0 500
 Metres
 GRID DATUM MGA94 ZONE 55

Source: Barrick (2010, 2013); Date of Orthophoto: April 2013

COWAL GOLD MINE EXTENSION MODIFICATION

FIGURE B-16

Eastern Pump Station

B4.2.1 Saline Groundwater Supply Bores

The saline groundwater supply bores are located within ML 1535 to the south-east of the open pit (Figure B-11). Continued operation of the existing saline groundwater supply bores is proposed for the mine life.

Pump tests (Coffey Geotechnics, 2008) indicate that a borefield of approximately four bores could supply up to 1 ML/day of saline water (with an EC of approximately 40,000 $\mu\text{S}/\text{cm}$) from the saline groundwater supply bores for use in the process plant. During periods when Lake Cowal is inundated, the bores would be shut-down and capped. Therefore the bores would operate in drier times and be rested in wetter times. At various times during the mine life, the saline groundwater supply bores would continue to reduce demand on the other external water supply sources.

B4.2.2 Eastern Saline Borefield

The eastern saline borefield is located approximately 10 km east of Lake Cowal's eastern shoreline (Figure B-1).

Pump tests (Groundwater Consulting Services, 2010) indicate that two bores could supply approximately 1.5 ML/day of saline water (with an EC of approximately 12,000 $\mu\text{S}/\text{cm}$). The borefield is currently approved for operation until the end of 2015.

B4.2.3 Bland Creek Palaeochannel Borefield

Extraction from the Bland Creek Palaeochannel Borefield (Bores 1 to 4) would continue for the mine life.

Groundwater extraction from the Bland Creek Palaeochannel borefield is limited by daily and annual licensed volumetric limits, as follows:

- maximum daily rate: 15 ML/day; and
- maximum annual extraction: 3,650 ML.

Based on pumping records provided by Barrick, the total volume pumped from the Bland Creek Palaeochannel Borefield up until 14 April 2013 was 14,111 ML. We understand Barrick will seek to remove the life-of-mine groundwater extraction limit (i.e. 30,000 ML cap) as part of this Modification. Extraction would be managed to maintain groundwater levels above the established NOW trigger levels.

Although Coffey Geotechnics (2013) have modelled continuous extraction of 7.2 ML/day as being sustainable with respect to maintaining groundwater levels above the NOW trigger levels, it is intended that sourcing water from this borefield would continue in a similar manner as occurs currently, by alternating between this source and the Lachlan River to manage groundwater levels and provide flexibility with respect to extraction rates and the availability of temporary water in the Lachlan River during "good" years.

B4.2.4 Lachlan River

The proposed external water supply arrangements for the remaining mine life involve continued purchase of temporary water from the Lachlan River regulated source. Barrick's high security and general security zero allocation water access licences enable trade of temporary water.

This supply source has proven to be reliable throughout the operating history of the approved CGM – Table B-6 summarises annual extraction volumes, from records supplied by Barrick. In 2013, up to 14 April, 1,050 ML had been extracted.

Table B-6
Annual CGM Lachlan River Extraction Volumes

| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|-------------------------|-------|-------|-------|------|------|------|
| Approximate Volume (ML) | 2,400 | 1,980 | 1,600 | 0 | 857 | 438 |

NOW trading records show that between approximately 4,000 ML and 202,000 ML of temporary water has been traded annually in the Lachlan River Regulated Water Source since records began in the 2004 to 2005 season. All general security accounts were reset on 8 March 2012 to 136 per cent following the first spill of Wyangala Dam since December 2000. As at 1 July 2013⁹, available water determinations (AWDs) for general security accounts were zero, with high security accounts at 100%. However general security accounts are continuous, with carry-over from year to year and therefore future available water determinations AWDs for general security accounts will only be made once account water is used and additional storable inflows are received in Wyangala Dam. NOW will continue to closely monitor rainfall and river inflows as well as usage in the valley to determine when a subsequent allocation is available. As at early July 2013, Wyangala Dam reservoir was at 65% of capacity.

Future water supply requirements (from external water sources and ultimately licensed extraction from the Lachlan River) have been estimated using a water balance model (refer Section B5.0). The median predicted annual demand from the Lachlan River during the primary ore processing phase peaks at approximately 2,194 ML in 2014 while the median predicted demand overall peaks in 2021 at 3,068 ML as a result of oxide ore processing. In relation to the projected CGM requirements during the Modification, it appears that there has in previous years been adequate temporary water available on the market from this source.

⁹ Refer: http://www.water.nsw.gov.au/ArticleDocuments/42/media_release_130701_available_water_determination_Lachlan_valley_approved.pdf.aspx

B5.0 SIMULATED PERFORMANCE OF WATER MANAGEMENT SYSTEM

The ability of the water management system to achieve its operational objectives was assessed by simulating the dynamic behaviour of its water balance over the remaining mine life (from the start of 2013) under a range of different climatic conditions that may be encountered. A water balance model of the CGM water management system has been developed to simulate its behaviour. The model structure is generally as per the schematic in Figure B-12, with planned new process water storage D10 modelled as an expansion to D9 from mid-2014 onwards.

The structure of this section is as follows:

- A description of the model structure, set-up data and assumptions (Section B 5.1).
- An outline of the model calibration using monitoring data sourced from Barrick (Section B 5.2).
- Details of model predictions for the remaining mine life (Section B 5.3) – the modelled ‘base case’.
- A discussion of model sensitivity to key water balance parameters (Section B 5.4).
- An assessment of the possible effects of climate change on model results (Section B5.5).

B5.1 Model Description

B5.1.1 General

The water balance model developed for the CGM simulates all the inflows, outflows, transfers and changes in storage of water on-site at each model time step (i.e. 4-hourly basis). The model simulates changes in stored volumes of water in all site storages (contained water storages, TSFs and open pit) in response to inflows (rainfall runoff, groundwater inflow, tailings water, groundwater bore extraction and licensed extraction from the Lachlan River) and outflows (evaporation, process plant use and dust suppression use).

For each storage, the model simulates:

$$\text{Change in Storage} = \text{Inflow} - \text{Outflow}$$

Where:

Inflow includes rainfall runoff, groundwater inflows to the open pit, water liberated from settling tailings (termed ‘bleed’ water – for the NTSF and STSF) and all pumped inflows from other storages, groundwater bores or the Lachlan River (via the Jemalong irrigation channel).

Outflow includes evaporation and all pumped outflows to other storages or to a water use¹⁰.

Runoff from all mine areas is modelled as reporting to one of the contained water storages or the open pit. Pumping rates between model storages were set based on information provided by Barrick.

¹⁰ The model also provides for spill if the simulated storage capacity of a water storage is ever exceeded.

The main water use at the CGM is for supply to the Process Plant. As indicated in Section B4.2, a priority system is in use (and was modelled) for supply to contained water storage D6 (the main supply source for the Process Plant). Supply is first drawn from the TSFs (return water), the open pit (including the dewatering bores) and contained water storages. Make-up supply is then sourced (to top-up storages D6 and D9/D10) from the three water supply borefields (refer Section B4.2). Ultimate make-up supply is then drawn from external water sources, including Lachlan River water entitlements. Lachlan River water is sourced via the Jemalong Irrigation channel – a channel loss rate of 1.3 ML/day was assumed based on advice from Barrick. The model was used to assess the future make up water supply requirements under the range of model conditions simulated.

Contained water storages D1 and D4 (which capture runoff from waste rock emplacement areas) are reliant upon pumping to transfer accumulated water to the remainder of the ICDS. Pump extraction rates of 100 litres per second (L/s) and 85 L/s for storages D1 and D4 respectively were assumed in the model (refer Section B5.7). Whilst not simulated in the model runoff from the outer batter of the perimeter waste rock emplacement would be pumped back to D6. In the model these were dewatered by pumping to either storages D6 or D9 as a priority, even if this led to spill of storages D6 or D9 (which spill internally within the ICDS – ultimately reporting to the open pit).

B5.1.2 Climatic Data

A total of more than 124 years of daily rainfall and pan evaporation data (from 1889 onwards) used in the model was sourced from the Silo Data Drill¹¹. The Data Drill rainfall data was compared with the CGM rainfall data record (for the period from 2002 to April 2013) and found to be well correlated – refer Figure B-17 which shows a plot of monthly rainfall totals from the CGM record versus monthly rainfall totals from Data Drill.

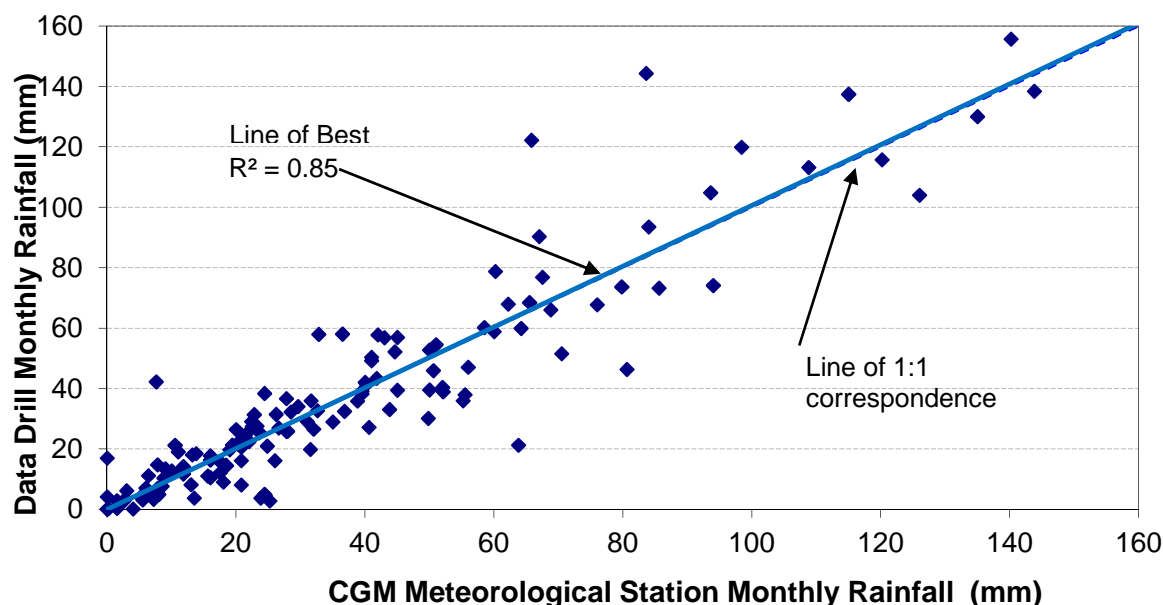


Figure B-17 Monthly Rainfall Comparison – CGM Meteorological Station and Data Drill

¹¹ The Data Drill is a system which provides synthetic data sets for a specified point by interpolation between surrounding point records held by the BoM. It is based on Jeffrey *et al.* (2001).

A similar comparison was made between monthly evaporation totals from the Silo Data Drill (at the CGM location) and monthly pan evaporation totals recorded at the BoM Condobolin Agricultural Research Station (refer Section B2.2) for the period of concurrent data, excluding obvious periods of missing data, from 1973 to February 2013. Figure B-18 shows a plot of monthly Data Drill pan evaporation totals and monthly recorded totals from the Condobolin station. The plot again shows that the data are well correlated.

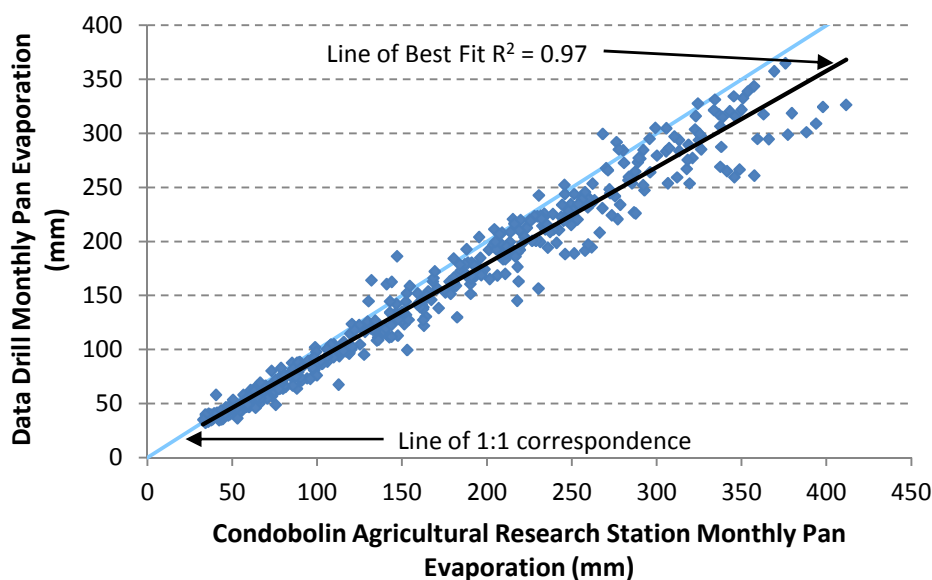


Figure B-18 Monthly Evaporation Comparison – From Condobolin Agricultural Research Station and Data Drill

Monthly pan evaporation factors (to convert pan evaporation to estimates of open water evaporation) were obtained from pan factors given in McMahon *et al.* (2013) for the nearest available location (Table B-7).

**Table B-7
Seasonal Evaporation Pan Factors**

| Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|--------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|
| Wagga Wagga AMO Pan Factor* | 0.81 | 0.81 | 0.81 | 0.86 | 0.94 | 0.98 | 1.07 | 1.10 | 1.05 | 0.99 | 0.89 | 0.84 |

* From McMahon *et al.* (2013), located approximately 160 km south of CGM.

The model was run repeatedly, simulating 124 possible mine life “sequences”, each 12 years in length (corresponding to the remaining mine life). The sequences were formed by moving along the Data Drill record one year at a time with the first sequence comprising the first 12 years in the record, the second sequence years 2 to 13 in the record while the third sequence comprised years 3 to 14 and so on. The start and end of the Data Drill record was ‘linked’ so that additional sequences, which included years from both the beginning and end of the historical record, were combined to generate additional climatic sequences. Using this methodology 124, 12-year sequences of daily rainfall and evaporation were formulated for use in the model simulations. CGM recorded daily rainfall data was used from November 2006 onwards¹² instead of the Data Drill.

B5.1.3 Runoff Simulation

The Australian Water Balance Model (AWBM) (Boughton, 2004) was used to simulate runoff from rainfall on the various catchments and landforms across the CGM area. The AWBM is a nationally-recognised catchment-scale water balance model that estimates streamflow from rainfall and evaporation. Modelling of the following six different sub-catchment types was undertaken:

- natural surface/undisturbed;
- waste rock emplacements;
- rehabilitated areas;
- hardstand;
- open pit; and
- tailings.

AWBM parameters for undisturbed areas were taken from model calibrations undertaken for a regional stream¹³. Parameters for tailings beach runoff were developed as part of calibration (refer Section B5.2). Parameters for the remaining sub-catchments were taken from literature-based guideline values or experience with similar projects, with some adjustment as part of calibration (refer Section B5.2). Table B-8 gives the AWBM parameters used in the model.

Catchment and sub-catchment areas were calculated from 2010 and future mine layout plans provided by Barrick (refer Section B4.1). The total catchment area reporting to all storages was approximately 13 km² and varies little throughout the mine life (although the area of different sub-catchment types does vary, for example as waste rock emplacements are progressively constructed and undergo rehabilitation).

¹² Date of commencement of automatic weather station operation.

¹³ GS410048 - Kyeamba Creek at Ladysmith.

Table B-8
Water Balance Model AWBM Parameters

| Parameter | Nat. Surface | Waste Rock | Rehabilitated Areas | Hardstand | Open Pit | Tailings |
|-------------------|--------------|------------|---------------------|-----------|----------|----------|
| C1 | 10 | 5 | 21 | 2 | 5 | 0 |
| C2 | 101.3 | 75 | 56 | 6 | 15 | 50 |
| C3 | 202.7 | - | 120 | - | - | - |
| A1 | 0.234 | 0.4 | 0.13 | 0.5 | 0.34 | 0.07 |
| A2 | 0.333 | 0.6 | 0.43 | 0.5 | 0.66 | 0.93 |
| A3 | 0.433 | - | 0.44 | - | - | - |
| BFI | 0.21 | 0.4 | 0.1 | 0.0 | 0.1 | 0.0 |
| K _{base} | 0.806 | 0.97 | 0.92 | - | 0.9 | - |
| K _{surf} | 0.5 | 0.2 | 0.2 | 0.1 | 0.1 | 0.2 |

Note: An evapotranspiration factor of 0.85 was used in the model as recommended by Boughton (2006).

No direct measurement of surface runoff is undertaken at CGM, so direct calibration of the AWBM was not possible. However, model parameters were able to be adjusted as part of calibration of the water balance model (refer Section B5.2).

B5.1.4 Groundwater Inflow and Borefield Supplies

Groundwater inflow to the open pit was set to a time-varying rate as predicted by groundwater modelling (Appendix A of the EA). Figure B-19 summarises the predicted inflow rate. Dewatering bore extraction was set to zero on the basis that the predicted groundwater inflows are understood to represent total groundwater inflows to the open pit.

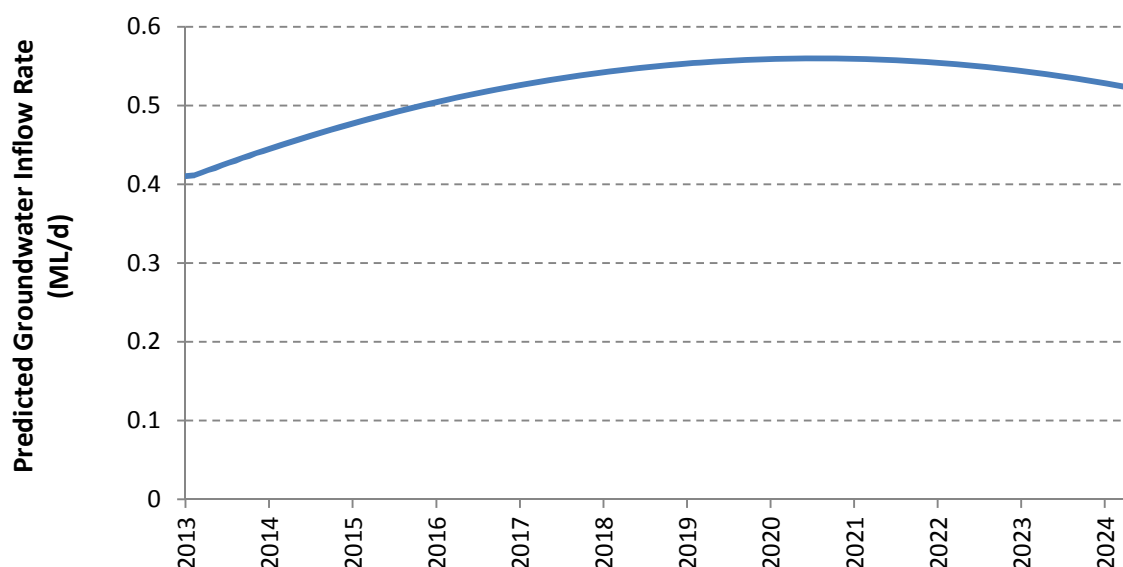


Figure B-19 Predicted Open Pit Groundwater Inflow Rate

The maximum pumped rate from the saline groundwater supply bores within ML 1535 was set to 0.7 ML/day (equivalent to 1 ML/day for 5 days/week). These bores are only available as a water source when the water level in Lake Cowal is low enough to allow access. Rather than simulating the water level in Lake Cowal as part of the water balance model, the availability of these bores was approximated by comparing the annual rainfall total for the given model year against long term median annual rainfall – if the annual rainfall in any simulated year was above the long term median, the bores were assumed unavailable.

The maximum pumped rate from the eastern saline borefield was set to 1.5 ML/day and these bores were assumed available up until the end of 2015 (consistent with Barrick [2010]).

Extraction from the Bland Creek Palaeochannel bores was controlled according to the following approved limits:

- A maximum daily extraction rate of 15 ML/day.
- A maximum annual extraction rate of 3,650 ML.

For modelling purposes, the latter annual volume was converted to a daily rate of 10 ML/day and used as the maximum daily extraction rate.

Supply via the mine borefield pipeline (i.e. Bland Creek Palaeochannel Borefield, eastern saline borefield and Lachlan River water entitlements) to storages D9/D10 is limited to 14 ML/day maximum rate (refer Section B4.2).

B5.1.5 CGM Water Demands

The Process Plant make-up water demand (total) is required to replace water pumped to the TSFs with process tailings. Process Plant water demand (total) was based on projected future processing tonnages (refer Section B4.2) and an assumed tailings solids concentration of 52% (based on the average tailings solids concentration monitored for the 2 years to December 2010¹⁴) for primary ore. For oxide ore (planned to be processed in two campaigns – refer Section B4.2), the tailings solids concentration was set at 37% (based on monitored data from the initial oxide ore processing phase undertaken in 2006-07). The calculated average Process Plant water demands (total) were 18.7 ML/day for primary ore and 35.9 ML/day for oxide ore.

A portion of Process Plant make-up water is required to be of high quality (low salinity water). This water is used in areas such as the semi-autogenous grinding mill and ball mill cooling towers, carbon elution circuit and scientific instrumentation. This water is produced from a reverse osmosis (RO) plant at the CGM. The RO plant is fed by water from external water supplies only (Bland Creek Palaeochannel borefield, eastern saline borefield and Lachlan River water entitlements) and brine from the RO plant is discharged to the TSFs. The modelled RO plant demand was set at 0.15 ML/day based on data supplied by Barrick.

¹⁴ Data provided by Barrick.

Demand for haul road dust suppression water was set to an average 0.63 ML/day, varying seasonally from 0.22 ML/day up to 1.18 ML/day, based on monitored data provided by Barrick. Dust suppression demand was set to zero on days with 10 mm of rain or more.

Water is also required for TSF embankment construction works which would be on-going throughout the mine life. A constant demand rate of 0.25 ML/day was set in the model for this purpose (drawn from contained water storage D9).

B5.2 Model Calibration

B5.2.1 Tailings Storage Facilities

B5.2.1.1 Tailings Settling Tests

Tailings settling test data for CGM tailings were compiled to allow initial estimates to be made of rates of water that may be liberated as tailings settle (bleed water) for differing tailings solids concentrations. Settling tests were reported by Knight Piesold (1994, 2010). Figure B-20 provides a summary plot of bleed water (as a percentage of initial water volume) versus solids concentration from the undrained settling tests.

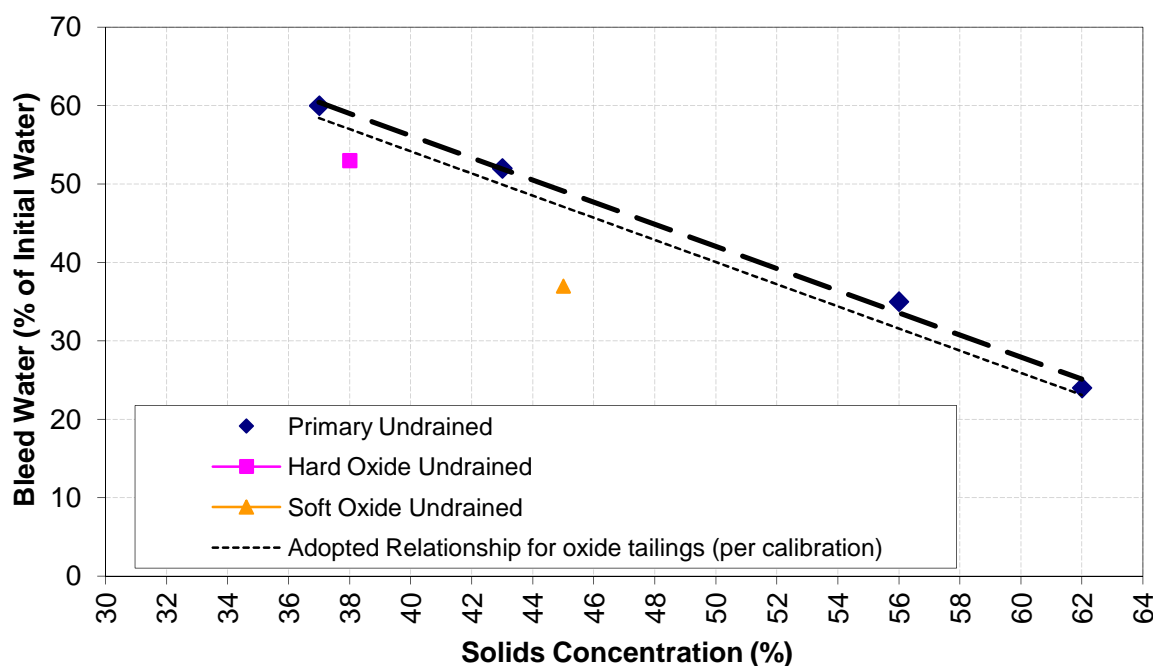


Figure B-20 CGM Tailings Undrained Settling Test Results

As may be seen in Figure B-20, a number of laboratory undrained settling tests have been performed on primary ore tailings over a range of solids concentrations – this gives a good linear fit between solids concentration and bleed water. Only two test results were available for oxide ore tailings – one each for the two types (soft and hard). As may reasonably be expected, oxide ore tailings (which has a higher clay fines content) “holds” water more than primary ore tailings – particularly the soft (more weathered) oxide ore tailings.

It should be noted that the undrained settling tests only estimate bleed water resulting from the initial settling phase. Following initial settling, tailings undergo consolidation (densification) which results in further release of water (albeit slowly). It should also be noted that the undrained settling test simulates tailings settling on an impermeable floor, with water only being able to report to the tailings surface (one-way drainage). In practice, the tailings beach itself has a degree of permeability and settling tailings can drain into the beach as well as having water report to the surface (two-way drainage). Drained settling tests (with a permeable base) simulate this behaviour and Knight Piesold (2010) report up to 15% more water discharging from settling tailings in undrained tests than in drained tests.

B5.2.1.2 Oxide Ore Tailings Water Balance Calibration

Barrick provided monitoring data relating to water stored, pumping to and from the STSF in the first half of 2007, during the initial oxide ore processing phase. Calibration of the TSF component of the water balance model was undertaken using this data as outlined below.

The following data were provided by Barrick:

- Monitored (surveyed) STSF water pond volumes (from January to May 2007) – 17 measurements in total.
- Daily processed ore tonnes and tailings solids concentrations (percent solids). The data in Figure B-20 was used as an initial guide to estimate the bleed water rate.
- Daily pumped return water volumes from the tailings storage.
- Daily rainfall and calculated evaporation data (from the CGM meteorological station).

In the water balance model calibration, allowance was made for water entrained (trapped) in the tailings beach (i.e. non-bleed water), water evaporation from the tailings beach and the decant pond and additional water lost as tailings discharge points (spigots) are opened and discharge occurs over previously dried tailings. Calibrated water pond and tailings beach evaporation factors of 0.75 and 0.9 were set as suggested by Knight Piesold (2010). It is noted that these pan factors are lower than regional values (refer Table B-7) however use of higher evaporation factors prevents a reasonable calibration of the model. Rainfall runoff from the tailings beach surface was simulated using the AWBM, while runoff from the decant pond was set to 100% of rainfall. Also as part of the calibration process, the bleed water percentage was varied, with the final calibration using the relationship shown in Figure B-20 (short dotted line) – which is 2% below the rates adopted for primary ore tailings. This is somewhat higher than the bleed water percentage from the oxide ore tailings undrained settling tests and may be due to additional water being available from two-way drainage and consolidation. Again the use of lower bleed rates prevents a reasonable calibration of the model. The sensitivity of model results to the oxide bleed reduction percentage was tested in subsequent model runs (refer Section B5.4).

Figure B-21 provides a summary plot of monitored decant pond water volumes and model predictions for the calibration period. A close match was obtained between the monitored volumes and model predictions.

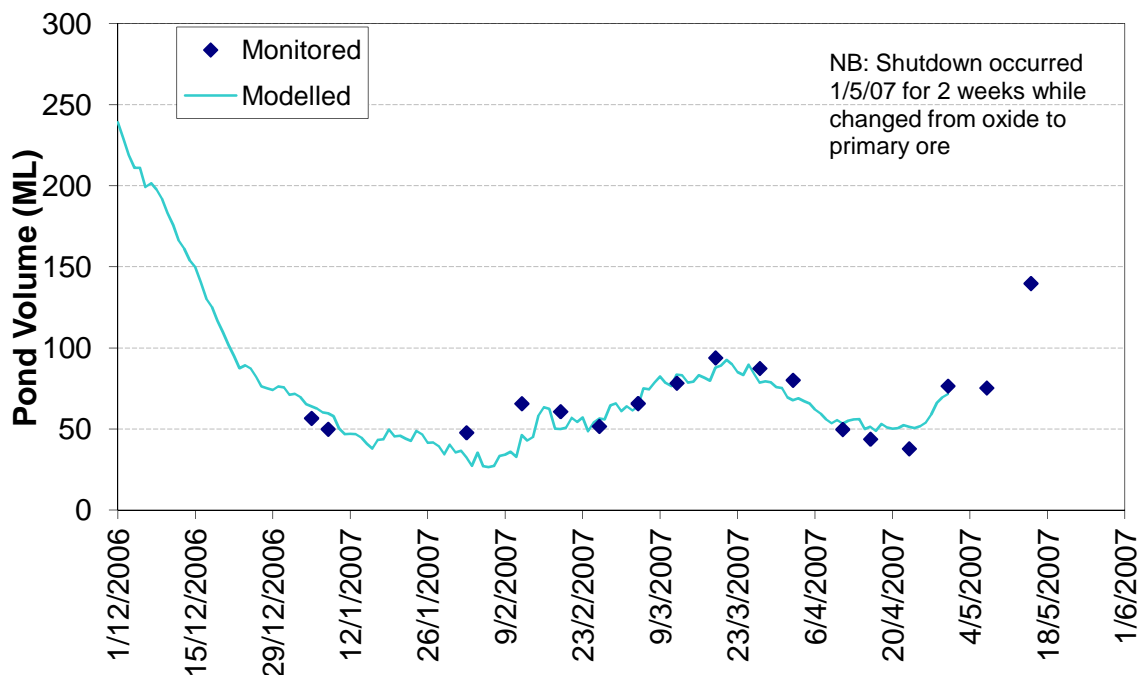


Figure B-21 Water Balance Model Calibration – STSF Oxide Ore Phase

B5.2.1.3 Primary Ore Tailings Water Balance Calibration

Barrick has provided daily data, for use in calibration, on pumping to and from the NTSF and STSF for the period from July 2007 to August 2010, as well as daily processed ore tonnes and tailings solids concentrations (percent solids) and meteorological data for the same period. It was assumed that the ponded water volume at the beginning and end of this period was similar.

Water pond and tailings beach pan factors were set consistent with the oxide phase calibration as were the AWBM parameters. As part of calibration, the bleed water percentage was varied, with the final calibration using 8.5% more bleed than the rate predicted by the undrained settling test straight-line fit for primary ore tailings in Figure B-20. This additional water is likely due to the effects of two-way drainage and consolidation (as discussed in Section B5.2.1.1).

Figure B-22 shows a plot of cumulative volume of water reclaimed from the tailings storages since July 2007 – monitored and calibrated. A reasonable match was obtained between the monitored volumes and model estimates.

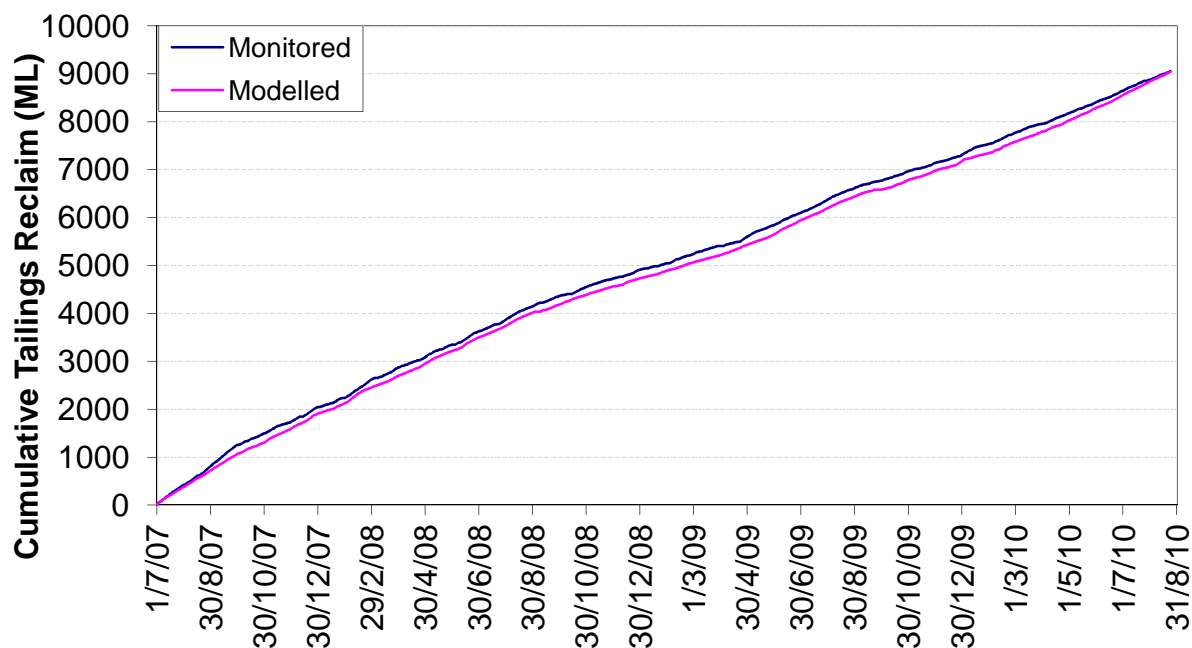


Figure B-22 Water Balance Model Calibration – Primary Ore Phase Tailings Storage Cumulative Reclaim Volume

Consistent with the tailings settling test results, the calibrated tailings parameters demonstrate that the primary ore requires less make-up water than the oxide ore in the Process Plant (refer Section B5.1.5) and releases proportionally more in the tailings storage facilities for return use.

B5.2.2 CGM External Water Demand

Barrick has provided daily volumes of water imported to CGM from external sources for the period from July 2007 to August 2010. This data was used to check against model predicted external water demand, as a final check on model performance. AWBM parameters and open pit groundwater inflows rates were adjusted to improve the model fit. Figure B-23 shows a plot of cumulative volume of water imported to CGM over the above period together with model predictions.

Figure B-23 indicates that the model is able to predict external demands with a reasonable degree of accuracy.

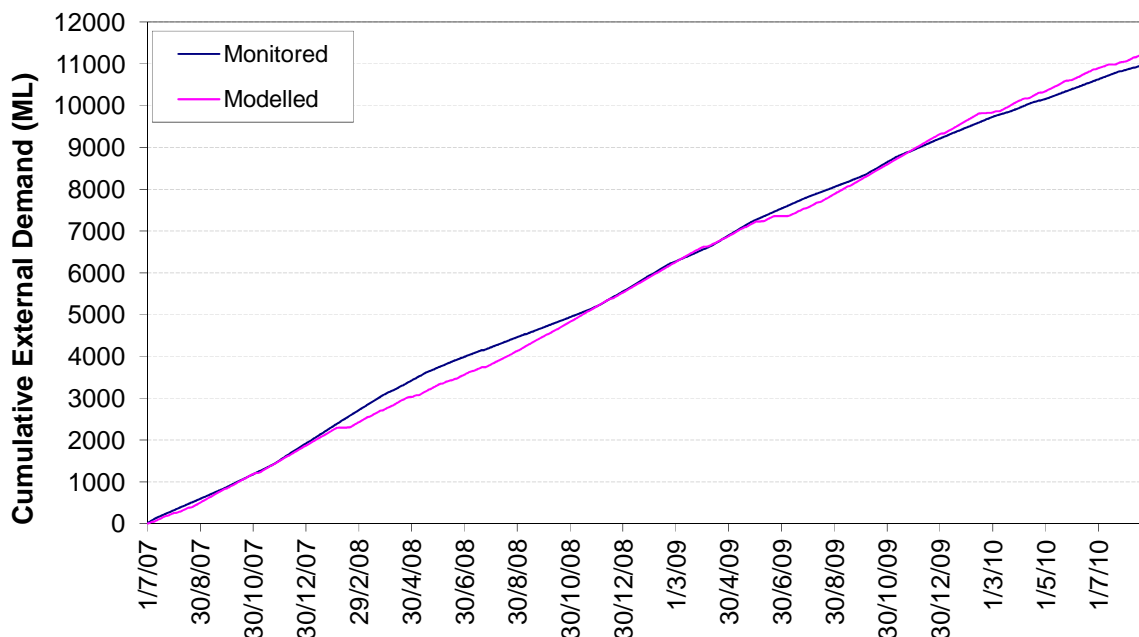


Figure B-23 Water Balance Model Calibration – CGM External Water Demand

B5.3 Simulated Future Performance

The calibrated model was used to simulate the likely performance of the water management system over the simulated 124 climatic sequences. The model was run commencing at 1 January 2013 with storage volumes and mine conditions as they were at that date (based on data supplied by Barrick). The simulation was run until 12 April 2024 (simulated end of processing operations), with the following parameters set:

- Borefield pipeline capacity 14 ML/day at 100% availability from 1 July 2014 (11 ML/day prior to this date).
- Oxide tailings bleed reduction = 2% (per model calibration – refer Section B5.2.1.2).
- Bland Creek Palaeochannel Borefield extraction rate limited to 10 ML/day.
- No limit on extraction from Lachlan River entitlements. If borefield supplies are inadequate to meet the demands for water importation to CGM, water is sourced from the Lachlan River and is limited only by the capacity of the borefield pipeline (i.e. 14 ML/day).

The results of this modelling are referred to as the base case. The model including its input parameters and input data was also varied in sensitivity simulations – refer Section B5.4 and also to assess the implications of predicted future climate change on the performance of the water management system – refer Section B5.5. Results of the sensitivity and climate change simulations were compared with the base case results.

B5.3.1 Overall Water Balance

Figures B-24 and B-25 summarise model predicted system inflows and outflows for the remaining mine life averaged over all climatic sequences.

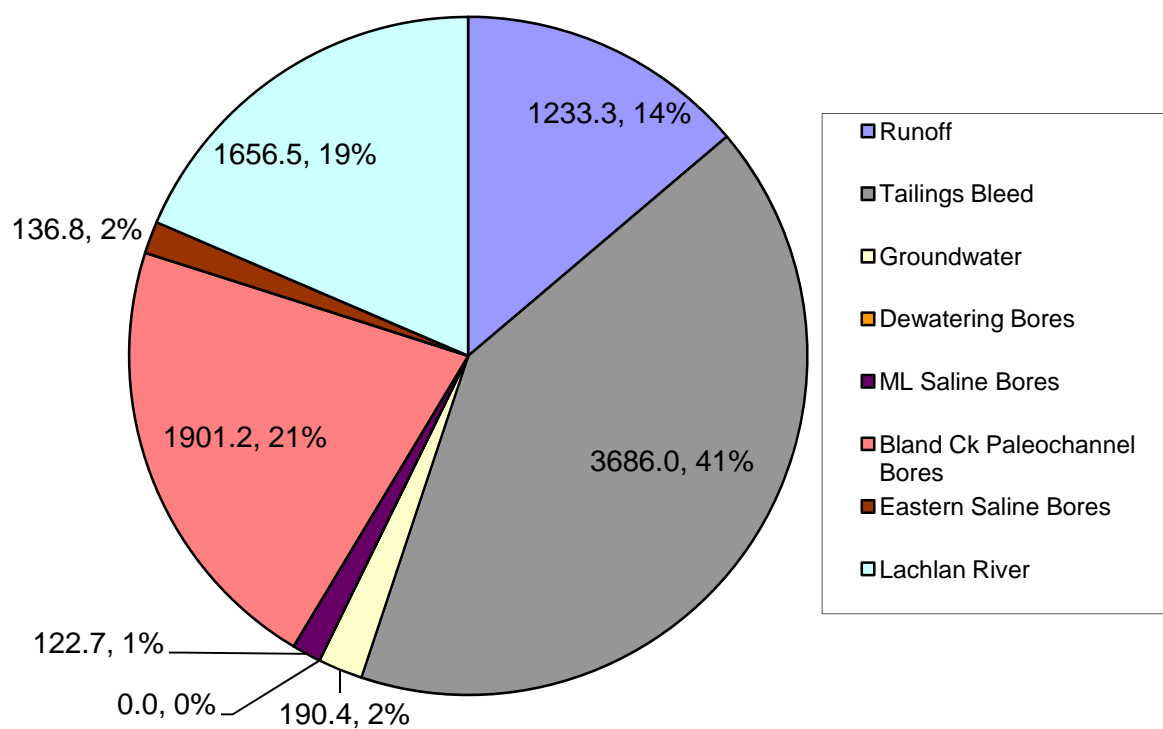


Figure B-24 Average Modelled System Inflows (ML/year)

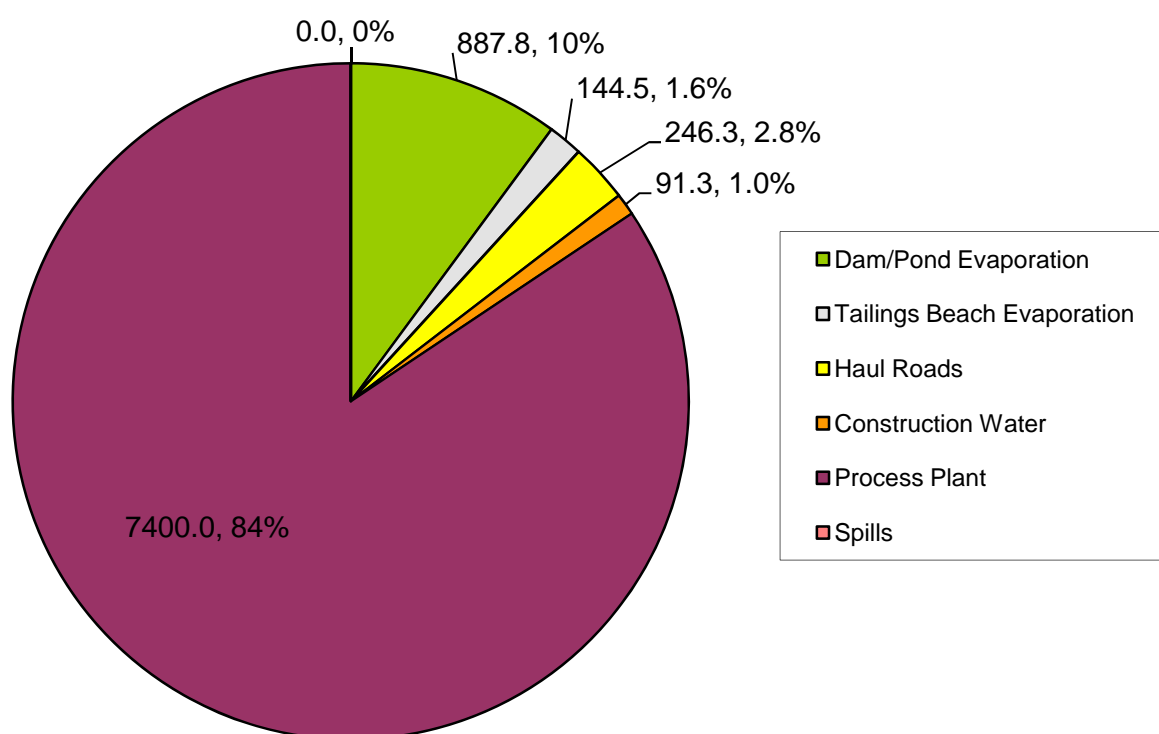


Figure B-25 Average Modelled System Outflows (ML/year)

Predicted total inflows average 8,927 ML/year while outflows average 8,770 ML/year.

Table B-9 summarises water balance model results in terms of system inflows and outflows for median, 10%ile (dry) and 90%ile (wet) 12-year total rainfall scenarios.

Table B-9
Water Balance Model Results
(Averaged over Remaining Mine Life ML/annum)

| | 10%ile Rainfall Sequence (Dry) | Median Rainfall Sequence | 90%ile Rainfall Sequence (Wet) |
|---|-----------------------------------|--------------------------------|-----------------------------------|
| <i>Inflows*</i> | | | |
| Catchment Runoff | 962 | 1,334 | 1,438 |
| Tailings Bleed | 3,686 | 3,686 | 3,686 |
| Open Pit Groundwater | 190 | 190 | 190 |
| Saline Groundwater Supply Bores (within ML 1535) | 161 | 148 | 133 |
| Bland Creek Palaeochannel Bores | 1,993 | 1,868 | 1,819 |
| Eastern Saline Bores | 141 | 140 | 140 |
| Lachlan River Licensed Extraction** | 1,773 | 1,588 | 1,567 |
| Total Inflow | 8,908 | 8,955 | 8,974 |
| <i>Outflows</i> | | | |
| Evaporation | 1,019 | 1,039 | 1,083 |
| Haul Road Dust Suppression | 248 | 247 | 244 |
| TSF Embankment Construction Water | 91 | 91 | 91 |
| Process Plant Supply | 7,400 | 7,400 | 7,400 |
| Spills | 0 | 0 | 0 |
| Total Outflow | 8,758 | 8,778 | 8,819 |

*Runoff recovered from the outside batters of the perimeter waste rock emplacement batters has not been simulated. Recovery would increase catchment runoff and would reduce by a corresponding amount the demand for water from external sources.

**Modelled volume of water actually reaching the CGM – excludes irrigation channel losses (refer Section B5.1.1).

B5.3.2 CGM External Water Demand

Figures B-26 to B-28 show predicted annual water demands from external sources – the eastern saline borefield, the Bland Creek Palaeochannel borefield and licensed extraction from Lachlan River water entitlements. As evident from Figure B-26 and stated in Section B5.1.4, the eastern saline borefield is assumed available only until the end of 2015. Figures B-26 to B-28 plot the median annual water demands, the 90th percentile demand (i.e. the demand that was predicted not to be exceeded in 90% of the simulated 124 climatic sequences) and the 10th percentile demand (i.e. the demand that was predicted not to be exceeded in 10% of the simulated 124 climatic sequences).

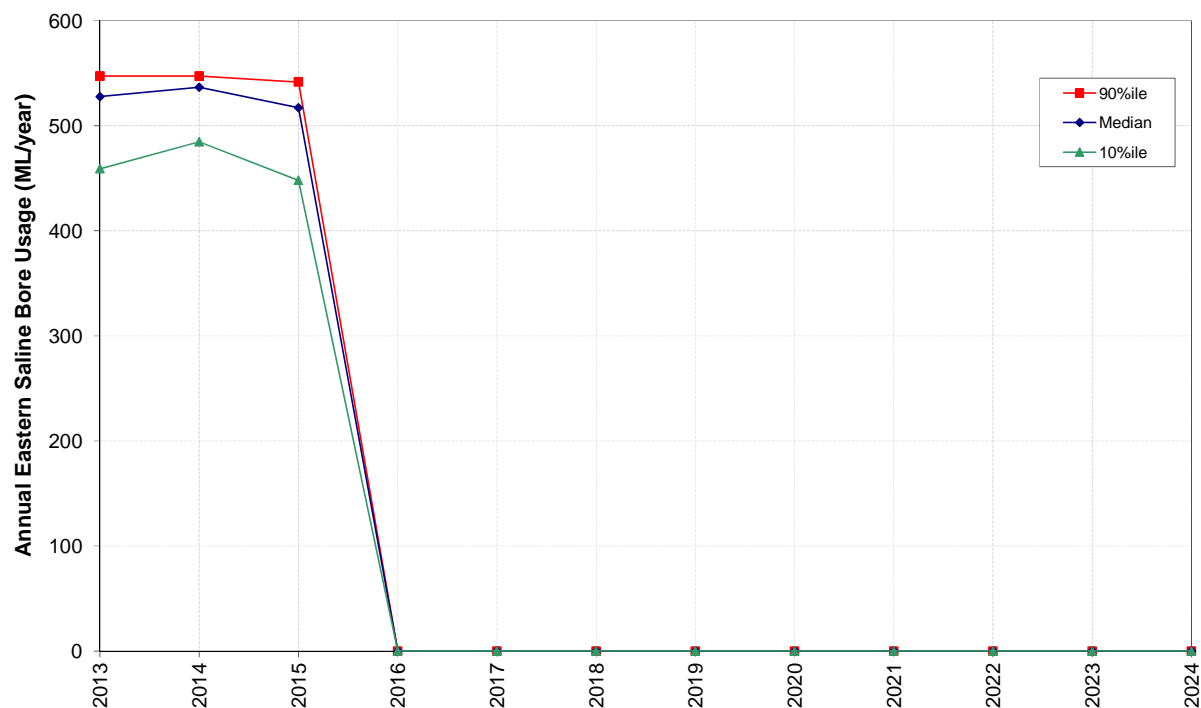


Figure B-26 Predicted Annual Eastern Saline Borefield Usage

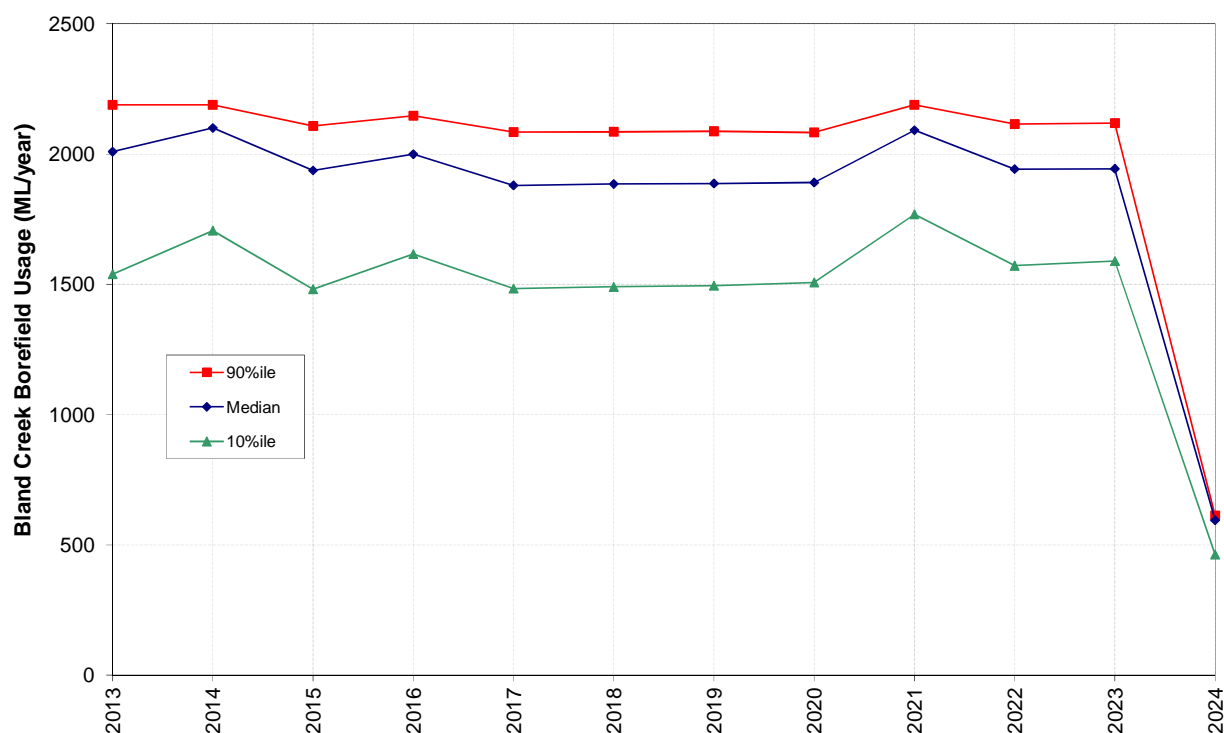


Figure B-27 Predicted Annual Bland Creek Borefield Usage

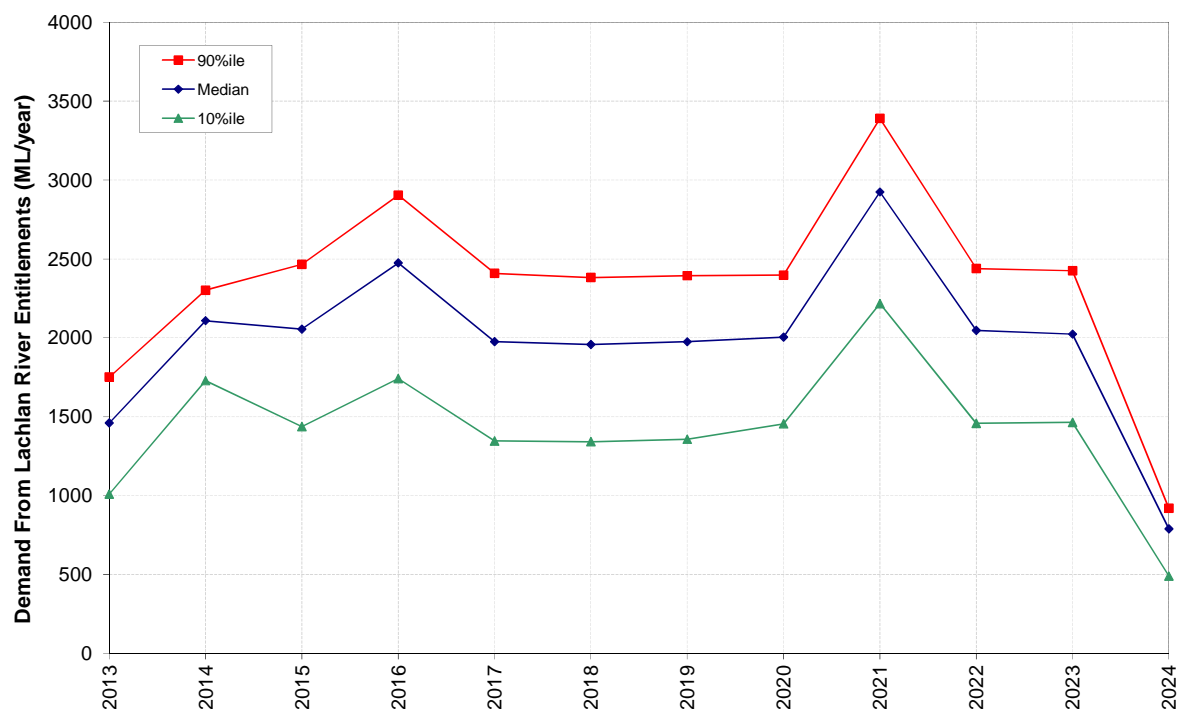


Figure B-28 Predicted Annual Demand from Lachlan River Entitlements

Figure B-28 shows that the predicted annual demand from licensed extraction from the Lachlan River increases once the operation of the eastern saline borefield is assumed to cease (i.e. after 2015) and is higher during the planned oxide ore processing campaigns.

No supply shortfalls were simulated in any of the 124 climatic sequences simulated.

B5.3.3 Maximum Pit Water Volume

The maximum water volume held in the open pit in all 124 simulated climatic sequences was 1,441 ML. However, the risk of such a large water volume is low. Model results indicate that there is only a 5% risk of exceeding a pit water volume of 706 ML, and a 20% risk of exceeding a pit water volume of 112 ML at any time during the remaining mine life.

B5.4 Model Sensitivity

A key outcome of the water balance model is the predicted water requirement from Lachlan River entitlements (Figure B-28). In order to test the sensitivity of this result and compare results with the base case simulation (Section 5.3), key model parameters were varied (within credible limits) in order to reduce the predicted yield from on-site water sources. The following summarises model parameters that were varied:

- Rainfall rates decreased by 10% and evaporation rates increased by 10% - denoted as Sensitivity Case 1.
- Tailings bleed rate (as a percentage of water pumped with tailings) reduced by 8.5% (for both primary and oxide ore) – refer Section B5.2.1 - denoted as Sensitivity Case 2.

Figure B-29 summarises the predicted median annual demand from licensed extraction from the Lachlan River as a result of the above sensitivity cases.

The average predicted requirement for water from Lachlan River entitlements (averaged over all modelled climatic sequences and the remaining mine life) for Sensitivity Case 1 was 2,162 ML/year, an increase of 232 ML/year or 12% from the predicted average base case rate (refer Figure B-29). Similarly, the average predicted requirement for water from Lachlan River entitlements for Sensitivity Case 2 was 2,396 ML/year, an increase of 466 ML/year or 24% from the predicted average base case rate. As noted in Section B4.2.4, the NOW trading records show that between approximately 4,000 ML and 202,000 ML of temporary water has been traded annually in the last nine years.

The sensitivity analysis indicates that when the model parameters are varied to account for a reasonable level of uncertainty, Barrick would still be able to meet water supply requirements.

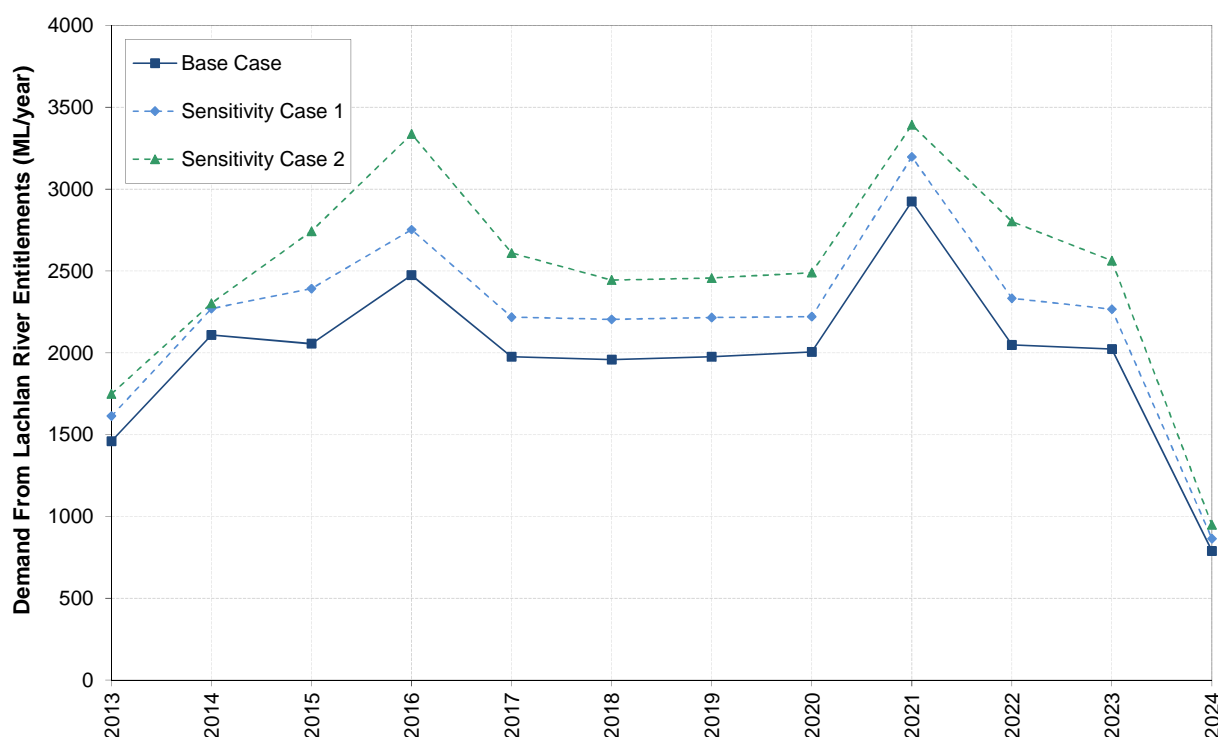


Figure B-29 Predicted Annual Demand from Lachlan River Entitlements from Sensitivity Analyses

B5.5 Climate Change Effects

Recent (post 1950) changes to temperature are evident in many parts of the world including Australia. The Intergovernmental Panel on Climate Change (IPCC, 2007) has, in its most recent (fourth) assessment, concluded that:

most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations. ... Discernible human influences now extend to other aspects of climate, including ocean warming, continental average temperatures, temperature extremes and wind patterns.

Predicting future climate using global climate models is now undertaken by a large number of research organizations around the world. In Australia much of this effort has been conducted and co-ordinated by the Commonwealth Scientific and Industrial Research Organisation (CSIRO). CSIRO has published a comprehensive assessment of future climate change effects on Australia (CSIRO, 2007). CSIRO has included assessments based on the predictions from 23 selected climate models from research organisations around the world. Model predictions were made for a range of different future greenhouse emission scenarios adopted by the IPCC.

CSIRO has used predictions of future climate from these various models to formulate probability distributions for a range of climate variables including temperature, rainfall potential evaporation, snow cover and drought. The model predictions are made relative to 1990 conditions at 5 yearly increments between 2030 and 2100. Predictions for 2030 are relatively insensitive to future emission scenarios because they largely reflect greenhouse gases that have already been emitted. Longer term predictions become increasingly more sensitive to future emission scenarios.

More recently, the CSIRO has developed (and is in the process of completing) the 'Representative Climate Futures' software tool (Whetton *et al.*, 2012). This allows analysis of future climate data sets to be confined to models which best represent a 'representative' climate future – e.g. that which is "most likely".

Predictions of future rainfall in south-eastern Australia are generally for reduced annual rainfall, but increased daily rainfall and a higher number of dry days per year. Future annual rainfall and evaporation change predictions for the Lake Cowal area have been provided by the CSIRO using the Representative Climate Futures tool (Whetton *et al.*, 2012) for the A1Fi emission scenario¹⁵ for a range of climate change models. The spatial extent to which these results refer is the land area contained in the 5 degree grid centred on 32.5 degrees north, 146.5 degrees east.

¹⁵ A1Fi emission scenario refers to expected emissions for a future characterised by very rapid economic growth, global population that peaks in mid-century and declines thereafter and a substantial reduction in regional differences in per capita income. It assumes rapid introduction of new and more efficient technologies but emphasises fossil-fuel intensity.

Although this may be regarded to be quite a large area, it is believed that the predictions are unlikely to vary significantly through the area, because:

1. The climate change values themselves are averaged from *global* climate models with resolutions ranging from 125 km to 400 km (refer Chapter 4 of CSIRO, 2007).
2. The range of change in potential evaporation for this region of Australia under the A1Fi scenario does not vary greatly spatially across a 5 degree grid (refer Chapter 5 of CSIRO, 2007).

Using the Climate Futures tool, projected changes to rainfall, and evaporation for 2030 and 2090 were simulated using 18 Climate Change Models which were considered by CSIRO to simulate climatic processes well in this region (Irving *et al.*, 2011).

The predicted annual average changes (relative to 1990 values) in rainfall obtained are summarised as follows:

- By 2030:

| | |
|--------------------|--------|
| Maximum decrease | 11.5 % |
| Maximum increase | 4.7 % |
| Average (decrease) | 2.9 % |
| Median (decrease) | 3.7 % |

- By 2090:

| | |
|--------------------|--------|
| Maximum decrease | 46.4 % |
| Maximum increase | 26.8 % |
| Average (decrease) | 5 % |
| Median (decrease) | 2.9 % |

Based on the median prediction, there would be a small decrease in rainfall in the future.

The CSIRO also produce summary prediction for future potential evapotranspiration. At the time of writing these were not available and were in the process of being updated. Broad average estimates were however available from CSIRO, 2007. These indicate that potential evapotranspiration would increase in central and eastern NSW by 2 to 4% by 2030 and by 8 to 12% by 2090. Using the average of these predictions and combining them with the median future average annual rainfall predictions results in a decrease in rainfall minus evapotranspiration of about 5% by 2030 and about 15% by 2070-2090.

B5.6 Water Management Implications of Climate Change Predictions

The implications of climate change predictions on water management are unlikely to be significant over the mine life because they are small compared to the natural climatic variability.

Longer term climate change predictions do however have potential implications for post mine water management and specifically the water balance of the final void. In this regard the currently most accepted scenarios would see a reduction in overall rainfall, an increase in evaporation and a corresponding decrease in rainfall excess. This would translate to reduced surface water runoff inflow to the void and reduced incident rainfall over the surface of the void. There would also be increased evaporation loss for the void surfaces and as a consequence lower average water levels in the mine void.

B5.7 Spill Risk to Lake Cowal

No spills were predicted in the water balance model from either of the contained water storages (D1 and D4) that could spill to Lake Cowal in any of the 124 possible climate sequences modelled. This outcome is contingent upon pumped dewatering of these storages in between rainfall events. Pump extraction rates of 100 L/s and 85 L/s for storages D1 and D4 were assumed respectively.

B6.0 POST-CLOSURE WATER MANAGEMENT SYSTEM

B6.1 EIS Post-Closure Management Concepts

The post-closure water management strategy described in the EIS included concepts for runoff minimisation from waste rock emplacements and TSFs, and the provision of stable drainage channels to drain site surface water to the final void. These concepts are described below.

B6.1.1 Waste Rock Emplacements

At the completion of mining the top surface of the northern and southern waste rock emplacement areas were to be graded such that any surface runoff would flow toward the final void. A cover layer comprising low salinity sub-soil and topsoil was to be laid over the graded top surface of the waste rock emplacements. The cover material and thicknesses were to be selected consistent with the overall objective of minimising runoff from the emplacement surface by encouraging infiltration and storage of rainfall in a relatively thick cover layer where it would be available for surface vegetation.

Deep rooting, high transpiration capacity vegetation species were to be utilised as cover vegetation to take-up and use the available moisture in the cover layer. The final surface of the waste rock emplacement areas was to be purposely left with a high degree of irregularity to provide surface retention of excess rainfall for longer term infiltration and take-up in the surface cover and plant system. A network of low energy drainage swales were to be provided on both waste rock emplacement areas for drainage of any net runoff to the final void. The external faces of the waste rock emplacements were to be constructed in a regular series of batters and berms. The berms were to be constructed with reverse grades to prevent overflow of berm runoff over the batters. Runoff retention areas and deep vegetated soil cover layers were proposed as concepts to minimise net runoff.

B6.1.2 Tailings Storage Facilities

Concepts developed for rehabilitation of the external batters and berms of the tailings storages involved a similar approach as those developed for the outer faces of the waste rock emplacements. The concepts developed for the top surface of the tailings storages included retention of the final inverted cone shape of the final beach surface which would, by virtue of the planned peripheral tailings discharge regime, slope downward from the embankment perimeters toward the central decant area. The final surface was to be covered with a relatively thick layer of low salinity sub-soil and topsoil to support a deep rooting plant cover. A capillary break layer between the final tailings surface and the cover was also identified as a requirement of the surface rehabilitation to prevent salt rise into the overlying soil cover layer. Planned surface irregularities, mounds and swale-like channels were also proposed for transient retention of surface runoff, to enhance moisture retention within the cover system and to provide a formal pathway for any net runoff under extreme conditions to be diverted to the final void.

B6.1.3 Final Void

The final open pit was to be left as a void. The UCDS and the ICDS were to be retained. Surface drainage from the CGM area was to be diverted to the final void via a series of low energy swales. Drainage from areas upslope of the CGM area would flow to Lake Cowal via the UCDS and pre-mine creek lines.

At the completion of mining and processing, pit dewatering operations would cease and groundwater and inflows from rainfall runoff from the CGM area would accumulate in the open pit. Final void water and solute balance model simulations conducted as part of the EIS showed that, in the long-term, the void would fill over a considerable period of time to a level some 22 to 24 m below the original ground level at the low point in the perimeter of the open pit. Modelling also indicated that water levels would fluctuate seasonally by a few metres above and below this level. The quality of final void was predicted to be dominated by the naturally high salinity of the surrounding groundwater which had reported salinity in the range of 31,000 to 38,000 mg/L – predominantly sodium chloride. The final void water levels were such that it was predicted to act as a permanent sink for the surrounding groundwater system. Because the void had no outflow - other than direct evaporation, the salinity of void waters was predicted to continue to increase in the longer term due to evapo-concentration. The quality of void water was also predicted to vary with depth due to stratification which would occur due to temperature and salinity differentials.

B6.2 Project Post-Closure Water Management

The concepts developed for the EIS are considered to remain valid for the post-closure situation for the Modification. The changes occasioned by the Modification in relation to post-closure relate principally to the increased size (area) of the waste rock emplacements and to the final void size. The shaping, surface covering and surface treatments proposed in the EIS for the waste rock emplacement areas and the tailings storages are equally applicable. Barrick is undertaking waste rock emplacement batter rehabilitation trials (using a number of different combinations of rock mulch, soil and vegetation). Results of these trials will inform the final design of the waste rock emplacement rehabilitation. Consistent with the 2010 Independent Monitoring Panel Report recommendations (Bell & Miller, 2010), Barrick would continue to monitor rehabilitation trials and focus on surface treatments showing most promise.

The implications of these changes associated with the Modification on the final void water balance are described in the following sub-sections.

B6.2.1 Final Void Water Balance

The final void would, as a result of the Modification, be larger in area and deeper than the original (EIS) void. The catchment area reporting to the final void would be slightly larger, with a greater proportion of rehabilitated waste rock emplacement area (due to enlargement of the waste rock emplacements). These changes in catchment and void size would have an effect on the water balance during the filling phase and potentially to the longer term post-equilibrium water levels. Groundwater inflows to the final void have been re-estimated (Coffey Geotechnics, 2013) and are predicted to be significantly lower than those that were originally predicted (in the EIS [North, 1998]).

Current inflow estimates vary from an initial maximum rate of 0.11 to 0.27 ML/day, declining as the water level in the pit approached the original (pre-mine) groundwater table.

A final void water balance model has been set up to simulate the behaviour of the final void water body. The model simulates inflow from catchment rainfall runoff (including direct rainfall) and groundwater and outflow due to evaporation. Key model assumptions included:

- A catchment area (ICDS) totalling approximately 13 km². The catchment was broken up into sub-catchment areas with the AWBM used to calculate rainfall-runoff from each sub-catchment (the same AWBM parameters were used in the CGM water balance model – refer Section 5.0).
- The same 124 year climatic data set as was used in the CGM water balance model was used in the final void model (refer Section B5.1.2). The 124 year climate data set was repeated over and over again to generate a 1,000-year daily time-step final void simulation (refer Section B6.2.2 for implications of possible climate change).
- Groundwater inflow rates varying from 0.11 to 0.27 ML/day with an empty final void, to 0 ML/day at a final void water level of RL 201 m with a dry lake or RL 206 m with an inundated Lake Cowal.
- Pan evaporation rates were factored down by a factor of 0.7, to allow for the effects of shading and wind reduction in a depressed water body¹⁶ and 0.968, to allow for the effects of salinity¹⁷.
- The final void level-volume-surface area relationship was taken from contour plans provided by Barrick.

¹⁶ As was used in Barrick (2006).

¹⁷ Using Equation 4.7.4 in Grayson *et al.* (1996), assuming an upper bound groundwater TDS of 35,200 mg/L, as given in Coffey Geotechnics (2013). It was assumed that the final void water column would stratify, with less saline groundwater rising above the more saline main water body, which would gradually increase in salinity due to evapo-concentration.

Model results are shown in Figure B-30 and indicate that the final void would fill slowly reaching an equilibrium water level between approximately RL 125 m and RL 135 m (approximately 80 m below spill level) over several hundred years. This is lower than the original predictions (North, 1998) due to lower groundwater inflows and higher evaporation rates from the larger void surface area.

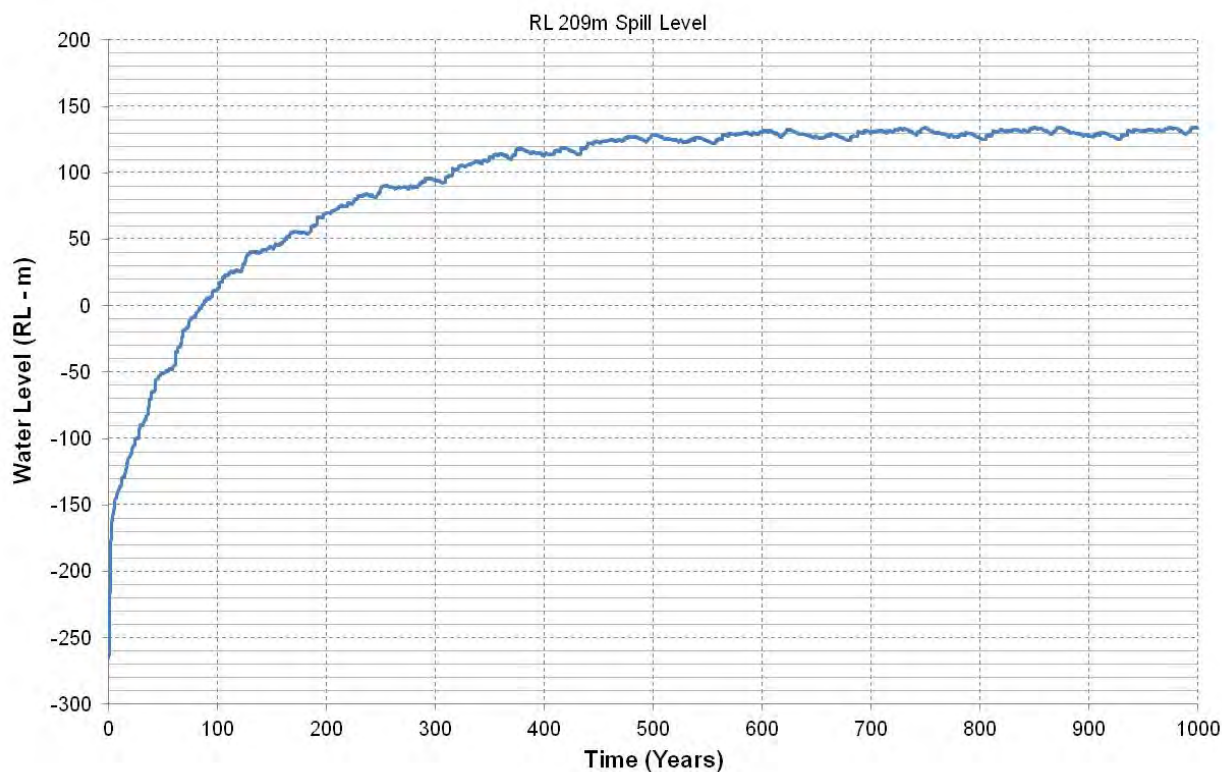


Figure B-30 Predicted Final Void Filling Behaviour – Water Level Response

The void water quality would reflect the influence of the high salinity in the groundwater. Given that the only outflow from the final void would be to evaporation, salinity is predicted to increase trending to hyper-salinity. Water quality in the final void at any given point in time will vary with depth as a result of mixing and stratification processes that will occur as a result of temperature and salinity differentials.

B6.2.2 Implications of Climate Change on Final Void Water Balance

Climate change has the potential to affect the validity of water balance predictions which have been based on historical climatic data. Future predictions of rainfall and evaporation were again estimated using information provided by the CSIRO – refer Section B5.5. The available data extends as far as 2090 and suggests an average decrease in annual rainfall of about 5% and an average increase in open water evaporation of about 10%. The effect of these predicted climate changes would be a lower final water level in the void compared with the prediction made using the available historically based climatic factors.

B7.0 POTENTIAL SURFACE WATER IMPACTS AND MITIGATION MEASURES

The following recommendations are made in consideration of the surface water management issues assessed for this Modification:

- The changes to water management outlined in this report be implemented in accordance with accepted and best practice management.
- The monitoring program and associated annual water management system performance reviews continue to be undertaken over the remaining CGM life.
- The soil and erosion control plan be modified to incorporate changes necessitated by the Modification. The modified plan should include measures (including quality control field testing and validation) to ensure that topsoil stockpiled in the north of ML 1535 excludes saline sub-soils which should be retained within the ICDS.

B7.1 Operational Phase

Table B-10 summarises potential surface water impacts of the Modification and mitigation measures.

Table B-10 – Potential Surface Water Impacts and Mitigation Measures – Operational Phase

| Potential Surface Water Impacts | Predicted Impact and/or Mitigation Measures |
|--|--|
| Change to Lake Cowal hydrology as a result of reduction in catchment area caused by topsoil stockpile in the north of ML 1535 intercepting runoff that would otherwise report to Lake Cowal. | The topsoil stockpile catchment area totals approximately 0.33 km ² , which is 0.003% of the 9,500 km ² catchment area of Bland Creek, the main tributary to Lake Cowal. Runoff from the topsoil stockpile catchment would be released into local drainages reporting to Lake Cowal following settling of sediment. The Modification would therefore not affect catchment inflows to Lake Cowal or its water balance. |
| Increased salinity or turbidity from runoff from the outer batters of waste rock emplacements that does not report to the ICDS. | Runoff from the majority of waste rock emplacement outer batters reports to either contained water storage D1 or D4. These storages are pumped out as part of the mine water management system (no spills from these storages were predicted in the water balance model). The outer batters of the waste rock emplacements are ultimately to be stabilised by placement of a low salinity rock mulch cover. Temporary stabilisation of the outer batters of the perimeter waste rock emplacement has been undertaken by revegetation. Runoff from the outer batters of the perimeter waste rock emplacement ponds against the temporary isolation bund and would be pumped to a contained water storage (D6) within the CGM water management system. |

Table B-10 – Potential Surface Water Impacts and Mitigation Measures – Operational Phase (Continued)

| Potential Surface Water Impacts | Predicted Impact and/or Mitigation Measures |
|---|---|
| Increased turbidity in Lake Cowal as a result of the soil stockpile in the north of ML 1535. | Appropriate erosion and sediment controls would be implemented during construction in accordance with Landcom (2004) and DECCW (2008). |
| Risk of contamination of Lake Cowal water from leakage of water from the mine borefield pipeline. | Differential flow monitoring/protection is installed in the pipeline either side of Lake Cowal, providing protection against substantial prolonged leakage. Catastrophic pipeline failure would result in some leakage to the Lake, however the volumes would be minor in comparison to the large volume of Lake Cowal. Leakage of saline water in the absence of any water in Lake Cowal would have a negligible effect given the volume would be low. |
| Risk of contamination of Lake Cowal water from leakage of water from ML1535 saline groundwater bores. | Bores are not operated at times of high Lake water levels. Automatic leak detection and automatic shut-down mechanisms are installed. The potential surface water impacts associated with these bores would be limited to impacts associated with pipeline failure and leakage of saline water (estimated at up to 36 kilolitres). Any leakage prior to automatic shut-down would be limited to increasing salinity surrounding the leakage inflow point (if there was any water in the Lake) and would be minimal. |
| Impacts of any leakage from Eastern Saline borefield. | Leak detection and automatic shut-down mechanisms are inherent in the design of the Eastern Saline borefield. The potential surface water impacts associated with these bores would therefore be limited to impacts in the area around the bore heads. Any leakage should have a negligible effect given the volume would be low because of the leak detection and automatic shut-down mechanisms inherent in the design of the system. |
| Impacts on Lachlan River flows of increased CGM water demand. | Increased water demand would be met (in part) by sourcing water from Lachlan River regulated flows (licensed extraction purchased on the open market). Given the provisions inherent in the <i>Water Management Act, 2000</i> regarding environmental flows, the impact of sourcing additional regulated flow from the Lachlan would be neutral because if not extracted by Barrick for use at Cowal the licenses could be either purchased and the same water extracted by others or the water could be used by the existing licence holders if they were unable to sell the water on the open market. |

Overall there has been no apparent causal link between the mining operations and water quality changes in Lake Cowal and it is concluded that there would be a low risk of more than a negligible hydrological impact on Lake Cowal due to the Modification.

B7.2 Post-Closure

Post-closure surface water impacts would include possible risks of structural instability of final mine landforms affecting Lake Cowal water quality (salinity and turbidity/sedimentation). There is also the risk of discharge from the final void water body to Lake Cowal.

Water balance modelling (Section B6.2) has indicated that the final void water level should stabilise well below spill level and below the local water table level, even allowing for adverse future climate change predictions. The majority of the CGM site post-closure would continue to drain to the final void and would therefore have no impact on the water quality of Lake Cowal. The final profiles of the waste rock emplacements, TSFs and lake isolation system have been designed to effectively preclude instability which could cause impact on the Lake (North, 1998). Stabilisation of the outer batters of the mine waste rock emplacements (using rock mulch and vegetation) would be undertaken well ahead of mine closure, allowing time for “proving” the stability of these batters.

Barrick is undertaking batter rehabilitation trials (using a number of different combinations of rock mulch, soil and vegetation). Results of these trials will inform the final design of the waste rock emplacement rehabilitation and will also allow prediction of sediment generation rates likely to be generated from the final landform to the Lake. North (1998) predicted final landform sediment generation rates that were of the same magnitude as (albeit somewhat greater than) those predicted from the site under pre-mine conditions. However given the direction of most of the site runoff to the final void, the area reporting to Lake Cowal would be reduced and therefore so would the net sediment yield to Lake Cowal. Likewise the majority of salt generated from the final landform would be directed to the final void which is predicted to trend towards hyper-saline conditions in the long term (regardless of salt influx).

The salt concentration from the rehabilitated outer waste rock emplacement to Lake Cowal would be expected to reduce with time as salts present in the near surface layers were removed by natural leaching. In the longer term salt fluxes were expected to be similar to or less than current rates (North, 1998). Salt fluxes were predicted to be extremely small compared with inflows to the Lake from Bland Creek and the Lachlan River.

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