FINAL REPORT

ENSHAM LIFE OF MINE EXTENSION PROJECT

Water Balance Model Development

Prepared for: Ensham Resources Pty Ltd

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EXECUTIVE SUMMARY

A GoldSim water and salt balance model (WSBM) for the existing Ensham Mine and the proposed Ensham Life of Mine Extension Project (the Project) has been developed by Hydro Engineering & Consulting Pty Ltd (HEC) for Ensham Resources Pty Ltd (Ensham Resources).

The WSBM for the Ensham Mine simulates the site water management system for the existing operation and the Project and enables assessment of key changes associated with the Project relating to:

- Occurrence and volume of any uncontrolled discharge from mine affected water storages;
- Volumes and predicted salinity of controlled discharge from release points defined in the Environmental Authority (EA) EPML00732813; and
- Volumes of water required to be imported to support operations.

The WSBM simulates the volume of water and mass of salt stored in and pumped between all simulated water storages, sourced from and released to the Nogoa River. The model simulates 131 possible climate scenarios based on 131 years of regional daily rainfall and evaporation data.

Calibration of the WSBM has not been undertaken at this stage, however, given the key drivers are site runoff (predicted using model parameters from other similar operations which have been calibrated) and groundwater inflow (predicted by SLR [2020] using groundwater modelling), the model outputs are considered suitable for assessment of the potential water management related impacts of the Project. Model predictions of electrical conductivity (salinity) at RP1 (controlled release point to the Nogoa River) have been reviewed against recorded data at this point to ensure validity of the modelled release salinities. Predictions have been shown to be within the range of recorded data.

The key model results for the existing operations and the Project are as follows:

- the average annual groundwater inflow is predicted at 4,112 ML/yr for the existing operation and 3,762 ML/yr for the Project (from separate groundwater modelling by SLR [2020]);
- for both the Project and existing operations, the average supply reliability (volume supplied divided by demand volume) is expected to be greater than 97% which is partly due to the predicted additional groundwater inflows pumped from the underground mine;
- the large volumes and duration of groundwater inflow pumped to the main surface water system is predicted to result in large stored water volumes on site in both the existing operation and Project scenario;
- the Project is not predicted to result in an increase in the average annual release to the Nogoa River and, as groundwater inflows to the Ensham underground reduce, annual volumes released to the Nogoa River are also predicted to decrease;
- the average annual release to the Nogoa River for the life of the existing operation is estimated at 2,896 ML/yr in comparison with an average annual release rate of 2,766 ML/yr for the Project;
- the annual modelled external overflow, consisting of only that from Sailors Dam, is predicted to be approximately 265 ML based on the 95th percentile of all climate scenario realizations. All overflows modelled are from Sailors Dam to the Nogoa River are clean as the dam contains only raw water due to being fed by undisturbed catchment run off and river water supply;
- the model predictions for the existing operation and the Project indicate that, based on the 95th percentile of all realizations, an annual extraction volume of between 600 ML and 700 ML is required to be supplied from the Nogoa River which is less than the current annual extraction allocation from the Nogoa River of 1,500 ML/yr; and

- The WSBM has shown that the existing water management system is sufficient for the proposed Project.

1.0 INTRODUCTION

Hydro Engineering & Consulting Pty Ltd (HEC) were commissioned, on behalf of Ensham Resources Pty Ltd (Ensham Resources), to develop a GoldSim water and salt balance model for the existing Ensham Mine and the proposed Ensham Life of Mine Extension Project (the proposed project, hereafter referred to as 'the Project').

1.1 PROJECT CONTEXT

Ensham Mine is an existing open-cut and underground bord and pillar coal mine located approximately 35 kilometres (km) east of Emerald in Queensland. The Project proposes to increase the life of the existing operation by extending the underground bord and pillar mine into an area identified as the Project Site (zones 1, 2, and 3) commencing from within Mining Lease (ML) 7459, ML 70326, ML 70365, and ML 70366 to an area west of ML 70365 within part of Mineral Development Licence (MDL) 217 (Figure 1). The Project will produce up to approximately 4.5 million tonnes per annum and would extend the Ensham Life of Mine (LOM) by up to nine years to approximately 2037. The extension of the underground operation will utilise existing infrastructure.

For the proposed project:

- Zone 1 will not require any surface disturbance for infrastructure with minor temporary disturbance for exploration activities;
- Zone 2 may have a need for some minor infrastructure (not located on strategic cropping area) with minor temporary disturbance for exploration activities, and
- Zone 3 will not require any surface disturbance for infrastructure with minor temporary disturbance for exploration activities.

As such, there are no significant disturbances or infrastructure requirements for the proposed project.

1.2 PROJECT DESCRIPTION

The activities associated with the Project that are covered by the existing approved operation are:

- further infill drilling activities;
- transfer of coal from the Project via the existing underground to the existing run-of-mine (ROM) stockpile using existing overland conveyors and haul roads;
- reclaiming ROM coal by loaders and transporting by road trains, as per the current arrangements, to the existing crushing plant;
- wastewater and sewage treatment using existing infrastructure;
- ventilation supplied to the underground workings via the existing ventilation fans and associated infrastructure; and
- use of the existing rail loop and spur to transport product coal via the Blackwater rail corridor to the Port of Gladstone for export.

The Project will utilise the facilities and infrastructure of the existing operation as follows:

- the integrated water management system for the existing mine;
- the existing portals for mine access which will limit the environmental impacts, costs, time and risks involved with construction of new portals; and
- the existing Mine Infrastructure Area (MIA) including the Coal Handling Plant (CHP) and other associated infrastructure that is located within the existing MLs.

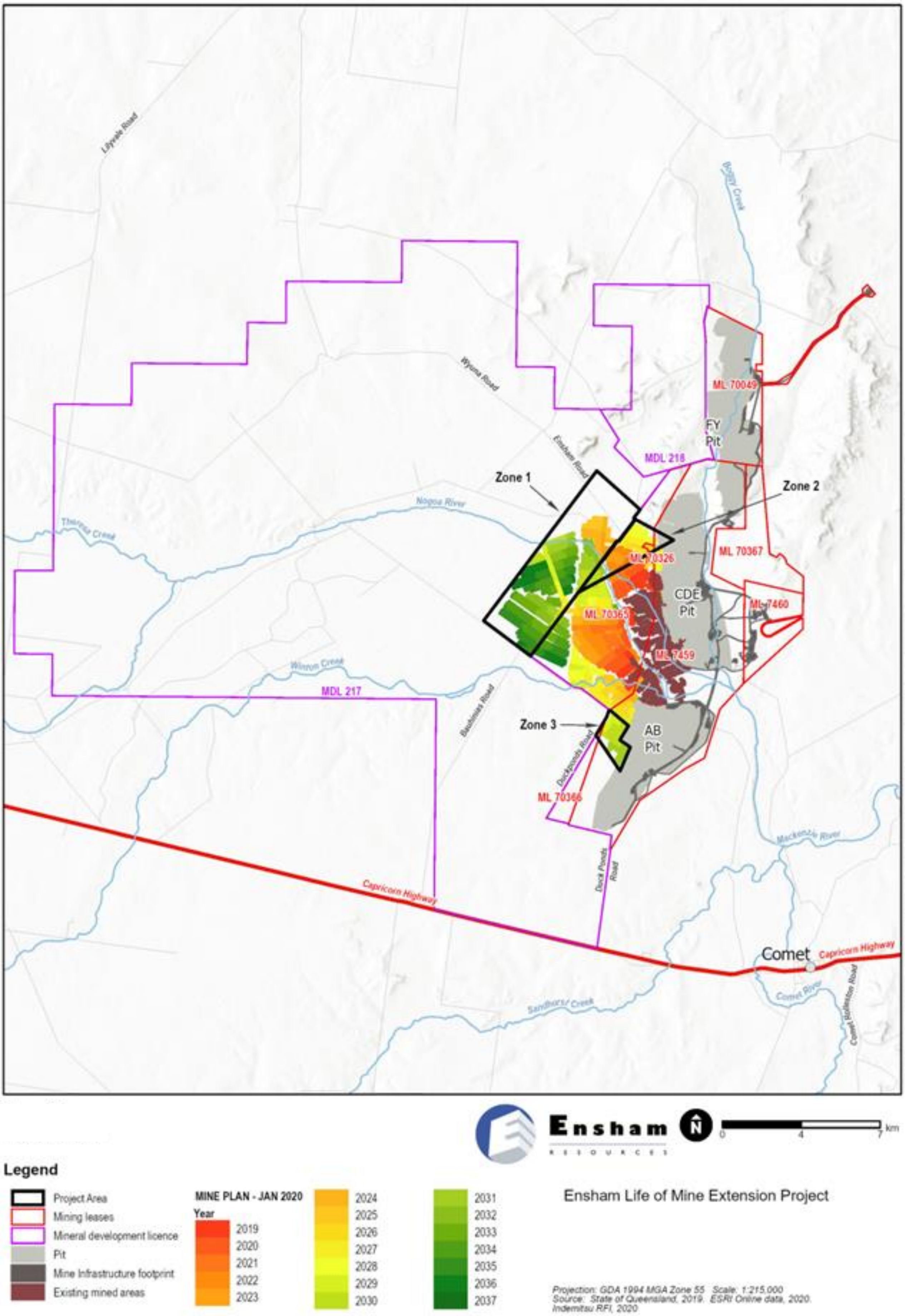


Figure 1 Existing Operation and Project Layout

The proposed mining sequence will comprise extension of the existing operation workings in both a northern and western direction. The proposed mining sequence will commence in approximately 2021 to access the northern part of the Project. The area south of the Nogoa River would be accessed in approximately 2024 with mining continuing in a western direction. The south western part of the Project will be accessed in 2026.

Underground mining for the Project will occur predominately at a depth of approximately 120 metres (m) to 210 m below the surface, however mining under the Nogoa River would occur at a depth of 120 m to 190 m below the surface.

1.3 PURPOSE OF WATER AND SALT BALANCE MODEL

A GoldSim® water balance model for the Ensham Mine was previously developed and reported on by Jacobs (Jacobs, 2018) and has been used as a basis for the development of a comprehensive water and salt balance model (WSBM). The updated WSBM for the Ensham Mine simulates the site water management system for the existing operation and the Project and enables assessment of key changes associated with the Project.

The objectives of the water and salt balance assessment were to:

- Build and document a WSBM and report on any assumptions adopted in this process;
- Forecast the site water and salt balance for the approved life of the existing operation;
- Forecast the site water and salt balance for the Project; and
- Compare key changes associated with the Project, relating to:
    - Occurrence and volume of any uncontrolled discharge from mine affected water storages;
    - Volumes and predicted salinity of controlled discharge from release points defined in the Environmental Authority (EA) EPML00732813; and
    - Volumes of water required to be imported to support operations.

Calibration of the WSBM has not been undertaken at this stage, however, given the key drivers are site runoff (predicted using the AWBM parameters from the Jacobs model and from other similar operation's assessments which have been calibrated by HEC) and groundwater inflow (predicted by SLR [2020]) the model outputs are deemed to be suitable for assessment of the potential water management related impacts of the Project. Recorded salinities within the ramps and dams were reviewed and discussed with Ensham Resources for suitability. Model predictions of EC at RP1 (controlled release point to the Nogoa River) have been reviewed against recorded data to ensure the validity of the model predictions.

2.0 SURFACE WATER MANAGEMENT SYSTEM

The existing water management system at the Ensham Mine comprises a number of interlinked components including open-cut (ramp) pit storages, water storage dams, the WTP and pumping systems; as shown in schematic form in Figure 2. As the Project will not involve material surface infrastructure or disturbance, the existing water management system conceptualised in Figure 2 is consistent for the Project.

The Ensham Mine water management system is comprised of three main sections: ramp pit storages to the north of the Nogoa River and west of Boggy Creek and ramp pit storages to the south of the Nogoa River (refer Figure 3 to Figure 5). These are connected by a pipeline (Northern Backbone) which allows water to be transferred between storages enabling efficient site water management. A system of water storage dams is located to the east of Boggy Creek and the Nogoa River, which store and transfer water to the Coal Handling Plant (CHP), the Water Treatment Plant (WTP) and the underground. All ramp pit storages and the underground are subject to groundwater inflows.

Ramp pit storages from the north of the Nogoa River pump to the connecting Northern Backbone and report to the Ramp 4 Fill Point Dam (R4 FPD) and Ramp 84 Sediment Dam (R84 SD) which are designated truckfill points. R4 FPD can also supply additional water to the CHP Dam to the east of Boggy Creek which, in turn, provides supply to the Lemon Tree Dam which serves the demands of the CHP. Any overflow from Lemon Tree Dam is returned to the CHP Dam under gravity flow allowing water to be retained in the site water management system.

A pumping operation from the CHP dam to Ramp 4 FPD also currently exists whereby water is transferred to Ramp 4 FPD to lower the level of the CHP Dam in advance of any potential overflow from the CHP Dam, via installed pipe infrastructure.

Water storage from the northern Ramps can also be pumped to Drain 3/4, via Drain 4/6, which can subsequently pump to Ramp 24 Fill Point Dam (R24 FPD). Stored water in Drain 3/4 can also be pumped back to the southern ramp pit storages at Ramp 24, Ramp 22 and Ramp 21, if sufficient capacity allows, or supplied to R4 FPD. Drain 3/4 can also pump to the Southern Backbone pipeline from which controlled releases are made to the Nogoa River at RP1 (see Figure 2).

Although water can be pumped to the south from the northern ramp pit storages, this only occurs when the volumes within Drain 3/4 and Ramp 4 FPD are low and cannot be supplied from any other source, or the northern pits are required to be dewatered. In this way, water stored in the northern ramp pit storages is supplied to the R84 SD as priority (there is no pump back from the southern to northern ramp pit storages).

As the underground pumps to Drain 3/4, water can be supplied to, or discharged from, much of the southern portion of the site. Much of the groundwater received by the underground is however held back in underground storage panels to prevent methane build-up in the completed mine. Ensham Resources have indicated that, after 2022, forty percent of groundwater flows are planned to be pumped to Drain 3/4.

The four southern ramps (Ramp 24, Ramp 22, Ramp 21 and Ramp 20) are able to pump to and from each other ensuring that water is maintained within the site water management system. Overflow from Ramp 22 is directed to Ramp 24 and overflow from Ramp 21 is directed to Ramp 20 (see Figure 2). Ramp 24 and Ramp 22 supply R24 FPD (which supplies truckfill demand for dust suppression) which, if required, can pump back to Ramp 24, Ramp 22 and Ramp 21. R24 FPD, Ramp 24 and Ramp 22 can also pump to the Southern Backbone pipeline with controlled releases made to the Nogoa River when EA release criteria are met. Ramp 24 is currently being dewatered, after which it will only serve as a contingency storage. Water will instead be stored preferentially in the other Southern Ramp storages.

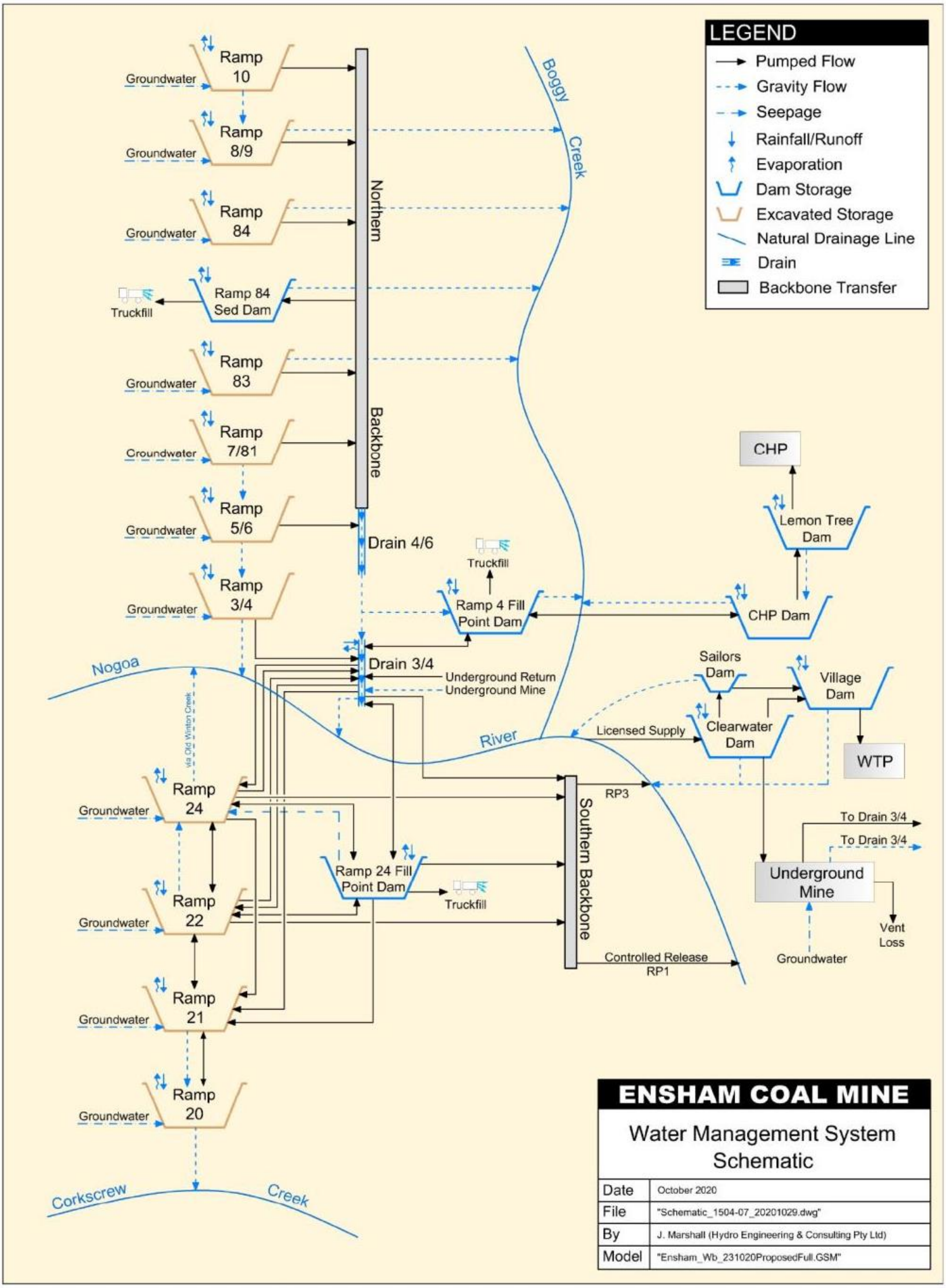


Figure 2 Water Management System Schematic

Table 10 summarises the operating and transfer rules between storages. These have been initially taken from the Jacobs model (Jacobs, 2018) but amended after discussion with Ensham Resources in order to represent the current water management system.

The water storage dams to the east of the underground and south of the CHP supply the underground and the WTP. The Village Dam can be topped up by transfer from the Sailors Dam or Clearwater Dam, the latter of which can be supplemented by raw water from the Nogoa River, subject to an annual allocation. There is also capability to pump from the Clearwater Dam to the R4 FPD so as to supplement any dust suppression requirements when the R4 FPD storage is low. However, Ensham Resources have advised that additional water from the Clearwater Dam has not been required since 2008 and as such this has not been simulated in the WSBM.

Water supply for the underground is comprised solely of groundwater inflow and transfer from the Clearwater Dam. Some water is removed through vent loss though the majority is stored or returned to Drain 3/4, with the return water able to be used or stored in all but the northern parts of the system.

The intricate system of ramp pit storages, water storage dams and transfer systems enable water to be transferred across much of the site as needed, reusing stored water efficiently and releasing externally in accordance with the EA conditions.

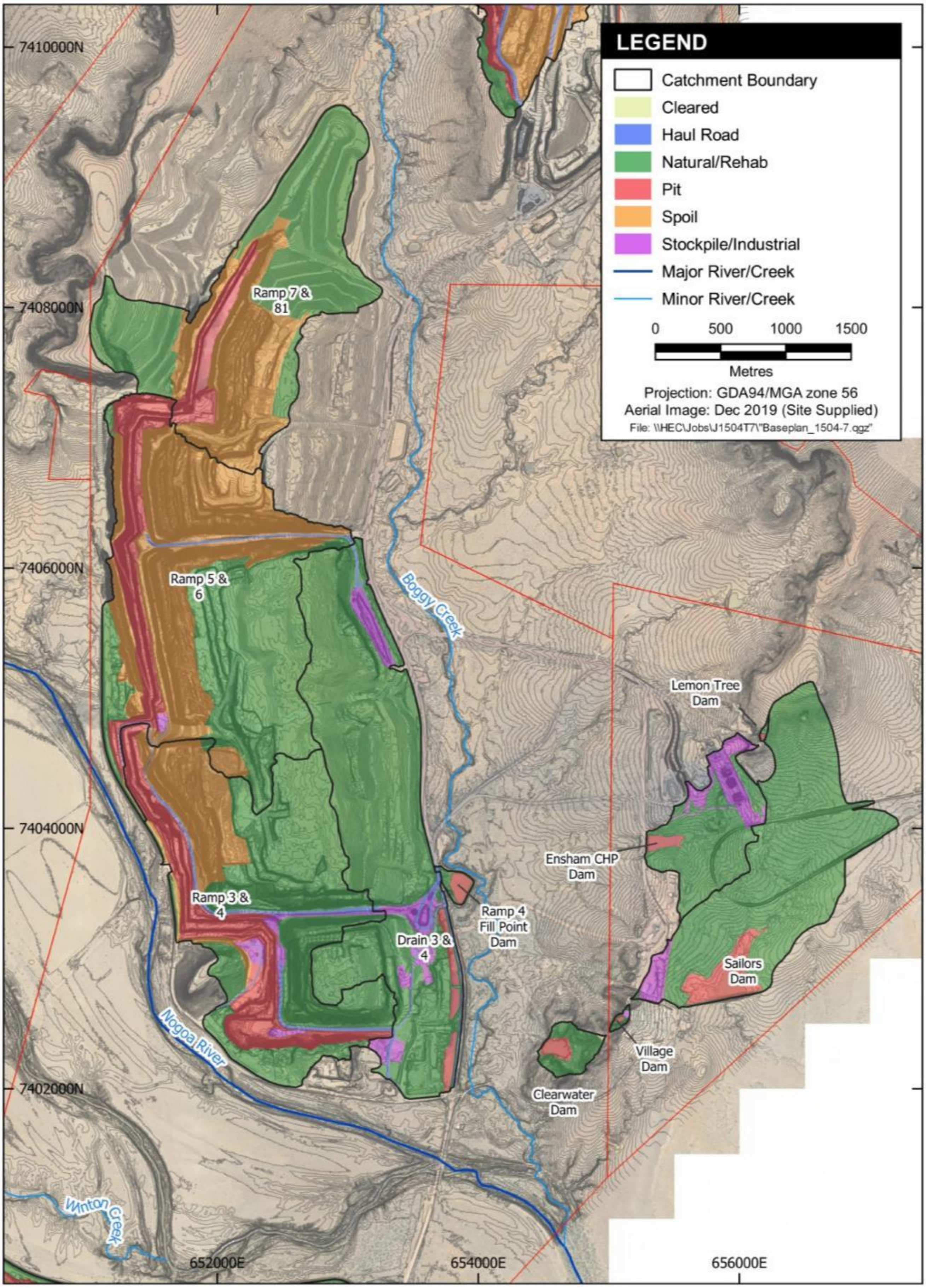


Figure 3 Central Storage Locations and Catchments

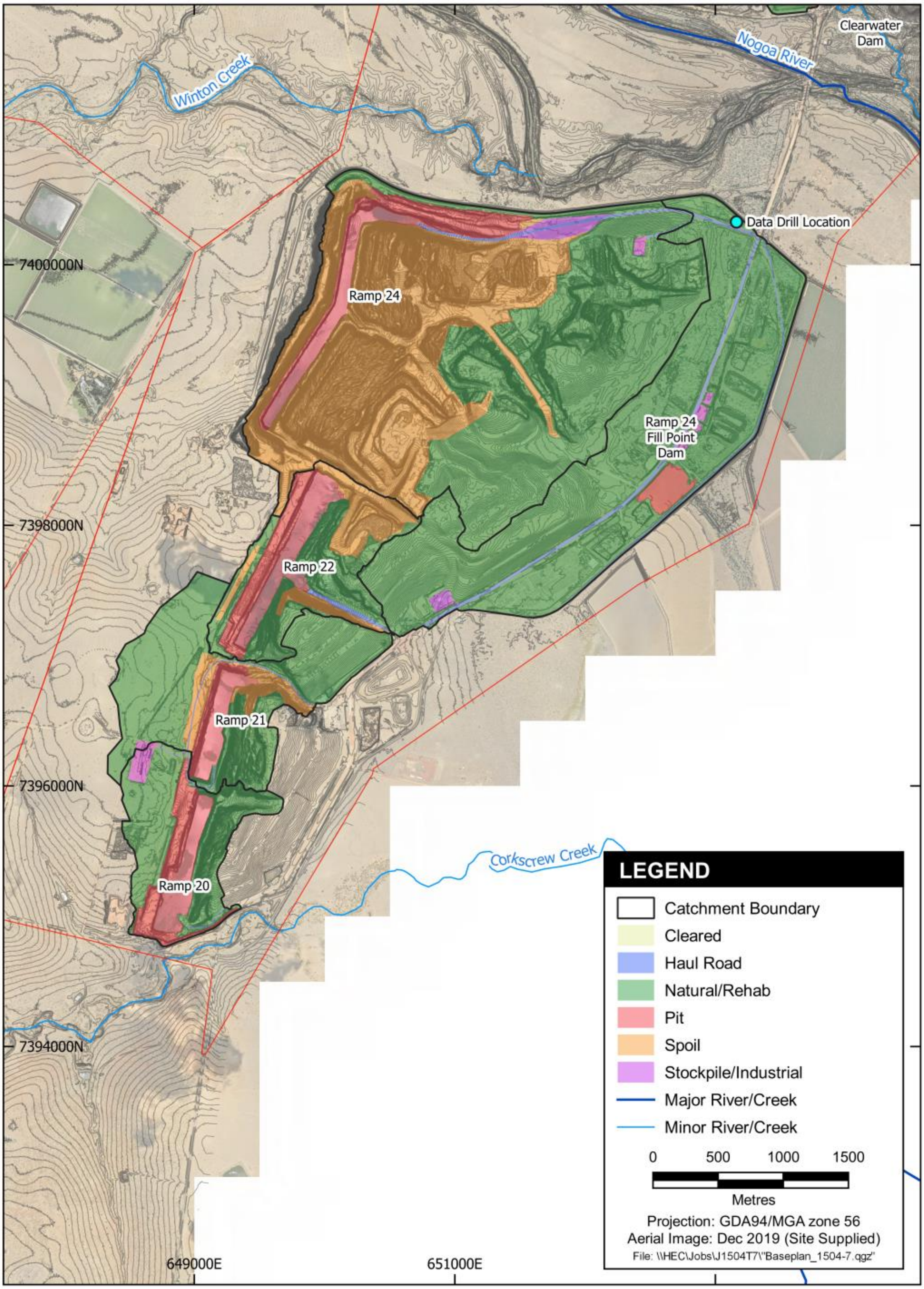


Figure 4 South Storage Locations and Catchments

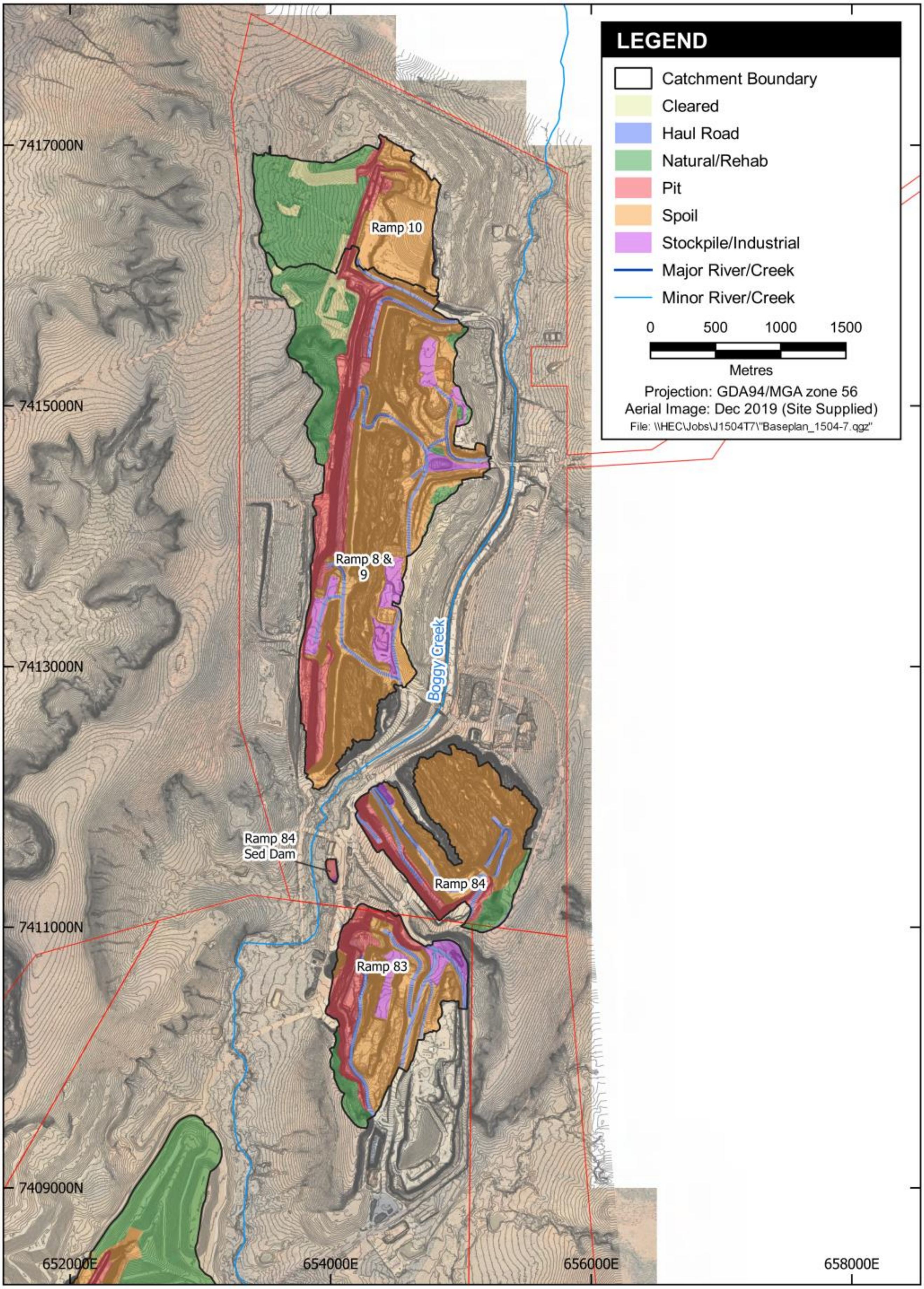


Figure 5 North Storage Locations and Catchments

3.0 WATER AND SALT BALANCE MODEL

3.1 MODEL DESCRIPTION

The WSBM has been based on the water management system schematic presented in the "Ensham Water Management Plan Update" (Jacobs, 2018) and subsequent discussion with Ensham Resources relating to the water management system for the existing operation (July 2020 to April 2028) and Project (July 2020 to April 2037).

The WBSM has been developed to simulate the majority of the storages and linkages shown in the Figure 2 schematic. The model has been developed to represent the existing operation and the Project, simulates the volume of water and mass of salt stored in and pumped between all simulated water storages, sourced from and released to the Nogoa River. For each storage, the model simulates:

Change in Storage = Inflow – Outflow

Where:

- *Inflow* includes rainfall runoff, groundwater inflow (for the ramp pits and dam), water sourced from Nogoa River and all pumped inflows from other storages.
- *Outflow* includes evaporation, spill, pumped outflows to other storages or to a demand sink (for example, the CHP) and controlled release to the Nogoa River.

The model operates on an eight hourly time step which allows for higher accuracy within the Goldsim model when modelling transfers from/to relatively small capacity storages (e.g. Ramp4 FPD). Model simulations commence in July 2020 and continue until April 2028, for the existing scenario, and April 2037 for the Extended Project (approximately 17 years). Simulations have commenced in July 2020, in line with the last storage water level readings (taken late June) provided by Ensham Resources, as well as the start of the water allocation year. The model simulates 131 "realizations" derived using historical daily climatic data from 1889 to 2020. The initial 17 years of data has been added to the end of this series so that 131 realizations of the 17 year assessment period can be simulated. The first realization uses climatic data from 1889 to 1906, the second uses data from 1890 to 1907 and the third from 1891 to 1908 and so on. The results from all realizations are used to generate water storage volume estimates, supply reliability and other relevant water balance statistics.

As no material infrastructure or surface disturbances are required for the Project, the changes to the WSBM are confined to the operation of Ensham underground, with these mainly involving the change in groundwater inflow rates and lifetime of the Project. Groundwater inflow rates to underground predicted for the currently approved operations and associated with the Project, as documented in SLR (2020), have been incorporated in the WSBM.

3.2 CLIMATE DATA

The Jacobs (2018) water balance model incorporated a stochastic rainfall dataset whereas the updated WSBM has been revised to incorporate long-term daily rainfall and evaporation data for the Ensham Mine obtained from the SILO Point Data[1]. The SILO Point Data provides 131 years of daily rainfall and evaporation data thereby enabling 131 model realizations to be simulated encompassing all historical climatic events including low, median and high rainfall periods.

[1] The SILO Point Data is a system that 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/

The SILO Point Data location is approximately midway between the southern and northern areas of the mine site (Figure 4). The average monthly rainfall and evaporation depths derived from the dataset are presented in Table 1. The data in Table 1 indicates a site annual average rainfall of 578 mm and an annual average evaporation rate of 2,108 mm.

Table 1 Average Monthly Rainfall and Evaporation

Month	Monthly Rainfall Average (mm)	Monthly Evaporation Average (mm)
January	99.7	237.9
February	87.9	192.6
March	59.8	193.1
April	32.0	154.0
May	29.3	120.3
June	31.3	93.8
July	24.8	103.7
August	17.6	136.1
September	21.9	172.4
October	38.0	218.4
November	52.1	233.0
December	83.3	252.2
Annual	577.7	2,107.5

3.3 AWBM PARAMETERS

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 six different sub-catchment types was undertaken, namely: rehabilitated and natural areas, haul road areas, pit floor areas, non-rehabilitated spoil areas, cleared areas and stockpile and industrial areas. The sub-catchment areas for each storage were estimated from aerial photography and recent mine contour plans (refer Section 2). The AWBM parameters for the sub-catchments, listed in Table 2, were initially adopted from Jacobs (2018) and adjusted based on experience with similar projects.

Table 2 Adopted AWBM Parameters

Parameter	Sub-catchment Type					
	Rehabilitated and Natural	Haul Road	Pit Floor	Non Rehabilitated Spoil	Cleared	Stockpile and Industrial
C_1 (mm)	7.5	5	5	10	7	10
C_2 (mm)	120	10	10	100	40	40
C_3 (mm)	150	10 (25)	25	160	100	40 (80)
A_1	0.134	0.5 (0.134)	0.134	0.134	0.134	0.134
A_2	0.433	0.5 (0.433)	0.433	0.433	0.433	0.433
A_3	0.433	0.0 (0.433)	0.433	0.433	0.433	0.433
K_s (d^{-1})	0.1	0.0 (0.1)	0.1	0.1	0.1	0.1
BFI	0.35	0 (0.1)	0.1	0.8	0.35	0.5 (0.1)
K_b (d^{-1})	0.8	0.8	0.8	0.98	0.8	0.9 (0.8)

*Jacobs (2018) model parameters altered, () =previous Jacobs (2018) value

3.4 CATCHMENT DATA

Catchment areas for each storage were estimated based on site plans provided by Ensham Resources, aerial imagery and 1 m contour interval LiDAR data for the site (recorded in December 2019). Additional information was provided by Ensham Resources on sub-surface drainage affecting some of the natural catchment areas. The derived sub-catchment areas are shown in Table 3. The total catchment area reporting to all modelled storages is 3,587 ha.

Table 3 Sub-Catchment Areas

Water Storage	Sub-catchment areas (ha)					
	Pit	Haul Road	Cleared	Stockpile/ Industrial	Natural/ Rehab	Spoil
Ramp 84 Sed Dam	0.95	0.00	0.00	0.32	0.00	0.00
Ensham CHP Dam	2.46	0.00	0.00	15.46	48.45	0.00
Clearwater Dam	3.00	0.00	0.19	0.00	11.06	0.00
Lemon Tree Dam	0.14	0.00	0.00	0.00	0.49	0.00
Village Dam	0.21	0.00	0.00	0.27	0.98	0.00
Sailors Dam	15.46	0.00	0.00	6.20	166.24	0.00
Ramp 4 FPD	2.53	0.16	0.00	0.00	2.03	0.00
Ramp 24 FPD	8.94	14.44	0.00	5.54	319.21	0.00
Ramp 20	36.07	0.90	0.00	3.76	67.83	0.00
Ramp 21	18.48	1.92	0.00	0.61	139.10	18.27
Ramp 22	41.67	2.22	0.00	0.00	53.54	32.66
Ramp 24	46.13	4.77	0.00	8.08	290.31	296.36
Ramp 3/4	67.58	9.84	0.00	7.94	171.43	55.15
Drain 3/4	7.03	7.85	0.00	20.32	258.05	0.00
Ramp 5/6	49.03	4.14	0.00	0.89	148.27	167.58
Ramp 7/81	22.95	0.00	0.00	0.00	143.68	89.40
Ramp 83	27.40	12.03	0.00	10.25	7.08	52.73
Ramp 84	16.64	7.94	0.00	0.98	8.52	48.41
Ramp 10	9.19	0.16	8.57	0.00	54.02	47.38
Ramp 8/9	66.14	18.22	10.07	24.05	44.08	194.53

3.5 PAN FACTORS

The WSBM contains two sets of pan factors which are used as a multiplier on the evaporation rates from the sub-catchment areas listed in Table 4 and the water surface area of the storages in Table 5.

Table 4 Sub-Catchment Pan Evaporation Factors

Sub-Catchment Type	Pan Factor
Pit floor	0.85
Haul road	1
Cleared	0.85
Stockpile and industrial	0.85
Rehab and natural	0.85
Non rehabilitated spoil	1

The monthly pan factor values applied to the evaporation rates to represent evaporation from the water surface area of the storages were adopted from McMahon et al. (2013) for a location closest to, and most representative of, the Ensham Mine.

Table 5 Water Storage Pan Evaporation Factors

Month	Pan Factor
January	0.77
February	0.79
March	0.79
April	0.77
May	0.75
June	0.74
July	0.76
August	0.79
September	0.81
October	0.81
November	0.81
December	0.77

3.6 STORAGE CHARACTERISTICS

Where available, storage characteristics, which show the increasing storage volume of a pit or dam, from the storage base to the storage crest, in relation to its increasing pond surface area, were adopted from the previous Jacob's model Jacobs (2018) or supplied by Ensham Resources. For Ramp 10, Ramp 8/9, Ramp 5/6 and Ramp 3/4, storage characteristics were derived from supplied LiDAR data by HEC.

The maximum capacity of each storage and the initial stored water volume adopted for the commencement of the model simulation (July 2020) are shown in Table 6. Several of the initial storage volumes were supplied by Ensham Resources based on records from 30 June 2020. Other initial volumes were assumed to be minimal at the commencement of the simulation, consistent with previous modelling (Jacobs, 2018).

It should be noted that the current estimated water storage capacity within the Ensham underground is approximately 6,000 ML.

As the underground is mined, completed areas will need to be filled with water for safety reasons (prevention of methane build-up), expanding the underground storage capacity. Although this additional capacity is presently unknown it has been assumed that this storage will be large enough to store the underground groundwater flows over the course of the both the existing operations and Project.

As such, a capacity of 50,000 ML has been assumed over the lifetimes of both the Project and the existing operations to ensure no overflow from the underground storage. Similarly it has been assumed that adequate pumping infrastructure will be in place to provide the necessary pumping to both the underground storage and to the surface at Drain 3/4 throughout the lifetime of both scenarios.

Table 6 Modelled Storage Capacities and Initial Volumes

Storage	Capacity (ML)	Initial Stored Water Volume (ML)	Dead Storage (ML)
CHP Dam	87	40	1.9
Lemon Tree Dam	2	0.2	0.04
Clearwater Dam	110	90	2.4
Village Dam	30	15	0.6
Sailors Dam	250	220	5
Ensham Underground	50,000*	4,246	500
Ramp 8/9	21,800	0	436
Ramp 10	482	0	9.6
Ramp 84	2,250	0	45
Ramp 84 Sed Dam	17	8.5	0.34
Ramp 83	7,866	50	157
Ramp 7/81	13,679	1,000	273
Ramp 5/6	9,923	0	198
Ramp 3/4	9,100	0	182
Ramp 4 FPD	68	38	1.36
Ramp 20	4,176	3,806	83.5
Ramp 21	2,984	2,501	59.7
Ramp 22	7,029	3,291	140
Ramp 24	48,088	1,070	500
Ramp 24 FPD	138	113	2.76
Drain 3/4	101	50	1.1

*Assumed capacity

3.7 SALINITY

Sub-catchment runoff and groundwater inflow salinity (electrical conductivity - EC) values were defined in the WSBM to enable simulation of salinity concentration in site storages and controlled release.

A groundwater inflow salinity of 2,000 µS/cm was initially adopted in accordance with Jacobs (2018). However recorded EC measurements provided by Ensham Resources show that groundwater inflow to the underground has EC of 10,200 µS/cm.

Ensham Resources has also estimated that water pumped to the surface from the underground has an EC of 8,750 µS/cm after mixing with the raw water supply to the active area of the Ensham underground. These EC values have been adopted in the WSBM.

Sub-catchment runoff salinity was also specified in accordance with Jacobs (2018) and adjusted based on experience with similar projects by HEC. The adopted salinity values for each sub-catchment type are listed in Table 7.

Initial EC values for each storage, as listed in Table 8, were specified based on field EC records and advice provided from Ensham Resources.

Table 7 Sub-Catchment Runoff EC Values

Sub-Catchment Type	EC (µS/cm)
Pit floor	1,500
Haul road	2,000
Cleared	250
Stockpile and industrial	500
Rehab and natural	250
Non rehabilitated spoil	500

Table 8 Storage Initial EC Values

Storage	Field EC (µS/cm)	Data Source
CHP Dam	8,750	ER* advised (based on Ramp 4 FPD)
Lemon Tree Dam	8,750	ER advised (based on Ramp 4 FPD)
Clearwater Dam	714	Recorded 13/12/2019
Village Dam	714	Assumed based on Clearwater Dam value
Sailors Dam	600	ER advised
Ensham Underground	8,000	ER advised
Ramp 8/9	2,080	Recorded 2/2/2020
Ramp 10	2,540	Recorded 10/4/2020
Ramp 84	5,000	ER advised
Ramp 84 Sed Dam	5,000	ER advised
Ramp 83	5,000	ER advised
Ramp 7/81	8,000	ER advised
Ramp 5/6	2,540	Assumed based on Ramp 10 value
Ramp 3/4	2,540	Assumed based on Ramp 10 value
Ramp 4 FPD	8,750	Recorded 14/7/2020
Ramp 20	10,100	Assumed based on Ramp 20 value
Ramp 21	10,100	Recorded 14/7/2020
Ramp 22	10,200	Recorded 14/7/2020
Ramp 24	10,400	Recorded 14/7/2020
Ramp 24 FPD	10,100	Recorded 14/7/2020
Drain 3/4	8,690	Recorded 14/7/2020

* Ensham Resources

As discussed in Section 3.9, an EC time series was generated for the simulation period based on a flow versus EC relationship generated from recorded data for the Nogoa River.

3.8 GROUNDWATER INFLOWS

Predicted groundwater inflow rates for the existing operation and the Project have been provided by SLR (2020) and agreed with Ensham Resources. These extend beyond the end of the LOM (refer Figure 6). The groundwater inflow predictions for the existing approved operation range between approximately 19.3 ML/d at the end of June 2020 to 0 ML/d at the start of 2030. The predicted groundwater inflow rates for the Project range from 19.3 ML/d at the end of June 2020, before falling to a low of approximately 5 ML/d and rising again to approximately 16 ML/d in late 2025. The predicted inflow rates then fluctuate for the remainder of the Project life, at an average rate of approximately 7 ML/d.

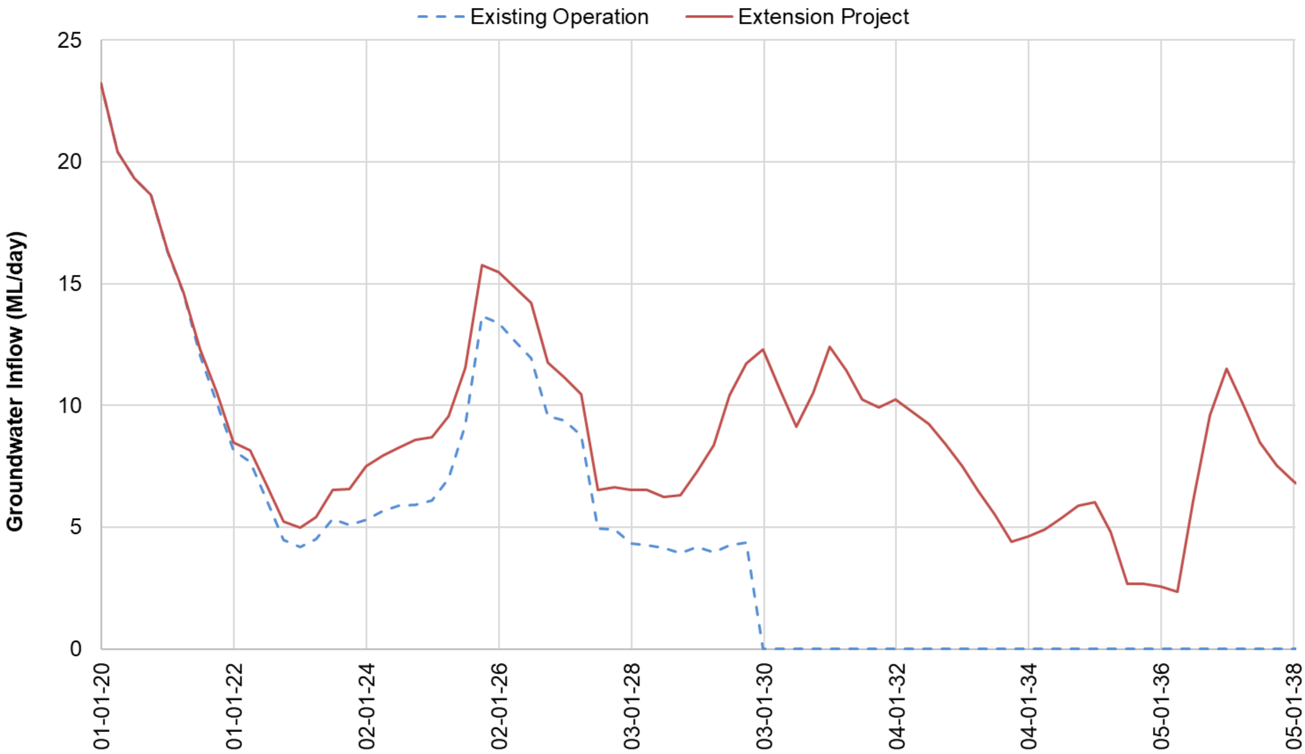


Figure 6 Predicted Underground Groundwater Inflow Rates

Ensham Resources have advised that the groundwater inflow to the underground will be preferentially used to fill underground storage capacity where possible.

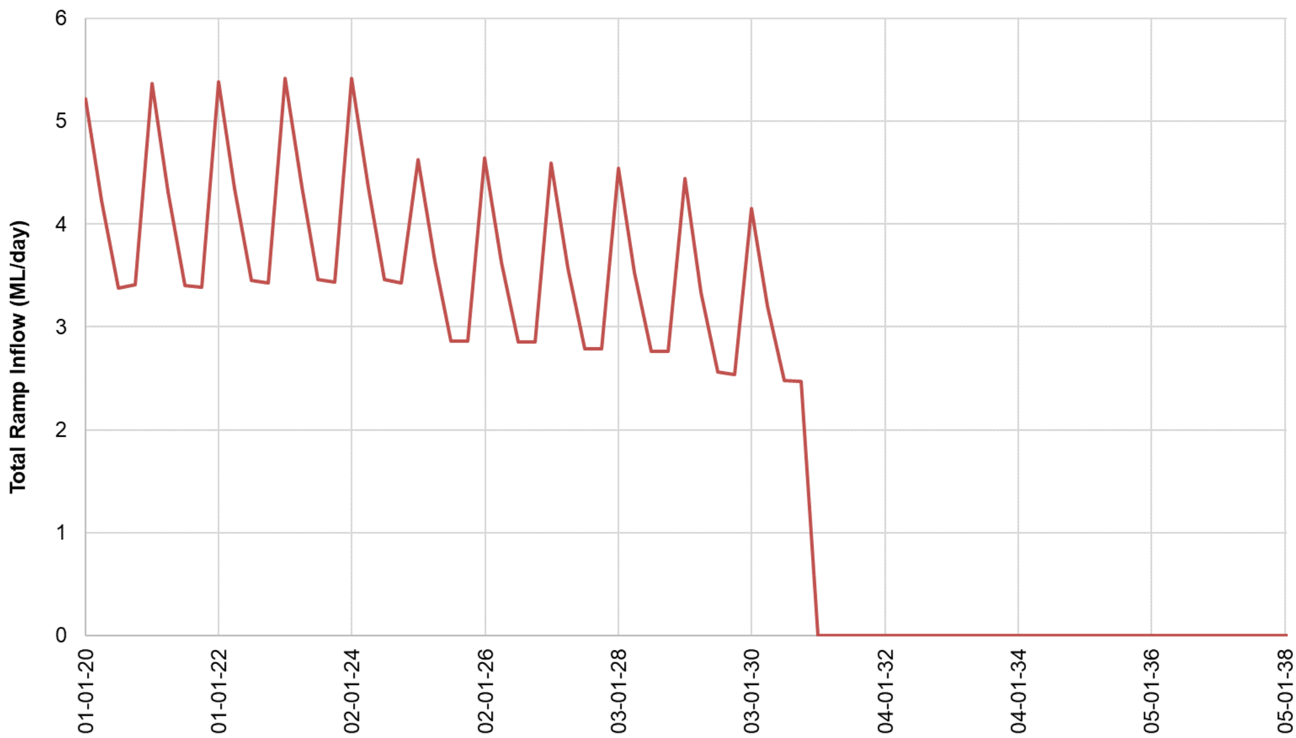


Figure 7 Predicted Total Ramp Groundwater Inflow Rates for the Proposed Project

Groundwater inflow predictions have also been provided for Ramp 3, Ramp 4, Ramp 5, Ramp 6, Ramp 7 and Ramp 84 (northern ramp pit storages). The groundwater inflow predictions extend to the end of the approved mine life in 2030 after which time the groundwater inflow to the ramp pits is predicted to cease. The total predicted groundwater inflow to these Ramps is shown in Figure 7.

According to SLR (2020), groundwater inflow will not report to the southern ramp pits, Ramp 20, Ramp 21, Ramp 22, Ramp 23 and Ramp 24 for either the existing operation or the Project.

3.9 NOGOA RIVER

The Nogoa River streamflow rates have been incorporated in the WSBM in order to simulate licenced discharge from RP1 which is dependent on the flow and salinity of the Nogoa River. Daily recorded and modelled (IQQM) streamflow data for the Nogoa River was supplied by Idemitsu Australia Resources Pty Ltd (IAR) for the period January 1891 to December 2007. Additional recorded data was obtained for the Department of Natural Resources, Mines and Energy gauging station at Duck Ponds (130219A) on the Nogoa River. This dataset spanned the time period from April 1993 to June 2020.

A streamflow time series was created whereby supplied modelled data was used to represent flows from 1891 until April 1993 and recorded data used from April 1993 to June 2020. Figure 8 shows the percentage of time in which streamflow is exceeded in the Nogoa River based on the time series for the period 1891 to 2020.

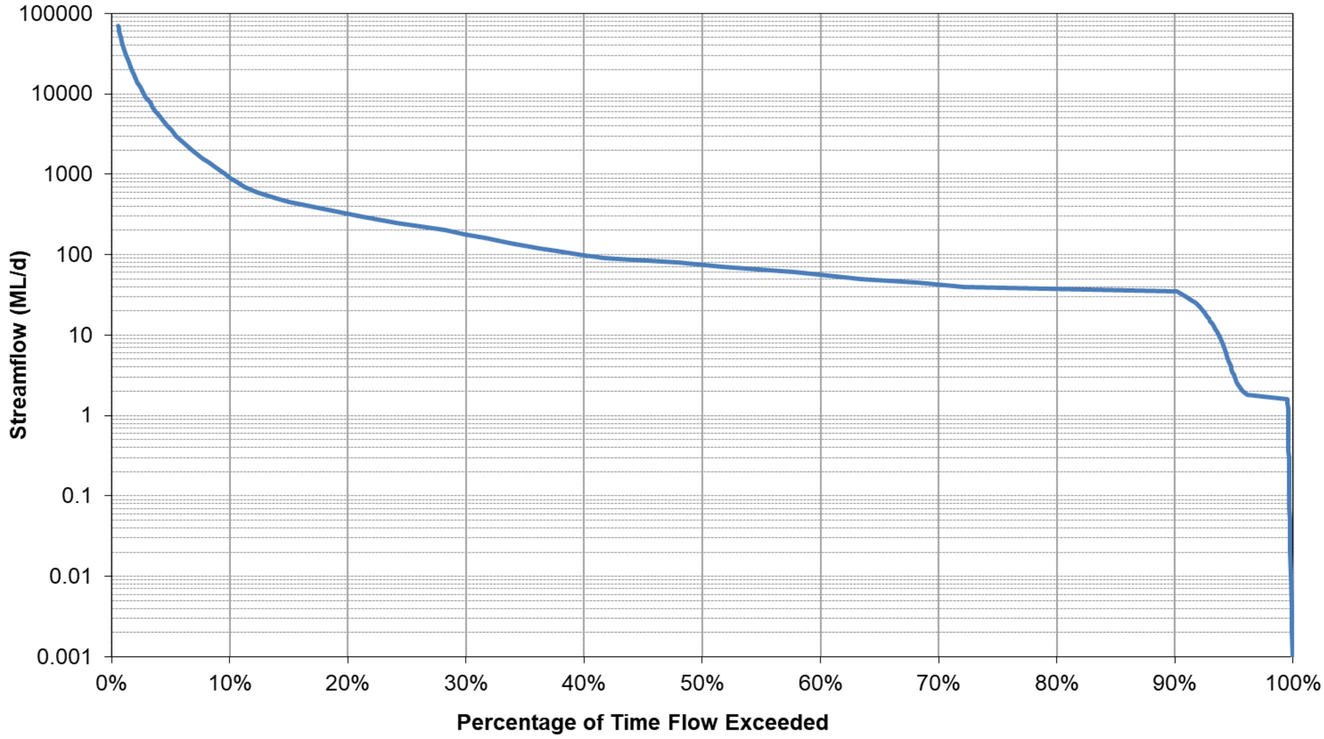


Figure 8 Nogoa River Streamflow Flow Duration Curve

Salinity (EC) records for the Nogoa River at Duckponds gauging station, available for the period July 2009 and June 2019, were used to generate a streamflow versus salinity relationship that could be applied to the long-term streamflow time series. Figure 9 shows the statistical relationship generated from this assessment. The maximum EC value was set at the maximum EC observed in the historic data set (4,745 µS/cm).

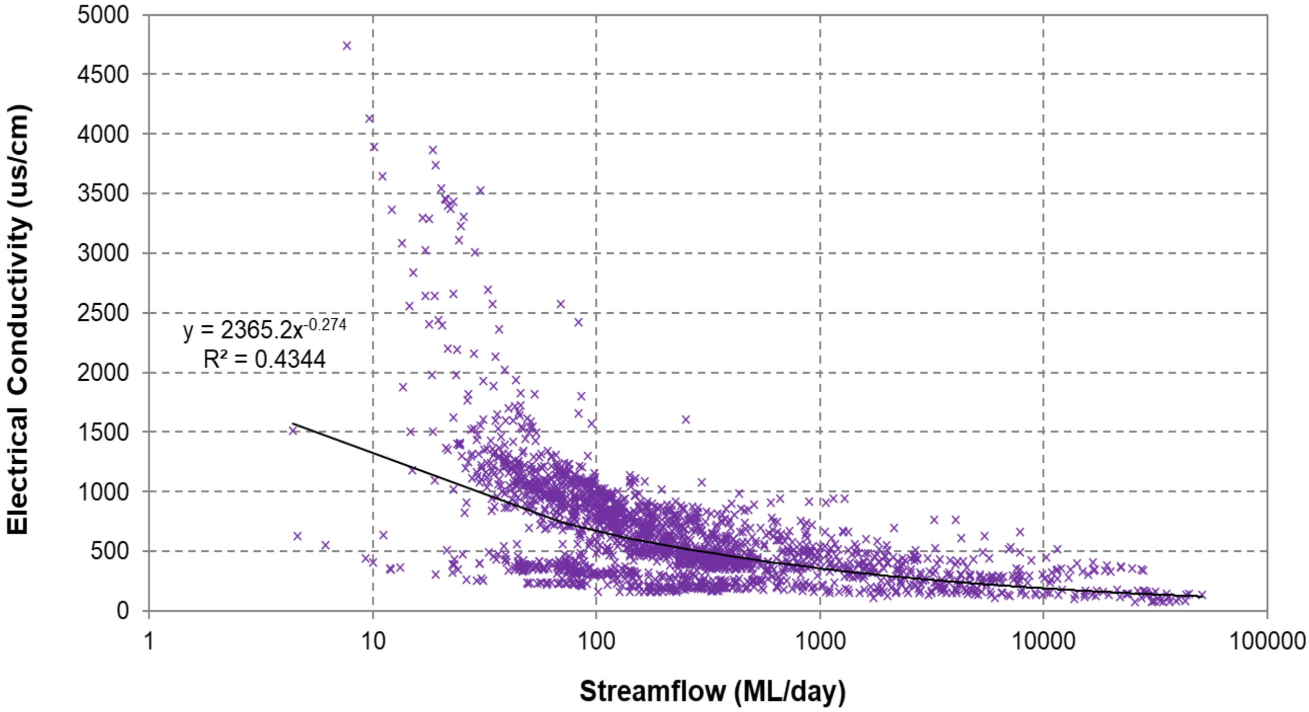


Figure 9 Nogoa River Streamflow to EC Relationship

3.10 DEMANDS

3.10.1 Water Treatment Plant Demand

The Water Treatment Plant (WTP) is supplied directly by the Village Dam and has a demand of 170,000 litres per day (L/d) based on information provided by Ensham Resources. Additional water supply is provided to the Village Dam from the Clearwater Dam or Sailors Dam, as required, which is supplied by a licensed allocation from the Nogoa River (see Section 3.11).

3.10.2 Coal Handling Plant Demand

A CHP demand of 1.16 L/s was adopted based on previous modelling (Jacobs, 2018), with no additional demand expected for the Project. This figure was agreed with Ensham Resources in lieu of historic records.

3.10.3 Truckfill Demand

Water for dust suppression is collected from three fill points: Ramp 24 FPD, Ramp 4 FPD and Ramp 84 Sediment Dam. The truckfill demand rates were adopted from the previous water balance model (Jacobs, 2018) which was based on seasonal conditions (see Table 9) and antecedent rainfall. Modelled demand was calculated as follows:

- if the previous days rainfall was greater than 7 mm, no dust suppression demand is required at truckfill points;
- if 0 to 5 mm rainfall occurred on the previous day, the dust suppression demand rates shown in Figure 9 were applied at truckfill points; and
- if between 5 mm and 7 mm of rainfall occurred on the previous day, half of the demand rate was applied at truckfill points.

Table 9 Maximum Dust Suppression Demand Rates

Month	Demand (ML/d)
January	3.5
February	3.5
March	3.25
April	3.25
May	3.25
June	3
July	3
August	3
September	3.25
October	3.25
November	3.25
December	3.5

3.10.4 Underground Mine Demand

The underground water demand was estimated from records of supply rates from the Clearwater Dam provided by Ensham Resources for the period of May 2015 to June 2020 (see Figure 10).

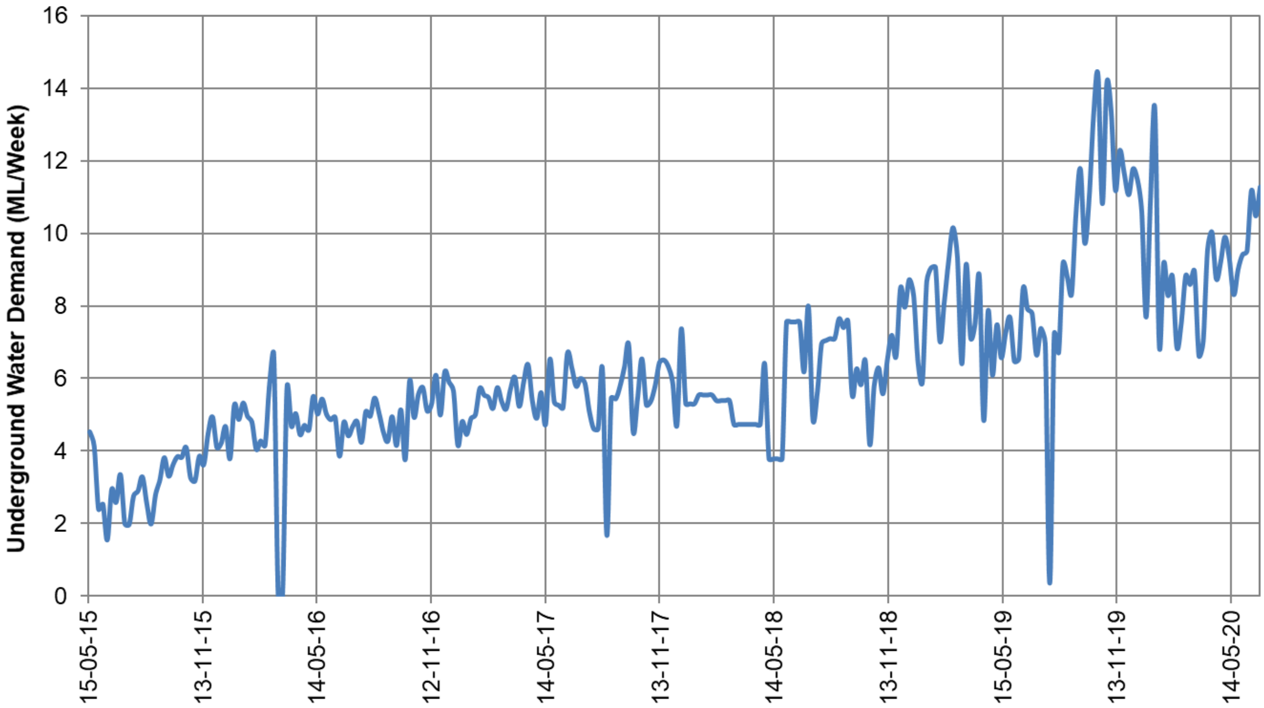


Figure 10 Ensham Underground Water Demand Record

The data presented in Figure 10 indicates that the average supply rate has increased considerably since commencement of monitoring. To reflect current site conditions, a median daily supply rate of 1.36 ML/d recorded for the period of July 2019 to June 2020 was adopted in the WSBM. A constant rate of 2.3 L/s vent loss was adopted in the WSBM, consistent with previous modelling carried out by Jacobs (2018).

3.11 NOGOA LICENCED SUPPLY

The Ensham Mine has a licenced allocation limit of 1,500 ML/year from the Nogoa River. Water supplied from the Nogoa River is sent to the Clearwater Dam which in turns supplies the WTP (refer Figure 2). The WSBM has been developed to simulate supply from the Nogoa River to the Clearwater Dam when the storage volume falls below 70% of the maximum capacity, up to a maximum of 1,500 ML/year supply. These assumptions are consistent with the previous water balance model (Jacobs, 2018) and confirmed by Ensham Resources.

Initially it was assumed that water could not be supplied from the Nogoa River when the flow rate was less than a certain percentile of historic flow rates. The EA for extraction from the Nogoa River does not however include a trigger level for extraction, as confirmed with Ensham Resources, and the extraction can occur as long as the annual allocation is not reached. In reality water is always available from the river, within the approved allocation, as requests can be made from the upstream Fairbairn Dam to release flows to the river when required.

The WSBM includes a historic river flow series (refer Section 3.9) which at times pre-dates Fairbairn Dam and as such there are time periods of zero flow, at which times water cannot be extracted. In such periods the river cannot supply the underground supply requirements via the Clearwater Dam. As the WSBM does not model Fairbairn Dam releases it has been agreed with Ensham Resources that, the modelled demands of the underground would be able to be supplied during these time periods through the addition of flows directly to the underground equal to that of the underground demands. This ensures that the modelled underground demands are always met as occurs in reality. This input of flows into the underground, occurs only when modelled river flows are such that the river flow is zero or less than the demand from the Clearwater Dam.

3.12 CONTROLLED RELEASES TO NOGOA

Controlled releases can be made to the Nogoa River from the Southern Backbone via release points RP1 and RP3 which have been represented as one release point in the WSBM. The Southern Backbone transfers water from Drain 3/4, Ramp 24, Ramp 22 and Ramp 24 FPD. The Ensham Mine EA, which came into effect in 3rd September 2020, states that the discharge EC from this pipeline must not exceed 12,500 µS/cm, that there must be at least 30 m^3/s flow in the Nogoa River and that the EC in the river downstream of the discharge point must not exceed 850 µS/cm in order for a controlled release to occur (i.e. combined controlled release and river EC). These requirements have been built into the WSBM to ensure that simulated controlled releases do not occur outside of the EA criteria.

3.13 PUMPING CONTROLS

The water management system and WSBM are based on several controls for the transfer of water between storages, demands and release points. All storages have been simulated with lower volume thresholds which limit pumped outflow (typically set at 2% of the maximum storage capacity) while receiving storages have been simulated with an upper volume threshold which restricts pumped inflow when the stored water volume reaches a specified level. Many storages pump to several other storages or supply demands and as such a priority has been set for each of these storages to specify which storage or demand will be supplied first.

Using these controls the volumes stored, volumes pumped out, demands supplied and spills from storages can be controlled within the constraints of the storage capacities and pumping rates available at each of the storages.

A summary of the pump rules and rates are provided in Table 10.

Table 10 Modelled Pumping Rates and Controls

<table>
<tr><th>Storage</th><th>Volume Threshold (% of Max Capacity)</th><th>Pump to in Order of Priority</th><th>Pump Start Volume (ML)</th><th>Pump Rate / Demand (L/s)</th></tr>
<tr><td rowspan="2">CHP Dam</td><td rowspan="2">5</td><td>Lemon Tree Dam</td><td>4.4</td><td>100</td></tr>
<tr><td>Ramp 4 FPD</td><td>4.4</td><td>200</td></tr>
<tr><td>Lemon Tree Dam</td><td>95</td><td>CHP</td><td>0.2</td><td>1.16</td></tr>
<tr><td rowspan="3">Clearwater Dam</td><td rowspan="3">70</td><td>Ensham underground</td><td rowspan="3">5.5</td><td>1.36</td></tr>
<tr><td>Village Dam</td><td>100</td></tr>
<tr><td>Sailors Dam</td><td>100</td></tr>
<tr><td>Village Dam</td><td>90</td><td>WTP</td><td>1.5</td><td>1.96</td></tr>
<tr><td>Sailors Dam</td><td>70</td><td>Village Dam</td><td>4</td><td>100</td></tr>
<tr><td>Underground</td><td>90</td><td>Drain 3/4</td><td>2</td><td>200</td></tr>
<tr><td rowspan="2">Ramp 8/9</td><td rowspan="2">95</td><td>Ramp 84 Sed Dam</td><td rowspan="2">2.2</td><td>100</td></tr>
<tr><td>NB* (effectively Drain 4/6)</td><td>100</td></tr>
<tr><td rowspan="2">Ramp 10</td><td rowspan="2">95</td><td>Ramp 84 Sed dam</td><td rowspan="2">96.3</td><td>100</td></tr>
<tr><td>NB (effectively Drain 4/6</td><td>100</td></tr>
<tr><td rowspan="2">Ramp 84</td><td rowspan="2">95</td><td>Ramp 84 Sed Dam</td><td rowspan="2">2.3</td><td>100</td></tr>
<tr><td>NB (effectively Drain 4/6)</td><td>100</td></tr>
<tr><td>Ramp 84 Sed Dam</td><td>80</td><td>Truckfill</td><td>2.0</td><td>Varies seasonally</td></tr>
<tr><td rowspan="2">Ramp/83</td><td rowspan="2">95</td><td>Ramp 84 Sed Dam</td><td rowspan="2">5.0</td><td rowspan="2">50</td></tr>
<tr><td>NB (effectively Drain 4/6)</td></tr>
<tr><td rowspan="2">Ramp 7/81</td><td rowspan="2">N/A</td><td>Ramp 84 Sed Dam</td><td rowspan="2">1.4</td><td rowspan="2">100</td></tr>
<tr><td>NB (effectively Drain 4/6)</td></tr>
<tr><td>Ramp 5/6</td><td>N/A</td><td>Drain 4/6</td><td>9.9</td><td>100</td></tr>
<tr><td>Ramp 3/4</td><td>95</td><td>Drain 3/4</td><td>9.1</td><td>100</td></tr>
<tr><td rowspan="3">Ramp 4 FPD</td><td>60</td><td>Truckfill</td><td rowspan="3">3.4</td><td>Varies seasonally</td></tr>
<tr><td>20 (for NB inflows)</td><td>CHP Dam</td><td>50</td></tr>
<tr><td>95 (for CHP Dam inflows)</td><td>Drain 3/4</td><td>200</td></tr>
<tr><td rowspan="2">Drain 4/6</td><td rowspan="2">N/A</td><td>Ramp 4 FPD</td><td rowspan="2">N/A</td><td>NB + Ramp 5/6 transfer</td></tr>
<tr><td>Drain 3/4</td><td>NB + Ramp 5/6 transfer</td></tr>
<tr><td>Ramp 20</td><td>85</td><td>Ramp 21</td><td>4.2</td><td>100</td></tr>
</table>

* Northern Backbone (NB), Southern Backbone (SB)

Table 10 Modelled Pumping Rates and Controls (continued)

Storage	Volume Threshold (% of Max Capacity)	Pump to in Order of Priority	Pump Start Volume (ML)	Pump Rate / Demand (L/s)
Ramp 21	90	Ramp 22	3.0	100
		Ramp 20		100
Ramp 22	85	Ramp 24 FPD	7.0	1550
		SB*		600
		Drain 3/4		1550
		Ramp 21		1550
		Ramp 24		1550
Ramp 24	60	Ramp 24 FPD	48.1	600
		SB		600
		Ramp 22		600
		Ramp 21		600
		Drain 3/4		600
Ramp 24 FPD	60	Truckfill	6.9	Varies seasonally
		SB		2000
		Drain 3/4		2000
		Ramp 21		600
		Ramp 22		2000
		Ramp 24		2000
Drain 3/4	80	Ramp 4 FPD	1.5	100
	95 (for Ramp 4 FPD Inflows)	Ramp 24 FPD		2000
		SB		2000
	85 (for NB inflows)	Ramp 22		2000

* Northern Backbone (NB), Southern Backbone (SB)

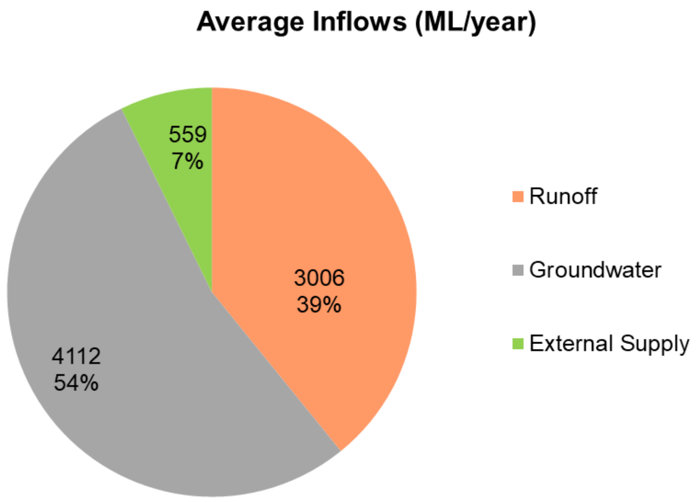
4.0 WATER AND SALT BALANCE MODEL RESULTS

4.1 SITE INFLOW AND OUTFLOW BALANCE

Model predicted average inflows and outflows (averaged over the 17 year simulation period and all 131 realizations) are presented in the following sections for the existing operation and the Project.

4.1.1 Existing Operation

The average annual inflows and outflows simulated for the existing operation are shown in Figure 11. Groundwater contributes the majority of system inflows with rainfall runoff also comprising a large component of the total inflow. Outflows from the site predominately comprise controlled release to the Nogoa River, evaporative losses and dust suppression (truckfill supply).



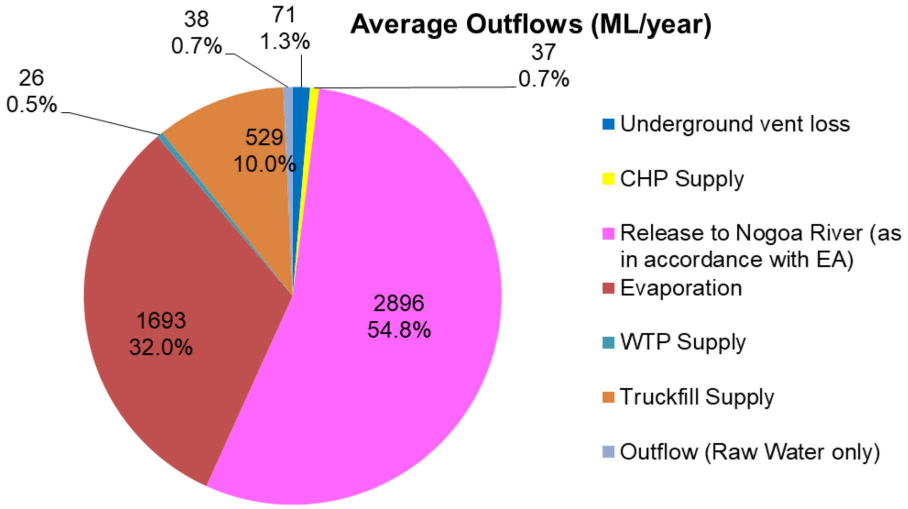
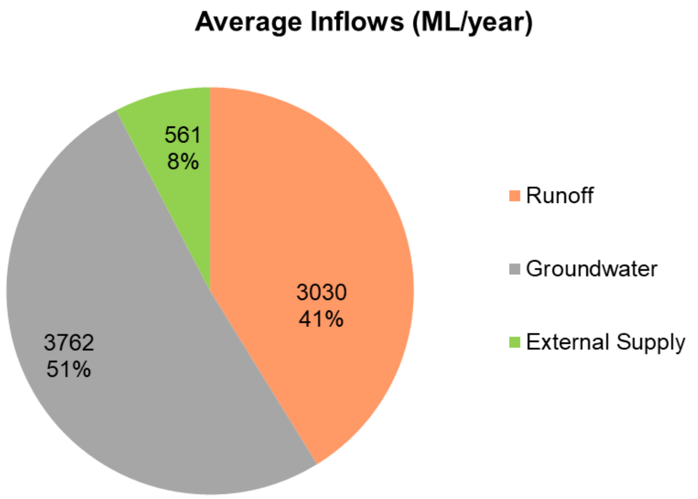


Figure 11 Average Predicted System Water Balance – Existing Operation

4.1.2 Proposed Project

The average inflows and outflows simulated for the Project are shown in Figure 12. For the Project, groundwater inflow is predicted to contribute the majority of system inflows with supply from the Nogoa River expected to be equivalent to the existing operation.

The Project is predicted to result in similar average volumes of outflow from the site over all realizations, predominately comprising controlled release to the Nogoa River, evaporative losses and dust suppression (truckfill supply).



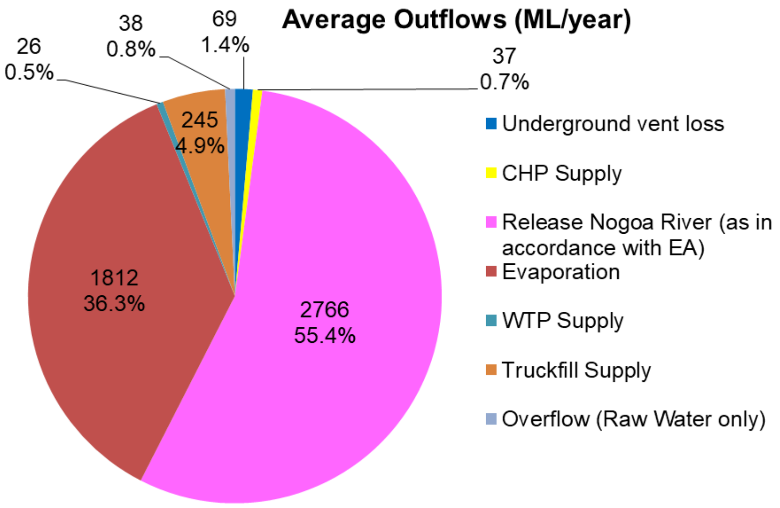


Figure 12 Average Predicted System Water Balance – Proposed Project

In comparison, the average annual groundwater inflow to the site for the existing operation is estimated at 4,112 ML/yr while this is expected to decrease to 3,762 ML/yr for the Project. This occurs as the averaged existing groundwater inflows is calculated over the eight years of the existing mine life whilst the groundwater inflows are averaged over the full seventeen years of the Project which includes an additional nine years in which underground groundwater inflows reduce. The average annual release to the Nogoa River for the existing operation is estimated at 2,896 ML/yr in comparison with a similar average annual release rate of 2,766 ML/yr for the Project.

4.2 PREDICTED STORAGE VOLUMES

4.2.1 Probability Plots

The following sections present the predicted stored water volume in the main site storages for the existing operation and a range of probabilities. The probability plots show the range of predicted total stored water volumes, with the 5th/95th percentile volumes representing long-term lower and higher rainfall conditions, respectively. There is a 90% chance that the total water volume will fall between the 5th/95th percentile volume plots while there is an 80% chance that the total water volume will fall between the $10^{th}/90^{th}$ percentile volume plots. It is important to note that the probability plots presented in the following sections do not represent a single climatic realisation – the probability plots are compiled from all 131 realisations – e.g. the median volume plot does not represent model forecast volume for median climatic conditions.

4.2.2 Ramp 24 Storage

Figure 13 illustrates that, based on the results of the 131 model realizations, the stored water volume in the Ramp 24 storage is generally predicted to decrease rapidly until approximately the end of 2020, after which discharges to the ramp from other storages will not be made except when the other southern ramps are unable to store more water having reached capacity. As such, the storage at Ramp 24 is kept at a low volume (in comparison to its capacity) and is only used infrequently, as reserve storage, as indicated by the spikes seen in the 95^{th} percentile results.

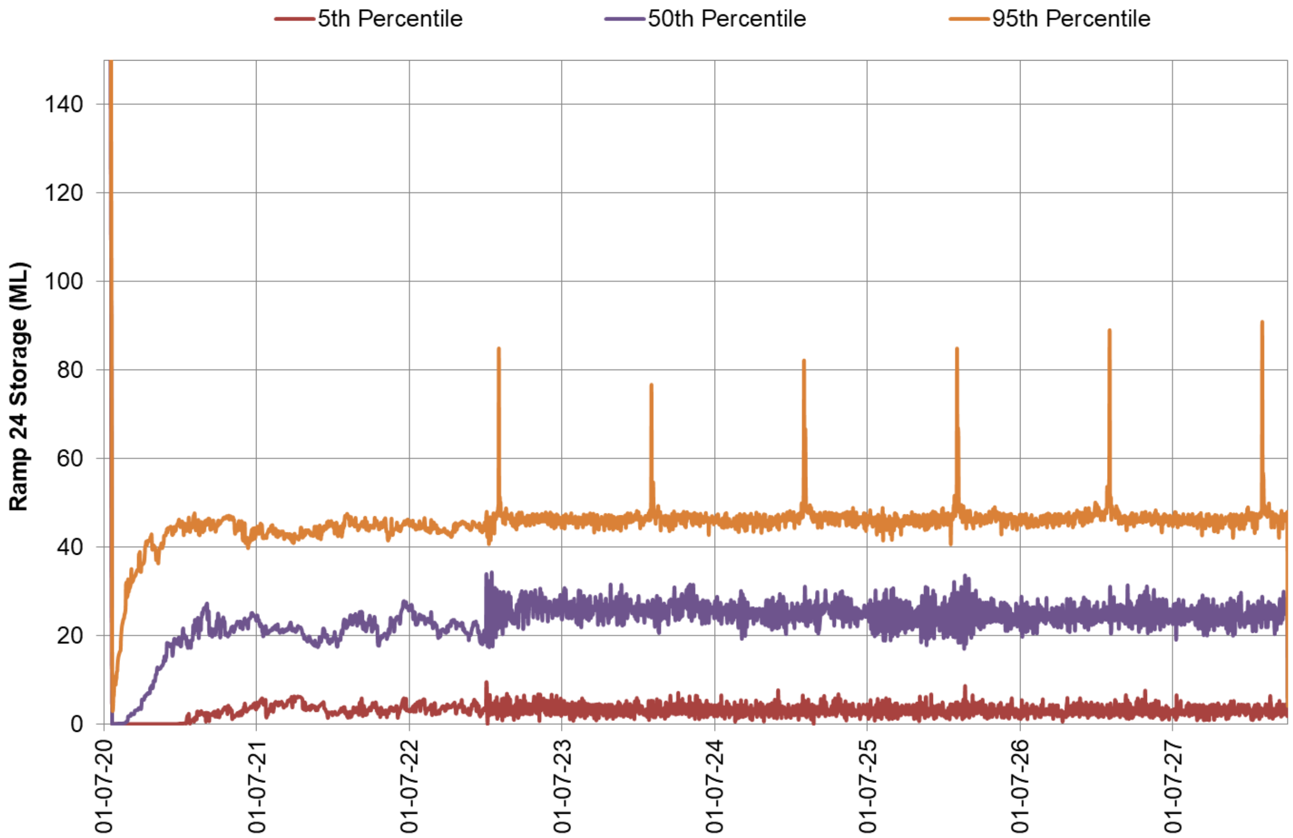


Figure 13 Ramp 24 Predicted Storage - Existing Operation

Similarly the Project scenario also simulates Ramp 24's volume to settle to a consistent low storage volume which is again used infrequently for additional storage when the remainder of the southern ramps are near their capacity (refer to Figure 14).

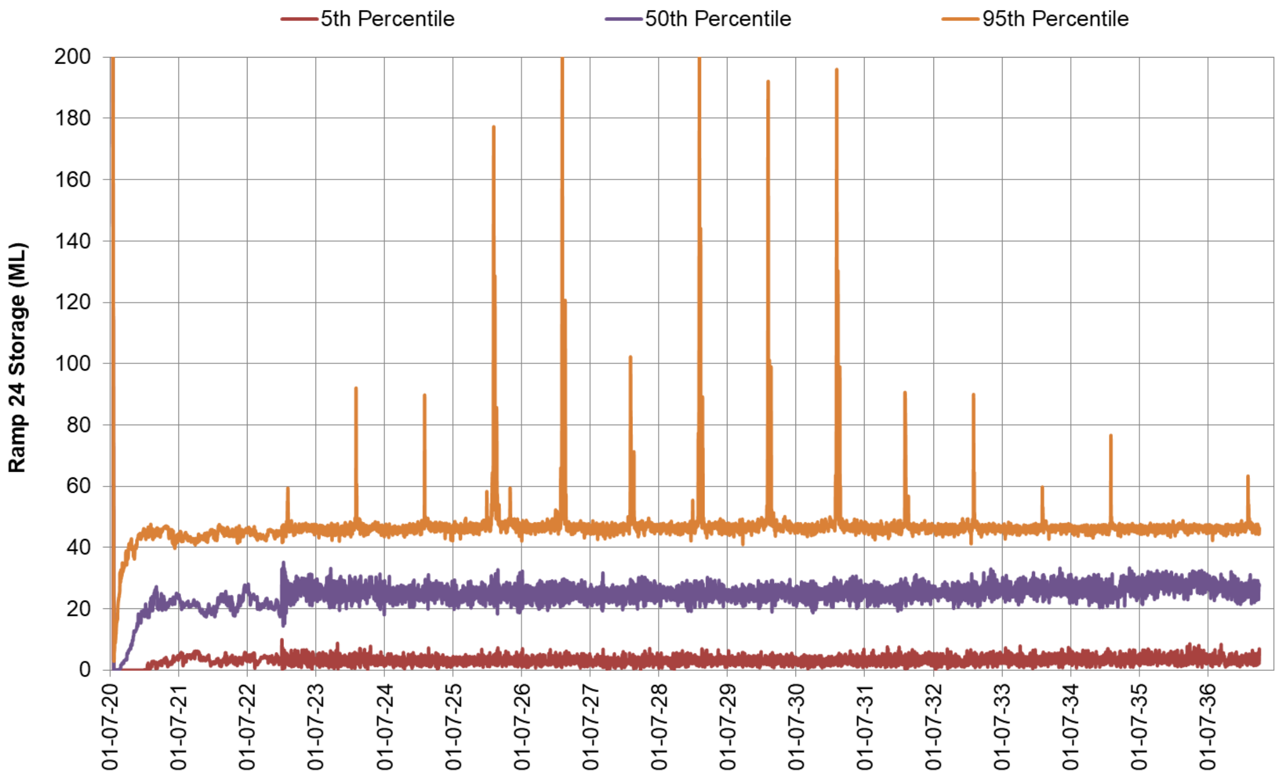


Figure 14 Ramp 24 Predicted Storage - Proposed Project

4.2.3 Ramp 22 Storage

Ramp 22 is the second main storage that discharges to the Southern Backbone for release to the Nogoa River. The modelled storage volume for the existing operation and the Project are shown in Figure 15 and Figure 16.

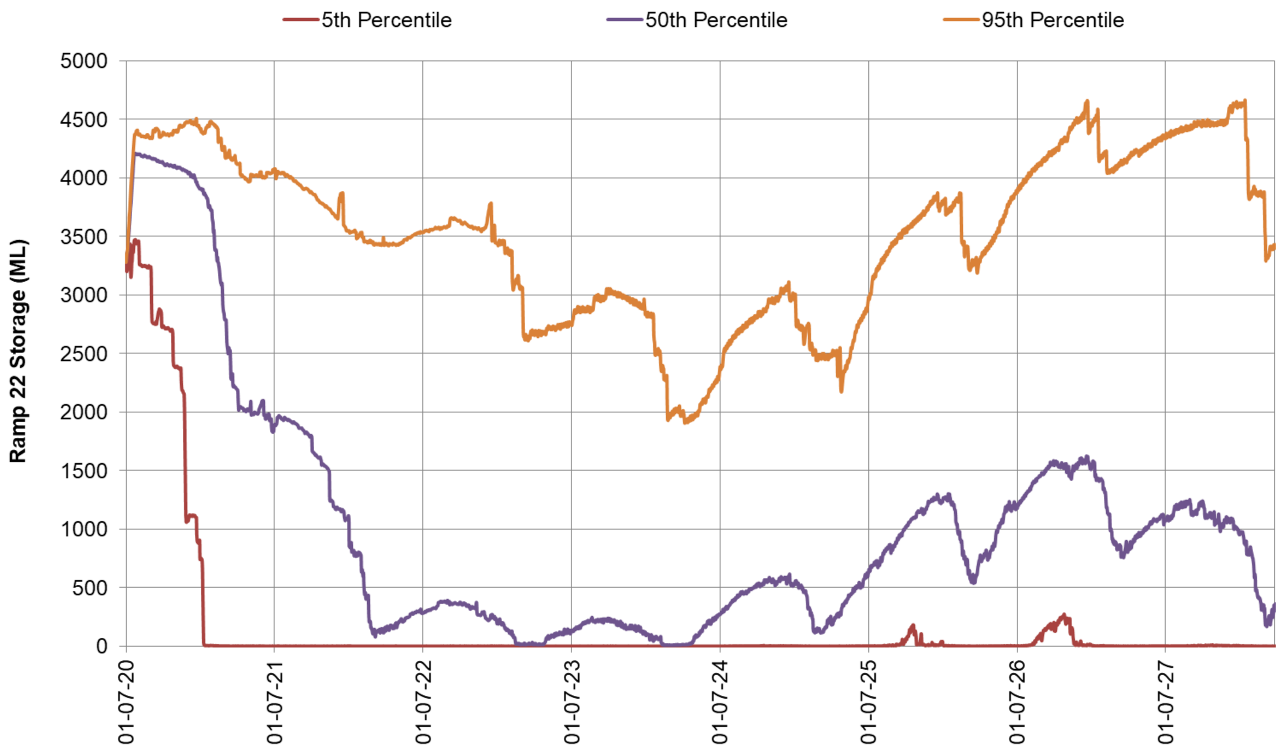


Figure 15 Ramp 22 Predicted Storage - Existing Operation

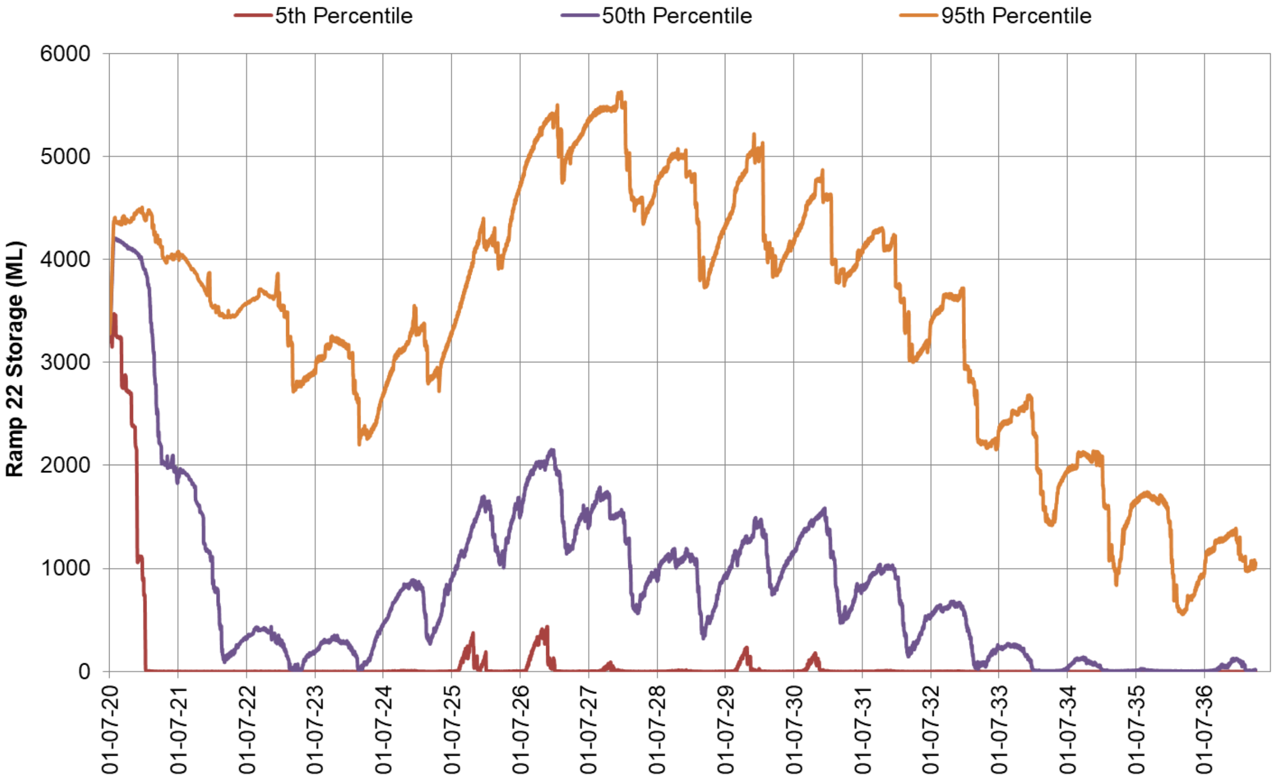


Figure 16 Ramp 22 Predicted Storage - Proposed Project

These figures indicate that, based on the model predictions, the stored water volume in Ramp 22 is predicted to decrease until 2024 and increase again as 40 percent of the underground groundwater is pumped from the mine to the surface and distributed to the southern ramps and dams. Discharges are made to the Southern Backbone for release to the Nogoa River when release criteria are met. Volumes in Ramp 22 diminish towards the end of the Project life as groundwater inflows to the underground reduce and less water is pumped to the surface.

4.2.4 Ensham Underground Storage

Ensham underground's storage is currently approximately 6,000 ML in volume although this will expand over the lifetime of the operations. Section 3.6 outlines the proposed storage of groundwater within the underground and transfer to the surface.

Figure 17 shows the volumes that have been assumed will be stored in the completed underground during the existing operations and Project scenarios modelled. These volumes show the storage capacity required over time.

By the end of the approved existing operational mine life approximately 20,000 ML of required additional storage has been estimated and by the end of the Project lifetime an additional 42,000 ML of required storage has been estimated.

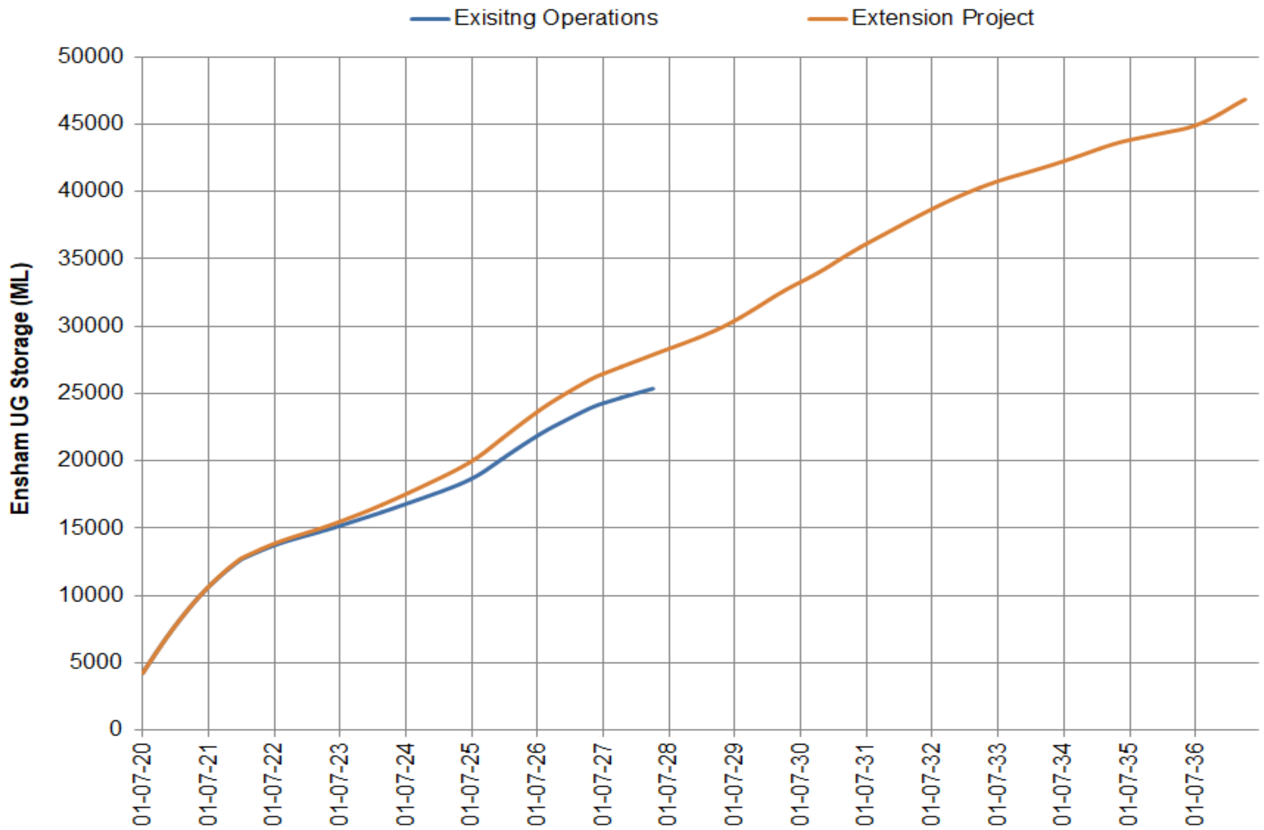


Figure 17 Ensham Underground Predicted Storage

4.2.5 Total Storage Inventory

The total surface storage inventory for the site was also simulated for the existing operation and the Project (refer Figure 18 and Figure 19). The total storage capacity of the mine affected water storages on site is shown in Figure 19 for comparison with model results for the proposed project.

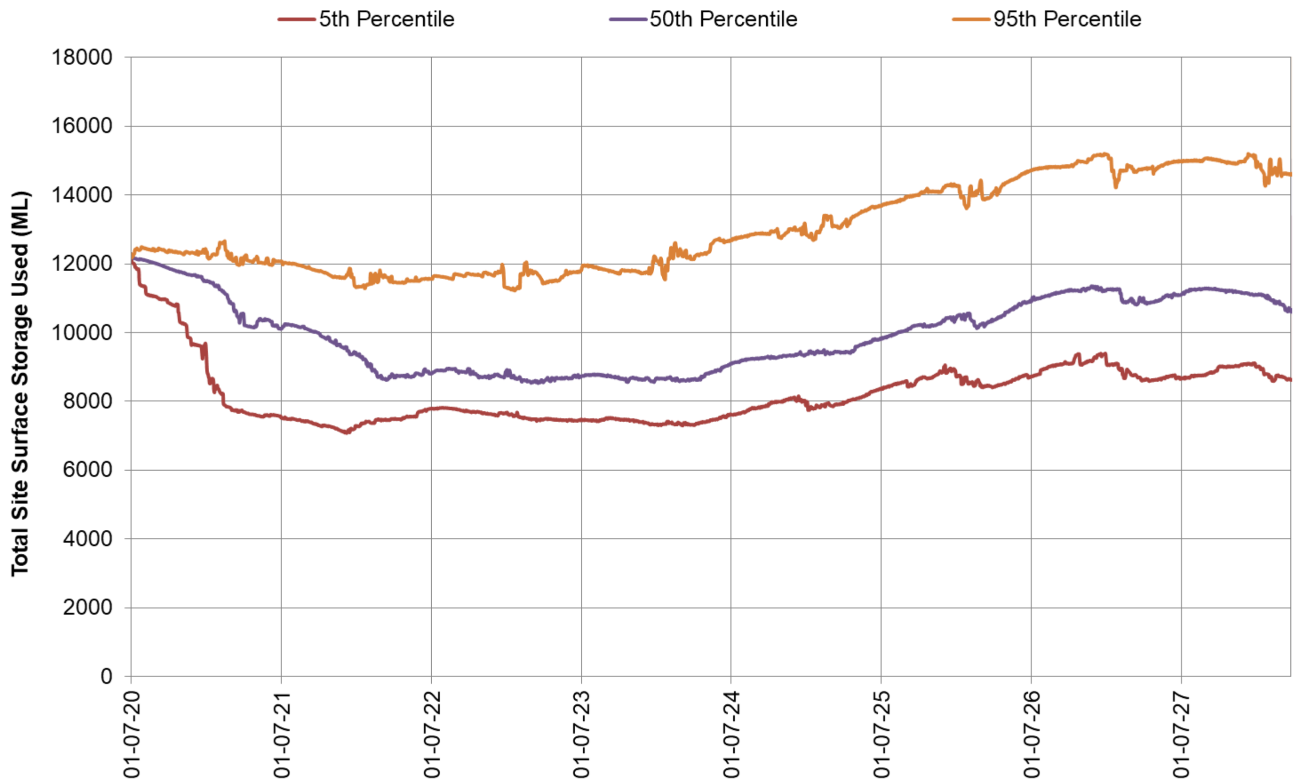


Figure 18 Predicted Total Site Surface Inventory - Existing Operation

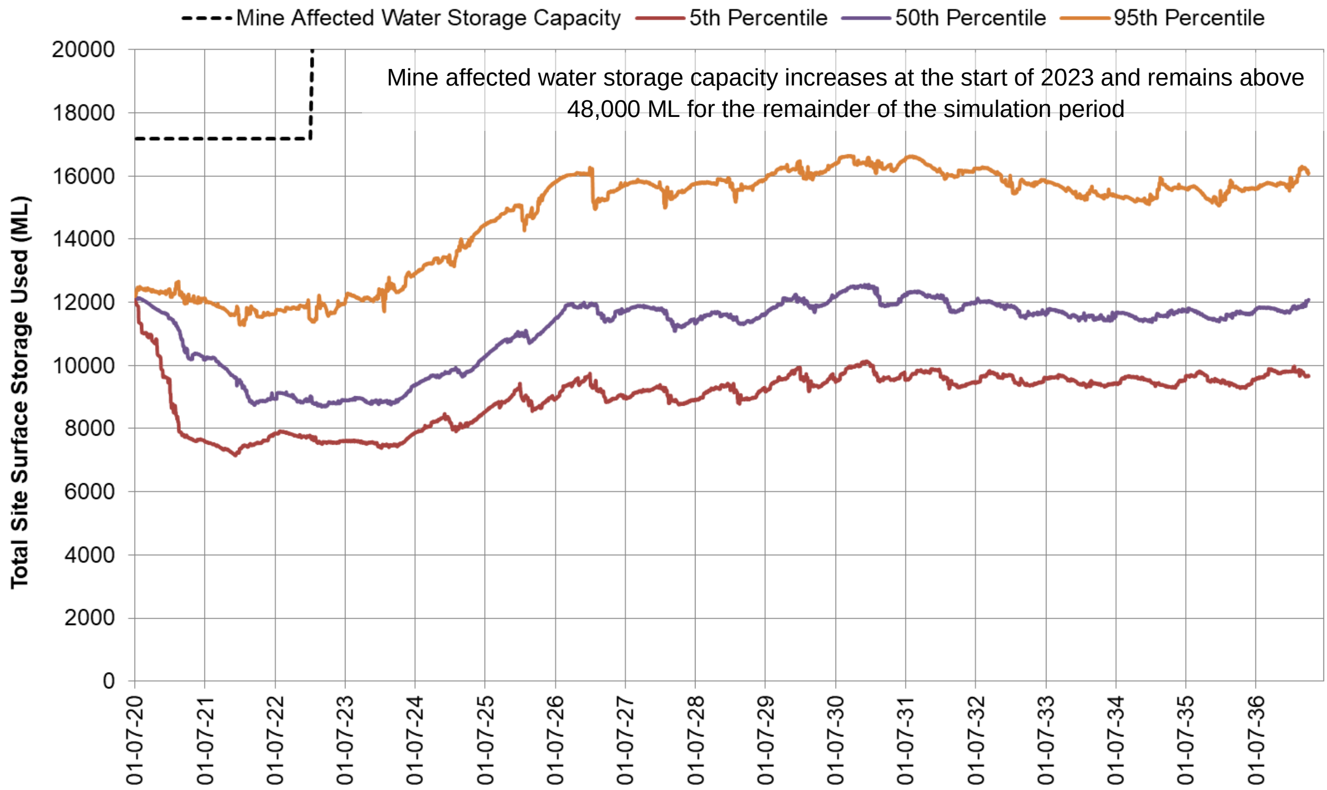


Figure 19 Predicted Total Site Surface Inventory - Proposed Project

The stored water volumes are predicted to be similar for both scenarios until mid-2028 (the end of the existing operational scenario) as inflows are approximately the same. There is an initial dip in volumes stored. As groundwater is pumped into the system from the underground (from 2022) the modelled volumes gradually rise and then remain fairly consistent, stabilising at just under 12,000 ML (for the 50th percentile). As the Project continues after mid-2028, overall modelled surface storage volumes remain fairly consistent, as some storages fill and as others release to the Nogoa River via the Southern backbone.

Figure 19 shows the mine affected water storage capacity is approximately 17,000 ML from the start of the simulation period and then increases notably at the start of 2023 due to Ramp 24 becoming available as a water storage in line with the rehabilitation schedule. By mid-2023, the mine affected water storage capacity is approximately 65,000 ML and while small decreases occur over the simulation period, the capacity remains above 48,000 ML which is notably higher than the predicted total site surface inventory. With simulated inventory volumes well below capacity, water can be sourced from the Nogoa River in line with licensed allocation limits and water can be discharged to the Nogoa River in line with the current EA discharge limits.

4.3 DEMAND REQUIREMENTS

Table 11 and Table 12 summarise the simulated average demand requirements and the predicted supply reliability for the existing operation and the Project. Predicted average supply reliability is expressed as total water supplied divided by total demand (i.e. a volumetric reliability) over the simulation period. Table 11 and Table 12 show the average supply reliability over all climatic realizations. The supply reliability is expected to be high due the significant volumes of groundwater being pumped to the surface in both the existing operation and Extended Project scenarios as well as the significant volumes of water currently stored on site.

Table 11 Predicted Existing Operation Supply Reliability

Demand	Average Demand ML (over project lifetime)	Average Reliability – Existing Project
CHP	283.8	100%
Ramp 24 FPD Truckfill	82.1	97.4%
Ramp 4 FPD Truckfill	2,175.8	100%
Ramp 84 Sed Dam Truckfill	1,847.3	100%
WTP	198.2	100%

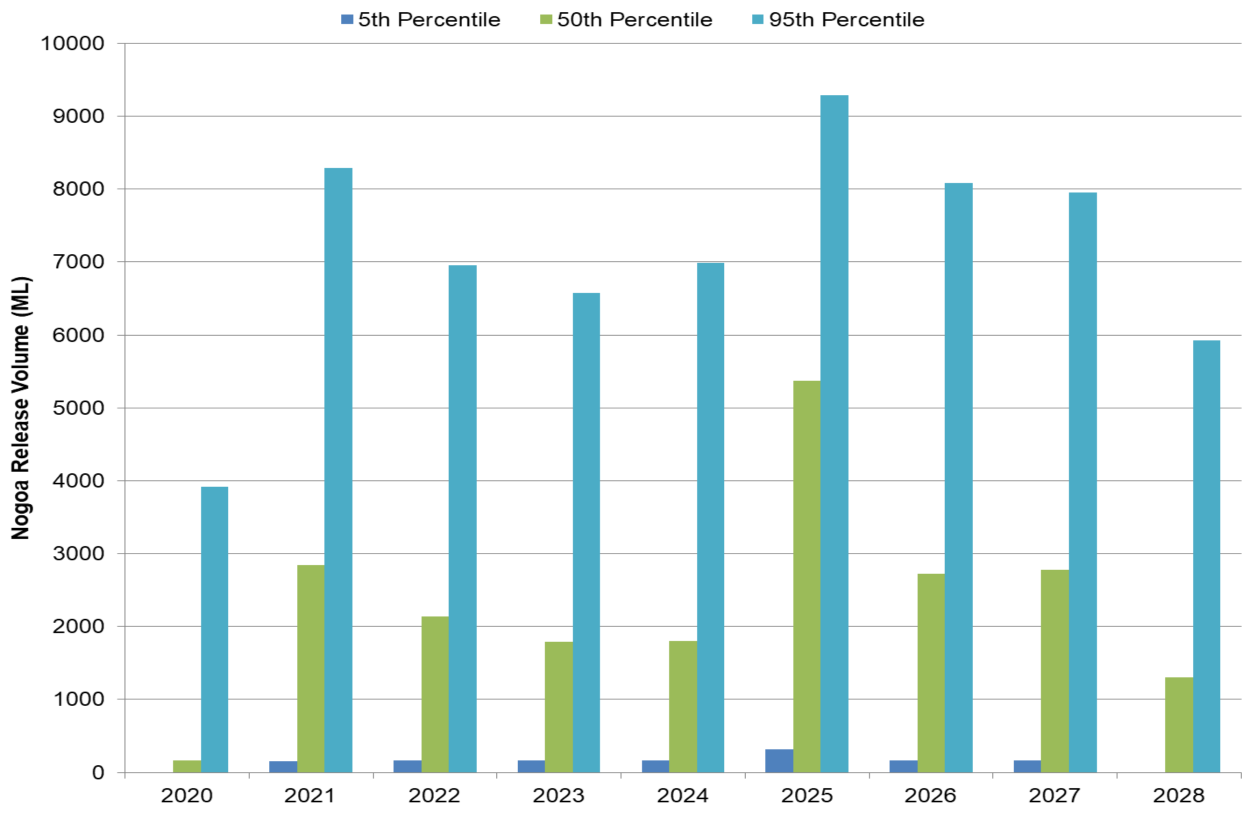
Table 12 Predicted Project Supply Reliability

Demand	Average Demand ML (over project lifetime)	Average Reliability – Project
CHP	613.3	100%
Ramp 24 FPD Truckfill	82.1	97.4%
Ramp 4 FPD Truckfill	2,175.8	100%
Ramp 84 Sed Dam Truckfill	1,847.3	100%
WTP	428.2	100%

4.4 CONTROLLED RELEASES AT RP1

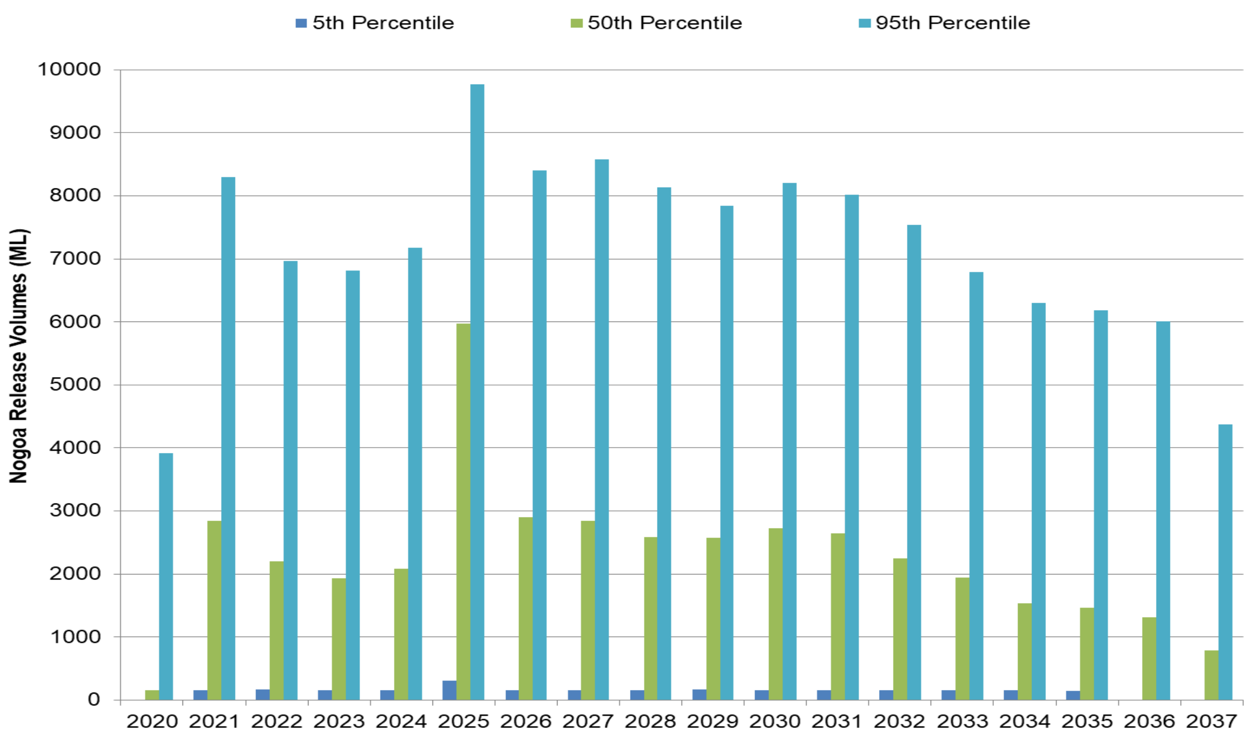
Figure 20 shows the predicted annual controlled release volumes to the Nogoa River during the existing operations scenario. The 50th percentile results show that the predicted annual release volume is estimated at to be generally between 1,800 ML and 2,800 ML a year over most complete years simulated.

This compares with predicted annual controlled release volumes to the Nogoa River model results for the Project scenario shown in Figure 21. The 50th percentile results show that the predicted annual release volume is estimated at to be generally between 2,000 ML and 3,000 ML a year, the release volumes reducing towards the end of the project lifetime as groundwater levels supplying the relevant surface storages reduce. A spike is seen in 2025 where higher volumes are released at the licensed discharge point. This is due to a peak in groundwater inflows being pumped from the underground to the surface at this time, allowing more water to be available in the storages for licenced release to the Nogoa River.



*Years 2020 and 2037 show only partial years extraction due to simulation start and end dates (5th percentile results are zero)

Figure 20 Predicted Controlled Release to Nogoa River - Existing Operation



*Years 2020 and 2037 show only partial years extraction due to simulation start and end dates (5th percentile results are zero)

Figure 21 Predicted Controlled Release to Nogoa River – Proposed Project

Figure 22 presents the predicted EC of the controlled release to RP1 based on the model results for the Project. The results indicate that the release EC is predicted to decline initially as water currently with an elevated salinity is diluted with lower salinity catchment inflow water. The EC rises subsequently as groundwater (also with elevated salinity) is pumped to the surface storages. The higher 95th percentile results remain below the 12,500 µS/cm EA discharge condition. Any water discharged to the Nogoa River will meet salinity levels required by the EA.

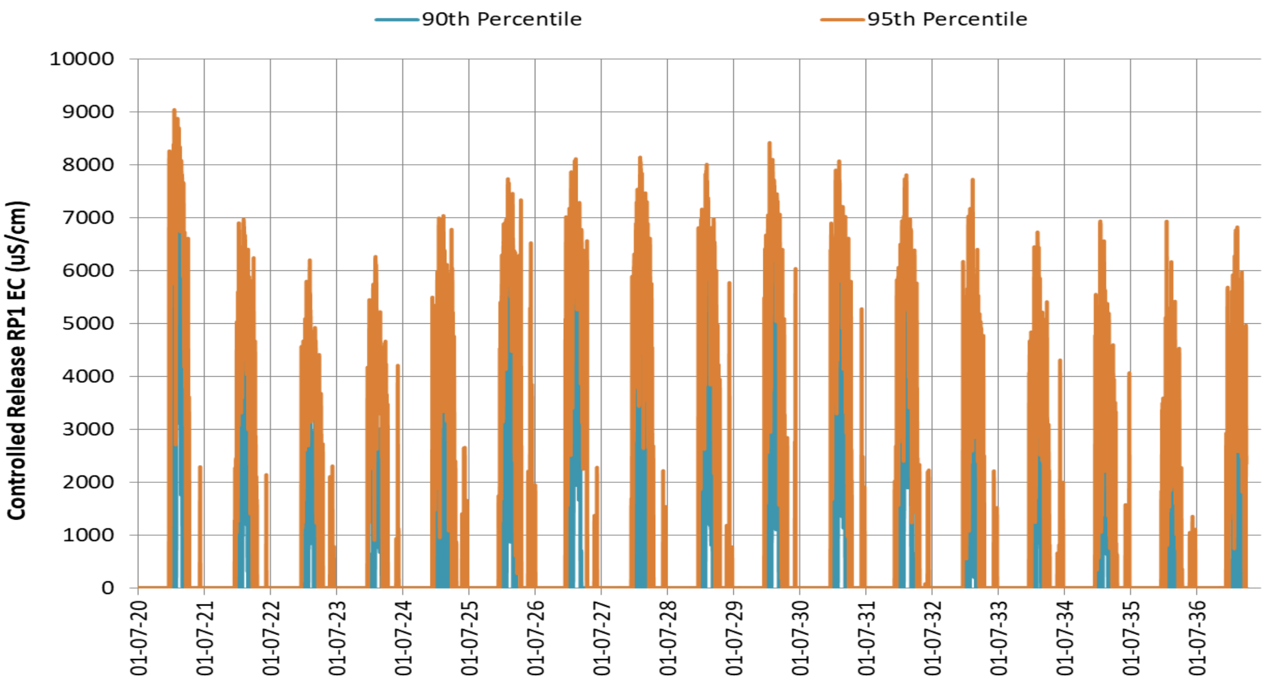


Figure 22 Predicted Controlled Release EC - Project

To illustrate the veracity of the model predicted release EC at RP1, the model results were compared with records of EC for discharge Point RP1 provided by Ensham Resources for the period 2014 to 2020 (see Figure 23). The predicted range of higher EC values in the controlled release from RP1, (Figure 22), is consistent with the range of recorded EC values.

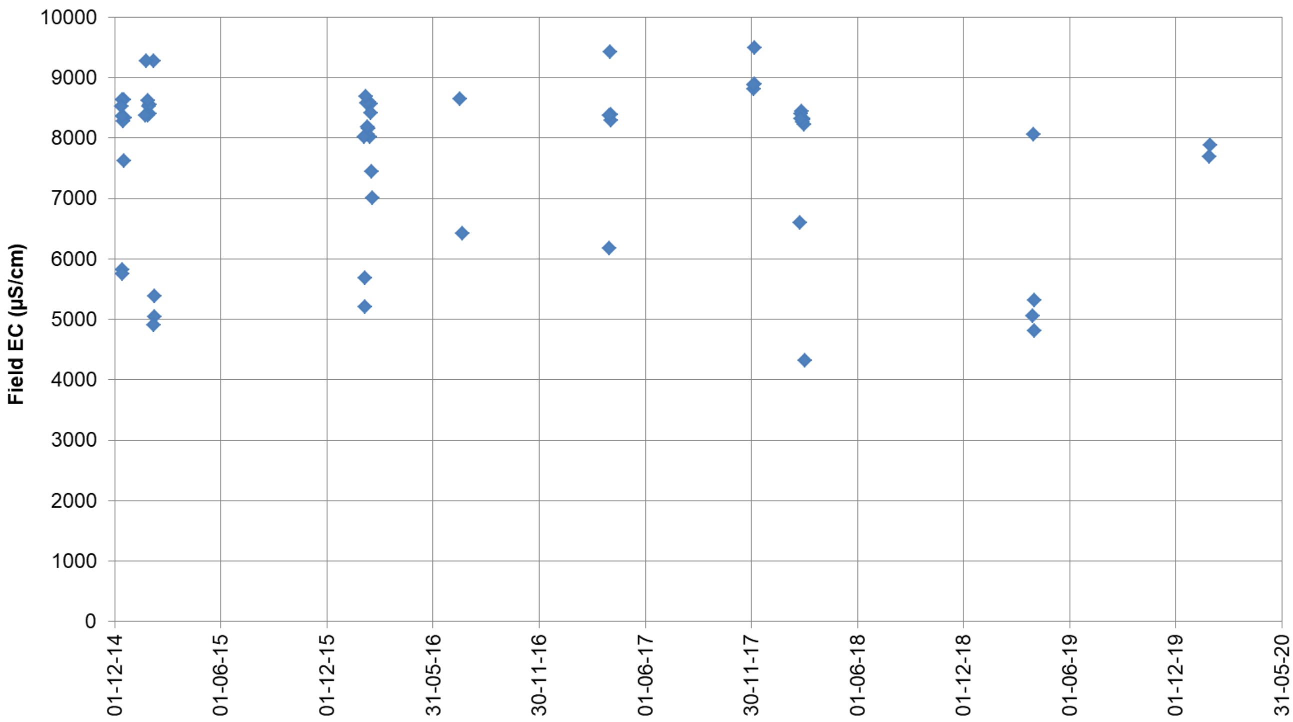
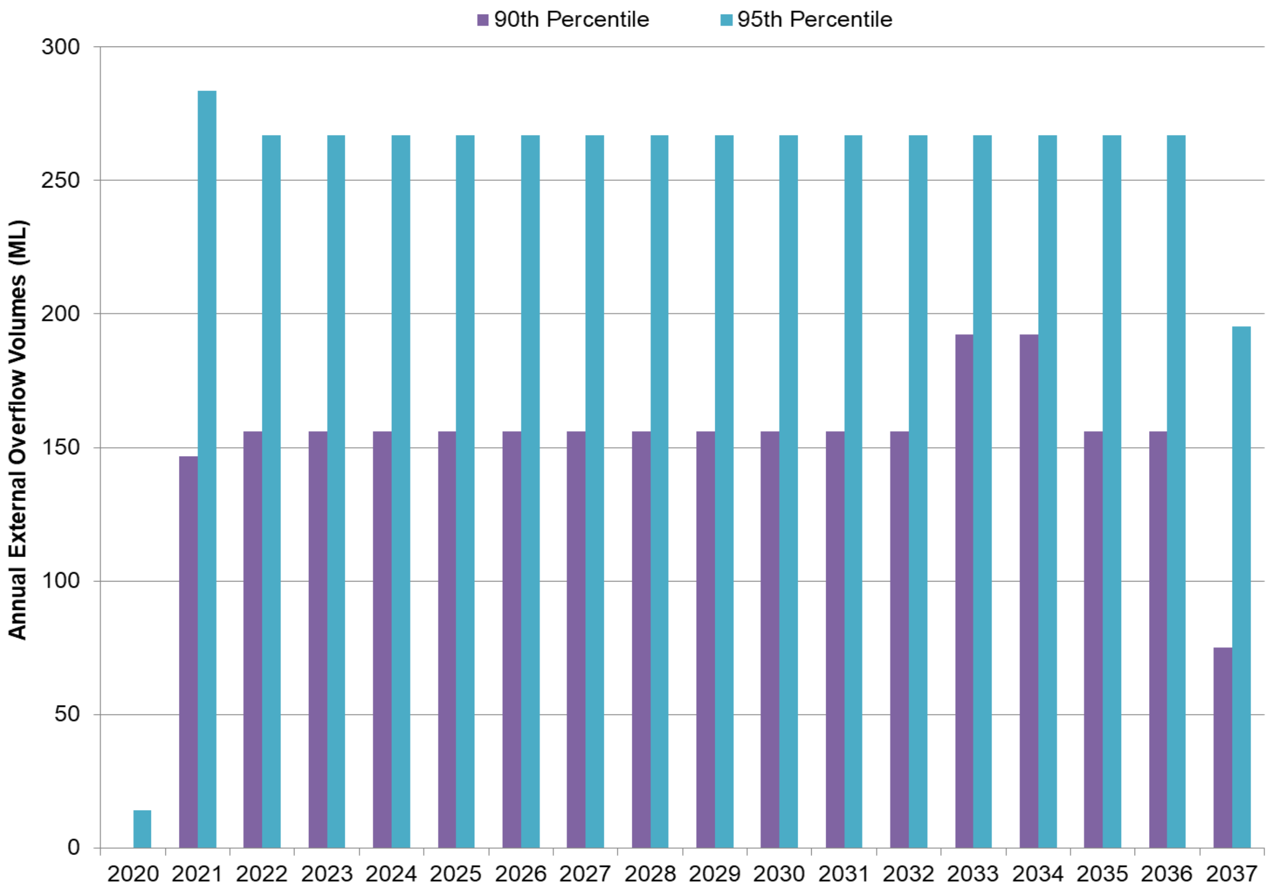


Figure 23 Recorded Controlled Release EC at Discharge Point RP1

The EC in the Nogoa River downstream of the controlled release point will not be affected by controlled releases in the Project scenario (in comparison to existing operations). Releases are set only to occur when they allow downstream EC's in the Nogoa River to remain below the EA stipulated 850 µS/cm threshold.

4.5 STORAGE OVERFLOW

The model rules were optimised to ensure no overflows from the northern and southern ramp pit storages and to ensure that any overflow was retained within the site water management system by transferring overflow to other site storages with available capacity. Clean water storage dams were simulated within the model as overflowing to the adjacent watercourse when full, following high rainfall. Overflows were only seen from the Sailors Dam. The Sailors Dam contains raw water, consisting of inflows from undisturbed catchment runoff and river top up supply. As such overflows from the Sailors Dam will be clean water as not affected by mine water. The WSBM overflow volumes predicted are shown in Figure 24 which consist only of overflows from Sailors Dam.



*Years 2020 and 2037 show only partial years extraction due to simulation start and end dates

Figure 24 Modelled Annual External Overflow Raw Water (Sailors Dam) - Proposed Project

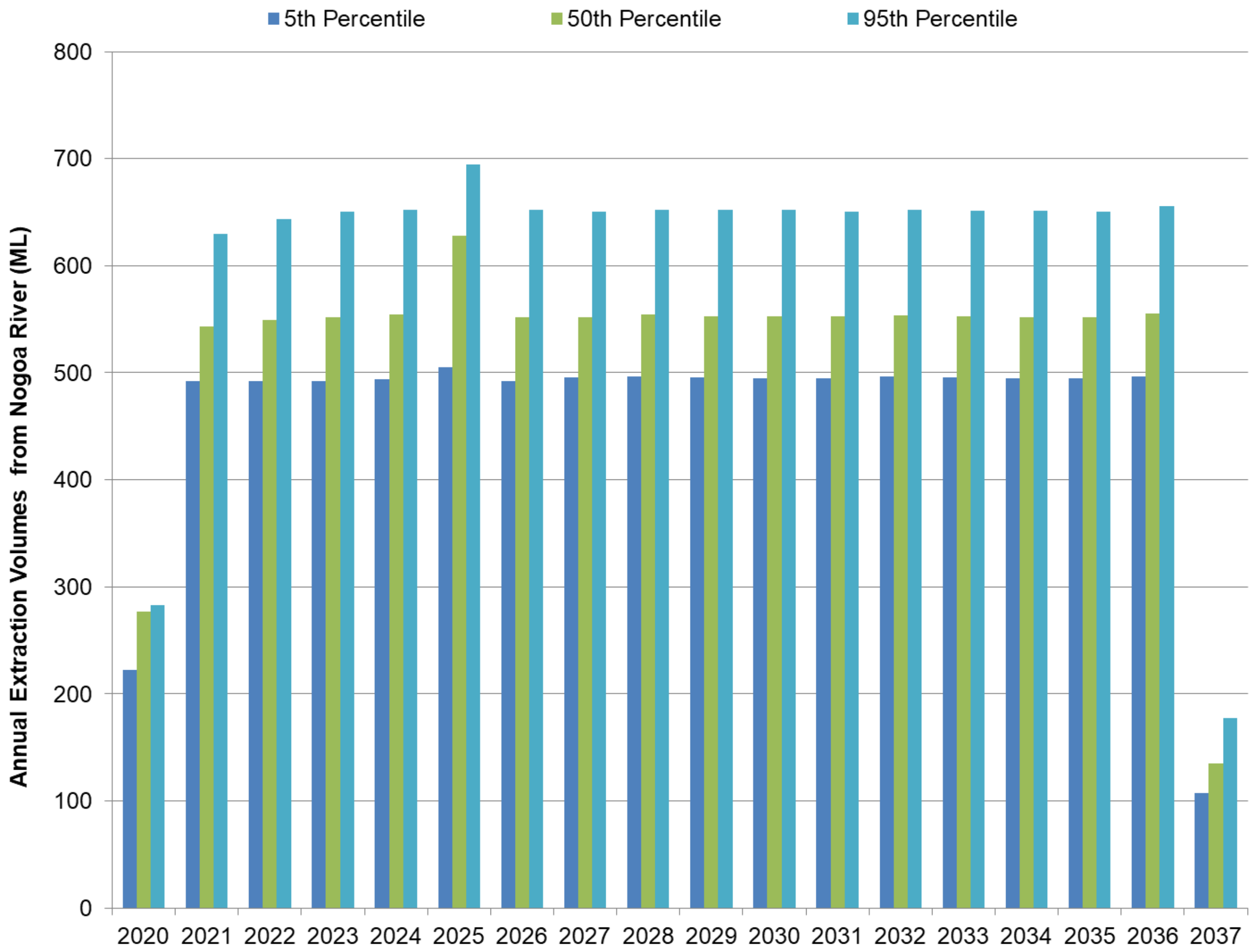
Overflows from Sailors Dam are predicted to occur in high rainfall periods. Overflows are not predicted to occur when extraction from the river is occurring as volumes are only extracted from the Nogoa River when volumes in the Clearwater Dam are below a minimum threshold (i.e. are well below spill level).

Figure 24 illustrates that the maximum annual overflow from Sailors Dam is predicted at 265 ML, based on the 95th percentile model results. The 95th percentile results typically are a result of only a few overflows a year from the Sailors Dam and as such most years show a similar volume.

4.6 NOGOA RIVER EXTRACTION

The model predictions for the existing operation and the Project indicate that, based on the 95th percentile of all realizations, an annual extraction volume of between 600 ML and 700 ML is required to be supplied from the Nogoa River to the Clearwater Dam (refer Figure 25).

As such, the current annual extraction allocation for the Nogoa River of 1,500 ML/yr is sufficient to meet the annual demand requirements for the existing operation and the Project.



*Years 2020 and 2037 show only partial years extraction due to simulation start and end dates

Figure 25 Predicted Extraction Rates from Nogoa River - Proposed Project

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

The key model conclusions for the existing operations and the Project are as follows:

- for both the Project and existing operations, the average supply reliability (volume supplied divided by demand volume) is expected to be greater than 97%;
- the existing water management system has been shown to manage surface water volumes for the proposed project;
- the Project is not predicted to result in an increase in the average annual release to the Nogoa River when compared to existing operations;
- all overflows are from Sailors Dam to the Nogoa River and are clean as the dam contains raw water due to being fed only by catchment run off and river water supply;
- the Project will not result in higher EC values compared to those seen in existing operations;
- the model predictions for the existing operation and the Project indicate that, based on the 95th percentile of all realizations, a similar annual extraction volume of between 600 ML and 700 ML is required in both scenarios. This is less than the current annual extraction allocation from the Nogoa River of 1,500 ML/yr; and
- model predictions of EC at RP1 (controlled release point to the Nogoa River) have been reviewed against recorded data and show that predicted EC values are similar to the historic range recorded, giving confidence in the modelling results.

5.2 RECOMMENDATIONS

It is recommended that additional relevant data required to complete model calibration be collected as part of normal water monitoring activities with the view to confirming the modelling provided in this report.

6.0 REFERENCES

Boughton, W.C. (2004). “The Australian Water Balance Model”, *Environmental Modelling and Software*, vol.19, pp. 943-956.

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