Narrabri Mine Modification 5

Environmental Assessment

APPENDIX C

Surface Water Assessment

Resource Strategies

WHITEHAVEN COAL

Modification 5 Surface Water Assessment

Narrabri Coal Operations Pty Ltd

0189-09-C4, 26 August 2015

Report Title	Modification 5 Surface Water Assessment
Client	Narrabri Coal Operations Pty Ltd
Report Number	0189-09-C4

Revision Number	Report Date	Report Author	Reviewer
	28 August 2015	RAC	GR

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1 Introduction

1.1 BACKGROUND

The Narrabri Mine (NM) is an underground coal mining operation located approximately 28 kilometres (km) south-east of Narrabri and approximately 65 km north-west of Gunnedah in the Gunnedah Basin, New South Wales (NSW) (Figure 1.1).

The NM is operated by Narrabri Coal Operations Pty Ltd (NCOPL) on behalf of the Narrabri Joint Venture, which consists of Whitehaven Coal Limited's subsidiary Narrabri Coal Pty Ltd (70 percent [%]), Upper Horn Investments (Australia) Pty Ltd (7.5%), J-Power Australia Pty Limited (7.5%), EDF Trading Australia Pty Limited (7.5%) and Daewoo International Narrabri Investment Pty Limited and Kores Narrabri Pty Limited (7.5%).

Stage 1 of the NM was originally approved under Part 3A of the NSW *Environmental Planning and Assessment Act, 1979* (EP&A Act) in 2007 and involved initial site establishment activities and continuous miner mining operations.

Project Approval (08_0144) for Stage 2 of the NM was issued in 2010 and allowed the mine to convert to a longwall mining operation.

Project Approval (08_0144) allows for the production and processing of up to 8 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal for a period of 21 years. ROM coal is processed at the NM to produce thermal and pulverised coal injection (PCI) product coal. Product coal is transported from the NM by rail to Newcastle.

In 2011, NCOPL submitted two minor applications to modify Project Approval (08_0144) under Section 75W of the EP&A Act to update subsidence management conditions in Project Approval 08_0144 and to allow for the one-off road transport of coal to the Tarrawonga Coal Mine. A third application to modify Project Approval (08_0144) under Section 75W of the EP&A Act submitted in 2012 was withdrawn.

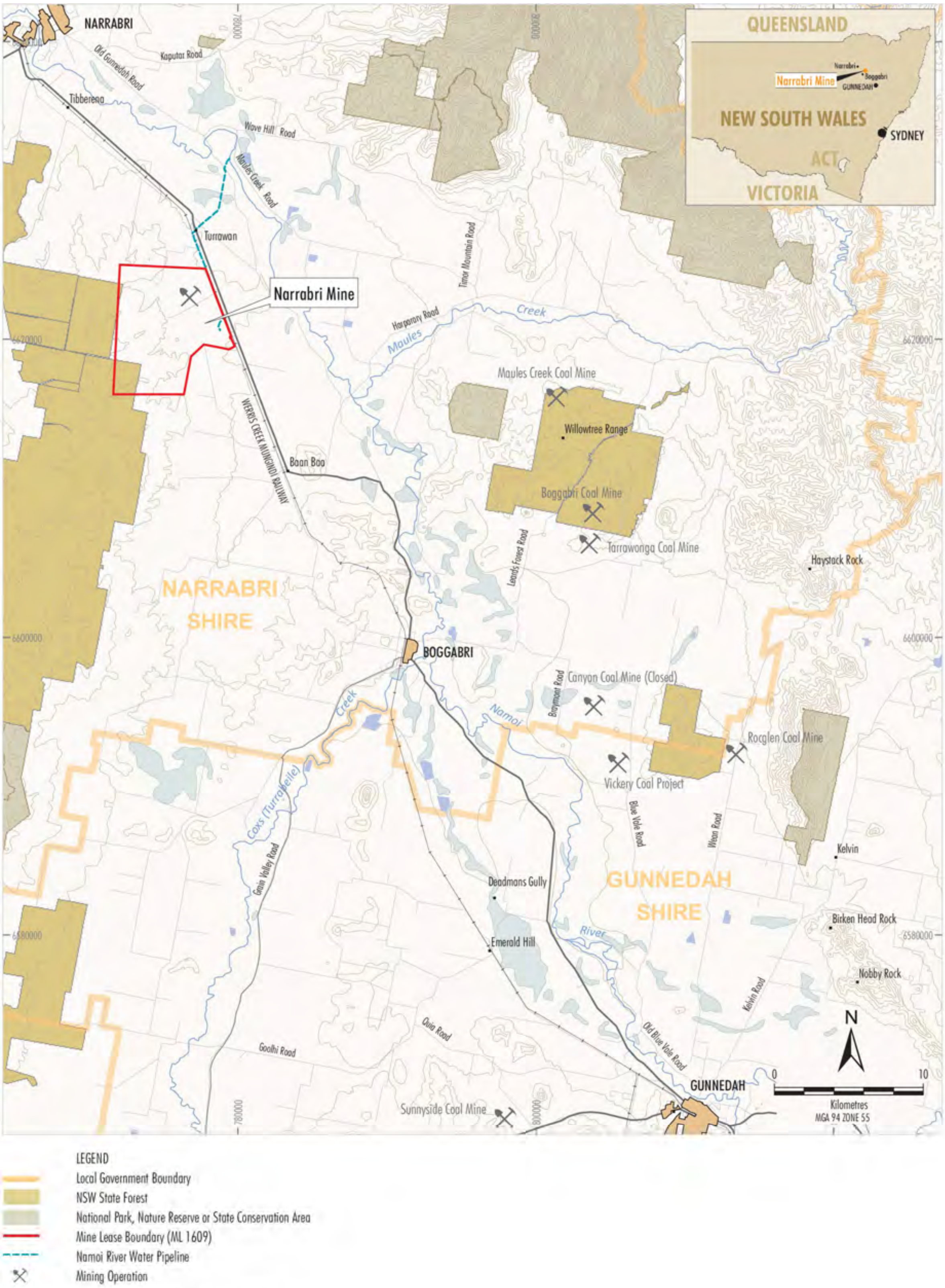
In April 2015, NCOPL submitted an application to modify Project Approval (08_0144) under Section 75W of the EP&A Act to increase the capacity of the existing ROM and product coal stockpiles (the Stockpile Extension Modification). The Stockpile Extension Modification is currently being assessed by the Department of Planning and Environment. Notwithstanding, the Stockpile Extension Modification has been assumed to have been approved for the purposes of this Surface Water Assessment.

NCOPL is now seeking a separate modification to Project Approval (08_0144) under Section 75W of the EP&A Act to reconfigure the approved underground mine geometry and to increase the ROM coal production rate (Modification 5 [the Modification]).

1.2 MODIFICATION OVERVIEW

The Modification would involve:

- an increase in longwall panel widths for LW107 to LW120 from 295 metres (m) to 400 m (LW101 to LW106 unchanged) (Figure 1.2);
- a reduction in the number of longwall panels from 26 to 20 (Figure 1.2);
- a western extension of underground mine footprint relative to the existing/approved underground mine footprint of approximately 60 m within Mining Lease (ML) 1609 (Figure 1.2);
- an increase in the ROM coal production from 8 Mtpa up to approximately 11 Mtpa;
- the continuation of pre-conditioning of the Digby Conglomerate to prevent or minimise the impact of wind blast in the underground workings;



Source: Geoscience Australia, 2006 and NSW Trade & Investment, 2013

Figure 1.1 – Narrabri Mine regional locality map (Source: Resource Strategies, 2015a)

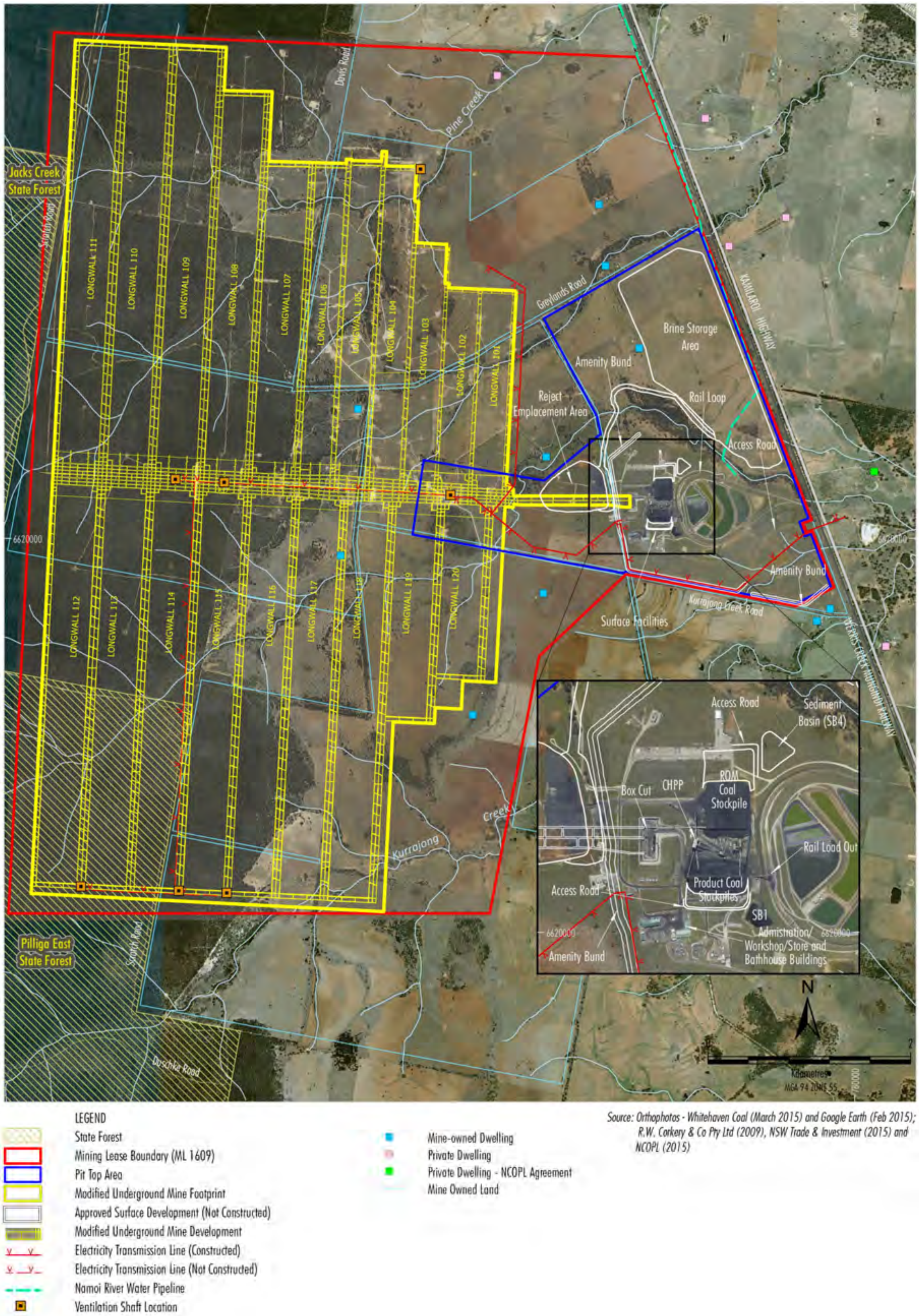


Figure 1.2 - Modified Narrabri Mine general arrangement (Source: Resource Strategies, 2015a)

- minor amendments to the site water management system; and
- an increase in the average number of trains from 3 trains/day to 4 trains/day (peak would remain unchanged).

There would be no significant change to other NM components.

A detailed description of the Modification is provided in the Environmental Assessment.

1.3 PURPOSE OF THIS REPORT

WRM Water and Environment (WRM) has been commissioned to undertake a Surface Water Assessment for the Modification. This report outlines the changes to the performance of the modified site water management system and identifies any additional or changed impacts to those documented in *Narrabri Coal Mine Stage 2 Longwall Project Surface Water Assessment* (WRM, 2009).

The structure of this report is as follows:

- Section 2 list the available data for the Surface Water Assessment.
- Section 3 outlines the key legislation and guidelines relevant to the Modification.
- Section 4 provides background information on the characteristics of the existing surface water environment.
- Section 5 describes the Modification.
- Section 6 presents the methodology and results of a numerical simulation of the site water balance, including both calibration against historical site data, and the predicted performance of the modified site water management system.
- Section 7 describes the potential surface water resource impacts of the Modification (compared to those identified in WRM [2009]) and provides an assessment of the likely magnitude of these impacts.
- Section 8 documents the proposed licensing, management and mitigation measures for the Modification.
- Section 9 is a summary of the findings of the Surface Water Assessment.
- Section 10 is a list of references.

2 Available data

2.1 PREVIOUS STUDIES

WRM has prepared the following previous surface water assessments for the NM, which have been referred to where relevant in this Surface Water Assessment:

- Narrabri Coal Project Surface Water Assessment (WRM, 2007); and
- Narrabri Coal Mine Stage 2 Longwall Project Surface Water Assessment (WRM, 2009).

The approved site water management system is described in WRM (2009).

2.2 TOPOGRAPHIC DATA

LIDAR survey data of the NM dated March 2015 was provided by NCOPL. The survey data included evidence of existing subsidence caused by extraction of coal from longwall panels 101, 102 and 103.

2.3 AERIAL PHOTOGRAPHY

Aerial photography of the NM dated March 2015 was provided by NCOPL.

2.4 SITE WATER MANAGEMENT AND WATER QUALITY DATA

A range of site water management data was provided by NCOPL, including:

- production data from the reverse osmosis (RO) and microfiltration (MF) plants from 2012 to 2015;
- detailed stage storage area relationships for all dams at the site;
- intermittent surveyed dam water levels from 2012 to 2015;
- ROM coal production records from 2010 to 2015, and the modified ROM coal production schedule;
- continuous water level recording data for Dam A1 (mine affected water), Dam B1 (filtered water) and Dam D (raw water);
- monthly surface water quality monitoring data for all dams at the site between 2009 and 2015;
- wet weather water quality monitoring data for the watercourses draining the mine site and the dams at the site; and
- details of water transfers and infrastructure changes between 2012 and 2015.

2.5 PREDICTED GROUNDWATER INFLOWS

Predicted groundwater inflows for the Modification were provided by HydroSimulations (2015).

2.6 PREDICTED SUBSIDENCE CONTOURS

Predicted subsidence contours for the Modification were provided by Ditton Geotechnical Services (2015).

3 Relevant legislation and guidelines

The following legislation and guidelines are relevant to the Modification for surface water management:

- *Water Management Act 2000* (WM Act), *Water Act 1912* (Water Act) and associated water sharing plans (WSP), which relate to the sustainable management of water resources;
- *Protection of the Environment Operations Act 1997* (POEO Act), which relates to the minimisation of pollution from the mine water management systems and discharge criteria;
- *Dams Safety Act 1978* (Dams Safety Act), which relates to the design, construction, monitoring and management requirements of any prescribed dams on the site or in the surrounding area;
- *National Water Quality Management Strategy: Australian Guidelines for Fresh and Marine Water Quality* (Australian and New Zealand Environment and Conservation Council [ANZECC]/Agriculture and Resource Management Council of Australia and New Zealand [ARMCANZ], 2000) and the NSW Government Water Quality and River Flow Objectives, which provide information on the environmental values of receiving waters and the definition of protection level based on ecosystem condition; and
- Managing Urban Stormwater Soils and Construction – Volume 2E Mines and Quarries, (DECC, 2008) and Managing Urban Stormwater, Soils and Construction, (Landcom, 2004), which provides guidelines on suitable management measures for erosion and sediment control.

The design of existing and modified NM site water management system has considered the requirements of the above legislation and guidelines. Further discussion on the regulatory framework with respect to surface water is provided in the following sections.

3.1 WATER MANAGEMENT ACT 2000 AND WATER ACT 1912

The Water Act and WM Act establish licensing regimes for the management of water resources in NSW. The licensing and approvals provisions of the WM Act apply to water sources that are the subject of a WSP. The Water Act continues to apply to water sources that are not the subject of a WSP.

With respect to surface water, the NM is located in the Lower Namoi River Water Source and Eulah Creek Water Source under the WM Act, as identified in the *Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2004* (NRWSP) and *Water Sharing Plan for the Namoi Unregulated and Alluvial Water Sources 2012* (NUAWSP). The WM Act is therefore relevant to the NM.

The objective of the WM Act is the sustainable and integrated management of the State's water for the benefit of both present and future generations. The WM Act provides clear arrangements for controlling land based activities that affect the quality and quantity of the State's water resources. It provides for four types of approval:

- water use approval – which authorises the use of water at a specified location for a particular purpose, for up to 10 years;
- water management work approval;
- controlled activity approval; and

- aquifer interference activity approval – which authorises the holder to conduct activities that affect an aquifer such as approval for activities that intersect groundwater, other than water supply bores and may be issued for up to 10 years.

3.1.1 Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2004

The NRWSP commenced on 1 July 2004. The NRWSP area comprises 26 water sources in the Namoi River catchment. The water sources of the NRWSP, including the Lower Namoi Water Source, which is located downstream of Keepit Dam, are shown in Figure 3.1.

The NRWSP allows for some extraction of water from the river and groundwater without a Water Access Licence to provide basic landholder rights, which include domestic and stock rights as well as Native Title rights.

All water extraction that is not for basic landholder rights must be authorised by a Water Access Licence. Each Water Access Licence specifies a share component. The share components of specific purpose licences, such as town water supply, stock and domestic are expressed as megalitres per year (ML/yr). The share components of high security, general security and supplementary Water Access Licences are expressed as a number of unit shares. Table 3.1 shows the categories of access licences in the Lower Namoi Water Source and their total share components at the start of the NRWSP (NSW Office of Water [NOW], 2004).

Extractions from the Namoi River are subject to Total Daily Extraction Limits which limit the daily extraction volume depending upon the river flow rate.

Table 3.1 - Lower Namoi River water source share components for different licence categories

Access Licence Category	Lower Namoi River Water Source Share Component	Total Share Component in the NRWSP Water Sources
Domestic and Stock Access (ML/yr)	1,967	2,013
Regulated River (High Security) Access (Unit Shares)	3,418	3,498
Regulated River (General Security) Access (Unit Shares)	246,692	256,421
Supplementary Water Access Licences (Unit Shares)	115,503	115,503
Local Water Utility (ML/yr)	2,271	2,420

3.1.2 Water Sharing Plan for the Namoi Unregulated and Alluvial Water Sources 2012

The NUAWSP commenced on 4 October 2012. The NUAWSP area comprises 26 water sources in the Namoi River catchment. The water sources of the Namoi Unregulated Rivers Extraction Management Unit of the Namoi Unregulated and Alluvial Water Sources, including the Eulah Creek Water Source (in which NM is located), are shown in Figure 3.2.

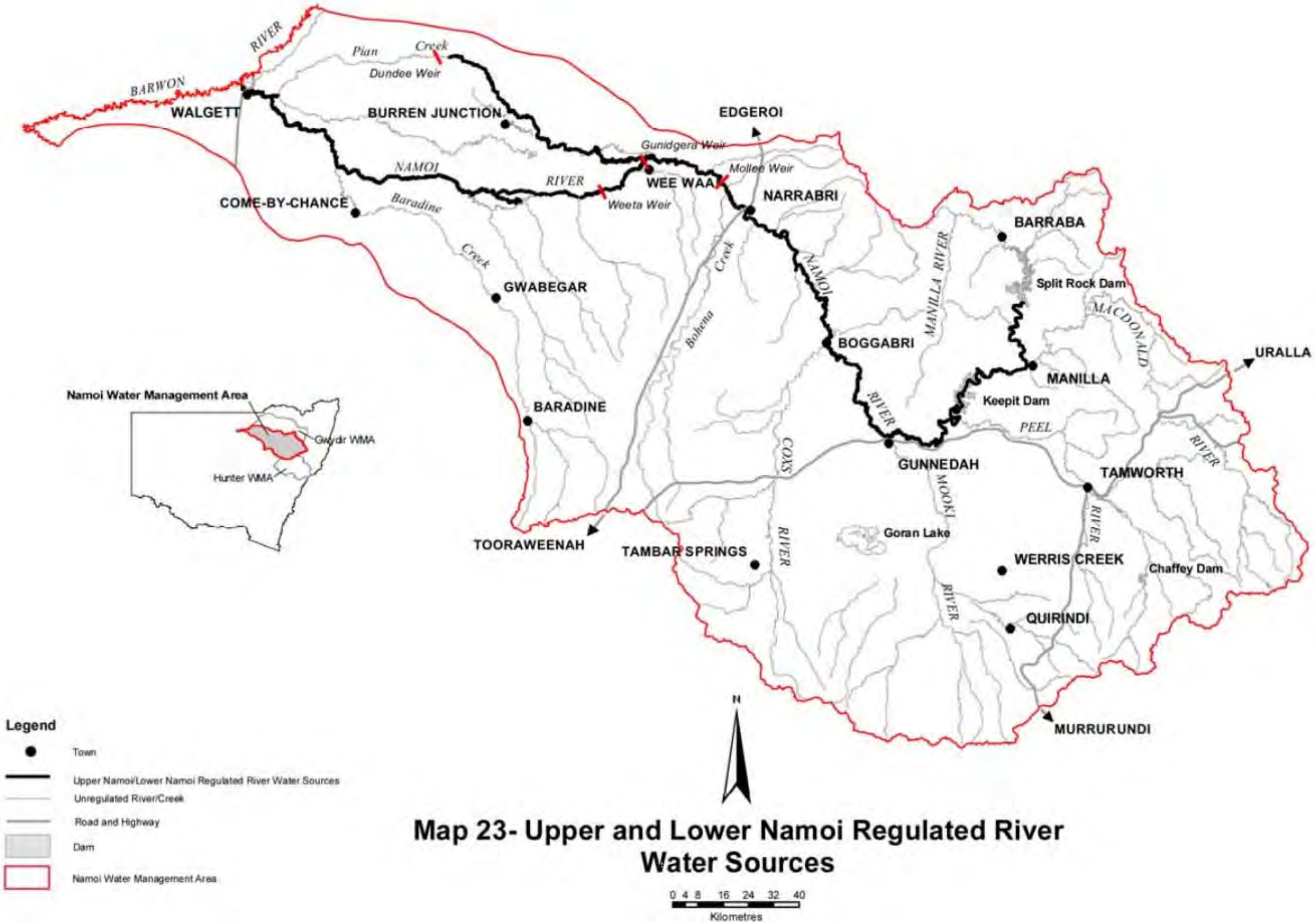


Figure 3.1 - Upper and Lower Namoi regulated water sources (Source: NOW, 2004)

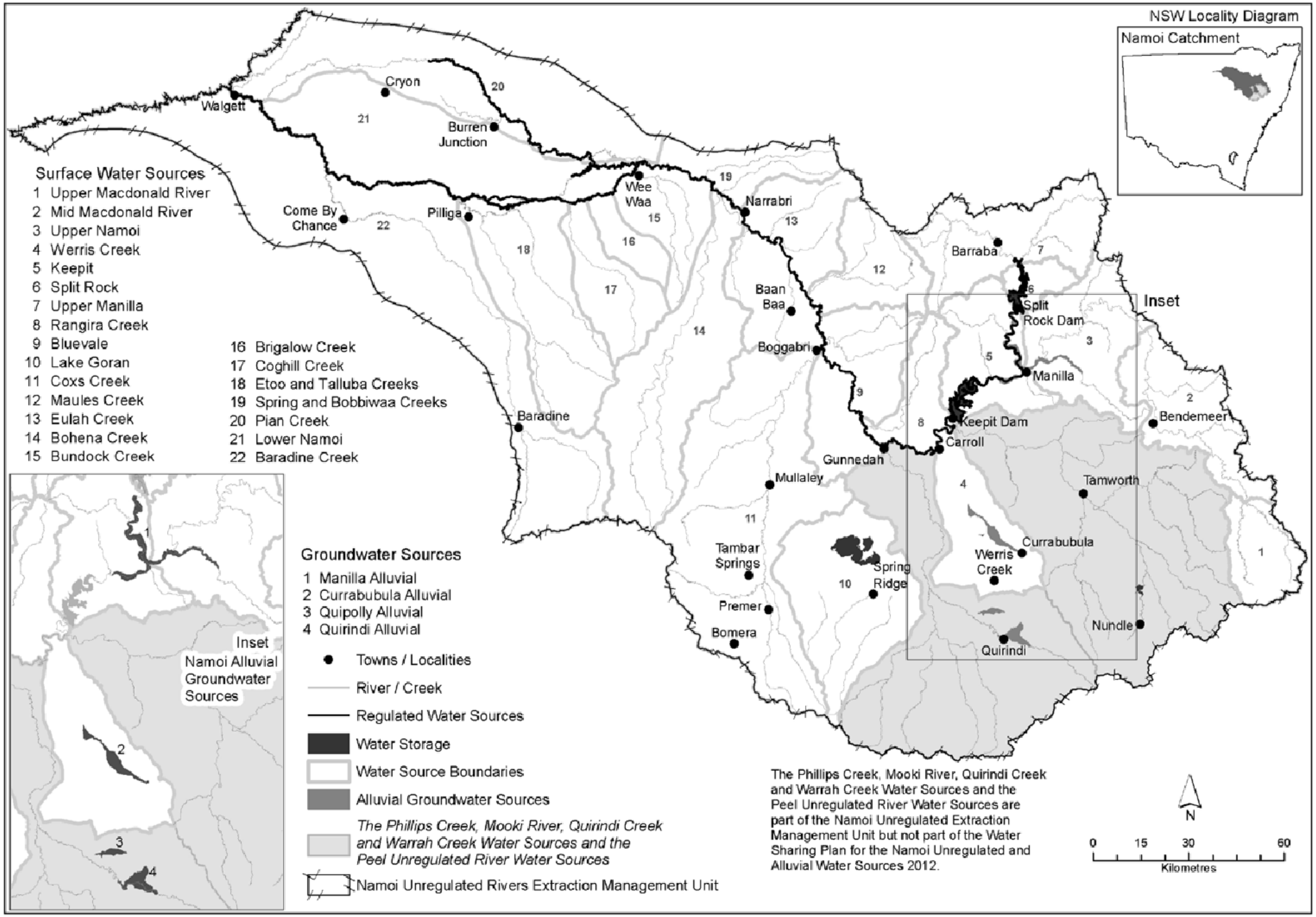


Figure 3.2 - Namoi unregulated and alluvial water sources (Source: NOW, 2012)

Table 3.2 shows the categories of access licences in the Eulah Creek Water Source and their total share components at the start of the NUAWSP (NOW, 2012).

Table 3.2 - Eulah Creek water source share components for different licence categories

Access Licence Category	Eulah Creek Water Source Share Component	Total Share Component in the NUAWSP Water Sources
Domestic and Stock Access (ML/yr)	35	627
Unregulated River Access (Unit Shares)	2,034	109,040.5
Unregulated River (Special Additional High Flow) Access (Unit Shares)	0	729
Aquifer Access Licences (Unit Shares)	0	4,968
Aquifer (General Security) Access (Unit Shares)	0	2,311
Local Water Utility (ML/yr)	0	1,715

3.2 PROTECTION OF THE ENVIRONMENT OPERATIONS ACT 1997

The POEO Act is the key piece of environment protection legislation administered by the NSW Environment Protection Authority. The POEO Act enables the government to set protection of the environment policies that provide environmental standards, goals, protocols and guidelines. The POEO Act also establishes a licensing regime for pollution generating activities in NSW. Under section 48, an environment protection licence (EPL) is required for "scheduled activities", which includes coal mining. NCOPL currently holds EPL 12789 for operations at the NM. The POEO Act also includes a duty to notify relevant authorities of pollution incidents where material harm to the environment is caused or threatened.

3.3 DAMS SAFETY ACT 1978

The Dams Safety Act establishes the role of the Dams Safety Committee (DSC) to ensure the safety of dams in NSW, including surveillance of prescribed dams, which are those listed in Schedule 1 of the Act. The DSC is empowered with various enabling functions under the Dams Safety Act and *Mining Act 1992*. The DSC has a general responsibility for the safety of all dams, and a special responsibility for prescribed dams. Determination of whether a dam is a prescribed dam is based on an assessment of its consequence category, which considers potential downstream impacts of dam failure. Detailed design of existing/approved dams at the NM will include assessment of consequence categories to determine whether any of the dams are required to be prescribed under the Dams Safety Act.

3.4 AUSTRALIAN AND NEW ZEALAND GUIDELINES FOR FRESH AND MARINE WATER QUALITY

The ANZECC and ARMCANZ have prepared a guideline for water quality management for use throughout Australia and New Zealand based on the philosophy of ecologically sustainable development. The guideline is called the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC/ARMCANZ, 2000) and is often referred to as the 'ANZECC guideline'.

The NSW Department of Environment and Climate Change and Water (now the Office of Environment and Heritage (OEH)) published online the *NSW Water Quality and River Flow Objectives* that provide guidance to technical practitioners with applying the ANZECC guidelines in NSW. The guideline defines the 'environmental values' of receiving waters as those values or uses of water that the community believes are important for a healthy ecosystem. Specific environmental values and water quality objectives for uncontrolled streams in the Namoi River catchment are provided in Section 4.5.1.

3.5 MANAGING URBAN STORMWATER: SOILS AND CONSTRUCTION

Managing Urban Stormwater: Soils and Construction (Landcom, 2004) provides guidance on best practice management measures for erosion and sediment control during construction and other land disturbance activities. A specific volume (2E: Mines and Quarries) provides specific advice on appropriate measures and design standards for mining operations. The design of erosion and sediment control measures for the NM has been based on the recommended approaches and design criteria from these documents.

4 Existing surface water environment

4.1 RAINFALL AND EVAPORATION

Daily rainfall data has been recorded at the NM since April 2008. Figure 4.1 shows a comparison of average monthly rainfalls recorded at the NM against monthly average rainfall obtained from the SILO Data Drill service (Jeffrey et al. 2001) for the NM site over the common period of April 2008 and April 2015. Figure 4.1 shows the general trend in monthly rainfall between the two datasets is the same. The monthly SILO data is generally slightly higher than the NM monthly data but is sufficient to provide a reasonable representation of the long term rainfall at the NM, and has been adopted for this study.

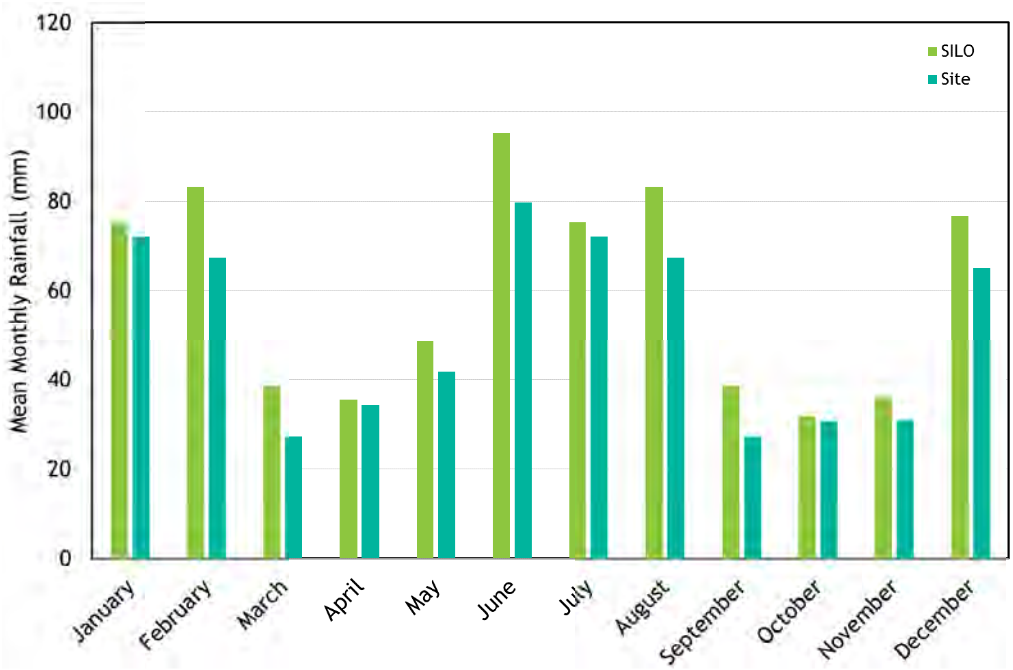


Figure 4.1 - Narrabri Mine rainfall and Silo rainfall monthly mean rainfall comparison, April 2008 to April 2015

Table 4.1 shows the long term seasonal variation in average monthly rainfall and potential evaporation for the NM based on 126 years (1889 to 2015) of interpolated data from the SILO Data Drill.

The mean and median annual rainfalls at NM are estimated at 609 millimetres (mm) and 598 mm respectively. The annual rainfalls can vary considerably from year to year. Based on the 126 years of record, the 10% and 90% annual rainfalls are estimated at 381 mm and 810 mm respectively.

The mean monthly rainfalls vary during the year from a low of 35 mm in April to a high of 79 mm in January. The summer average monthly rainfalls (60 mm to 79 mm) are generally higher than the equivalent winter month rainfalls (37 mm to 47 mm).

Table 4.1 - Mean monthly rainfall and potential evaporation at the Narrabri Mine based on SILO Data Drill

Month	Mean rainfall (mm)	Mean potential evaporation (mm)
January	79	200
February	60	165
March	50	152
April	35	105
May	43	74
June	47	53
July	42	58
August	37	77
September	38	106
October	51	148
November	59	174
December	67	199
Annual	609	1,511

The mean and median annual potential evaporation is estimated at 1,511 mm and 1,501 mm respectively. Evaporation varies seasonally, with high evaporation rates occurring in the months between October and March. The values in Table 4.1 indicate that the potential evaporation rate during the summer months is greater (up to 3 to 4 times) than the evaporation rate during the winter months. In addition, average potential evaporation exceeds average rainfall for all months of the year.

4.2 REGIONAL DRAINAGE

The NM is located in the Namoi River catchment and within the tributary catchments of Kurrajong Creek, Pine Creek and Tulla Mullen Creek. The Namoi River flows in a north-westerly direction approximately 3 km to 5 km to the east of the eastern boundary of the NM.

The Namoi River stretches for over 350 km, with a catchment extending from the Great Dividing Range in the east to Walgett in the west where the Namoi River discharges into the Barwon River. Some of the Namoi River's major tributaries include the Peel River, Mooki River, Manilla River, Coxs Creek, Baradine Creek and Pian Creek. It has a total catchment area of approximately 42,000 km^2 to Walgett.

The Namoi River catchment has been used extensively for agricultural activities for over 100 years. It is one of Australia's most developed irrigation areas, supporting significant cotton and broad acre cropping (mainly sorghum, sunflower and wheat) as well as other crops, and some sheep and cattle grazing.

There are a number of major storages in the Namoi River catchment, namely Keepit, Chaffey and Split Rock Dams located on the Namoi, Peel and Manilla Rivers, to provide water for the licensed water users in the region.

4.3 LOCAL DRAINAGE

4.3.1 Local watercourses and drainage catchments

The NM is located within the catchments of Kurrajong and Pine Creeks as shown in Figure 4.2. Pine Creek and its tributaries traverse through the northern part of the NM, before entering the Namoi River 4.7 km downstream of the Turrawan gauging station.

Kurrajong Creek originates in the south-western corner of the NM and together with its tributaries traverse the southern portion of the NM, draining to Tulla Mullen Creek, which in turn drains into the Namoi River approximately 4 km upstream of the Turrawan gauging station. The total catchments areas of Pine and Kurrajong Creeks are 76 km^2 and 62 km^2 respectively.

Pine and Kurrajong Creeks, which originate in the hills immediately to the west of the NM, are ephemeral, generally flowing for short periods after significant rainfall events or protracted wet periods. Base flows in these creeks are insignificant. Detailed discussion of the characteristics of Pine and Kurrajong Creeks is given in WRM (2009).

4.3.2 Existing subsidence impacts

The surface water impacts associated with existing subsidence (e.g. ponding) above longwall panels 101, 102, 103 and the northern half of longwall panel 104 are generally consistent with the impacts predicted in WRM (2009), with maximum ground subsidence depths of approximately 2.5 m.

4.4 EXISTING/APPROVED SITE WATER MANAGEMENT

4.4.1 Water management

The Water Management Plan (WMP) (URS, 2013) sets out the key objectives and general operating rules of the site water management system at the NM, including site demands and water sources.

In addition, the Extraction Plan Water Management Plan (URS, 2012) provides for the management of the potential impacts and/or environmental consequences of subsidence impacts on surface water resources, groundwater resources and flooding.

4.4.2 Surface water types

For the purposes of site water management, the surface water generated at the NM is divided into seven types based on water quality:

- 'Raw' – raw water imported to the NM from external sources (e.g. Namoi River).
- 'Clean' – surface runoff from the NM site areas where water quality is unaffected by mining operations. Clean water includes runoff from undisturbed areas and any fully rehabilitated areas.
- 'Filtered' – water treated by the RO or MF plants, suitable for use in the underground workings or controlled release to the Namoi River in accordance with Condition 11, Schedule 4 of Project Approval (08_0144) (subject to a variation of EPL 12789).
- 'Disturbed runoff' – surface runoff water from the NM site areas that are disturbed by mining operations. This runoff may contain silt and sediment, but does not contain other pollutants (e.g. chemicals, hydrocarbons). This water can be released from site in accordance with EPL 12789, if required.
- 'Reclaim' – surface water from NM site areas affected by mining operations and potentially contain silt/sediment and other pollutants (e.g. chemicals and hydrocarbons). Reclaim water areas include sumps, coal stockpile areas, service ponds and fuel storage areas. Reclaim water is managed to avoid its discharge from the NM.

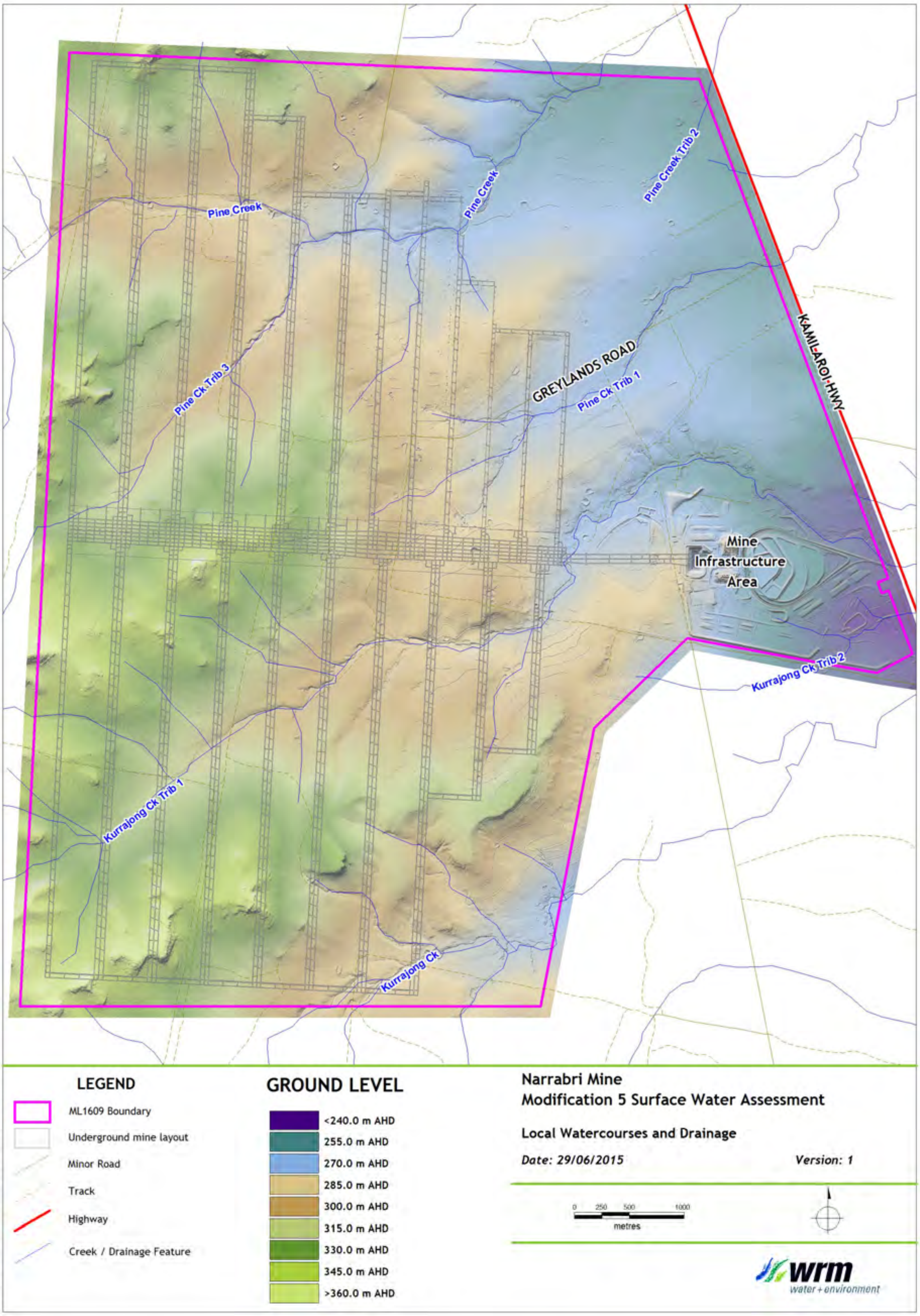


Figure 4.2 - Local watercourse and drainage features at the Narrabri Mine

- 'Saline' – water pumped from the underground workings containing elevated concentrations of total dissolved solids (TDS).
- 'Brine' – waste or concentrate produced by the RO plant containing high concentrations of TDS.

4.4.3 Dams and infrastructure

Figure 4.3 shows the existing/approved dams at the NM, and Table 4.2 provides a summary of the key characteristics of each dam. Note that the catchment area of SB3 shown in Figure 4.3 represents the entire reject emplacement area (some 25 hectares [ha]). The reject emplacement area is managed such that the maximum catchment area draining to SB3 at any time is limited to 10 ha, with runoff from rehabilitated or undisturbed areas bypassing SB3.

Table 4.2 - Existing/approved dams at the Narrabri Mine

Dam	Water Type Stored	Capacity (ML)	Catchment Area (ha)
A1	Saline / Reclaim	127.6	3.6
A2	Saline / Reclaim	30.0	1.2
A3	Saline / Reclaim	32.0	1.1
B1	Filtered	39.4	1.9
B2	Saline / Reclaim / Brine[1]	158.0	5.8
C	Brine	208.9	8.5
D	Raw	136.8	5.4
SB1	Reclaim	20.7	29.6
SB2	Reclaim	38.5	1.9
SB3	Reclaim	11.8	12.0
SB4[2,3]	Reclaim	25	6.8
SD1	Disturbed	3.1	43.4
SD2[4]	Disturbed	52.1	26.3
SD3	Disturbed	6.3	25.9
SD4[4]	Disturbed	30.2	4.5
SD5[4]	Disturbed	11.1	10.0
SD6	Disturbed	5.8	4.6
SD7[2,4]	Disturbed	-[5]	-[5]
Containment Bund	Raw	40.1	11.1
BR1[2]	Brine	470	8.5
BR2[2]	Brine	748	13.7
BR3[2]	Brine	898	16.2
BR4[2]	Brine	-[6]	55
BR5[2]	Brine	-[6]	65

1 Once it has been lined in accordance with Condition 20, Schedule 4 of Project Approval 08_0144.
2 Not currently constructed.
3 Subject to approval of the Stockpile Extension Modification.
4 EPL 12789 surface water discharge location.
5 SD7 will be sized once the area and footprint of BR1, BR2, BR3, BR4 and BR5 are confirmed.
6 Capacity to be defined as these contingency storages are not expected to be required based on the WRM (2009) water balance modelling.

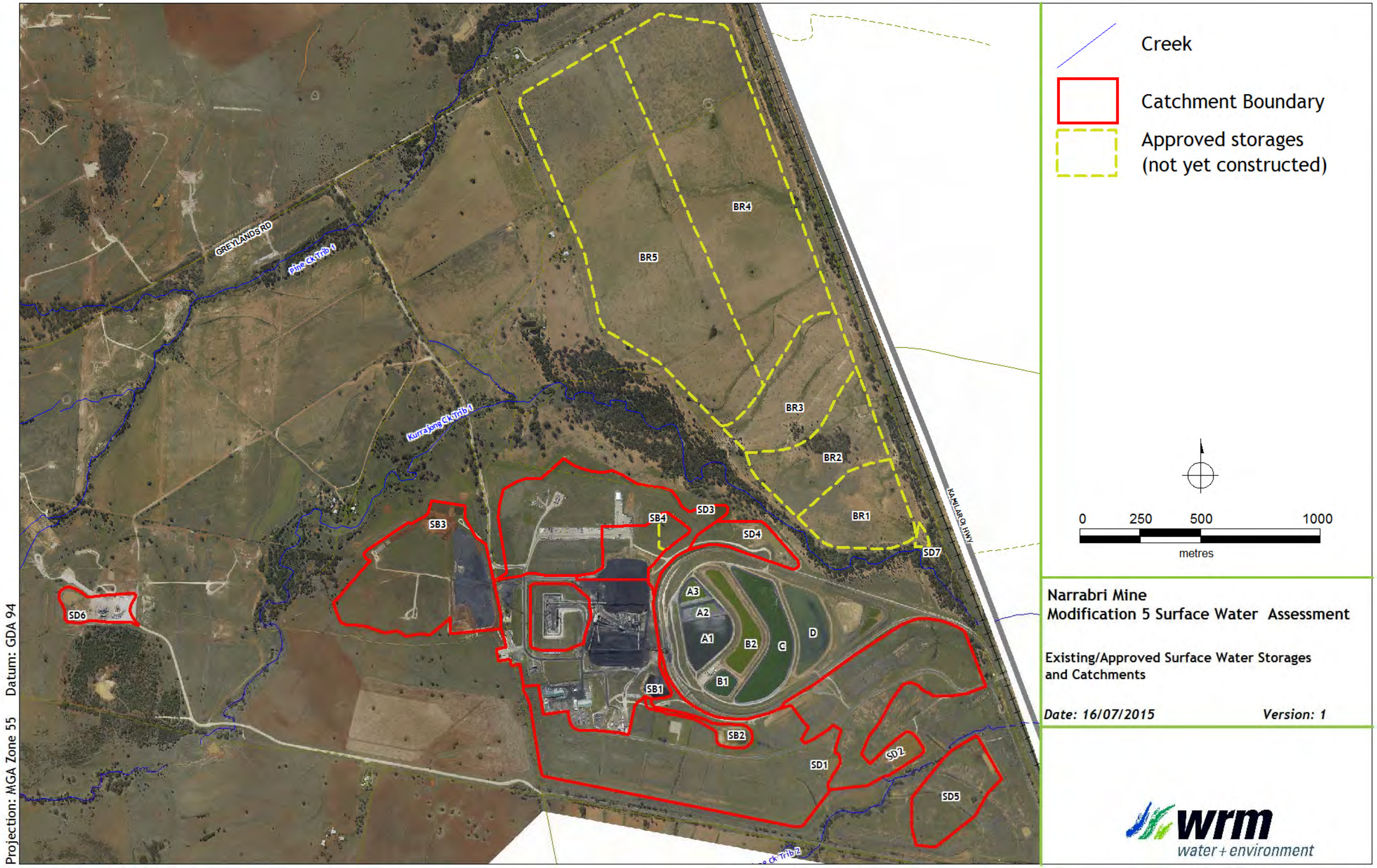


Figure 4.3 - Existing/approved dams and catchments

4.4.4 Site water management system

The operation of the existing/approved site water management system is shown schematically in Figure 4.4[1], and can be summarised as follows:

- Reclaim water is collected in SB1, SB2 and SB3. Water collected in these dams is pumped to A1 for reclaim use or treatment in the RO plant. Reclaim water is transferred from A1 to the reclaim water tanks at the box cut for use in the coal handling and preparation plant (CHPP), dust suppression (trucks and coal stockpiles) and washdown bay.
- SB1 has a permanent automatic pump, but all other reclaim dams are dewatered as required using mobile diesel pumps. Any spills from SB1 drain to SB2. Some overflows from SB1 are to be expected, as it is undersized for the catchment area draining to it. SB2 was constructed to account for the lack of capacity in SB1. Any spills from SB2 drain to SD2, which forms part of the disturbed runoff management system.
- Underground process water and groundwater entering the underground workings are pumped to the box cut sump, then transferred to A1 for reclaim use or treatment in the RO plant. Gas drainage water is also pumped from the bores into A1, A2 or A3.
- Demands for reclaim water at the NM are obtained from A1 (via the reclaim water tank at the box cut).
- Disturbed runoff is collected in sediment dams SD1, SD2, SD3, SD4, SD5[2], SD6 and SD7. Four of these dams (SD2, SD4, SD5 and SD7) are EPL 12789 surface water discharge points. Note that SD4 and SD7 have not yet been constructed.
- The expected maximum RO plant feed flowrate anticipated in WRM (2009) was 5 million litres per day (ML/day) or approximately 58 litres per second (L/s) when groundwater inflows peak later in the NM life. The existing RO plant maximum feed flowrate is 16 L/s, however when backwashing and 'clean-in-place' operations are taken into account, the RO plant unit feed flowrate averages out at approximately 10 L/s over a 24 hour period (based on available RO plant monitoring data). The RO plant product raffinate (clean) / concentrate (brine) split is approximately 70% / 30% respectively.
- Brine from the RO plant is currently stored in C, but has also been stored in A2 and A3 in the past. B2 will be lined and additional brine storages (BR1 to BR5) will be constructed to contain excess brine if and when they are required.
- Filtered water from the RO and MF plants is pumped into B1, and then transferred to the filter water storage tanks at the box cut, for use underground and for firewater purposes. Any treated water in excess of the NM requirements will be piped to the Namoi River for release in accordance with Condition 11, Schedule 4 of Project Approval (08_0144) (subject to a variation of EPL 12789).
- Dam D receives water from the Namoi River pump station and the various water supply bores and is used to supply the potable water treatment plant (WTP), or for shandying with water in A1 prior to treatment in the RO plant. Water from D can also be treated by the MF plant and discharged to B1 to assist in satisfying demands for filtered water. Water from the Namoi River is sourced as required to supply deficits in the NM site water demands.

[1] Figure 4.4 assumes that the Stockpile Extension Modification has been approved (i.e. SB4 is approved).

[2] SD5 collects runoff from an undisturbed catchment and does not receive any disturbed catchment runoff from the NM. In significant flow events, undisturbed water from Kurrajong Creek Tributary 2 also overflows into SD5. As part of the Modification, it is proposed to remove SD5 from the NM site water management system as it does not collect runoff from disturbed NM catchments (Section 5).

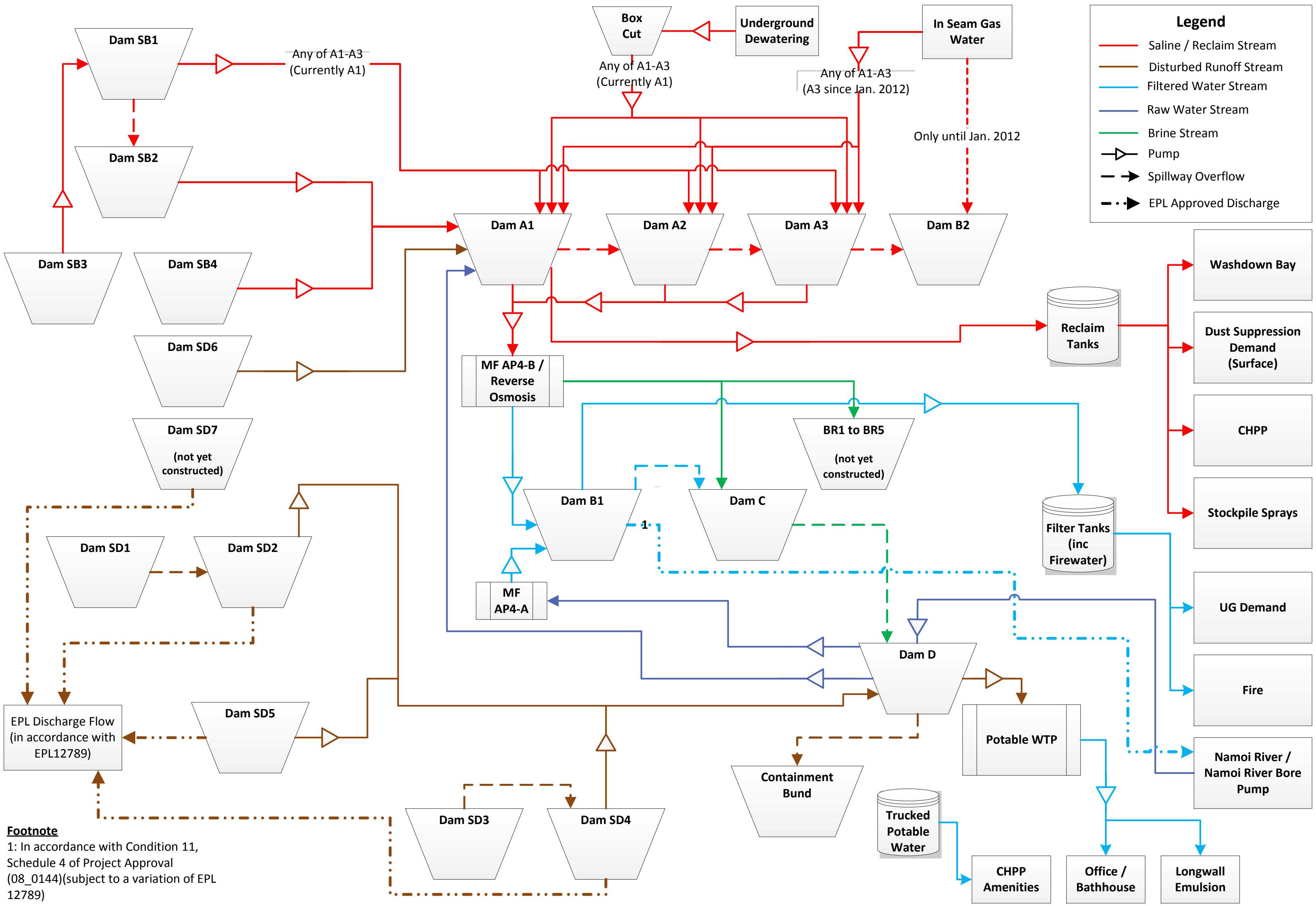


Figure 4.4 - Existing/approved site water management system schematic

4.4.5 Historical behaviour of the site water management system

Figure 4.5 and Figure 4.6 show the historical behaviour of the site water management system, including site water inventory and recorded water usage and underground dewatering. Key operational changes in the water management system since operations commenced include:

- The CHPP was commissioned in August 2011 and commenced fulltime operation in mid-2012.
- Longwall mining commenced in October 2012 and the RO plant commenced operations in June 2012.
- A2 and A3 were used to store brine from the RO plant until July 2014, when lining of Dam C was completed, and it became the primary brine storage. The contents of A2 and A3 were transferred into Dam C in September 2014.
- Prior to January 2012 all gas drainage water was stored in B2. From January 2012 onwards gas drainage water has been deposited in A1 to A3.
- An additional package RO plant was operated between October 2013 and September 2014. The package RO plant treated water from A1, A2 and B2. Some of the brine stored in A2 and A3 was transferred into B2 for treatment using the package RO plant. This explains the decrease in brine inventory and corresponding increase in saline / reclaim inventory between September and November 2013.

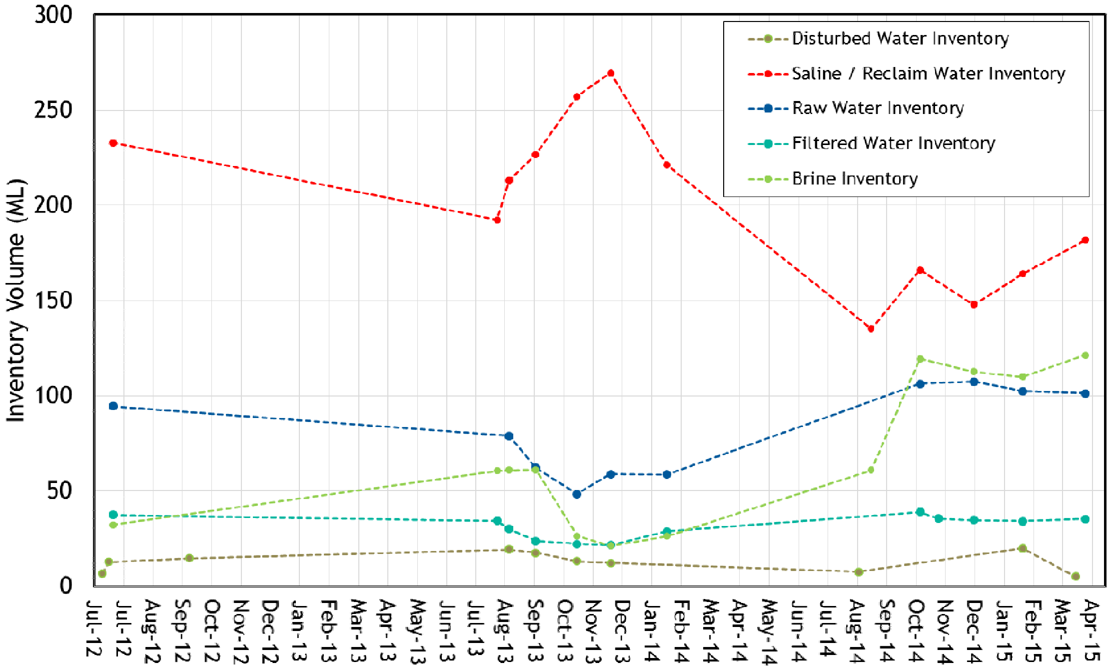


Figure 4.5 - Historical behaviour of site water inventory, July 2012 to April 2015

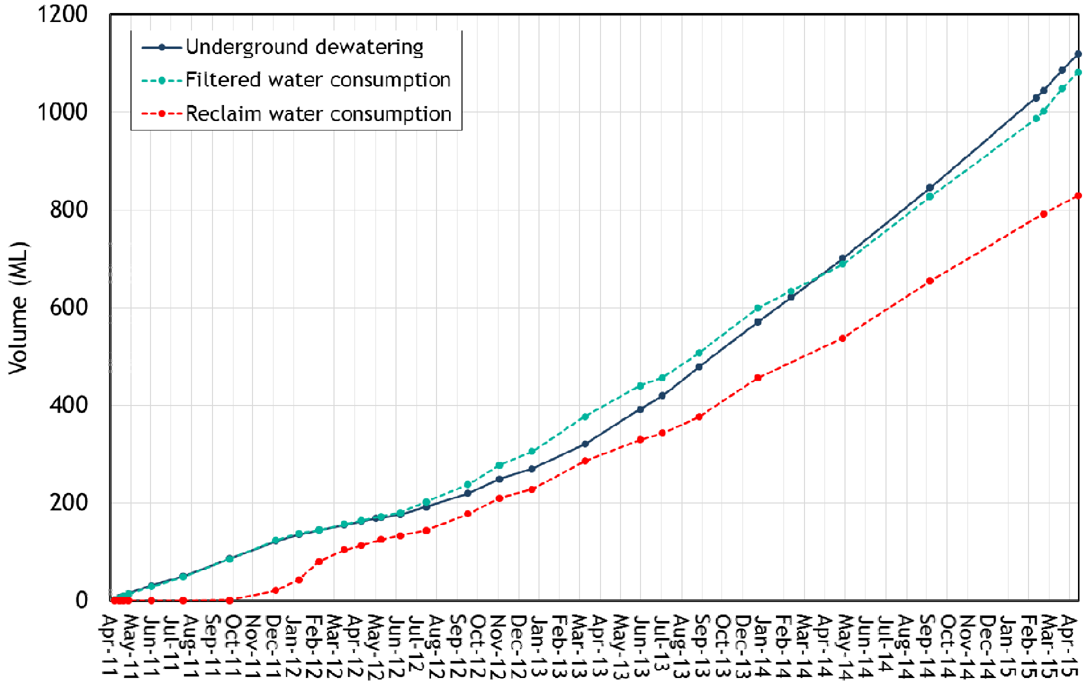


Figure 4.6 - Historical water consumption and underground dewatering, April 2011 to April 2015

4.4.6 Groundwater extraction

Groundwater is extracted via underground workings and via the gas drainage wells. Water pumped from underground into the boxcut sump is made up of both returned underground mine filtered water and groundwater inflows. The split between the two is important to calculate for both licensing and water management purposes.

To delineate the fractions of underground dewatering made up by return underground mine filtered water usage and groundwater inflows, the following assumptions were adopted based on discussions with NCOPL:

- Water enters the underground workings via:
  - underground filtered water demands;
  - longwall emulsion; and
  - groundwater inflows.
- Water is lost from the underground workings via:
  - increase in coal moisture from in-situ to ROM;
  - vent humidity extraction; and
  - underground dewatering.

The underground mine filtered demand returning to the boxcut sump via underground dewatering is calculated as follows:

- Underground demand return = [underground filtered water demand + longwall emulsion] – [increase in coal moisture + vent humidity extraction].
- If the above result returns a negative number (i.e. losses exceed inflows) then there is no underground demand return for that day.

- The increase in coal moisture is based on an increase of 2% by mass from in-situ to ROM, and is estimated based on monthly ROM coal production totals provided by NCOPL.
- The vent humidity extraction is assumed to be 133 ML/yr (0.37 ML/day) based on calculations by NCOPL.

Groundwater inflow is unlikely to be lost to coal wetting or vent extraction. Therefore all groundwater inflow would report to the boxcut sump via underground dewatering, and the estimated volume of groundwater inflow reporting the boxcut sump can be calculated as follows:

- Groundwater inflow = [Recorded boxcut flowmeter volume] – [Calculated underground demand return].

The total amount of groundwater extracted is then equal to the groundwater inflow plus the gas drainage extraction. Figure 4.7 shows a comparison between the groundwater inflow predictions from *Narrabri Coal Mine Stage 2 Longwall Project Hydrogeological Assessment* (Aquaterra, 2009) and the estimated historical groundwater extraction at the NM since operations commenced. Figure 4.7 indicates that the estimated actual extractions of groundwater at the NM have been equal to or less than the Aquaterra (2009) base case estimates since August 2012, and for much of the time are also less than the Aquaterra (2009) low vertical permeability (Kv) scenario.

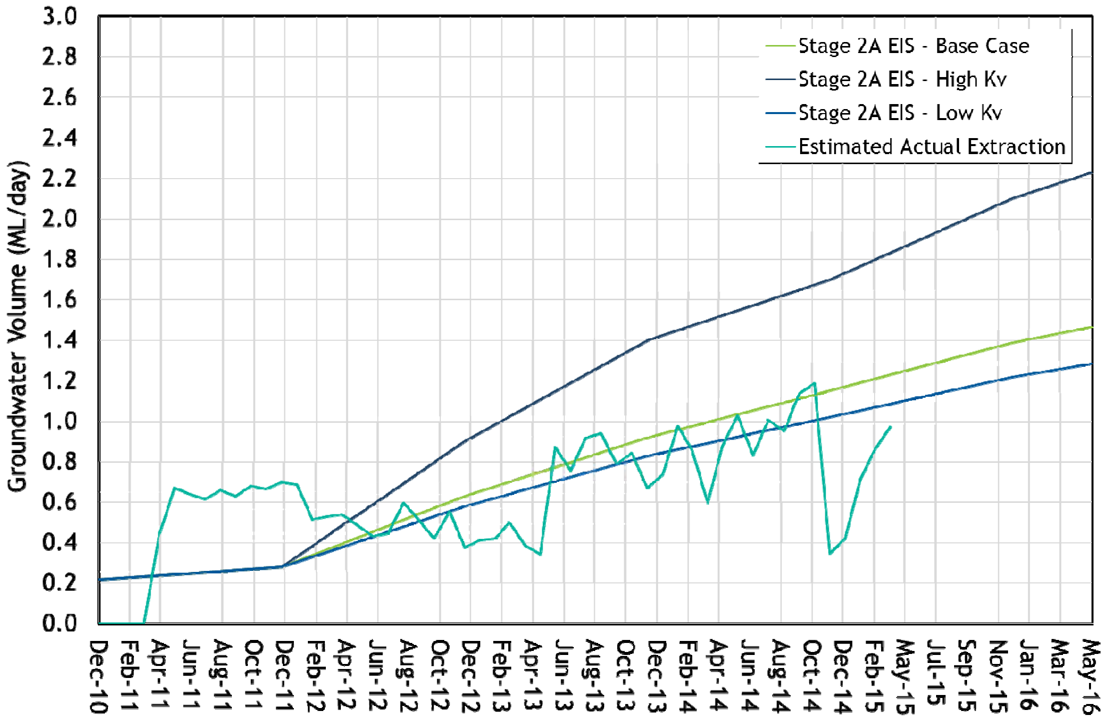


Figure 4.7 - Comparison of Aquaterra (2009) Stage 2 Environmental Impact Statement (EIS) groundwater inflow predictions and estimation of actual groundwater inflows

4.4.7 Licences

The current Water Access Licences held by NCOPL are listed in Table 4.3. These Water Access Licences allow for the extraction from the Namoi River.

Table 4.3 - Existing surface water licences

Licence	Licence Type	Volume (ML)
90CA802130 / WAL6762	River (high security)	20
90CA802130 / WAL2671	River	48
90CA802130 / WAL2728	River	10
90CA802130 / WAL20152	River	600
Total		*678*

Details of NCOPL's groundwater licences are provided in HydroSimulations (2015).

4.5 SURFACE WATER QUALITY

4.5.1 Environmental values and water quality objectives

Environmental values for uncontrolled streams in the Namoi River catchment, which include Pine and Kurrajong Creeks, are published in the OEH's *Namoi River Water Quality and River Flow Objectives*. The identified environmental values for water quality are protection of:

- aquatic ecosystems;
- visual amenity;
- primary contact recreation;
- secondary contact recreation;
- livestock water supply;
- irrigation water supply;
- homestead water supply;
- drinking water at point of supply - disinfection only;
- drinking water at point of supply - clarification and disinfection;
- drinking water at point of supply - groundwater; and
- aquatic foods (cooked).

River flow objectives are:

- protect pools in dry times;
- protect natural low flows;
- protect important rises in water levels;
- maintain wetland and floodplain inundation;
- manage groundwater for ecosystems; and
- minimise effects of weirs and other structures.

Default trigger values for water quality indicators relevant to the various environmental values from the *Namoi River Water Quality and River Flow Objectives* are shown in Table 4.4.

Table 4.4 - Water quality trigger values

Parameter	Unit	Trigger Value						
		Irrigation	Livestock drinking	Ecosystem[1]	Recreation	Homestead Water Supply	Drinking Water for Disinfection	Aquatic Foods
pH	pH	6.0 - 9.0	-	6.5 - 8.0	5.0 - 9.0	6.5 - 8.5	6.5 - 8.5	-
Electrical Conductivity (EC) (uncompensated)	µS/cm	1,000[2]	-	-	-	-	-	-
EC (25C)	µS/cm	-	-	30-350	-	-	<1500	-
Dissoslved Oxygen (% Saturation)		-	-	90-110	-	-	-	-
Total Dissolved Solids (TDS)	mg/L	-	2,000[2]	-	1,000	<500 - 1000	-	-
Turbidity	NTU	-	-	2 - 25	6	5	-	-
Calcium (Ca)	mg/L	-	1000	-	-	-	-	-
Sodium (Na)	mg/L	115[3]		-	300	-	-	-
Magnesium (Mg)	mg/L	-	2,000[4]	-	-	-	-	-
Sulphate as SO4	mg/L	-	1000	-	400	-	-	-
Chloride as Cl	mg/L	175[3]	-	-	400	-	-	-
Aluminium	mg/L	5[6]	5	-	0.2	-	-	-
Arsenic	mg/L	0.1[6]	0.5[2]	0.013[2, 5]	0.05	-	-	-
Barium	mg/L	-	-	-	1	-	-	-
Beryllium	mg/L	0.1[6]	-	-	-	-	-	-
Cadmium	mg/L	0.01[6]	0.01	0.0002[5]	0.005	-	-	-
Chromium	mg/L	0.1[6]	1	0.001[5]	0.05	-	-	-
Cobalt	mg/L	0.05[6]	1	-	-	-	-	-
Copper	mg/L	0.2[6]	0.4[2]	0.0014[5]	1	-	-	0.005
Iron	mg/L	0.2[6]	-	-	0.3	-	-	-
Lead	mg/L	2[6]	0.1	0.0034[5]	0.05	-	-	-
Manganese	mg/L	0.2[6]	-	1.9[5]	0.1	-	-	-
Mercury	mg/L	0.002[6]	0.002	0.0006[5]	0.001	-	-	0.001
Nickel	mg/L	0.2[6]	1	0.011[5]	0.1	-	-	-
Selenium	mg/L	0.02[6]	0.02	0.011[5]	0.01	-	-	-
Vanadium	mg/L	0.1[6]	-	-	-	-	-	-
Zinc (Zn)	mg/L	2[6]	20	0.008[5]	5	-	-	0.005
Ammonia	mg/L	-	-	0.013	-	-	-	-
Total phosphorus (Total P)	mg/L	0.05[6]	-	0.02	-	-	-	-
Total nitrogen (Total N)	mg/L	5[6]	-	0.25	-	-	-	-
NOx	mg/L	-	-	0.015	-	-	-	-
Nitrate-N	mg/L	-	400	0.7[5]	10	-	-	-
Nitrite-N	pH	-	30	-	1	-	-	-

Source: *Namoi River Water Quality and River Flow Objectives*.
Notes: - No Trigger Value recommended
[1] Upland River
[2] Lowest recommended value
[3] Sensitive crops
[4] Cattle (insufficient information on other livestock)
[5] 95% of species protected
[6] Long term Trigger Value

4.5.2 Environmental Protection Licence 12789 pollutant concentration limits

EPL 12789 for the NM sets out the water quality limits for discharges from the licensed discharge points on dams SD2, SD4 and SD5. Table 4.5 shows the EPL 12789 limits for wet weather discharges from the above dams.

Table 4.5 - EPL 12789 wet weather discharge limits

Pollutant	Units	Limit
Oil and grease	mg/L	10
pH		6.5 – 8.5
Total suspended solids	mg/L	50

EPL 12789 also states that the total suspended solids (TSS) concentration limit specified may be exceeded for water discharged provided that:

a) the discharge occurs solely as a result of rainfall measured at the premises that exceeds 38.4 mm over any consecutive 5 day period immediately prior to the discharge occurring; and
b) all practical measures have been implemented to dewater all sediment dams within 5 days of rainfall such that they have sufficient capacity to store run off from a 38.4 mm, 5 day rainfall event.

The 38.4 mm rainfall depth referred to above equates to the 5 day 90th percentile rainfall depth for Gunnedah sourced from Table 6.3a in Landcom (2004).

4.5.3 Background and receiving water quality

Surface water quality monitoring has been undertaken by NCOPL at eight sites on the watercourses draining the NM from July 2007 to April 2015. Figure 4.8 shows the surface water monitoring locations. Sampling has been undertaken during or immediately following flow events, for EC, pH, TSS, oil and grease and total organic carbon (TOC). Note that there is no disturbance due to the NM operations within the catchment areas draining to monitoring locations KCUS, KCDS, KC1US and KC2US. Monitoring locations KC1DS and KC2DS are downstream of the NM surface infrastructure areas and may be affected by discharges of disturbed runoff from the sediment dams at the NM. Monitoring locations PC1 and PCA are located downstream of longwall panel subsidence and gas pre-drainage drill sites.

Table 4.6 shows the recorded surface water quality monitoring data with the *Namoi River Water Quality and River Flow Objectives* 'Ecosystem' trigger values (Table 4.4). The surface water quality in the water courses draining the NM can be characterised as follows:

- slightly alkaline, with median laboratory measured pH values ranging from 6.9 to 7.5 (within the 'Ecosystem' trigger value range);
- fresh, with median EC values ranging from 65 µS/cm to 218 µS/cm (within the 'Ecosystem' trigger values range);
- variable levels of TSS, with median values ranging from 30 mg/L to 160 mg/L;
- not affected by oil and grease contamination; and
- exhibiting low levels of TOC, with median values ranging from 9 mg/L to 14 mg/L.

There appears to be no significant difference in water quality between undisturbed monitoring locations and those located downstream of the NM.

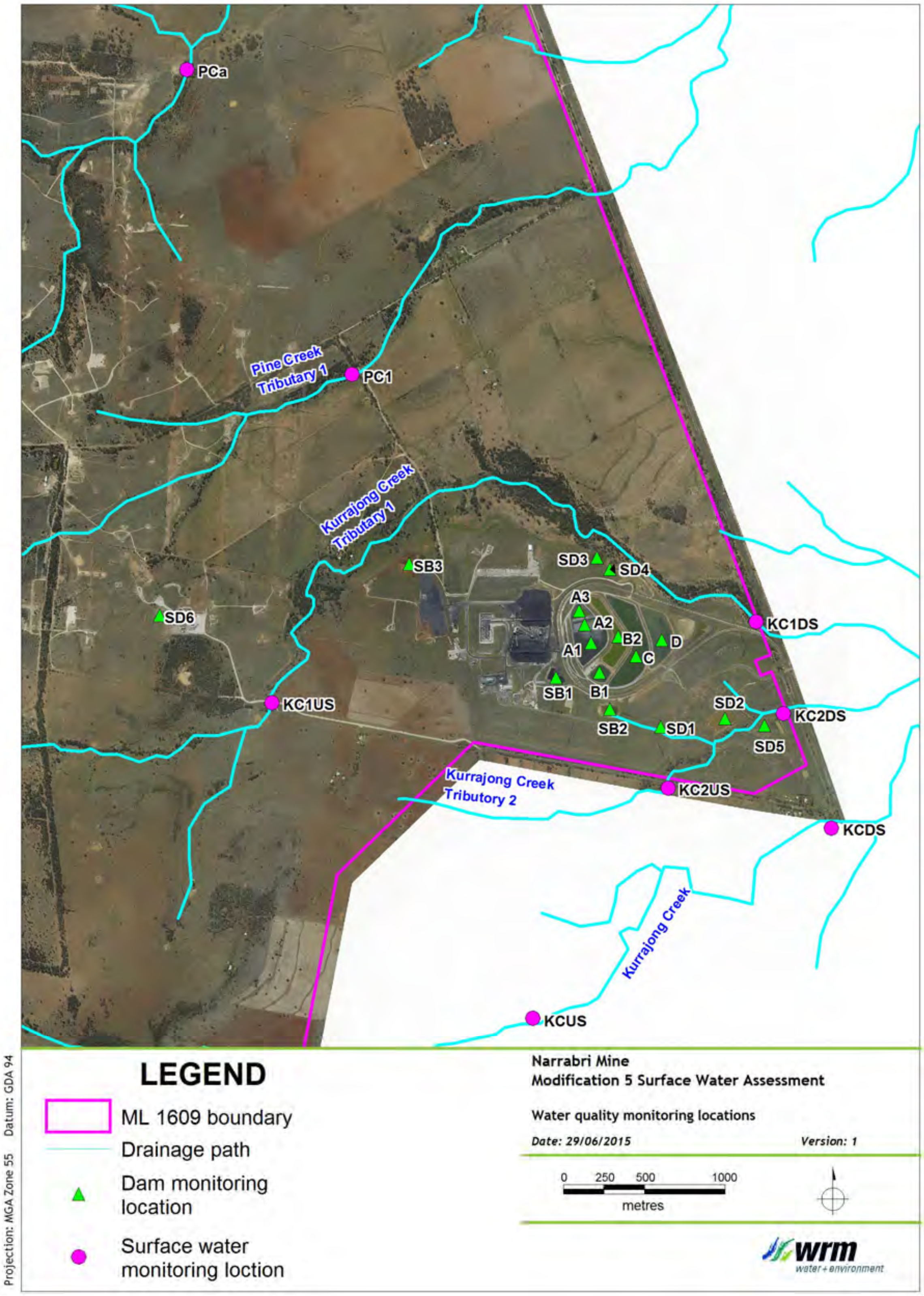


Figure 4.8 - Narrabri Mine surface water monitoring locations

Table 4.6 - Comparison of background and receiving water quality (July 2007 to April 2015) with *Namoi River Water Quality and River Flow Objectives* 'Ecosystem' trigger values

Water Quality Parameter		Sampling Site								WQO Trigger Value[*a]
		Kurrajong Creek						Pine Creek		
		KCUS	KCDS	KC1US	KC1DS	KC2US	KC2DS	PCA	PC1	
pH	20^{th} %ile	7.1	6.9	7.0	7.1	6.7	6.8	6.9	7.0	6.5 – 8.0
	Median	7.4	7.2	7.4	7.5	6.9	7.2	7.2	7.3	
	80^{th} %ile	7.7	7.5	7.7	7.7	7.3	7.5	7.4	7.5	
	N	27	23	18	32	25	28	31	30	
Electrical Conductivity (µs/cm)	20^{th} %ile	76.4	99.4	71.6	102.0	44.4	85.0	58.0	48.8	30 - 350
	Median	218.0	200.0	112.5	166.5	65.0	109.5	72.0	87.0	
	80^{th} %ile	299.6	415.2	176.8	309.2	86.0	142.6	159.0	120.4	
	N	27	23	18	32	25	28	31	30	
Total Suspended Solids (mg/L)	20^{th} %ile	54.8	27.6	30.0	39.6	15.6	23.6	40.0	31.2	NA
	Median	160.0	113.0	112.0	73.5	30.0	44.0	82.0	85.0	
	80^{th} %ile	299.6	263.6	220.0	149.2	43.2	105.2	238.0	205.6	
	N	27	23	18	32	25	28	31	30	
Oil and Grease (mg/L)	20^{th} %ile	<5	<5	<5	<5	<5	<5	<5	<5	NA
	Median	<5	<5	<5	<5	<5	<5	<5	<5	
	80^{th} %ile	<5	<5	<5	<5	<5	<5	<5	<5	
	N	25	21	16	29	23	26	30	30	
Total Organic Carbon (mg/L)	20^{th} %ile	6.0	7.0	7.0	9.0	8.0	11.6	7.0	7.0	NA
	Median	9.0	10.0	10.0	11.0	12.0	14.0	10.0	9.0	
	80^{th} %ile	12.0	15.4	12.0	15.0	16.0	17.0	14.0	12.8	
	N	23	19	16	29	22	24	28	27	

[*a] Namoi River Water Quality and River Flow Objectives 'Ecosystem' trigger values (Table 4.4).

4.5.4 Dam water quality

Water quality monitoring has been undertaken by NCOPL in the dams at the NM from August 2010 to April 2015. Figure 4.8 shows the dam monitoring locations. Sampling has typically been undertaken on a monthly basis, with some sediment dams sampled during wet weather discharge events as well. Samples are tested for EC, pH, TSS, oil and grease and TOC.

Table 4.7 and Table 4.8 show the recorded dam water quality monitoring data, with the *Namoi River Water Quality and River Flow Objectives* 'Ecosystem' trigger values (Table 4.4) and EPL 12789 discharge limits (Table 4.5). Table 4.7 indicates that water in the reclaim, saline and brine dams typically exceeds the 'Ecosystem' trigger values for EC and pH and the EPL 12789 discharge limits for pH and TSS. Filtered and raw water dams typically exceed the 'Ecosystem' trigger values for EC and pH and the EPL 12789 discharge limit for pH.

Table 4.8 indicates that water in sediment dams SD1, SD2, SD3, SD4 and SD6 typically exceeds the 'Ecosystem' trigger values for pH and EC, and the EPL 12789 discharge limits for pH and TSS.

It is of note that SD5 is typically within the 'Ecosystem' trigger values for pH and EC, and the below the EPL 12789 discharge limits for pH, TSS and oil and grease. This is expected as SD5 collects runoff from an undisturbed catchment and does not receive any disturbed catchment runoff from the NM. In significant flow events, undisturbed water from Kurrajong Creek Trib. 2 also overflows into SD5.

As part of the Modification, it is proposed to remove SD5 from the NM site water management system as it does not collect runoff from disturbed NM catchments (Section 5.2.1).

Table 4.7 - Comparison of reclaim / saline, brine, raw and filtered dam water quality (August 2010 to April 2015) with *Namoi River Water Quality and River Flow Objectives* 'Ecosystem' trigger values and EPL 12789 discharge limits

Water Quality Parameter		Dam										WQO Trigger Value[*a]	EPL 12789 Limit
		Reclaim / Saline					Brine			Filtered	Raw		
		A1	SB1	SB2	SB3	B2	A2	A3	C	B1	D		
pH	20th %ile	8.8	9.0	8.8	9.0	9.1	9.1	9.1	8.9	8.5	8.5	6.5 – 8.0	6.5 – 8.5
	Median	9.0	9.1	9.1	9.2	9.5	9.2	9.3	9.3	8.7	8.6		
	80th %ile	9.2	9.3	9.4	9.4	9.7	9.4	9.6	9.5	8.8	8.7		
	N	56	56	35	32	48	41	38	27	38	50		
EC (µs/cm)	20th %ile	2,000	2,020	1,142	2,380	12,680	2,900	8,752	778	291	365	30 - 350	NA
	Median	4,310	3,180	1,390	4,760	13,750	15,600	14,850	1560	422	415		
	80th %ile	6,520	5,974	1,878	10,764	15,120	17,600	29,780	21,400	616	683		
	N	56	56	35	32	48	41	38	27	38	50		
TSS (mg/L)	20th %ile	11.0	20.4	5	14.8	22.4	20	24.4	24	5	5	NA	50.0
	Median	20.0	48.5	14	52.5	35.5	49	42	42	5	15		
	80th %ile	34.0	100.2	48.4	187.4	70.6	98	69.2	339	7.2	29.2		
	N	56	56	35	32	48	41	38	27	38	50		
Oil and Grease (mg/L)	20th %ile	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	NA	10.0
	Median	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5		
	80th %ile	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5		
	N	56	43	35	32	48	41	38	27	38	50		
TOC (mg/L)	20th %ile	4.0	4	8	10.8	14	7	16.2	13.2	1	2	NA	NA
	Median	7.0	10	10	33.5	18.5	24	38	41	3	5		
	80th %ile	12.0	30.4	17.6	99.4	38.8	63	370.6	89.2	6	8		
	N	56	55	35	32	48	41	38	27	38	50		

[*a] Namoi River Water Quality and River Flow Objectives 'Ecosystem' trigger values (Table 4.4).

Table 4.8 - Comparison of sediment dam water quality (August 2010 to April 2015) with *Namoi River Water Quality and River Flow Objectives* 'Ecosystem' trigger values and EPL 12789 discharge limits

Water Quality Parameter		Dam						WQO Trigger Value*a	EPL Limit
		SD1	SD2	SD3	SD4	SD5	SD6		
pH	20th %ile	8.1	8.0	8.0	8.2	7.8	8.7	6.5 – 8.0	6.5 – 8.5
	Median	8.4	8.3	8.3	8.7	8.2	8.8		
	80th %ile	8.8	8.6	8.7	9.0	8.5	8.9		
	N	45	53	46	45	53	37		
EC (µs/cm)	20th %ile	327	194	327	320	154	1170	30 - 350	NA
	Median	382	256	382	543	222	1300		
	80th %ile	492	353	520	1164	314	1608		
	N	45	53	46	45	53	37		
TSS (mg/L)	20th %ile	9.8	11.0	6.0	9.8	8.0	15.2	NA	50.0
	Median	23.0	20.0	24.0	39.0	22.0	50		
	80th %ile	48.0	64.0	92.0	133.0	49.2	302.6		
	N	45	53	46	45	53	37		
Oil and Grease (mg/L)	20th %ile	<5	<5	<5	<5	<5	<5	NA	10.0
	Median	<5	<5	<5	<5	<5	<5		
	80th %ile	<5	<5	<5	<5	<5	<5		
	N	45	51	46	45	48	37		
TOC (mg/L)	20th %ile	8.0	6.0	6.0	6.0	8.0	9.2	NA	NA
	Median	12.0	8.0	10.5	8.0	10.0	19		
	80th %ile	16.2	10.6	15.0	11.2	13.6	35.8		
	N	45	53	46	45	53	37		

*a Namoi River Water Quality and River Flow Objectives 'Ecosystem' trigger values (Table 4.4).

5 Modification description

5.1 OVERVIEW

As described in Section 1.2, the Modification would involve:

- an increase in longwall panel widths for LW107 to LW120 from 295 m to 400 m (LW101 to LW106 unchanged) (Figure 1.2);
- a reduction in the number of longwall panels from 26 to 20 (Figure 1.2);
- a western extension of underground mine footprint relative to the existing/approved underground mine footprint of approximately 60 m within ML 1609 (Figure 1.2);
- an increase in the ROM coal production limit from 8 Mtpa up to approximately 11 Mtpa;
- the continuation of pre-conditioning of the Digby Conglomerate to prevent or minimise the impact of wind blast in the underground workings;
- minor amendments to the site water management system; and
- an increase in the average number of trains from 3 trains/day to 4 trains/day (peak would remain unchanged).

A description of changes associated with the Modification relevant to site water balance and potential surface water impacts is provided in Section 5.2.

5.2 SITE WATER MANAGEMENT SYSTEM

5.2.1 Modifications to the site water management system

Subject to the ongoing performance of the site water management system, prevailing climatic conditions and actual underground mine inflows, the Modification would include the following minor amendments to the site water management system:

- removal of SD5 from the NM site water management system; and
- installation of evaporator spray systems on Dams A1, A2, A3, B2 and C.

Figure 5.1 shows the modified site water management system schematically[3]. The locations of the dams and catchments do not change from that shown in Figure 4.3.

SD5

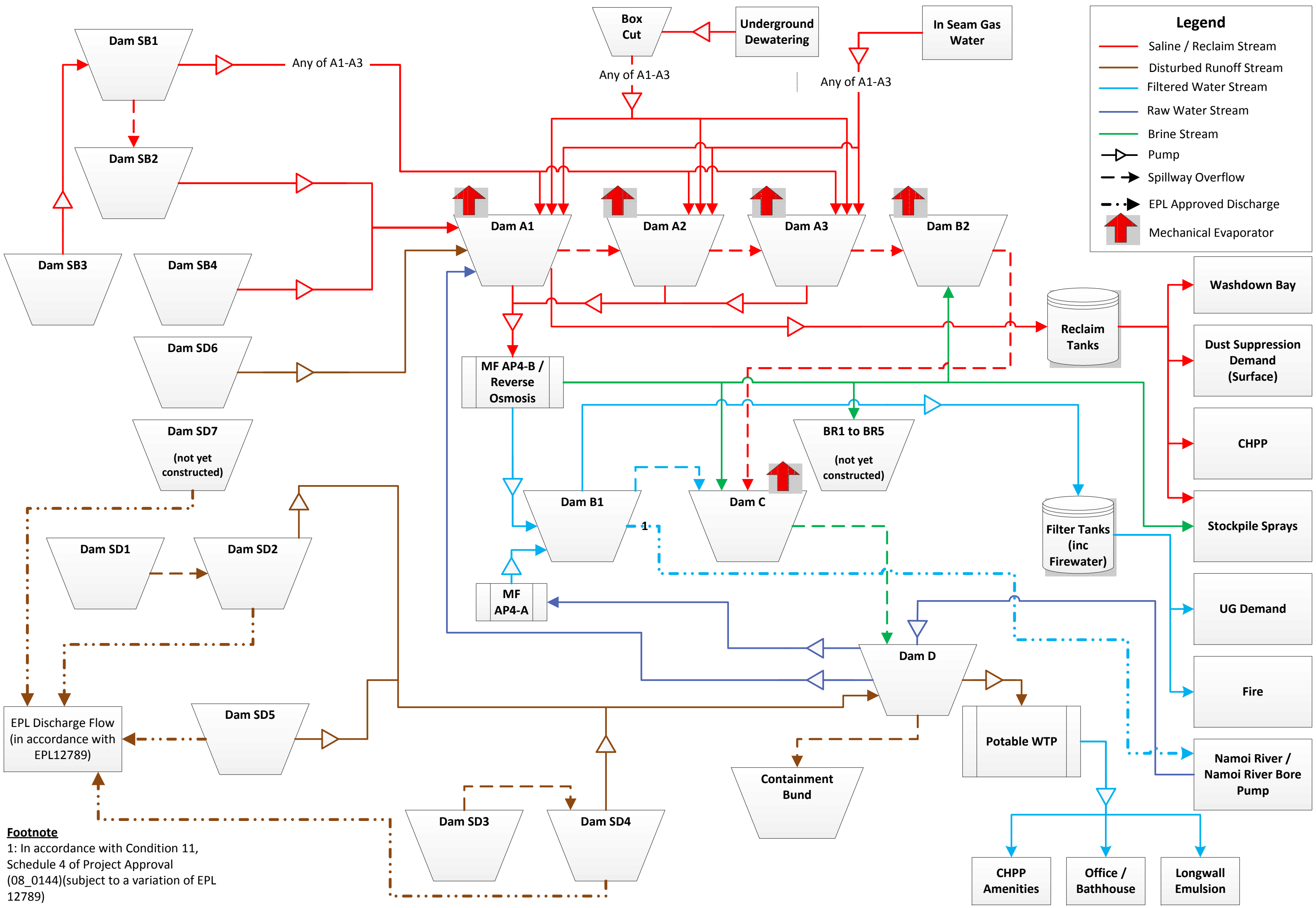
Runoff reporting to SD5 is from undisturbed catchments associated with agricultural land use areas and undisturbed water from Kurrajong Creek Trib. 2 during significant flow events. This runoff is typically within the 'Ecosystem' trigger values for pH and EC, and below the EPL 12789 discharge limits for pH, TSS and oil and grease (Section 4.5.4).

It is therefore proposed to remove SD5 from the NM site water management system as it does not collect runoff from disturbed NM catchments. This is consistent with the principle of diverting 'clean' water away from the NM site water management system as outlined in the WMP. NCOPL would seek a variation to EPL 12789 to remove SD5 as a discharge point.

Evaporator Spray Systems

Evaporator spray systems would be installed on Dams A1, A2, A3, B2 and C to reduce the volume of water stored on-site. The evaporators would be operated during the daytime only.

[3] Figure 5.1 assumes that the Stockpile Extension Modification has been approved (i.e. SB4 is approved).



Footnote

1: In accordance with Condition 11, Schedule 4 of Project Approval (08_0144)(subject to a variation of EPL 12789)

Figure 5.1 - Modified water management system schematic

The WMP would be revised to incorporate an operational protocol for the evaporators to minimise potential for impacts associated with the operation of the evaporators (e.g. cessation of the operation of evaporators during strong winds to minimise spray drift).

5.2.2 Future approved changes to the current site water management system

The following approved changes to the current site water management system will be implemented as part of the modified NM site water management system:

- The capacity of the RO plant will be increased or decreased as required to treat saline water generated at the NM.
- B2 to be lined to facilitate the storage of brine.
- The brine storage dams (BR1 to BR5) will be constructed as required to store brine produced by the RO plant.
- Dam SB4 will be constructed as described in the *Stockpile Extension Modification Environmental Assessment* (Resource Strategies, 2015b)[4].
- Dam SB1 will be augmented (no change to catchment area or capacity is required) as described in the *Stockpile Extension Modification Environmental Assessment* (Resource Strategies, 2015b)[4].
- Filtered water will be released to the Namoi River as required in accordance with Condition 11, Schedule 4 of Project Approval (08_0144) (subject to obtaining a variation to EPL 12789).
- Reclaim/saline water and brine will be used as dust suppression water for the ROM and product stockpile sprays.

5.3 MODIFIED LONGWALL LAYOUT AND PRODUCTION SCHEDULE

Figure 1.2 shows the approved and modified longwall layout. Table 5.1 outlines the ROM production schedule for the Modification.

Table 5.1 - Modification ROM production schedule

Year	ROM production (Mtpa)	Year	ROM production (Mtpa)
2015	6.4	2024	10.2
2016	8.0	2025	10.1
2017	9.6	2026	10.1
2018	10.0	2027	10.2
2019	10.5	2028	9.8
2020	9.5	2029	10
2021	10.4	2030	10
2022	10.1	2031	2
2023	10.2		

[4] Subject to approval of the Stockpile Extension Modification.

5.4 PREDICTED GROUNDWATER INFLOWS

Hydrosimulations (2015) provides predicted groundwater inflows for the Modification. Table 5.2 shows the Hydrosimulations (2015) predicted groundwater inflows, and Figure 5.2 compares the Hydrosimulations (2015) predictions to the groundwater inflow predictions for the approved NM described in Aquaterra (2009). Aquaterra (2009) provided a base case groundwater inflow estimate based on the expected results and an upper and lower bound estimate based on higher and lower rock permeabilities. The following is of note:

- The Hydrosimulations (2015) groundwater inflow estimates are higher than the base case of the Aquaterra (2009) estimates until June 2024. From 2025 onwards the predicted volume of groundwater rapidly drops away.
- The total volume of groundwater to be extracted based on the Hydrosimulations (2015) estimates is significantly lower than the base case and upper bound of the Aquaterra (2009) estimate.
- The peak daily groundwater inflow rate, predicted by Hydrosimulations (2015) to occur in 2021, is some 28% lower than the peak daily inflow rate predicted by the upper bound of the Aquaterra (2009) estimates, and about 1% lower than the Aquaterra (2009) base case peak daily inflow rate.

Table 5.2 - Predicted Modification groundwater inflows (Source: Hydrosimulations, 2015)

Year	Groundwater inflow (ML/day)	Year	Groundwater inflow (ML/day)
2015	1.61	2024	3.56
2016	1.77	2025	3.14
2017	1.88	2026	2.79
2018	2.34	2027	2.42
2019	2.78	2028	2.17
2020	3.19	2029	1.66
2021	3.48	2030	1.16
2022	3.76	2031	0.51
2023	3.78		

5.5 PREDICTED SUBSIDENCE

Predicted subsidence contours for the Modification were provided by Ditton Geotechnical Services (2015). The subsidence contours include predicted ground subsidence due to extraction of coal from longwall panels 101, 102 and the northern half of panel 103. As these panels have already been mined, and the impact of subsidence is evident in the LIDAR ground survey data, the predicted subsidence contours of these panels were not used in this study. Figure 5.3 shows a digital elevation model (DEM) of the predicted longwall subsidence contours for the Modification. The following is of note:

- Predicted subsidence ranges from a maximum of 2.7 m along the centre of the longwall panels to less than 0.005 m around the edges of the subsidence zones, and about 0.5 m in the areas between longwall panels.
- The predicted subsidence would occur beneath Pine Creek, Pine Creek Trib. 1, Pine Creek Trib. 3, Kurrajong Creek, Kurrajong Creek Trib. 1 and Kurrajong Creek Trib. 2.

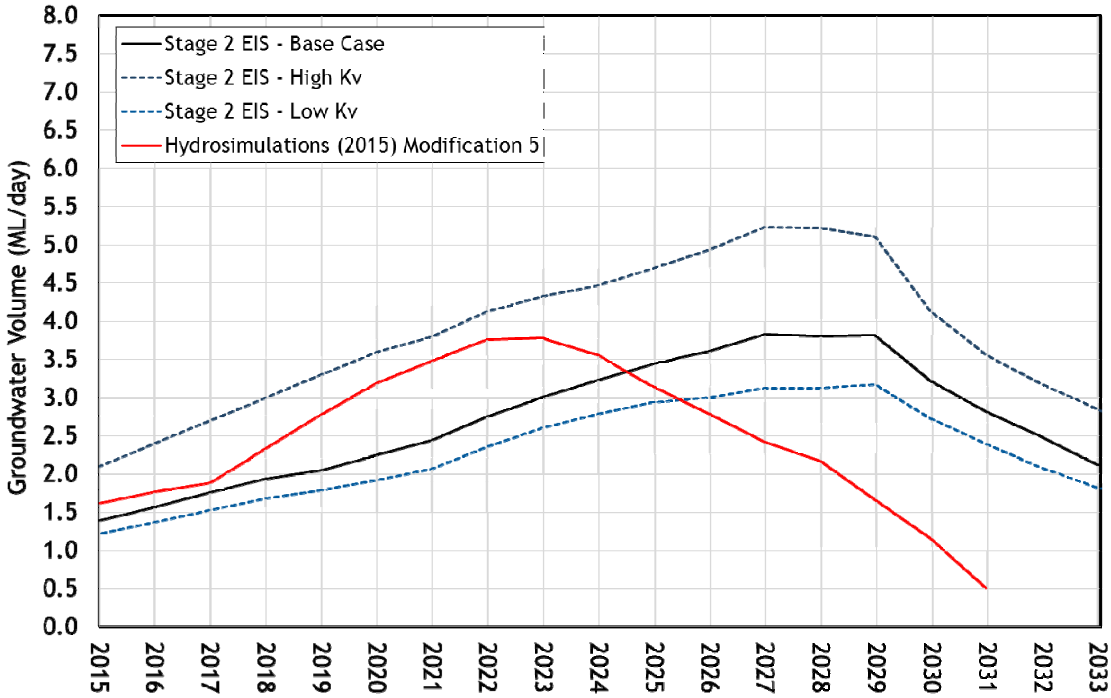


Figure 5.2 - Comparison of Hydrosimulations (2015) predicted Modification groundwater inflows and Aquaterra (2009) predicted groundwater inflows

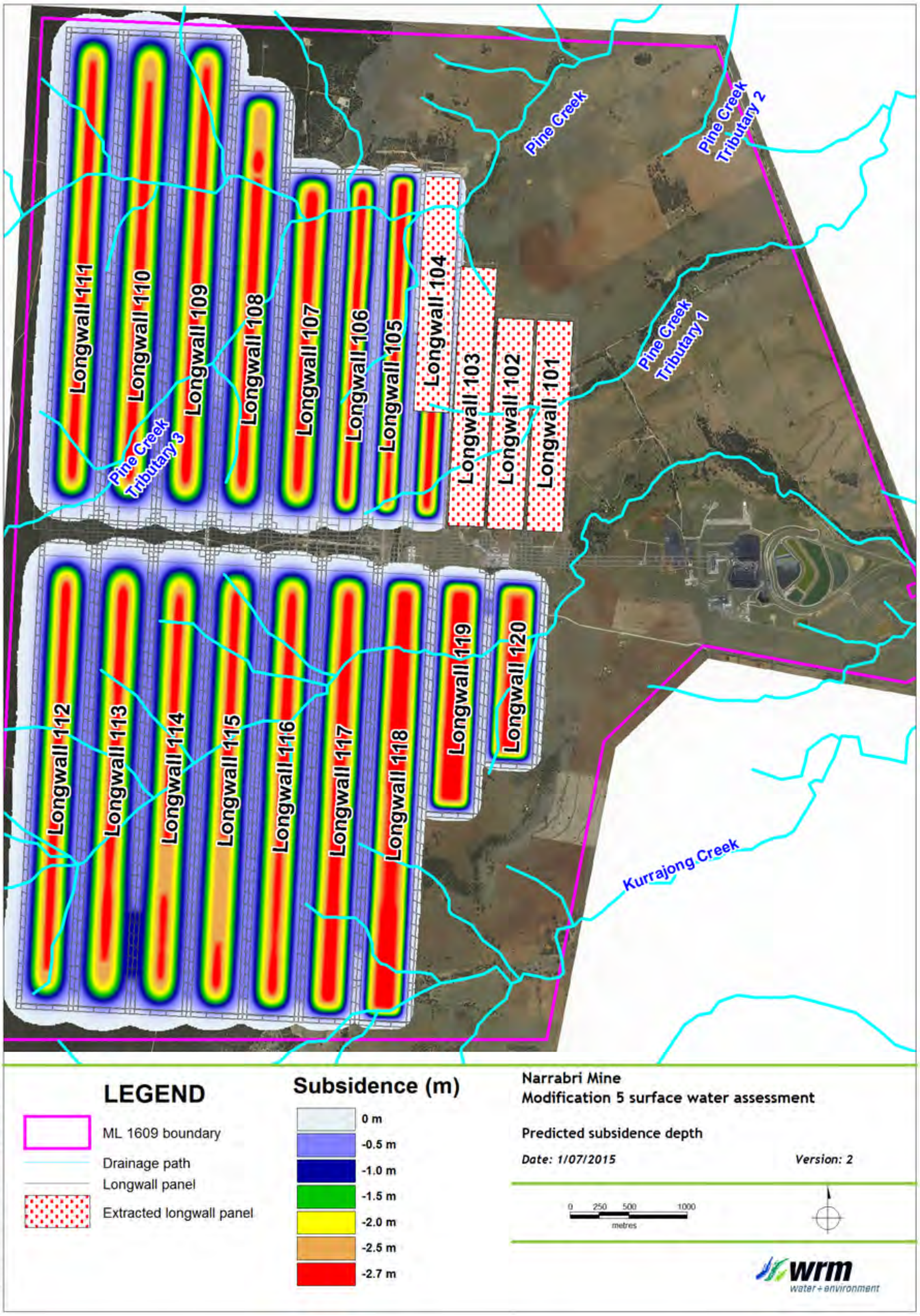


Figure 5.3 - Predicted Modification subsidence depths (Source: Ditton Geotechnical Services, 2015)

6 Water balance modelling

6.1 METHODOLOGY

The Goldsim (Goldsim Technology Group, 2015) software was used to develop a detailed water balance model of the NM site water management system. In order to undertake forecasting simulations of the behaviour of the water management system over the future 17 years of mine operations, for a range of climatic conditions, the water balance model was configured to run 126 simulations of a 17 year period, using the 126 years of available SILO Data Drill historic climate data. In order to achieve 126 simulations of 17 years, historical climate data was looped within the model to ensure the full range of climatic conditions was applied to all stages of mine life. For example, if a simulation commences between 1998 and 2015, historical data from 1889 to 1906 is added to provide a complete 17 year simulation period. The 17 year forecast simulation period commences on 1 July 2015 and ends on 1 July 2031.

The water balance model was calibrated by comparing predicted dam volumes and salinity against recorded data for the period July 2012 to April 2015.

6.2 WATER BALANCE MODEL CONFIGURATION

6.2.1 Rainfall and evaporation

The rainfall and evaporation data obtained from the SILO Data Drill for the NM were used in the Goldsim model. The SILO Data Drill climate data in the model currently extends to 6 May 2015.

6.2.2 Catchment runoff

The uncalibrated Australian Water Balance Model (AWBM) (Boughton, 1993) parameters for runoff from natural / revegetated, hardstand / industrial and stockpile catchments areas developed for the Stage 2 EIS (WRM, 2009) were refined for use in this study, and adjusted based on the results of the model calibration. Table 6.1 summarises the calibrated AWBM parameters used in the Goldsim model.

Table 6.1 - Adopted rainfall-runoff parameters - AWBM model

Parameter	Natural/ revegetated	Hardstand/ industrial	Stockpiles
A1	0.134	0.134	0.134
A2	0.433	0.433	0.433
C1	20.0	3.0	7.5
C2	100.0	30.0	45.0
C3	200.0	60.0	80.0
C_{AVG}	132.6	39.3	55.1
K_{BASE}	1.0	1.0	1.0
K_{SURF}	0.0	0.0	0.0
BFI	0.0	0.8	0.8
Long term volumetric runoff coefficient	6.0%	21.2%	15.2%

6.2.3 Salt generation parameters

Table 6.2 outlines the salinity parameters adopted in the Goldsim model. The salinity parameters were adjusted as part of the calibration process to match with observed salinity in the water management system.

A factor of 0.6 has been adopted to represent the relationship between TDS and EC at the NM site. There is currently no data available to confirm the accuracy of the adopted TDS to EC conversion factor. The adopted value is considered reasonable and is based on known relationships throughout Australia.

Table 6.2 - Adopted salinity parameters

Runoff / Water Type	Adopted TDS (mg/L)	EC (µS/cm)
Natural catchments	200	333
Stockpile catchments	2,500	4,167
Industrial catchments	2,000	3,333
Groundwater / Gas Drainage Water	6,000	10,000
Namoi River / Bore Imported Water	200	333
Reverse Osmosis Permeate	20	33

6.2.4 Dam stage-storage-surface area data

The dams at the NM site were represented in the Goldsim model based on the survey and design data provided by NCOPL.

6.2.5 Key assumptions

The following key assumptions were made in both the calibration (Section 6.3) and forecast (Section 6.4) water balance models:

- A percentage of the reclaim demand returns to the water management system via SB1. The water balance model assumes that 35% of the total reclaim demand (this includes washbay and surface water dust suppression) would drain to SB1 and be recycled into the site water management system.
- A constant longwall emulsion demand of 6.33 ML/yr (0.0175 ML/day) was adopted in the model, based on advice from NCOPL.
- A constant vent humidity loss of 133 ML/yr (0.37 ML/day) has been adopted in the water balance model.
- The assumptions and formula given in Section 4.4.6 was used in the water balance model to determine the fraction of groundwater inflows included in underground dewatering volumes.

6.3 WATER BALANCE MODEL CALIBRATION

6.3.1 Methodology

The water balance model was calibrated to match observed water levels and salinity at the NM site water management system over the period July 2012 to April 2015. The calibration water balance model was configured to reflect the water management schematic shown in Figure 4.4.

The calibration water balance model was configured to represent the changes to the water management system that occurred during the calibration period including the following:

- transferral of water from Dam A2 and A3 to Dam B2 and Dam C in 2013 and 2014;
- RO plant operation (i.e. source of feed water, destination of brine and waste);
- permanent RO plant operation;
- longwall changeover periods; and
- gas drainage water management.

Recorded NM site data was incorporated into the water balance model for the following components of the site water management system:

- underground dewatering volumes;
- reclaim water use;
- filtered water use;
- potable water use;
- raw water imports;
- RO plant feed and production volumes; and
- ROM coal production.

6.3.2 Results summary

Figure 6.1 and Figure 6.2 show a comparison of predicted and observed site water and salt inventories at the NM over the calibration period. Calibration plots for individual dams are provided in Appendix A.

Note that due to irregular dam water level measurements, the contents of sediment dams and reclaim Dams SB1, SB2 and SB3 have not been included in the inventory plots shown in Figure 6.1 and Figure 6.2, and no individual calibration plots have been produced for these dams. The volumes of water held in these dams at any time are typically small and have little bearing on the overall site inventory. Further, the water balance model includes the regular pumping out of these dams to prevent spills, and hence the contribution of these dams to overall site inventory over the calibration period is adequately represented.

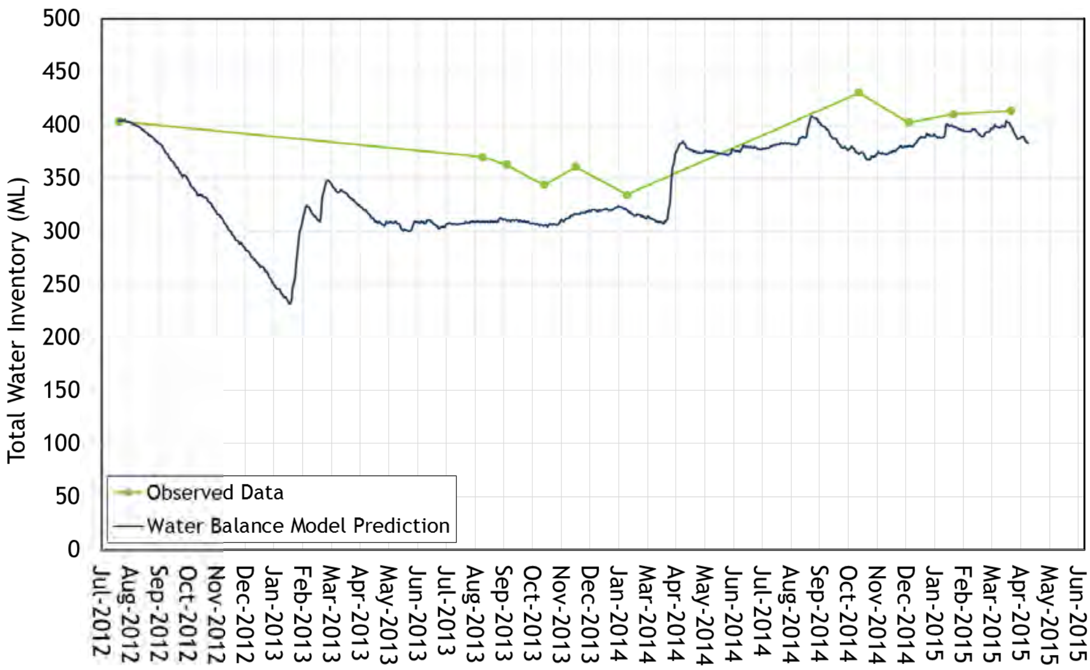


Figure 6.1 - Water balance model calibration results, total site water inventory

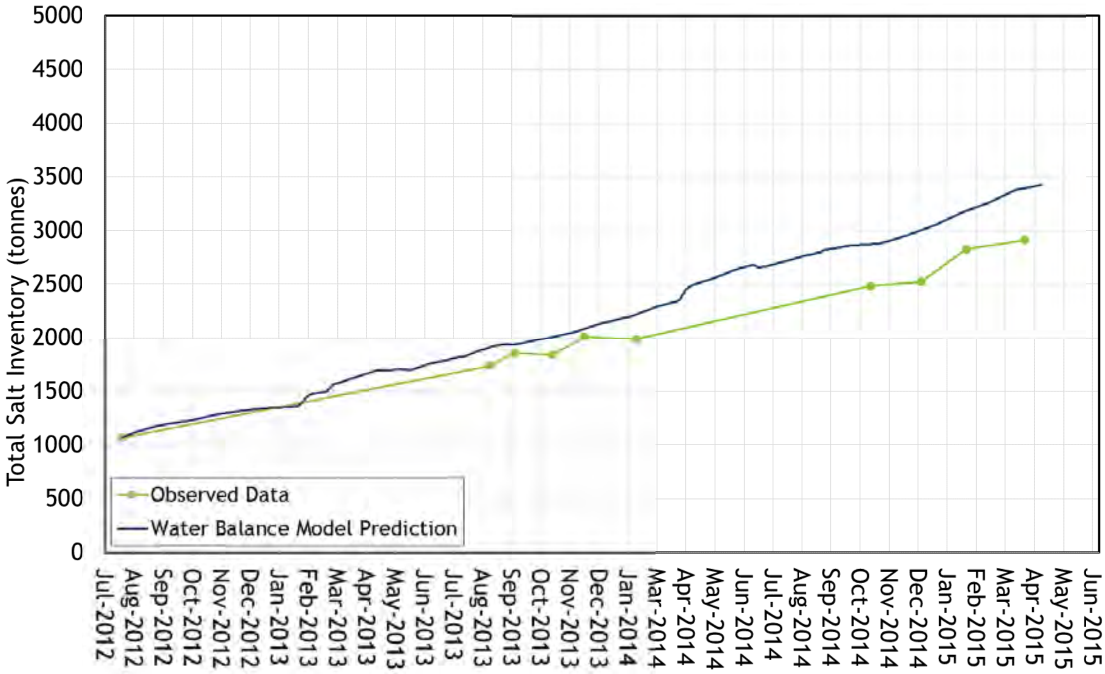


Figure 6.2 - Water balance model calibration results, total site salt inventory

The calibration results show that the water balance model adequately matches the trends in the observed data, for both site water and salt inventories. The calibration is considered acceptable, particularly considering the complex nature of the NM site water management system, and the numerous variations to the operation of the system during the calibration period.

6.4 FORECAST WATER BALANCE MODELLING

6.4.1 Methodology

The calibrated model was used to forecast the behaviour of the mine site water balance over the life of the Modification. The model was used to simulate 126 realisations of the future 17 years of mine operations, allowing the future behaviour of the water management system to be assessed for a range of climatic conditions. The 17 year forecast simulation period commences on 1 July 2015 and ends on 1 July 2031.

6.4.2 Site water management system

The forecast water balance model was configured to reflect the site water management system described in Section 5.2.

6.4.3 Water demands

The key water demand assumptions used in the forecast water balance model are described below:

- A demand of 0.23 ML/day was adopted for the ROM / product coal stockpile sprays as per advice from NCOPL. All water used by the sprays remains with the coal, and does not return to the mine water management system. Saline/reclaim water from Dam A1 will be used in the ROM and product coal stockpile sprays until July 2016. From July 2016 onwards, brine from Dam C and Dam B2 will be used.
- A demand of 0.43 ML/day was adopted for each mechanical evaporator, as per advice from NCOPL. Water lost via the mechanical evaporators is removed from the site water management system. It has been assumed that there would be a mechanical evaporator located in Dams A1, A2, A3, B2 and C from January 2016.

- ROM/product coal stockpile sprays would only be operated on non-rain days.
- Mechanical evaporators would only be operated during the day time on non-rain days.
- A reclaim demand (CHPP and surface dust suppression) of 0.053 thousand litres per ROM tonne (kL/ROM tonne) was adopted based on recorded reclaim usage and ROM coal production at the NM for the period April 2011 to April 2015. As per the calibration model, 35% of reclaim water use is recycled via Dam SB1.
- An underground filtered water demand of 0.058 kL/ROM tonne was adopted based on recorded underground filtered water use and ROM coal production for the period August 2012 to April 2015.
- Reclaim and underground filtered water demands are calculated by the water balance model based on the proposed Modification ROM coal production schedule.
- Longwall emulsion demand, vent humidity loss and increase in coal moisture were kept as per Section 6.2.5.

6.4.4 New dams

It has been assumed that SB4 will be constructed and SB1 will be augmented as described in the *Stockpile Extension Modification Environmental Assessment* (Resource Strategies, 2015b) in 2015[5].

The forecast water balance modelling suggests that only BR1 will be required. However if groundwater inflows significantly exceed the Hydrosimulations (2015) estimates, additional brine storages (i.e. BR2 to BR5) may be required. The need for additional brine storages (i.e. BR1 to BR5) will be assessed against the actual groundwater extraction over the life of the NM.

6.4.5 Water RO treatment capacity

It has been assumed that an upgrade to the existing RO plant will be commissioned at NM in May 2016, with a treatment capacity of 2 ML/day. The RO plant is assumed to be capable of treating water of approximately 12,500 µS/cm, with a recovery rate of 75%. The RO plant will be upgraded to cater for the increasing groundwater inflows over the life of the mine. Figure 6.3 shows the assumed RO treatment capacity at the site over the forecast modelling period.

[5] Subject to the approval of the Stockpile Extension Modification.

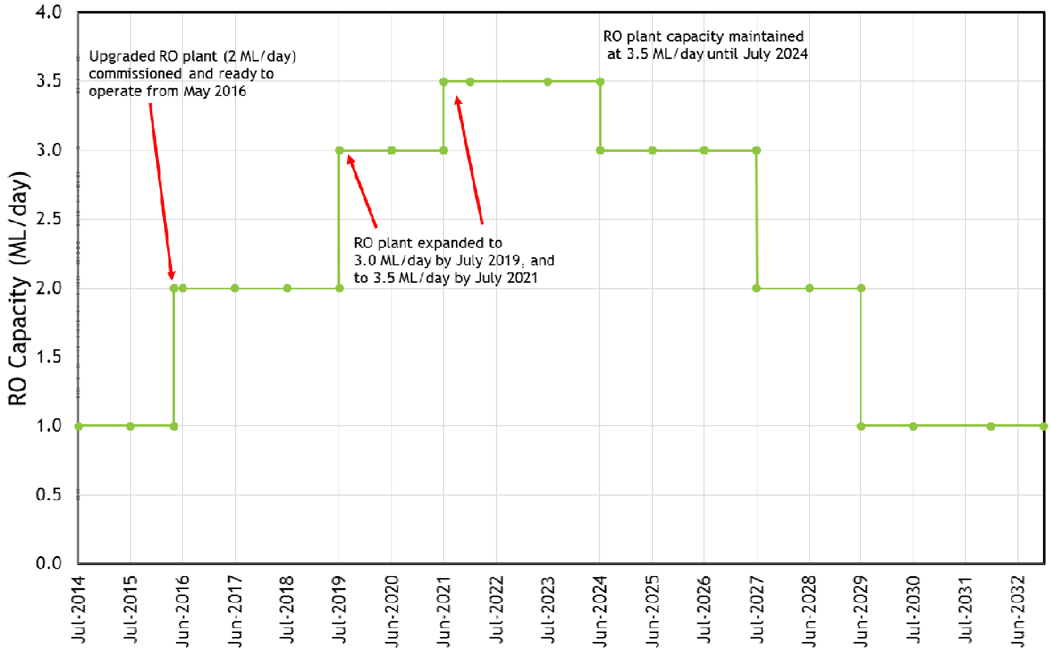


Figure 6.3 – Proposed RO plant capacity

6.4.6 Releases of treated water to the Namoi River

The water balance model includes the release of treated water to the Namoi River.

6.5 RESULTS

6.5.1 Water management system performance

The forecast water balance model was used to predict the likely site water inventory for reclaim/saline water, brine, disturbed runoff, raw and filtered water. The results have been used to assess whether the modified water management system is adequate and in particular whether the water management infrastructure (dams/pumps and pipes) are capable of preventing uncontrolled spills from the brine and saline storages. The water balance model was also used to predict the volume of treated water released to the Namoi River.

Figure 6.4 and Figure 6.5 show the predicted stored volumes probability plots of the saline/reclaim dams (A1, A2, A3, SB1, SB2, SB3 and SB4) and the brine storage dams (B2, C and BR1) respectively over the life of the Modification. Predicted 20th, median, 80th and 99th percentile inventory values are shown for each water type for each day. The probability plots reflect the likelihood of the stored volume being at or above this value on any given day. For instance 80% of stored volumes are expected to be at or below the 80th percentile value. The predicted site inventory on 31 December in each year of the forecast period is summarised in Table 6.3. The following is of note:

- The saline/reclaim storage volumes generally vary between 90 ML and 270 ML over the simulation period.
- The predicted 99th percentile stored volume in the saline/reclaim storages is 271 ML, which is less than the combined maximum storage volume of A1, A2, A3, SB1, SB2, SB3 and SB4 (286 ML).

- There is less than a 1% chance of an uncontrolled release occurring from SB2 and SB3, and no predicted uncontrolled releases from SB4, or from the rail loop dams (A1, A2, A3, B1, B2, C and D) into the containment bund.
- The predicted brine storage volumes generally vary in accordance with groundwater inflows. Brine storage volumes trend downwards until about 2018 as the evaporator fan and other losses exceed groundwater inflows. The brine storage volumes start to rise after 2018 as the groundwater inflows start to increase above what can be handled by the evaporator fans and fall again after 2025 when the groundwater inflows start to fall.
- The predicted 99th percentile stored volume in the brine dams (B2 and C) is 347 ML, which is lower than the combined capacity of B2 and C of 367 ML. This indicates that there is a less than 1% chance that BR1 will be required for brine management. The need for BR1 will be reassessed annually based on actual groundwater extraction rates and status of the water management system.
- Sediment dams are generally well below the maximum storage volume of 103 ML and spill infrequently in accordance with the EPL 12789 limits for wet weather discharges.
- Stored filtered water volumes are generally maintained at between 80% to 90% of its maximum available volume to maintain adequate water supplies to the underground and do not spill over the simulation.
- Raw water volumes are generally maintained at between 60 ML to 100 ML with infrequent top ups from the sediment dams and occasionally from the Namoi River.

In summary, the water balance model indicates that there is less than a 1% chance of an uncontrolled release of saline / reclaim water from the water management system to the receiving environment in any year of mine life. The water balance model predicts that there would be no release of brine from the site water management system, and that the BR1 additional brine dam is likely to be sufficient to manage the predicted volumes of brine to be produced.

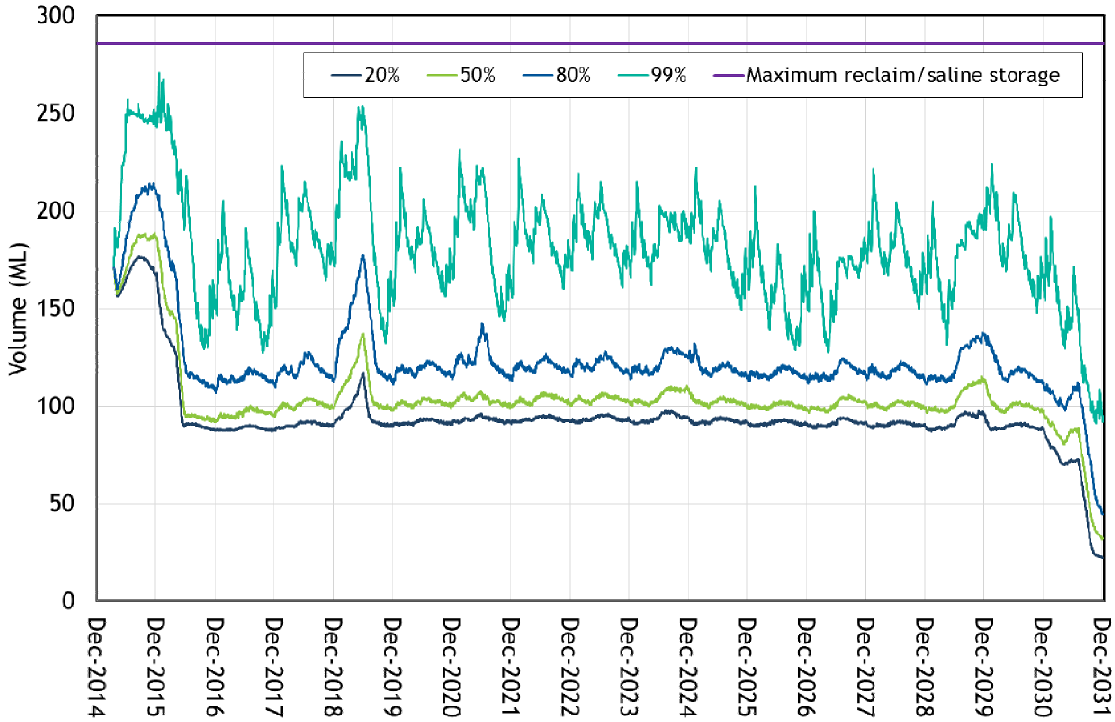


Figure 6.4 - Predicted storage inventory in the saline/reclaim dams A1, A2 A3, SB1, SB2, SB3 and SB4

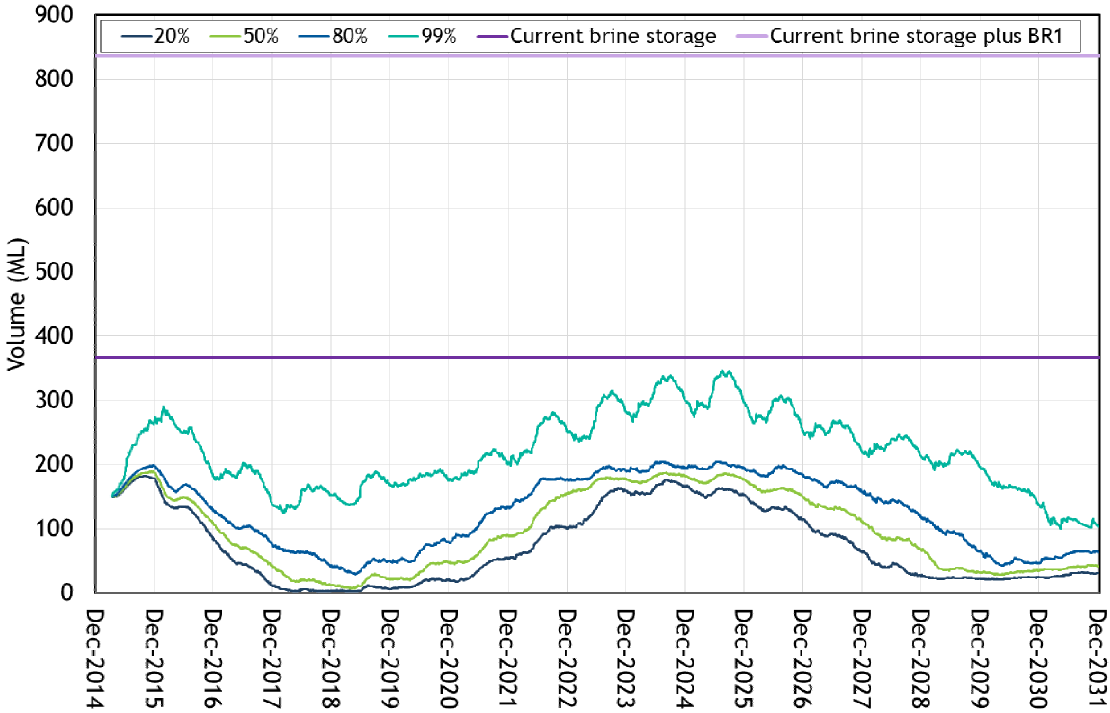


Figure 6.5 - Predicted storage inventory in the brine storage dams B2, C and BR1 (not yet constructed)

Table 6.3 - Forecast water inventory results

Year	Reclaim / saline volume (ML)			Brine volume (ML)			Sediment dam volume (ML)			Filtered water volume (ML)			Raw water volume (ML)		
	20th %ile	Median	80th %ile	20th %ile	Median	80th %ile	20th %ile	Median	80th %ile	20th %ile	Median	80th %ile	20th %ile	Median	80th %ile
2015	167.1	186.4	209.0	178.2	187.2	197.7	4.4	7.1	12.1	24.0	24.6	25.7	56.6	72.6	72.6
2016	87.6	92.0	107.6	82.5	106.3	127.2	4.5	9.3	17.0	24.0	25.6	27.0	60.8	87.5	87.5
2017	87.8	95.5	110.5	11.4	40.3	73.5	4.7	9.4	17.4	23.6	25.4	26.6	50.6	80.3	80.3
2018	89.9	99.4	112.4	3.4	11.3	42.4	4.7	9.7	18.6	24.6	25.8	26.9	52.1	86.5	86.5
2019	90.5	98.4	112.5	5.9	20.8	48.8	4.9	10.4	19.9	25.7	27.2	29.3	54.7	81.2	81.2
2020	90.5	100.2	113.9	19.0	48.2	78.0	5.3	12.0	28.5	31.2	33.0	34.1	56.8	73.7	73.7
2021	90.9	100.3	114.2	54.5	88.4	133.4	4.9	11.5	25.9	30.5	32.2	34.3	60.0	74.5	74.5
2022	91.8	101.6	115.3	101.1	154.9	176.0	5.3	12.1	26.8	31.5	33.0	34.8	61.7	76.5	76.5
2023	92.4	101.9	116.0	158.7	176.4	188.3	5.3	11.8	25.9	30.9	32.7	34.4	63.9	78.7	78.7
2024	94.3	108.7	126.2	165.5	181.3	194.8	5.3	11.6	26.0	30.9	32.9	34.6	60.8	77.2	77.2
2025	91.7	99.9	113.6	152.6	176.5	194.0	5.0	11.7	27.8	30.0	31.8	33.7	62.0	77.4	77.4
2026	91.0	98.2	113.1	114.3	148.8	182.9	5.1	11.1	25.5	26.0	28.1	30.8	55.7	76.4	76.4
2027	90.8	101.6	115.5	63.2	110.0	157.2	4.5	9.3	18.8	24.0	25.5	27.0	58.1	85.5	85.5
2028	89.8	99.0	111.7	26.4	66.3	117.1	4.5	8.9	17.9	24.1	25.6	27.1	59.9	85.7	85.7
2029	95.8	113.5	137.3	22.1	31.4	65.8	4.9	9.6	16.8	19.5	24.1	26.2	29.6	58.6	58.6
2030	87.6	96.8	110.9	24.3	35.2	46.2	5.3	11.5	21.0	0.9	1.1	1.8	6.6	70.0	70.0
2031	22.3	32.4	44.4	30.9	42.0	63.3	4.8	9.6	18.2	24.6	26.2	27.0	58.1	82.1	82.1

6.5.2 Raw water supply

The forecast supply of raw water from the Namoi River is given in Table 6.4. Little to no raw water is required at the NM between 2020 and 2026 as the majority of the clean water demand is supplied by the RO plant. It is likely that additional RO plant capacity may reduce the raw water demand during these later years.

It is noted that small volumes of raw water will continue to be extracted for potable water use.

6.5.3 Controlled releases

Table 6.4 summarises the predicted volume of treated water released to the Namoi River in each year of the forecast period. The following is of note:

- Controlled releases generally track the groundwater inflows. There is very little variation in controlled releases between the 20th percentile and 80th percentile plots due to the system being groundwater dependent and not rainfall dependent.
- Relatively low releases (less than 100 ML) are made until 2019 whilst the evaporator fans and other demands exceed the groundwater inflows.
- Releases increase between 2019 and 2023 when groundwater inflows increase, with maximum predicted 80th percentile releases of 288 ML/year.

Table 6.4 - Forecast imported raw water and controlled releases of treated water to the Namoi River

Year	Raw water supply volume (ML)			Release volume (ML)		
	20th %ile	Median	80th %ile	20th %ile	Median	80th %ile
2015	0	30	46	0	0	0
2016	87	251	298	0	7	12
2017	73	340	402	0	0	0
2018	24	93	389	0	0	0
2019	0	37	150	21	30	41
2020	0	0	51	138	145	161
2021	0	0	0	170	186	207
2022	0	0	0	270	281	281
2023	0	0	0	276	274	283
2024	0	0	0	210	210	218
2025	0	0	0	110	119	120
2026	0	0	56	28	40	34
2027	0	90	321	4	1	9
2028	0	199	386	0	0	0
2029	351	402	402	0	0	0
2030	402	402	402	0	0	0
2031	80	263	340	2	4	5

7 Potential impacts

7.1 WATER MANAGEMENT SYSTEM

7.1.1 Water demand and supply

The Modification would not change the approved water supply for the NM (i.e. water captured in the site water management system and Namoi River extraction).

The water balance modelling in Section 6.4 indicates that there would be an excess of water produced at the modified NM. The modified NM water demands would therefore mostly be satisfied by water captured in the site water management system. Some raw water would be required at the end of mine life as groundwater inflows reduce. These demands however may be satisfied by refining the RO capacity at this time.

Notwithstanding the above, NCOPL will maintain existing Water Access Licences for the extraction of water from the Namoi River (Section 4.4.7). No additional Water Access Licences would be required.

7.1.2 Flow regimes

The Modification would decrease the size of catchment reporting to the NM site water management system. The proposed removal of SD5 from the NM site water management system would result in an additional 10 ha of undisturbed catchment reporting to Kurrajong Creek.

The Modification would not change the size of the catchment reporting to Pine Creek.

Additional discussion of potential flow regime impacts associated with predicted modified subsidence is provided in Section 7.2.

7.1.3 Water quality

The water balance model indicates that the likelihood of an uncontrolled release of saline/reclaim water is very low (less than 1%), and that no brine would be released from the NM site. The sediment dams at the site would continue to be dewatered following runoff events, and would only spill within the EPL 12789 limits for wet weather discharges. Therefore the modified NM site water management system is unlikely to result in adverse impacts to water quality due to uncontrolled releases of water.

The water that is proposed to be released to the Namoi River would be treated by RO, and would comply with the release criteria outlined in Condition 11, Schedule 4 of Project Approval (08_0144). The controlled release of treated water would not adversely impact on water quality in the Namoi River. Nevertheless, NCOPL would implement the salinity offset works proposed in WRM (2009) in consultation with the NOW.

NCOPL will prepare and implement a Raffinate Discharge Control and Monitoring Plan in accordance with Condition 17, Schedule 4 of Project Approval (08_0144) to monitor potential Namoi River water quality impacts associated with the controlled release of treated water.

7.2 STREAM GEOMORPHOLOGY IMPACT ASSESSMENT

7.2.1 Methodology

The predicted subsidence contours were combined with the LIDAR survey data to generate a post subsidence DEM. The post subsidence DEM was then inspected to identify areas of stream geomorphological impacts, including ponding and potential for erosion. Details of the impacts for each creek system are given below.

7.2.2 Pine Creek and Pine Creek Trib. 3

Figure 7.1 shows a visual interpretation of the potential impacts of the predicted subsidence along Pine Creek and Pine Creek Trib. 3. The following is of note:

- Substantial in stream and over bank ponding is predicted to occur along Pine Creek above longwall panels 104 to 111.
- An existing farm dam above longwall panel 108 may become damaged by subsidence, and will ultimately form part of a larger ponded area.
- Numerous contour banks above longwall panels 103 to 106 would be impacted by subsidence. Some contour banks would ultimately drain in two directions, causing contour banks to silt up or erode, resulting in downstream erosion as new gullies are created.
- No additional impacts above the approved impacts given in WRM (2009) are expected.

7.2.3 Pine Creek Trib. 1

Figure 7.2 shows the in stream and over bank ponding along Pine Creek Trib. 1 associated with the existing subsidence. These subsidence predictions and impacts are generally consistent with the approved impacts given in WRM (2009).

7.2.4 Kurrajong Creek and Kurrajong Creek Trib. 1

Figure 7.3 shows a visual interpretation of the potential impacts of the predicted longwall subsidence above the southern long wall panels. The following is of note:

- Minor in stream ponding is likely to occur in Kurrajong Creek above longwall panel 118, similar to what was predicted in WRM (2009).
- Minor in stream and over bank ponding is predicted to occur along Kurrajong Creek Trib. 1 above longwall panels 115 to 121.
- Existing farm dams above longwall panels 120 and 121 may become damaged by subsidence, and would ultimately form part of larger ponded areas.
- Numerous contour banks above longwall panels 119 to 121 would be impacted by subsidence. Some contour banks would ultimately drain in two directions, causing contour banks to silt up or erode, resulting in downstream erosion as new gullies are created.

The predicted impacts over the southern longwall panels are marginally greater than what has been predicted in WRM (2009) due to the improved ground level data. The differences are not significant and are expected to be minor.

7.2.5 Potential Impacts on channel morphology

Overall the impacts are generally consistent with the currently approved impacts described in WRM (2009). However the predicted impacts for the Modification are moderately larger due to the more detailed LIDAR survey data available for this assessment.

An inspection of the results suggests that major changes in channel morphology are not expected. Significant changes in channel location (avulsions) are unlikely across the mine subsidence zone. However, some of the minor (first order) channels may drain into the major watercourses at alternate locations and cause localised bank scour. Some sedimentation of the channel is expected in the ponded areas, which may change the channel form over time. Again, these impacts are in accordance with the approved impacts given in WRM (2009).

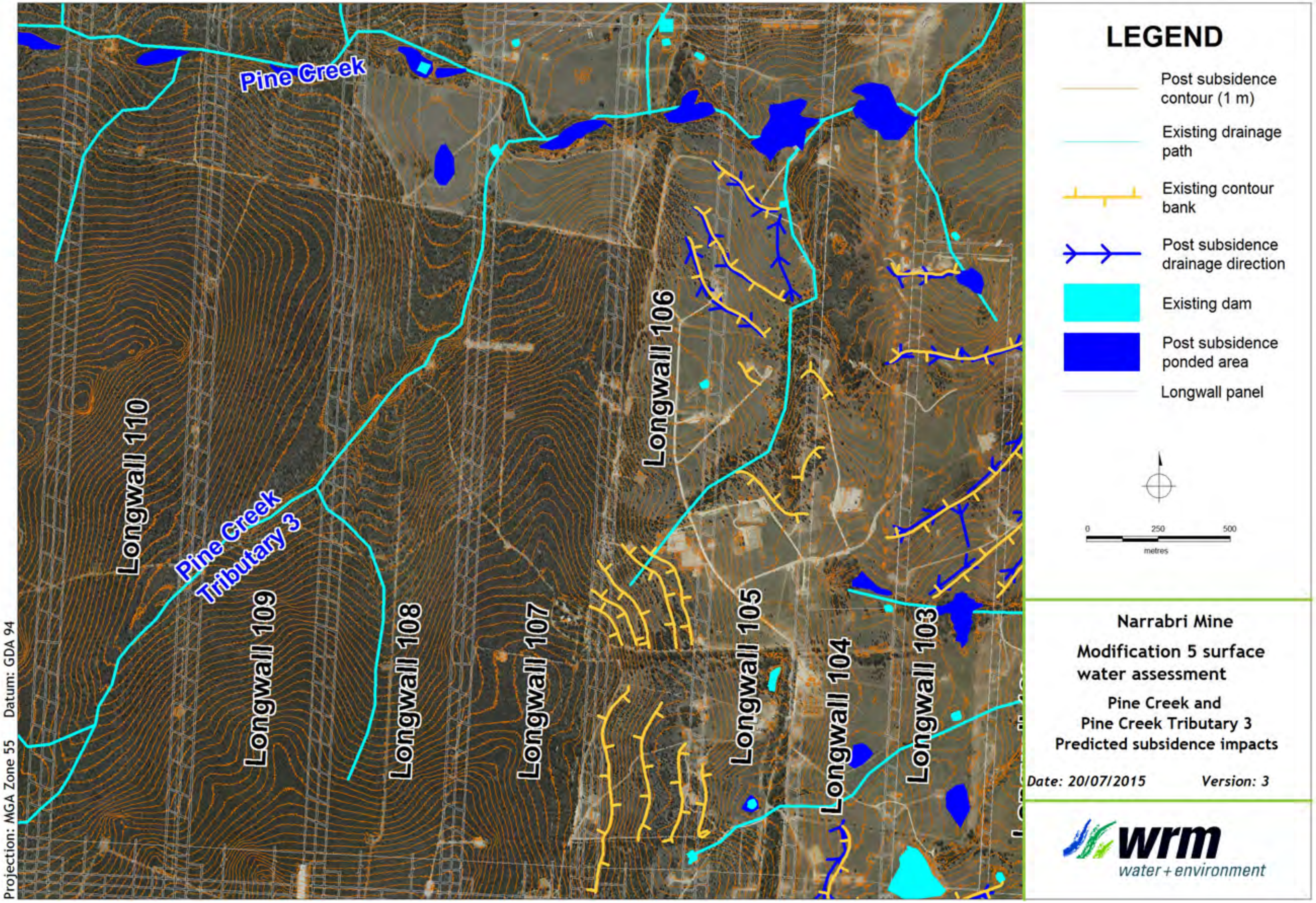


Figure 7.1 - Predicted subsidence impacts, Pine Creek and Pine Creek Trib. 3

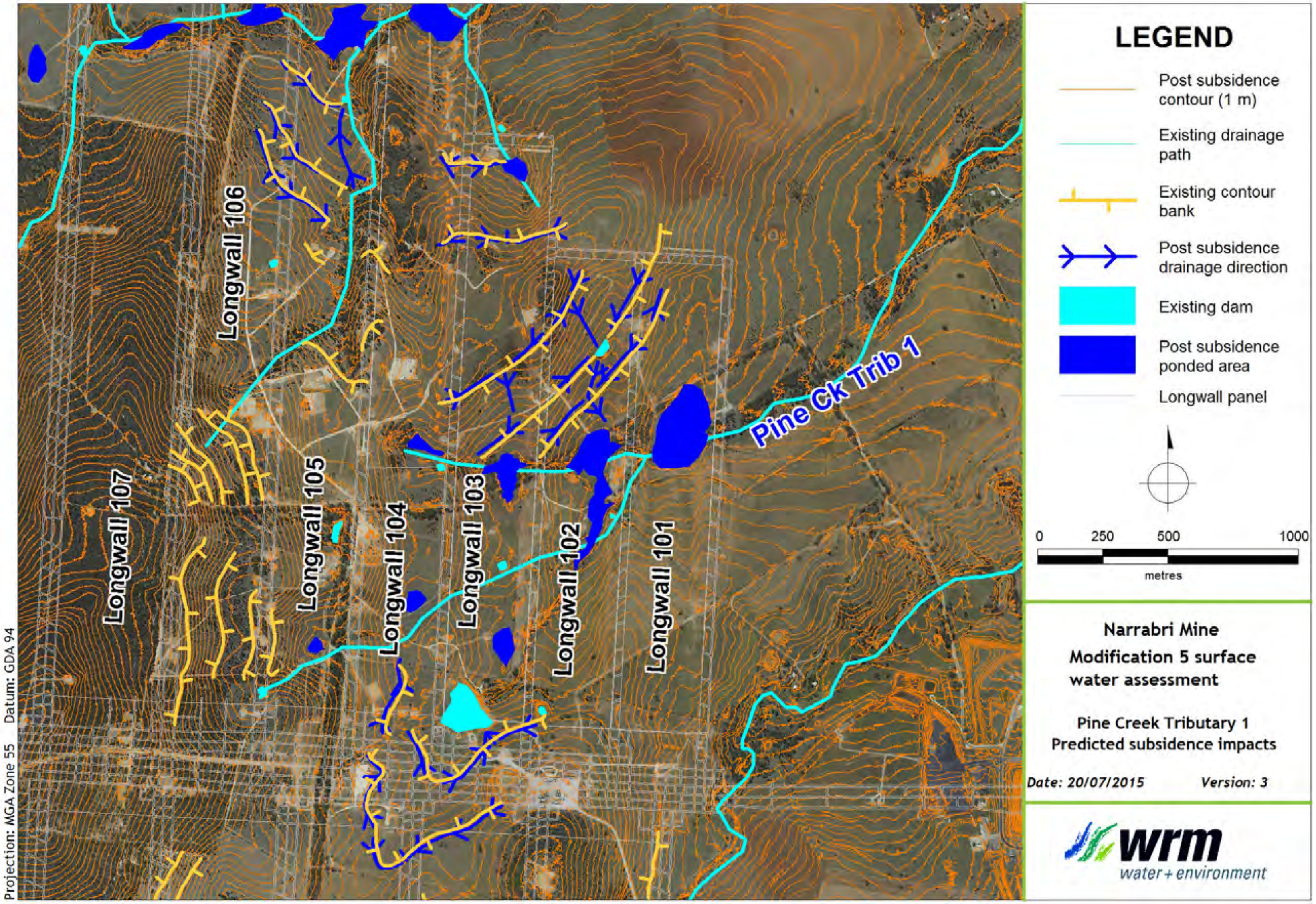


Figure 7.2 - Predicted subsidence impacts, Pine Creek Trib. 1

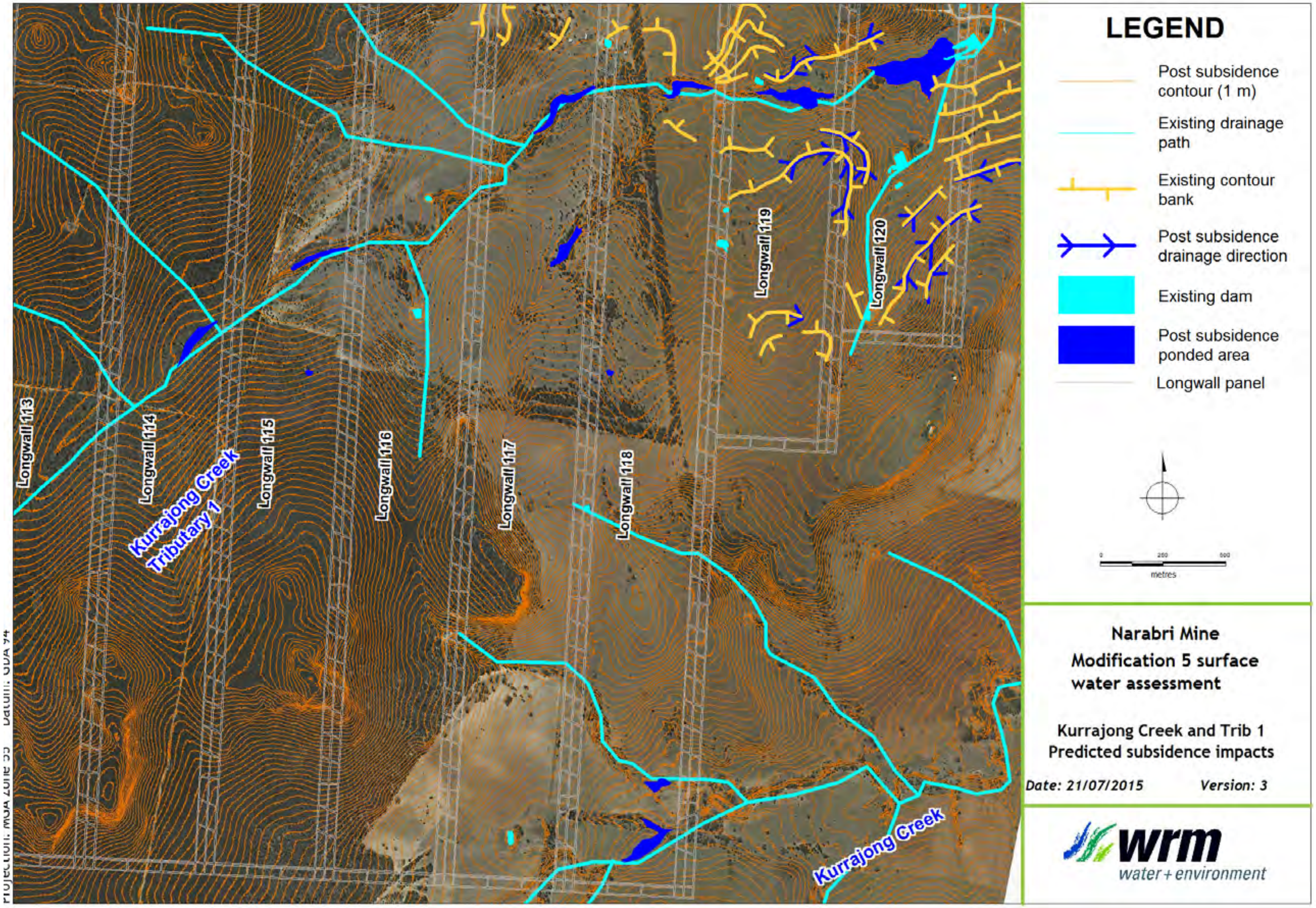


Figure 7.3 - Predicted subsidence impacts, Kurrajong Creek and Kurrajong Creek Trib. 1

7.3 CUMULATIVE IMPACTS

The Modification is unlikely to result in any cumulative impacts to surface water resources.

The nearest mining activity to the NM is the Maules Creek Coal Mine which is located approximately 25 km to the east of the NM (Figure 1.1).

Santos NSW (Eastern) Pty Ltd (2014) lodged a Preliminary Environmental Assessment for the Narrabri Gas Project (which would be located to the immediate west of the NM) in March 2014. The Preliminary Environmental Assessment included limited information on the proposed Narrabri Gas Project. It is expected that Santos NSW (Eastern) Pty Ltd will assess potential cumulative impacts in the Narrabri Gas Project Environmental Impact Statement.

Given the above, no quantitative cumulative impact assessment is proposed for the Modification.

8 Management, monitoring and licensing

8.1 MANAGEMENT AND MITIGATION OF IMPACTS

The modified NM site water management system is considered robust and adequate provided the required infrastructure can be provided in the timeframes specified in this report. In accordance with Condition 14(c), Schedule 4 of Project Approval (08_0144), the site water balance should be revisited on an annual basis to compare the actual behaviour of the NM site water management system to the predicted outcomes of this study.

The Extraction Plan Water Management Plan outlines the management actions and contingency measures for potential subsidence impacts on Pine and Kurrajong Creeks and their tributaries. These management actions should continue to be implemented for the Modification.

8.2 SURFACE WATER MONITORING

The existing on-site and immediate receiving waters surface water monitoring program outlined in the WMP is considered adequate for the Modification.

NCOPL will however prepare and implement a Raffinate Discharge Control and Monitoring Plan in accordance with Condition 17, Schedule 4 of Project Approval (08_0144) to monitor potential Namoi River water quality impacts associated with the controlled release of treated water.

8.3 LICENSING

The existing water access licences held by NCOPL will be maintained, and are considered adequate for the Modification.

9 Summary and conclusions

9.1 OVERVIEW

NCOPL is currently seeking a modification to Project Approval (08_0144) under Section 75W of the EP&A Act to reconfigure the approved underground mine geometry at NM and to increase the ROM coal production rate.

This report has investigated the potential impacts of the proposed Modification on surface water resources, in particular the impact of the Modification on the site water management system and downstream water quality, and the impact of the Modification on stream geomorphology due to subsidence.

9.2 IMPACT OF THE MODIFICATION ON THE SITE WATER MANAGEMENT SYSTEM

9.2.1 Site water management system performance

The water balance model indicates that there is less than a 1% chance of an uncontrolled release of saline / reclaim water from the water management system to the receiving environment in any year of mine life. The water balance model predicts that there would be no release of brine from the site water management system.

The water balance modelling indicates that there would be an excess of water produced at the modified NM. The modified NM water demands would therefore likely to be satisfied by water captured in the site water management system with raw water supply generally only expected during the later years of the Modification but still within the existing available Water Access Licence allocations.

The modified NM site water management system is considered robust and adequate based on the assumed infrastructure and timeframes specified in this report. In accordance with Condition 14(c), Schedule 4 of Project Approval (08_0144), the site water balance should be revisited on an annual basis to compare the actual behaviour of the NM site water management system to the predicted outcomes of this study.

9.2.2 Flow regime

The Modification would decrease the size of catchment reporting to the NM site water management system. The proposed removal of SD5 from the NM site water management system would result in an additional 10 ha of undisturbed catchment reporting to Kurrajong Creek. The Modification would not change the size of the catchment reporting to Pine Creek.

9.2.3 Water quality

The modified NM site water management system is unlikely to result in adverse impacts to water quality due to uncontrolled releases of water.

The water that is proposed to be released to the Namoi River would be treated by RO, and would comply with the release criteria outlined in Condition 11, Schedule 4 of Project Approval (08_0144). The controlled release of treated water would not adversely impact on water quality in the Namoi River. Nevertheless, NCOPL would implement the salinity offset works proposed in WRM (2009) in consultation with the NOW.

9.3 IMPACT OF THE MODIFICATION ON STREAM GEOMORPHOLOGY

Overall the impacts are generally consistent with the currently approved impacts described in WRM (2009). However the predicted impacts for the Modification are moderately larger due to the more detailed LIDAR survey data available for this assessment.

An inspection of the results suggests that major changes in channel morphology are not expected. Significant changes in channel location (avulsions) are unlikely across the mine subsidence zone. However, some of the minor (first order) channels may drain into the major watercourses at alternate locations and cause localised bank scour. Some sedimentation of the channel is expected in the ponded areas, which may change the channel form over time. Again, these impacts are in accordance with the approved impacts given in WRM (2009).

The Extraction Plan Water Management Plan outlines the management actions and contingency measures for potential subsidence impacts on Pine and Kurrajong Creeks and their tributaries. It is recommended that these management actions should continue to be implemented for the Modification.

10 References

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Appendix A Water Balance Model Calibration Results

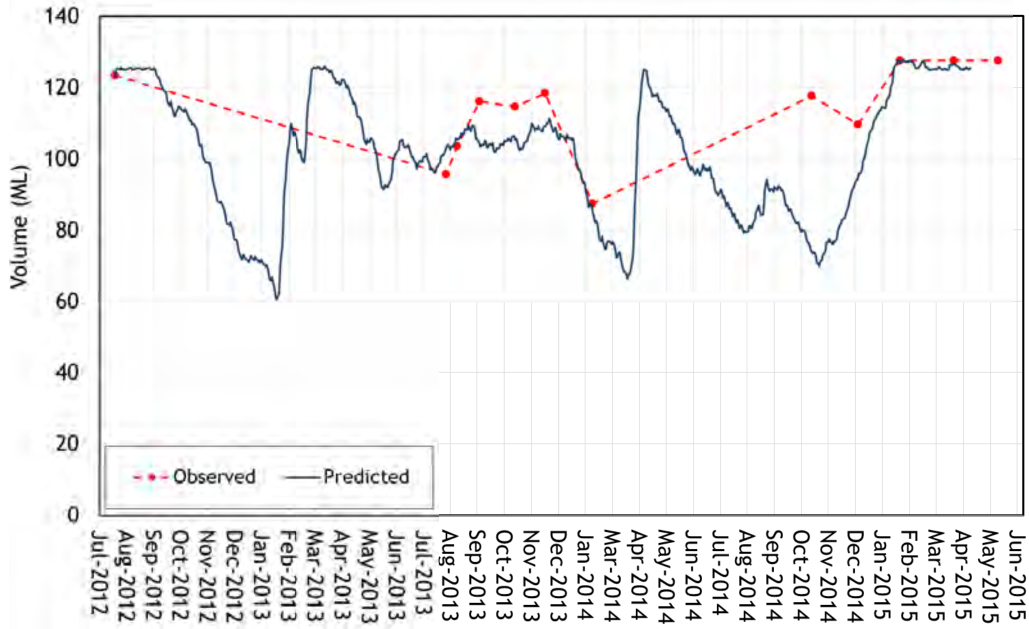

Figure A.1 - Observed and predicted volume in Dam A1, July 2012 to April 2015

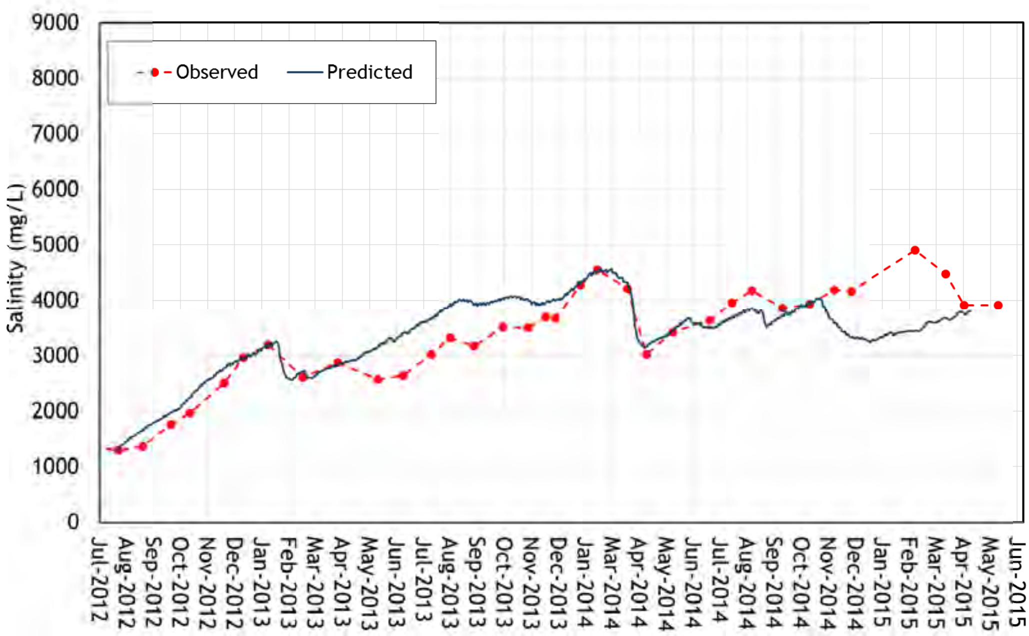

Figure A.2 - Observed and predicted salinity in Dam A1, July 2012 to April 2015

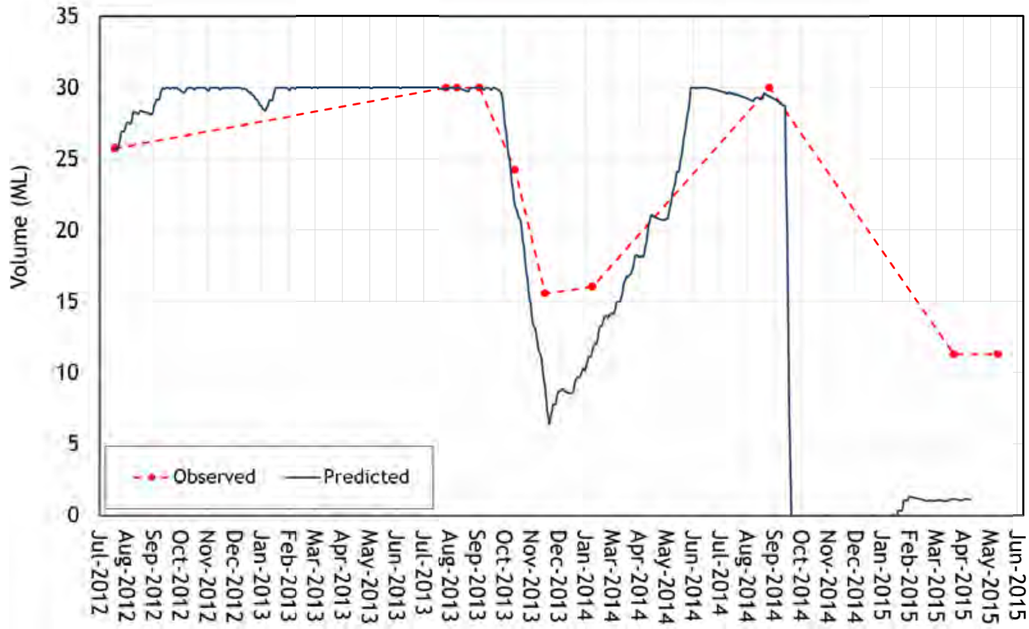

Figure A.3 - Observed and predicted volume in Dam A2, July 2012 to April 2015

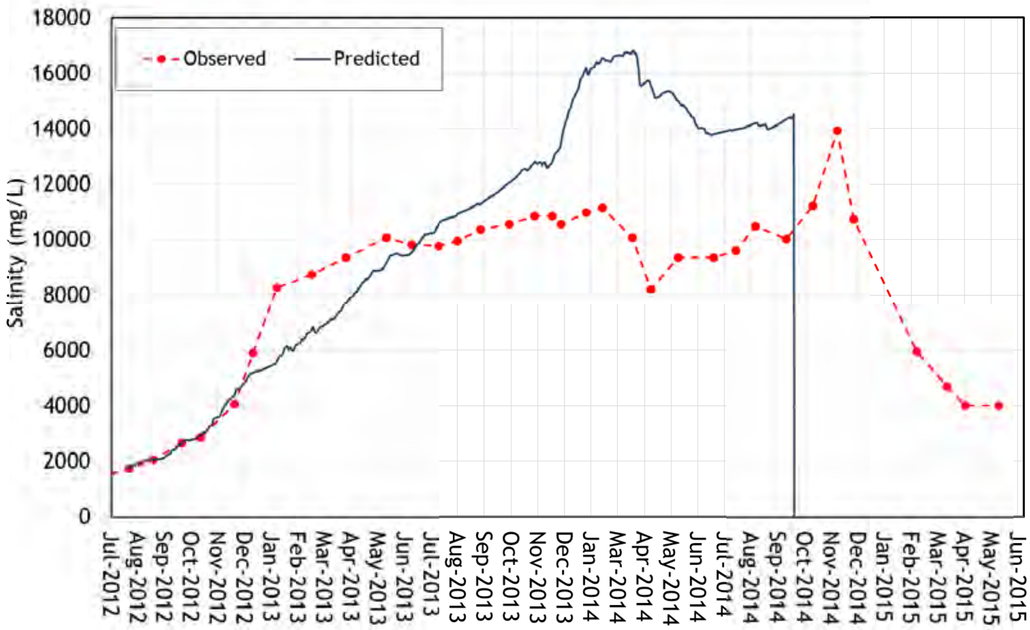

Figure A.4 - Observed and predicted salinity in Dam A2, July 2012 to April 2015

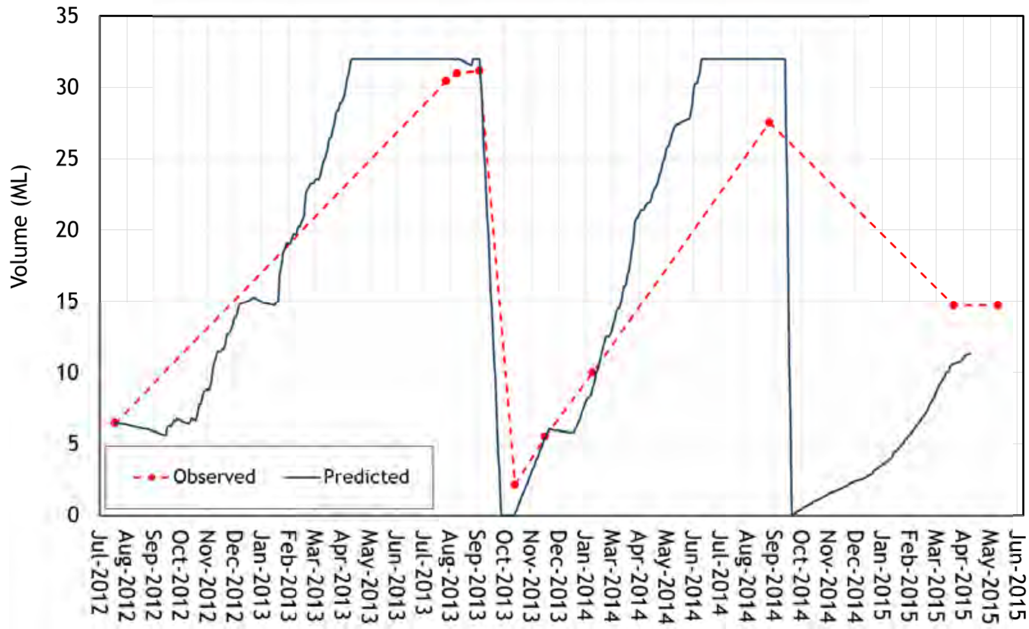

Figure A.5 - Observed and predicted volume in Dam A3, July 2012 to April 2015

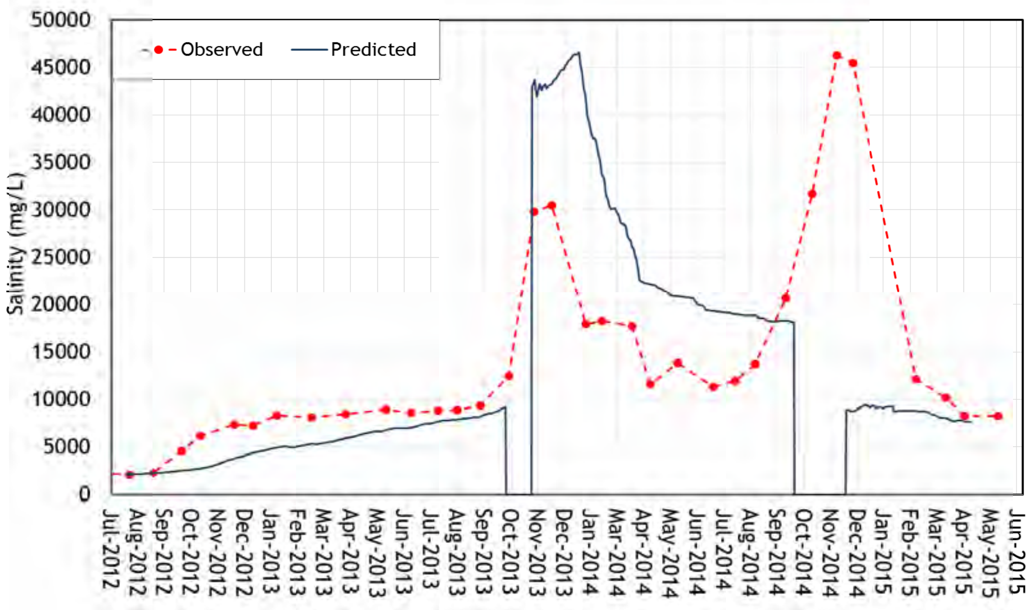

Figure A.6 - Observed and predicted salinity in Dam A3, July 2012 to April 2015

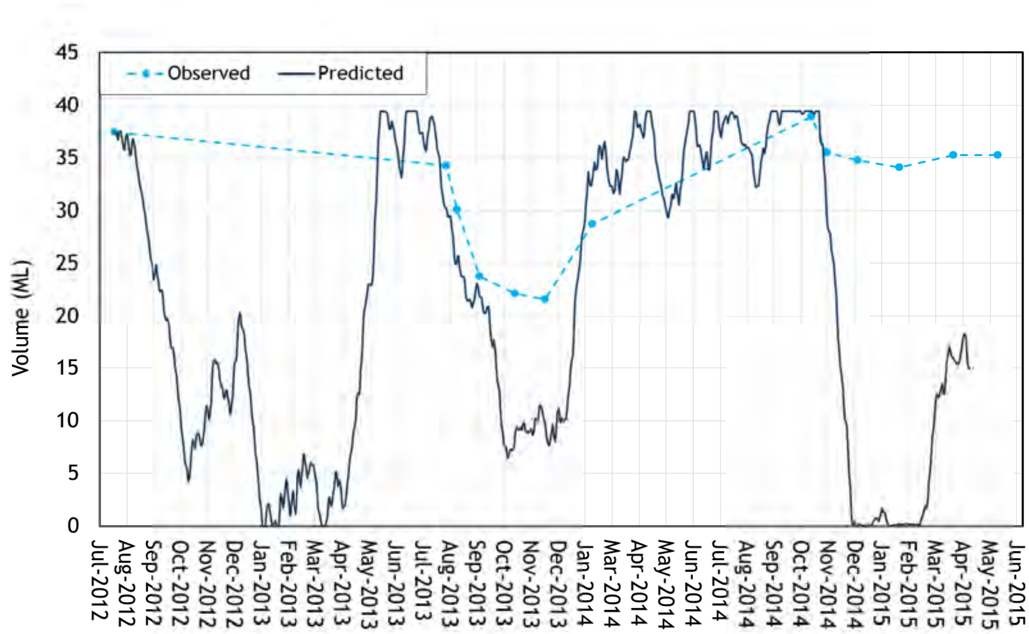

Figure A.7 - Observed and predicted volume in Dam B1, July 2012 to April 2015

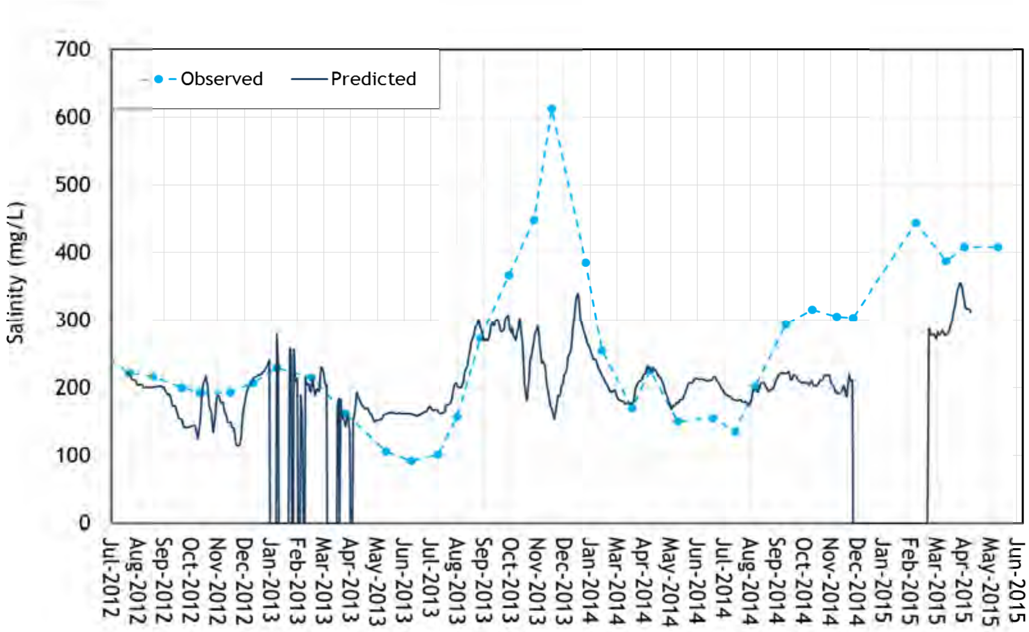

Figure A.8 - Observed and predicted salinity in Dam B1, July 2012 to April 2015

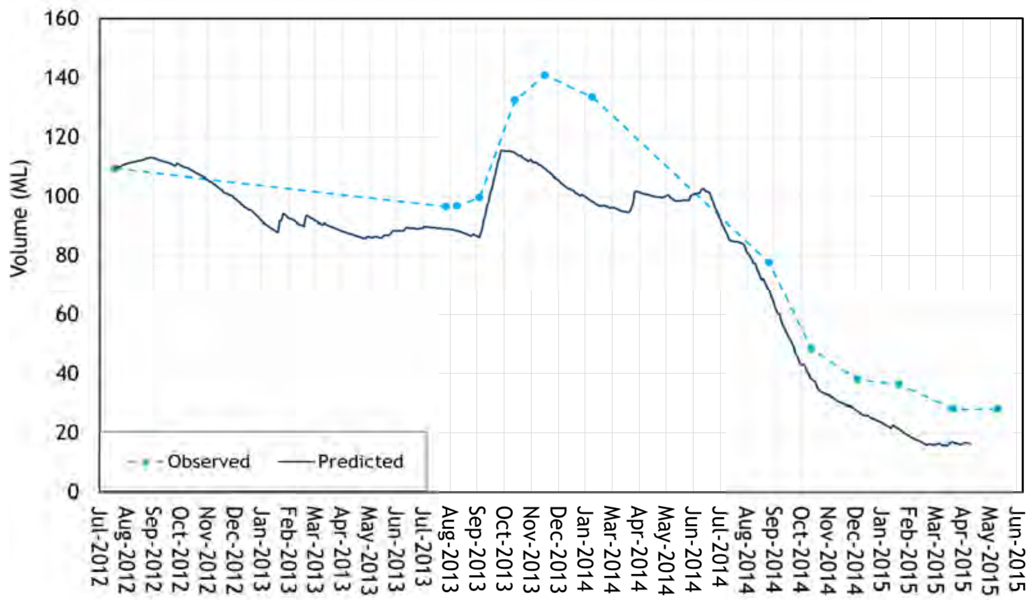

Figure A.9 - Observed and predicted volume in Dam B2, July 2012 to April 2015

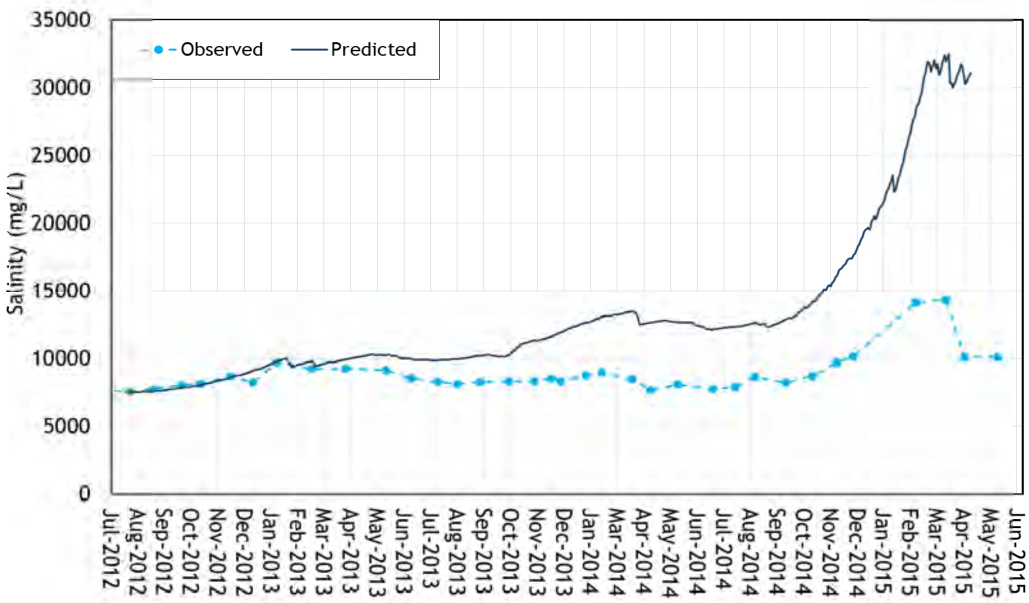

Figure A.10 - Observed and predicted salinity in Dam B2, July 2012 to April 2015

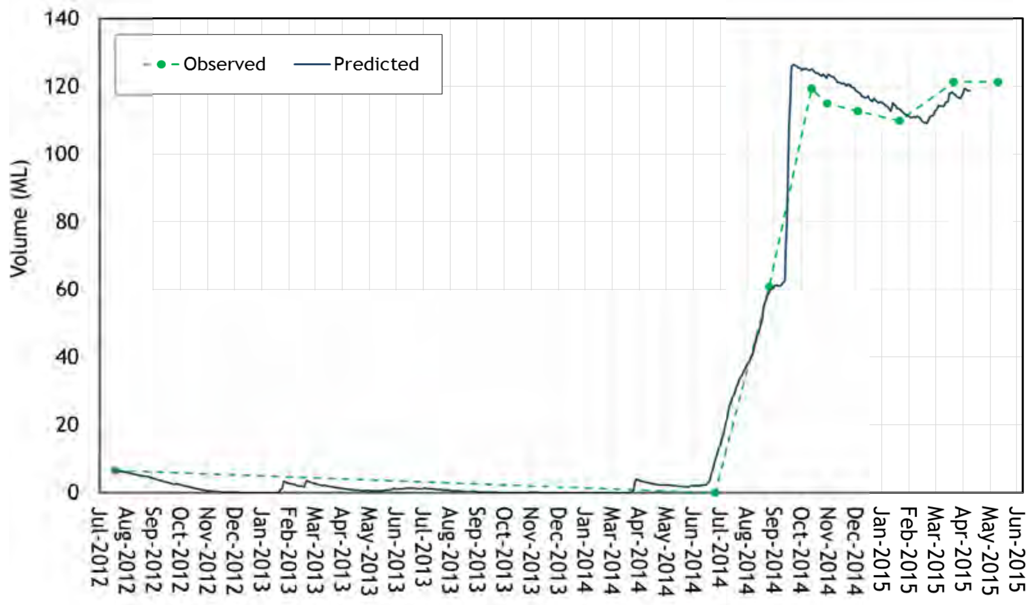

Figure A.11 - Observed and predicted volume in Dam C, July 2012 to April 2015

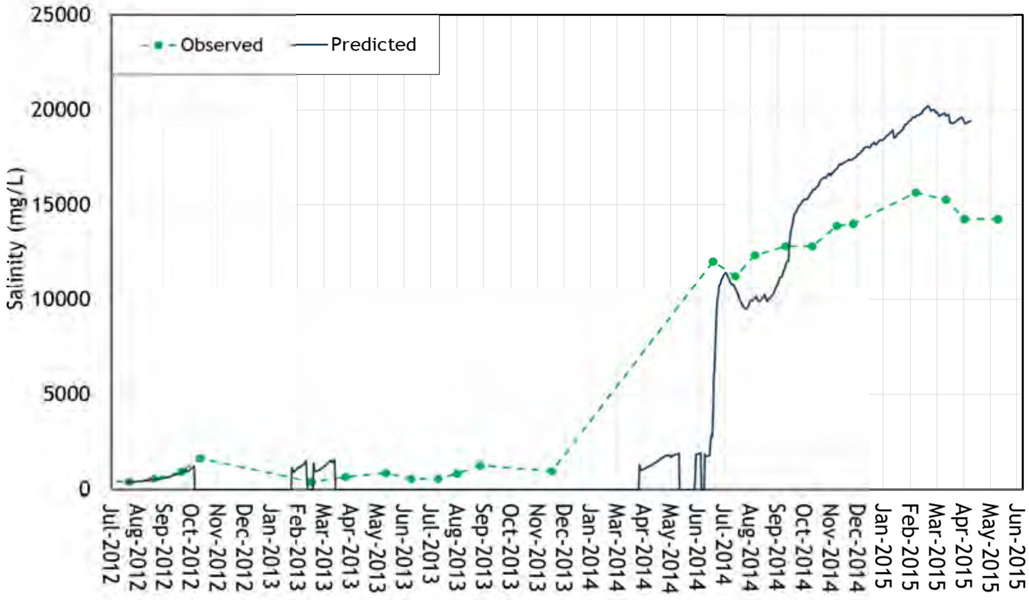

Figure A.12 - Observed and predicted salinity in Dam C, July 2012 to April 2015

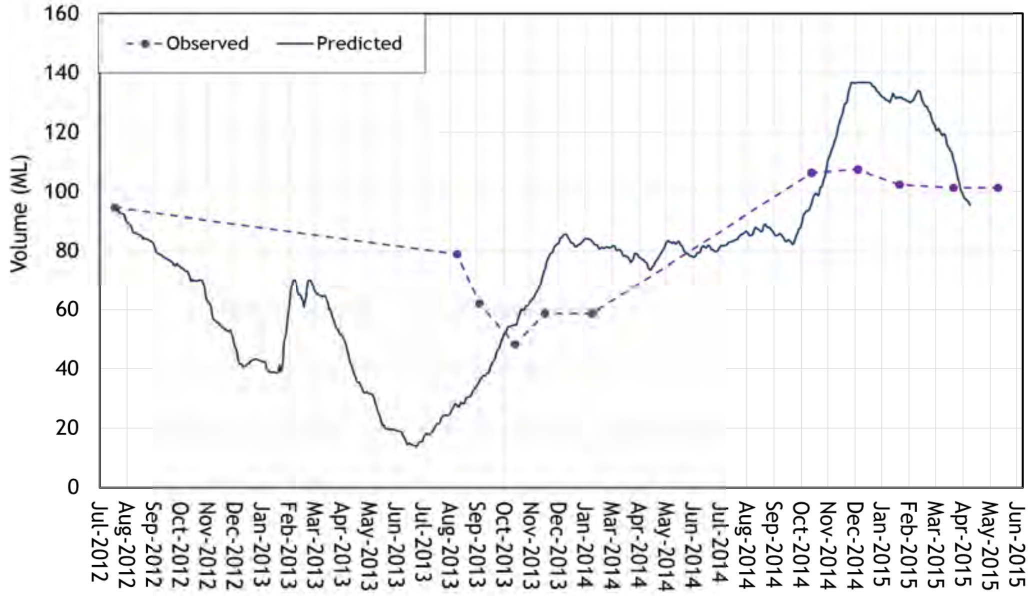

Figure A.13 - Observed and predicted volume in Dam D, July 2012 to April 2015

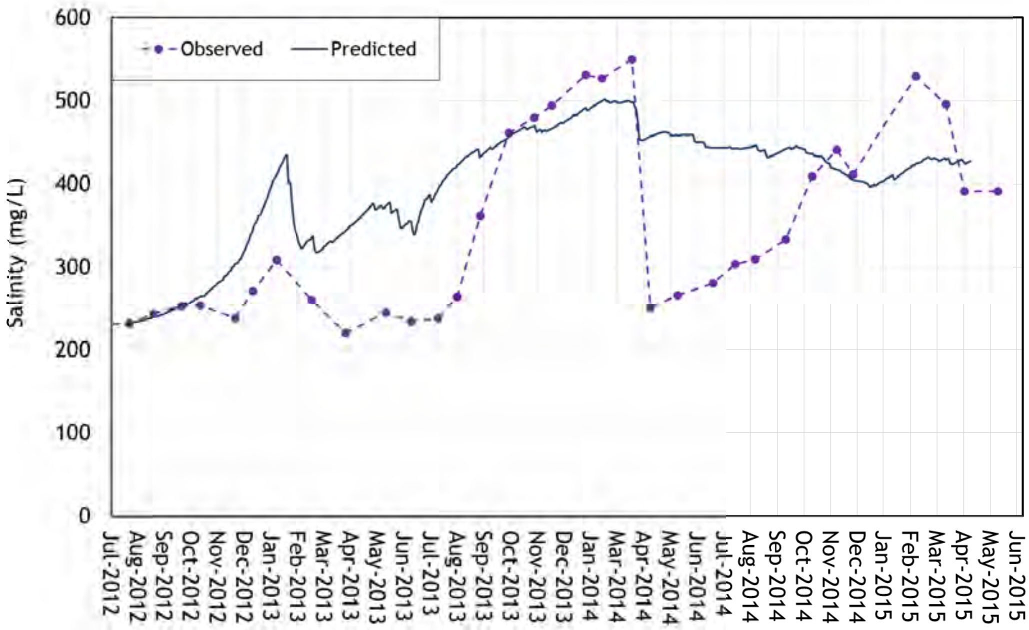

Figure A.14 - Observed and predicted salinity in Dam D, July 2012 to April 2015