BHP

MT ARTHUR COAL MINE
MODIFICATION 2

Modification Report

Appendix G
Surface Water Assessment

Resource Strategies

REPORT

HUNTER VALLEY ENERGY COAL PTY LTD
ABN: 39 062 894 464

Mt Arthur Coal Modification 2

Surface Water Assessment

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1 INTRODUCTION

1.1 Project Overview

The Mt Arthur Coal Mine (MAC) is an existing open cut coal mining operation located approximately 5 kilometres (km) south-west of Muswellbrook, within the Muswellbrook Local Government Area in the Upper Hunter Valley of New South Wales (NSW) (refer **Map 1**).

MAC is owned and operated by Hunter Valley Energy Coal Pty Ltd (HVEC), a wholly owned subsidiary of BHP. MAC is currently approved to operate until 30 June 2026 in accordance with condition 5 of Schedule 2 of Project Approval MP 09_0062 (MP 09_0062).

HVEC is proposing to modify MP 09_0062 to allow for the extension of mining operations at MAC until 30 June 2030 (hereafter referred to as the Modification). The Modification is being sought under section 4.55(2) of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

A Modification Report has been prepared to support the modification application in consideration of the *State Significant Development Guidelines* (Department of Planning, Industry and Environment [DPIE], 2022a), in particular *Appendix E – Preparing a Modification Report* (DPIE, 2022b).

This Surface Water Assessment (SWA) report forms a component of the Modification Report.

1.2 Modification Overview

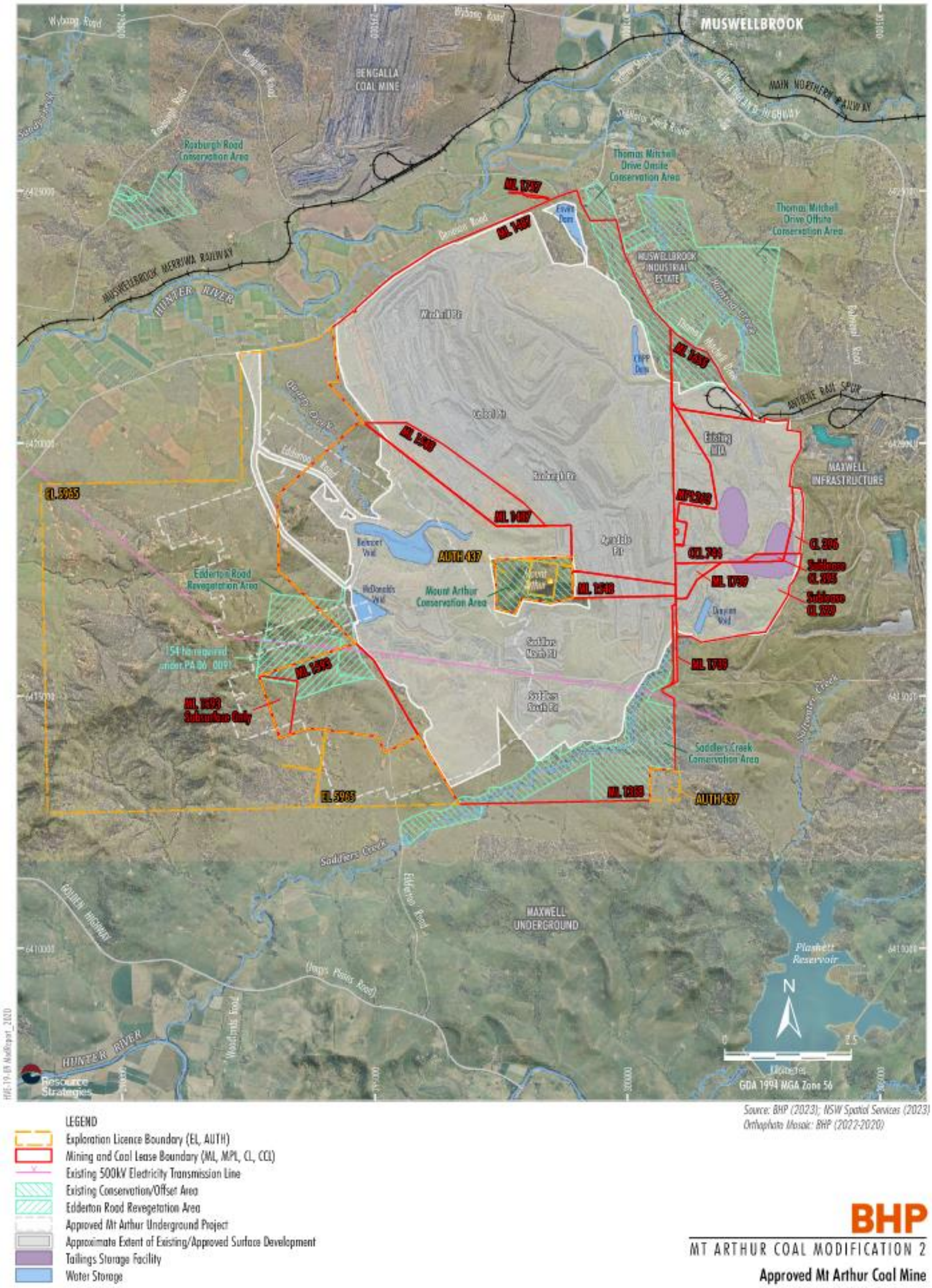
The modified MAC would be wholly located within the approved Development Application Area listed in Appendix 1 of MP 09_0062, and would include the following changes to the approved MAC (refer **Map 2**):

- four-year extension of mining activities to 30 June 2030;
- reduction in the approved open cut mining rate from 32 Mtpa of run-of-mine (ROM) to a maximum of 25 Mtpa ROM (similar to current actual ROM coal production);
- reduction in the cumulative open cut and underground ROM coal handling rate from 36 Mtpa to 29 Mtpa;
- reduction in maximum total (open cut and underground) coal rail transportation from 27 Mtpa of product coal to 20 Mtpa, and a reduction in train movements from 30 to 20 movements per day;
- minor extension of the approved disturbance area in the north-west corner of the operation predominantly to allow for access and ancillary infrastructure (refer to *Modification new disturbance area* on **Map 2**);
- an overall reduction (387 ha) in approved disturbance, as some previously approved disturbance areas are no longer intended to be disturbed (refer to *Impact Minimisation Area* on **Map 2**); and
- revised final landform and final void configuration, including an overall reduction in the approved height of the northern overburden emplacement areas and the final landform (to reflect the current actual height).

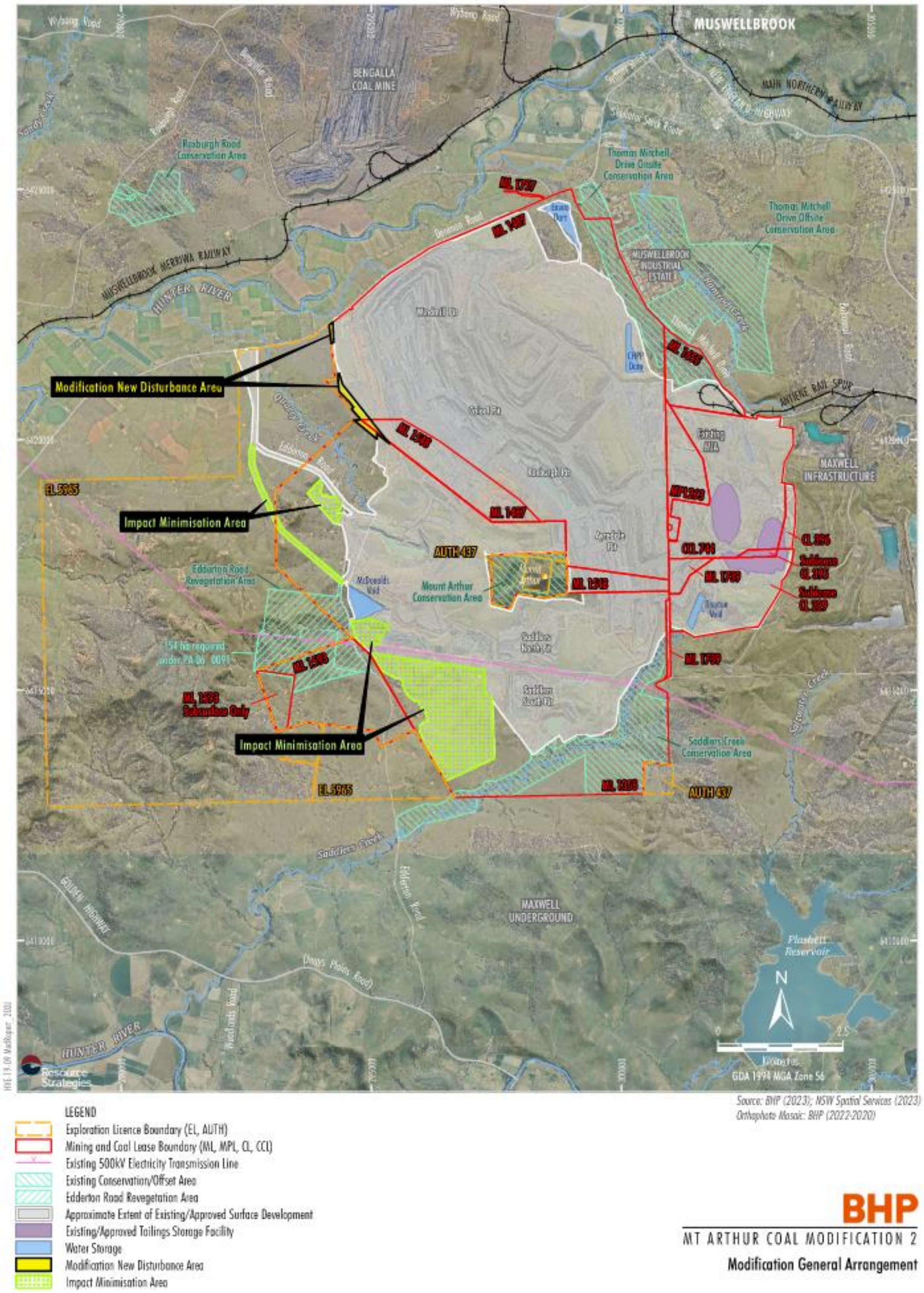
The Modification would involve no change to:

- existing mining tenements;
- existing coarse rejects and tailings management;
- existing workforce;
- the existing explosives facility;
- existing site accesses;
- existing electricity supply and distribution;
- existing offset and rehabilitation objectives;
- existing services, plant and equipment; and
- the existing hours of operation and associated activities (undertaken 24 hours per day, seven days a week).

MAP 1: APPROVED MT ARTHUR COAL MINE



MAP 2: MODIFICATION GENERAL ARRANGEMENT



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1.3 Assessment Scope

ATC Williams Pty Ltd (ATCW) was commissioned by HVEC to prepare a SWA in support of the Modification to MP 09_0062. The scope of the SWA comprised:

1. review of the environmental management performance of MAC in relation to surface water and water resources;
2. operational water balance modelling of the MAC water management system to reflect the proposed Modification;
3. a post-closure final void water balance assessment;
4. assessment of the impacts of the proposed Modification on the quantity and quality of relevant surface water resources; and
5. review of the existing surface water monitoring, mitigation and management strategies and recommendations relating to the proposed Modification.

The outcomes of the above works are detailed herein.

2 SURFACE WATER RESOURCES AND REVIEW OF ENVIRONMENTAL MANAGEMENT PERFORMANCE

2.1 Local and Regional Overview

The MAC approved disturbance area encompasses approximately 6,710 hectares (ha) (refer **Map 1**). The site topography comprises mostly undulating hills, with Mount Arthur rising as the dominant landscape feature. Surface elevations vary from approximately 133 metres (m) Australian Height Datum (AHD) along Denman Rd at the north-western boundary of the mining tenements to 482 m AHD at Mount Arthur.

Land use other than coal mining in the local area includes residential and rural residential dwellings and industrial operations, while alluvial lands near the Hunter River are utilised for crop production including vineyards and orchards, thoroughbred breeding and cattle grazing. Much of the surrounding lands have been cleared of original vegetation cover and are predominantly grassland. Areas of original and remnant vegetation are scattered throughout the Modification Area.

2.2 Climate

Based on long-term historical climate data recorded at several established Bureau of Meteorology (BoM) stations in the surrounding region, MAC experiences a dry temperate climate. The closest open rainfall station with a long-term record is Muswellbrook at Lindisfarne (station number 061168); with a recorded annual average rainfall of approximately 611 millimetres (mm). The highest monthly rainfall recorded at Muswellbrook at Lindisfarne (061168) was recorded in June 2007 (278.4 mm). Rainfall is distributed throughout the year, however, on average, is generally higher in the summer months.

In contrast, evaporation records for Lostock Dam (station number 061288) indicate average annual pan evaporation of approximately 1,570 mm.

2.3 Surface Water Catchments

2.3.1 Regional Surface Water Catchment

MAC is located wholly within the Hunter River catchment, which is one of the six major regulated river basins in NSW. Flow regulation in the Hunter River is provided by three main water storages – Glenbawn, Glennies Creek and Lostock. These storages are operated by WaterNSW to provide flows for irrigation and other uses, including mining and power generation. Glenbawn Dam also provides flood mitigation in the Hunter River with a substantial reserve storage held for this purpose.

Hunter River streamflow gauging stations in close proximity to MAC are located at Muswellbrook Bridge (GS210002) and Denman (GS210055) (refer **Map 3**). GS210002 is located on the Hunter River upstream of MAC and has a catchment area of 4,220 square kilometres (km^2). GS210055 is located on the Hunter River downstream of MAC and has a catchment area of 4,530 km^2. Monitoring data obtained from WaterNSW indicates that the mean annual flow recorded at GS210055 between January 1959 and June 2023 was 252,509 megalitres (ML).[1]

2.3.2 Local Watercourses

Surface drainage generally consists of ephemeral creeks flowing north and south-westwards, ultimately discharging to the Hunter River. Quarry Creek and Ramrod Creek flow northwards to the Hunter River within and adjacent to the existing mining operations. Saddlers Creek flows generally to the south-west and joins the Hunter River downstream of Denman. The local watercourses are first order streams (according to the Strahler classification system), with the exception of the headwaters of Saddlers Creek which are first and second order.

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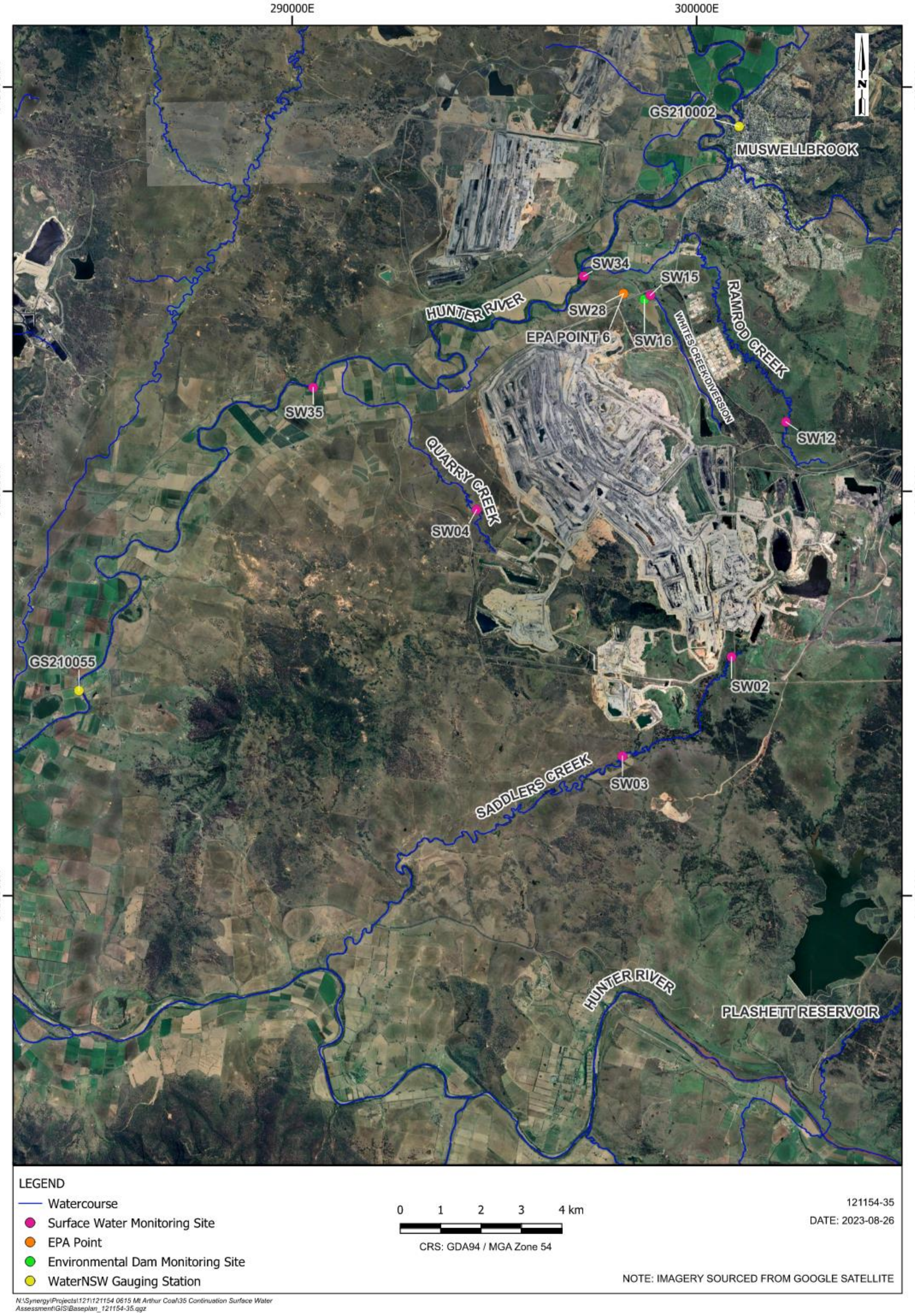
[1] Source: www.realtimedata.waternsw.com.au

MAP 3: SURFACE WATER SYSTEMS AND MONITORING SITES



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The catchment area of several watercourses has previously been modified by the approved mining operations including Quarry Creek, Whites Creek and Ramrod Creek. The Whites Creek Diversion captures and conveys runoff from undisturbed and rehabilitated mining areas around the north-eastern areas of MAC. The diversion discharges to a small tributary downstream of Denman Road which then flows to the Hunter River.

2.4 Flooding

An alluvial cut-off wall and flood levee has been constructed adjacent to the Windmill open cut pit, parallel to Denman Road. A flood study of the Hunter River, undertaken by Golder Associates (2018), predicted a Probable Maximum Precipitation flood level of approximately 135.4 to 135.9 m AHD in the vicinity of the cut-off wall and flood levee. Digital Elevation Model data indicates a minimum crest elevation of the alluvial cut-off wall and flood levee of 136.4 m AHD. As such, the risk of flood ingress to the open cut operations is extremely low.

2.5 Surface Water Compliance

Water management at MAC is undertaken in accordance with the *Water Management Plan* (BHP, 2023) and the *Sediment and Erosion Control Plan* (BHP, 2021). The *Water Management Plan* (BHP, 2023) details the surface water monitoring program, impact assessment criteria and response plan to be implemented in the event of a trigger exceedance. The water monitoring program and surface water response plan have been developed to ensure that MAC complies with the conditions of MP 09_0062, EPL 11457 and the HRSTS.

2.5.1 Hunter River Salinity Trading Scheme and Environment Protection Licence 11457

The HRSTS is managed by the NSW Environment Protection Authority (EPA) under the *Protection of the Environment Operations (Hunter River Salinity Trading Scheme) Regulation 2002*.

The HRSTS prohibits the release of saline water during periods of low flow in the Hunter River and controls releases of saline water during periods of high flow such that specific salinity targets at various points in the river are not exceeded.

Participants in the HRSTS are able to acquire HRSTS discharge credits at auction every two years. Credits are also able to be temporally traded between participants at any time per private negotiations. Each credit entitles the holder to a share of the available salt discharge capacity announced by WaterNSW during high flow periods. The amount of saline water that may be discharged from a given discharge licence holder is determined by reference to the salinity of the discharge waters, the river flow, the number of credits held and any overriding limit that may be applied as a condition of an EPL.

HVEC currently holds 20 HRSTS discharge credits. As required, controlled release of water from the Environmental Dam to the Hunter River is undertaken in accordance with the HRSTS and EPL 11457 (refer also **Section 4.1.3**).

EPL 11457 specifies monitoring requirements and discharge limits for release of water from the Environmental Dam to the Hunter River – EPA identification point 6 (refer **Map 3**). The monitoring requirements and discharge limits are summarised in **Table 1**.

TABLE 1: EPL 11457 POINT 6 MONITORING REQUIREMENTS AND DISCHARGE LIMITS

Parameter	Limit	Monitoring Requirements
pH	6.5 – 9.0	Representative sample collected daily during any discharge
EC (µS/cm)	As per HRSTS	Continuous records during discharge via an EC probe
TSS (mg/L)	120	Representative sample collected daily during any discharge
Discharge (ML/d)	450	Continuous during discharge

EC = electrical conductivity; TSS = total suspended solids
µS/cm = microsiemens per centimetre; mg/L = milligram per litre; ML/d = megalitres per day

2.5.2 Water Management Plan

Water quality monitoring is undertaken at several locations within and adjacent to MAC. In addition to EPL 11457 Point 6 (SW28), the *Water Management Plan* (BHP, 2023) specifies seven statutory water quality monitoring sites. Five statutory monitoring sites are located on local watercourses downstream of mining operations – SW02, SW03, SW04, SW12 and SW15 and two are located on the Hunter River – SW34, upstream of MAC and SW35, downstream of MAC. The site locations are shown on **Map 3**.

Water quality monitoring is undertaken as follows (BHP, 2023):

- Field pH, field EC and TSS – monitored monthly or following a rainfall event of 25 mm or greater with a 24 hour period.
- Dissolved aluminium, antimony, arsenic, barium, boron, cadmium, chromium, copper, lead, mercury, molybdenum, selenium and zinc – monitored annually.

Trigger values are presented in the *Water Management Plan* (BHP, 2023) for specific surface water monitoring sites. A Stage 1 trigger initiates review and quality assurance of the recorded data while a Stage 2 trigger initiates further actions in accordance with the *Water Management Plan* (BHP, 2023). Stage 1 and Stage 2, as defined in BHP (2023), comprise:

- Stage 1
    - pH - measured values exceed the upper or lower pH trigger level at a given monitoring site for one monitoring event.

    And / Or

    - EC and/or TSS values exceed the Stage 1 trigger value at a given monitoring site for one monitoring event.
- Stage 2
    - pH - measured values exceed the upper or lower pH trigger level at a given monitoring site for three consecutive monitoring events.

    And / Or

    - EC and/or TSS values exceed the Stage 1 trigger value at a given monitoring site for three consecutive monitoring events OR the Stage 2 trigger value for two consecutive monitoring events.

HVEC also monitors stream health at monitoring sites SW03, SW04, SW12 and SW15. Stream health monitoring is undertaken annually and comprises monitoring of riparian vegetation, in-stream vegetation and channel stability.

2.6 Surface Water Quality Review

2.6.1 Surface Water Monitoring Sites

HVEC has conducted an extensive water quality monitoring program, with monitoring data available for several sites from 1995. Monitoring data for the full period of record is presented graphically in **Appendix A.**

Table 2 presents the current trigger values for each site and summary statistics of the historical water quality monitoring data recorded following approval of the *Mt Arthur Coal Consolidation Project* (BHP, 2009) from September 2010 to present.

It is noted that, since approval of the *Mt Arthur Coal Consolidation Project* (BHP, 2009), the monitoring sites and trigger values have been revised over time and documented in several versions of the *Water Management Plan.* For indicative purposes only, the current *Water Management Plan* (BHP, 2023) trigger values are presented in **Table 2**.

TABLE 2: SURFACE WATER QUALITY SUMMARY STATISTICS

Constituent	Trigger Value[1]		No. of Samples	Minimum	Median	Maximum
SW02 – Saddlers Creek (Sep 2010 – Apr 2017)[2]						
pH	6.5 – 9.0		46	6.9	7.5	8.3
EC (µS/cm)	Stage 1	12,365	46	1,360	7,010	11,000
	Stage 2	13,900				
TSS (mg/L)	Stage 1	219	46	5	14	828
	Stage 2	277				
SW03 – Saddlers Creek (Sep 2010 – Mar 2023)						
pH	6.5 – 9.0		139	7.0	7.9	8.5
EC (µS/cm)	Stage 1	10,133	139	485	5,190	12,300
	Stage 2	11,402				
TSS (mg/L)	Stage 1	37	139	5	7	136
	Stage 2	46				
SW04 – Quarry Creek (Sep 2010 – Mar 2023)						
pH	6.5 – 9.0		128	7.3	8.2	9.3
EC (µS/cm)	Stage 1	13,959	128	258	8,085	21,000
	Stage 2	15,509				
TSS (mg/L)	Stage 1	82	128	2	5	127
	Stage 2	104				
SW12 – Ramrod Creek (Sep 2010 – Mar 2023)						
pH	6.5 – 9.0		145	6.8	7.9	8.7
EC (µS/cm)	Stage 1	6,659	145	502	5,040	12,600
	Stage 2	7,153				
TSS (mg/L)	Stage 1	555	145	5	10	340
	Stage 2	708				
SW15 – Whites Creek Diversion (Sep 2010 – Mar 2023)						
pH	6.5 – 9.0		115	7.2	8.1	9.1
EC (µS/cm)	Stage 1	7,128	115	45	2,347	11,100
	Stage 2	8,262				
TSS (mg/L)	Stage 1	103	115	3	6	380
	Stage 2	130				
SW34 – Hunter River Upstream (Sep 2013 – Mar 2023)[3]						
pH	-		115	7.5	8.1	8.8
EC (µS/cm)	-		114	242	470	1,021
TSS (mg/L)	-		115	5	15	1,500
SW35 – Hunter River Downstream (Mar 2014 – Mar 2023)[3, 4]						
pH	7.8 – 8.5		109	7.4	8.2	9.0
EC (µS/cm)	323 – 893		109	262	530	1,057
TSS (mg/L)	54		109	5	17	3,800

Notes:

1. Source: *Water Management Plan* (BHP, 2023).
2. Site records provided by HVEC indicate that monitoring site SW02 was either dry or unable to be accessed after April 2017.
3. From start of available record to March 2023.
4. SW34 is an upstream reference site and, as such, does not have trigger values.

The data presented in **Table 2** indicates that near neutral to slightly alkaline pH conditions have been recorded at monitoring sites SW02 and SW03 on Saddlers Creek since September 2010, with a slight declining trend in pH recorded over the period of monitoring (refer **Appendix A**). EC has ranged from 1,360 µS/cm to 11,000 µS/cm at monitoring site SW02 and from 485 µS/cm to 12,300 µS/cm at monitoring site SW03. A median TSS concentration of 14 mg/L was recorded at SW02 while a median TSS concentration of 7 mg/L was recorded at SW03. Based on the water quality data presented in **Appendix A**, there is no discernible change in the trend of EC or TSS values recorded at monitoring sites SW02 and SW03 on Saddlers Creek for the full period of monitoring.

The data presented in **Table 2** indicates that near neutral to slightly alkaline pH conditions have been recorded at monitoring sites SW04, SW12 and SW15 since September 2010, with a very slight declining trend in pH recorded over the period of monitoring (refer **Appendix A**). EC has ranged from 258 µS/cm to 21,000 µS/cm at monitoring site SW04 and from 502 µS/cm to 12,600 µS/cm at monitoring site SW12. As illustrated in **Appendix A**, the EC values recorded at monitoring site SW12 from 2017 have been more variable than that recorded prior to 2017. It is considered that the EC variability was related to variability in climatic conditions with an extended period of below average rainfall recorded from 2017 to 2019 and above average rainfall recorded from 2020 to 2022 (refer **Appendix A**). At monitoring site SW15, EC has ranged from 45 µS/cm to 11,100 µS/cm historically although it is noted that there has been a substantial decline in EC recorded at SW15 since 2015 (refer **Appendix A**). A median TSS concentration of 5 mg/L was recorded at SW04, 10 mg/L at SW12 and 6 mg/L at SW15. Based on the water quality data presented in **Appendix A**, there is no discernible change in the trend of TSS values recorded at monitoring sites SW04, SW12 and SW15 for the full period of monitoring and no discernible change in the trend of EC recorded at monitoring site SW04.

The data presented in **Table 2** indicates that near neutral to slightly alkaline pH conditions have been recorded at monitoring sites SW34 and SW35 on the Hunter River since September 2013 and March 2014 respectively, with a very slight declining trend in pH recorded over the period of monitoring (refer **Appendix A**). EC has ranged from 242 µS/cm to 1,021 µS/cm at monitoring site SW34 and from 262 µS/cm to 1,057 µS/cm at monitoring site SW35. A median TSS concentration of 15 mg/L was recorded at SW34 while a median TSS concentration of 17 mg/L was recorded at SW35. Based on the water quality data presented in **Appendix A**, there is no discernible change in the trend of EC or TSS values recorded at monitoring sites SW34 and SW35 on the Hunter River for the full period of monitoring.

Based on the water quality data presented in **Table 2** and **Appendix A**, it is considered that MAC operations have had no discernible impact on the water quality of adjacent watercourses, including the Hunter River.

2.6.2 Mine Water Storage

The mine water management system is predominantly maintained as a closed system, with controlled release occurring from the Environmental Dam in accordance with the HRSTS and EPL 11457 (refer **Section 2.5.1**). Based on site records provided by HVEC, there were no controlled releases from the Environmental Dam from July 2012 to June 2022 or from December 2022 onwards. From July to November 2022, controlled release was undertaken on a total of 79 days.

Table 3 provides summary statistics of the Environmental Dam water quality (monitoring site SW16) recorded from September 2010 to March 2023. It is noted that the data presented in **Table 3** reflects the water quality of the stored water in the Environmental Dam at the time of monitoring**,** rather than the water quality of controlled release which was undertaken in accordance with the HRSTS and EPL 11457.

TABLE 3: ENVIRONMENTAL DAM WATER QUALITY SUMMARY STATISTICS

Constituent	No. Of Samples	Minimum	Median	Maximum
Field pH	151	8.1	8.7	9.2
Field EC (µS/cm)	151	168	1,780	5,580
TSS (mg/L)	151	5	22	158
Dissolved Aluminium (mg/L)	73	<0.01	<0.01	2
Dissolved Antimony (mg/L)	72	<0.001	<0.001	0.003
Dissolved Arsenic (mg/L)	72	<0.001	<0.001	0.004
Dissolved Barium (mg/L)	72	0.03	0.05	0.11
Dissolved Boron (mg/L)	72	<0.05	<0.05	0.1
Dissolved Cadmium (mg/L)	73	<0.0001	<0.0001	0.0003
Dissolved Chromium (mg/L)	72	<0.001	<0.001	0.002
Dissolved Copper (mg/L)	72	<0.001	<0.001	0.013
Dissolved Iron (mg/L)	130	<0.05	<0.05	0.19
Dissolved Lead (mg/L)	73	<0.001	<0.001	0.001
Dissolved Mercury (mg/L)	73	<0.0001	<0.0001	0.006
Dissolved Molybdenum (mg/L)	72	<0.001	0.007	0.031
Dissolved Selenium (mg/L)	72	<0.01	<0.01	0.02
Dissolved Zinc (mg/L)	73	<0.005	<0.005	0.007

The data presented in **Table 3** shows that the pH of the Environmental Dam ranged between pH 8.1 and pH 9.2 from September 2010 to March 2023. TSS ranged between 5 and 158 mg/L while EC ranged between 168 to 5,580 µS/cm. Median concentrations of dissolved metals were less than the limit of reporting for the majority of constituents.

Summary statistics of the water quality records for monitoring site SW28 (EPL Point 6) are presented in **Table 4** in comparison to the EPL 11457 Point 6 discharge limits (refer **Table 1**). The monitoring data was recorded during the periods of controlled release from the Environmental Dam (between July and November 2022).

TABLE 4: SW28 WATER QUALITY SUMMARY STATISTICS

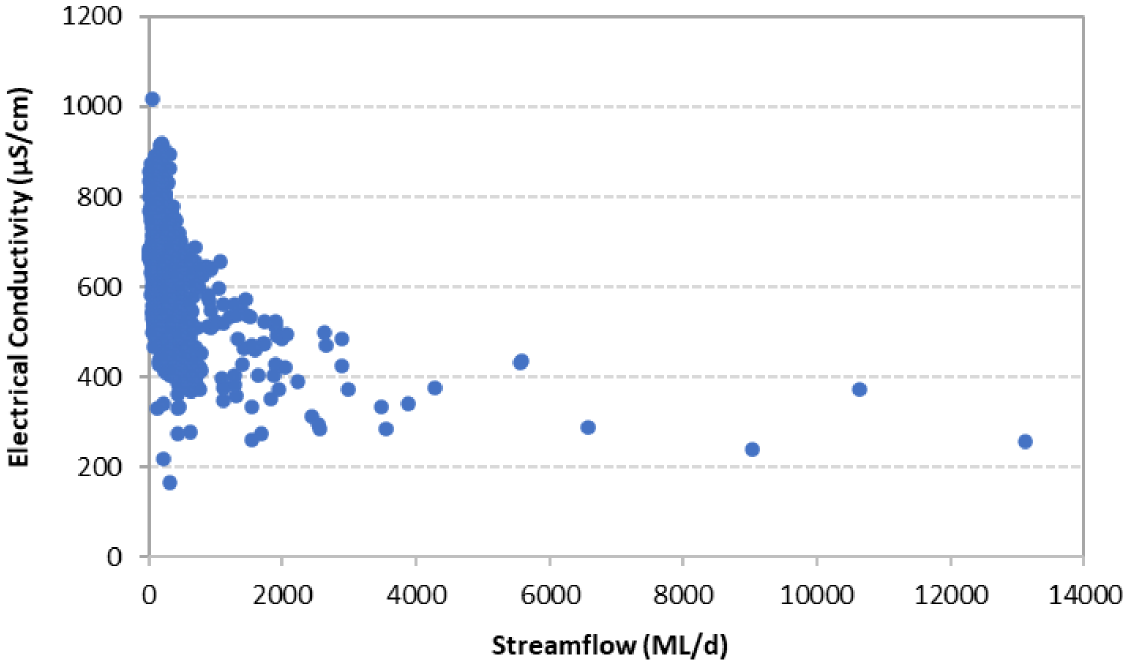
Constituent	EPL Point 6 Discharge Limit	Minimum	Median	Maximum
pH	6.5 – 9.0	7.5	8.8	8.9
EC (µS/cm)	As per HRSTS	2,930	3,690	4,300
TSS (mg/L)	120	6	22	106

The data presented in **Table 4** shows that the EPL Point 6 discharge limits were met for pH, EC and TSS during the periods of release from the Environmental Dam.

2.6.3 Hunter River

Salinity, as indicated by EC, has been monitored continuously by the WaterNSW at Muswellbrook Bridge (GS210002) upstream of the MAC since early 1992 and at Denman (GS210055) downstream of MAC since early 1993. The EC values at both sites have been highly variable due to varying flow; ranging from 93 µS/cm to 1,135 µS/cm at GS210002, and from 119 µS/cm to 1,492 µS/cm at GS210055. The median EC recorded at GS210002 and GS210055 was 452 µS/cm and 531 µS/cm respectively. The EC values are influenced by flow rate, as is illustrated in **Graph 1** below, which shows a generally inverse correlation between EC and flow rate. There is considerable scatter evident in the EC values at low flow rates.

GRAPH 1: RECORDED EC AND STREAMFLOW – HUNTER RIVER AT DENMAN (GS210055)



3 SURFACE WATER MANAGEMENT

3.1 Existing Water Management System

MAC comprises a large multi-open cut mine and coal handling and preparation plant (CHPP). The MAC surface water management system involves a number of interlinked active mining pits, former pit voids, dams, a tailings storage facility (TSF), the CHPP and water pumping systems. The system is illustrated in schematic form in **Diagram 1**. The location of water storages, and the catchment and sub-catchment areas of these storages at mid-2022, are shown in **Map 4**.

ROM coal from the open cut pits is transported by trucks to a ROM Pad, prior to crushing, with a portion of the coal washed in the CHPP. Product coal is stockpiled near the CHPP prior to transport via conveyor to an export coal loader where it is loaded onto trains via a rail loop. CHPP tailings discharge occurs to the Mt Arthur TSF. Little direct reclaim of water has occurred from the tailings storage, with tailings water understood to either be retained within the tailings, percolate into surrounding spoil or seep to the nearby Drayton Void where is it managed within the MAC mine water management system.

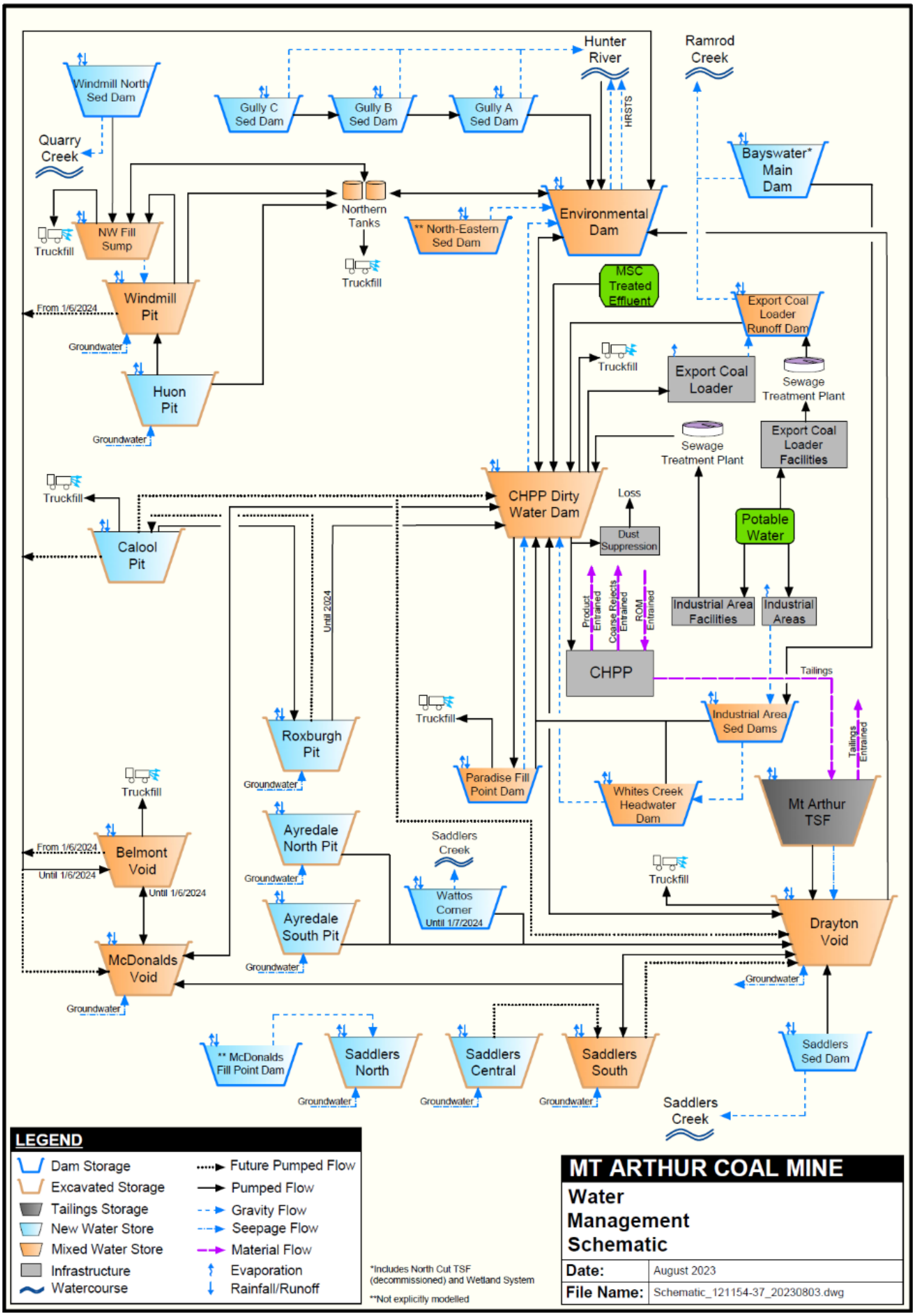
The network of on-site storages incorporates separation of undisturbed area runoff from mine water catchment areas. Runoff from undisturbed or rehabilitated areas where vegetation is fully established is diverted away from disturbed mining catchments to the downstream environment. Runoff from areas of spoil or rehabilitated spoil that could contain elevated suspended solids (but that is unlikely to have the potential to generate elevated levels of other environmentally significant constituents) would either continue to be predominantly directed to on-site storages for reuse or be directed to sediment dams. Sediment dams are sized in accordance with Landcom (2004) and DECC (2008) and managed in accordance with the MAC *Erosion and Sediment Control Plan* (BHP, 2021). Runoff from the CHPP area collects in an adjacent mine water storage which overflows to the CHPP Dirty Water Dam, where it is recycled for site use. Runoff from the industrial (workshops and administration) and mining areas collects in a series of mine water storages for site re-use.

Treated effluent pumped from the Muswellbrook Waste Water Treatment Plant is directed into the CHPP Dirty Water Dam. Domestic wastewater is collected and treated in an on-site treatment plant. The treated effluent is then directed to a wetland system for further treatment and subsequently returned to the mine water system for reuse. A second treatment plant treats wastewater from the export coal loader facilities, with treated wastewater directed to the Export Coal Loader Runoff Dam. Sludge is then removed and trucked offsite by a licensed contractor to appropriate waste handling facilities.

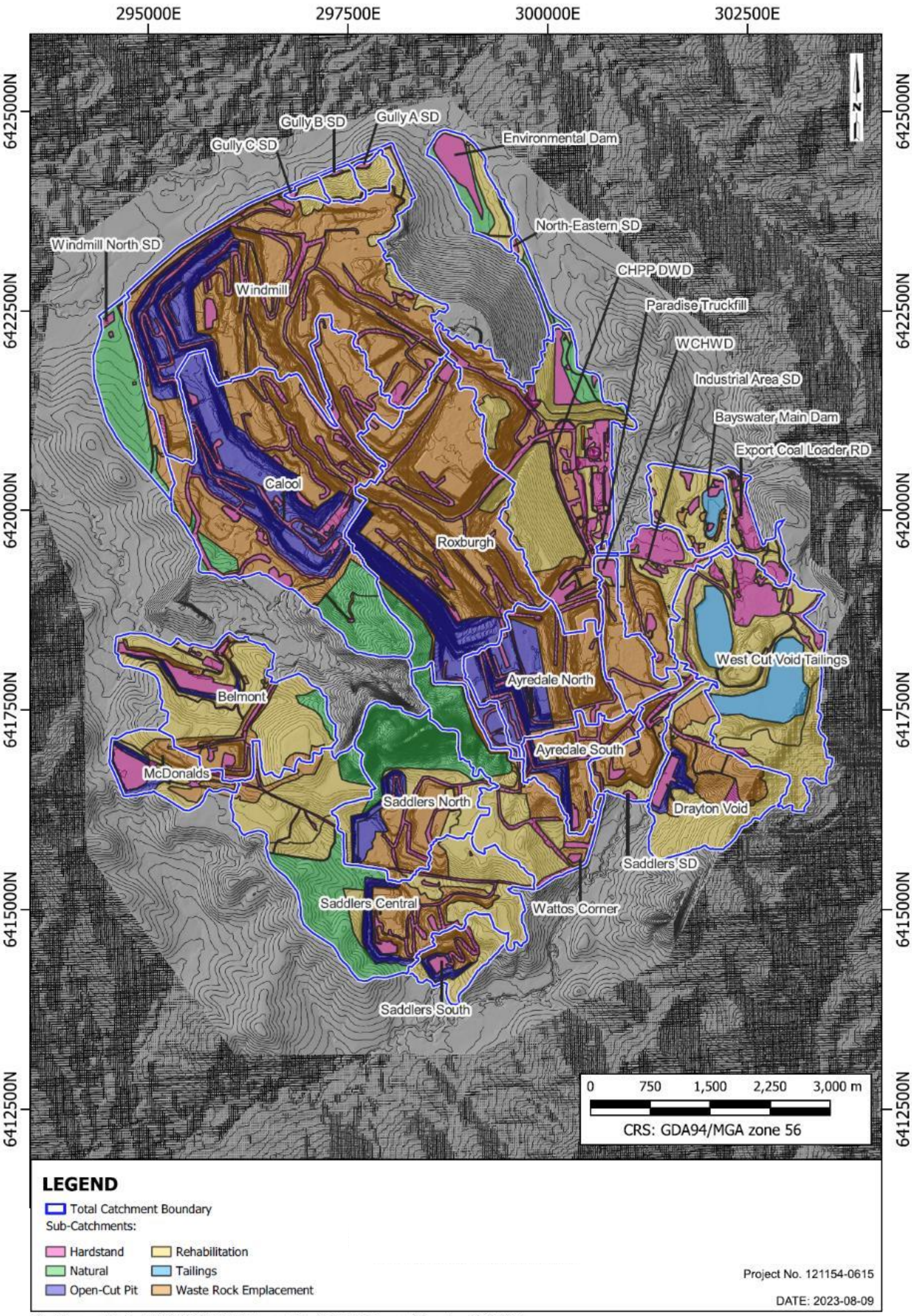
The MAC surface water management system is operated to maintain a secure water supply for the CHPP and for haul road dust suppression. The CHPP, which is the dominant user of water on-site, incorporates a tailings thickener and water recovery system to enhance water recycling. The majority of the mine water supply is obtained from runoff captured from disturbed mine landforms, groundwater inflow to the open cut and from water imported to the site. Imported water includes licensed extraction from the Hunter River and treated effluent water sourced from the town of Muswellbrook. HVEC currently holds 2,197 ML high security water allocation licence (WALs) and 3,564 ML general security WALs for MAC. Water pumped from the Hunter River is initially stored in the Environmental Dam prior to use.

As stated in **Section 2.5.1**, controlled release from the Environmental Dam to the Hunter River may be undertaken in accordance with the HRSTS and EPL 11457.

DIAGRAM 1: MODELLED WATER MANAGEMENT SYSTEM SCHEMATIC



MAP 4: CATCHMENT AND SUB-CATCHMENT AREAS – 2022



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3.2 Modification Water Management System

The Modification water management system would remain generally as per that of the existing MAC water management system. Some elements of the existing system would be decommissioned as they become redundant during the life of the mine.

As stated in **Section 1.2**, the Modification would comprise:

- minor extension of the approved disturbance area in the north-west corner of the operation predominantly to allow for access and ancillary infrastructure (refer to *Modification new disturbance area* on **Map 2**); and
- an overall reduction in approved disturbance, as some previously approved disturbance areas are no longer required (refer to *Impact Minimisation Area* on **Map 2**).

The proposed future mine progression and water management system is described at four stages (2024, 2026, 2028 and 2030) in the following sub-sections.

3.2.1 Year 2024 Layout

The proposed 2024 MAC layout plan is shown in **Map 5**. At this stage, the northern open cut mining areas (Ayredale, Roxburgh, Calool and Windmill) would continue progressing to the south and west of the existing open cut operations. Overburden would continue to be placed behind (generally east of) the northern open cut mining areas and in the McDonalds, Belmont and Saddlers Central catchments.

Saddlers Central open cut would continue progressing to mid-2024 with overburden placed in the former Saddlers North open cut. The maximum surface area of open cut operations is expected to be reached in mid-2024.

Runoff and seepage from the overburden emplacements would continue to report to adjacent active open cut mining areas or to on-site storages.

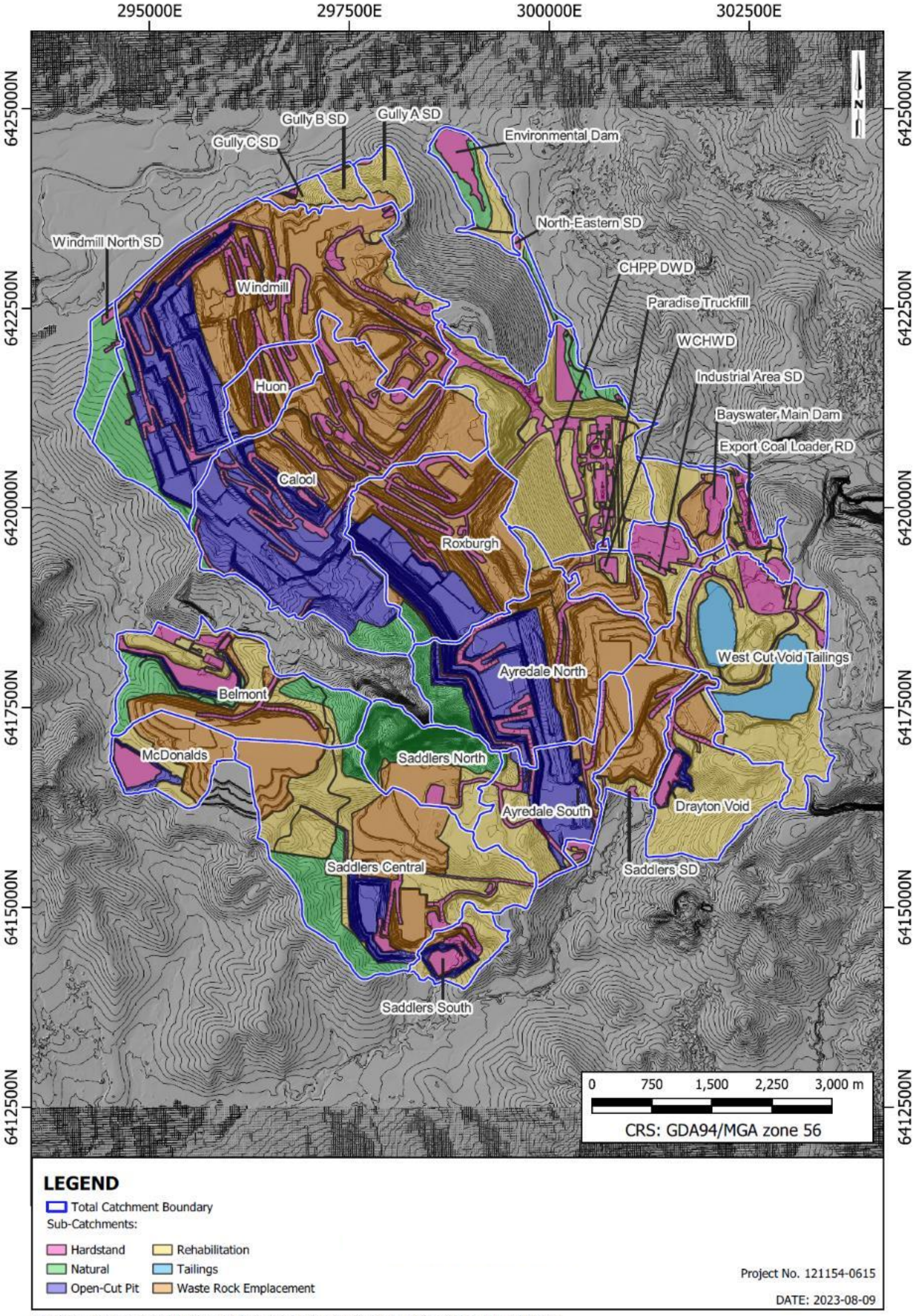
As Ayredale South open cut mining progresses, the catchment area of Wattos Corner Sediment Dam would progressively reduce with Wattos Corner Sediment Dam expected to be decommissioned in late 2024. Runoff and direct rainfall would be captured in the open cut mining area and pumped to the mine water system for reuse.

3.2.2 Year 2026 to Year 2030 Mine Layout

The proposed mine layout plans for Year 2026, 2028 and 2030 are shown in **Map 6** to **Map 8** respectively. From 2026 to 2030, the northern open cut areas would continue progressing to the south and west with overburden placed generally east of the open cut operations. As of 2028, mining of Ayredale North would be completed with overburden placed in the former open cut.

The 2026 to 2030 water management system would remain generally consistent with that implemented in 2024.

MAP 5: CATCHMENT AND SUB-CATCHMENT AREAS – MID 2024



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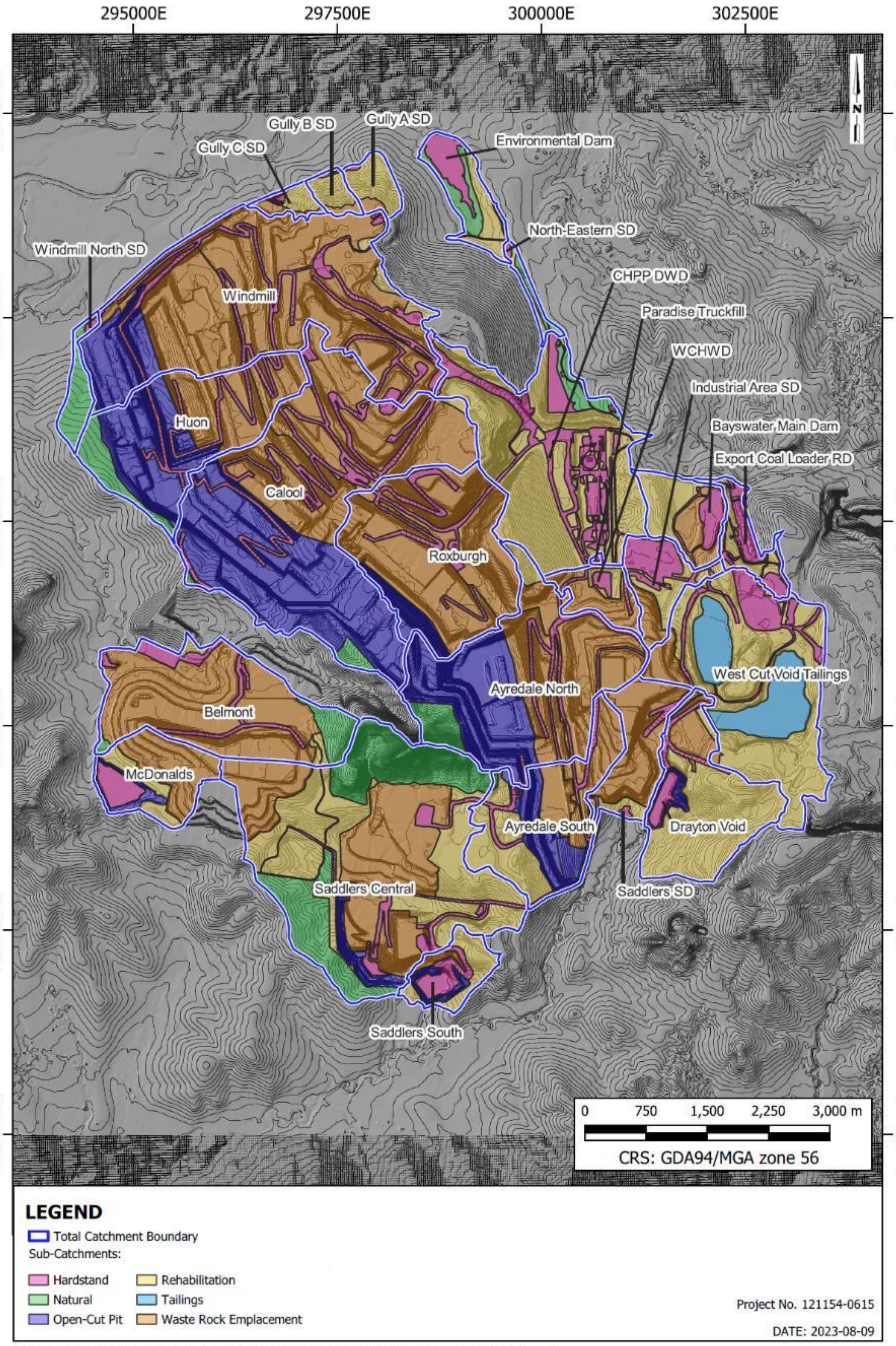
MAP 6: CATCHMENT AND SUB-CATCHMENT AREAS – MID 2026



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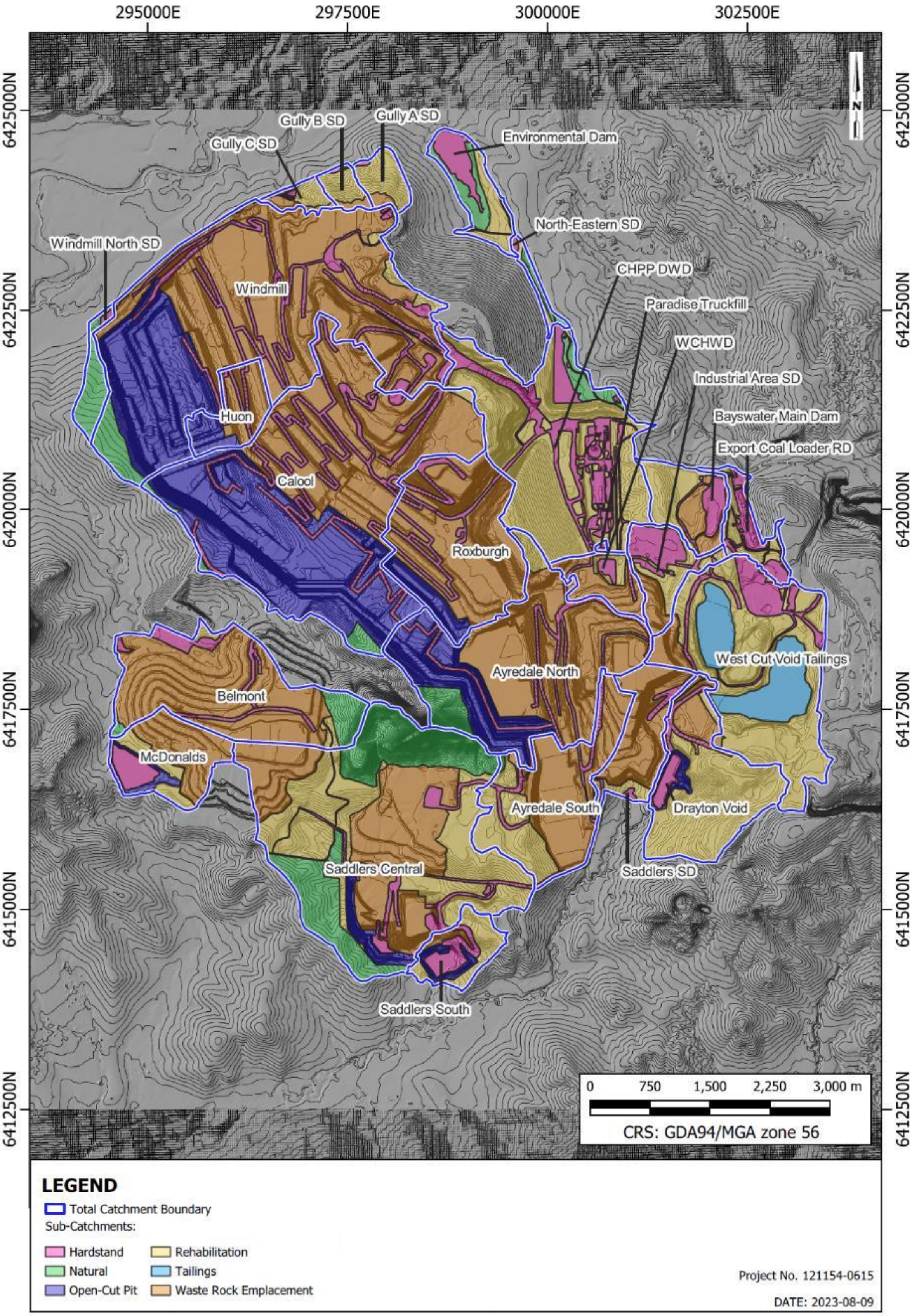
MAP 7: CATCHMENT AND SUB-CATCHMENT AREAS – MID 2028



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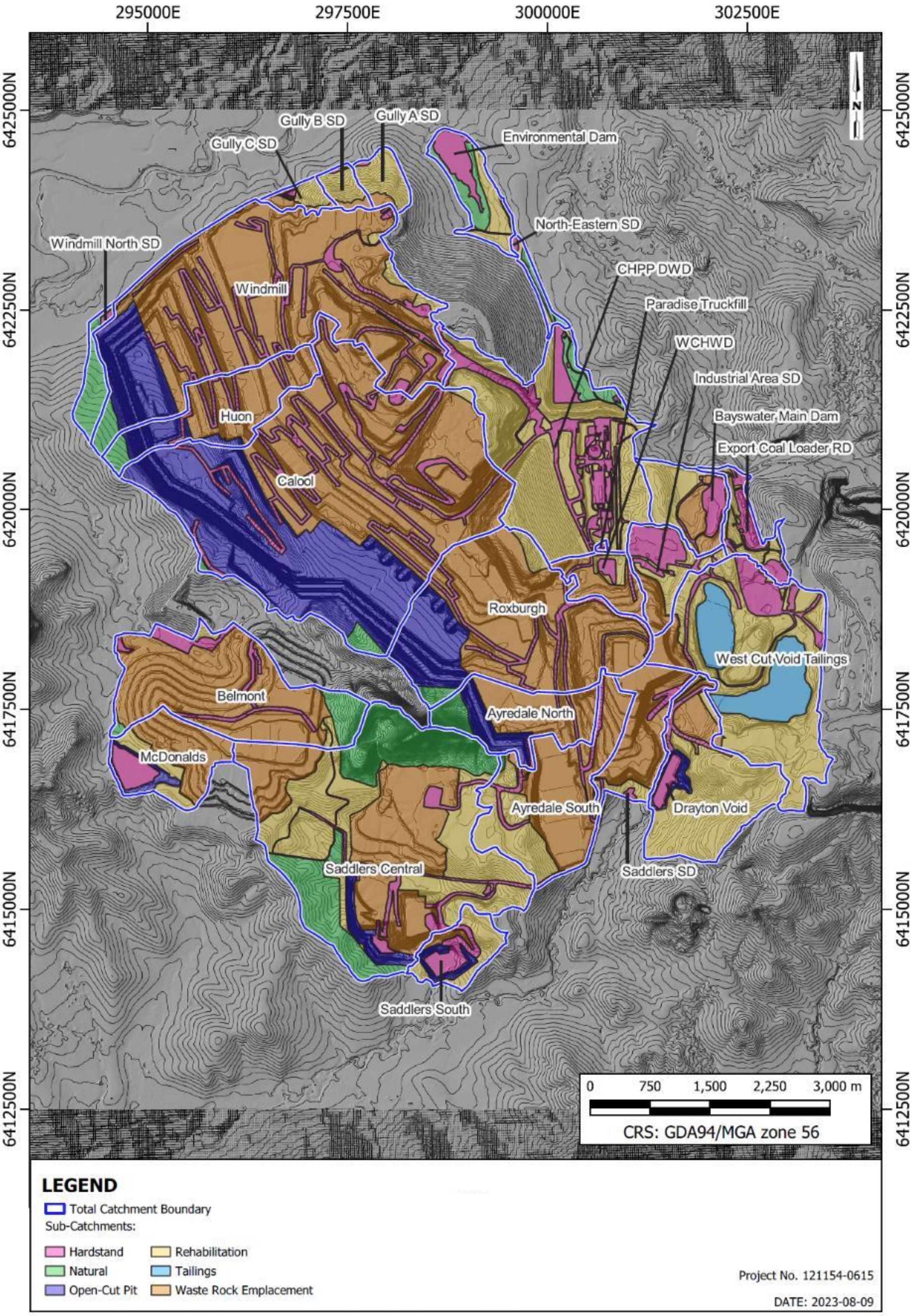
MAP 8: CATCHMENT AND SUB-CATCHMENT AREAS – MID 2030



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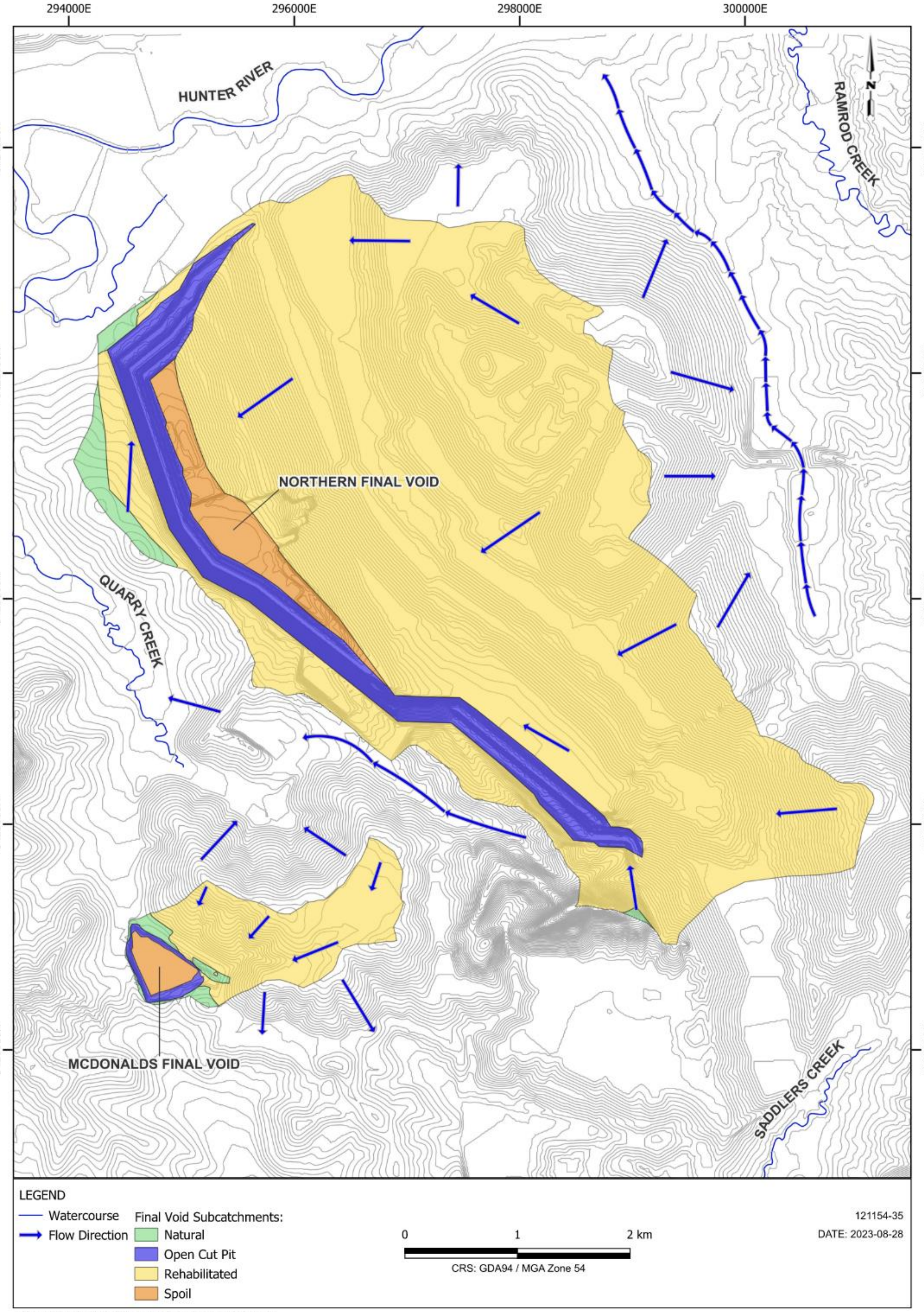
3.3 Post-Mining Water Management System

The conceptual final landform water management system is illustrated in **Map 9**. The final landform is proposed to comprise two remnant final voids: Northern and McDonalds. Post-mining, runoff from rehabilitated and revegetated areas of the mine, other than that directed to the final voids, would be directed to the local drainage network. Drainage control works and a stable drainage system would be designed to direct runoff from the rehabilitated mine area to local creeks.

The total catchment area reporting to the remnant final voids is estimated at 25.7 km^2. A total of 23.8 km^2 is estimated as reporting to the Northern final void and 1.9 km^2 estimated as reporting to McDonalds final void.

The final landform presented in the *Mt Arthur Coal Open Cut Modification – Environmental Assessment* (BHP, 2013) proposed a total catchment area of 14.2 km^2 to be directed to the Northern final void. As such, the proposed Modification would result in an increase of 9.6 km^2 catchment area reporting to the Northern final void in comparison to that currently approved.

MAP 9: CONCEPTUAL FINAL VOID PLAN



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4 SIMULATED OPERATIONAL WATER MANAGEMENT SYSTEM

4.1 Model Description

4.1.1 Overview

A water balance model of the operational MAC water management system has been developed to simulate the storages and linkages shown in schematic form in **Diagram 1**. The model simulates the volume of water held in and pumped between all simulated water storages. For each storage, the model simulates:

Change in Storage = Inflow – Outflow

Where:

Inflow includes rainfall runoff, groundwater inflow (for mine open cut pits), tailings bleed[2] (for the TSF), water sourced from the Hunter River and all pumped inflows from other storages.

Outflow includes evaporation, spill, seepage, licensed discharge to the Hunter River via the HRSTS and all pumped outflows to other storages or to a demand sink (the CHPP, dust suppression, industrial area/facilities and export coal loader).

The model operates on a maximum 8 hourly time-step and simulates any period up to the end of planned operations in mid-2030. The model simulates a large number of different daily climatic (rainfall and evaporation) 'realizations' compiled from historical regional daily data from 1892 onwards (refer Section 4.1.4.1). For the simulations reported herein, each realisation comprised a 7-year period from mid-2023 to mid-2030. Modelled realizations were formed by 'moving' along the historical record one year at a time with the first realisation comprising the first 7 years in the record, the second advancing by one year in the record, the third advancing by two years and so on. The start and end of the historical data was 'linked' so that additional realizations which included years from both the beginning and end of the historical data were combined to generate additional climatic realizations. Using this methodology, 129 7-year realizations of daily rainfall and evaporation were formulated for use in the model simulations. The results from all realizations were used to generate water storage volume estimates and other relevant water balance statistics such as supply shortfall and simulated spills (if any). This method effectively includes the majority of the recorded historical climatic events in the water balance model, including high, low and median rainfall periods. By ranking simulated outcomes, the model can be used to estimate the probability and consequences of different water management outcomes occurring.

4.1.2 Hunter River Licensed Extraction

The MAC water management system includes licensed extraction of water to the Environmental Dam from the regulated Hunter River. In order to simulate possible future variations in available water from the Hunter River, the model was integrated with output from the Hunter River Integrated Quantity and Quality Model (IQQM). The IQQM is the model used by the NSW Department of Planning & Environment Water (DPE Water) to forecast allowable extractions or available water determinations (AWDs) through the water year (July to June). AWDs (also known as allocation levels) are used as a multiplier on annual volumetric licences held by each licensee. The IQQM was run using the same climatic data period and mine life realizations as the water balance model, to generate simulated future AWDs, daily streamflow at locations in the Hunter River and stored water volumes in the two main regulating storages: Glenbawn and Glennies Creek Dams. In addition, available DPE Water "rules" governing the declaration of "off-allocation" conditions (when extraction is temporarily not limited by AWDs) were incorporated in the model so as to simulate these events. Allocation carry-over was also simulated. Where available, recorded historical flows in the Hunter River were used instead of IQQM output.

Supply to the Environmental Dam from the Hunter River at a rate of 180 L/s is simulated according to the following conditions:

[2] Tailings bleed water is water liberated from tailings slurry as it settles within a tailings storage. This water either reports to the tailings surface, ponds and is available for reclaim pumping, or seeps to a neighbouring storage.

- When the stored volume in Glenbawn Dam is below 65% of capacity and the stored volume is declining or Hunter River AWDs are zero:
  - Extraction commences[3] when the stored site water inventory falls below 7,500 ML;

  otherwise:
  - Extraction commences[4] when the stored site water inventory falls below 6,405 ML.
- Extraction ceases when the stored site water inventory rises above 7,990 ML.

The model adopts 2,197 high security licence shares (ML) and 3,564 general security licence shares, reflecting the existing licence shares held by HVEC.

4.1.3 Hunter River Licensed Release

The model also includes the ability to simulate controlled discharge (licensed release) under the HRSTS. The model uses IQQM simulated or recorded actual flows for the Hunter River at Muswellbrook, along with relationships between flow and salinity (EC) developed from historical recorded data, to simulate EC in the river and to model allowable release using 13 credits simulated as held by HVEC[4]. Water is modelled as discharged from the Environmental Dam (depending on modelled flow in the Hunter River at that point in time) whenever the total volume of water held in all storages exceeds[5] 7,990 ML (as advised by HVEC personnel). A salinity of 2,736 mg/L total dissolved solids was adopted for Environmental Dam water (based on an average of recorded EC values for 12 months to May 2023 of 4,275 µS/cm) to simulate HRSTS release during high flow conditions. A peak discharge rate of 5,208 L/s (450 ML/d)[6] was adopted based on the maximum licensed rate in EPL 11457 (Clause L3.1).

4.1.4 Key Model Data and Assumptions

4.1.4.1 Climate Data

Modelling used 129 years of rainfall and pan evaporation data (1892-2020 inclusive) for the MAC location from SILO point data[7].

4.1.4.2 Catchment Areas

Modelled storage catchment areas were derived from the most recent available actual site plan (2022) and future mine stage plans. The interpreted catchment and sub-catchment areas for each stage plan (as adopted for rainfall-runoff modelling – refer Section 4.1.4.3) are shown in **Map 4** to **Map 8**. Derived total catchment and sub-catchment areas for all storages combined are summarized in **Graph 2**. Areas were assumed to vary linearly between the plan dates.

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[3] In addition, modelled conditions in the Environmental Dam, CHPP Dirty Water Dam and Drayton Void need to be met – refer Section 4.1.4.12.

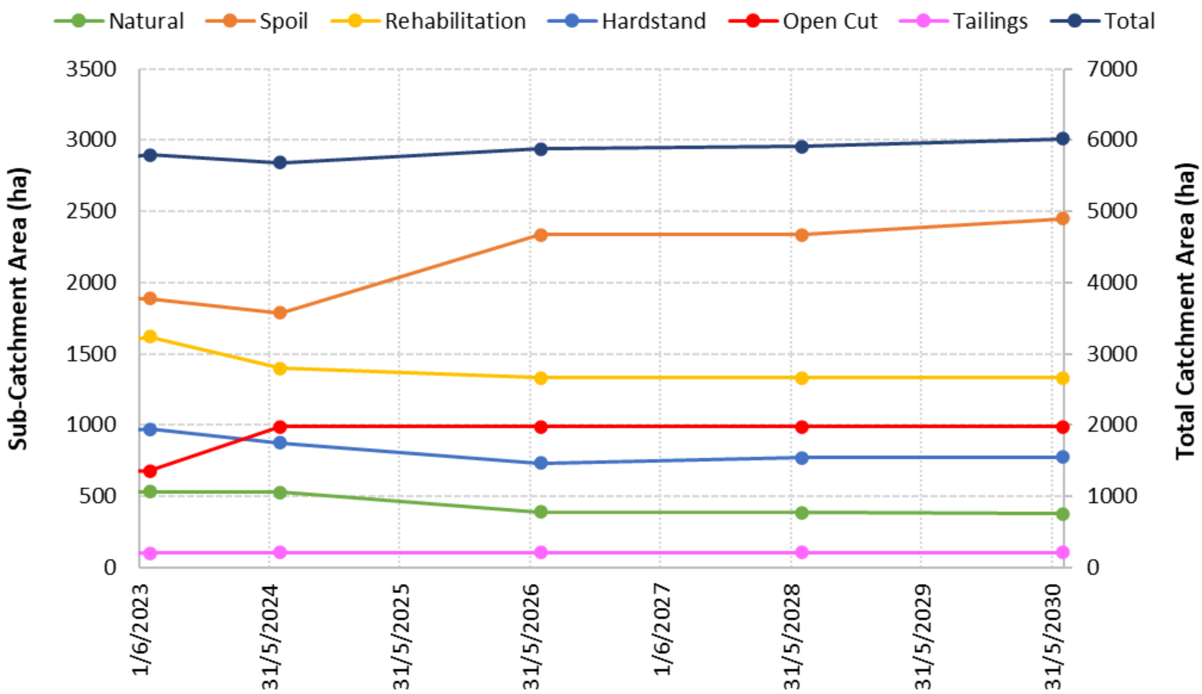
[4] Although 20 credits are currently held, 13 credits have been simulated in the site water balance to reflect the likely variability in regard to the number of credits held in the future due to the auction process that occurs for these credits every 2 years.

[5] In addition, modelled trigger volumes in the Environmental Dam and CHPP Dirty Water Dam need to not be exceeded – refer Section 4.1.4.12.

[6] Per EPL 11457.

[7] SILO point data is a system which provides synthetic daily climate data sets for a specified point in Australia by interpolation between surrounding point records held by the BoM. Refer https://www.longpaddock.qld.gov.au/silo/point-data/

GRAPH 2: TOTAL CATCHMENT AND SUB-CATCHMENT AREA VERSUS TIME



4.1.4.3 Rainfall Runoff Simulation

The Australian Water Balance Model (AWBM) (Boughton, 2004) is used to simulate runoff from rainfall on the various catchments and landforms across the mine 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;
- spoil emplacements;
- rehabilitation;
- hardstand (e.g. roads, roofs and paved areas);
- open cut/mine; and
- tailings.

AWBM parameters for undisturbed areas were adopted from model calibrations undertaken for a nearby stream, while parameters for the remaining sub-catchments were initially adopted from literature-based guideline values or experience with similar projects and then adjusted as part of model calibration (refer HEC, 2018).

4.1.4.4 Evaporation from Storage Surfaces

Storage volumes simulated by the model are used to calculate storage surface area (i.e. water area) based on storage volume-area-level relationships for each water storage either provided by HVEC or estimated from supplied data or topographic contours. For the TSF, time-varying relationships were derived from ATCW (2017) information.

Evaporation from storages is calculated in the model by multiplying storage surface area by a daily pan evaporation rate (from SILO point data – refer **Section 4.1.4.1**) and by a pan factor to allow for the typically lower evaporation from open water bodies compared to evaporation pans. For above ground storages (i.e. dams) monthly pan factors between 0.84 and 0.95 were used based on published values for Scone (McMahon et al, 2013). For open cut pits, a pan factor of 0.8 was adopted to allow for shading effects and likely lower wind speed at depth, while for the TSF a pan factor of 1.1 was adopted to allow for the lower reflectance of the dark-coloured coal tailings.

4.1.4.5 CHPP Demand

Water is supplied to the CHPP to make up water lost to tailings, coarse reject and to increased moisture in product coal (above that in ROM coal). Demand is calculated using forecast CHPP feed, product and reject tonnages and moistures. Forecast tonnages, as advised by HVEC, are summarised in **Table 5**, with total rejects and tailings calculated by subtraction of product from feed and tailings calculated from the tabulated percentages. Forecast tonnes are assumed to be at the relevant moisture content. Modelled moisture data is as follows:

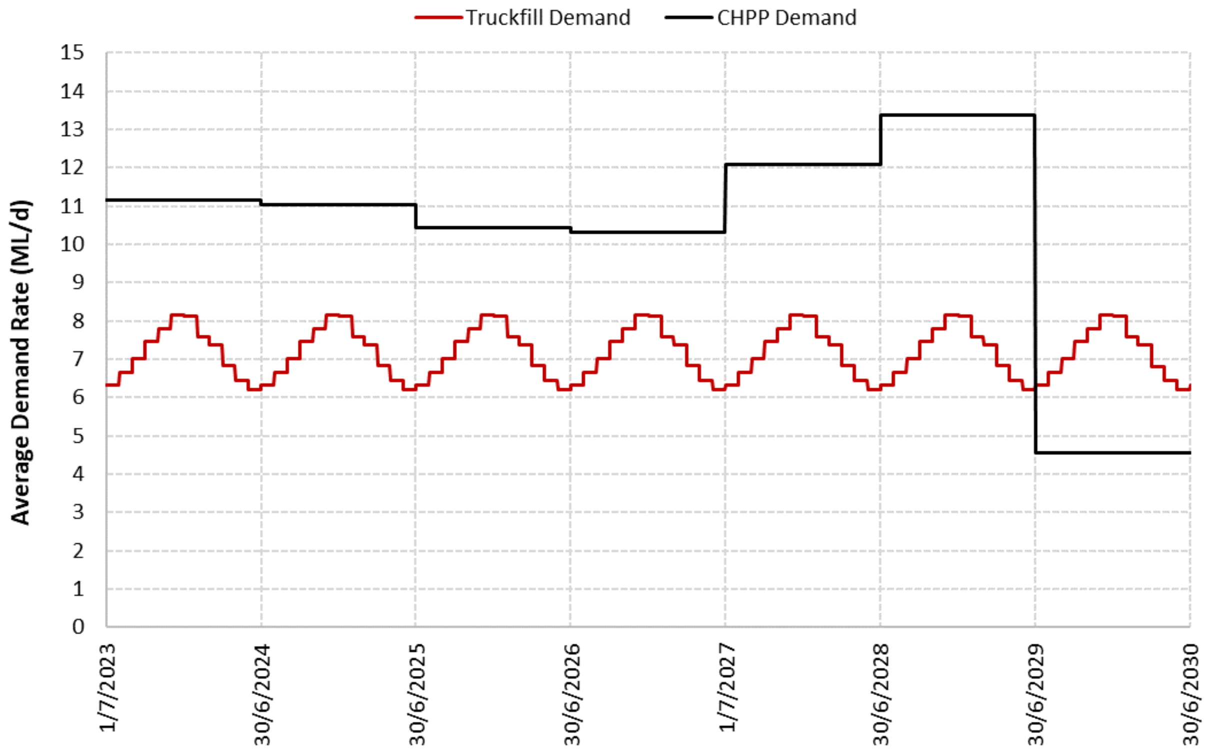
- ROM coal moisture: 8.5% w/w.
- Product coal moisture: 9.5% w/w.
- Coarse reject moisture: 20% w/w.
- Tailings solids content: 32.5% w/w.

TABLE 5: FORECAST CHPP ANNUAL PRODUCTION

Year Commencing	CHPP Feed (Mt)	CHPP Product (Mt)	Tailings as % of Total Reject
1/7/2022	19.08	11.48	37.06
1/7/2023	18.16	11.93	28.57
1/7/2024	18.29	12.14	28.54
1/7/2025	19.81	13.77	26.81
1/7/2026	21.80	15.58	25.09
1/7/2027	21.96	15.55	30.00
1/7/2028	20.63	14.06	33.55
1/7/2029	13.69	10.29	17.91

Modelled CHPP demand calculated from the above data is shown in **Graph 3**.

GRAPH 3: MODELLED CHPP AND TRUCKFILL DEMAND



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4.1.4.6 Tailings Water

Water is generated from settling tailings (termed 'bleed' water herein). The bleed rate is calculated based on the calculated tailings tonnage rate, initial solids content (refer Section 4.1.4.5), an initial settled density of 0.56 t/m^3 and a tailings particle density of 2.02 t/m^3 (both derived from ATCW, 2017). Historically, this water has not been available for direct reclaim by ponding on the surface of the TSF tailings, with water infiltrating into surrounding spoils and to the nearby Drayton void. The modelled rate of seepage from the TSF to the Drayton void has been set at 20 L/s based on advice from HVEC personnel. The model allows ponding within the TSF and pumped reclaim to the Drayton Void at a rate of up to 540 L/s (refer also **Section 4.1.4.12**).

4.1.4.7 Haul Road Dust Suppression (Truckfill) Demand

A correlation relationship between monthly total evaporation and truckfill water usage was developed based on monitored usage for the period June 2020 to October 2022. This relationship has been used in forecast simulations, with demand rates varying seasonally from approximately 8.1 ML/d to 6.2 ML/d. Forecast average truckfill demand rate is shown in **Graph 3**. Truckfill demand is split evenly between the truckfill points indicated on **Diagram 1**.

4.1.4.8 Other Demands

Demand for CHPP stockpile sprays is calculated based on daily evaporation data multiplied by an estimated area of 8 ha and an evaporation factor of 1.2 (to allow for the lower reflectance of the dark coal stockpile). Calculated average demand varies seasonally from approximately 0.13 ML/d to 0.63 ML/d.

The modelled export coal loader demand is set at 1.5 ML/month based on monitored rates provided by HVEC personnel. The modelled industrial area demand is set at 45.3 ML/month based on data provided by HVEC personnel. It is assumed that 10% of this water is lost to evaporation with the remainder recovered to the industrial area sediment dams.

4.1.4.9 Groundwater Inflows

Groundwater inflow predictions for the open cut pits were provided by SLR (2023) for the model simulation period (mid-2023 to mid-2030). Total rates of between approximately 0.3 and 1.8 ML/d were predicted for the Mt Arthur North open cuts (Windmill, Huon, Calool, Roxburgh and Ayredale), with this inflow rate divided between the individual open cuts. Groundwater inflows were reduced to allow for estimated in-pit evaporation from the coal seam allowing for a total coal seam thickness of 11.5 m as advised by HVEC personnel. Rates of between approximately 0.06 and 0.54 ML/d were predicted by SLR for the Saddlers open cuts. Zero groundwater inflow rates were predicted by SLR to the McDonalds and Belmont voids.

4.1.4.10 Muswellbrook Effluent

The model adopts a rate of 840 ML/annum treated effluent supplied from Muswellbrook, as advised by HVEC personnel. This rate is modelled as continuously supplied to the CHPP Dirty Water Dam.

4.1.4.11 Main Water Storages

The main site water storages, together with their modelled capacities, are listed in **Table 6**. Note that storages are operated to maintain water levels below these spill levels.

TABLE 6: MAIN SITE WATER STORAGE CAPACITIES

Storage	Spill Level (m AHD)	Capacity (ML)
CHPP Dirty Water Dam	186	500
Environmental Dam	156.5	1,267
Drayton Void	188	2,955
Belmont Void	174	2,656*
McDonalds Void	195	6,342
South Saddlers Void	140	4,448

* Belmont capacity to reduce to an estimated 884 ML by mid-2026 due to backfilling with spoil.

4.1.4.12 Pump Rates and Pumping Triggers

Modelled pump rates are summarised in **Table 7**.

TABLE 7: MODELLED PUMP RATES

Source Storage	Destination	Pump Rate (L/s)
Environmental Dam	CHPP Dirty Water Dam Northern Fill Point Tanks Belmont Void McDonalds Void Windmill Pit (contingency) Hunter River licensed discharge	211 (300 from 2024) 163 139 (until mid-2024) 400 (from mid-2024) 400 5,208
CHPP Dirty Water Dam	CHPP Northern Fill Point Tanks Industrial Area Export Coal Loader McDonalds Void Drayton Void Environmental Dam	At demand rate 60 At demand rate At demand rate 100 450 100 (450 from 2024)
McDonalds Void	Belmont Void CHPP Dirty Water Dam Drayton Void	100 (until mid-2024) 101 150
Belmont Void	Environmental Dam McDonalds Void	150 100 (until mid-2024) 150 (from mid-2024)
Drayton Void	Environmental Dam CHPP Dirty Water Dam McDonalds Void South Saddlers Void	300 150 or 300 300 150
Northern Fill Point Tanks	Environmental Dam NW Fill Sump	250 100
Windmill Pit	Northern Fill Point Tanks Environmental Dam NW Fill Sump McDonalds Void	100 120 (from mid-2024) 100 120 (from mid-2024)
Huon Pit	Northern Fill Point Tanks Windmill Pit	100 100

TABLE 7 (CONT): MODELLED PUMP RATES

Source Storage	Destination	Pump Rate (L/s)
Calool Pit	Roxburgh Pit CHPP Dirty Water Dam Environmental Dam Drayton Void McDonalds Void	100 (until mid-2024) 150 (from mid-2024) 150 (from mid-2024) 150 (from mid-2024) 150 (from mid-2024)
Roxburgh Pit	CHPP Dirty Water Dam Calool Pit	120 (until mid-2024) 120 (from mid-2024)
Ayredale North Pit	Drayton Void	100
Ayredale South Pit	Drayton Void	100
Saddlers South Void	Drayton Void	150 (from mid-2024)
Saddlers Central Pit	Saddlers South Void	150 (from mid-2024)
Wattos Corner Sediment Dam	Drayton Void	100
Saddlers Sediment Dam	Drayton Void	150
West Pit TSF	Drayton Void	540
Whites Creek Headwater Dam	CHPP Dirty Water Dam	80
Industrial Area Sediment Dam	CHPP Dirty Water Dam	80
Export Coal Loader Runoff Dam	CHPP Dirty Water Dam	275
Windmill North Sediment Dam	Windmill Pit	80
Gully C Sediment Dam	Gully B Sediment Dam	130
Gully B Sediment Dam	Gully A Sediment Dam	130
Gully A Sediment Dam	Environmental Dam	130
Bayswater Main Dam*	Industrial Area Sediment Dam	100

* Note: Bayswater Main Dam is in the process of being rehabilitated and is normally maintained dewatered.

Pump trigger volumes for the smaller/minor water storages are at the modelled dead (unrecoverable) storage volume, which is typically a small volume. Operating volumes and triggered actions for the main water storages are summarised in **Table 8**.

TABLE 8: MODELLED MAIN STORAGE OPERATING VOLUMES

Storage	Modelled Volume	Modelled Action
Environmental Dam	Low Operating Volume = 270 ML (152 m AHD)	If below this volume: • No licensed discharge or pump to Belmont. • Pump from McDonalds Void to CHPP Dirty Water Dam if CHPP Dirty Water Dam is below its High Operating Volume. • Pump from Belmont Void. • Pump from Drayton Void to CHPP Dirty Water Dam if CHPP Dirty Water Dam is below its Low Operating Volume. • From mid-2024, pump from Calool Pit provided low volume contained in Windmill Pit, no pumping from Calool Pit to Belmont or McDonalds Voids nor from Belmont Void to Environmental Dam. If above this volume: • From mid-2024, pump to McDonalds Void if McDonalds is below its High Operating Volume and stored inventory/volumes are such that licensed extraction from Hunter is required (refer Section 4.1.2) and Calool Pit has less than 500 ML. • Pump to Belmont Void if Belmont is below its High Operating Volume and stored inventory/volumes are such that licensed extraction from Hunter River is required (refer Section 4.1.2) and is before mid-2024 or Calool Pit has less than 500 ML.
	High Operating Volume = 639 ML (154.0 m AHD)	If above this volume: • Prior to mid-2024, pump to Belmont Void if Belmont is below its High Operating Volume and stored inventory/volumes are such that licensed extraction from Hunter not required (refer Section 4.1.2). • No pump from Hunter River, Windmill Pit, Belmont Void. Northern Fill Point Tanks or Gully A Sediment Dam. • No pump from Drayton Void to CHPP Dirty Water Dam. • From mid-2024, pump to McDonalds Void if McDonalds is below its High Operating Volume. • Allow pump to CHPP Dirty Water Dam up to its High Operating Volume (otherwise only allow up to its Low Operating Volume). • No pump from Export Coal Loader Dam to CHPP Dirty Water Dam unless Export Coal Loader Dam is more than 50% of capacity and Environmental Dam remains below 75% of capacity. If below this volume: • Pump from Belmont Void if Belmont is above its High Operating Volume. • From mid-2024 allow pumped dewatering from Belmont Void provided low volume contained in Windmill Pit. • Allow pump from Drayton Void to CHPP Dirty Water Dam provided Drayton above its High Operating Volume. • Pump from Drayton Void if releasing via HRSTS.
	Maximum Operating Volume = 751 ML (154.5 m AHD)	If above this volume, pump to Windmill Pit (contingency to control spill risk).
	Capacity = 1,267 ML	

TABLE 8 (CONT): MODELLED MAIN STORAGE OPERATING VOLUMES

Storage	Modelled Volume	Modelled Action
CHPP Dirty Water Dam	Low Operating Volume = 227 ML	If below this volume: • No licensed discharge from Environmental Dam. • No pumping to Environmental Dam. • Allow pump from Drayton Void if Environmental Dam is below its Low Operating Volume. If above this volume: • During HRSTS release, pump to Environmental Dam provided Environmental Dam is below its Maximum Operating Volume.
	High Operating Volume = 426 ML	If below this volume: • Allow pump from Whites Creek Headwater Dam, Industrial Area Sediment Dam and, from mid-2024, Calool Pit. • Allow pump from McDonalds Void if Environmental Dam is below its Low Operating Volume. • Allow pump from Environmental Dam if Environmental Dam is above its High Operating Volume. • From mid-2023 to mid-2024 pump from Roxburgh Pit. If above this volume: • Allow pump to McDonalds Void if McDonalds Void is below its High Operating Volume. • Allow pump to Drayton Void if Drayton Void is below its High Operating Volume. • No pump from Hunter River.
	Capacity = 500 ML	If below this volume from mid-2024, pump from Calool Pit if Calool Pit has more than 500 ML.
McDonalds Void	Low Operating Volume = 355 ML (170 m AHD)	If above this volume, allow pump to Drayton Void if Drayton Void is below its High Operating Volume and not pumping to CHPP Dirty Water Dam or Belmont Void and not pumping from Drayton Void to McDonalds Void. If below this volume allow pump from Drayton Void if Drayton Void is above its Minimum Operating Volume.
	High Operating Volume = 3,101 ML (188 m AHD)	If below this volume: • Allow pump from CHPP Dirty Water Dam if CHPP Dirty Water Dam is above its High Operating Volume. • Prior to mid-2024, pump from Belmont Void if Belmont Void is above its Low Operating Volume and Belmont Void has a greater percentage full than McDonalds Void. • From mid-2024, pump from Belmont Void unless pumping from Belmont to Environmental Dam. • From mid-2024, pump from Windmill Pit unless pumping from Belmont Void to Environmental Dam, Environmental Dam to Belmont or Windmill to Environmental Dam. • From mid-2024 pump from Environmental Dam if Environmental Dam above its Low Operating Volume and stored inventory/volumes are such that licensed extraction from Hunter is required (refer Section 4.1.2) and Calool Pit has less than 500 ML. • From mid-2024, pump from Calool Pit unless pumping from Windmill Pit or from/to Environmental Dam. • Allow pump from Drayton Void if Drayton Void is above its High Operating Volume.

TABLE 8 (CONT): MODELLED MAIN STORAGE OPERATING VOLUMES

Storage	Modelled Volume	Modelled Action
McDonalds Void	High Operating Volume = 3,101 ML (188 m AHD)	If above this volume: • Pump to Drayton Void if Drayton Void is below its High Operating Volume and not pumping to CHPP Dirty Water Dam and not pumping from Drayton Void to McDonalds Void. • Pump to South Saddlers Void if South Saddlers is below its Maximum Operating Volume and not pumping to Drayton Void or CHPP Dirty Water Dam. This also applies if Belmont Void is pumping to McDonalds and McDonalds is within 500 ML of this volume.
	Capacity = 6,342 ML	
Belmont Void	Low Operating Volume = 1,095 ML reducing to 322 ML by mid-2026 as void is backfilled (168.5 m AHD)	Prior to mid-2024, if above this volume pump to McDonalds Void if McDonalds Void is below its High Operating Volume and Belmont Void has a greater percentage full than McDonalds Void. Prior to mid-2024, if below this volume, pump from McDonalds Void if McDonalds has a greater percentage full than Belmont and no pumping occurring from McDonalds to CHPP Dirty Water Dam.
	High Operating Volume = 1,187 ML reducing to 358 ML as void is backfilled (169 m AHD)	If below this volume and prior to mid-2024: • Pump from Environmental Dam if Environmental Dam is above its High Operating Volume and not sourcing water from Hunter River. • Pump from Environmental Dam if Environmental Dam is above its Low Operating Volume and sourcing water from Hunter River. If above this volume: • Pump to Environmental Dam if Environmental Dam is below its High Operating Volume
	Capacity = 2,656 ML	
Drayton Void	Minimum Operating Volume = 10 ML	Do not pump from Drayton Void if below this volume.
	High Operating Volume = 1,873 ML (178 m AHD) reducing to 1,032 ML (168 m AHD)	If above this volume: • Do not pump from CHPP Dirty Water Dam, Ayredale South, Ayredale North, Wattos Corner Sediment Dam, Saddlers Sediment Dam, McDonalds Void, South Saddlers Void, TSF, Calool Pit. • No pump from Hunter River. • Pump to CHPP Dirty Water Dam provided Environmental Dam is below its High Operating Volume or, if releasing via HRSTS, Environmental Dam is below its Maximum Operating Volume. • Pump to McDonalds Void if McDonalds Void is below its High Operating Volume. • Pump to South Saddlers Void if South Saddlers is below its High Operating Volume.
	Capacity = 2,955 ML	
South Saddlers Void	High Operating Volume = 2,646 ML (125 m AHD)	If above this volume, no pump in from McDonalds, Central Saddlers or Drayton Voids.
	Capacity = 4,448 ML	

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4.1.5 Initial Stored Water Volumes

The following modelled initial storage volumes, as at the start of July 2023, for the main water storages and open cut pits, were adopted from information provided by HVEC personnel:

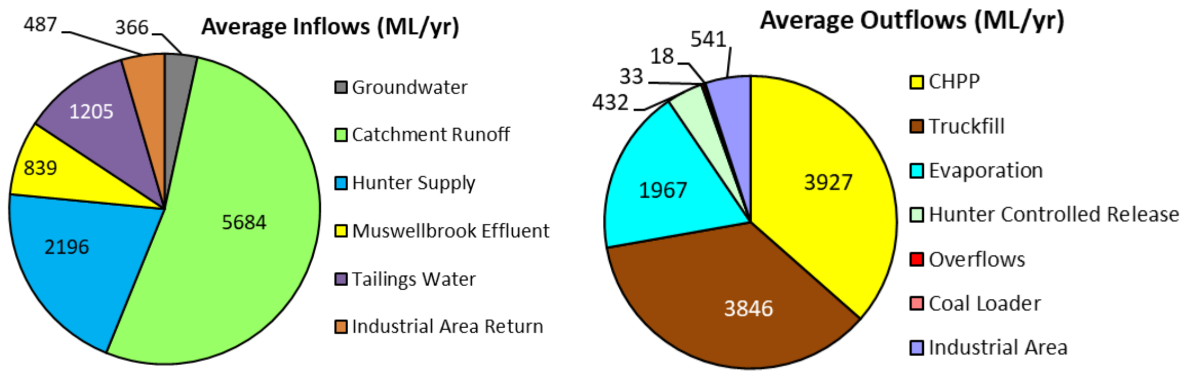
- Belmont Void: 704 ML
- McDonalds Void: 2,050 ML
- Drayton Void: 1,570ML
- Environmental Dam: 532 ML
- CHPP Dirty Water Dam: 342 ML
- Huon open cut pit: 70 ML
- Roxburgh open cut pit: 489 ML
- Windmill open cut pit: 0 ML
- Central Saddlers open cut pit: 679 ML
- South Saddlers Void: 1,485 ML

5 SIMULATED PERFORMANCE OF WATER MANAGEMENT SYSTEM

5.1 Overall Forecast Water Balance

Average system inflows and outflows, averaged over the 7-year forecast period and all 129 realizations, are shown in **Graph 4**.

GRAPH 4: MODELLED AVERAGE WATER BALANCE



Average modelled inflows are dominated by site catchment runoff, with the next largest inflow from Hunter River licensed extraction. The largest modelled system outflows are to CHPP supply and truckfill (haul road dust suppression). Approximately 30% of CHPP supply is returned as tailings (supernatant) water.

5.2 Water Supply Reliability

Predicted average supply reliability over the 7-year forecast period is expressed as total water supplied divided by total demand (i.e. a volumetric reliability) over the simulation period. Average supply reliability over all climatic realizations, as well as the lowest single realisation reliability (representing a simulated 7-year 'worst case'), for CHPP supply, truckfill, supply to the industrial area and export coal loader are summarised in **Table 9**.

TABLE 9: FORECAST SUPPLY RELIABILITY

Demand	Volumetric Supply Reliability (%)	
	Average	Lowest
CHPP	99.7	90.6
Truckfill	99.4	86.3
Industrial Area	99.5	86.1
Export Coal Loader	99.5	86.1

Model results indicate a high level of average supply reliability for all three scenarios and for all demands. An average 99.7% CHPP supply reliability is equivalent to 8 days of lost operation over the 7-year simulation period. Significantly lower reliabilities are forecast for the 'worst case' realisation (likely corresponding to a very low rainfall period).

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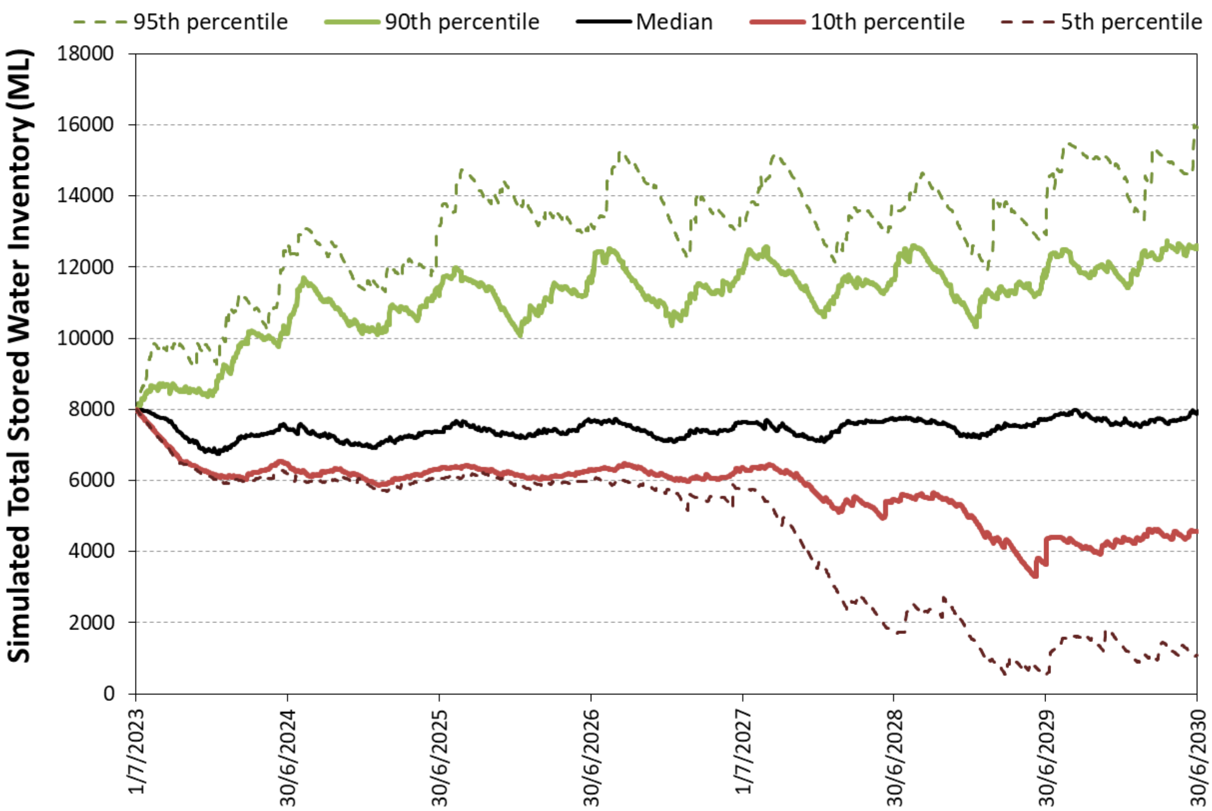
5.3 Forecast Stored Water Volumes

Simulated forecast total site water inventory is shown in **Graph 5**. These probability plots show the range of likely total stored water inventory, with the solid central plot representing the median result and the broken upper and lower plots showing the 5th/95th percentile volume plots. The 95th percentile results are only exceeded in 5% of modelled realizations. There is a predicted 90% chance that the total water inventory will fall in between the 5th/95th percentile volume plots. It is important to note that none of these plots represents a single climatic realization – these probability plots are compiled from all 129 realizations - e.g. the median inventory plot does not represent model forecast volume for median climatic conditions.

GRAPH 5: MODELLED TOTAL SITE WATER INVENTORY



The model results shown in **Graph 5** indicate that the median volume, which oscillates seasonally, should remain between approximately 6,750 ML and 8,000 ML – this volume is likely related to the 7,990 ML trigger volume adopted in the model, whereby when the total inventory rose above this volume, Hunter River licensed extraction would cease and licenced release could commence subject to the provisions of the HRSTS (refer **Section 4.1.2**). The 95th and 90th percentile results show a short-term increase followed by a slow gradual upward trend with time. The 5th and 10th percentile results show a short term decrease to approximately 6,000 ML to 6,500 ML where the forecast volume remains for approximately 4 years – this volume is likely related to the 6,405 ML trigger volume adopted in the model, whereby when the total inventory fell below this volume, Hunter River licensed extraction would commence (refer **Section 4.1.2**). In the last 3 years simulated, the forecast 5th and 10th percentile volumes fall, which is likely related to lower rainfall conditions and lower AWDs. Note that the forecast total water inventory remains above zero even for the 5th percentile result, which is reflective of the forecast high supply reliabilities (refer **Table 9)**.

5.4 Licensed Release and Forecast Overflows

All licensed releases would occur from the Environmental Dam in accordance with the HRSTS. An average annual licensed release volume of 432 ML is forecast (refer **Graph 4**). Based on median model results, an average annual release volume of 360 ML is forecast, while 1,155 ML is predicted based on 95th percentile model results.

All forecast storage wet weather overflows occur from sediment dams. Overflows are only forecast to occur from Gully A, Gully B and Gully C sediment dams (to the Hunter River) and Saddlers Sediment Dam (to Saddlers Creek). No overflows are forecast from other storages including the Environmental Dam and Export Coal Loader Dam. A summary of forecast sediment dam overflow volumes and the percentage of realizations in which overflow is forecast to occur is given in **Table 10**.

TABLE 10: FORECAST SEDIMENT DAM OVERFLOWS

Sediment Dam	Realizations (of 129) in Which Overflow is Forecast	Forecast 7-year Overflow Volume (ML)		
		Median	75^{th} Percentile	95^{th} Percentile
Gully A	66%	0.6	3.4	7.7
Gully B	64%	0.6	2.1	6.0
Gully C	23%	0.0	0.0	2.8
Saddlers	22%	0.0	0.0	12.1

The following is noteworthy regarding the forecast sediment dam overflows:

- The sediment dams have been designed to overflow, in accordance with Landcom (2004) and DECC (2008). The catchments of these sediment dams comprise areas of spoil and rehabilitated spoil and are not active mining or processing areas. The catchment areas reporting to these sediment dams are small, ranging from an estimated 9 ha (Gully C sediment dam in 2023) to 162 ha (Saddlers sediment dam in 2023).
- There is a significant forecast probability that no overflows would occur from these sediment dams, with Gully C and Saddlers Sediment Dams only forecast to experience overflow in 23% and 22% of realizations.
- Median forecast 7-year overflow volumes are very low or zero.
- At the 95^{th} percentile level, 7-year overflow volumes are also low, ranging from 2.8 ML to 12.1 ML.
- Overflows are forecast to occur during wet weather when there is likely to be significant flow downstream in the Hunter River and Saddlers Creek (i.e. sediment dam overflows are likely to be highly diluted by rainfall and surface water flow).

6 FINAL VOID WATER BALANCE

6.1 Model Description

A daily timestep, final void water balance model was developed using the GoldSim® simulation package. The model simulates the stored water volume of each final void as follows:

Change in Storage = Inflow – Outflow

Where:

Inflow includes direct rainfall, runoff, groundwater inflow and spoil seepage.

Outflow includes evaporation.

6.2 Key Data and Assumptions

Key model input data and assumptions included:

- A 134-year rainfall and evaporation dataset (1889 to 2022) obtained from SILO Point Data. The dataset was repeated several times over to generate an extended period of climate data for final void simulation – to ensure equilibrium water levels were reached during the simulation period.
- A constant pan factor of 0.75 assumed for calculation of evaporation from the final void. The low pan factor was adopted to reflect likely lower evaporation rates at depth as a result of shading effects.
- Surface rainfall runoff estimated using the AWBM applied to the final void sub-catchments (refer **Map 9**), in a manner similar to the operational water balance model (refer **Section 4.1.4.3**). Direct rainfall was simulated on the contained water surface.
- Final void level-volume-area relationships derived from the final void plans (refer **Map 9**). It is noted that storage of water within the in-pit spoil void spaces was not included in the derived level-volume-area relationships – this will not affect the predicted equilibrium water levels. The inclusion of in-pit spoil void storage would increase the time required to reach equilibrium.

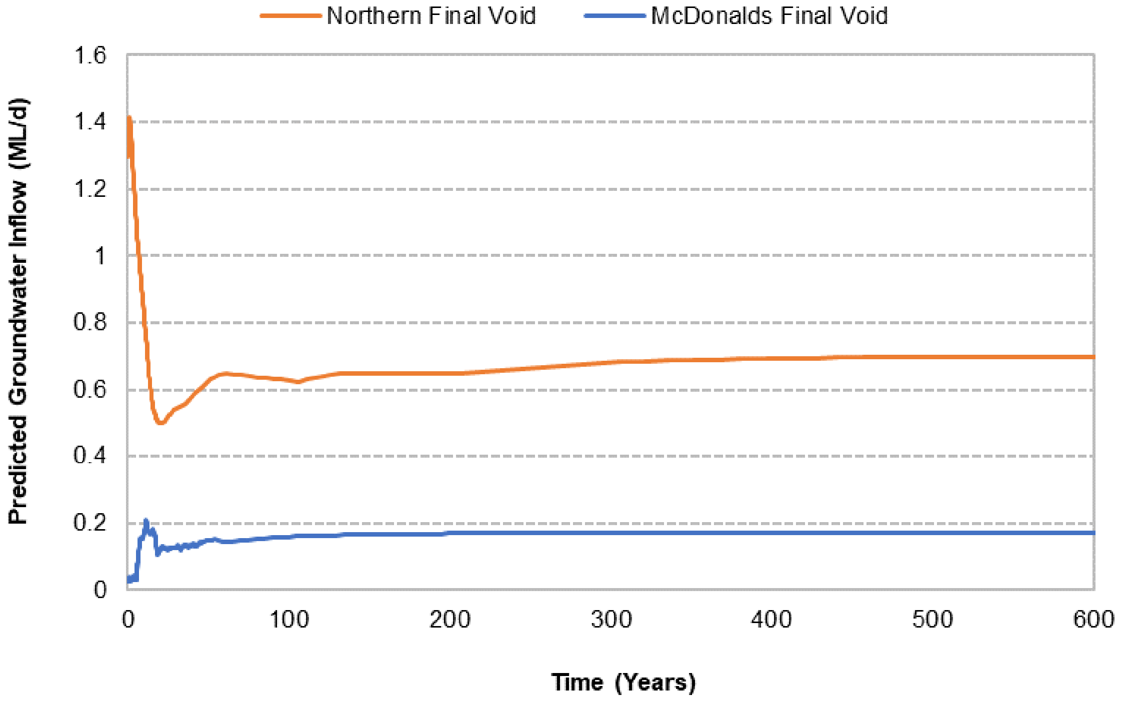
The catchment area of the final voids is expected to comprise natural, spoil, rehabilitated and remnant open cut areas (refer **Section 3.3**). The estimated sub-catchment areas for the McDonalds and Northern final void are presented in **Table 11**.

TABLE 11: FINAL VOID CATCHMENT AND SUB-CATCHMENT AREA

Sub-Catchment	Northern Final Void	McDonalds Final Void
	Area (km^2)	
Natural	0.4	0.1
Spoil	0.8	0.2
Rehabilitation	20.6	1.5
Open Cut Pit	2.1	0.1
Total	**23.8**	**1.9**

Groundwater inflow to the final voids is expected to occur from the in-pit spoil and hard rock. Predicted rates of groundwater inflow over time post cessation of mining were provided by SLR (2023) and are shown in **Graph 6**. The predicted groundwater inflow includes estimates of seepage from in-pit spoil and therefore sub-surface seepage from the catchment AWBM ('baseflow' in the AWBM) was not included as an input to the final void.

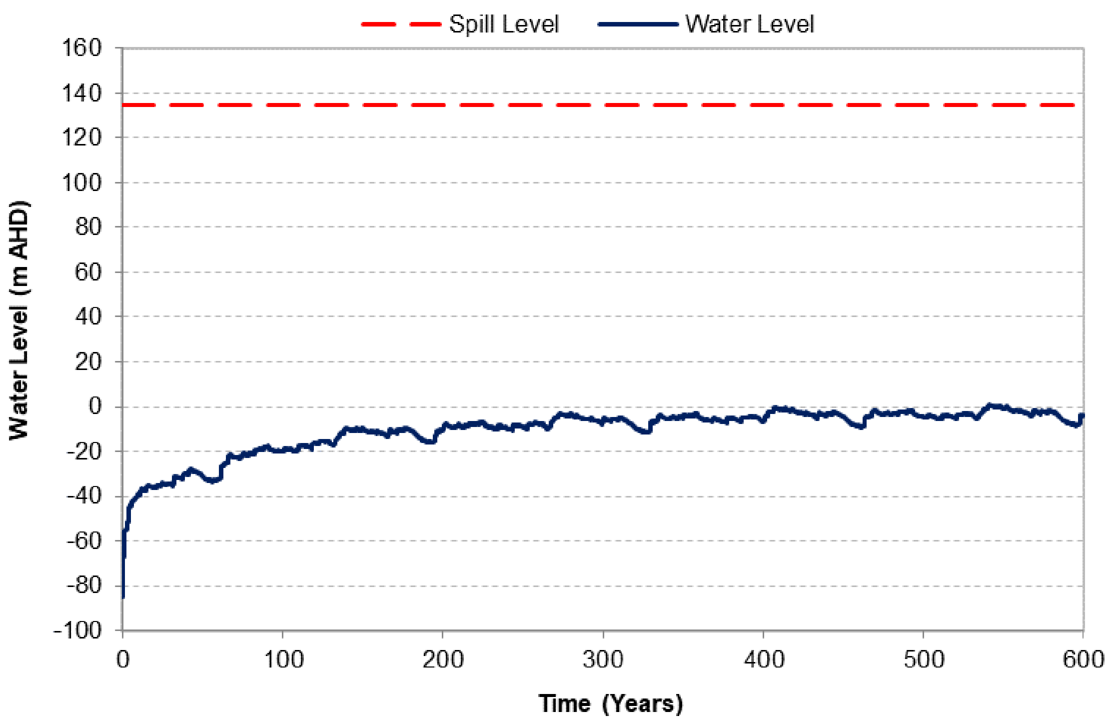
GRAPH 6: PREDICTED FINAL VOID GROUNDWATER INFLOW



6.3 Simulated Future Performance

The model predicted post-mining water level is shown in **Graph 7** and **Graph 8** for the Northern final void and McDonalds final void respectively.

GRAPH 7: PREDICTED POST-MINING WATER LEVEL – NORTHERN FINAL VOID



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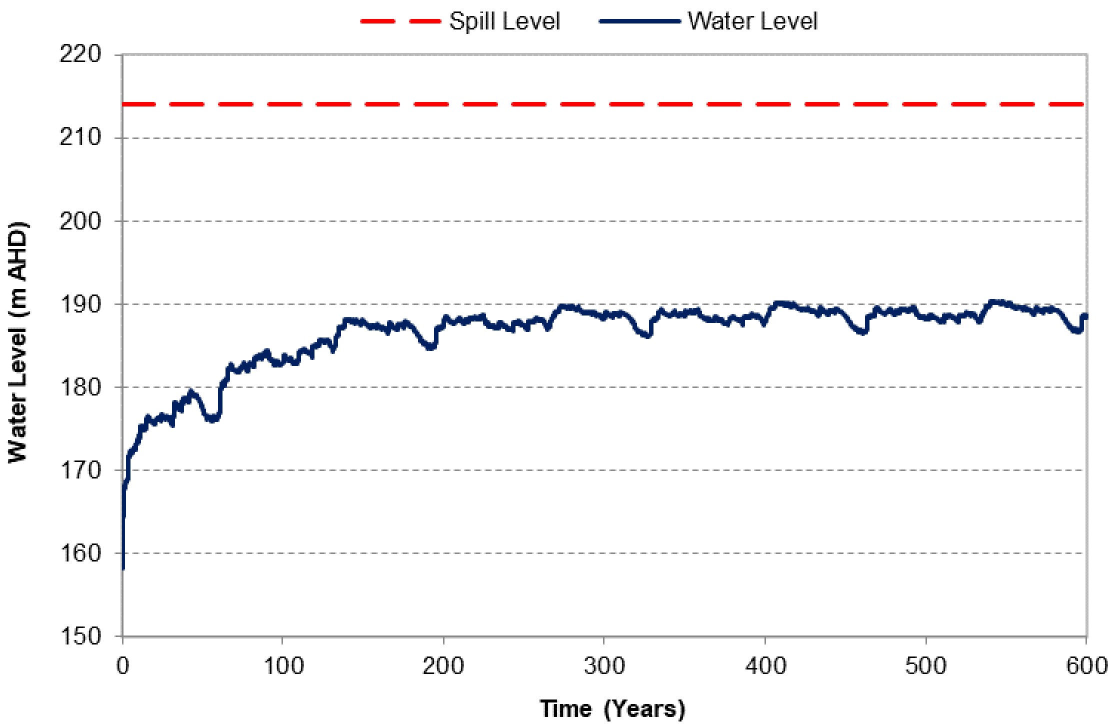
GRAPH 8: PREDICTED POST-MINING WATER LEVEL – MCDONALDS FINAL VOID



The model predictions presented in **Graph 7** indicate that the Northern final void would reach a peak equilibrium level of more than 130 m below the spill level. The model predictions presented in **Graph 8** indicate that the McDonalds final void would reach a peak equilibrium level of approximately 24 m below the spill level. Equilibrium levels would be reached slowly over more than 300 years. The model results indicate that surface spills are not predicted from either final void.

The salinity of void waters would slowly increase with time, as a result of ongoing slow migration of saline groundwater and flushing of residual salts from the overburden. In the longer term, salt concentrations would also be affected by evapo-concentration.

As detailed in the *Mt Arthur Coal Open Cut Modification Surface Water Assessment* (Gilbert & Associates, 2013), the Northern final void water level was predicted to stabilise over more than 200 years at a level more than approximately 135 m below the spill level. As stated above, for the current Modification, the Northern final void water level is predicted to stabilise over more than 300 years at a level more than approximately 130 m below the spill level.

Accordingly, the above overarching findings are considered generally consistent with those detailed in the *Mt Arthur Coal Open Cut Modification Surface Water Assessment* (Gilbert & Associates, 2013) noting the proposed change in final void and contributing total catchment area (refer **Section 3.3**).

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7 ASSESSMENT OF POTENTIAL SURFACE WATER IMPACTS

The potential impacts of the Modification on local and regional surface water resources are:

- Changes to flows in local creeks due to expansion and subsequent capture and use of drainage from mine area catchments.
- Potential for additional export of contaminants (principally sediments and soluble salts) in mine area runoff and accidental spills from containment storages (principally sediments, soluble salts, oils and greases), causing degradation of local and regional water courses.
- Short term additional increases in salinity in the Hunter River during periods of licensed discharge under the HRSTS.

7.1 Flow Regime in Local Creeks

7.1.1 During Operations

As stated in **Section 1.2**, the Modification would comprise an overall reduction in approved disturbance. As such, the total catchment area reporting to the mine water management system over the life of the Modification would be less than that currently approved. The effect of the Modification on the yield of local watercourses would therefore be less than that currently approved.

7.1.2 Post-Closure

As stated in **Section 3.3**, the area to be excised from the Hunter River catchment post-closure is estimated at 25.7 km^2 with 23.8 km^2 to be directed to the Northern final void. The final landform presented in the *Mt Arthur Coal Open Cut Modification – Environmental Assessment* (BHP, 2013) proposed a total catchment area of 14.2 km^2 to be directed to the Northern final void. As such, the proposed Modification would result in an increase of 9.6 km^2 catchment area reporting to the Northern final void in comparison to that currently approved.

The total catchment area of the Hunter River at Denman (GS210055 – refer **Map 3**) is 4,530 km^2. A reduction in contributing catchment area of 25.7 km^2 equates to approximately 0.6% of the total catchment area of the Hunter River at Denman (GS210055), with average flow rates in the Hunter River expected to reduce proportionally. With a mean annual flow volume of 252,509 ML[8], this equates to an annual reduction in flow volume of approximately 1,515 ML. The estimated reduction in flow volume represents a small impact to flow in the Hunter River at Denman.

7.2 Potential Water Quality Impacts to Local Watercourses

As stated in **Section 3**, mine water and disturbed area runoff would continue to be directed to on-site storages for reuse. Controlled release would be undertaken from the Environmental Dam in accordance with the HRSTS and EPL 11457.

Runoff from areas of spoil or rehabilitated spoil that could contain elevated suspended solids (but that is unlikely to have the potential to generate elevated levels of other environmentally significant constituents) would either continue to be predominantly directed to on-site storages for reuse or be directed to sediment dams. The sediment dams have been, and would continue to be, sized in accordance with Landcom (2004). These guidelines provide for sediment dams to overflow when rainfall exceeds the design criteria of the dams.

Based on the operational water balance results presented in **Section 6.3**, there is a significant forecast probability that no overflows would occur from the sediment dams, with Gully C and Saddlers Sediment Dams only forecast to experience overflow in 23% and 22% of modelled realizations. Overflows are forecast to occur during wet weather when there is likely to be significant flow downstream (in the Hunter River and Saddlers Creek). As such, it is expected that overflow from the sediment dams would be highly diluted.

8 Data recorded from 1/1/1959 to 22/6/2023. Source: www.realtimedata.waternsw.com.au.

It is therefore concluded that the impact of the sediment dam overflows on downstream water quality is likely to be negligible.

7.3 Potential Water Quality Impacts to the Hunter River

All licensed releases would occur from the Environmental Dam in accordance with the HRSTS. The HRSTS involves a finite system of salt credits that can be purchased for discharge to the Hunter River. The HRSTS prohibits the release of saline water during periods of low flow in the Hunter River and controls releases of saline water during periods of high flow such that specific salinity targets at various points in the river are not exceeded. The amount of salt that can be discharged by industry is therefore balanced with the background salinity of the river. As MAC holds a portion of a finite allocation of credits and only discharges in accordance with the HRSTS, , controlled discharge from the Environmental Dam would not result in an increase in the background salinity of the Hunter River.

As stated in **Section 5.4**, an average annual licensed release volume of 432 ML is forecast. Based on median model results an average annual release volume of 360 ML is forecast. This compares with the median annual total flow in the Hunter River at Denman (GS210055) of approximately 172,900 ML, meaning the forecast maximum median discharge represents 0.2% of the recorded median annual river flow. Similarly, an annual release volume of 1,155 ML is predicted based on 95th percentile model results. This compares with a 95th percentile annual flow recorded at GS210055 of approximately 717,600 ML, meaning the forecast 95th percentile discharge represents approximately 0.16% of the recorded 95th percentile annual river flow.

For indicative purposes only, **Table 12** presents the results of a dilution calculation based on the forecast median annual discharge from the Environmental Dam, the recorded median annual flow in the Hunter River at Denman (GS210055) and the monitored median EC values of the Environmental Dam and the Hunter River at Denman (GS210055).

TABLE 12: CONTROLLED RELEASE DILUTION CALCULATION

Component	Median Annual Forecast Release from Environmental Dam	Monitored Flow Hunter River at Denman (GS210055)
Median Annual Flow Volume (ML)	360	172,900
Median EC (µS/cm)	1,780	531
Estimated EC with Controlled Release (µS/cm)		534

The data presented in **Table 12** indicates that controlled release from the Environmental Dam is estimated to result in a less than 1% increase in the EC of the Hunter River (assuming median discharge, streamflow and ambient EC). However, as noted above, discharge from the Environmental Dam is undertaken in accordance with the HRSTS where the amount of salt that can be discharged is balanced with the background salinity of the river via salt credits.

As indicated in **Section 2.6.2**, the Environmental Dam typically contains low concentrations of environmentally significant metals. It is therefore considered that licensed discharge of water from the Environmental Dam is unlikely to result in impacts to the Hunter River.

8 RECOMMENDED MONITORING, MITIGATION AND MANAGEMENT

Water management at MAC is undertaken in accordance with the *Water Management Plan* (BHP, 2023) and the *Sediment and Erosion Control Plan* (BHP, 2021). The *Water Management Plan* (BHP, 2023) details the surface water monitoring program, impact assessment criteria and response plan to be implemented in the event of a trigger exceedance. The water monitoring program and surface water response plan have been developed to ensure that MAC complies with the conditions of MP 09_0062, EPL 11457 and the HRSTS.

The current surface water monitoring program for MAC is comprehensive and sufficient to enable potential surface water impacts associated with the proposed Modification to be appropriately identified and managed.

In accordance with the WMP, the site water balance model would continue to be updated and verified on a regular basis to maintain the model as a reliable tool for assessing the effectiveness of the site water management system. Periodic forecast water balance modelling would continue to be undertaken to inform near term water supply reliability for MAC as it progresses and the need for periodic release of water via the HRSTS.

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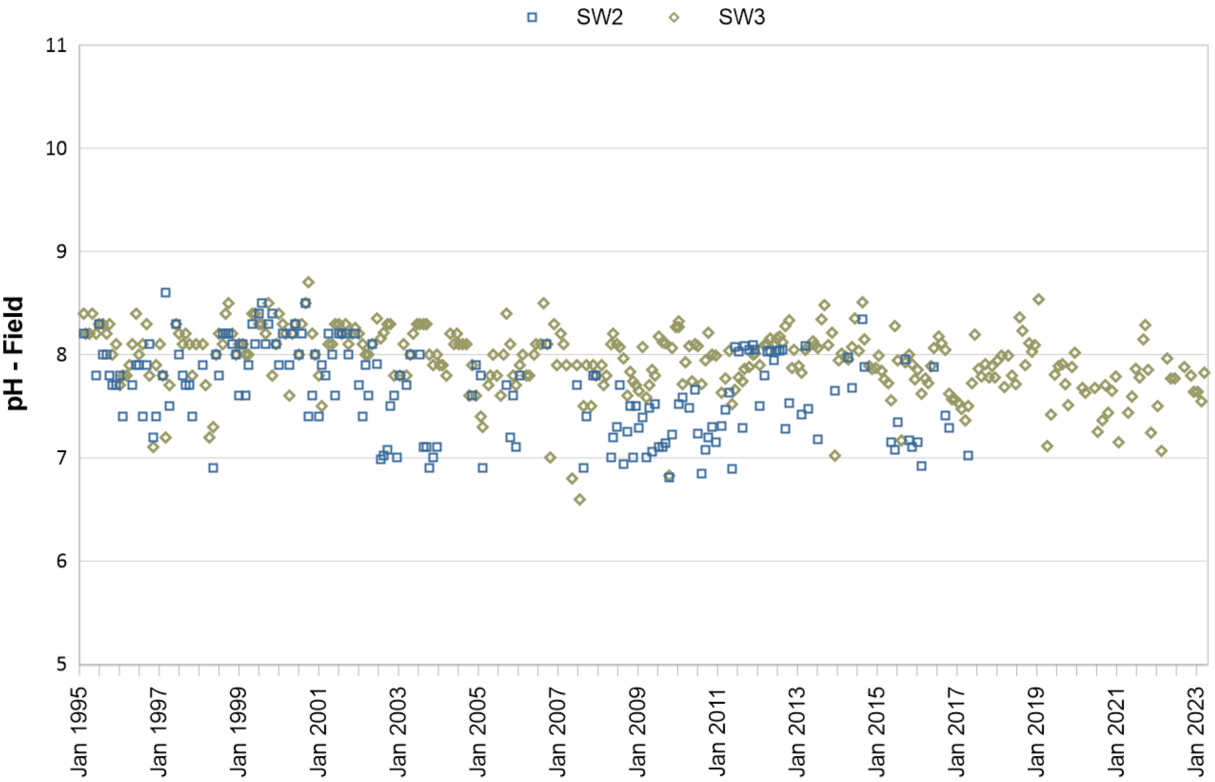
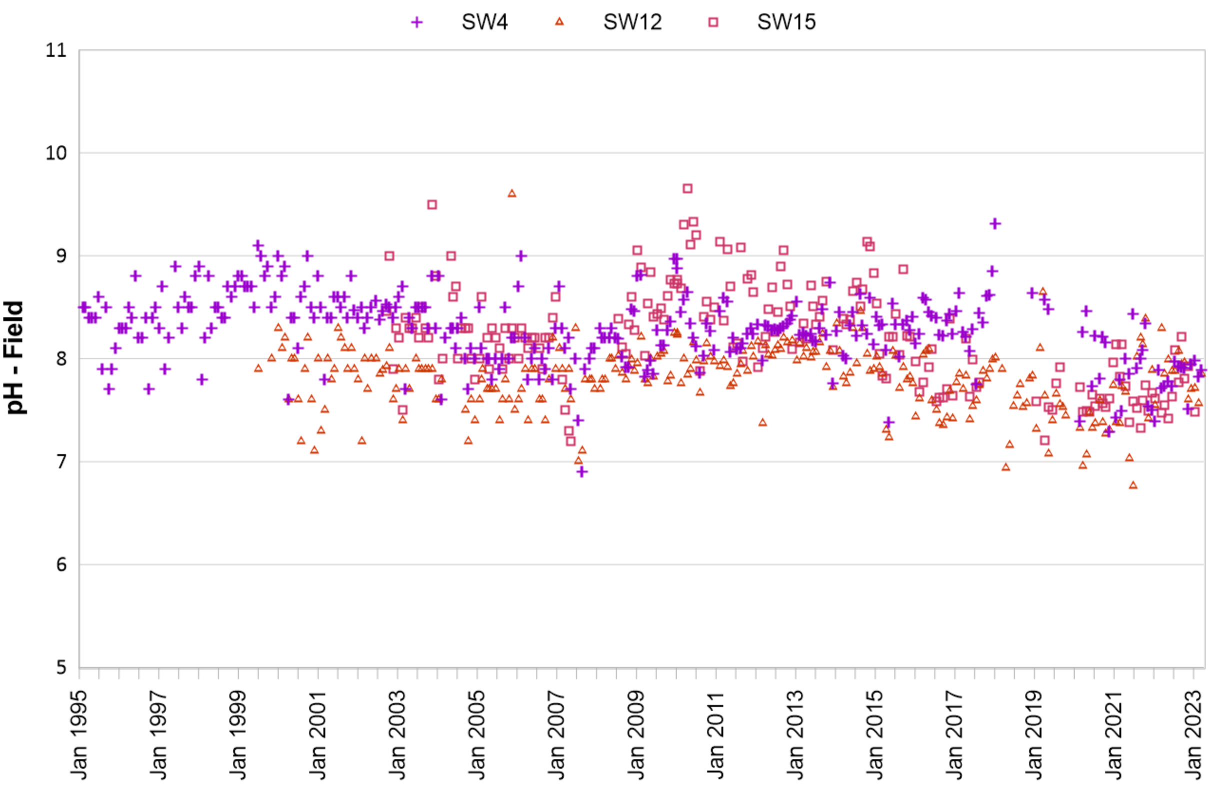
APPENDICES

APPENDIX A – SURFACE WATER QUALITY MONITORING DATA

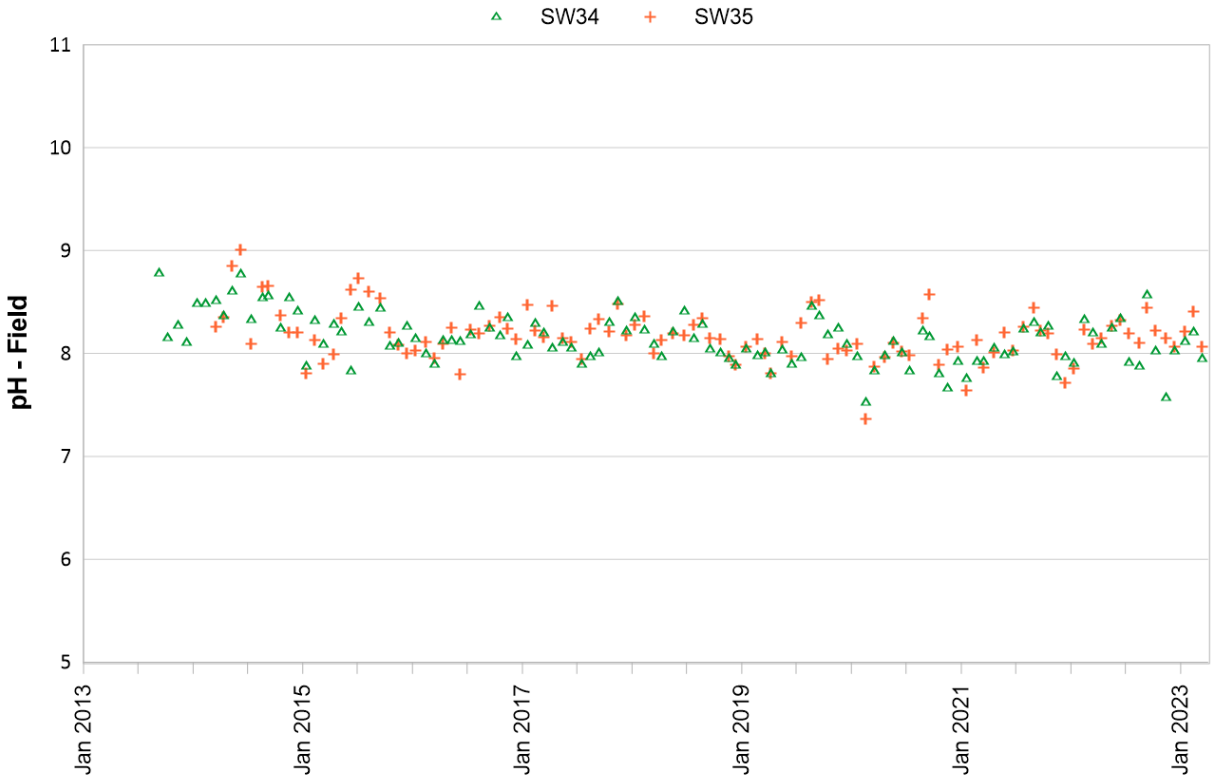
GRAPH A1: FIELD pH – SW2 AND SW3



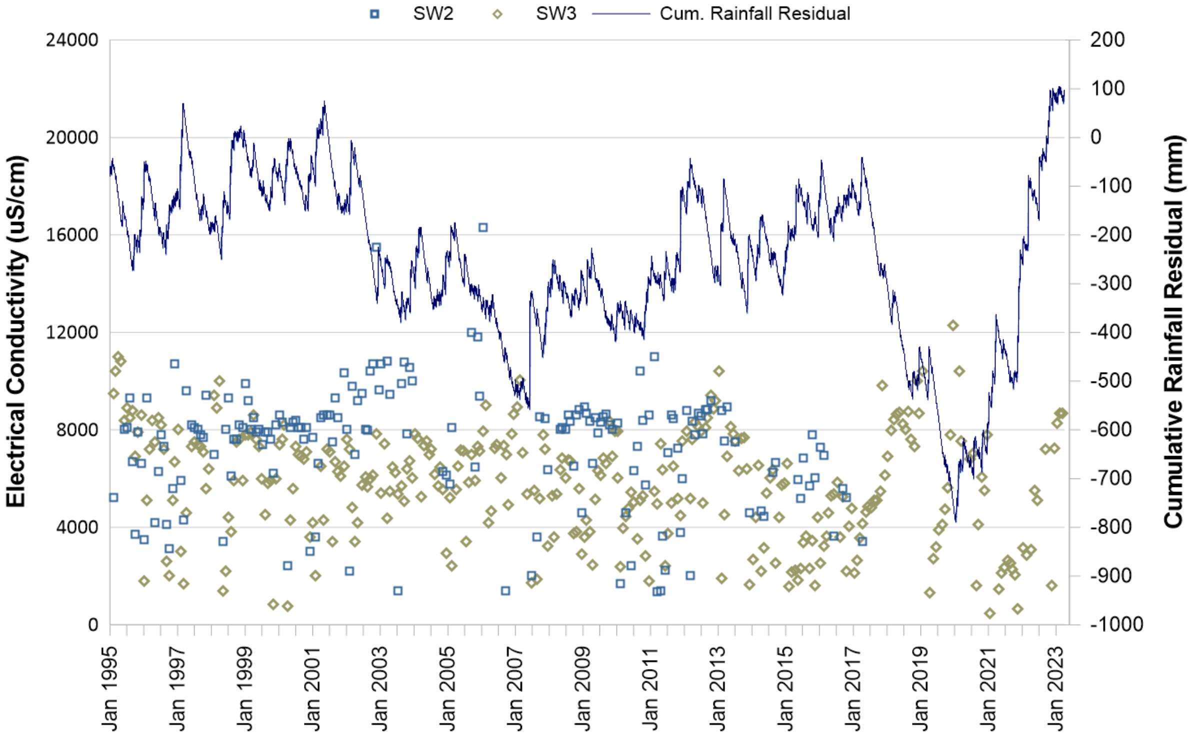
GRAPH A2: FIELD pH – SW4, SW12 AND SW15



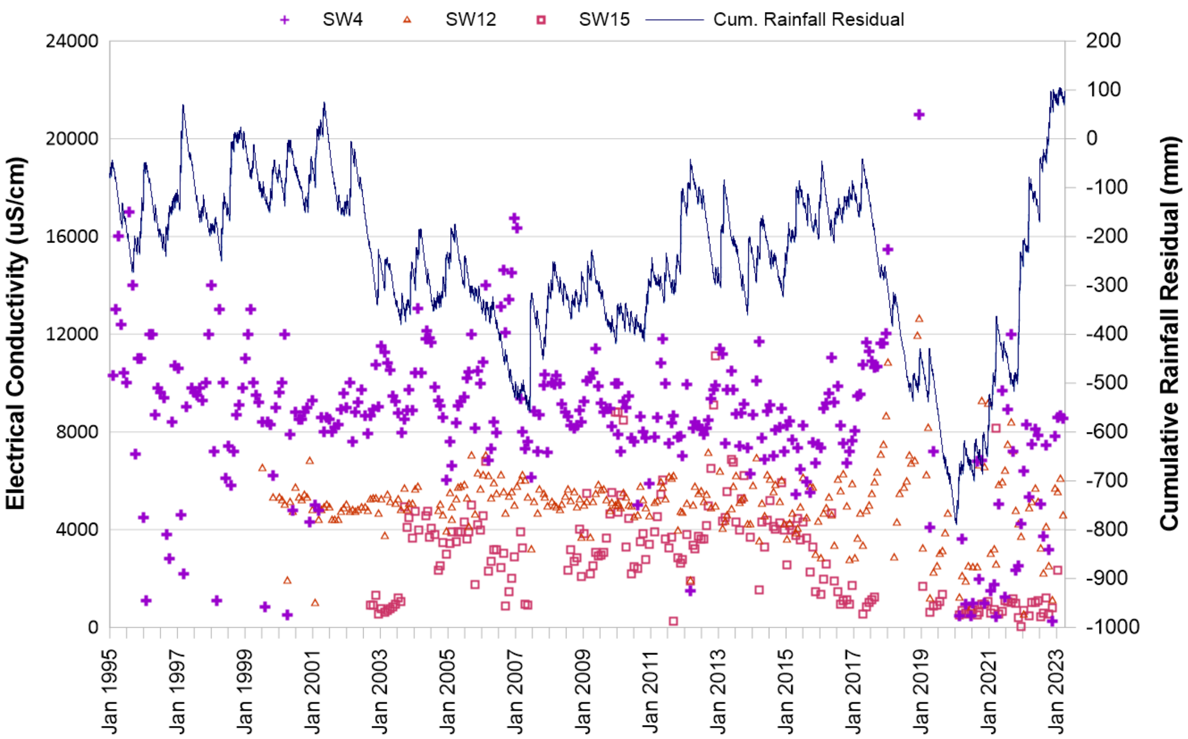
GRAPH A3: FIELD pH – SW34 AND SW35



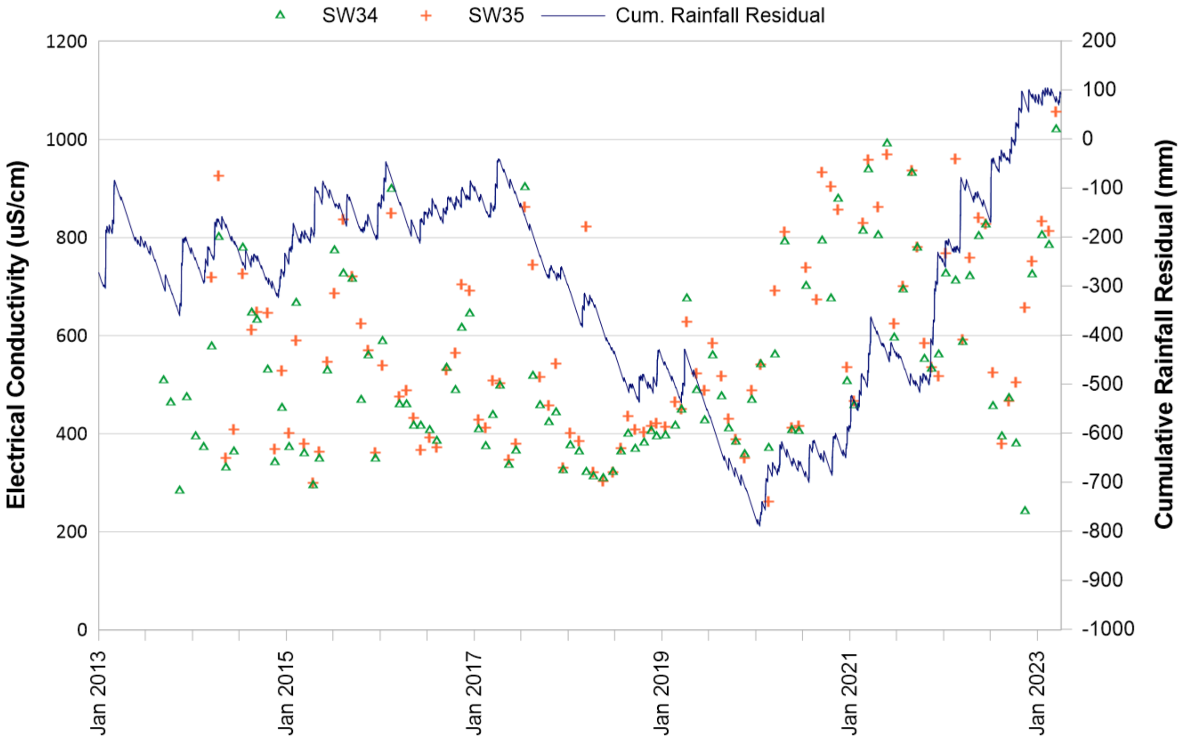
GRAPH A4: FIELD EC AND CUMULATIVE RAINFALL RESIDUAL – SW2 AND SW3



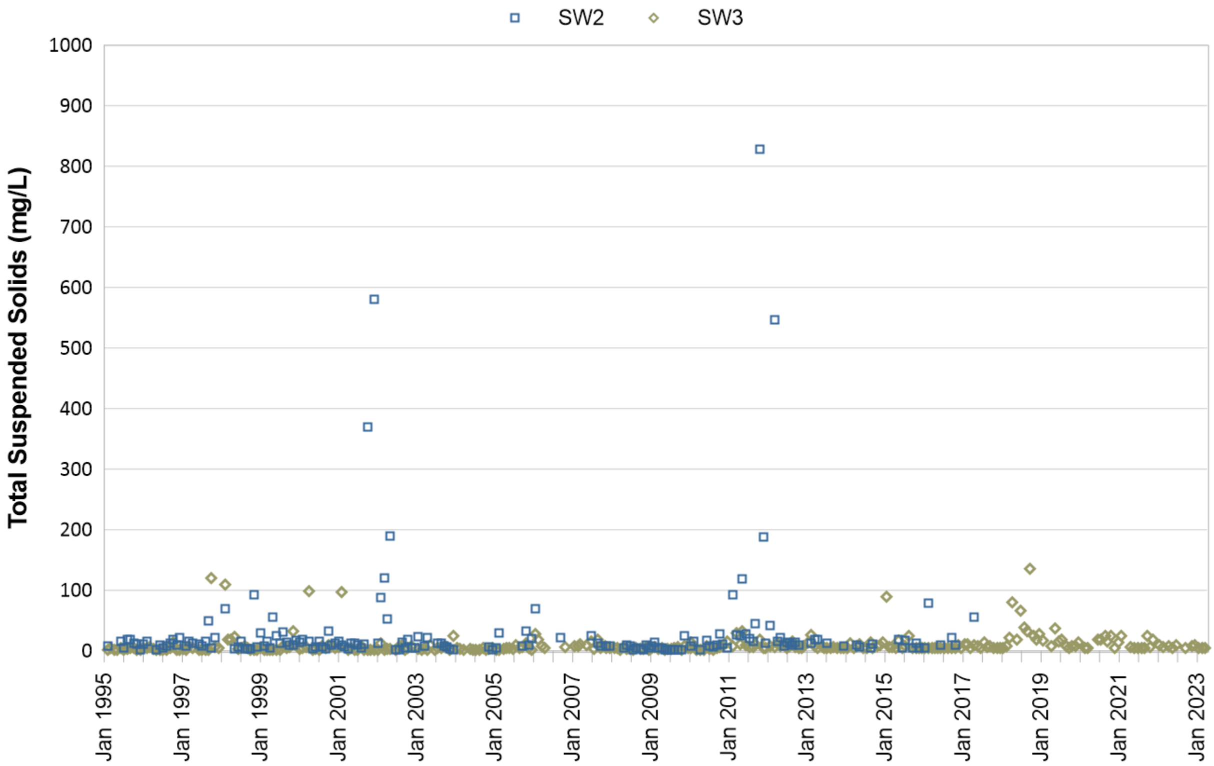
GRAPH A5: FIELD EC AND CUMULATIVE RAINFALL RESIDUAL – SW4, SW12 AND SW15



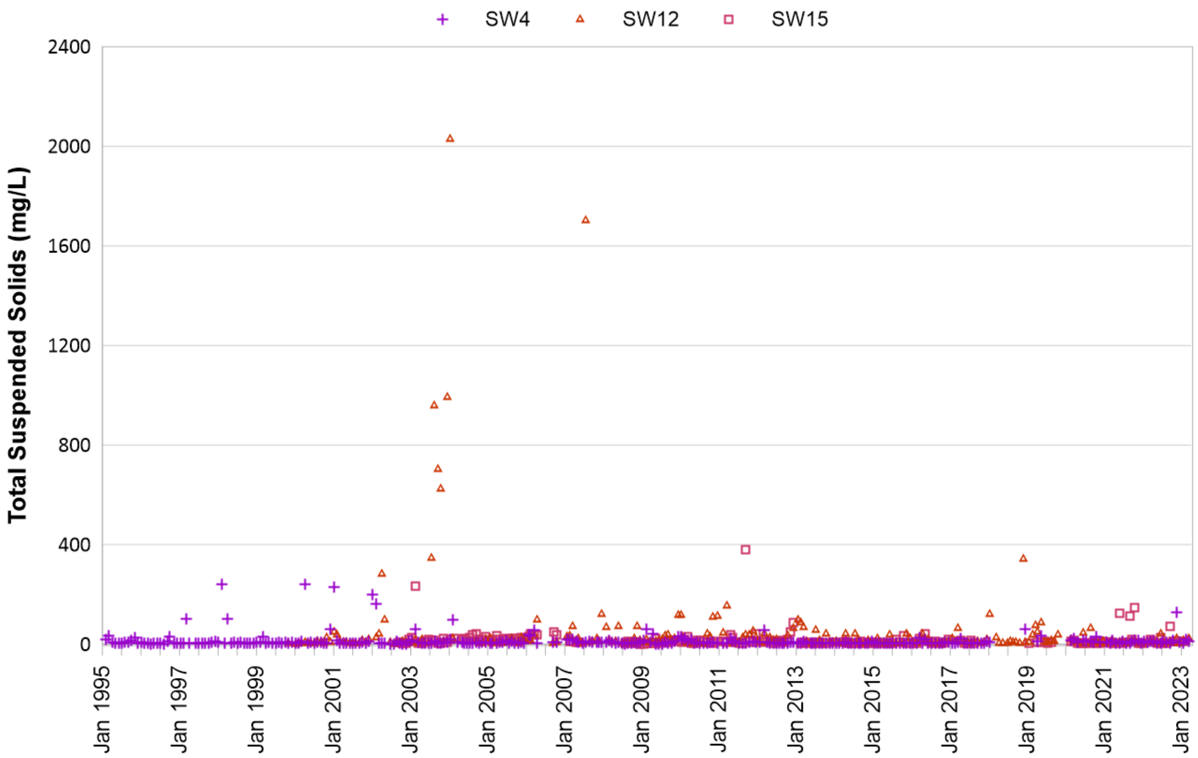
GRAPH A6: FIELD EC AND CUMULATIVE RAINFALL RESIDUAL – SW34 AND SW35



GRAPH A7: TOTAL SUSPENDED SOLIDS – SW2 AND SW3



GRAPH A8: TOTAL SUSPENDED SOLIDS – SW4, SW12 AND SW15



GRAPH A9: TOTAL SUSPENDED SOLIDS – SW34 AND SW35