WATER BALANCE MODEL UPDATE 2023

Model Update & Calibration

Prepared for:

Wilpinjong Coal Pty Ltd

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BASIS OF REPORT

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DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
665.10014-R01-v1.0-20230331	31 March 2023	Walter Rowlands/ Jack Jenness	Paul Delaney	Paul Delaney
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1 Introduction

Wilpinjong Coal Pty Ltd (WCPL) operates the Wilpinjong Coal Mine (WCM), which is located approximately 40 km north-east of Mudgee in the Mid-Western region of New South Wales (NSW).

WCPL have developed and continue to maintain a water balance simulation model for the WCM. The model was updated and converted to Goldsim software in 2020 by SLR Consulting Pty Ltd (SLR, 2020a), based on calibration against monitoring data collected between January 2018 and December 2019. Prior to this update the model utilised OPSIM simulation software which was calibrated to monitoring data between January 2014 and January 2018. SLR recalibrated the model again during 2022 to provide updated forecasts for WCM, and for the 2022 annual review process.

WCPL are required to prepare a site water balance in accordance with Condition 30(d)(ii), Schedule 3 of Development Consent SSD-6764. WCPL have engaged SLR to review and update the WCPL Water Balance Model (WBM) to capture changes to the site water catchments and management system during 2022 and calibrate the WBM using monitoring data collected up to the end of December 2022.

This report documents the model update process and outcomes, including:

- Collation and review of historical water monitoring data;
- Updated catchment and land use mapping and changes incorporated to the Water Management System (WMS) in 2022;
- Calibration of WCPL's Goldsim model against the 2022 Goldsim output and data collected between January 2018 and December 2022;
- Description of the Goldsim model, operating rules and model schematic; and
- Forecast of site water behaviour for the next three years (2023 to 2025).

The intent of this report is to document the basis of the updated WCPL Goldsim model, assess the predicted water balance versus actual monitored water inventory during 2022, and to provide a 3-year forward projection of water balance at WCM.

2 Background

2.1 Operational Description

The WCM is an open cut thermal coal mine located approximately 40 km north-east of Mudgee near the village of Wollar, within the Mid-Western Regional Local Government Area (LGA) in central NSW. WCM is owned and operated by WCPL, a wholly owned subsidiary of Peabody Energy Australia (PEA). The WCM ("the mine" or "the site") extracts Run-Of-Mine (ROM) coal from the Ulan Seam or Moolarben Coal Member which is either processed on site at the Coal Handling and Preparation Plant (CHPP) or bypassed directly to product stockpiles. Current approvals permit production of up to 16 million tonnes per annum (Mtpa) of ROM coal. Coal products are transported by rail on the existing Sandy Hollow Gulgong Railway to domestic energy generators and to the Port of Newcastle for export (Resource Strategies, 2015).

The WCM has eight approved open cut mining areas, named Pit 1 through to Pit 8. Mining is currently undertaken in Pits 1 to 8. Open cut mining of Pit 1, 2 and 5 historically originated at a point and has progressed outward, forming a series of peripheral excavations separated by backfilled spoil. These sub-pits are defined based on their relative position within the associated main pit, i.e., Pit 5 South (Pit 5S), Pit 5 North (Pit 5N) and so on (WRM, 2019).

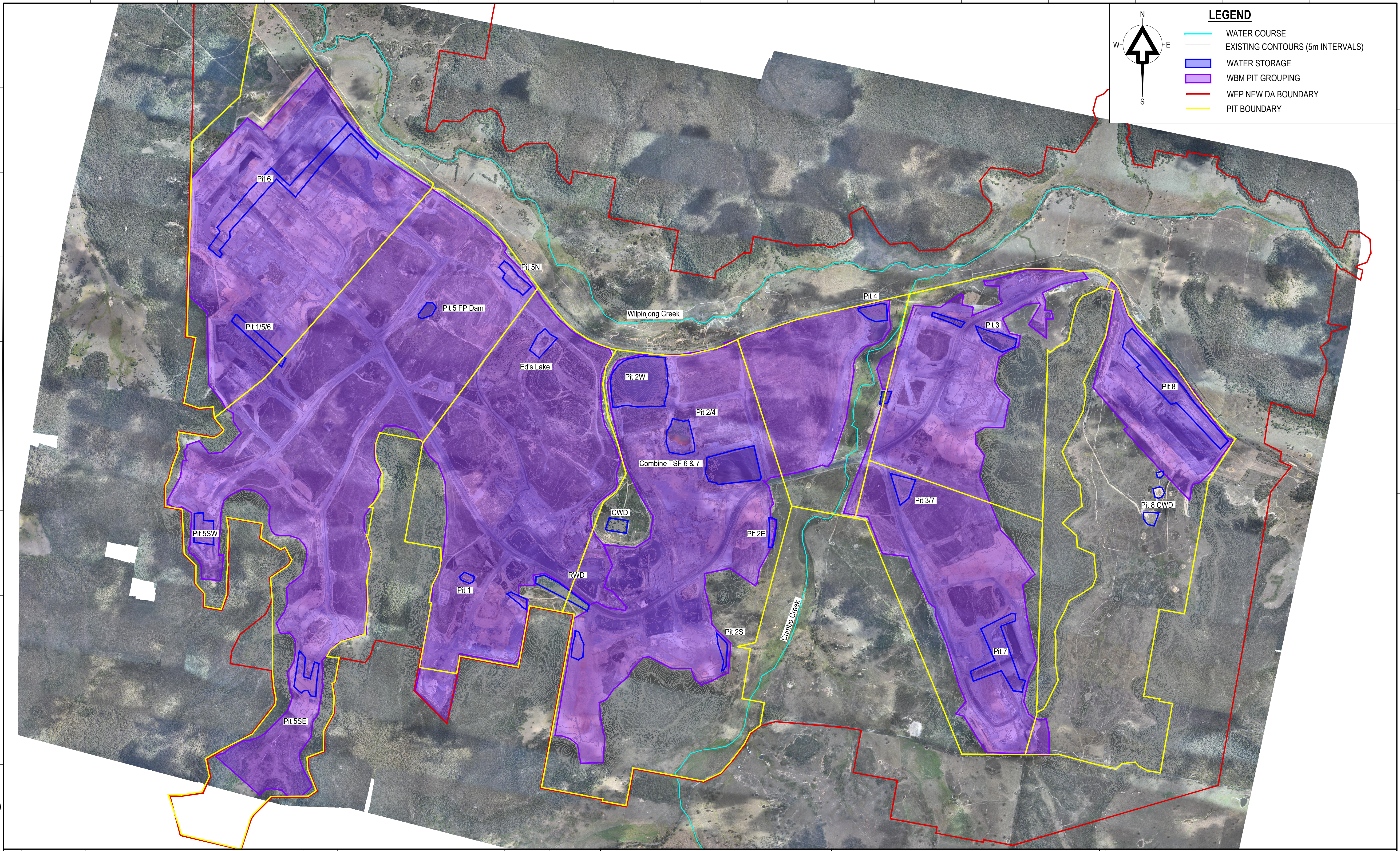
WCM is located adjacent to the right (southern) bank of Wilpinjong Creek, which is incised into a valley between the sandstone plateaus of the Munghorn Gap Nature Reserve to the south, and the Goulburn River National Park to the north. The mine is located on the alluvial/colluvial flats associated with the gullies draining the southern escarpment. The valley flats have typical gradients toward Wilpinjong Creek of approximately 1 in 65 (1.5%). The escarpment rises approximately 100 m from the valley floor to elevations exceeding 450 m Australian Height Datum (mAHD) on the plateau. The sandstone plateaus are heavily forested. The surrounding valley flats are used for cattle and sheep grazing with intermittent cropping, principally for fodder (WRM, 2015).

A general arrangement plan of WCM as of 31 December 2022 is provided in **Figure 1**.

2.2 Approvals & Licences

WCM originally operated under Project Approval 05-0021 that was granted by the NSW Minister for Planning under Part 3A of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) on 1 February 2006. On 24 April 2017, WCPL was granted Development Consent SSD-6764 for the Wilpinjong Extension Project (WEP) that provides for the continued operation of WCM at rates of up to 16 Mtpa of ROM coal out to 2033, and access to approximately 800 hectares (ha) of open cut extensions. Development Consent SSD-6764 has superseded the Project Approval 05-0021, which was surrendered on 28 April 2020 as required under SSD-6764.

WCM is also subject to conditions outlined in Environmental Protection Licence (EPL) No. 12425. Mining operations are carried out upon Mining Leases (MLs) 1573, 1779 and 1795, in accordance with the Mining Operations Plan (MOP), a requirement of MLs and SSD-6764.



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3 Water Management System

3.1 Overview

The WCM Water Management System (WMS) comprises a network of internal dams interconnected via pumps/pipelines and drainage channels. The main objective of the WMS during wet periods is to minimise the risk of uncontrolled discharge of water to the receiving environment and to minimise the risk of pit inundation which may impact coal production. During dry periods, the main objective of the WMS is to ensure that adequate reserves are available to maintain water supply for mining operations. If required, WCM have access to a water supply bore field which can be activated to import external water during these periods. The majority of the system's water storage capacity is provided by Pit 2W, a former open cut mining pit located adjacent to Ulan Wollar Road. Other significant water storages include the Recycled Water Dam (RWD) and Clean Water Dam (CWD) (refer **Figure 1**).

WCM currently has eight open cut mining pits (Pit 1, 2, 3, 4, 5, 6, 7 and 8). Review of deepest mined topographic data shows that historical mining has occurred within three distinct voids, which each share a common and continuous pit floor, and are divided from each other by an unmined in-situ rock barrier. These voids are referred to herein as Pit 1/5/6 (containing Pits 6, 5S, 5N, and 1), Pit 2/4 (containing Pits 2W, 2S, and 4) and Pit 3/7 (containing Pits 3 and 7). Pit 1/5/6 and Pit 2/4 feature a central overburden emplacement area, which acts as a highly permeable aquifer. During 2022, mining activities proceeded in Pits 1, 4, 5, 6,7 and 8.

Water within each void passively drains to the north down the dip of the former coal seam, collecting in either Pit 5N, Pit 4, or Pit 3, where it is then pumped to the Pit 2W hub water storage. Note that the Pit 1/5/6, Pit 2/4 and Pit 3/7 definitions are only used in the context of water management; these definitions do not align with mine planning terminology.

Water inflows to the WMS include rainfall, catchment runoff and groundwater interception. The mine has intersected several ephemeral creeks and these catchments now report to the WMS. It is also noted that WCM's mine rehabilitation is still progressing in accordance with the MOP and those completed rehabilitated areas have not yet had sufficient time to mature to the extent that would allow runoff from these areas to be discharged off-site.

Water is used for dust suppression (road watering, stockpile sprays), wash down (washbays and vehicle wash stations) and for washing coal. The majority of water used for these applications is lost via evaporation or entrainment within railed product coal and waste rock dumps. The coal washing process formerly included a wet-tailings circuit, with tailings slurry pumped to a number of approved Tailings Dams (TDs) adjacent to Pit 2W for consolidation and water recovery (note that tailings was pumped into two approved TDs located at the northern end of Pit 1 prior to using the Pit 2 TDs).

The process was modified in April 2015 to include a tailings Belt Filter Press (BFP). Mixed reject is now co-disposed of within the overburden dumps. TD1 to TD5 have been capped and rehabilitated. TD6 remains active to allow for the deposition of tailings slurry during periods in which the BFP is undergoing maintenance. TD7 receives only water that has seeped through the north-western corner of TD6.

During periods of high-water inventory, WCM operates a Water Treatment Facility (WTF) which utilises Reverse Osmosis (RO) technology and discharges a blend of permeate and Pit 2W water to the adjacent Wilpinjong Creek in accordance with flow and water quality limits specified in EPL 12425.

Prior to 2018, the WTF comprised a WCPL owned primary plant, supplemented with a second leased plant installed to provide temporary additional treatment/discharge capacity. The temporary WTF was decommissioned at the beginning of 2018. WTF reject was pumped to Pit 1S and/or the RWD until late 2018 when Pit 1S was taken offline and was mined through in early 2019. WTF reject, along with backwash from the WTF and water that doesn't meet the requirements outlined in EPL 12425, is now directed to Pit 2W and/or the RWD.

During periods of low water inventory associated with extended drought, WCM are licenced to draw water from a network of water supply bores to supplement site water demands.

WCM also imports potable water which is used to supply amenities. Sewage is treated and disposed on site via irrigation in accordance with EPL 12425. The potable water circuit has no functional influence on the performance of the WMS and is not discussed further in this study.

The following subsections summarise the physical characteristics of the WCM water management system, including water storage specifications and function, catchment and land use classification breakdown, and key transfer infrastructure specifications as incorporated in the model.

3.2 Water Storage Infrastructure and Voids

3.2.1 Function and Specification

Table 1 summarises the location, specifications and description for key water storages and voids within the WMS. Consistent with documentation associated with previous water model updates, infrastructure has been grouped as follows:

- Water Storages: Infrastructure used for storing water that has come into contact with mining operations. Comprises surface ponds/dams and inactive mining pits used for bulk water storage;
- Sediment Dams: Sumps/dams used to intercept and capture sediment laden runoff generated from disturbed areas. Water captured in these structures is pumped back to the mine WMS;
- Tailings: Dams or repurposed open cut mining pits used to store tailings waste. Note that tailings storage capacities have not been listed in the following tabulation, as available air space is not intentionally used for water storage; or
- Mining Pits: Open cut voids currently subject to active mining. Not used for water storage (unless required to prevent off-site discharge to the environment).

Table 1 Key Water Storage and Void Specifications and Functional Description

Storage	Location (GDA94 Zone 55)		Catchment (ha)	Full Storage Capacity		Functional Description
	Easting	Northing		(mAHD)	(ML)	
Water Storages						
Pit 2 West	770975	6419350	231.6	398	4,088	Hub water storage, and primary buffer storage. Receives dewatering from mining and processing areas, and supplies water to industrial tasks as required. Feed water supply for the WTF.
Pit 1 South (offline from late 2018)	769250	6417120	-	421.4*	295*	Stores reject from the WTF.
Pit 5 Fill Point (FP) Dam	769030	6419995	33.1	392.2	8	Water supply for dust suppression activities in the Pit 5 mining area. Water makeup from local mining area dewatering, or Pit 2W as a backup.
Clean Water Dam (CWD)	770785	6418000	2.1	397	51	Water supply for CHPP/MIA area tasks. Water makeup from Pit 2W.
Recycled Water Dam (RWD)	770270	6417430	26.7	412.6	295	Water supply for CHPP/MIA area tasks and to the ROM truck fill point. Water makeup from Pit 2W. May also receive concentrate from the WTF.
Ed's Lake	770085	6419690	286.7	375.3	110	Transfer dam located in backfilled Pit 1N void. Storage capacity includes basin to the north-east of the main void storage.
MIA Dam	770570	6417820	-	-	-	Sediment trap located near admin area. Intercepts sediments from water draining back to Pit 2W from the CHPP/Mine Infrastructure Area (MIA). Note: not included in Goldsim model.
Pit 8 CWD (constructed in Q1 2020)	775683	6418277	311.4	-	16	Captures majority of Pit 8 upslope catchment via Pit 8 upstream diversion. Constructed March 2020. Two downstream farm dams capture overflow which in turn overflow to Pit 2W.
Sediment Dams						
Pit 5N Sed. Dams	769530	6420700	-	-	-	Sediment interception works located adjacent to open cut workings. Function is to capture sediment laden runoff, allowing this water to then be pumped back to the WMS. Note: these dams have been functionally modelled as additional catchment assigned to their respective open cut void (i.e. assumes no storage in sediment ponds, and no pumping constraints).
Pit 2E Sed. Dams	772800	6418580	-	-	-	
Pit 3 Sed. Dams	773850	6420010	-	-	-	
Pit 7 Sed. Dams	773240	6417880	-	-	-	
Pit 8 Sed. Dams	775782	6419484	-	-	-	
Mining Pits						
Pit 5 South	767730	6418020	592.3	n/a	n/a	Active mining pits.
Pit 5 North	769220	6420690	729.6	n/a	n/a	
Pit 1	769440	6417660	296.0	n/a	n/a	
Pit 2 South	771250	6416940	220.2	n/a	n/a	

Storage	Location (GDA94 Zone 55)		Catchment (ha)	Full Storage Capacity		Functional Description
	Easting	Northing		(mAHD)	(ML)	
Pit 2 East	772070	6417900	32.4	n/a	n/a	
Pit 4	772840	6419850	132.6	n/a	n/a	
Pit 3	773840	6419230	292.2	n/a	n/a	
Pit 7	774210	6417780	294.2	n/a	n/a	
Pit 6	767950	6420330	359.8	n/a	n/a	
Pit 8	775851	6419225	153.4	n/a	n/a	
Tailings Storage						
TD6	771800	6418530	77.7	n/a	n/a	Inactive tailings storage facilities. Scheduled to be capped and rehabilitated. Note that TD6 is used intermittently when the BFP is offline. TD7 does not receive tailings however does collect seepage from TD6.
TD7	771320	6418860		n/a	n/a	

*2018 data prior to decommissioning.

3.2.2 Storage Characteristics

Storage characteristics (level-area-volume relationships) remain generally consistent with the previous model update (SLR, 2022) with some updates made to active pits.

Modelled level-area-volume profiles for all storages have been provided for reference in **Appendix C**.

3.2.3 Storage Capacities

3.2.3.1 Water Storages

Adopted Full Storage Levels (FSLs) for all water storages are listed in **Table 2**.

Table 2 Adopted Full Storage Levels for Site Water Storages (Source: WRM, 2019)

Storage	FSL (mAHD)	Basis
Pit 2 West	398	As per the stage storage provided by WCPL.
Pit 1 South (offline from late 2018)	422	Nominal 0.5 m offset below the level at which additional seepage flows to Ed's Lake were inferred as part of the WBM verification (WRM,2019).
Pit 5 Fill Point (FP) Dam	392	Defined based on review of 2019 surface topography. Nominal level at which overflow to Pit 5N would occur.
Clean Water Dam	397	Maximum water level recorded in historical water level survey. FSL defined as a maximum operating level rather than a spillway level. It is understood that this dam has no formally constructed spillway outlet.
Dirty Water Dam	413	It is understood that this dam seeps to the CHPP area at high water levels, and water levels in the dam are managed to minimise the risk of this occurring. FSL defined as an operational level rather than a spillway level. It is understood that this dam has no formally constructed spillway outlet (WRM, 2019).

Storage	FSL (mAHD)	Basis
Ed's Lake	375	Defined based on review of 2019 surface topography. Nominal elevation at which overflow to Wilpinjong Creek would occur via a low point in adjacent road/rail.
Pit 8 CWD	-	Dam has a capacity of 16 ML.

3.2.3.2 Open Cut Pits

To prevent an uncontrolled release of water to the receiving environment, excess mine water would be temporarily stored within one or more open cut mining pits. This practice would continue until the excess water is drawn down through evaporation, supplied to demands (e.g. dust suppression) or via EPL Licensed Discharge Point (LDP) LDP No.24 (via the site's WTF).

The assumed order of preference in which pits would be filled is Pit 5N, Pit 4 then Pit 3 (per WRM, 2019). Note that water storage in up-dip pits (i.e. Pit 5S, Pit 1, Pit 2S, Pit 7, Pit 6) is not possible as these voids freely drain down the dip of the coal seam, through the in-pit spoil placement areas to their respective down-dip pits.

Overflow and recommended maximum fill levels have been listed in **Table 3**. Recommended maximum fill levels reflect settings incorporated into the WBM for current storage capacities. Recommended fill levels have been set five metres below the nominal overflow level. Actual fill levels (which trigger filling of the next pit in sequence) should continue to be confirmed/defined to reflect changes due to mine progression.

Table 3 Mining Pits Overflow and Recommended Maximum Fill Levels

Pit	Level		Notes
	Overflow	Max Fill	
Pit 5N	381.0	369.0	Assumed hydraulic connection between Pit 5N and Ed's Lake.
Pit 4	366.0	362.0	Overflow level based on low point in northern end of Pit 4N high wall. Note that low point will reduce as mining progresses eastward.
Pit 3	365.0	358.0	Overflow level based on low point on western side of Pit 3N void (adjacent to Cumbo Creek).

3.2.4 Catchment Breakdown

Catchment boundaries for water storages within the WCM have been delineated based on the most recent available topographic data and advice from operational personnel. 2022 catchment areas have been summarised in **Table 1**. Catchment maps and land use maps have been provided in **Appendix B**.

Land use classifications used for the model calibration have been determined based on Peabody mapping and review of end of year 2022 satellite imagery.

Current investigations have adopted a land use classification schedule to align with catchment yield parameters:

- Natural / undisturbed – no disturbance, typically grass or brush;
- Roads / industrial / hardstand/ mining Pit – sealed or unsealed road or track, cleared and compacted earth or concrete (layout areas etc.), open-cut void;
- Spoil / overburden – unrehabilitated spoil emplacement, clear of vegetation, also includes cleared areas and beach and other exposed tailings reject areas;

- Rehabilitated overburden – emplacement areas that have been shaped and re-vegetated;

Land use data has been used to calculate catchment yield within the WBM. Different land use classifications generally correspond with a unique catchment runoff model parameter set. Catchment yield is discussed further in **Section 4.4**.

A breakdown of land use type per water storage catchment area has been provided in **Appendix B**, in addition to catchment and land use plans.

3.2.5 Water Transfer Infrastructure

The WCM transfer network comprises a mixture of fixed pump and pipeline infrastructure connections, supplemented with portable infrastructure that can be moved around for pit dewatering. Water transfer capacities adopted as part of the WCM Goldsim WBM are consistent with the previous model update and are summarised in **Table 4**. Active management of Pit 8 commenced in 2020 and pumped discharge from the Pit 8 CWD via EPL Licensed Discharge Point LDP No.30 commenced in 2021 and are included below. Note the following:

- Assumed no pumping from up-dip pits, i.e. Pit 5S, Pit 1, Pit 2S and Pit 7. These pits passively drain along the dip of the mined coal seam (either along the surface or through the highly permeable in-pit spoil placement areas) to their respective down-dip pits.
- Water transfers from dams for industrial tasks are assumed to be constrained by demand, not by pump/pipeline capacity.
- Assumed no pumping from any tailings dams – water inflow to these areas is assumed to evaporate or seep to the underlying Pit 2/4 spoil aquifer which is hydraulically connected to Pit 2W.

Table 4 Water Transfer Infrastructure Modelled Capacities

Category	Connection Points		Flow Capacity	
	Storage (From)	Directed (To)	L/s	ML/day
Pit Dewatering	Pit 5N	Pit 2W	180[1]	15.5
	Pit 4	Pit 2W	160[1]	13.8
	Pit 3N	Pit 2W	100	8.6
	Pit 8	Pit 2W	100	8.6
Mine Water Containment	Ed's Lake	Pit 5 FP Dam	100	8.6
	Ed's Lake	Pit 2W	100	8.6
	Pit 2W	Pit 5N	100	8.6
	Pit 2W	Pit 3N	100	8.6
Controlled Discharge	Pit 8 CWD	Offsite[2]	200	17.3
Other	Pit 2W	CWD	100	8.6
	Pit 2W	RWD	100	8.6

[1] Dewatering capacity for active pits is variable subject to allocation of pump resources.
[2] Prior to 2021 water was pumped from Pit 8 CWD to Pit 2W at 160 L/s.

4 Climate

4.1 Overview

Climatic influences on the WMS include catchment rainfall–runoff and evaporation (from wetted areas) and evapotranspiration (from catchments). The WBM has been configured to simulate system performance on the basis of long-term historical climate data. Historical data has been directly applied, based on the assumption that climatic conditions observed in the past, and captured in the data, are indicative of persistent local climatic trends. Historical data is therefore assumed to represent the range of potential conditions likely to be observed in the near future.

This investigation, and those prior, have not included allowance for climate change effects as these are unlikely to be material in the three-year forecasting period.

Updated climatic data for WCM (latitude -32.35, longitude 149.9) has been sourced from the SILO Data Drill service (Queensland Government Department of Science, Information Technology and Innovation). The Data Drill service accesses grids of climate data interpolated from point observations by the Bureau of Meteorology (BoM) for any point in Australia. Sourced information includes daily resolution rainfall and evaporation data, for the 123-year period 1900 to present. This information has been processed and summarised in the following sub-sections.

WCPL have also provided rainfall data for the January 2016 to December 2022 period, recorded at the site Automated Weather Station (AWS), located within the rail loop (near the CWD). Rainfall data recorded at the neighbouring BoM rainfall gauge at Wollar (Wollar Barrigan St Station 062032) has also been sourced and used for reference. Site AWS and BoM rainfall data has been compared against Data Drill rainfall in **Section 4.2.3**.

4.2 Rainfall

4.2.1 Annual Rainfall (Data Drill)

WCM experienced drought conditions during the end of 2018 and throughout 2019. During 2019 a total annual rainfall of 266 mm was recorded at the Site AWS, which is significantly less than a 10th percentile annual rainfall. Changes to the WBM were undertaken in the previous update (SLR, 2020a) to reflect monitored conditions during these years. During 2020 and 2021, a significant increase in annual rainfall was observed with 987 mm and
899 mm recorded, respectively. Far wetter than average conditions continued to prevail in 2022 as a total of 994 mm was reported across the year, equating to 97th percentile rainfall. Annual rainfall totals (calendar year) have been presented in on a percentile basis in **Figure 2.**

Annual rainfall varies between approximately 200 mm and 1,200 mm (~1,000 mm range), with a median of 608 mm ± 183 mm. Approximately 70% of the data set falls within 1 standard deviation of the median. Also shown for reference are calendar year rainfall totals for the seven most recent years. Review of this information shows that during the recent drought conditions the 2018 rainfall was equivalent to a historical 26th percentile (dry), whilst the 2019 rainfall was equivalent to a historical 1st percentile (very dry). In contrast, rainfall experienced during 2020, 2021 and 2022 was equivalent to a historical 96th percentile, 94th percentile rainfall and 97th percentile, respectively (very wet).

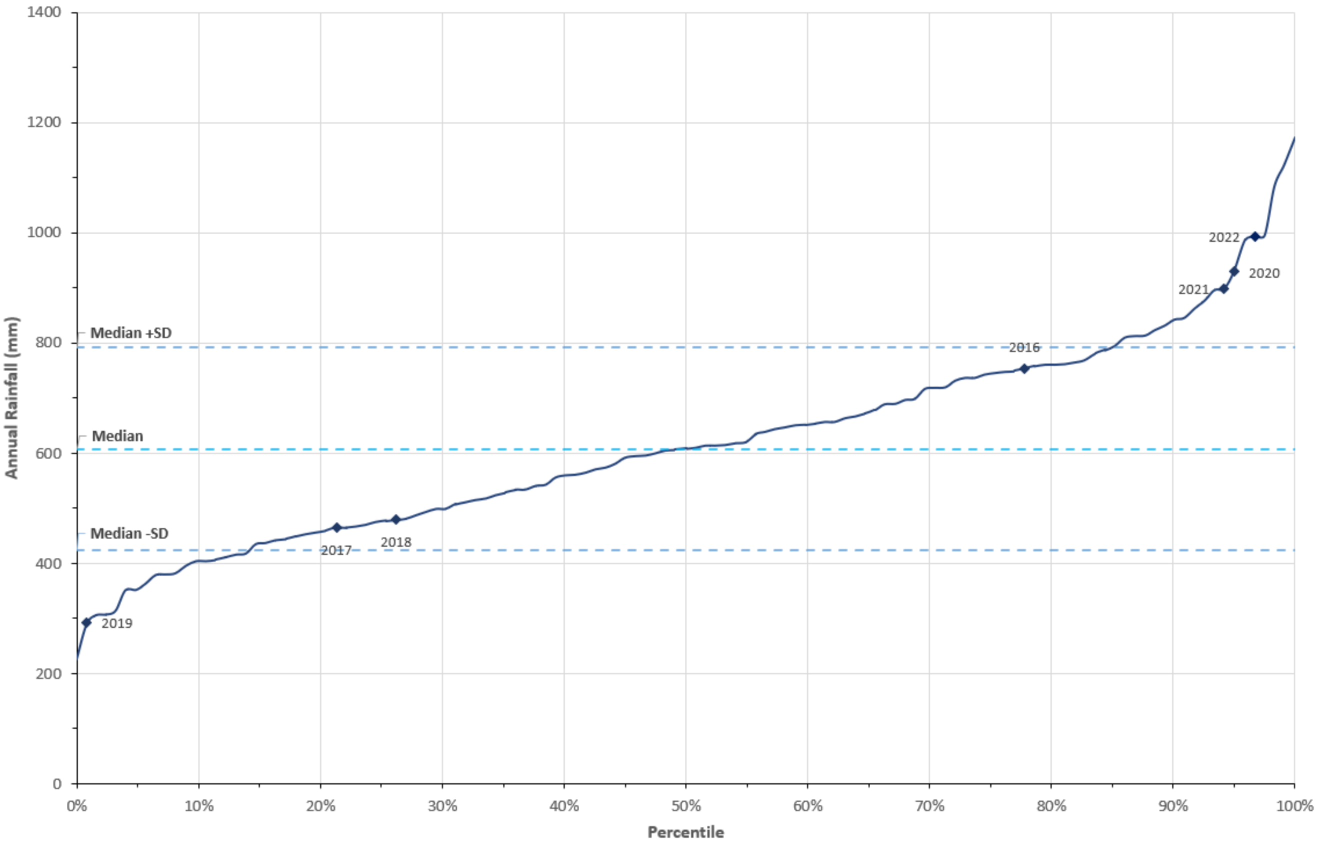


Figure 2 Historical Annual Rainfall Percentiles

4.2.2 Rainfall Statistics (Data Drill)

The statistics for the long-term Data Drill rainfall data for the 123-year period are summarised in **Table 5**. Annual totals are for a calendar year January to December.

Table 5 Long-term Data Drill Rainfall Statistics (mm)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max	204	364	241	200	184	249	175	137	174	216	266	203
90th %ile	132	142	123	79	74	88	97	85	90	110	124	124
Median	60	45	45	29	31	34	40	37	35	51	56	50
10th %ile	14	5	5	2	5	10	7	12	10	9	10	12
Min	0	0	0	0	0	0	1	0	0	0	0	0
Mean	67	62	57	40	38	45	45	44	43	54	61	61
St. Dev	46	59	49	38	33	41	33	29	32	42	47	47
Count	123	123	123	123	123	123	123	123	123	123	123	123

4.2.3 Data Drill vs Site and BoM Rainfall

SILO Data Drill rainfall data has been compared against data recorded at the WCM AWS and at the neighbouring BoM rainfall gauge at Wollar (approximately 8 km east of Wilpinjong).

The intent of comparing SILO Data Drill rainfall against the site and BoM reference data is to:

- demonstrate that the SILO rainfall is comparable to local measurements, and is therefore an appropriate input time-series to the Wilpinjong WBM model (for long-term modelling); and
- identify an appropriate measured rainfall dataset to be used in the WBM calibration exercise completed as part of current investigations.

Cumulative rainfall totals, resetting on an annual basis, are presented in **Figure 3.**

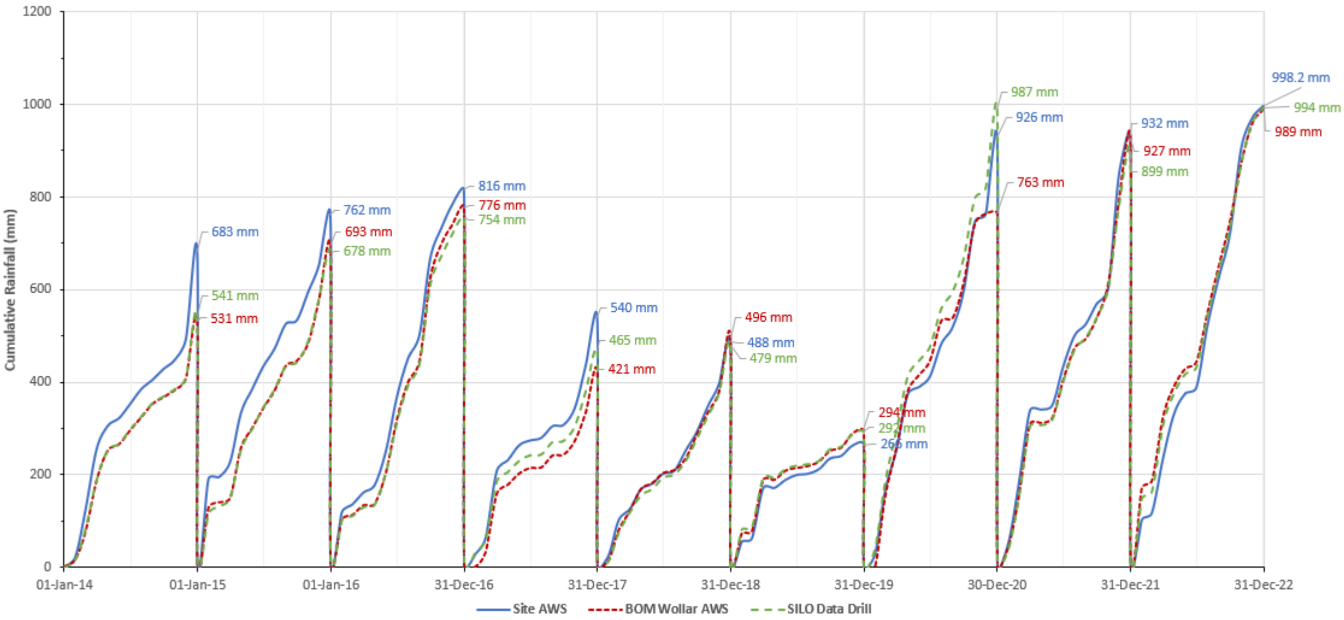


Figure 3 Cumulative Rainfall (resetting 1st Jan) – Site AWS, BoM Wollar, SILO

Review of **Figure 3** shows the following:

- Cumulative rainfall reported by the Site AWS was significantly higher than the other two datasets prior to mid-2015, primarily due to discrepancies in events in March 2014, December 2014 and January 2015. From July 2015 onward, data from the AWS appears to be more consistent with the other gauges. Note the previous 2016 model update (Hatch, 2017) compared Site AWS data against data from nine surrounding BoM rainfall gauges (including Wollar) and observed similar trends in 2014 and early 2015.
- SILO Data Drill rainfall totals are generally consistent with the Wollar BoM gauge throughout the review period, and with the Site AWS data from mid-2015 onward.

Key outcomes of the above comparison are:

- The model calibration exercise completed as part of this update has focused on the period January 2018 to December 2022 (five years). The first year of this period overlaps with the calibration period studied as part of previous investigations (WRM, 2019). For consistency with previous model updates, model calibration was based on the Site AWS data.
- SILO Data Drill rainfall is consistent with rainfalls recorded at gauges in the study area and is therefore considered to be an appropriate input time-series to the WBM.

4.3 Evaporation

Long term daily evaporation data for the WCM has been sourced from the SILO Data Drill service. Morton lake evaporation (M_{lake}) has been used to estimate evaporation from the wet surface areas of surface storages. No adjustment factors have been applied to pits or catchment areas. The statistics for the long-term Data Drill M_{lake} evaporation data are summarised in **Table 6**.

Table 6 Long-term Data Drill M_{lake} evaporation statistics (mm)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Max	229	186	164	108	67	45	53	84	122	165	204	232	1539
90th %ile	217	174	151	98	62	42	50	76	112	157	186	212	1461
Median	196	156	136	90	57	38	44	68	102	142	168	192	1392
10th %ile	169	138	124	81	50	33	39	62	91	126	149	176	1300
Min	153	122	106	67	44	30	33	58	79	101	109	149	1135
Mean	194	156	136	89	56	38	44	69	102	142	168	193	1387
St. Dev	17	14	11	7	5	3	4	6	8	12	15	15	65
Count	123	123	123	123	123	123	123	123	123	123	123	123	123

4.4 Catchment Yield

4.4.1 Overview

Accurate estimation of catchment yield hydrology is an important component of water management investigations. Catchment yield within the WBM is simulated using the Australian Water Balance Model (AWBM). The AWBM is a saturation overland flow model which uses daily rainfalls and estimates of catchment evapotranspiration to calculate daily values of runoff using a water balance approach (Boughton, 1993). The AWBM is widely accepted and commonly used throughout Australia.

4.4.2 Parameters

Different AWBM model parameters are defined for each land use type within the mine catchment. AWBM model parameters were initialised using values from the previous 2019 model update (WRM, 2019) and are considered to remain well suited to current site conditions, determined through the WBM calibration.

Adopted AWBM model parameters are summarised in **Table 7**.

Table 7 Calibrated AWBM Parameters

Parameter		Natural	Rehab	Spoil	High Runoff (Hardstand/Active Pit)
Partial Areas	A1	0.134	0.134	0.134	1.0
	A2	0.433	0.433	0.433	-
	A3	0.433	0.433	0.433	-
Soil Storage	S1	17.6 mm	14.7 mm	11.0 mm	17.0 mm
	S2	182.6 mm	153.2 mm	114.1 mm	-
	S3	366.2 mm	306.9 mm	228.8 mm	-
Baseflow Index	BFI	0.50	0.50	0.50	0.00
Surface Lag	Ks	0.80	0.97	0.97	0.00
Baseflow Lag	Kb	0.97	0.80	0.80	0.00
Avg. Storage	Savg	239.9 mm	201.2 mm	150.0 mm	17.0 mm

5 Site Water Usage

5.1 CHPP & MIA Usage

Water is pumped from Pit 2W to the RWD and CWD. Water is then pumped from these dams into a distribution network which is used to supply water to the following demands within the CHPP and MIA area:

- CHPP process;
- Heavy Vehicle (HV) and Light Vehicle (LV) wash bays;
- MIA wash-down pads;
- Coal handling/stockpile dust sprays; and
- Other miscellaneous MIA/CHPP tasks (cleaning/hoses, clarifier tank overflow or bleed-off via old tailings lines).

Water supply from the RWD and CWD to the distribution network is metered, but the individual offtakes are not (WRM, 2019).

The following sub-sections summarise a process which has attempted to separate the CHPP process water makeup from the other MIA area demands.

5.1.1 CHPP Usage

5.1.1.1 Overview

A conceptual model of the coal washing process is shown in **Figure 4**. Note that prior to April 2015 the CHPP reject circuit comprised separate coarse and fine waste material streams. Coarse rejects were trucked and disposed of within in-pit overburden dumps, and fine tailings were pumped as a slurry to tailings cells adjacent to Pit 2W. The CHPP tailings circuit was modified in April 2015 to include a BFO, which dewaters the tailings stream and allows this material to be disposed of as a dry waste stream with the coarse reject. Any moisture bleed-off from within the BFP process is captured and re-circulated to the clarified water tank. Excess water from the clarified water tank may be drained off by pumping water to the tailings dams via the old slurry pipelines (WRM, 2019).

The following moisture contents are assumed for various material streams within the CHPP:

- ROM: 5% moisture w/w
- Bypass coal: 7.5% moisture w/w
- CHPP feed: 7.5% moisture w/w
- Product coal: 10.3% moisture w/w
- Mixed reject: 28.0% moisture w/w

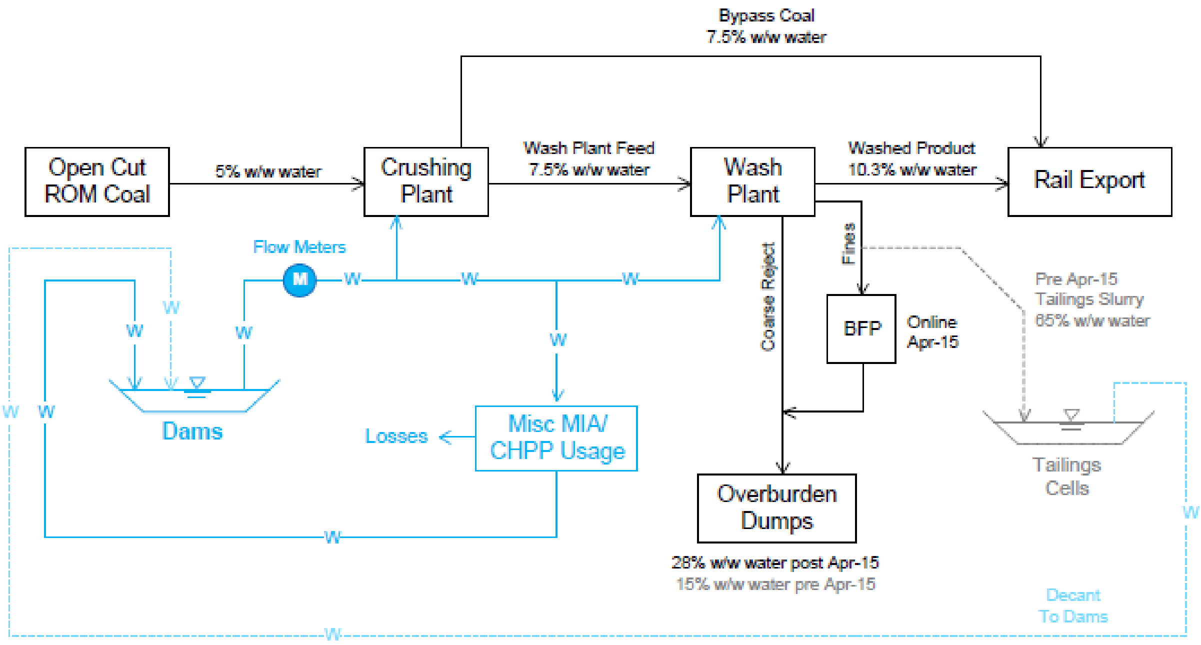


Figure 4 Coal Washing Process Conceptual Model (Source: WRM, 2019)

5.1.1.2 Historical Production

Recent observed material tonnages have been summarised in **Table 8** for the 2019, 2020, 2021 and 2022 calendar years. Review of **Table 8** shows that the annual railed product was approximately 11.58 Mt in 2022 which is a minor decrease from 2021. Since 2019, the volume of railed product has continually declined.

Table 8 Production Summary

Material Stream	2019	2020	2021	2022
Waste Rock/Overburden	45.52 Mbcm	54.59 Mbcm	43.71 Mbcm	49.48 Mbcm
ROM coal^	15.12 Mt	14.74 Mt	14.48 Mt	13.96 Mt
Coarse Reject & Tailings (TFP*)	2.31 Mt	2.63 Mt	2.57 Mt	2.33 Mt
Fine Tailings	0	0	0	0
Railed product	12.79 Mt	12.50 Mt	12.17 Mt	11.58 Mt

^WCM approved rate of up to 16 Mtpa out to 2033.
*Tailings Filter Press.

5.1.1.3 Process Water Makeup

Figure 5 presents the metered water supply from the RWD and CWD to the CHPP-MIA water distribution network. Data relating to the allocation of water to the CHPP area and MIA separately is not available for the 2020 monitoring period.

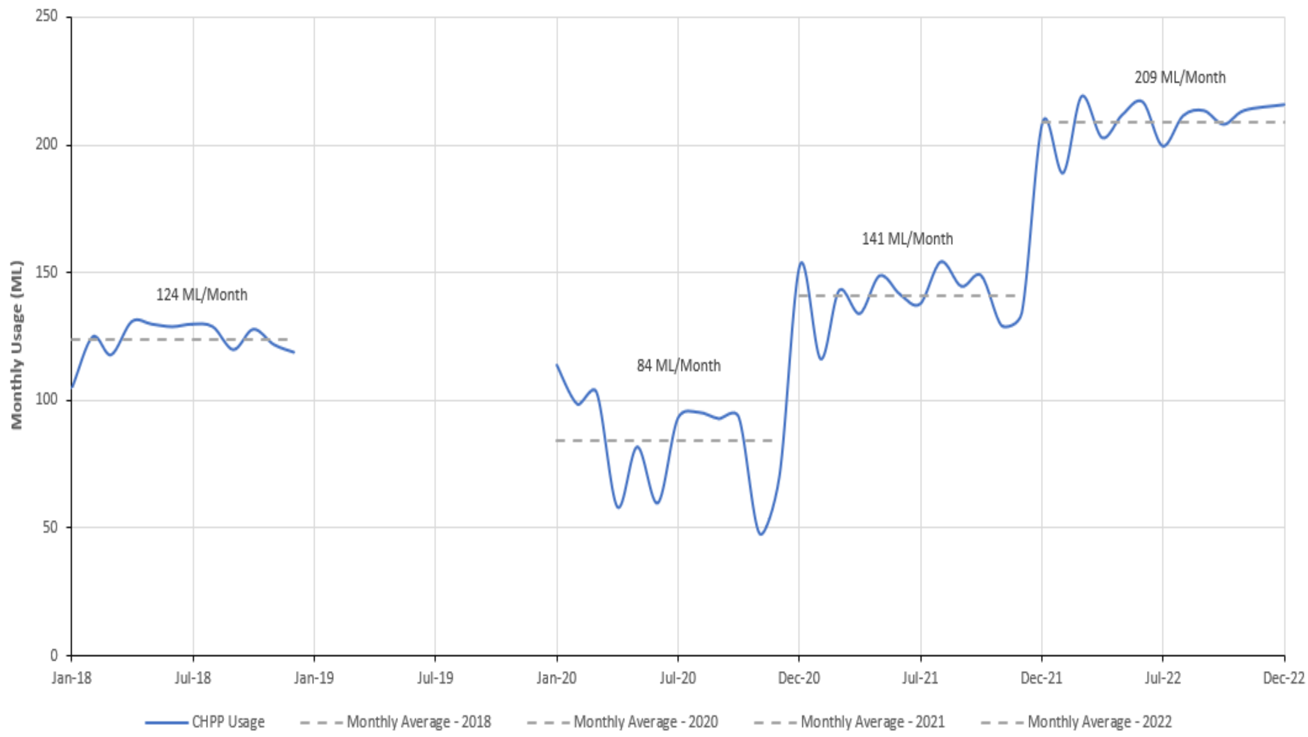


Figure 5 CHPP and MIA Monitored Demand

Review of **Figure 5** shows the following:

- Water usage at the CHPP has continued on an increasing trend from 2020 with 209 ML/month used on average during 2022;
- The water supply rate for 2021 fluctuated between 116 ML/month and 154 ML/month throughout the year. The average monthly usage rate was 141 ML/month;
- Combined CHPP water usage for 2020 was an average supply rate of 84 ML/month which is significantly less than 2021;
- Combined CHPP water usage for 2018 was an average water supply rate of 124 ML/month. No water usage data is available for 2019; and
- Given the above, the average water supply for the calibration period is approximately 140 ML/month.

5.1.1.4 Model Configuration

The yearly fluctuation in water demand at the CHPP has been set as a time series with demand for each year set as the average monthly usage for that year (i.e. 209 ML/month for 2022). Note the model assumes all water sent to the CHPP to close the mass balance is lost, with nil recovered (e.g. all water is entrained within railed product or in-pit dumps). Note that a 20 ML/month miscellaneous usage is modelled with a large percentage of this water returning to Pit 2W (see **Section 5.1.2**). It is possible that a portion of this water is associated with activities in the CHPP.

5.1.2 MIA and Miscellaneous Usage

Previous model updates have shown an unaccounted-for component of the RWD and CWD water supply which is estimated at approximately 20 ML/month. This flow rate is understood to represent water supply to the various demands listed in **Section 5.1**.

Based on the previous water balance modelling, the inferred net loss rate from this miscellaneous water usage stream is expected to be relatively low. Modelling has adopted a net water loss of 100 ML/year (8.3 ML/month) which is consistent with the previous 2019 model update (WRM, 2019) and typical MIA water consumption observed at other operations comparable to Wilpinjong.

The WBM has been configured to extract 20 ML/month from the CWD or RWD and recirculate 17.4 ML/month of this flow back into the WMS via Pit 2W.

5.2 Haul Road Dust Suppression

5.2.1 Measured Water Usage

Water is extracted from the WMS and applied using water trucks over HV/LV roads to minimise dust lift-off. There are three Fill Points (FPs) in operation: the ROM FP, Pit 2 FP and Pit 5 FP. All water truck fill points have been fitted with flow meters.

Dust-a-side (DAS) is a dust suppression agent that reduces dust generation on roads, hardstand and laydown areas and reduces the need for water carts. To help water usage associated with dust suppression WCM commenced the use of DAS in 2019.

On the occasion that FP flow meters are offline or technical malfunction occurs and daily data cannot be obtained, trip-count data is used to estimate usage. WCM operates a Global Positioning System (GPS) logging system which maintains a count of how many times each truck has driven within a certain proximity of a FP. Water usage is estimated by multiplying each individual truck's trip count by its respective water fill capacity.

WCPL have provided updated flow meter data and trip-count-based estimates of water usage for January 2016 to December 2022. This information has been processed and presented in **Figure 6**. Water usage data is based on flow metered records and trip count data.

It has been assumed that actual haul road dust suppression water losses are lower than what is recorded by the flow meters and/or estimated based on GPS trip counts. Consistent with previous model updates an adjustment factor of 0.9 has been applied to the historical water usage data to account for the following:

- Flow recirculation recorded by flow meters (e.g. trucks being overfilled, with excess water draining back to the supply dam); and
- Over-estimation bias inherent to trip-count based methods, which assume every 'trip' entails a truck being filled from empty to full, whereas in practise trucks may return to the fill point part-full, or may even drive past the fill point without stopping (which is still registered as a 'trip').

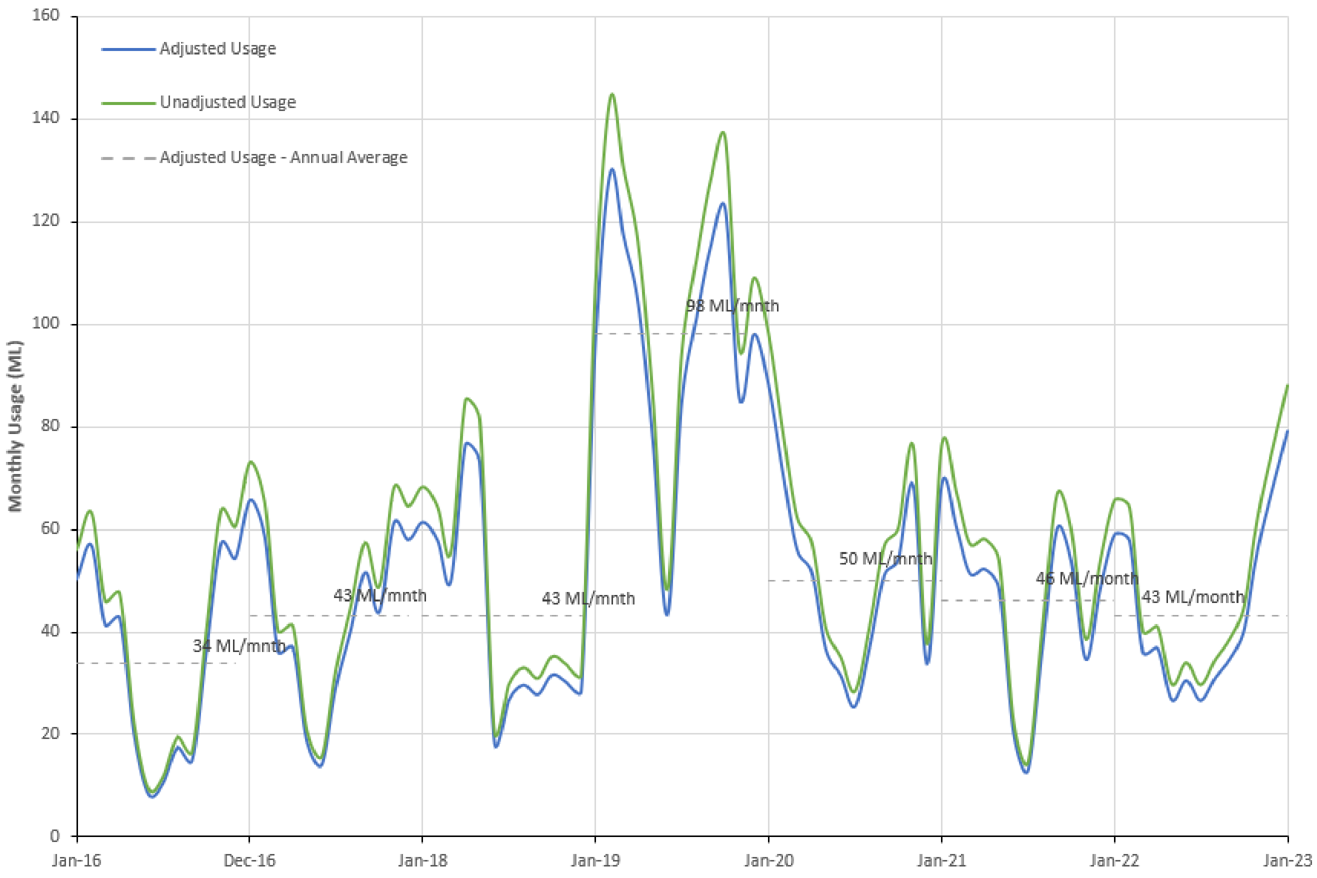


Figure 6 Metered Haul Road Dust Suppression Water Usage

Review of **Figure 6** indicates:

- Water usage is seasonal, with highest usage rates occurring in summer, and lows in winter. Seasonal variability is driven largely by changes in ambient temperature and evaporation rates;
- Water usage is also lower during periods of rainfall; and
- Average water usage rates during 2016-2018 are relatively consistent year-to-year at around 34-43 ML/month (408-516 ML/year), however, 2019 usage was significantly higher than previous years. This is likely to be attributed to the prevalent drought conditions experienced throughout 2019 including limited rainfall and increased evaporation. Water usage during 2020 and 2022 has reduced and has closely followed pre-2019 levels with annual averages from 43-50 ML/month due to increased rainfall throughout the year.

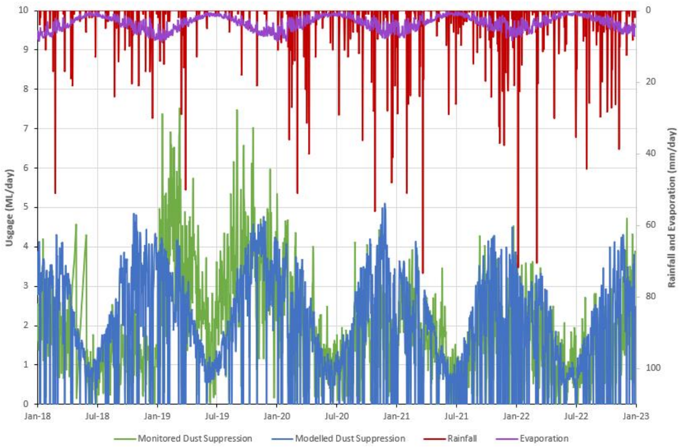
No data breakdown of dust suppression demand by FP was provided for 2019 – 2022 and it is therefore assumed to be consistent with 2018 values discussed in the previous 2019 update (WRM, 2019). The breakdown by FP in 2018 is as follows:

- ROM FP 75.08%
- Pit 2 FP 24.91%
- Pit 5 FP 0.01%

5.2.2 Dust Suppression Sub Model

Haul road dust suppression water usage is simulated within the WBM using a sub-model, which accounts for the seasonal variation and sensitivity to rainfall observed in the metered usage data. Daily water application is calculated as a function of wetted haul road area, evaporation, and rainfall. Water is applied to offset daily evaporation from the wetted area. Evaporation rates are subject to monthly adjustment factors. Application is cancelled if rainfall exceeds a nominated minimum threshold (1.5 mm/day) (WRM, 2019).

Monthly evaporation factors and the rainfall threshold determined in the previous model update are compared to measured water usage rates during the period January 2018 to December 2022 and adjusted as required. The results of this process are presented in **Figure 7**. Note that measured data has been factored per **Section 5.2.1**.



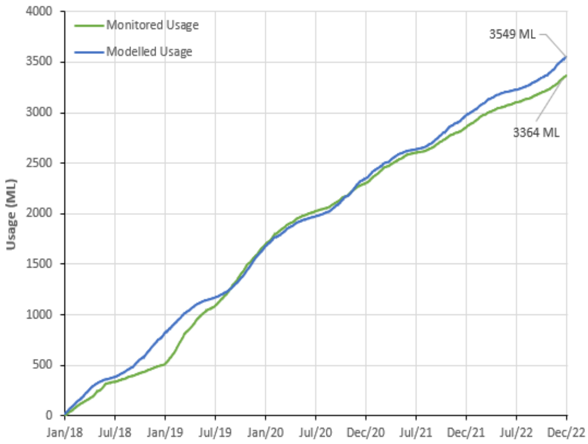


Figure 7 Dust Suppression Sub Model: Modelled vs Monitored Values

Review of **Figure 7** shows relatively good agreement between calculated and measured data. Anomalies do occur throughout the calibration period however overall usage shows good correlation with seasonal trends demonstrated. Results have been derived using the following parameter set consistent with the previous 2019 model update (WRM, 2019):

- Haul road wetted area: 44.0 ha (per WEP surface water assessment, WRM 2015)
- Rainfall threshold: 1.5 mm/day
- Evaporation adjustments:
  - January to February: 1.1
  - March to June: 1.6
  - July to September: 1.9
  - October: 1.7
  - November: 1.5
  - December: 1.3

The parameter adjustment process has sought to reproduce: 1. total usage volumes, 2. seasonal variation in water usage (i.e. general peaks and troughs in spring/summer and autumn/winter respectively), and 3. sensitivity to rainfall (reductions in usage during wet periods such as winter 2016 and 2020). Additionally, monthly adjustment factors are the same for each year, and should also follow a relatively smooth profile within the year (e.g. not fluctuating up and down repeatedly).

5.3 Water Destruction (Sprays)

WCPL have previously operated a system of evaporator sprays which are located on the eastern bank of Pit 2W between October 2017 and February 2018. During this time, there were 10 sprays in operation. Water supply to the spray system was unmetered and has been estimated at approximately 1 ML/day. Net water losses have been estimated at 0.25 ML/day assuming a 25% spray efficiency, which has been selected based on past experience with similar systems at other operations. These evaporator sprays were not operated from 2019 – 2021. The sprays were commissioned again in 2022 and were used on an ad-hoc basis.

The WBM has been configured to model a net 0.25 ML/day water extraction from Pit 2W. The outflow is assumed to remove no salt from Pit 2W. Operation of the spray system has been assumed to cease if the combined inventory in the WMS reduced below a specified minimum threshold, which has been initially defined at 1,000 ML in previous models. This threshold has been increased to 3,500 ML in the 2021 model update to better reflect site operations during drier periods. This threshold is considered suitable for continued use in this model update, however this threshold should continue to be confirmed on a case-by-case basis.

6 Water Treatment Facility

6.1 Overview

WCM operate a Water Treatment Facility (WTF), which is used to treat excess mine water, and discharge a blend of permeate and mine water to Wilpinjong Creek in accordance with conditions outlined in EPL 12425. The WTF comprises a Reverse Osmosis (RO) treatment plant which has the capacity to release at a rate of 5 ML/day. For the period between January 2017 and January 2018, a secondary RO treatment plant leased from General Electric (GE) was in operation, increasing the prescribed maximum release rate to 15 ML/day. The second RO treatment plant was decommissioned at the beginning of 2018 once the site's mine water inventory had been sufficiently reduced. Following decommission, the capacity of the WTF reverted back to the original capacity of 5 ML/day. Due to considerable drought conditions experienced during 2018 and 2019, the RO treatment plant was decommissioned for the period between November 2018 and November 2020. The RO plant was recommissioned following considerable rainfall throughout 2020 resulting in significant surplus water within the site inventory.

Current license conditions require a maximum release water electrical conductivity of 500 µS/cm, a pH range between 6.5 and 8.5, oil and grease not to exceed 10 mg/L and total suspended solids not to exceed 50 mg/L.

The WTF is located adjacent to and east of Pit 2W (location marked in **Figure 1**). Feed water is extracted from Pit 2W (EC 3,500 to 4,000 µS/cm), and then passes through a process of strainers, UF filters and RO membranes to produce a low EC permeate stream (typically ≈180 µS/cm). The permeate stream is blended with a small amount of feed water prior to release to achieve a mixed EC closer to the 500 µS/cm limit prescribed in the EPL. The EC of the RO reject by-product varies depending on permeate recovery but is typically around 14,000 µS/cm EC. Prior to Q4 2018, reject was pumped to Pit 1S. Reject is now pumped to either the RWD or Pit 2W given that Pit 1S has been taken offline (mined through). Some permeate is also used for RO back-flushing/cleaning. A conceptual schematic of the WTF and river discharge process is presented in **Figure 8** (based on the configuration prior to Q4 2018).

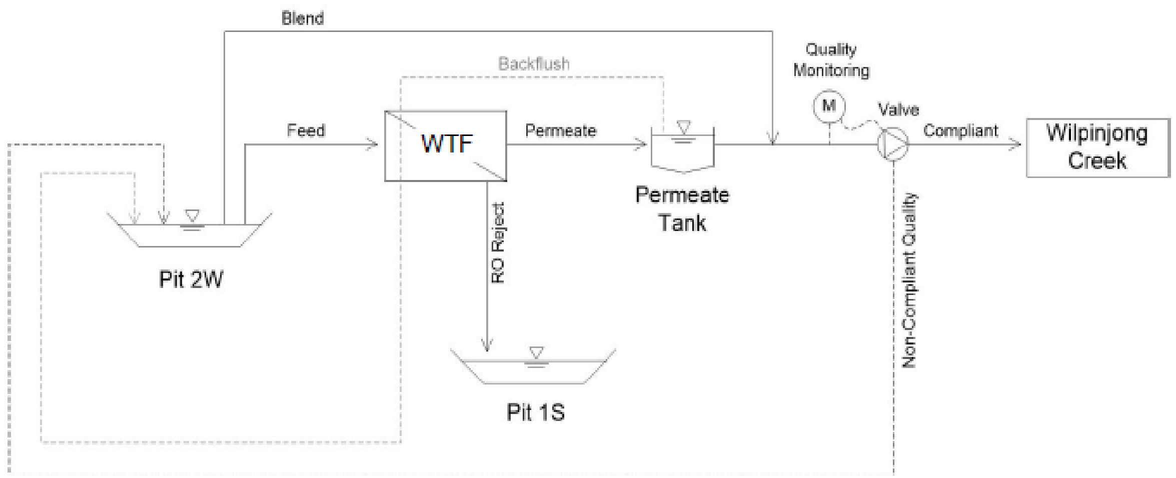


Figure 8 Conceptual Schematic – WTF and River Discharge Process (Configuration prior to Q4 2018) (Source, Hatch, 2017)

The WCPL WTF is currently capable of producing enough permeate to discharge a blended stream of water to Wilpinjong Creek at up to 3 ML/day. With both the WCM and GE WTFs operating, the combined rate of discharge had the capacity to reach up to approximately 8 ML/day. This capacity of the WCPL WTF was increased to discharge 5 ML/day from July 2021 due to significant rainfall experienced at WCM throughout 2020 and 2021.

6.2 Historical Performance

WCPL have provided records of daily volumes discharged to Wilpinjong Creek (from both plants), for the period January 2016 to December 2022. This information is presented in **Figure 9**.

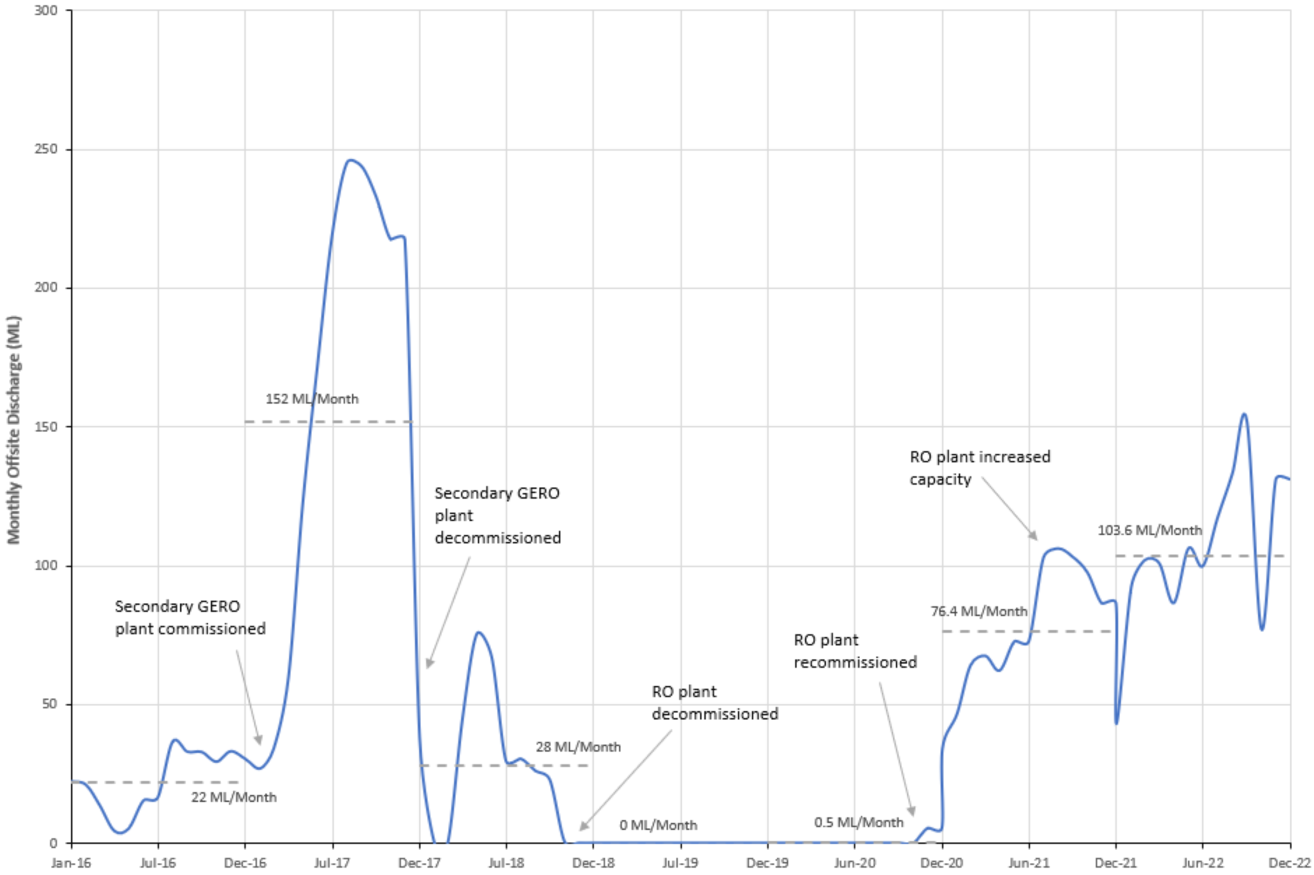


Figure 9 Historical WTF Discharge Volumes

Review of **Figure 9** shows the following:

- Discharge volumes significantly increase after March 2017, following a significant wet period, modification of the Site's EPL discharge limit, optimisation of the WCPL WTF, and installation/ramp-up of the GE WTF;
- Slightly higher discharge volumes in 2018 compared to 2016, given a comparable WTF configuration. However, it is understood that the WCPL WTF was upgraded/optimised in 2016 to rectify performance problems associated with out- of-spec feed water.
- The WTF facility was not operated during 2019 and majority of 2020 due to low levels within the site inventory and very low rainfall throughout 2019;

- Discharge volumes increased in July 2021 following an increase in WTF discharge capacity after significant rainfall in 2020 and 2021; and
- Average monthly discharge to Wilpinjong Creek in 2022 was the highest observed since 2017, with more months than not recording over 100 ML/month in release volume.

6.3 Model Configuration

The WBM has been constructed to be used for future studies with the following defined as part of the previous model updates, assuming the GE plant is offline:

- WTF capacity: 4 ML/day and 6.6 ML/day from July 2021;
- Permeate recovery: 75% of feed;
- Permeate EC: 180 µS/cm EC;
- Reject EC: calculated in model based on feed water EC;
- Discharge water EC: 350 µS/cm EC (per recent historical sampling – see **Table 12**);
- Blend water volume: assumed 0.3 ML/day based on average feed water EC and required discharge EC; and
- Assumed no reduction in RO recovery due to increasing feed water EC.

As part of the previous model updates, a set of operating rules were established within the WBM which aim to reflect onsite decisions regarding the WTF for use in future studies. These updates included adjustment of the WTFs deactivation trigger to 2,000 ML rather than the previously adopted 1,000 ML in the WRM (2019) WBM, and incorporation of the relationship between climatic conditions (i.e. rainfall) and feed water flow. These changes have been further verified as part of this update.

Operation of the WTF is based on both site mine water inventory and rainfall forecasts. From historical monitoring data it is also observed that discharge flows vary and may not always operate at full capacity. Due to limited software capabilities, predicting rainfall beyond the current timestep cannot be determined. Rather, daily feed water flows within the WBM are determined by the previous 5-day rainfall and the level within the site mine water inventory. Application is cancelled if site inventory exceeds the nominated minimum threshold of 2,000 ML.

Inflow rates to the WTF have been based on discharge flows and their associated rainfall and site inventory levels given in the January 2018 to December 2022 monitoring data. The results of this process are shown in **Figure 10**. It should be noted that adjustments to the model were made to account for WTF decommission throughout the majority of 2020.

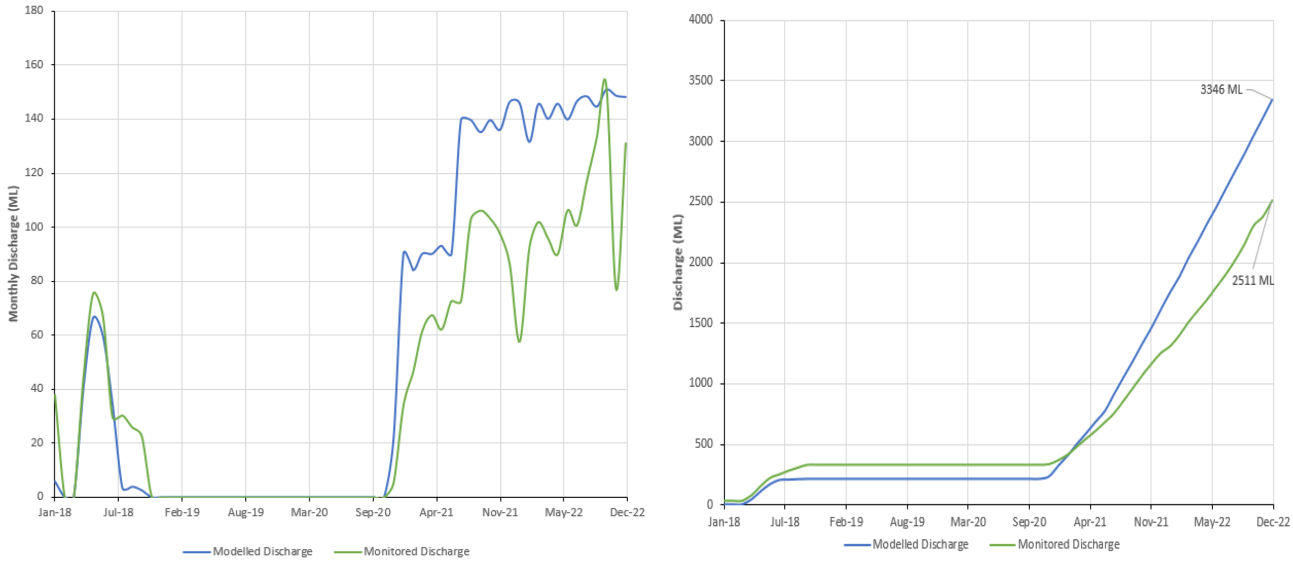


Figure 10 WTF Sub Model: Modelled vs Monitored Values

Review of **Figure 10** shows relatively good agreement between calculated and measured data. Results have been derived using the relationship described in **Table 9**.

Table 9 Feedwater Flow Rate Relationship

Site Inventory (ML)	5 Day Rainfall (mm)	Feedwater Flow (ML/day) (Post July 2021)
>3500	-	4 (6.6)
3500 - 3250	-	4 (6.3)
3250 - 3000	-	4 (6.0)
3000 - 2900	>1.5	4 (5.5)
	≤1.5	3.8
2900 - 2800	>1.5	3.7
	≤1.5	3.3
2800 - 2700	>1.5	3.5
	≤1.5	3.1
2700 - 2600	>1.5	2.9
	≤1.5	2.0
2600 - 2500	>1.5	2.8
	≤1.5	0.9
2500 - 2400	>1.5	2.5
	≤1.5	0.8
2400 - 2350	>20	0.9
	20 – 1.5	0.7

Site Inventory (ML)	5 Day Rainfall (mm)	Feedwater Flow (ML/day) (Post July 2021)
	≤1.5	0.3
2350 - 2000	>20	0.3
	≤20	0
<2000	-	0

The WTF operating rules has sought to better simulate inflows and associated outflows for the WTF based on climate variation and site inventory levels for use in predictive studies. The WBM has been verified with three years of data and should continue to be refined and validated using site monitored data.

7 External Water Import

WCM have access to external water supply bores that are operated when required. Given the recent surplus mine water in storage at the site, WCM did not require this source until the extreme drought conditions that occurred during 2018 and 2019. External water was sourced from the water supply bores during May 2019 to March 2020. Accessible external water supply sources are outlined below:

- WCM water supply system includes a water supply borefield;
- It is understood that WCPL are licensed to collectively take up to 3,121 ML annually (equivalent to 8.55 ML/day) including water pumped from mining pits, inferred groundwater and water supply bores;
- Based on the 2019-2020 monitoring data a maximum of 27.3 L/s of water was supplied to the mine via the water supply borefield; and
- WCPL has an in-principle agreement with the nearby Moolarben Coal Mine to source excess water from this mining operation (by pipeline) if required in the future (subject to approval).

WCM have provided records of water import volumes for the January 2019 to December 2022 period. This information has been presented in **Figure 11**. It is understood that the external water supply bores were not utilised during 2022 due to adequate water holdings/supply on site.

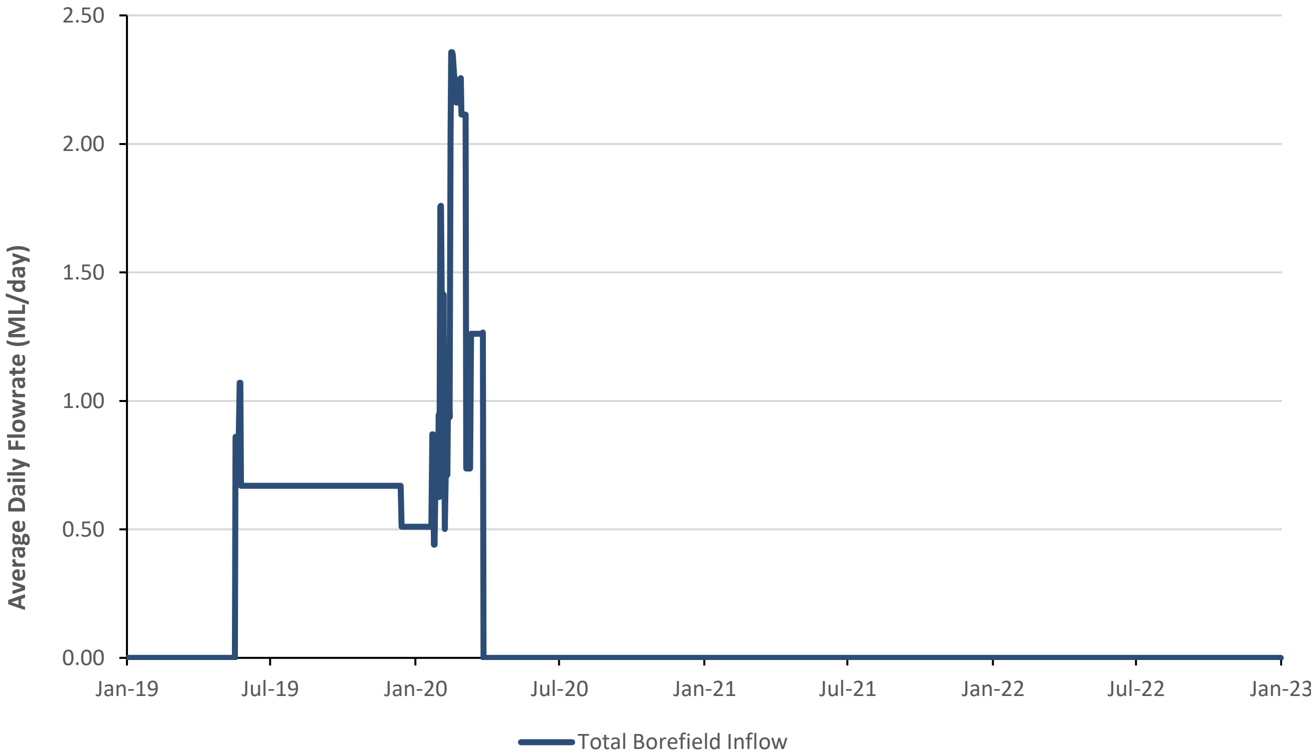


Figure 11 Average Daily Import Rates

A review of **Figure 11** shows a consistent supply of water from the 17 May 2019 to the 26 March 2020 with an average flowrate of 0.67 ML/day (7.8 L/s) in 2019 and 1.16 ML/day (13.4 L/s) in 2020.

7.1 Model Configuration

The WBM has been configured to import water from an external source if the combined mine water inventory falls below a specified minimum threshold. This threshold was increased from 500 ML in the WRM (2019) update to 2,000 ML in the previous model updates to reflect observed operations during dry periods. Additionally, a series of pump operation rules have been established to relate the rate of external supply into the WMS to the site inventory levels. These operating rules have been further refined during this model update by altering the pump rate for the set benchmark values. The external supply operating rules included in the WBM are as follows:

- External water is supplied at a varying rate depending on combined mine water inventory levels;
- Benchmark values are set as:
    - Combined mine water inventory 2,000 ML - assumed pumping rate of 5.1 L/s (0.44 ML/day).
    - Combined mine water inventory 1,000 ML - assumed pumping rate of 9.9 L/s (0.86 ML/day).
    - Combined mine water inventory 500 ML - assumed pumping rate of 27.3 L/s (2.35 ML/day).
- External water supply pump rates are linearly interpolated between the benchmark values based on the combined mine water inventory; and
- Water is assumed to be sourced from the borefield and pumped into the CWD storage, where it is then pumped on to supply tasks as required.

Modelled external supply volumes determined using the above operating rules have been compared to the measured water supply volumes during the January 2019 to December 2022 period. The results of this process are presented in **Figure 12**.

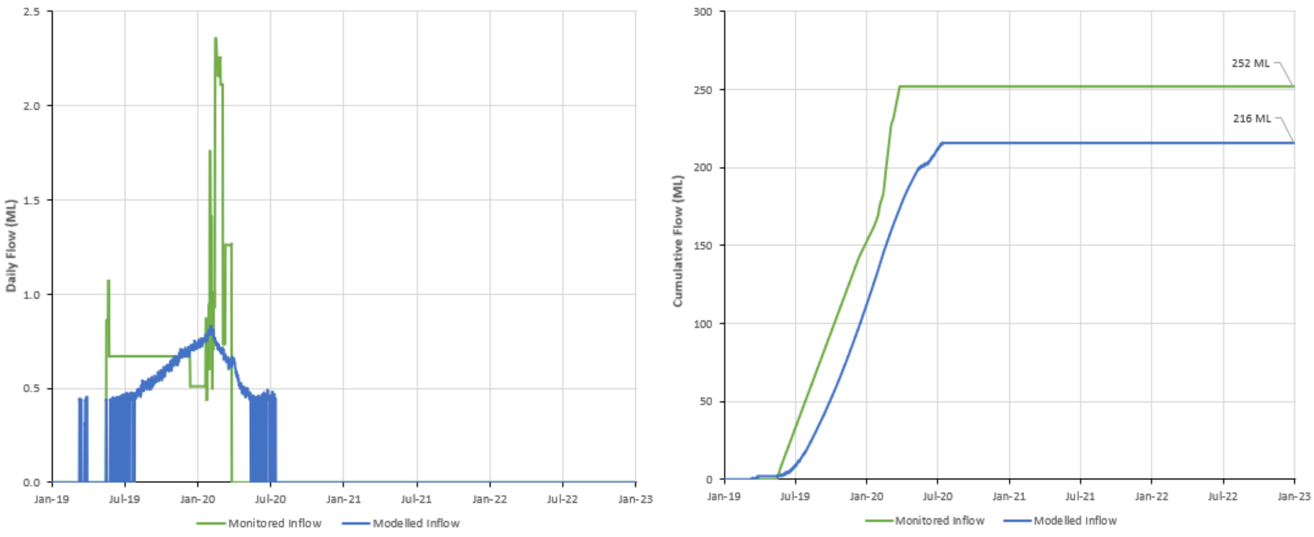


Figure 12 External Water Supply: Modelled vs Monitored Values

As shown in **Figure 12** modelled data shows reasonable correlation to measured data where external water supply is active. Although anomalies are observed between the modelled inflows and that of the monitored data, the intent of this operation is to allow predictive studies to more effectively determine reliance on external water sourcing. The modelled operating rules provide a more reflective simulation during dry conditions as opposed to a single threshold trigger as previously applied within the WBM.

8 Groundwater

8.1 Groundwater Inflows

8.1.1 Definition

Groundwater inflows are defined as waters reporting to the WMS from aquifers external to the current extent of disturbance. This generally includes seepage from coal seams and in- situ rock and alluvial aquifers, and water released from cracks and pores within coal and rock as it is broken as part of the mining process (WRM, 2019).

8.1.2 Previous estimates

Previous estimates of groundwater inflow to the WCM include the following:

- WEP EIS (2015): net groundwater inflow rates adopted as part of the WEP surface water assessment (WRM, 2015) were derived by applying highwall evaporative losses to gross inflow rates determined through hydrogeological modelling as part of the groundwater assessment (HydroSimulations, 2015);
- Previous 2016 model update (Hatch, 2017): net groundwater inflow rates were inferred at a constant rate of 3.8 ML/day through the period January 2014 to January 2017 as part of the water balance model calibration process;
- Previous 2019 model update (WRM, 2019): net inflow rates determined through model calibration exercise varying from 3.51 ML/day in 2014 to 2.00 ML/day in 2018;
- Previous 2020 model update (SLR, 2020a): net inflow rates determined through model calibration exercise as 2.19 ML/day in 2019; and
- Groundwater Model Update (SLR, 2020b): net groundwater inflow rates determined from hydrogeological modelling as 2.5 ML/day.

8.1.3 Current estimates (this study)

Groundwater inflow rates have previously been inferred for a given year through historical model calibration (WRM, 2019). However, during a previous model update an operation within the model was established that varies groundwater inflow depending on the state of groundwater influences therefore allowing the model to be more effectively used as a predictive tool for determining future onsite water volumes. This operation allows groundwater inflows to be adjusted based on recent rainfall trends to align simulated mine water inventory trends during dry and wet periods. The degree to which groundwater inflows are adjusted has been determined using historical model calibration. Updated adjustment factors include the following:

- Mean 6-monthly rainfall (300 mm) correlates to the mean modelled groundwater inflow (SLR, 2020a) of 2.0 ML/day;
- 6-monthly rainfall greater than 25% of the mean correlates to a 15% increase in groundwater inflow (2.2 ML/day) to reflect increased groundwater recharge; and
- 6-monthly rainfall less than 25% of the mean correlates to a 15% decrease in groundwater inflow (1.7 ML/day) to reflect reduced groundwater recharge.

Based on the above operation average groundwater inflow for the calibration period are as shown in **Table 10**. It should be noted that assessment of inferred groundwater take for WCM licence conditions is assessed based on the water year (period 1 July to 30 June).

Table 10 Summary of Average Daily Groundwater Inflow

Calendar Year			Water Year		
Period	Modelled Groundwater Inflow (ML/day)	Groundwater Model (SLR, 2020b) (ML/day)	Period	Modelled Groundwater Inflow (ML/day)	Groundwater Model (SLR, 2020b) (ML/day)
2018	1.8	3.3	2018-2019	1.8	2.1
2019	1.8	3.1	2019-2020	1.7	1.7
2020	2.0	2.4	2020-2021	2.3	2.5
2021	2.3	1.9	2021-2022	2.3	2.4
2022	2.0	2.2	2022-2023	1.9	1.8

Groundwater inflows in 2022 were estimated at an annual average of 2.3 ML/day for the 2021-2022 water year. This is comparable to predictions made in the current groundwater model (SLR, 2020b) of 2.4 ML/day.

8.1.4 Model Configuration

The WBM has been configured to simulate a future net inflow rate based on 6-monthly rainfall trends as described in **Section 8.1.3**, reporting to the site WMS. Prior to 2020 the combined rate is apportioned as follows:

- Pit 1/5/6 void: 25%
- Pit 2/4 void: 25%
- Pit 3/7 void: 50%

Note that the 2019 WBM model configuration does not include any groundwater inflow to Pit 8. Activities in the Pit 8 extraction area began during 2019, predominantly during the early stages of mining (i.e. pre-stripping) with limited pit development. It is therefore expected that Pit 8 was elevated above the groundwater table throughout 2019 hence no direct groundwater interception would have occurred. Groundwater inflow to Pit 8 was expected to occur during 2020 with the commencement of mining within Pit 8. Therefore, the model configuration for 2020 onwards is given as:

- Pit 1/5/6 void: 30%
- Pit 2/4 void: 20%
- Pit 3/7 void: 20%
- Pit 8 void: 30%

Groundwater operations within the model are used as a preliminary tool to determine groundwater inflows, however, there remains scope to improve measurement of groundwater inflow to the pits in order to further validate groundwater inflow within the WBM. It is recommended that inflow assumptions continue to be revised/adjusted as further information becomes available.

8.2 Spoil Aquifers

8.2.1 Overview

Mining operations have extracted coal from three distinct voids, termed Pit 1/5/6, Pit 2/4 and Pit 3/7 with the addition of Pit 8 in 2019 (see **Section 3.1** and **Figure 1**). In-pit spoil placement areas have been formed within Pit 1/5/6 and Pit 2/4 for creation of most the mining landform. These in-pit placement areas are porous and highly permeable. The drainage characteristics of the spoil are such that up-dip pits (such as Pit 5S, Pit 1 and Pit 2S) do not need to be pumped out following rainfall events, as they freely drain down the dip of the coal (through the spoil) to the down-dip pits (i.e. Pit 5N and Pit 4). Pit 2W is also observed to seep at a high rate to Pit 4, through the interconnecting spoil placement areas, due to the high water level difference between these two areas. As mining commenced within Pit 8 during 2020, some groundwater interaction is expected to have taken place, however, is not expected to interact with the spoil aquifers.

Storage of water in-pit is expected to result in flow of water from the open water body into the adjoining spoil placement area, forming a saturated zone within the spoil in which significant volumes of water may be stored. In the event of a pit filling with water, leakage to the adjoining spoil aquifer will prolong the filling process, and conversely, leakage from the aquifer will prolong the subsequent dewatering process.

8.2.2 Properties

Spoil aquifer extents have been estimated based on comparison between end of year 2017 surface topography and deepest mined topographic survey (WRM, 2019). Spoil aquifer storage capacity is a function of the spoil extent and the spoil porosity.

The previous 2016 water balance model update (Hatch, 2017) adopted a spoil aquifer porosity of 30%, determined through model calibration (January 2014 to January 2017). The 2017 water balance update (WRM, 2018) extended the model calibration to include data recorded between January 2017 and December 2017, which includes the drawdown of Pit 5N and its adjacent spoil aquifer. A reduction in the spoil aquifer porosity value from 30% to 20% was found to be required. The 2018 water balance update (WRM, 2019) assumes a further reduction in the Pit 5N spoil aquifer porosity to 10% to replicate the observed rate of drawdown in Pit 5N during 2018. The 2018 water balance update (WRM, 2019) assumes values of 20% and 10% porosity for Pit 2 and Pit 4 spoil aquifers respectively. The porosity of spoil aquifers in this model update has been assumed as consistent with the 2018 values.

8.2.3 Model Configuration

Spoil aquifers have been modelled in the Wilpinjong WBM in accordance with the following:

- Spoil aquifers have been modelled adjacent to Pit 5N, below Ed's Lake, Pit 2W and Pit 4;
- Recharge and discharge occurs to balance water levels between the pit lake and the adjacent spoil aquifer. Rates of transfer are governed by head difference but are typically in the order of 10 ML/day – 20 ML/day when flowing (model assumption);
- Pit 2W spoil aquifer drainage to Pit 4 (via Pit 4 spoil aquifer) modelled at a constant rate of ~10 ML/day;
- Storage characteristics have been modelled assuming 10-20% spoil porosity. Stage- storage characteristics have been provided for reference in Appendix C; and
- Seepage from up-dip pits into spoil aquifers, and back out into down-dip pits (e.g. Pit 5S to Pit 5N, or Pit 2E to Pit 2W), at relatively unconstrained flow rates.

9 Water Quality

Water quality sampling at WCM is undertaken at a number of locations with samples analysed for the standard suite of quality indicators. Monthly average measurements of EC for selected surface water locations have been summarised in **Table 12**. Note that limited EC data for the WMS dams or pits was provided in 2020, 2021 and 2022. Review of available information shows the following:

- Water circulating through the WMS is typically within the EC range of 3,000 to 4,000 µS/cm (see Pit 2W and CWD);
- The EC of water within CWD increased slightly in 2019, coinciding with input from external bore supplies;
- During 2019 and 2020 EC of water within the RWD increased to slightly above average levels;
- The EC of water within Pit 1S prior to 2018 is higher than the water in the rest of the WMS, due to inflow of RO reject. Concentrations of salt within this storage appear to have been diluted with upstream clean catchment runoff (RO reject EC sampled at 14,000 µS/cm in Feb-17 vs. Pit 1S EC of around 7,850 µS/cm in October 2017).
- The EC of the blended discharge stream to Wilpinjong Creek is typically around 300 to 350 µS/cm vs the 500 µS/cm EC end-of-pipe limit specified in EPL 12425. A reading in December 2022 did however exceed this limit (1,577 µS/cm).

The WBM maintains a running account of salt mass in all water storages which is equated to and reported as EC. Salt mass inflows are typically estimated by assigning salinity concentrations to runoff from various land use types, and to point water sources (e.g. groundwater, pipeline water).

Water quality model parameters were initially defined as part of the WEP surface water assessment (WRM, 2015). This water balance model update confirmed that these parameters continued to produce reasonable estimates of EC in the circulating WMS inventory (based on Pit 2W data). The current investigation has retained water quality parameters from these earlier studies.

Adopted water quality parameters are summarised in **Table 11**.

Table 11 Adopted Salinity Generation Rules

Item	Salinity (EC) (µS/cm)
Catchment Runoff Source	
Natural / undisturbed	1,600
Roads / industrial / hardstand / pit	3,000
Spoil / overburden / cleared	2,500
Rehabilitated overburden	2,000
Point water sources	
Groundwater	3,000
External water supply (e.g. borefield)	3,000

Table 12 Average Electrical Conductivity (µS/cm) by month and sampling location

Year	Month	Monthly Rainfall (mm)	Dams						Pits				WTF				Reference (Waterways)		
			Pit 2W	Pit 1S	Pit 5 FP	CWD	RWD	Ed's Lake	Pit 5	Pit 2 NB	Pit 4	Pit 3	Feed	Permeate	Discharge (ML)	Concentrate	Wilp. Ck Upstream	Wilp. Ck Downstream	Cumbo Creek
2015	Jan	115.7													325				
	Feb	17.5								5,290									
	Mar	16.3	3,048							4,790					310				
	Apr	109.3	3,390	6,670		3,330	3,510	880	1060	4,940	3,960				285				
	May	43.2													210				
	Jun	45.8		9,180						4,100					221				
	Jul	38.4								4,620					144				
	Aug	51.5													185		739	530	5,112
	Sep	10.6	3,490	5,690	2,110	3,440	3,580		2,290		4,250	3,030			158		1,296	365	5,203
	Oct	46.9			3,540					5,190					176		1,957	379	6,005
	Nov	90.3													212		1,007	352	4,694
	Dec	105.1								4,290					269		883	446	
2016	Jan	99.9	3,280	5,770		3,470	3,440	2,210	2,330	4,940	3,640				267		1,053	431	
	Feb	9.1													255		1,351	441	
	Mar	19.2													235			590	
	Apr	4.4													232				
	May	67.9													195				3,620
	Jun	107.7		7,700											176			386	6,254
	Jul	83													208		497	1,082	3,987

Year	Month	Monthly Rainfall (mm)	Dams						Pits				WTF				Reference (Waterways)		
			Pit 2W	Pit 1S	Pit 5 FP	CWD	RWD	Ed's Lake	Pit 5	Pit 2 NB	Pit 4	Pit 3	Feed	Permeate	Discharge (ML)	Concentrate	Wilp. Ck Upstream	Wilp. Ck Downstream	Cumbo Creek
	Aug	43.3													201		792	562	5,582
	Sep	172	3,310	6,180		3,280	3,320		2,740		3,880				199		313	73	1,942
	Oct	71.3													235		430	1,100	2,530
	Nov	44.9													284		536	976	
	Dec	35.6													276		1,446	465	
2017	Jan	34.4	3,545												294			486	
	Feb	25.8	3,520												305	14,000		539	
	Mar	130.4	3,670												301	13,400		686	
	Apr	19.4	3,620												307			539	1,431
	May	23.4	3,660												276			359	4,804
	Jun	11.8	3,630												347			344	5,796
	Jul	1.9	3,580												372			272	5,716
	Aug	26.4													357			285	5,365
	Sep	76.3													336			26	5,745
	Oct	33.3	3,710	3,710			7,610								321			290	6,280
	Nov	76.3	3,950	3,950											335			310	
	Dec	82.3													342			384	
2018	Jan	15.7															4,110	599	
	Feb	60.7																1,500	476
	Mar	45.2															4,360	2,020	3,690
	Apr	37.4															2,363	590	237

Year	Month	Monthly Rainfall (mm)	Dams						Pits				WTF				Reference (Waterways)		
			Pit 2W	Pit 1S	Pit 5 FP	CWD	RWD	Ed's Lake	Pit 5	Pit 2 NB	Pit 4	Pit 3	Feed	Permeate	Discharge (ML)	Concentrate	Wilp. Ck Upstream	Wilp. Ck Downstream	Cumbo Creek
	May	13.4															2,147	424	6,950
	Jun	24.2															1,805	351	3,776
	Jul	7.5													288		1,726	375	6,820
	Aug	29													312		1,656	356	3,655
	Sep	48.9													229		1,600	385	3,521
	Oct	51.3													328		1,781	418	3,629
	Nov	49.6													365		2,001	437	3,977
	Dec	105													367				
2019	Jan	82.3	4,350																
	Feb	4.8	4,290																
	Mar	107.3	4,340																
	Apr	0	4,250																
	May	18.9	4,170																
	Jun	7.2	4,010																7,860
	Jul	3.2	4,120																7,077
	Aug	7.5	4,120			4,100	3,990												6,956
	Sep	25.1	4,260			4,180	4,250												7,580
	Oct	5.6	4,400																
	Nov	26.2				4,350	4,370												
	Dec	4.2	4,430																
2020	Jan	27	4,550			4,610	4,550												

Year	Month	Monthly Rainfall (mm)	Dams						Pits				WTF				Reference (Waterways)		
			Pit 2W	Pit 1S	Pit 5 FP	CWD	RWD	Ed's Lake	Pit 5	Pit 2 NB	Pit 4	Pit 3	Feed	Permeate	Discharge (ML)	Concentrate	Wilp. Ck Upstream	Wilp. Ck Downstream	Cumbo Creek
	Feb	137																1,190	4,940
	Mar	92	3,560			3,740	4,390											2,650	4,025
	Apr	117	2,990			3,260	3,750										532	510	5,850
	May	16	3,000			3,140	3,530										660	744	6,270
	Jun	23	3,080			3,060	3,410										698	835	5,575
	Jul	70	3,050			3,050	3,240										467	545	5,500
	Aug	36	3,080			3,000	3,190										260	311	4,330
	Sep	77	3,110			3,060	3,170										291	420	3,907
	Oct	151	3,140			3,070	3,100										518	492	7,120
	Nov	17															458	464	
	Dec	162															471	629	7,050
2021	Jan	53	2,970												367				
	Feb	127	3,020												390				7,220
	Mar	160													352				7,870
	Apr	2	3,100												345				6,880
	May	9	3,050												381				6,700
	Jun	84													361				3,335
	Jul	67	3,280												371				3,115
	Aug	25	3,320												382				
	Sep	44	3,350												375				
	Oct	31	3,610												398				

Year	Month	Monthly Rainfall (mm)	Dams						Pits				WTF				Reference (Waterways)		
			Pit 2W	Pit 1S	Pit 5 FP	CWD	RWD	Ed's Lake	Pit 5	Pit 2 NB	Pit 4	Pit 3	Feed	Permeate	Discharge (ML)	Concentrate	Wilp. Ck Upstream	Wilp. Ck Downstream	Cumbo Creek
	Nov	249	3,610												395				
	Dec	81													366				
2022	Jan	101											3,238				294	812	3,143
	Feb	16											3,310				432	540	3,655
	Mar	120											3,393				317	901	2,758
	Apr	95											3,483				352	1,411	2,842
	May	44											3,502				311	1,588	2,781
	Jun	13											3,693				337	1,516	2,645
	Jul	136											3,738				198	1,136	1,763
	Aug	103											3,860				175	1,026	1,374
	Sep	94											3,610				172	1,014	1,753
	Oct	185											3,535				145	754	1,170
	Nov	64											3,570				492	1,944	1,207
	Dec	27											3,513				1577	1,787	1,885

Note: Wilpinjong Creek and Cumbo Creek EC values are flow-weighted averages, calculated for that month Rainfall totals were calculated based on the data obtained from the SILO Data Drill service.

10 Water Balance Model

10.1 Overview

The WBM has been designed to simulate the operation of all major components of the water management system, including catchment runoff, water inventory fluctuation and overflow, pump and gravity transfers, coal mining operations usage and return, climatic influence, groundwater inflow, open cut mine dewatering, external water supply, discharge of water to Wilpinjong Creek (via the WTF), and interaction with spoil aquifers.

Key components of the WMS are generally described and quantified in the preceding report sections.

10.2 Model Schematisation

A representative schematic of the WBM has been provided in **Appendix A**. Review of **Figure 1A** shows the model is comprised of a collection of inter-connected nodes. Nodes represent key components of the water management system (dams, wash plant, pits, etc.).

10.3 Model Calibration

10.3.1 Overview

The Goldsim model has been constructed to represent the operations taking place at WCM in the period 2018 - 2022 hence calibration of the model has been undertaken using the monitoring data provided by WCPL for the January 2018 to December 2022 period. Water level data has been converted to estimates of water volume using storage characteristics as described in **Section 3.2.2**. Inventory data and water usage data/discharge data has been utilised for model calibration.

The model calibration exercise has specifically focused on reproducing the measured inventory in the combined WMS (Pit 2W, Pit 1S, RWD, CWD, Pit 5N, Pit 4 and Pit 3N) with particular focus on behaviour of the water inventory during drought conditions experienced during 2018 and 2019 followed by recovery of the water inventory during the 2020 – 2022 wet period. The objective of the exercise was to infer or establish key model inputs and parameters, and to demonstrate that the WBM suitably replicates observed site inventory trends.

10.3.2 Configuration

The following inflows and outflows were hard-coded into the model as time-series data:

- Extraction of water from the RWD and CWD to supply demands in the MIA/CHPP area, including the CHPP and miscellaneous MIA demands (modelled as per metered stream in **Section 5.1**);

The following processes were simulated within the model:

- Climatic influence: evaporation, evapotranspiration, direct rainfall and catchment runoff based on daily rainfall data at the BoM Wollar Gauge and Site AWS (see **Section 4.2.3**) and SILO Data Drill evaporation data (refer to **Section 4.3**);
- Water extraction from Pit 2W, the RWD and Pit 5 FP Dam for dust suppression (per **Section 5.2**);
- Transfer of water between storages, pit dewatering etc (refer to **Table 4**);

- Seepage from up-dip pits into down-dip pits via spoil aquifers (e.g., Pit 5S seepage to Pit 5N);
- Saturation and drainage of spoil aquifers adjacent to open cut pits (spoil aquifers modelled adjacent to Pit 5N, Pit 2W and Pit 4) (refer to **Section 8.2**);
- WTF inflow and outflow rates (refer to **Section 6.3**);
- Groundwater inflow rates (refer to **Section 8.1**); and
- External water supply rates (refer to **Section 7**).

The following parameters were adjusted to improve the overall agreement between simulated and observed historical WMS performance:

- WTP operating rules;
- Groundwater adjustment factors and groundwater inflow apportioning to Pits; and
- Incorporation of operations regarding Pit 8 CWD.
- Other settings and configuration assumptions include:
    - Catchment and land use information described in Section 3.2.4;
    - Catchment and land use data in 2018 and 2019 based on data in the previous model updates; and
    - Stage storage updates given in **Appendix C**.

10.3.3 Outcomes

Model simulated volumes have been compared against historical measurements in **Figure 13** for the period January 2018 to December 2022. Results have been plotted for the combined water inventory in the WMS (comprising Pit 2W, Pit 1S, RWD, CWD, Pit 5N, Pit 4 and Pit 3).

Review of **Figure 13** found discrepancies in modelled and monitored inventory levels during the period July 2019 and May 2020. Investigation found a significant drop in site inventory occurred in July as a result of gaps in Pit 4 monitoring, monitoring then resumed in May 2020 resulting in a sudden spike in site inventory. To account for these discrepancies, the model results have been adjusted to account for the sudden loss and gain of volume associated with Pit 4 monitoring results, as shown in **Figure 13**. By adjusting these values to match monitoring variances **Figure 13** shows that the simulated WMS inventory is well aligned with historical inventory measurements throughout the 2018 to 2022 calibration period.

Following a significant rainfall event in March 2021, a rapid increase in the site inventory was observed. This increase was seen to have caused a greater effect on the modelled mine water management system than that monitored. This response results in elevated levels modelled although the general trend in water inventory remains the same. Following incorporation of the capacity increase of the WTP event the modelled inventory returns to similar levels to that monitored. Given the relatively good correlation of the WBM prior to this event, this may be attributed to immediate site water management, including storage transfers, following this event that are not consistent with those within the site WBM.

In 2022, the highest intensity rainfall events were observed earlier in the year and late in the year. The model generally reflects trends across the year, however, did not capture an inventory drop observed in February/March 2022. This noted, as the year progressed and actual inventory increased, the end of year monitored and modelled inventory results are consistent.

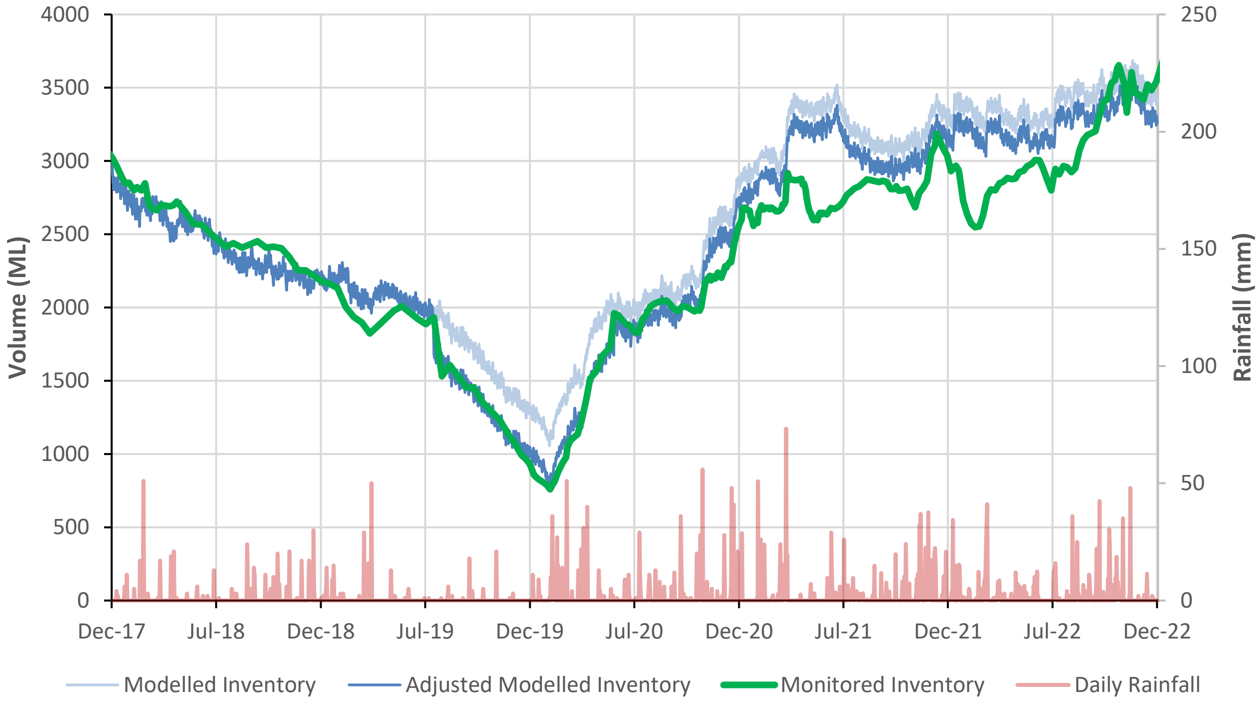


Figure 13 WBM Calibration Simulated vs Measured Combined Site Inventory

Key outcomes of the calibration process include:

- Effective representation during significantly dry conditions and during subsequent water recovery;
- Effective representation of inventory reduction through measures such as evaporators and operation of the RO plant; and
- Verification of a series of operating rules regarding groundwater inflow rates, WTF operation and external allow the model to be more effectively used as a predictive tool for onsite water behaviour.

10.4 Salt Balance Verification

The WBM maintains a running account of salt mass in all water storages which is equated to and reported as EC. Model verification of the salt balance has been undertaken using salinity monitoring for the 2022 calibration period (1 January 2018 to 31 December 2022) specifically this includes storages CWD, RWD and Pit 2W due to the limited availability of monitoring data for this period. The objective of this verification is to establish that salt transfer is effectively being captured within the WBM.

Salt mass inflows are typically estimated by assigning salinity concentrations to runoff from various land use types, and point water sources (e.g., groundwater, pipeline water) as described in **Section 9**. Increased salt concentrations are also recirculated into the WMS via the concentrate return from the WTF, directed to the RWD from following decommissioning of Pit 1S. No salinity is lost via evaporation from storages.

From available monitoring data it is found that water circulating through the Water Management System (WMS) is typically within the EC range of 3,000 and 4,000 µS/cm. Where data is unavailable, the initial conditions within storages was assumed to be within this range. Model simulated salinity have been compared against historical measurements in **Figure 14** to **Figure 16** for the period January 2018 to December 2022. The results have been plotted for the storages CWD, RWD and Pit 2W.

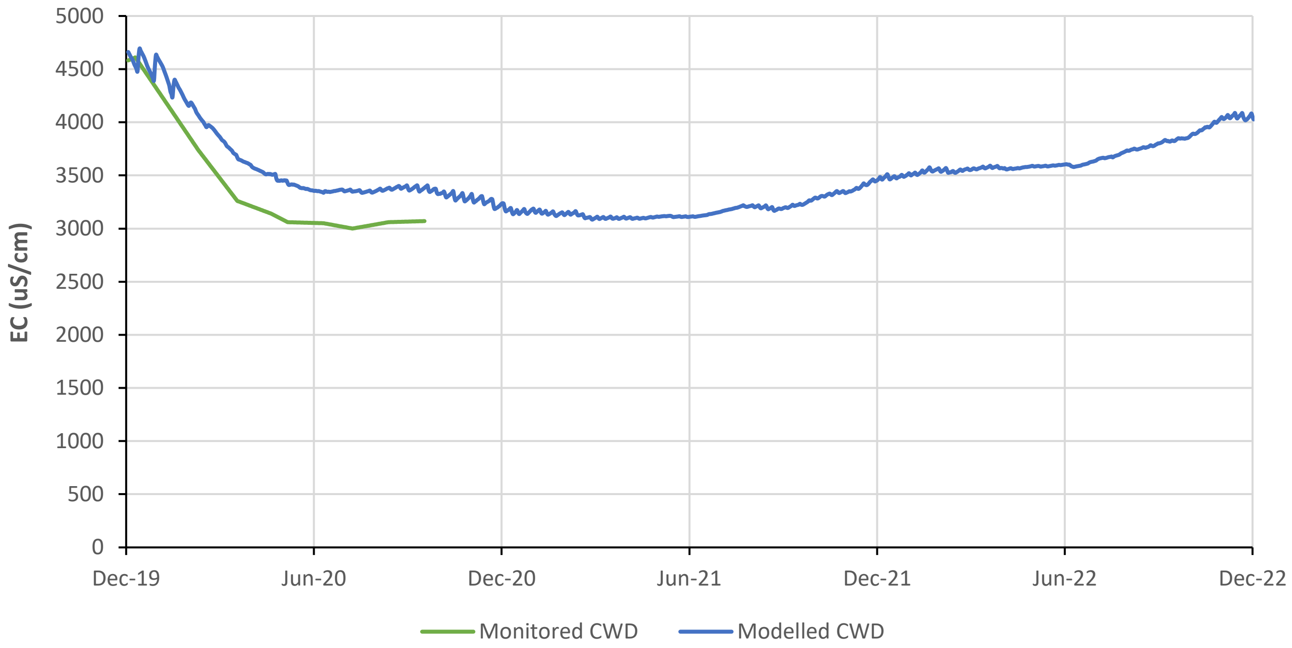


Figure 14 Salinity Verification Simulated vs Measured CWD

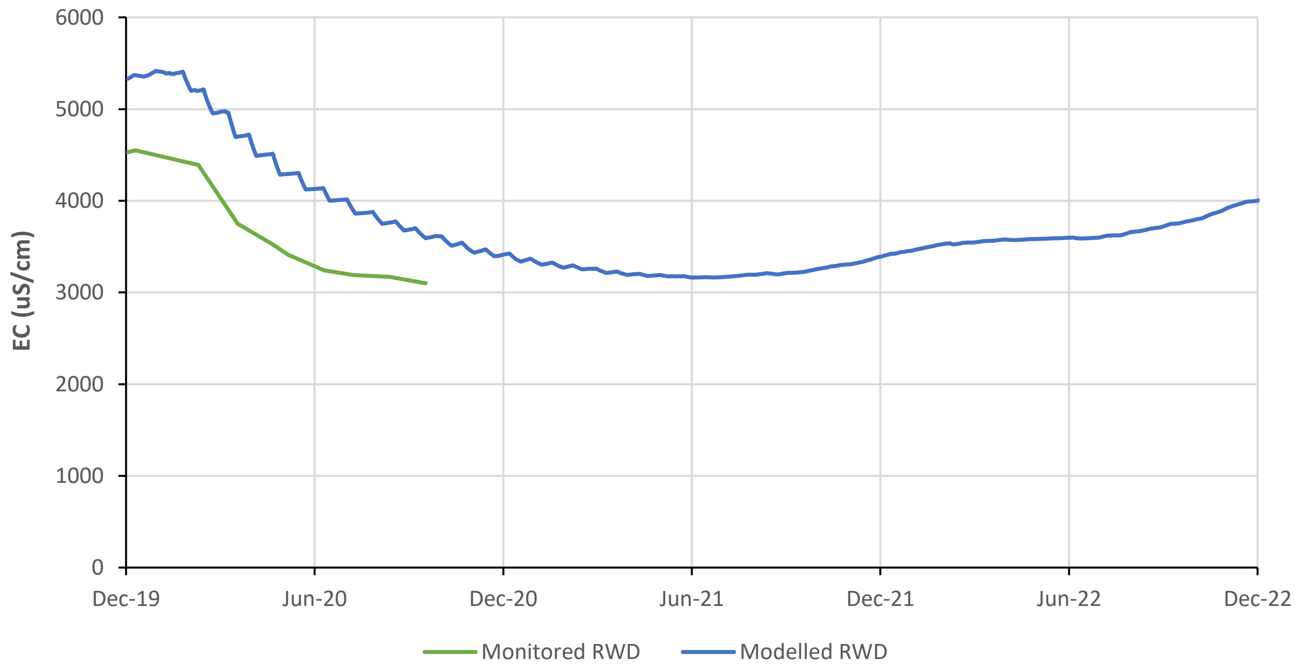


Figure 15 Salinity Verification Simulated vs Measured RWD

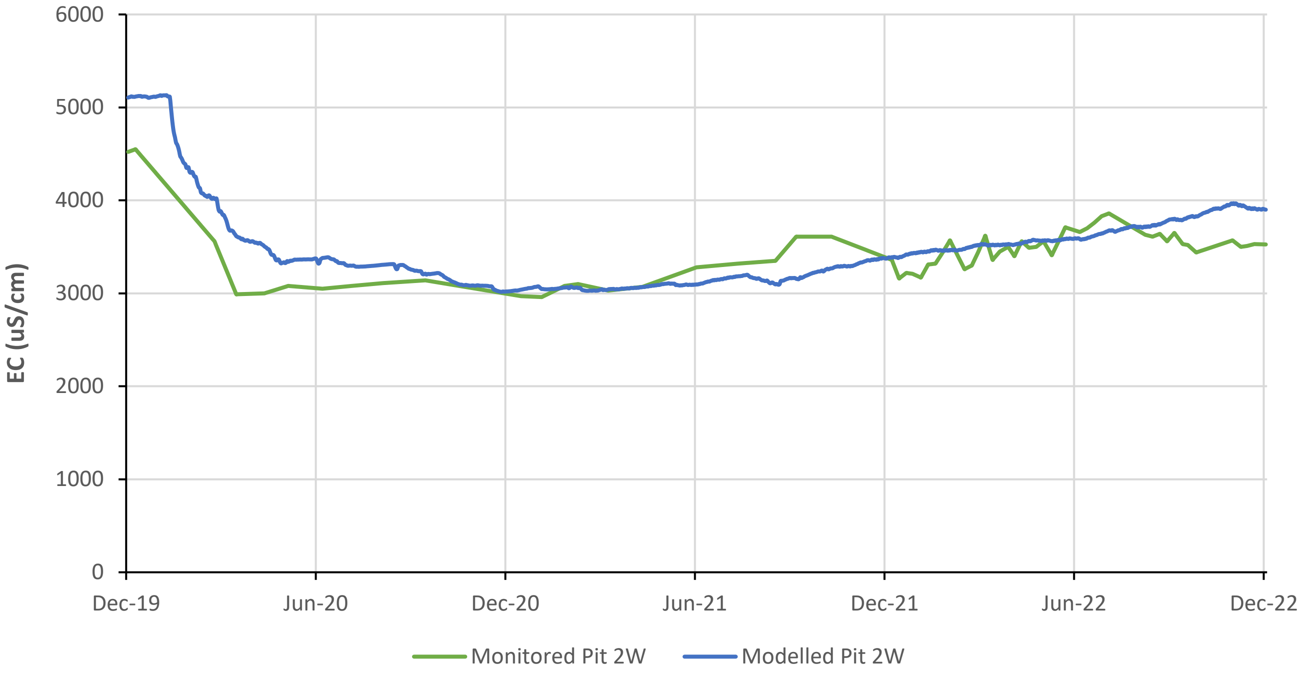


Figure 16 Salinity Verification Simulated vs Measured Pit 2W

Key outcomes of this verification process include:

- Effective representation of salinity that aligns with trends in monitored data (where available).

10.5 Base Case Model Operating Rules

Representative operating rules that define the Wilpinjong WBM are summarised in **Table 13**. The operating rules have been refined by calibration against monitored data over a 5-year period.

Table 13 Wilpinjong WBM Operating Rules

Item	Description	Operating Rules
1.0	**External Water Supply**	
1.1	External Water Supply	• Water imported from an external source to sustain mine water demands during prolonged drought periods • External water supplied when site inventory below 2,000ML, import rate dependent on site inventory level and ranges from 5.1L/s to 27.3L/s (see **Section 7**). • Inflow directed to CWD
2.0	**Supply to Demands**	
2.1	CHPP	• Modelled as a net water extraction of 139 ML/month (4.6 ML/day) sourced evenly between the CWD and RWD • Usage consistent with CHPP water balance and forecast production (WRM, 2019) (see **Section 5.1.1.4**) • No return from demand
2.2	Miscellaneous Industrial Area	• Modelled as a net water extraction of 20 ML/month (0.66 ML/day) sourced evenly between the CWD and RWD • Assumed loss rate of 0.274 ML/day (100 ML/year) • Balance assumed to return to Pit 2W

Item	Description	Operating Rules
2.3	Dust suppression	• Water usage calculated daily in model as a function of climate and application area. (Refer to **Section 5.2.2**) • No dust suppression if rainfall exceeds 1.5 mm/day • Demand supplied based on the following breakdown: • ROM FP (RWD) – 75.08% • Pit 2 FP (Pit 2W) – 24.91% • Pit 5 FP (Pit 5 FP Dam) – 0.01% • No return from demand modelled
2.4	Evaporators	• Modelled as a net 0.25 ML/day loss from Pit 2W • Outflow stream assumed to be water only, no salt removed from Pit 2W • Disabled if site water inventory is less than 3,500 ML
2.5	WTF	• Used to draw down mine water inventory. Operated if inventory in WMS exceeds 2,000 ML • Supplied from Pit 2W at up to 6.6 ML/day, flowrate modelled dependent of previous 5-day rainfall (see **Section 6.3**) • Permeate recovery modelled as 75% of feed. No reduction in recovery modelled due to high feed water EC • Permeate EC modelled at 180 µS/cm • WTF reject EC modelled as a function of feed water EC based on salt mass balance • WTF reject pumped to Pit 1S prior to Q4 2018 after which reject pumped to RWD. If Pit 1S/RWD full, reject pumped to Pit 2W. Following recommission in December 2020 reject is pumped to Pit 2W. • Discharge water EC modelled at 350 µS/cm, achieved by adding Pit 2W water to the residual permeate stream assumed 0.3 ML/day based on average EC of Pit 2W and discharge water
3.0	**Operation of Key Storages**	
3.1	Water Storages	
3.1.1	Pit 2W	• Primary hub mine water storage • Supplies makeup water to the following locations as required: • RWD and CWD • Pit 2 FP • Pit 5 FP Dam • Receives pumped dewatering from Pit 5N, Pit 4, Pit 3N, Pit 8 and Pit 8 CWD • Pumps to Pit 5N at 100 L/s (8.64 ML/day) if water level exceeds 370 mAHD. If Pit 5N is full, Pit 2W pumps to Pit 4, and then to Pit 3 as a last resort • Seeps to Pit 4 via Pit 2/4 spoil aquifer • Supplies water to WTF for treatment and discharge to Wilpinjong Creek under EPL 12425 • Feed water for evaporator spray system • Exchanges water with adjacent Pit 2/4 spoil aquifer to maintain equalised water levels (exchanges water with Pit 2 half of spoil aquifer only) • No spillway overflows modelled.

Item	Description	Operating Rules
3.1.2	RWD	• Mine water dam in the CHPP/MIA area • Supplies water to the following locations: • CHPP process water makeup • MIA/CHPP miscellaneous water usage • ROM FP • Sources water from Pit 2W to maintain water level at 412.6 mAHD (295 ML) • Receives reject from WTF following decommission of Pit 1S in Q4 2018 • No spillway overflow modelled
3.1.3	CWD	• Mine water dam located north of CHPP/MIA, within the rail loop. • Supplies water to the following locations: • CHPP process water makeup • MIA/CHPP miscellaneous water usage • Sources water from Pit 2W to maintain water level at 395.7 mAHD (30 ML) • No spillway overflow modelled
3.1.4	Pit 1S (offline as of Q4 2018)	• RO reject storage dam • Receives pumped inflow of reject from WTF • Maximum operating level defined as 421.4 mAHD (295 ML) to minimize seepage to downstream areas within the WMS • Constant seepage rate of 1 mm/d modelled. Seepage assumed to report to Pit 1/5/6 spoil aquifer • Additional seepage of 0.45 ML/day to Pit 1/5/6 spoil aquifer modelled if water level exceeds 422.4 mAHD (345 ML)
3.1.5	Pit 5 FP Dam	• Water supply for Pit 5 FP • Receives pumped inflows from Pit 5N and Ed's Lake • Sources makeup water from Pit 2W to maintain a minimum water level of 391.5 mAHD (3 ML) • Spillway overflow to Pit 5N at 392.2 mAHD (full storage volume 8.5 ML)
3.1.6	Ed's Lake	• Residual void left within backfilled and rehabilitated Pit 1N void • Supplies makeup water to Pit 5 FP Dam • Pumps excess water to Pit 2W at 100 L/s (8.64 ML/day) • Seepage to underlying Pit 1/5/6 spoil aquifer modelled at 0.5 ML/day • Spillway overflow to Wilpinjong Creek at 375.3 mAHD (storage capacity nominally 110 ML)
3.1.7	Pit 8 Clean Water Dams	• Constructed in 2020 • Capture water from the Pit 8 upstream diversion • Excess water pumped to Pit 2W at 160L/s when volume reaches 6.5 ML prior to 2021, after which water is discharge via a licenced discharge point at up to 200L/s
3.2	**Tailings Storage Facilities**	
3.2.1	All TD's	• Old tailings storage cells • All receive local catchment runoff with no pumped inflows • No pumped outflows modelled. Standing water left to evaporate, or seep to Pit 2/4 spoil aquifer (at an assumed rate of 2 mm/day)
3.3	**Mining Pits**	

Item	Description	Operating Rules
3.3.1	Pit 5N	• Pumps to Pit 5 FP Dam if it requires water. Excess water pumped to Pit 2W at 180 L/s (15.6 ML/day) unless receiving storage is above its maximum operating level • Maximum water level of 369 mAHD modelled. If water level exceeds this threshold, pumping to Pit 2W will occur regardless of downstream inventory (this will trigger filling of next pit in sequence) • Receives groundwater inflow of 25% of total inflow prior to 2020, receives 30% groundwater inflow following the commencement of mining Pit 8 (modelled via Pit 1/5/6 spoil aquifer) • Exchanges water with adjacent Pit 1/5/6 spoil aquifer to maintain equalised water levels • Receives seepage from up-dip pits (Pit 5S, Pit 6 and Pit 1) via spoil aquifer
3.3.2	Pit 5S	• Seepage to Pit 5N (via Pit 1/5/6 spoil aquifer) modelled as a depth loss rate of 300 mm/day • No pumped dewatering
3.3.3	Pit 4	• Receives seepage from Pit 2W via Pit 2/4 spoil aquifer • Excess water pumped to Pit 2W at 160 L/s (14.0 ML/day) unless receiving storage is above its maximum operating level • Maximum water level of 362.0 mAHD modelled. If water level exceeds this threshold, pumping to Pit 2W will occur regardless of downstream inventory (this will trigger filling of next pit in sequence) • Receives groundwater inflow of 25% of total inflow prior to 2020, receives 20% groundwater inflow following the commencement of mining Pit 8 • Exchanges water with adjacent Pit 2/4 spoil aquifer to maintain equalised water levels (exchanges water with Pit 4 half of spoil aquifer only)
3.3.4	Pit 1	• Seepage to Pit 1/5/6 spoil aquifer modelled as a depth loss rate of 300 mm/day • No pumped dewatering
3.3.5	Pit 2S	• Seepage to Pit 2/4 spoil aquifer modelled as a depth loss rate of 300 mm/day • No pumped dewatering
3.3.6	Pit 3	• Receives drainage from Pit 7 • Excess water pumped to Pit 2W at 90 L/s (7.8 ML/day) unless receiving storage is above its maximum operating level • Maximum water level of 358.0 mAHD modelled. If water level exceeds this threshold, pumping to Pit 2W will occur regardless of downstream inventory • Receives groundwater inflow of 50% of total inflow prior to 2020, receives 20% groundwater inflow following the commencement of mining Pit 8
3.3.7	Pit 7	• Passively drains to Pit 3 • No pumped dewatering
3.3.8	Pit 6	• Seepage to Pit 5N (via Pit 1/5/6 spoil aquifer) modelled as a depth loss rate of 300 mm/day • No pumped dewatering
3.3.9	Pit 8	• No pumped dewatering prior to 2020 • Excess water pumped to Pit 2W at 100L/s • Receives groundwater inflow of 30% of total inflow from 2020, does not receive groundwater inflow prior to 2020
3.4	**Spoil Aquifers**	
3.4.1	Pit 1/5/6 Aquifer	• Modelled as two separate cells: Pit 5 spoil aquifer and Pit 1 spoil aquifer • Pit 5 spoil aquifer equalises with Pit 5N open cut above 351 mRL • Pit 5 spoil aquifer equalises with Pit 1 spoil aquifer above 354 mRL

Item	Description	Operating Rules
3.4.2	Pit 2/4 Aquifer	• Modelled as two separate cells: Pit 2 spoil aquifer and Pit 4 spoil aquifer • Pit 2 spoil aquifer equalises with Pit 2W open cut above 350.75 mRL. • Pit 4 spoil aquifer equalises with Pit 4 open cut above 331 mRL. • Pit 2 spoil aquifer seeps to Pit 4 spoil aquifer at a fixed rate of 10 ML/day (seepage calculation based on level difference cannot be modelled within OPSIM due to large head difference – i.e., unstable calculation)
4.0	**Other**	
4.1	Climate	• All water storages receive catchment runoff and lose water to evaporation.
4.2	Groundwater Inflow	• Passive groundwater inflow is experienced due to active mining • Groundwater inflow is determined using adjustment factors to simulate rainfall and recharge responses (see **Section 8.1.4**) • Inflow directed to downdip pits within void areas, Pit 5N, Pit 4, Pit 3 and Pit 8 (Post 2019). The total expected rate is apportioned as follows: • Pit 1/5/6 void: 25% (prior to 2020), 30% (from 2020) • Pit 2/4 void: 25% (prior to 2020), 20% (from 2020) • Pit 3/7 void: 50% (prior to 2020), 20% (from 2020) • Pit 8 void: 30% (from 2020)

10.6 Performance of Site WMS During Drought Conditions

As discussed in **Section 4** during 2018 and 2019, significant drought conditions were experienced in the region. As a result, water within the site water inventory was seen to decrease to a minimum of 760 ML during this period. In order to preserve site water supplies a number of strategies have been implemented at WCPL including:

- Operation of the revised CHPP model which includes a Belt Filter Press (BFP) (as opposed to direct pumping into tailings dams); and
- The use of Dust-a-side (DAS) to reduce dust generation on roads, hardstand and laydown areas and reduces the need for water carts.

As discussed in **Section 5.1.1** The CHPP tailings circuit was modified in April 2015 to include a BFP, which dewaters the tailings stream and allows this material to be disposed of as a dry waste stream with the coarse reject. Any moisture bleed-off from within the BFP process is captured and re-circulated to the clarified water tank, thereby reducing the net water usage of the CHPP.

In order to reduce water resources required in times of increased demand for dust suppression, WCPL implemented the use of DAS in 2019. During 2019, minimal rainfall fell at the site (equivalent to a 1st percentile historical rainfall) which increased the need for dust suppression significantly, as illustrated in **Section 5.2**. It is considered that this water consumption and associated loss of site water to evaporation would have increased without DAS usage.

Although the site water inventory reduced significantly during this drought period, the above practices along with reduced discharge from the WTF, import of external water sources and effective management of site water storages ensured the site could operate effectively throughout this period.

11 Forecast of Site Water Behaviour

11.1.1 Overview

The Wilpinjong WBM, as described in the preceding sections, has been utilised to investigate the behaviour of the site water inventory for the 3-year forecast period from 1 January 2023 to 31 December 2025.

11.1.2 Model Configuration

The WBM has been configured to account for changes required to simulate, site operations proceeding current conditions (2023). The WBM primarily operates as per the configuration previously described in this report, however, adjustments have been made to the simulation methodology, catchment breakdown, CHPP Demand, site WMS operations. These elements are described in the following sections.

11.1.2.1 Simulation Methodology

The WBM was run on a daily timestep for the period between 1 January 2023 and 31 December 2025. As described in **Section 4.2** and **4.3**, 122 years of climate data sourced from the SILO Data Drill is available for WCM for use in analysis in long-term climate trends. Stochastic climate data has been used in order to determine rainfall patterns for the forecasted years.

The purpose of stochastic rainfall generation is to develop a wide range of climate sequences based on the recorded rainfall data of the area. These sequences have the similar statistical distribution to that of the historical data set for a range of parameters, including mean, variance, skew, and number of wet days or dry days. Each sequence has an order in which the rainfall has occurred. For example, one sequence may have wetter years at the start of the sequence, where another sequence may have the wetter years towards the end of the sequence. Some sequences may be wetter or dryer than others in order to account for the variability of the climate which may occur during the mine life. The probabilistic rainfall data replicates the seasonality of the historical rainfall data.

The probabilistic climate data for the WBM was used to predict the rainfall at the site during the forecast period to determine the volume of water on site, which needs to be managed. The probabilistic rainfall sequences were produced through the use of the Stochastic Climate Library (SCL) software (eWater CRC).

Stochastic rainfall data was produced for 500 replicates of 3-year rainfall data (1500 years of probabilistic data). This allows a wide range of climatic conditions to be simulated, which then gives the mean and median of the assessment. The assessment also yields percentiles which are interpreted as a percentage exceedance probability (i.e., the risk of an event occurring).

Monthly evaporation rates have been utilised for the forecast period as per **Section 4.3**. Due to limitations in the number of stations in the region, long term average values were used in the WBM as opposed to stochastic evaporation data.

The stored volumes prior to the simulated forecast period (to 31 December 2022) were estimated based on monitored water level data recorded by WCPL. The combined site volume on 29 December 2022 was 3540 ML.

The results of the site water inventory are presented in terms of the following climatic conditions:

- Very Wet Climatic – 99th Percentile results of the volume predicted using the 500 probabilistic climatic sequences;

- Wet Climatic – 90th Percentile results of the volume predicted using the 500 probabilistic climatic sequences;
- Median Climatic – 50th Percentile results of the volume predicted using the 500 probabilistic climatic sequences;
- Dry Climatic – 10th Percentile results of the volume predicted using the 500 probabilistic climatic sequences; and
- Very Dry Climatic – 1st Percentile results of the volume predicted using the 500 probabilistic climatic sequences.

11.1.2.2 Catchment Breakdown

Catchment boundaries for water storages within WCM along with land use classifications for the years 2023, 2024 and 2025 have been delineated based on the most recent available catchment areas and land types provided by WCPL and the long-term mine forecast. A breakdown of land use type per water storage catchment area and catchment and land use maps, have been provided in **Appendix B**.

11.1.2.3 Site Water Management System Operations

The operations within the site water management system for the forecast period are expected to be generally consistent with the arrangement described previously in this report. However, WCM is scheduled to construct a second clean water diversion at Pit 8 to redirect clean water off the eastern escarpments around the Pit 8 area. This clean water is assumed to flow offsite. This change has been incorporated into the catchment areas for the forecast period as shown in **Appendix B**.

From the start of 2022 the smaller farm dam to the north of the Pit 8 CWD which currently captures any overflow, is planned to be pumped back into the Pit 8 CWD once the dam has been emptied. The capacity of the northern dam is 9 ML. Given the pumping relationship between the two dams, they have been modelled within the WBM as a single dam with a combined capacity of 25ML.

Evaporator sprays were commissioned once again in 2022, and therefore are allowed to draw water from Pit 2W in accordance with threshold rules described in **Section 5.3**.

11.1.2.4 CHPP Demand

As the model has been updated to include a time series of CHPP water demand based on the monitored usage, for model forecasting an annual average across the calibration period of (4.6 ML/day) has been adopted.

11.1.3 Outcomes

11.1.3.1 Water Balance

Model simulated volumes have been forecast for the period 1 January 2023 to 31 December 2025. Results have been plotted for the combined water inventory in the WMS (comprising Pit 2W, Pit 1S, RWD, CWD, Pit 5N, Pit 4 and Pit 3).

Figure 17 shows the forecasted total site inventory and associated WTF discharge for the period 1 January 2023 to 31 December 2025 through varying climatic conditions.

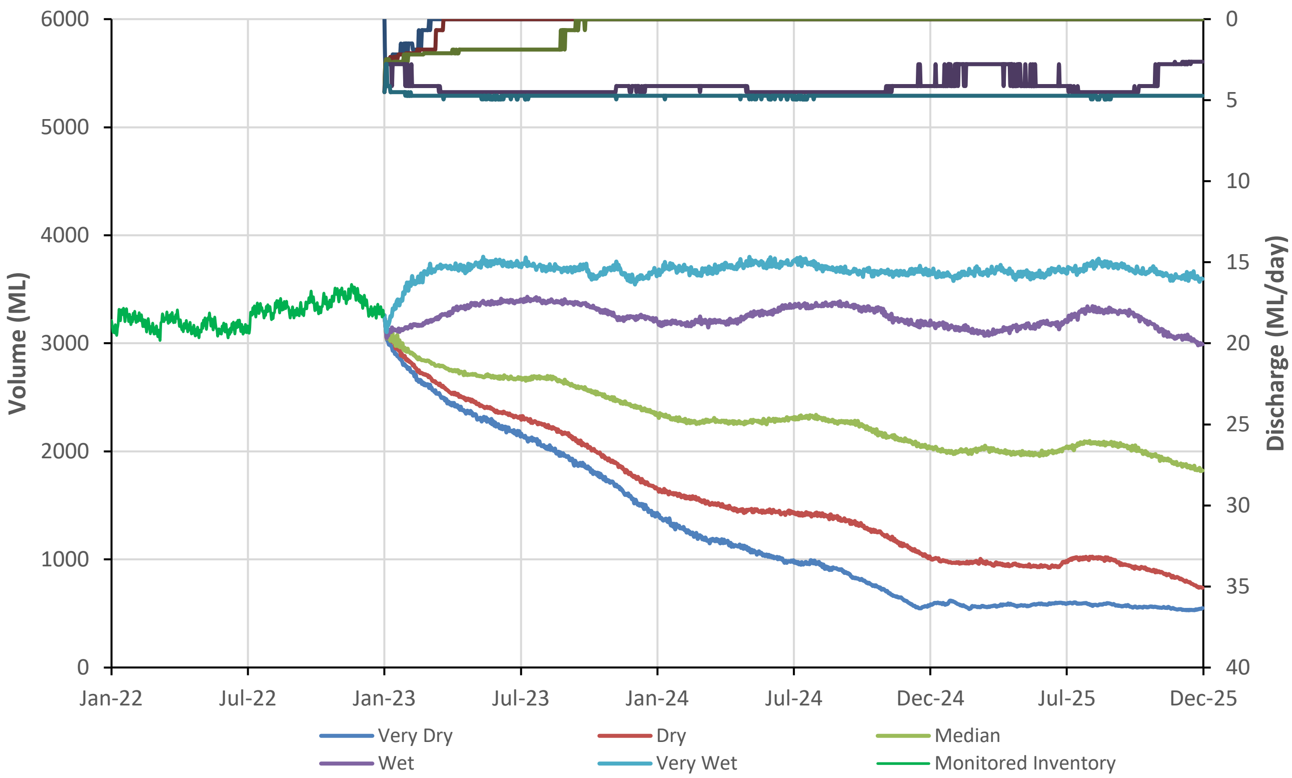


Figure 17 Forecast Site Water Inventory

Review of **Figure 17** shows the following:

- The 1%ile (very dry climatic conditions) results in a total site water decrease to 1429 ML at the end of 2023, 572 ML at the end of 2024, and 549 ML at the end of 2025;
- The 10%ile (dry climatic conditions) results in a total site water decrease to 1655 ML at the end of 2023, 1028 ML at the end of 2024, and 736 ML at the end of 2025;
- The 50%ile (median climatic conditions) results in a total site water decrease to 2335 ML at the end of 2023, 2037 ML at the end of 2024, and 1827 ML at the end of 2025;
- The 90%ile (wet climatic conditions) results in a total site water decrease to 3210 ML at the end of 2023, 3164 ML at the end of 2024, and 2993 ML at the end of 2025; and
- The 99%ile (very wet climatic conditions) results in a total site water increase to 3622 ML at the end of 2023, 3633 ML at the end of 2024, and 3581 ML at the end of 2025.

Overall, the forecast indicates that there is adequate water security during dry conditions, with opportunities to reduce inventory destruction, and that water inventory is manageable during very wet years.

11.1.3.2 Salt Balance

Model simulated salinity have been forecast for the period 1 January 2023 to 31 December 2025. Results have been plotted for the primary transfer storages within the combined water inventory in the WMS (i.e., Pit 2W, RWD, CWD).

Salinity has been presented in terms of salinity percentile of salinity levels that may result from the varying climatic conditions simulated and provides an indication of the range of salinities that may be experienced within storages. Hence, the 99th percentile salinity is the highest 99 percent of possible salinity levels occurring in the water storage and therefore does not necessarily correlate to very wet (99th percentile) rainfall.

Where water within storages becomes significantly low, such as during very dry or dry conditions described in **Section 11.1.3.1**, The model does not capture all of the process associated with the movement and transfer of salt. For this reason, the salt concentration of the site water storages has been capped at a maximum of 25,000 mg/L (EC of 37,313 µS/cm). This rarely activates in the model and typically only applies to very dry or dry climate conditions when storages dry out or reach very low water levels. In these instances, the mass of salt predicted is small but as the volume of water modelled is also small this is reported as a very high salt concentration. In reality a proportion of the salts would be lost to seepage, or settle as sediment in the storage.

Figure 18 shows the forecasted salinity of the CWD throughout the forecast period.

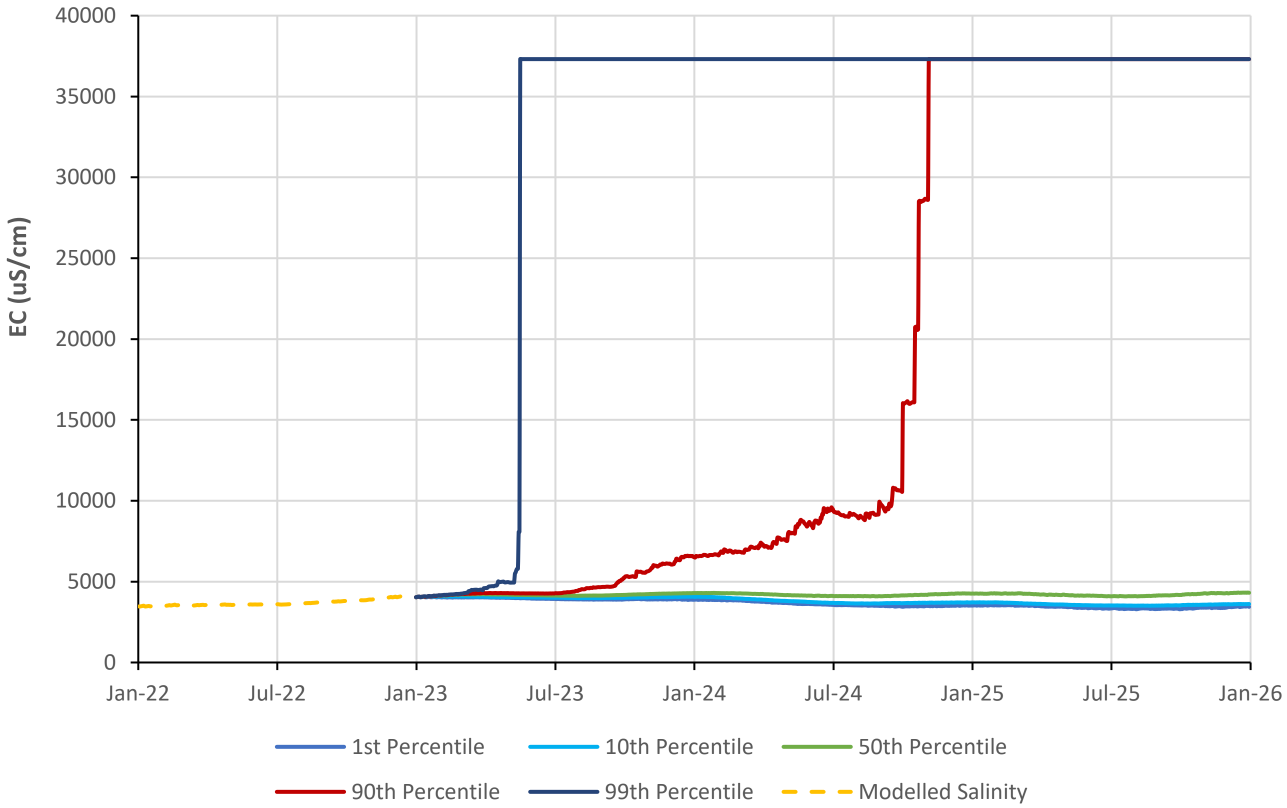


Figure 18 Forecast Salinity: CWD

Review of **Figure 18** shows that median salinity within the CWD fluctuate between 4035 µS/cm to 4323 µS/cm throughout the simulation. The 90th and 99th percentile results reach the maximum EC modelled; however, this is likely due to limitations within the model regarding significantly small storage volumes that cause a rise in the modelled EC. Although salt concentrations have large fluctuations, the total salt mass within the system remains consistent.

Figure 19 shows the forecasted salinity of the RWD throughout the forecast period.

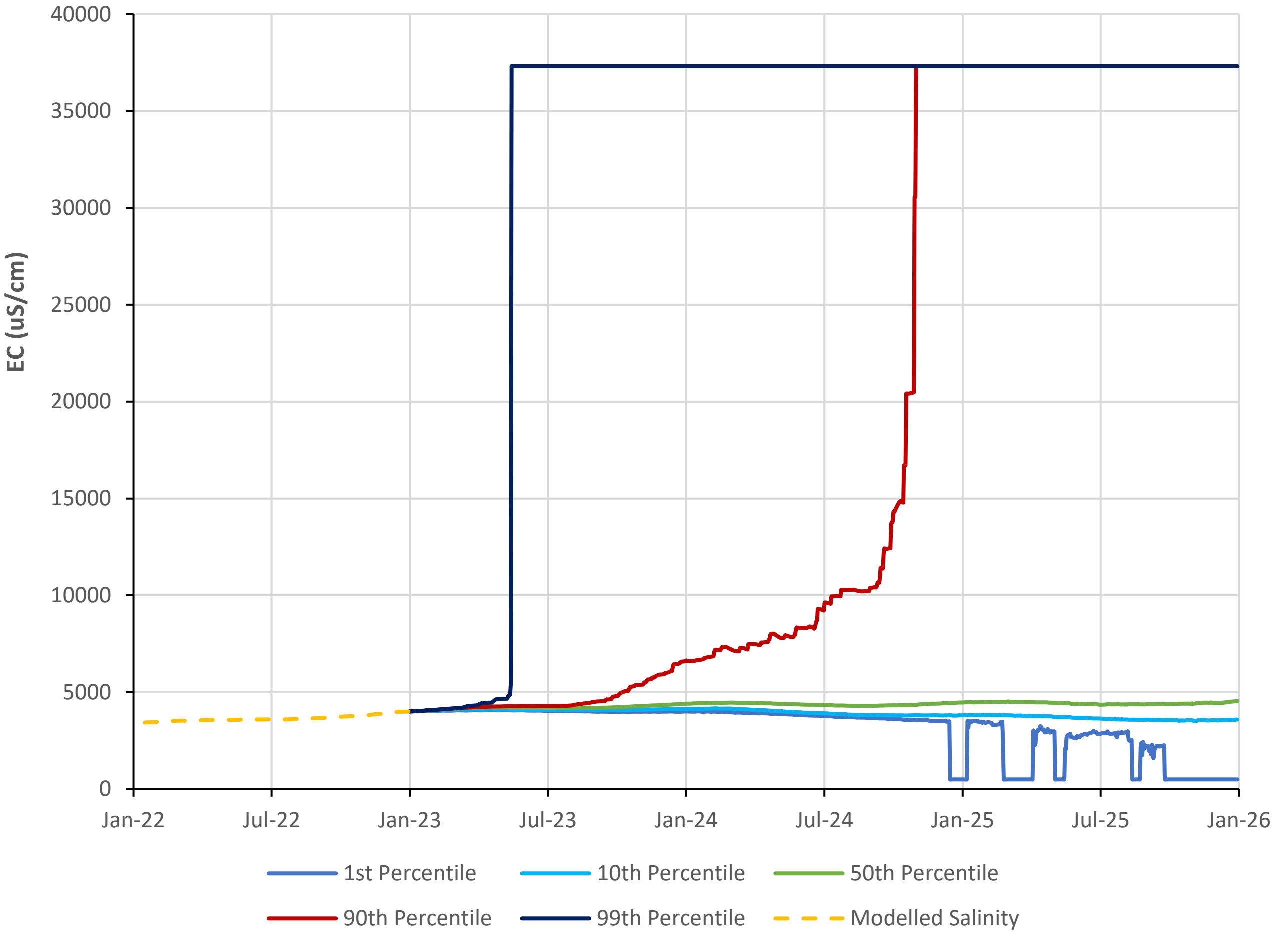


Figure 19 Forecast Salinity: RWD

Figure 19 shows that median salinity within the RWD fluctuate between 4006 µS/cm to 4549 µS/cm throughout the simulation. The 90th and 99th percentile results reach the maximum EC modelled; however, this is likely due to limitations within the model regarding significantly small storage volumes that cause a rise in the modelled EC. Although, salt concentrations fluctuate largely the total salt mass within the system remains consistent.

Figure 20 shows the forecasted salinity for Pit 2W throughout the forecast period.

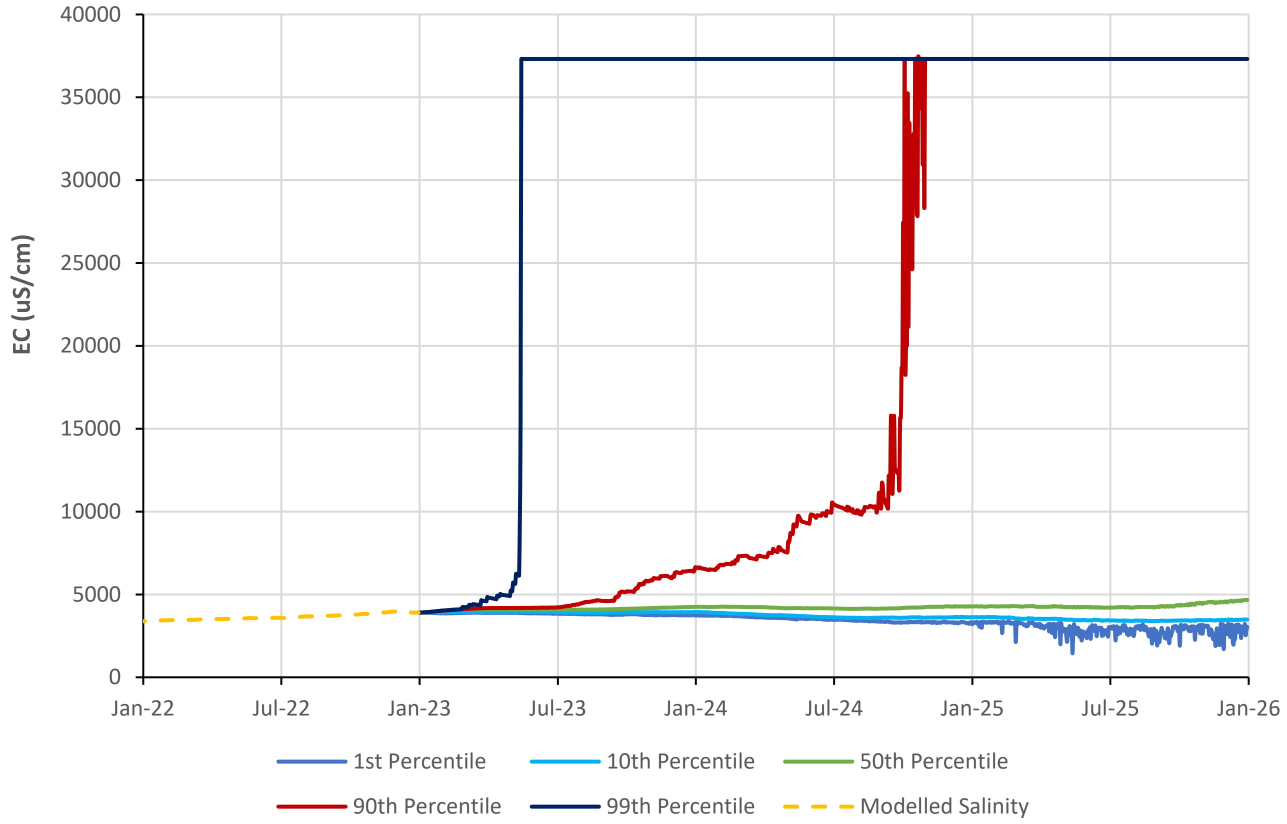


Figure 20 Forecast Salinity: Pit 2W

Figure 20 shows that median salinity within the Pit 2W fluctuate between 3900 µS/cm to 4670 µS/cm throughout the simulation. The 90th and 99th percentile results reach the maximum EC modelled; however, this is likely due to limitations within the model regarding significantly small storage volumes that cause a rise in the modelled EC. Although salt concentrations have large fluctuations, the total salt mass within the system remains consistent.

12 Conclusion and Recommendations

The current investigation has updated the WCM WBM to reflect changes in the WMS and additional monitoring data recorded during 2022. Key outcomes of current investigations include:

- Updated catchment schedule and land use classifications based on information current as at the end of year 2022;
- Overall, the WBM provides a good correlation between monitored and predicted water inventory and provides a sound platform for future studies;
- The salt balance incorporated within the WBM effectively tracks overall salt mass within the site storages; and
- Forecast site mine water inventory behaviour for the period 2023-2025 under different site operating scenarios and climatic conditions. Overall, the forecast indicates that there is adequate water security during dry conditions, with opportunities to reduce inventory destruction, and that water inventory is manageable during very wet years.

It is recommended that WCM implement improved monitoring of groundwater inflows which will allow for improved calibration on this aspect of the WBM in future studies. Groundwater inflow has previously been inferred by reviewing monitored volumes of water extracted from the WCM open cut pits. It is recommended that pumping records are again reviewed to measure/ estimate groundwater inflow. This will enable validation and improved calibration of the WBM and numerical groundwater model in future studies. Specifically, Pit 8 could be a good indicator for groundwater inflows as it has minimal interaction with spoil aquifers and pumped inflows.

The updated WBM is considered to be well suited for planning studies, infrastructure sizing and operational decision making, provided these studies incorporate sensitivity analysis (as any robust study should).

It should be noted that the content of this report may be subject to revision with any future improved understanding of the operational and response characteristics of the WCM water management system.

12.1 Model Limitations

Climatic data (rainfall and evaporation), supply, demand and transfer volumes have been modelled as daily totals. The model assumes that daily data can be distributed over 24 hours. The model does not accurately represent events with durations less than 24 hours. For example, storm runoff events with durations less than 24 hours cannot be accounted for using the WBM.

The WBM has been developed and calibrated with a focus on the water management system as a whole. Model accuracy is considered better for design applications of wider scope (e.g. site water balance) relative to studies of narrower focus (e.g. single dams). Although the model is well suited for undertaking smaller studies, inputs and controls should always be first understood and then modelled to a level of detail suitable to the task at hand.

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