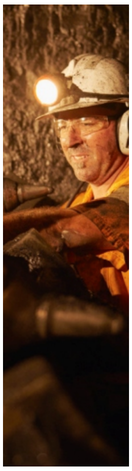

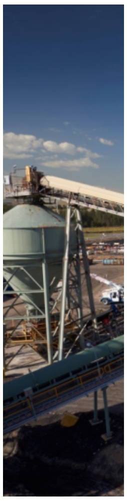

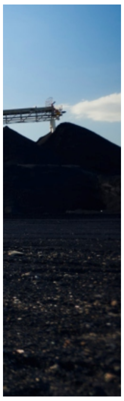

Ashton-Ravensworth
Underground Mine Integration

EPBC Act
Preliminary Documentation

APPENDIX D

Modification Site Water Balance

YANCOAL
兖煤澳大利亚有限公司

HYDRO ENGINEERING
& CONSULTING PTY LTD

REPORT

Ashton-Ravensworth Underground Integration Modification Site Water Balance

Prepared for: Ashton Coal Operations Pty Ltd

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f	Sixth Draft	TSM	RS	TSM	1 Nov 2021
g	Final	TSM	Client	TSM	8 Nov 2021

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1.0 INTRODUCTION AND BACKGROUND

1.1 PROJECT BACKGROUND

The Ashton Mine Complex is located in the Upper Hunter Valley of New South Wales (NSW), approximately 14 kilometres (km) north-west of Singleton, as shown in Figure 1. The site is operated by Ashton Coal Operations Pty Limited (ACOL); a wholly owned subsidiary of Yancoal Australia Limited (Yancoal). The Ashton Mine Complex includes the Ashton Coal Project (including the completed North East Open Cut [NEOC] and the Ashton Underground Mine) and approved Ashton South East Open Cut (SEOC) Project. The SEOC Project has not yet commenced.

The Ashton Coal Project comprises the following key components (ACOL, 2020):

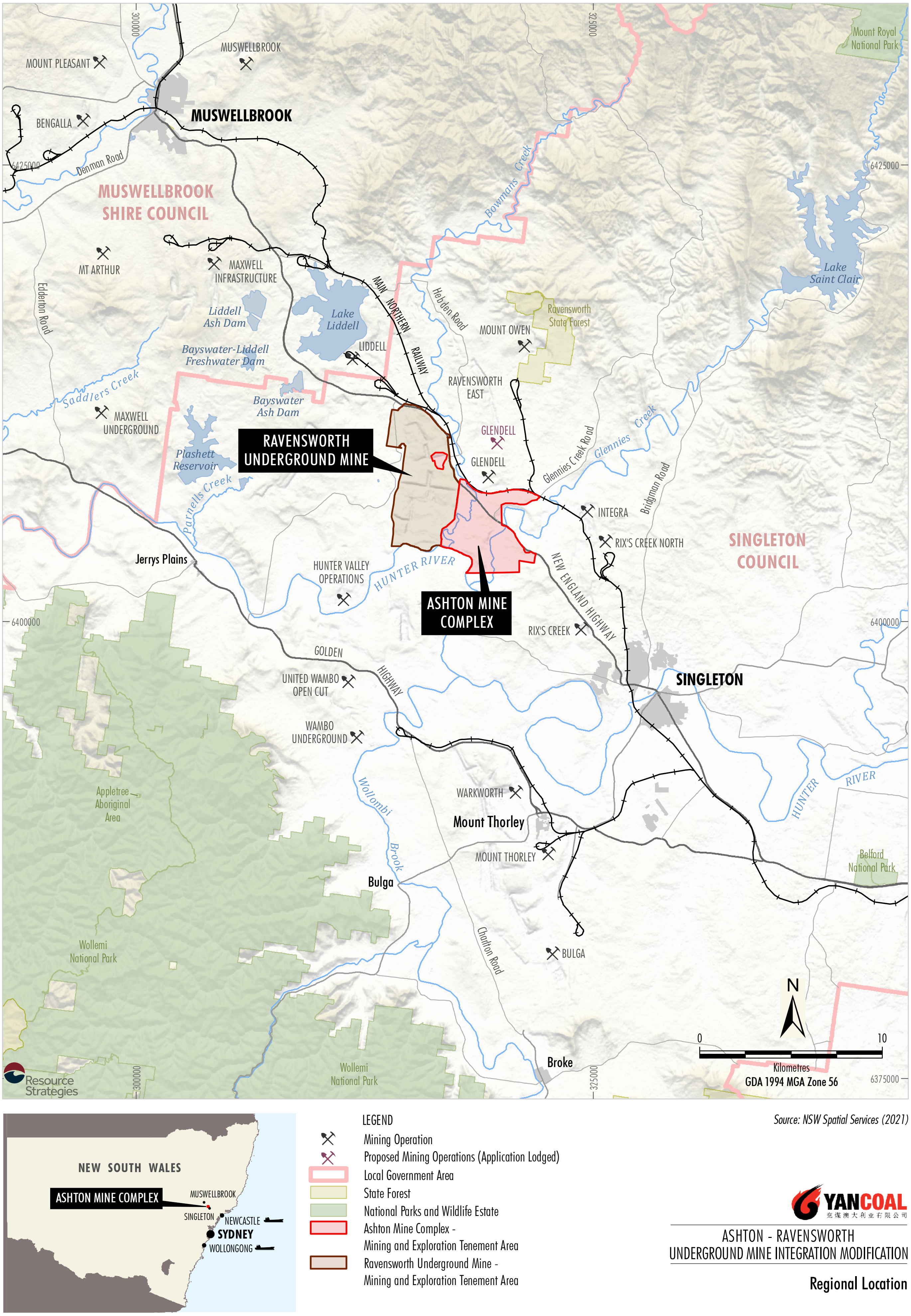
- An open cut pit (the north-east open cut - NEOC) that has been completed, with the final void remaining for the storage of water, coarse reject and fine reject;
- A four seam descending underground mine (the Ashton Underground Mine) with approval to extract up to 5.45 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal until 26 February 2024;
- Surface mine infrastructure associated with the underground mine, including gas drainage bores, ventilation fans and mine dewatering infrastructure;
- A coal handling and preparation plant (CHPP) including rail siding and rail loading bin;
- Reject and tailings emplacements; and
- Administration, bathhouse and workshop buildings.

The underground mining operation comprises longwall mining of the Pikes Gully (PG), Upper Liddell (ULD), Upper Lower Liddell (ULLD) and Lower Barrett (LB) coal seams (in descending order). The general longwall layout consists of eight longwall panels in the PG Seam (LW 1 to LW 8) and ULLD Seam (LW 201 to LW 208) and seven longwall panels in the ULD Seam (LW 101 to LW 107). The PG Seam was mined from 2006 to 2012 and the ULD seam from 2012 to 2017. Mining of the ULLD Seam is anticipated to be completed by approximately August 2023. The LB Seam would be next to be mined under the approved mining sequencing for the Ashton Underground Mine. The longwall layout for the PG and ULLD seams are shown in Figure 2.

The Ravensworth Complex is a neighbouring operation located to the west of the Ashton Coal Project. It comprises the Ravensworth Open Cut, the Ravensworth Underground Mine (RUM) and the Ravensworth CHPP. The RUM is owned and operated by Resource Pacific Pty Limited. RUM was placed into care and maintenance in October 2014.

Yancoal has identified an opportunity to maximise recovery of available coal resource through the integration of the RUM and Ashton Underground Mine. ACOL is investigating the potential to access approved remaining coal reserves in the PG seam and Middle Liddell seam at the RUM. The approved longwalls would be accessed by a new set of workings extended from the existing main headings at the Ashton Underground Mine in the PG seam (into the RUM PG Seam) and ULLD seam (refer Figure 3). ACOL plans to seek a modification under the State Significant Development provisions of Section 4.55 of the NSW *Environmental Planning & Assessment Act, 1979*. The modification proposes to integrate the existing Ashton Underground Mine and the RUM via the Ashton-Ravensworth Integration Modification (the Modification).

Under Yancoal's preferred pathway for continued operations at the Ashton Mine Complex, ACOL would utilise the existing Ashton Coal Project workforce to mine the approved RUM and would not proceed with the SEOC Project. This site water balance assumes the SEOC Project does not commence and therefore is excluded in predictions presented below.



Source: NSW Spatial Services (2021)

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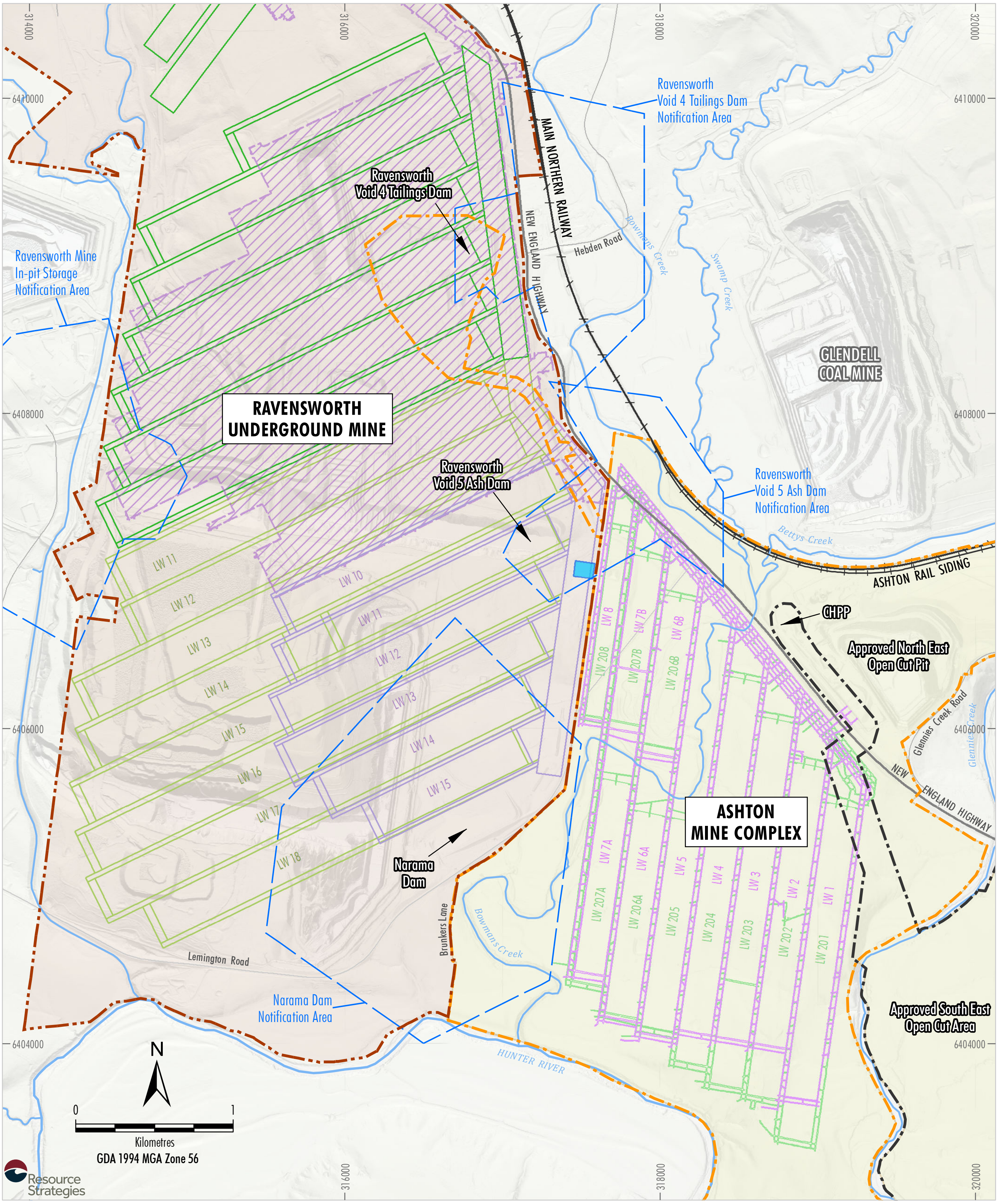
ASHTON - RAVENSWORTH
UNDERGROUND MINE INTEGRATION MODIFICATION

Regional Location

Figure 1



LEGEND

- Dam Notification Area

Ashton Mine Complex

- Ashton Coal Project Development Consent Boundary
- South East Open Cut Approval Boundary
- Ashton Mine Complex
- Pikes Gully Seam Longwall Layout
- Upper Lower Liddell Seam Longwall Layout

Ravensworth Underground Mine

- Ravensworth Underground Mine Development Consent Boundary
- Existing Shaft 5 Location
- Completed Pikes Gully Seam Workings
- Approved Pikes Gully Seam Longwall Layout
- Approved Middle Liddell Seam Longwall Layout
- Approved Upper Liddell Seam Longwall Layout

NOTE
The approved Upper Liddell and Lower Barrett Seams at the Ashton Coal Project and approved Lemington and Barrett Seams at the Ravensworth Underground Mine are not shown on this figure.

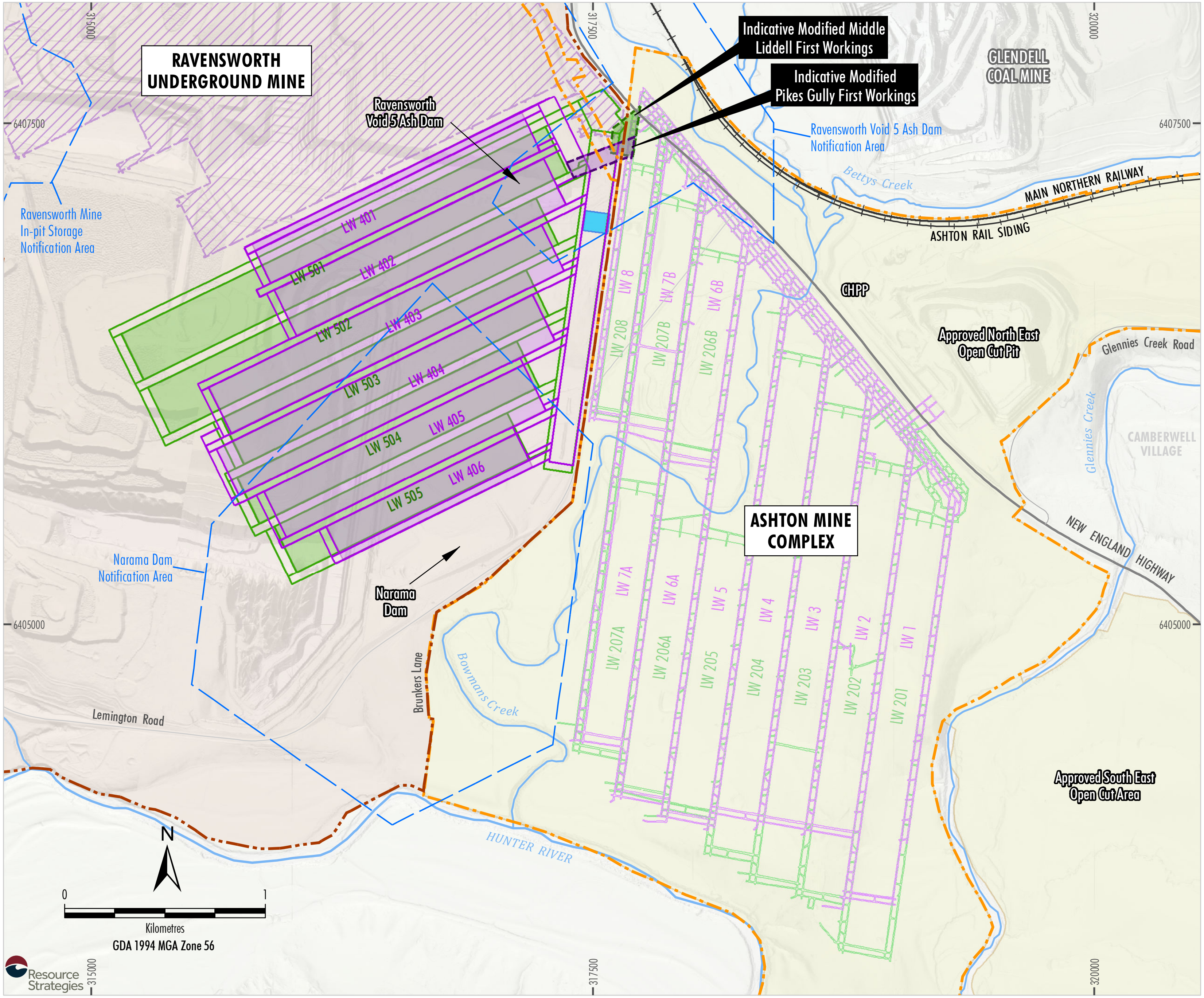
Source: NSW Spatial Services (2021); Dams Safety NSW (2020)

YANCOAL

ASHTON - RAVENSWORTH
UNDERGROUND MINE INTEGRATION MODIFICATION

Approved Longwall Layouts

Figure 2



LEGEND
- Dam Notification Area

Ashton Mine Complex
- Ashton Coal Project Development Consent Boundary
- Ashton Mine Complex
- Pikes Gully Seam Longwall Layout
- Upper Lower Liddell Seam Longwall Layout

Ravensworth Underground Mine
- Ravensworth Underground Mine Development Consent Boundary
- Completed Pikes Gully Seam Workings
- Existing Shaft 5 Location

Proposed Modification
- Indicative Pikes Gully Seam Longwall Layout
- Indicative Modified Pikes Gully First Workings
- Indicative Middle Liddell Seam Longwall Layout
- Indicative Middle Liddell Seam First Workings

NOTE

The approved Upper Liddell and Lower Barrett Seams at the Ashton Coal Project and approved Lemington and Barrett Seams at the Ravensworth Underground Mine are not shown on this figure.

Source: NSW Spatial Services (2021); Dams Safety NSW (2020)

YANCOAL

ASHTON - RAVENSWORTH
UNDERGROUND MINE INTEGRATION MODIFICATION

Indicative Modification General Arrangement

Figure 3

The main elements proposed for the Modification include the following:

- underground connection from the existing Ashton Underground Mine workings to the approved RUM Pikes Gully and Middle Liddell coal seams via first workings;
- receipt of ROM coal mined in the RUM Pikes Gully and Middle Liddell coal seams for handling, processing and transportation using the existing Ashton Coal Project infrastructure;
- management of RUM ROM coal coarse rejects and tailings by emplacement in the NEOC void and at the Ravensworth Void 4 tailings storage[1];
- receipt and management of water and gas from the ACOL-operated portion of the RUM;
- RUM mine life extension to December 2032 and Ashton Coal Project mine life extension until December 2035; and
- other administrative changes to facilitate management of the ACOL-operated portion of the RUM and integration with the Ashton Coal Project, such as integrated environmental management plans (as appropriate).

1.2 PROPOSED MODIFICATION CHANGES TO SURFACE WATER MANAGEMENT

The relevant components of the Modification that have been assessed as part of this review are as follows:

- continuation of coal handling and preparation at the Ashton CHPP for a further 11 years, with associated water demands and management;
- emplacement of additional RUM tailings within the Ravensworth Void 4 tailings storage and tailings and coarse rejects within the completed NEOC; and
- management of additional groundwater inflows due to ACOL managing groundwater inflows associated with the Modification longwalls at the RUM and extended operation of the Ashton Coal Project until 2035.

There would be no change to approved surface development areas associated with the Modification. There would also be no increase to mining rates or water supply requirements compared to the approved Ashton Coal Project.

1.3 PURPOSE AND SCOPE

Hydro Engineering & Consulting Pty Ltd (HEC) was commissioned by ACOL to provide specialist surface water input and specifically a water balance review and update for the Modification.

The scope of works is as follows:

- A description of the existing and modified site water management system and site water balance model assumptions.
- Review and update of the site water balance model to incorporate the Modification and latest site data.
- Using the model, analyse the performance of the surface water management system, particularly with respect to off-site uncontrolled spill risk and water availability.
- Assessment of potential changes to water quality in the NEOC as a result of the Modification and any treatment requirements/objectives.
- Preparation of a comprehensive Site Water Balance report (this report).

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[1] Also known as the Ravensworth Void 4 Tailings Dam by ACOL.

HEC has previously been engaged to undertake water balance modelling of the Ashton Coal Project, with a calibrated site water balance model developed initially in 2013 with annual reviews conducted thereafter. The work reported herein builds on the most recent model review (HEC, 2021).

2.0 WATER MANAGEMENT SYSTEM

The surface water management system of the Ashton Coal Project involves a number of interlinked storages, their catchments, the CHPP and water pumping systems. A schematic of the modelled water management system is provided in Figure 4.

The following main Ashton Coal Project water storages are simulated by the water balance model (refer Section 3.0):

- The Process Water Dam (PWD) supplies water to the CHPP, for road dust suppression (truckfill) and miscellaneous CHPP usage (e.g. sprays, washdown). The PWD also has the ability to pump to the Ravensworth Void 4 tailings storage and to the NEOC (via a bank of evaporator sprays). The PWD can receive pumped inflow from most storages on site as well as directly from the Hunter River, Glennies Creek and underground mine dewatering bores[2]. The PWD has the potential to spill externally to Bettys Creek but is managed as a nil discharge dam.
- The Settling Dam is located adjacent to the PWD and captures runoff from the CHPP and administration areas and from part of the rehabilitated NEOC waste rock emplacement. It receives pumped inflow from the Ravensworth Void 4 tailings storage reclaim and spills to the adjacent PWD. The Settling Dam also receives return water from PWD supply to miscellaneous CHPP usage.
- Arties Pit Sump receives mine inflows pumped from the underground mine portal. ACOL has indicated that Arties Pit Sump seeps to the NEOC.
- Dam 56 captures runoff from part of the adjacent rehabilitated NEOC waste rock emplacement as well as having in the past received pumped inflow from the nearby Glennies Creek Mine (Integra). Dam 56 can pump out to either the PWD or the NEOC and has the potential to spill externally to the catchment of Glennies Creek but is managed as a nil discharge dam.
- The NEOC is the remnant former open cut pit which is now in the process of being progressively backfilled with coarse rejects. In terms of available capacity, it is the main water storage at the Ashton Coal Project. The NEOC receives groundwater inflow and pumped inflow from Dam 56, the PWD (via evaporator sprays) as well as seepage from Arties Pit Sump. Water reclaim occurs to the PWD via a decant pump located within a slotted concrete riser[3] in the northwest corner of the NEOC.

Rainfall runoff reports to and evaporation occurs from all above-ground storages, with the exception of the NEOC, where water is contained within the coarse rejects hence direct rainfall onto and evaporation from an exposed water surface does not occur.

The system also includes the Tank Farm which supplies water to the underground mine. The Tank Farm receives inflows pumped direct from Glennies Creek (accessed using water access licences [WALs]). The Tank Farm also provides site potable supply and supply to secondary flocculant dosing at the Ravensworth Void 4 tailings storage.

Construction of the Bowmans Creek Diversion occurred between 2011 and late 2012. Irrigation of the diversion vegetation, which was an on-going periodic demand (sourced from Hunter River WALs), has now ceased.

---

[2] ACOL have indicated that one underground dewatering bore discharges to the PWD and the other to the Settling Dam. The Ashton Coal Project water balance model simulates a slight simplification with discharge only to the PWD.

[3] Known on site as “the caisson”.

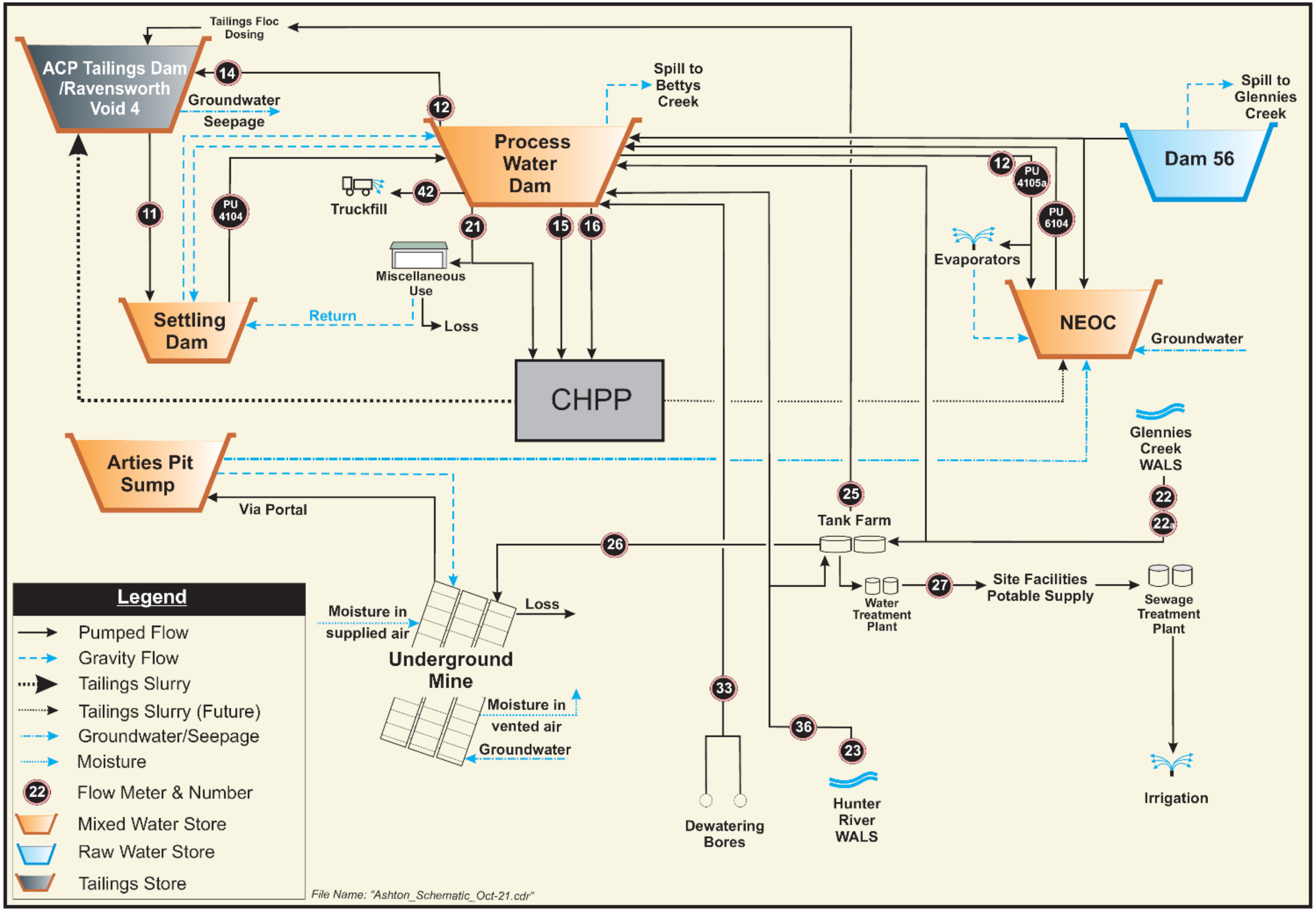

Figure 4 **Ashton Coal Project Water Management System Schematic**

The majority of inflows to the system are from groundwater inflow to the Ashton Underground Mine and runoff captured from disturbed mine landforms. Other sources of water supply are from Glennies Creek and the Hunter River (accessed with WALs), tailings water reclaim and water returned to the system from CHPP miscellaneous use. Outflows from the system are dominated by supply to the CHPP but also include loss from supply to the underground and evaporation as well as supply to irrigation, truckfill and potable use.

ACOL has advised that the capacity of the Ravensworth Void 4 tailings storage will be exhausted by approximately the start of December 2022. From this point it is intended to direct CHPP tailings to the NEOC, initially with whole tailings slurry (thickener underflow) pumped to the NEOC. A tailings dewatering system (conceptually involving a belt filter press to substantially lower tailings moisture) is proposed to be commissioned by the start of 2025. The Ravensworth Void 4 tailings storage will be allowed to dry, be rehabilitated, with drainage directed off site once it is of suitable quality and no longer form part of the water management system.

Underground dewatering of the Ashton Underground Mine and RUM would continue via dewatering bores and pumping from the underground portal to Arties Pit Sump as indicated on Figure 4.

The water management system would remain substantially unchanged for the Modification. It is noted that ACOL is yet to emplace tailings in the NEOC, however it is approved and designed for tailings emplacement. In particular, it has been designed to ensure the efficient dewatering of tailings and maximum water recovery (ACOL, 2019).

Disposal of either whole or dewatered tailings to the NEOC has the potential to change the NEOC water quality, particularly the TSS content. A recent water quality sample, collected from the water reclaim facility within the NEOC, returned a TSS of 9 mg/L which is a low value. An increase in the TSS of reclaimed NEOC water has the potential to affect its utility for re-use within the CHPP (via the PWD). Prior to the commencement of tailings discharge to the NEOC, the potential impacts on reclaim water quality should be assessed and the water reclaim facility amended if required. It should be noted that any impact on the NEOC water quality only has the potential to affect on site water use because discharge of NEOC water is not planned. However, a key underpinning assumption for the Ashton Coal Project water balance is the continued re-use of NEOC water on site (refer Section 3.0).

3.0 WATER BALANCE MODELLING

3.1 MODEL DESCRIPTION

The water balance model has been developed to simulate the storages and linkages shown in schematic form in Figure 4.

The model simulates the volume of water held in and pumped between all simulated water storages. For each storage, the model simulates:

Change in Storage = Inflow – Outflow

Where:

> *Inflow* includes rainfall runoff, groundwater inflow (for the NEOC and the underground mine), moisture in supplied air to the underground mine tailings bleed[4] (for Ravensworth Void 4 and the NEOC), water sourced from Glennies Creek WALs and Hunter River WALs and all pumped inflows from other storages.
>
> *Outflow* includes evaporation, spill (if any), entrainment in the mine spoils surrounding the Ravensworth Void 4 tailings storage (while active), moisture in air vented from the underground mine and all pumped outflows to other storages or to a demand sink (for example, the CHPP which includes entrainment in product coal).

The forecast model can simulate any period from 2021 for the life of the operation. The model simulates 121 “realizations” derived using the climatic record[5] from 1892 to 2012. The first realization uses climatic data starting in 1892, the second starts in 1893, the third in 1894 and so on. The results from all realizations are used to generate water storage volume estimates and other relevant water balance statistics. This method effectively includes all recorded historical climatic events in the water balance model, including high, low and median rainfall periods.

The water balance model has been linked to output from the Hunter River Integrated Quantity and Quality Model (IQQM). The IQQM is the model used by the NSW Department of Planning, Industry and Environment - Water (DPIE-Water) to set licence allocation levels in the Hunter Valley, in accordance with the “Water Sharing Plan for the Hunter Regulated River Water Source” (the Water Sharing Plan). The IQQM was run using climatic data from 1892 to 2012 to generate predictions of general security available water determinations (AWDs) and periods of uncontrolled flows.

3.2 MODEL DATA

3.2.1 Rainfall Runoff Modelling

Rainfall runoff in the model is simulated using the Australian Water Balance Model (AWBM) (Boughton, 2004). The AWBM is a nationally-recognised catchment-scale water balance model that estimates catchment yield (flow) from rainfall and evaporation.

AWBM simulation of flow from seven different sub-catchment types was undertaken, namely: undisturbed (natural) areas, hardstand (for example, roads and infrastructure areas), open cut pit, waste rock, rehabilitated waste rock, stockpile areas and tailings. Each storage catchment area was divided into these sub-catchment areas which were estimated from available aerial photography and recent mine contour plans. For the undisturbed sub-catchment type, model parameters were derived

---

[4] Tailings ‘bleed’ refers to water liberated from tailings as settling occurs.

[5] Data was sourced from SILO Point Data generated climatic data for the mine location. The SILO Point Data is a system which provides synthetic data sets for a specified point by interpolation between surrounding point records held by the Bureau of Meteorology (refer https://www.longpaddock.qld.gov.au/silo/point-data/. Both rainfall and pan evaporation data were obtained from this source.

from regionally calibrated values. For other sub-catchment types, model parameters were initially taken from literature-based guideline values or experience with similar projects. These were then adjusted on the basis of calibration (refer Section 3.3).

3.2.2 Catchment Areas

Surface and sub-surface catchment areas were used to calculate the surface runoff reporting to storages. Current estimated catchment areas are given in Table 1. To account for rainfall that infiltrates through the NEOC waste rock emplacement and is simulated as baseflow (seepage) to the NEOC and Dam 56, sub-surface areas were calculated for both Dam 56 and the NEOC using the NEOC pit shell geometry. Sub-surface catchment areas are also given in Table 1. The only future change to the Ashton Coal Project catchment areas would be as a result of the excision of the Ravensworth Void 4 tailings storage which was assumed fully rehabilitated and then excised from the water management system by the end of November 2025 (3 years after the end of tailings discharge). Total site catchment areas without the Ravensworth Void 4 tailings storage are also given in Table 1. Note that for modelling purposes no tailings have been assumed to be present in the surface of the NEOC, which has been assumed to continue to be simulated as primarily comprising coarse reject which is simulated as "waste rock" sub-catchment. This is because coarse reject will continue to be deposited into the NEOC for the forecast simulation period.

Table 1 Calculated Total Ashton Coal Project Catchment Areas

Sub-Catchment Type	Surface Catchment Area (ha)		Sub-Surface Catchment Area (ha)	
	Existing	Without Void 4 Tailings Storage	Existing	Without Void 4 Tailings Storage
Rehabilitated Waste Rock	133	125	97.0	89.1
Undisturbed (Natural)	0	0	0	0
Hardstand	50.2	48.5	49.5	47.8
Waste Rock	40.5	33.8	40.3	32.8
Coal Stockpile	7.68	7.68	7.68	7.68
Open Cut Pit	6.38	6.38	6.38	6.38
Tailings	14.5	0	14.5	0

Note: ha = hectare

3.2.3 Evaporation From Storage Surfaces

Storage volumes calculated by the model are related to storage surface area (i.e. water area) based on storage level-volume-area relationships for each water storage either provided by ACOL or estimated from supplied plans. For the Ravensworth Void 4 tailings storage, level-volume-area relationships were developed using a combination of contour plans and projected future tailings volumes.

Pan evaporation was multiplied by a pan factor to calculate storage evaporation losses for water storages. Monthly pan factors were taken from McMahon et al. (2013) data for Scone (located 50 km north-west of the Ashton Coal Project) and are listed in Table 2.

Table 2 Adopted Monthly Pan Evaporation Factors

Month:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pan Factor:	0.86	0.85	0.84	0.87	0.88	0.89	0.91	0.93	0.95	0.94	0.89	0.85

A pan factor of 1.1 was used in the estimation of evaporation from wet tailings surfaces (due to the darker tailings surface) and for estimation of internal road and CHPP area watering demand.

3.2.4 Tailings Disposal

As outlined in Section 2.0, tailings discharge to the Ravensworth Void 4 tailings storage was simulated as continuing until the start of December 2022, with tailings discharge then directed to the NEOC. Water pumped out with the conventionally thickened tailings was calculated based on an on-going thickener underflow solids concentration of 25% as advised by ACOL. Reclaim of supernatant tailings water (bleed) and rainfall runoff from the Ravensworth Void 4 tailings storage was included in the water balance model, with an assumed 50% of water discharged with the tailings reporting to the surface of the settled tailings. The same rate of bleed was assumed applicable to thickened tailings discharged to the NEOC between December 2022 and December 2024 (i.e. prior to the tailings dewatering system being commissioned). For the Ravensworth Void 4 tailings storage, it was also assumed that the rate of reclaim from the tailings storage would not exceed 1.8% of the volume of water pumped out with the tailings (this was based on recorded reclaim rates). Once the ponded water volume in the Ravensworth Void 4 tailings storage exceeded 10 megalitres (ML), it was assumed that any accumulated water was lost to the spoils surrounding the tailings storage void, based on the observation that ponded water volumes are typically low (as advised by ACOL personnel).

A small volume of water is supplied from the Tank Farm supply to secondary flocculant dosing at the Ravensworth Void 4 tailings storage. This rate has been set at 0.035 ML/d based on monitoring records and has been assumed to continue for flocculant dosing of conventionally thickened tailings discharged to the NEOC.

Also as outlined in Section 2.0, from the start of 2025 a tailings dewatering system, conceptually involving a belt filter press is to be implemented in order to substantially reduce tailings moisture prior to disposal to the NEOC. A dewatered tailings solids content of 64% has been adopted for modelling as advised by ACOL. No bleed water was simulated returned to the NEOC for the dewatered tailings.

3.2.5 Coarse Rejects Disposal and NEOC Storage

The empty NEOC void level-volume relationship was calculated from empty void topographic contours supplied by ACOL. In addition, supplied pit shell contours (i.e. contours of the pit without the waste rock emplacement) were used to derive the level-volume relationship for the in-pit waste rock emplacement with an assumed waste rock porosity of 20%.

Since completion of open cut mining, coarse reject disposal has occurred by trucking to the NEOC and is on-going. The level-volume relationship of the NEOC was adjusted to allow for the pit filled with coarse reject (assuming it is filled to above the stored water level at all times) with a coarse reject porosity value of 28.2%[6].

Following commencement of tailings discharge to the NEOC, the porosity of the combined tailings and coarse rejects will reduce due to the inclusion of the fine tailings stream. A revised NEOC storage level-volume relationship was calculated based on a combined tailings and coarse rejects porosity of 12.5% above a level of 28 m AHD[7]. The derived NEOC level-water volume relationship is shown in Figure 5. No change to the porosity has been assumed with the implementation of tailings dewatering (e.g. by belt filter press).

---

[6] Derived from calculation of difference between rejects surfaces in 12 months from January 2012, monitored rejects tonnages during this period and allowing for in-situ moisture of the rejects from measurements on samples of rejects – all data provided by ACOL.

[7] Data as advised by and level-volume relationship supplied by Engeny Water Management.

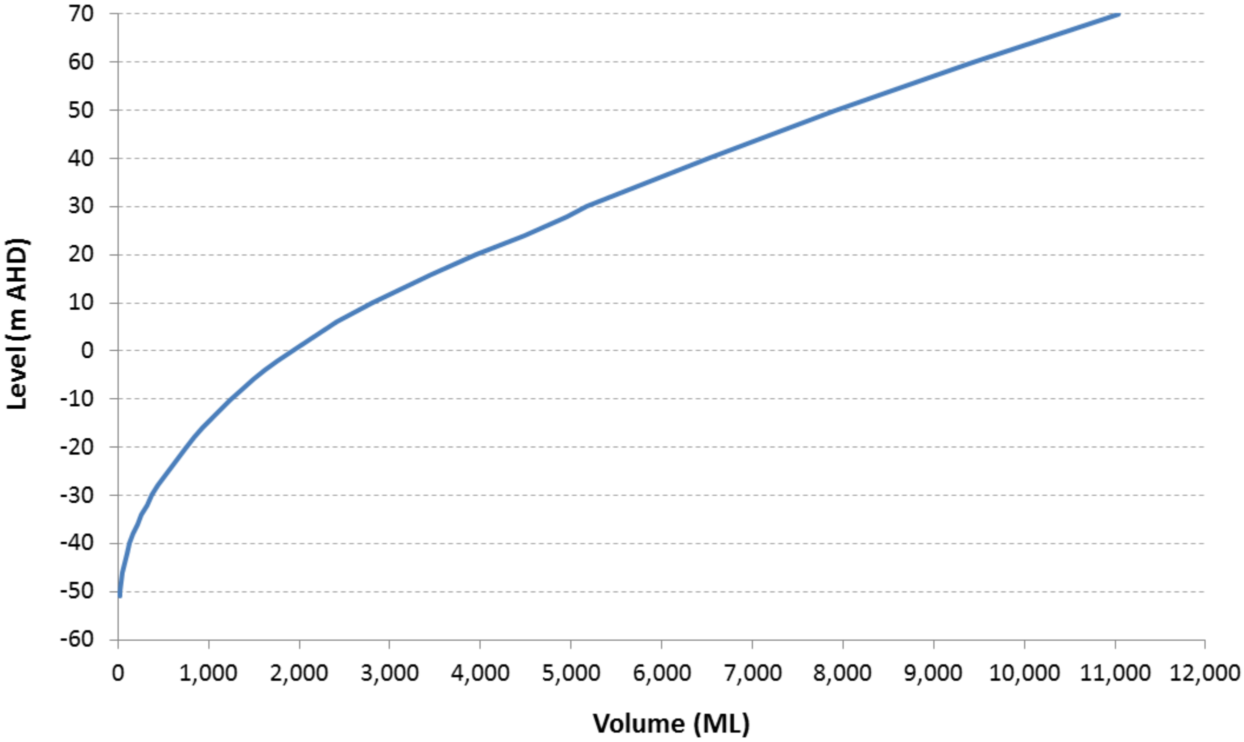

Figure 5 **NEOC Level-Volume Relationship**

ACOL provided a monthly forward production schedule for the Modification which includes CHPP (ROM) feed and product tonnes, as well as estimated total rejects tonnages (refer Figure 6). In the schedule, coarse rejects are calculated as 45% of the CHPP feed while tailings are calculated as 13% of the CHPP feed up until January 2030 (commencement of mining of LB seam) from when this increases to 20%. The balance of the CHPP feed is product coal. The forecast coarse rejects tonnages have been used, together with the above level-volume relationships, to calculate a forecast future NEOC rejects surface level (assumed uniform across the NEOC) versus time, based on an estimated average NEOC rejects level of approximately 23.5 m AHD as at August 2021 (from NEOC survey supplied by ACOL). These forecast levels were again adjusted on the basis of forecast future tailings disposal to the NEOC[8].

3.2.6 CHPP Feed Rate and CHPP Demand

Monthly planned ROM coal tonnages (CHPP feed) for the Ashton Coal Project with the Modification are summarised in Figure 6, as well as coarse rejects and tailings tonnes.

Relevant coal and rejects moisture contents which affect CHPP water demand are summarised below (supplied by ACOL personnel) – refer also Section 3.2.5.

- ROM coal moisture: 8.6%
- Product coal moisture: 9.0%
- Coarse reject moisture: 9.0%

The above moisture contents, planned ROM, coarse rejects and tailings tonnages shown in Figure 6, the rejects proportions given in Section 3.2.5 and tailings moistures given in Section 3.2.4 were used to calculate future CHPP water makeup demand in the model for the Ashton Coal Project as summarised in Figure 7. The calculated CHPP water demand drops at the start of 2025 in line with commissioning of a tailings dewatering system. Otherwise the CHPP water demand fluctuates mainly in response to tailings tonnages (refer Figure 6).

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[8] Adjusted levels provided by Engeny Water Management (spreadsheet entitled “Storage NEOC_Engeny Update 19.10.21.xlsx”).

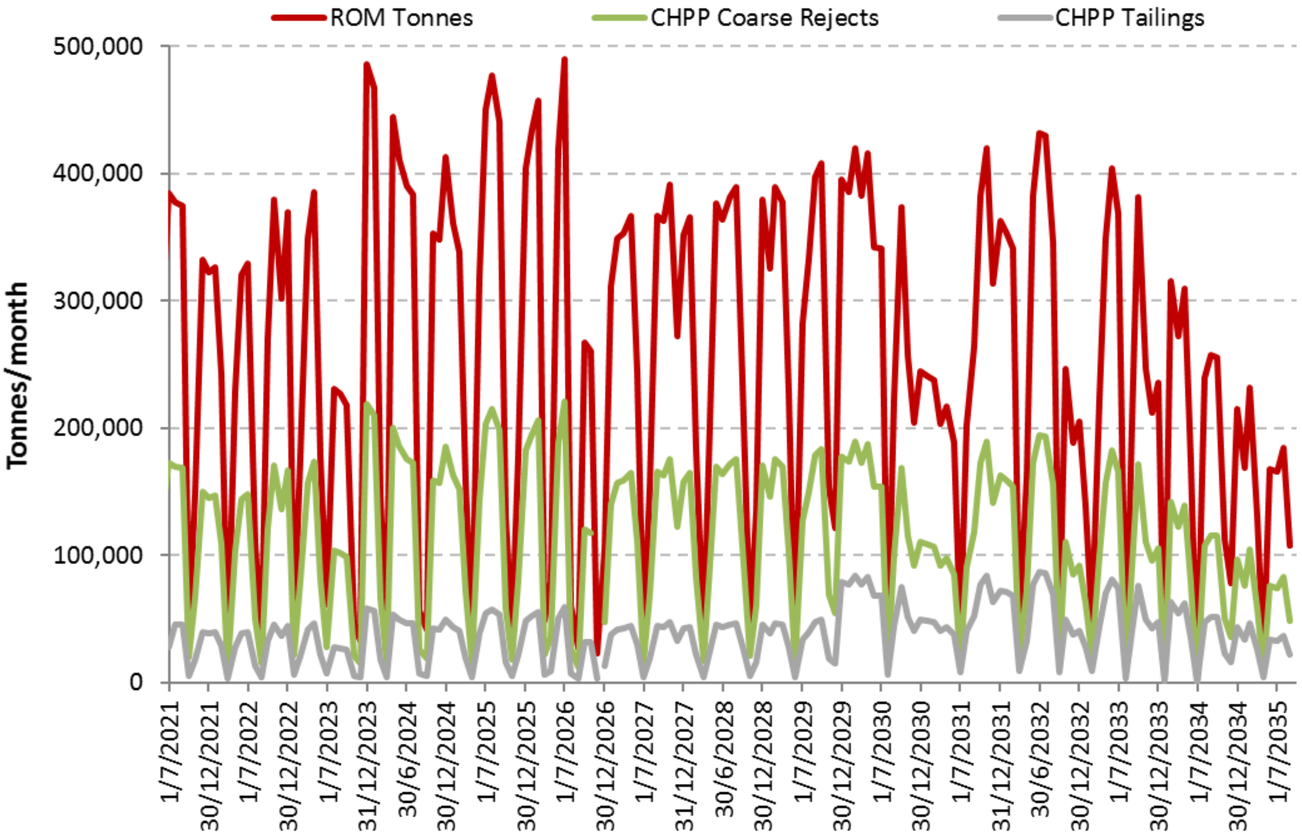

Figure 6 Planned ROM Coal and Rejects Rates

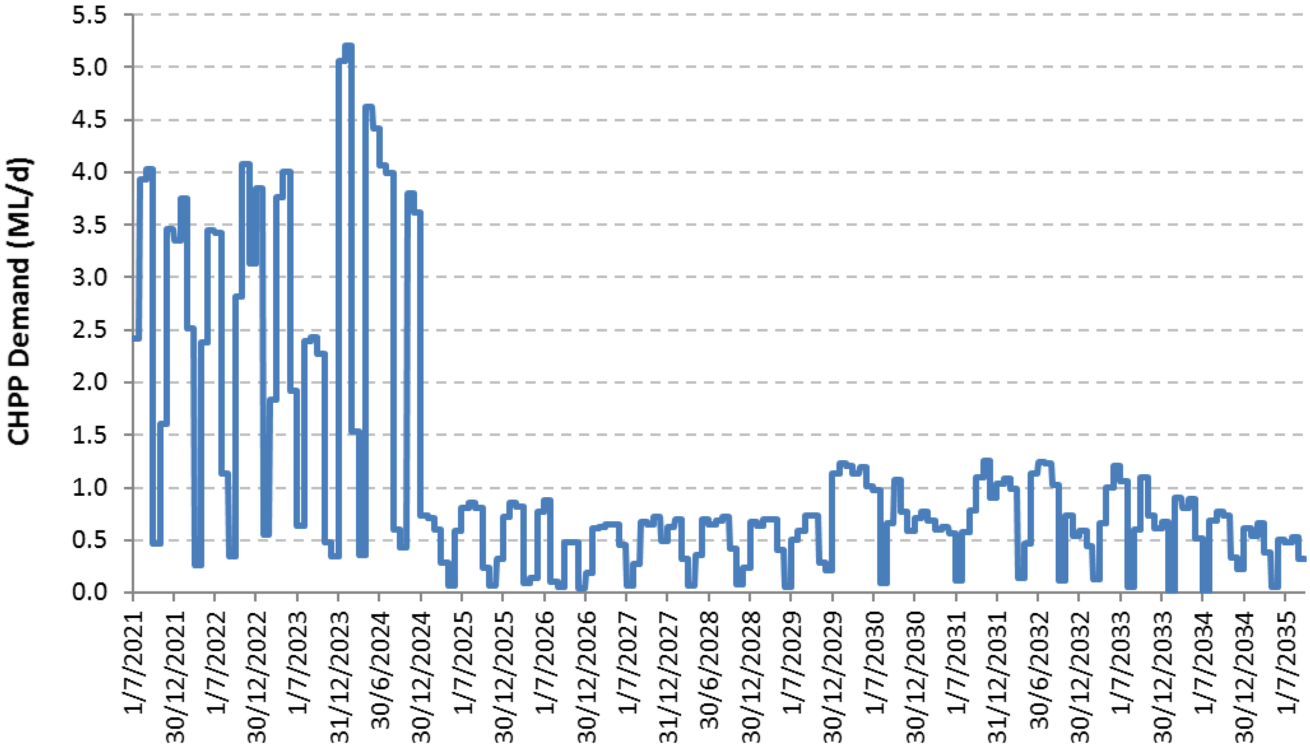

Figure 7 Calculated CHPP Water Demand

3.2.7 Groundwater Inflow

Forecast groundwater inflow rates to the underground operations (both Ashton Underground Mine and ACOL-operated portion of the RUM) were predicted by AGE (2021) based on the operation of the modification. Figure 8 shows a plot of predicted inflow rates for the period of water balance model simulation. Predicted inflow rates average 1.4 ML/d.

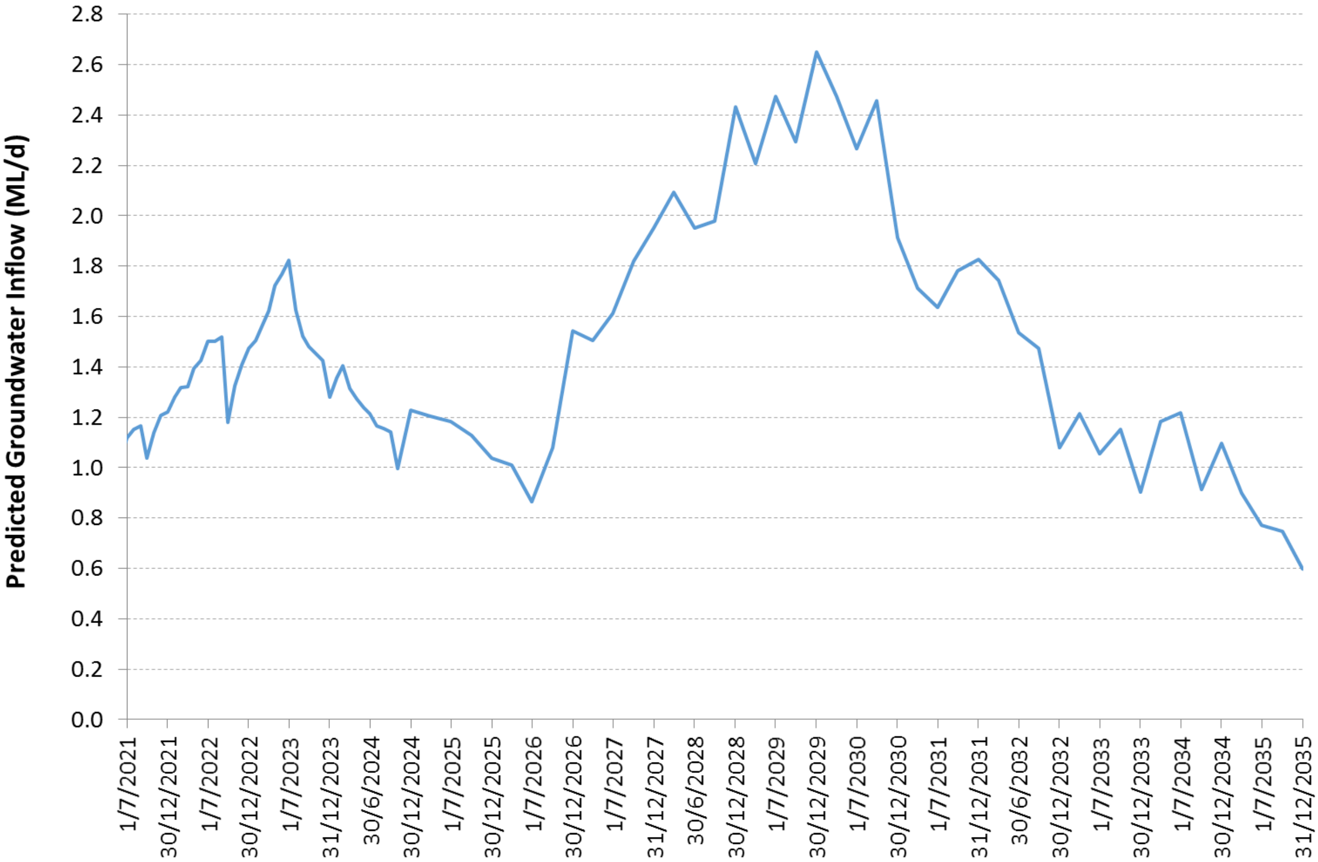

Figure 8 Predicted Underground Groundwater Inflow Rates

Future groundwater inflow rates to the NEOC were assumed negligible which was estimated from model calibration (refer Section 3.3).

3.2.8 Hunter River and Glennies Creek Supply

The water balance model simulates water sourced from the Hunter River and Glennies Creek WALs. DPIE-Water's Hunter River IQQM has been run[9] and the following key IQQM output was used as input to the Ashton Coal Project water balance model:

- Daily simulated AWDs for general security WALs.
- Daily river flows at Singleton, Greta and Glennies Creek gauging stations[10] - used to determine periods of uncontrolled flows, when extractions are not limited by AWD levels, in accordance with the Water Sharing Plan.
- Daily simulated volume stored in Glenbawn Dam and Glennies Creek Dam (the two Hunter River major regulating storages), used to estimate AWD for high security WALs as outlined below and for calculation of carry-over in accordance with the Water Sharing Plan.

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[9] Modelling undertaken by DPIE-Water.

[10] IQQM generated streamflows at these gauging stations were only used prior to the period of available (actual) recorded flows. Recorded flows were obtained from http://waterinfo.nsw.gov.au/water.shtml?ppbm=SURFACE_WATER&rs&3&rskm_url

The IQQM does not explicitly determine AWDs for high security WALs. According to the Water Sharing Plan, when general security AWD is determined as being greater than 50%, high security AWD is set to 100%. If general security AWD is less than 50%, high security AWD is varied linearly in proportion to general security AWD from 100% down to 75% (i.e. 75% high security AWD when general security AWD equals zero). These rules were incorporated into the water balance model.

There is no provision in the Water Sharing Plan for reductions of high security AWD below 75%. However, if regulating storage levels fall towards “dead” storage, the Minister could and would likely act to reduce high security AWD to preserve water for local water utilities licences (town water), major utilities licences (e.g. power stations), stock and domestic licences, basic landholder rights and Environmental Contingency Allowance (ECA). The Water Sharing Plan does not however detail how high security AWD could/would be reduced in such circumstances. Therefore the following algorithm was devised and used in the water balance model to simulate reductions in high security AWD below 75%:

- A “high level trigger” was set equal to 271,497 ML, which is the sum of the ECA (in the two major regulating storages), allowance for basic landholder rights, stock & domestic access licences, major utility access licences, local water utility licences and 75% of the total high security unit shares, all times 2 years, plus 15,780 ML total dead storage in the two regulating storages.
- A “low level trigger” was set equal to 238,848 ML, which is the above number subtracting 75% of the total high security unit shares.
- If the volume held in Glenbawn and Glennies Creek Dams falls below the high level trigger, the high security AWD is reduced from 75% linearly towards zero in proportion to the volume between the triggers.
- If the volume held in the two storages falls below the low level trigger, the high security AWD is set to zero until the dam volume rises above the low level trigger again.

Currently ACOL holds 133 ML/year of high security WAL entitlements and 335 ML/year of general security WAL entitlements on the Hunter River as well as 91 ML/year of high security WAL entitlements and 363 ML/year of general security WAL entitlements on Glennies Creek.

Water pumped from both Glennies Creek and the Hunter River pump stations can supply the Tank Farm, which in turn supplies water to the underground mine, for secondary tailings flocculant dosing and the site water treatment plant (potable supply) – refer Figure 4. Hunter River extraction can also be supplied direct to the PWD. In the model it is assumed that Glennies Creek water supplies the Tank Farm as a priority over Hunter River water.

3.2.9 Road Water Demand

Future internal road and CHPP area dust suppression water demand (truckfill) was calculated using a 2.3 ha area of watering surface (derived from model calibration), the daily pan evaporation rate (refer Section 3.1) less rainfall, multiplied by a factor of 1.1 (to allow for higher evaporation off the dark road surface). No haul road use was modelled on days in which rainfall exceeded evaporation. The simulated truckfill rate averages 31 ML/year for the predictive simulation.

3.2.10 Underground Demand and Recovery

Future underground demand was calculated based on historical pumping records for Meter 26 (refer Figure 4) since July 2007 with cognisance of active mining and longwall change-out periods. The average demand during mining was set as 0.59 ML/d while during longwall change-outs this was lowered to 0.23 ML/d. Note that underground supply can only be provided by WALs due to water quality requirements.

Water supplied to the underground plus groundwater inflow is modelled recovered (either by bores or pumping to Arties Pit Sump from the underground mine portal - refer Figure 4) less the water consumed in wetting up the coal from in-seam to on-conveyor less net water lost to ventilation from the mine. Historical records were used to set the in-seam moisture to 4.75%, while on-conveyor moisture was set to 8.63% based on CHPP feed records. Planned future underground mining rates (refer Figure 6) were used together with these moistures to calculate underground water loss. Ventilation losses were set to 32 ML/year in the model, based on recorded underground moisture data.

3.2.11 Evaporator Sprays

The Ashton Coal Project has previously experienced an increasing water inventory in the NEOC. Therefore, in order to increase system losses and mitigate the increase, a bank of evaporator sprays were commissioned in the NEOC in July 2014. The water balance model can simulate pumping from the PWD to these evaporators at a rate of 2.81 ML/d in summer and 1.87 ML/d in winter[11] (on days with less than 5 mm rain), with 30% of the water pumped modelled as lost and the balance reporting to the NEOC (loss rate based on model calibration, refer Section 3.3).

It is recognised that the use of the evaporators has been limited in recent times due to reducing site water inventory. The model simulates that evaporator use would remain suspended until the NEOC water volume increased to 1.3 times the estimated total 2019 CHPP demand (1,521 ML) (HEC, 2018) and would be suspended again if the volume fell below the estimated total 2019 CHPP demand (1,170 ML) (HEC, 2018).

3.2.12 Pumping Rates

Modelled pumped transfer rates from storages are shown in Table 3. These were based on values advised by ACOL or derived from monitoring data.

Table 3 Modelled Water Management System Pumping Rates

From	To	Rate (Litres/second)
Dam 56	PWD	56
NEOC	PWD	28
PWD	NEOC/Evaporators	81
Settling Dam	PWD	35
Ravensworth Void 4 tailings storage	Settling Dam	80
Underground Dewatering Bores	PWD	86
Glennies Creek Pump Station	Tank Farm & PWD	62
Hunter River Pump Station	Tank Farm & PWD	27.5
Underground Mine (Portal)	Arties Pit sump	0.74

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[11] Rates as advised by ACOL.

3.2.13 Miscellaneous CHPP Use and Return

As indicated in Figure 4, water is pumped from the PWD to the CHPP via multiple pumps. Two of these pumps (monitored via Meters 15 and 16) supply the CHPP directly. A third pump (monitored via Meter 21) supplies a number of miscellaneous uses in the CHPP including the rotary breaker, conveyor sprays and washdown. The volume supplied via this pump (based on flow meter readings[12]) has averaged 1.4 ML/d. Based on monitoring of instantaneous flow rates undertaken by ACOL, it has been calculated that approximately half this water ultimately contributes to tailings, rejects or product moisture (i.e. CHPP outflow). Of the remaining half, based on model calibration, it has been estimated that approximately 37% is returned to the Settling Dam, with the remaining 63% lost.

Initial Modelled Storage Volumes

Initial storage levels and corresponding stored water volumes in the NEOC, PWD, Arties, Dam 56 and the Settling Dam as at July 2021 are provided in Table 4. A nominal volume was assumed initially stored in the Ravensworth Void 4 tailings storage.

Table 4 Modelled Initial Storage Levels and Volumes (July 2021)

Storage	Water Level (m)	Water Volume (ML)
NEOC	-8.97	1,309
PWD	68.22	34.5
Settling Dam	67.78	18.0
Arties Pit Sump	60.29	22.8
Dam 56	75.6	3.1

3.2.14 Storage Operating Volumes

A number of operating levels/volumes were adopted in the model which affect when pumping to and from certain storages is triggered. Table 5 provides a summary of the adopted operating levels for the Ashton Coal Project water balance model. Advised or estimated storage capacities are also given for reference.

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[12] August 2010 to May 2016

Table 5 Modelled Operating Volumes, Storage Capacities and Operating Conditions

Storage	Level or Volume	Operating Conditions
PWD	Low Operating Level = 66 m AHD (6.8 ML)	Below this level begin sourcing water from Hunter River and Glennies Creek WALs.
	Normal Operating Level = 66.5 m AHD (11.6 ML)	Source water from other dams and NEOC if below this volume until High Operating Level reached. Cease pumping from WALs above this level.
	Evaporator Stop Level = 67.2 m AHD (19.7 ML)	Stop evaporator use below this level (50% level).
	Evaporator Start Level = 67.68 m AHD (26.2 ML)	Commence evaporator use above this level (60% level).
	High Operating Level = 68.8 m AHD (44.7 ML)	Above this level cease pumping in from other dams and NEOC and pump back to NEOC.
	Very High Operating Level = 69.2 m AHD (52.3 ML)	Above this level cease pumping out of Underground until level drops to High Operating Volume.
	Capacity = 60.5 ML	
Dam 56	High Operating Level = 75.6 m AHD (3.1 ML)	Above this level commence pumping to NEOC.
	Capacity = 60.7 ML	
Settling Dam	Normal Operating Level = 68.8 m AHD (35.1 ML)	Above this level cease pumping from Ravensworth Void 4 tailings storage.
	Capacity = 48.9 ML	
NEOC	1,521 ML	Above this volume activate evaporator use.
	1,170 ML	Below this volume suspend evaporator use.
	Capacity = 11,040 ML (when filled with rejects and tailings to 70 m AHD)	

3.3 MODEL CALIBRATION

Calibration involved comparing model estimates of total water volume stored in all monitored water storages (NEOC, Arties Pit Sump, PWD, Settling Dam, Dam 56) against water volumes estimated from monthly monitoring records for the period December 2012 to December 2020 inclusive and adjusting model parameters (e.g. rainfall runoff model parameters) to obtain a close match between the two. This period includes frequent monitoring of water levels in the NEOC, which comprises the majority of stored water at the Ashton Coal Project and therefore a specific focus was to simulate the stored water volumes in the NEOC as closely as possible for this period. The following data was used in model calibration:

- Recorded Ashton Coal Project daily rainfall data.
- Daily pan evaporation data sourced from the SILO Point Data.
- Open cut pit and mine water storage catchment and sub-catchment areas estimated from contour plans and aerial photography.

- Recorded storage water levels provided by ACOL, which were used along with storage volume-area-level relationships for each water storage to estimate water storage volumes for the calibration period.
- Recorded monthly CHPP feed tonnes and product yields and underground mine ROM tonnes.
- Groundwater inflow estimates to the underground from modelling undertaken by various specialist groundwater consultants. Groundwater inflow estimates for the NEOC were assessed as part of the calibration process.
- Recorded pumped volumes from flow meters shown in Figure 4, including water pumped from Glennies Creek and Hunter River WALs.

Estimated actual total stored water volumes in the monitored water storages and those generated by the calibrated model are plotted in Figure 9. It should be noted that the 'recorded' volumes plotted continuously in Figure 9 are based on series of level records taken at discrete points in time (not daily) with intermediate levels interpolated between these points and volumes estimated from storage level-volume relationships.

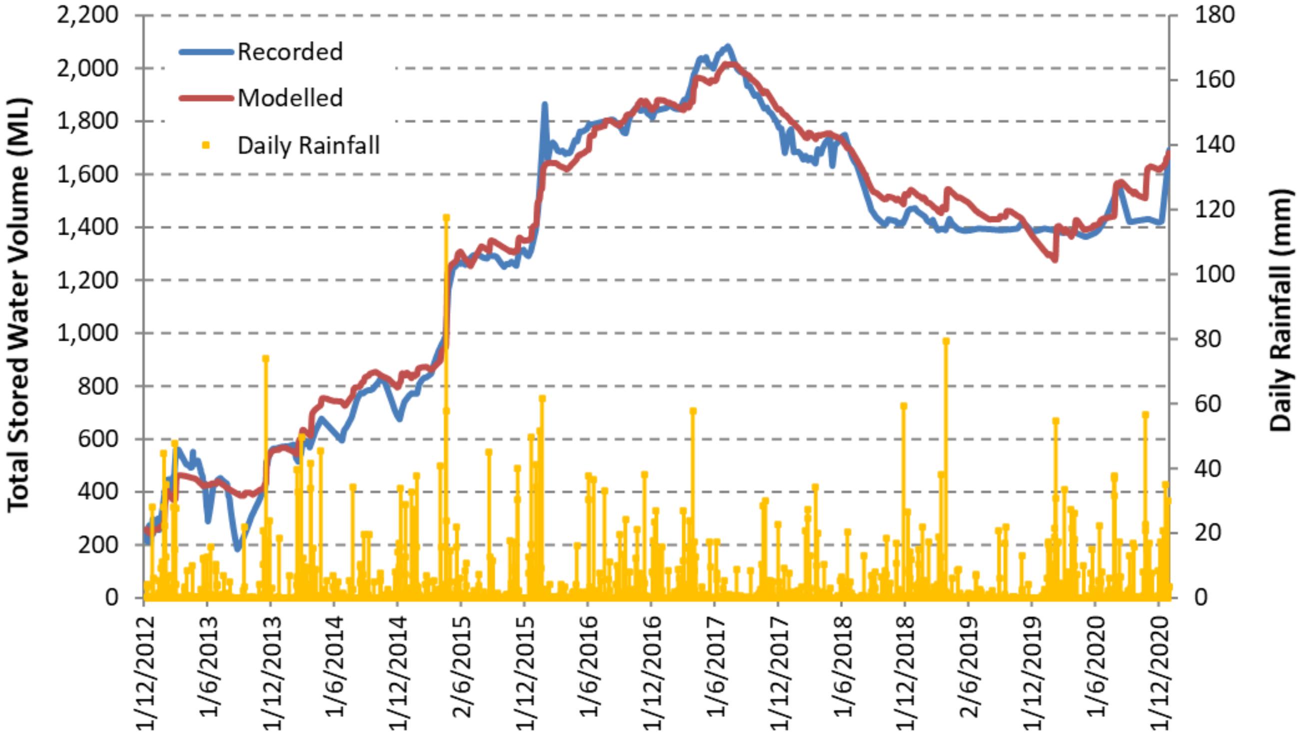

Figure 9 Calibrated Model and Estimated Actual Ashton Coal Project Total Stored Water Volume

A similar plot for the NEOC (which comprises the majority of the stored water volume) is given in Figure 10 and shows recorded discrete data points.

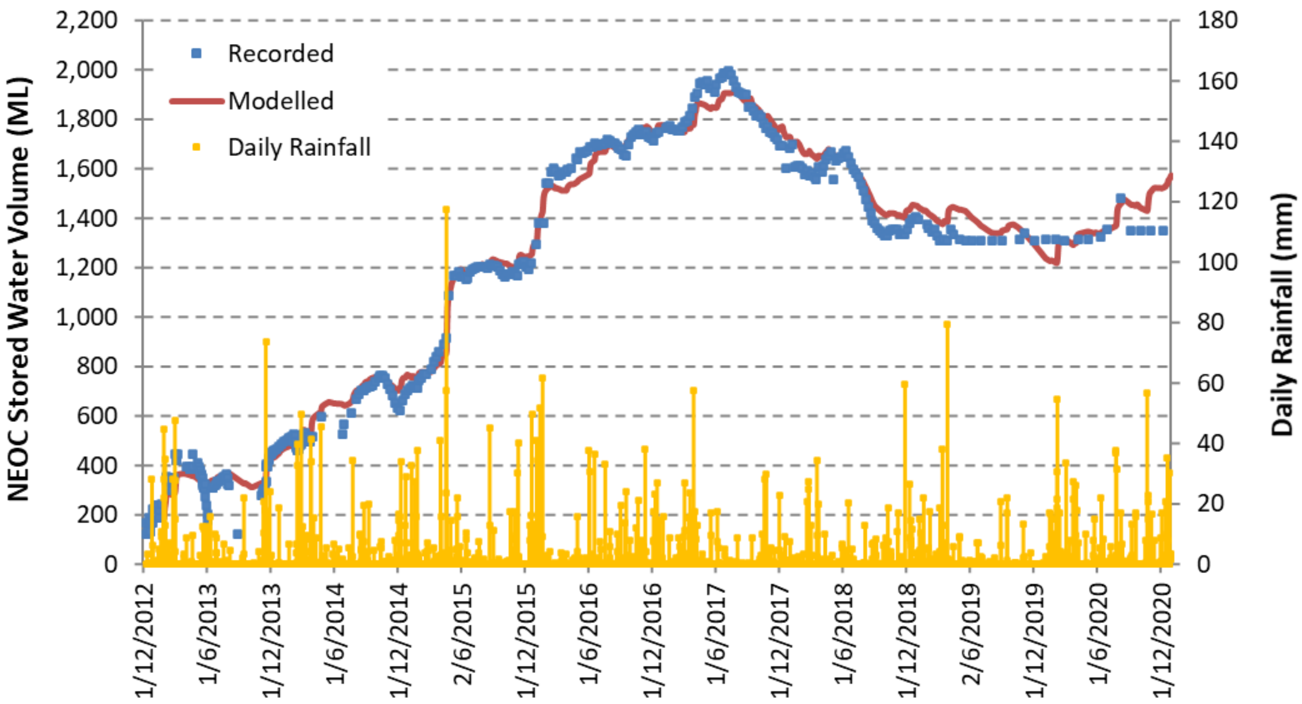

Figure 10 **Calibrated Model and Estimated Actual NEOC Stored Water Volume**

A good match between modelled and recorded water volumes is apparent in Figure 9 and Figure 10. The linear correlation coefficient for the modelled to recorded total stored water volumes (based on continuous data) is 0.985, while for the modelled to recorded NEOC volumes (based on discrete data) it is 0.993.

3.4 MODIFICATION MODEL FORECAST RESULTS

3.4.1 Overall Water Balance

Average forecast system inflows and outflows are shown in Figure 11 plotted as average rates (in ML/year) and as percentages over all 121 climatic realizations.

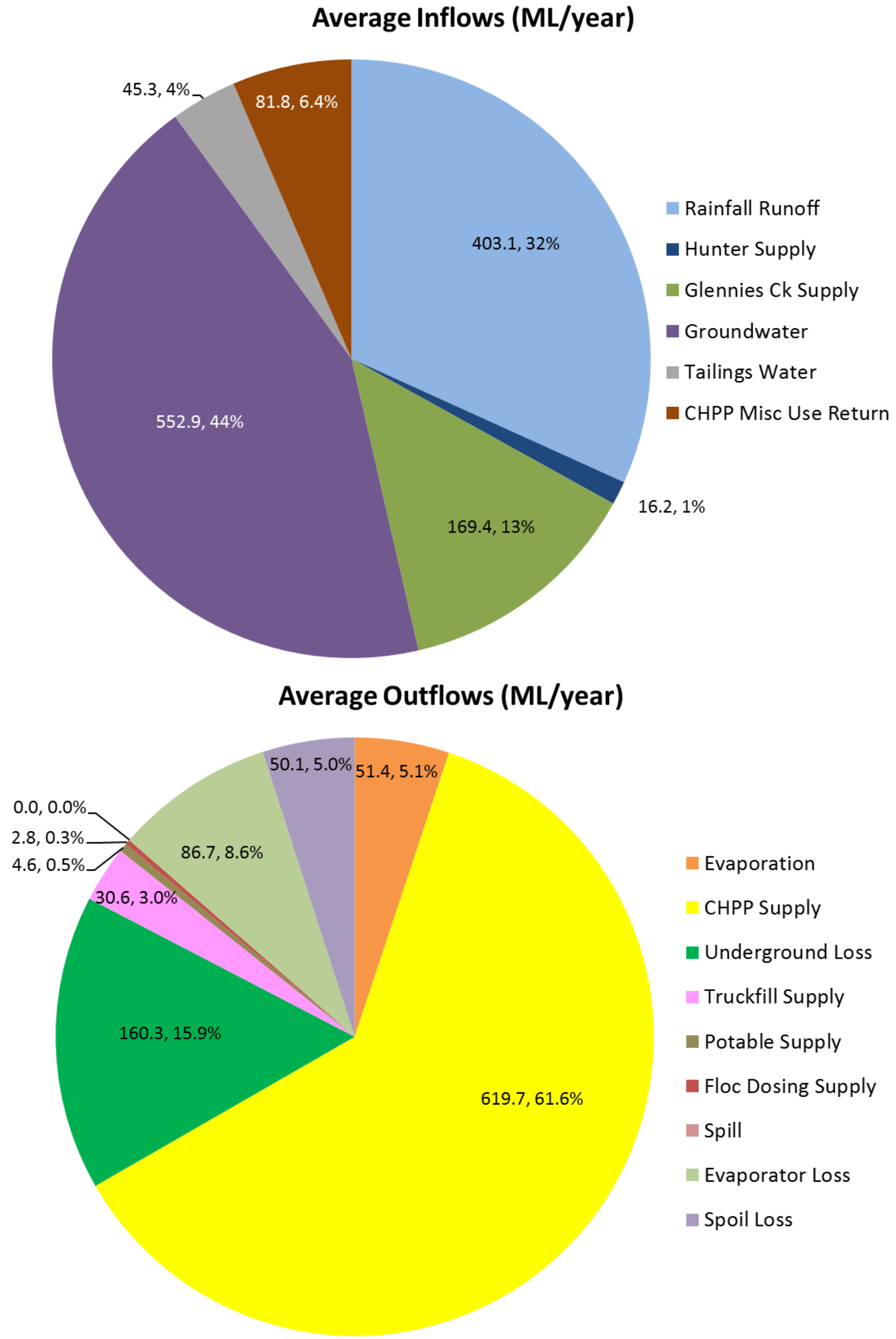

Figure 11 Modelled Average System Inflows and Outflows – Existing System

Figure 11 indicates that the majority of forecast system inflow is from groundwater, with rainfall runoff contributing approximately one third of average inflows. The tailings water inflow only applies up until the commencement of tailings dewatering from the start of 2025. The majority of system outflows are to CHPP supply.

3.4.2 Simulated Stored Water Volumes

The simulated total volume of water contained in all Ashton Coal Project storages versus time is shown in Figure 12 derived from all 121 climatic realizations, shown as probability plots. The 10th and 90th percentile plots in Figure 12 indicate predicted total water volume ranges within which the predicted total volume could vary, within these risk or confidence limits/levels (derived from an analysis of results from all realizations modelled). There is a predicted 80% probability that the total water volume will fall in between the 10th and 90th percentile plots. It is important to note that the plots do not represent a single climatic realization – the probability plots are compiled from all 121 realizations - e.g. the median volume plot does not represent model forecast volume for median climatic conditions.

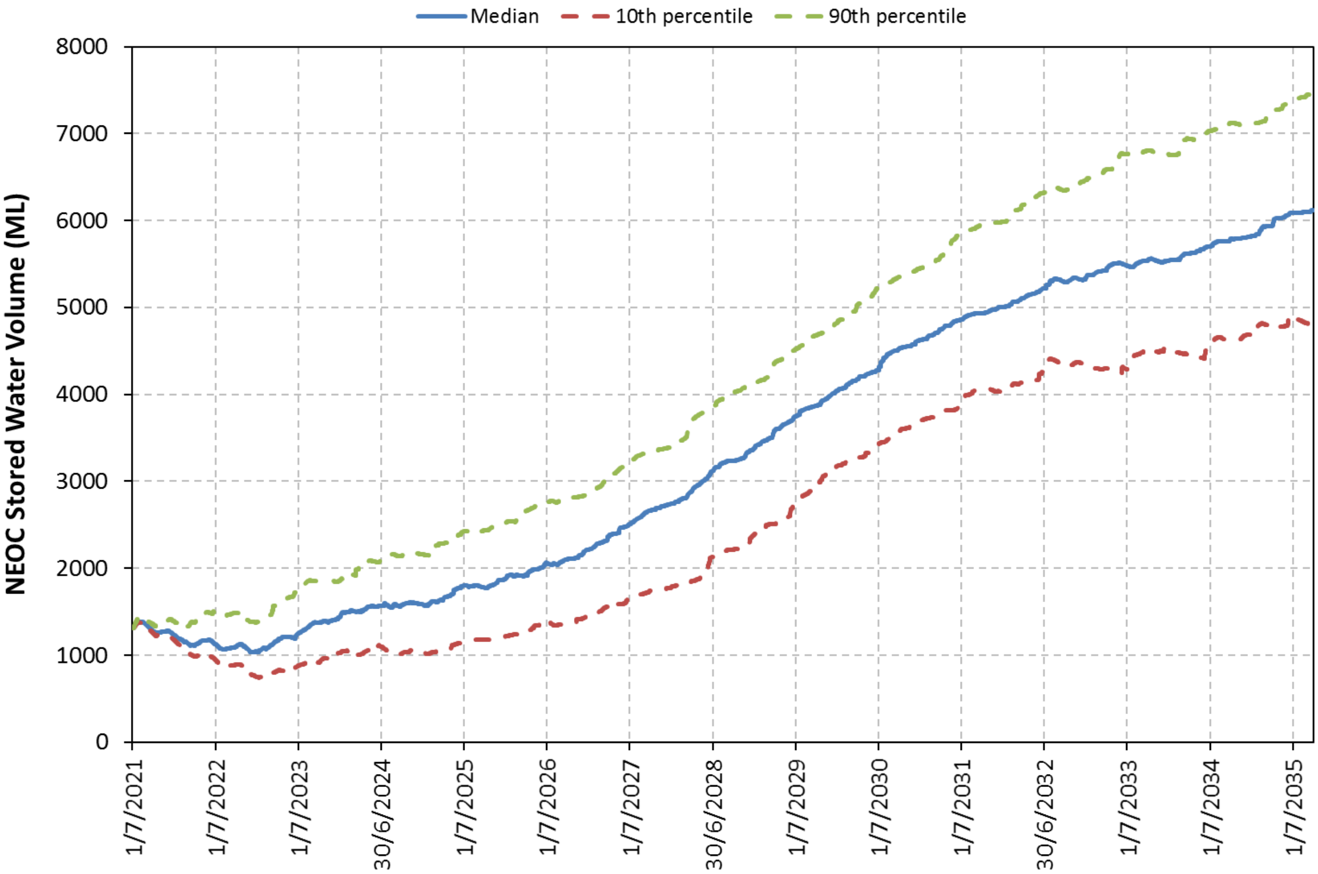

Figure 12 Simulated Total Stored Water Volume

The forecast result in Figure 12 indicates that the total stored water volume is predicted to remain fairly steady in the near term, with a slight increase from approximately late 2022, likely related to a forecast increase in groundwater inflows (refer Section 3.2.7). From 2025, the forecast total stored water volume is predicted to steadily rise which is likely related to the reduced CHPP demand (refer Section 3.2.6) associated with planned commissioning of tailings dewatering.

The forecast NEOC water level compared with calculated rejects level (and a level 3 m below the rejects surface) is shown in Figure 13. It is understood that, in order to meet geotechnical and stability requirements, the water level within the NEOC rejects emplacement must not rise to within 3 m of any coarse rejects surface. From Figure 13 it may be seen that the 90th percentile modelled water level remains approximately 23 m below the filled NEOC level. The NEOC does not completely fill with water in any of the 121 modelled realizations.

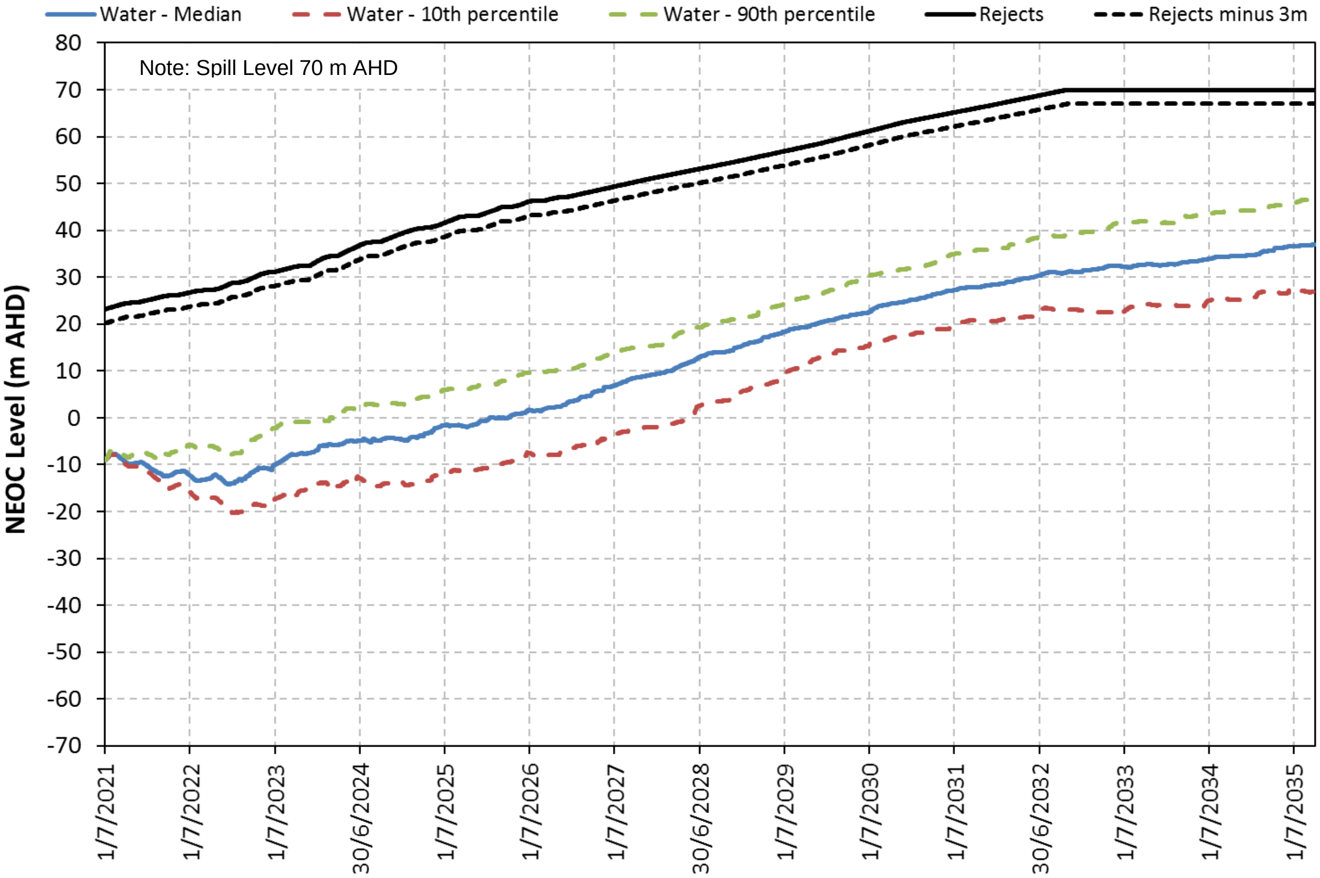

Figure 13 Simulated NEOC Water Level

3.4.3 Supply Reliability

Supply reliability is calculated as the volume supplied divided by the demand volume totalled over the simulation period. This is calculated as an average over all forecast years and 121 realizations as well as the lowest in any of the 121 realizations.

No CHPP shortfalls were forecast in any realization. This is related to the planned commissioning of tailings dewatering at the start of 2025 which significantly reduces CHPP makeup demand.

For supply to the underground (which is drawn only from WALs due to water quality constraints), the average reliability over all realizations was 83.7%, while the lowest in any one realization was 43.2%. This indicates that underground supply reliability can, in drought conditions, fall significantly. This is because underground supply is reliant upon WALs, which are affected by the available volume in the regional regulating storages. This result is similar to model forecasts undertaken for the existing approved operation (HEC, 2021). Options for improving the reliability of supply to the underground would include acquiring additional permanent WALs or temporary allocation assignment to improve reliability of supply from off site sources. ACOL could also investigate the use of treating stored water on site (i.e. in the NEOC) for underground supply.

3.4.4 Storage Discharge

No external discharges are forecast from the NEOC, Dam 56 or Ravensworth Void 4 tailings storage. However discharges (via spillway flow) are forecast from the PWD in 6 of 121 modelled realizations. Simulated discharges occur over 1 or 2 days over the 14½ year simulation period. This equates to a less than 1% annual risk of discharge.

Examination of model results shows that 5 of the 6 forecast PWD discharges, which ranged in volume from 0.2 ML to 11.5 ML, are associated with a single rainfall event which occurred in February 1955 where 272 mm rainfall occurred in a three day period. The February 1955 flood is known as being one of the largest and most deadly floods the region has ever experienced[13]. The high runoff and streamflow experienced were caused not only by the high rainfall at the time but also as a result of significant rainfall in the preceding weeks and months. The remaining forecast PWD discharge, with a predicted volume of 2.7 ML, resulted from a high rainfall event which occurred in March 1893 where 300 mm occurred in a three day period.

It is clear from the above that the risk of discharge from the PWD is very low and forecast discharge is associated with rare high rainfall events. Such high rainfall would cause high flows to occur in Bowmans Creek and the Hunter River. As such, water quality constituents in the PWD during the brief discharge periods would be highly diluted by flow in downstream waters and therefore the impact of discharge from the PWD on downstream water quality is expected to be negligible.

3.4.5 Summary Outcomes

The following summarises the results of forecast mine water balance modelling for the modification:

1. Underground groundwater inflow and site rainfall runoff provide the greatest average modelled system inflows, while the largest average system outflow comprises supply to the CHPP. Supply from WALs averages 186 ML/year.
2. Predicted median site water inventory is predicted to rise following planned commissioning of tailings dewatering. The calculated storage capacity of the NEOC should provide adequate storage for this increased inventory for the life of the Modification.
3. CHPP supply reliability is high, with no shortfalls forecast. The average supply reliability for the underground (calculated as the volume supplied divided by the demand volume) is 83.7%. Options for improving the reliability of supply to the underground would include acquiring additional permanent WALs or temporary allocation assignment. ACOL could also investigate the use of treating stored water on site (i.e. in the NEOC) for underground supply.
4. No external discharges are forecast from the NEOC, Dam 56 or Ravensworth Void 4 tailings storage. Small simulated discharges are predicted from the PWD, ranging in volume from 0.2 ML to 11.5 ML over 1 or 2 days in 14½ years, resulting from rare high rainfall events – mainly from the February 1955 flood event. Such high rainfall would cause high flows to occur in Bowmans Creek and the Hunter River. As such, water quality constituents in the PWD during the brief discharge periods would be highly diluted by flow in downstream waters and therefore the impact of discharge from the PWD on downstream water quality is expected to be negligible.

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[13] https://www.huntervalleynews.net.au/story/2902222/the-deluge-of-a-lifetime-1955-flood/
http://archive.lls.nsw.gov.au/__data/assets/pdf_file/0004/496570/archive_factsheet_2_1955-hunter-valley-flood.pdf

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