NEWLANDS COAL EXTENSION PROJECT

Mine Water Management Report

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Revision History

Revision	Date	Comment	Signatures		
			Originated by	Checked by	Approved by
0	17/7/12	Client Issue	[signature]	[signature]	[signature]

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Glossary

AEP	Annual Exceedance Probability
ARI	Average Recurrence Interval, which describes the average, or expected, value of the periods between exceedances of a given rainfall total accumulated over a given duration.
AWBM	Australian Water Balance Model, which is a widely applied hydrological model based on partial area saturation overland flow.
BOM	Bureau of Meteorology
CHPP	Coal Handling Preparation Plant, where coal is washed to increase the quality of the product
Clean water	Water from undisturbed catchments, suitable for discharge without treatment
Datadrill	A service provided by the Queensland Department of Natural Resources and Water (DNRW) that produces continuous patched-point meteorological datasets for any given location in Australia
DERM	Department of Environment and Resource Management (now EHP)
DNR	Department of Natural Resources (now EHP)
DSA	Disturbed Soil Area
EA	Environmental Authority
EC	Electrical Conductivity
EHP	Department of Environment and Heritage Protection
ESP	Exchangable sodium percentage
Mine-affected water	Water from disturbed catchments, potentially unsuitable for direct discharge due to salt concentration. It may also contain sediment that requires removal prior to release to the environment.
ML	Mining Lease
MRL	Mandatory Reporting Limits
OPSIM	A software package specifically design for mine water balance studies
Pan evaporation	Evaporation measured in a Class A pan
Pan factor	Relationship between pan evaporation and evaporation observed from a large open waterbody.
ROM	Run Of Mine, coal delivered from the pit face prior to washing
Sediment-affected water	Water from disturbed catchments, suitable for discharge after sediment removal
Sedimentation dam	A structure that is designed to settle suspended sediment
TDS	Total dissolved salts
VRC	Volumetric Runoff Coefficient, which defines the proportion of rainfall appearing as runoff over the long term
WRD	Waste rock dump

1 Introduction

This report presents a site water management strategy and water balance for the Newlands Coal Extension Project (the Project). The purpose of the water balance is to establish a site mine water management system that can ensure a supply of water to meet mining needs, and enable planning for water management infrastructure to protect the environment.

Water management for the Project will operate independently of the existing mine, and therefore this strategy considers the Project only. There may be benefits that could be achieved by linking water management at the existing mine with the Project. These may be explored closer to the time the new open cut mining areas come online, in consultation with regulators and site operators.

1.1 WATER MANAGEMENT OBJECTIVES

The objective of the Project water management strategy is to be able to manage water generated within the Project area and reuse or control releases to the environment in a manner that does not cause adverse impacts to surface water quality or stream hydrology. Therefore the strategy aims to:

- release to the environment only when the receiving waterway is flowing or has recently flowed
- contain sediment within the mining area
- maintain water quality in the receiving environment within the ranges observed in the catchment prior to mining disturbance.

1.2 DESCRIPTION OF THE PROJECT

1.2.1 Project components

The main features of the Project include:

- Progressive development of the Northern Underground mine to the east and south of the existing underground workings on the existing Mining Leases (ML's 4774, 4748, 1031610317, 10322 and 10348). The new operations requiring assessment are located on three new mining leases including ML10352, ML10361 and ML10362.
- Continuation of open cut mining activities at Eastern Creek mine, extending eastward of the existing lease boundary (ML4755) onto ML10352.
- Progressive development of three new open cut pits on ML10352 – Eastern Creek South, Eastern Creek East and Eastern Creek West.

- Development of new haul roads on ML10352 connecting the Eastern Creek South, Eastern Creek East and Eastern Creek West pits to the existing Eastern Creek haul road on ML10322.
- Staged establishment of new Run of Mine stockpile areas for the Eastern Creek South, Eastern Creek East and Eastern Creek West pits.
- Construction of hardstand areas, relocation or purchase of mobile, self-contained offices and abolitions facilities from other existing mine operations to new pit areas for Eastern Creek South, Eastern Creek East and Eastern Creek West.
- Progressive rehabilitation of overburden stockpiles with a self-sustaining vegetation community as the proposed post–mining land use.

1.2.2 Mining progression

The mining progression involves catchment disturbance and progressive rehabilitation. The type and extent of disturbance within the catchment throughout the life of the Project is shown in Figures 1.1 to 1.7. These represent snapshots for Years 2017, 2020, 2023, 2026, 2030, 2034 and 2038.

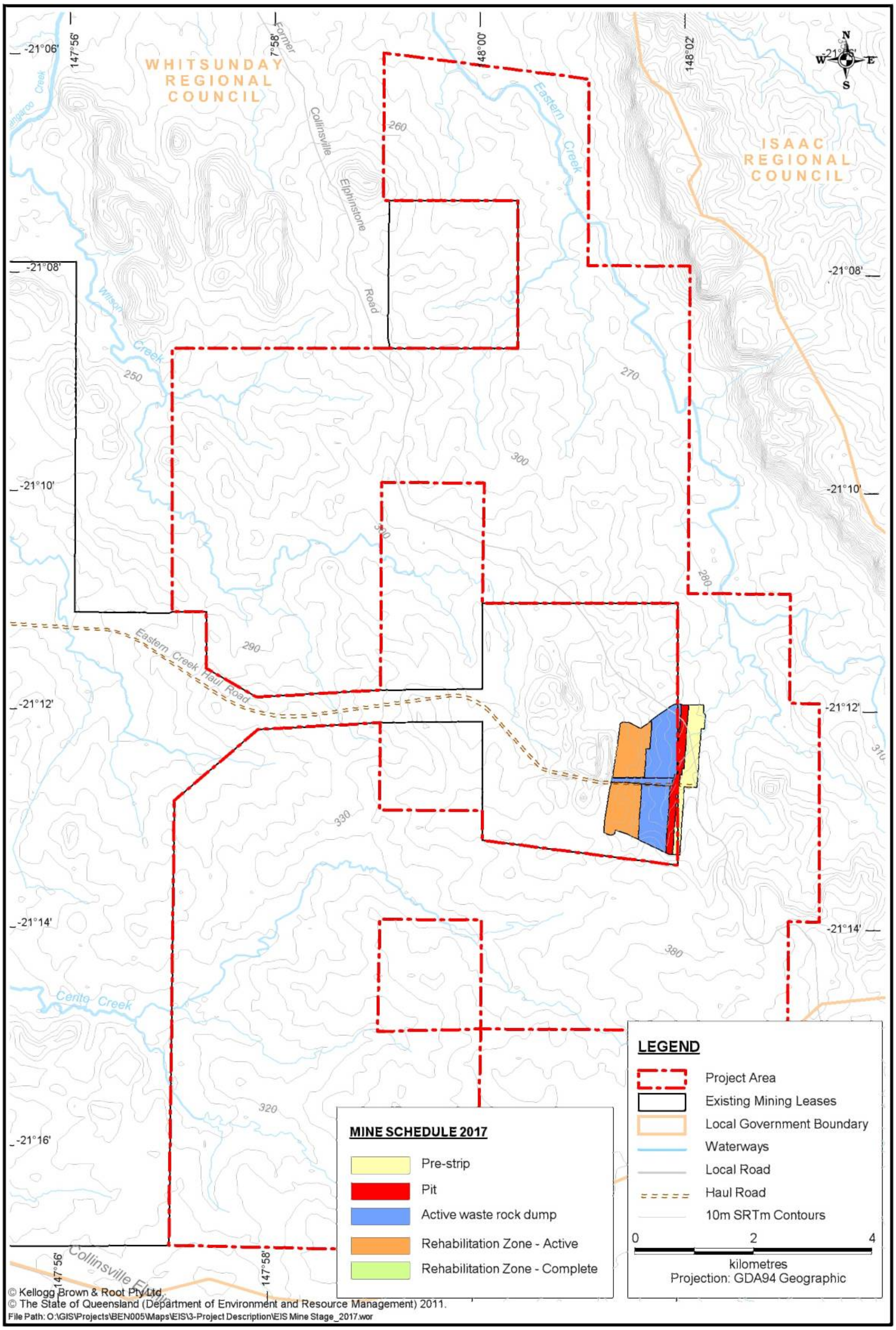

Figure 1.1
MINE STAGING PLAN 2017

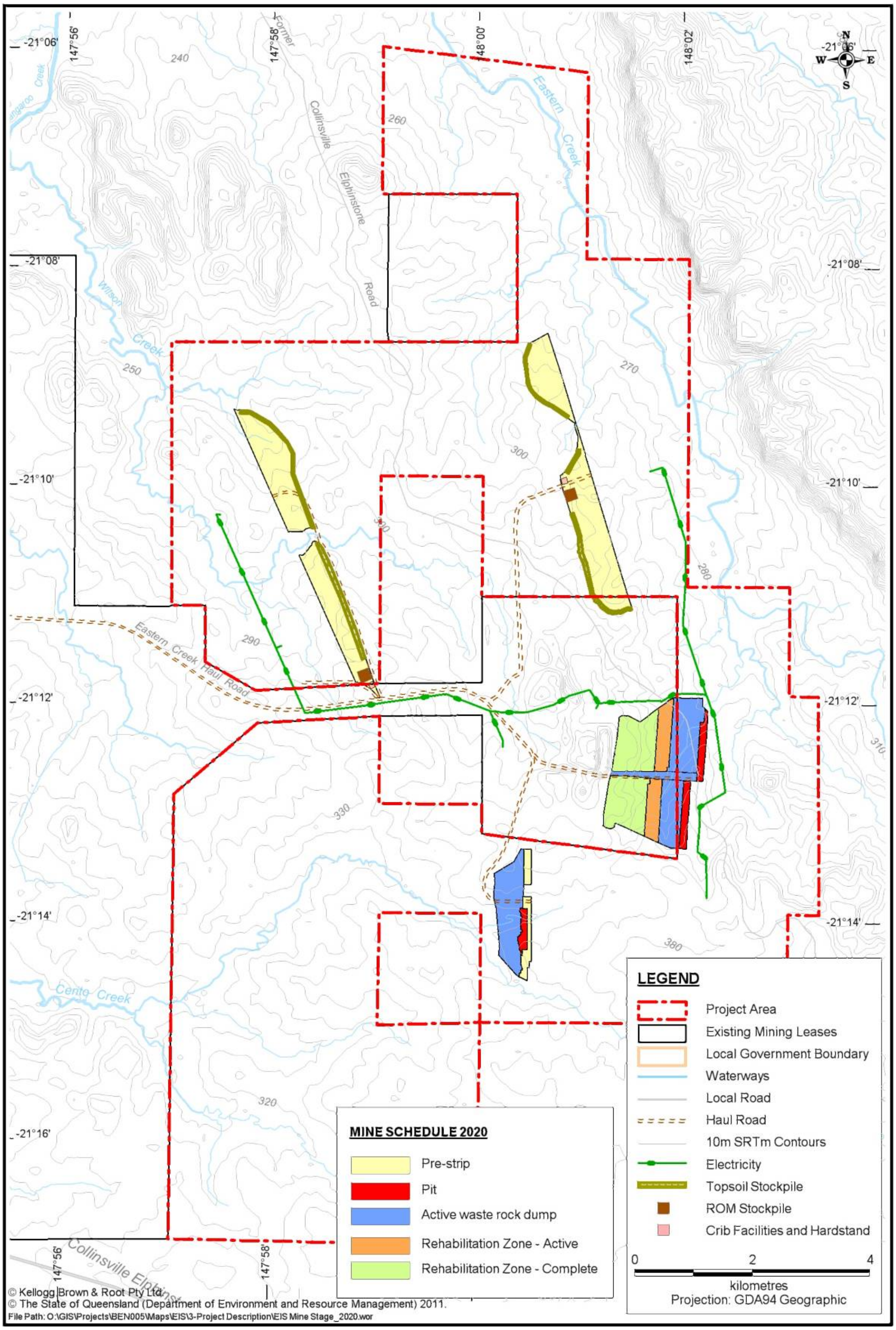

Figure 1.2
MINE STAGING PLAN 2020

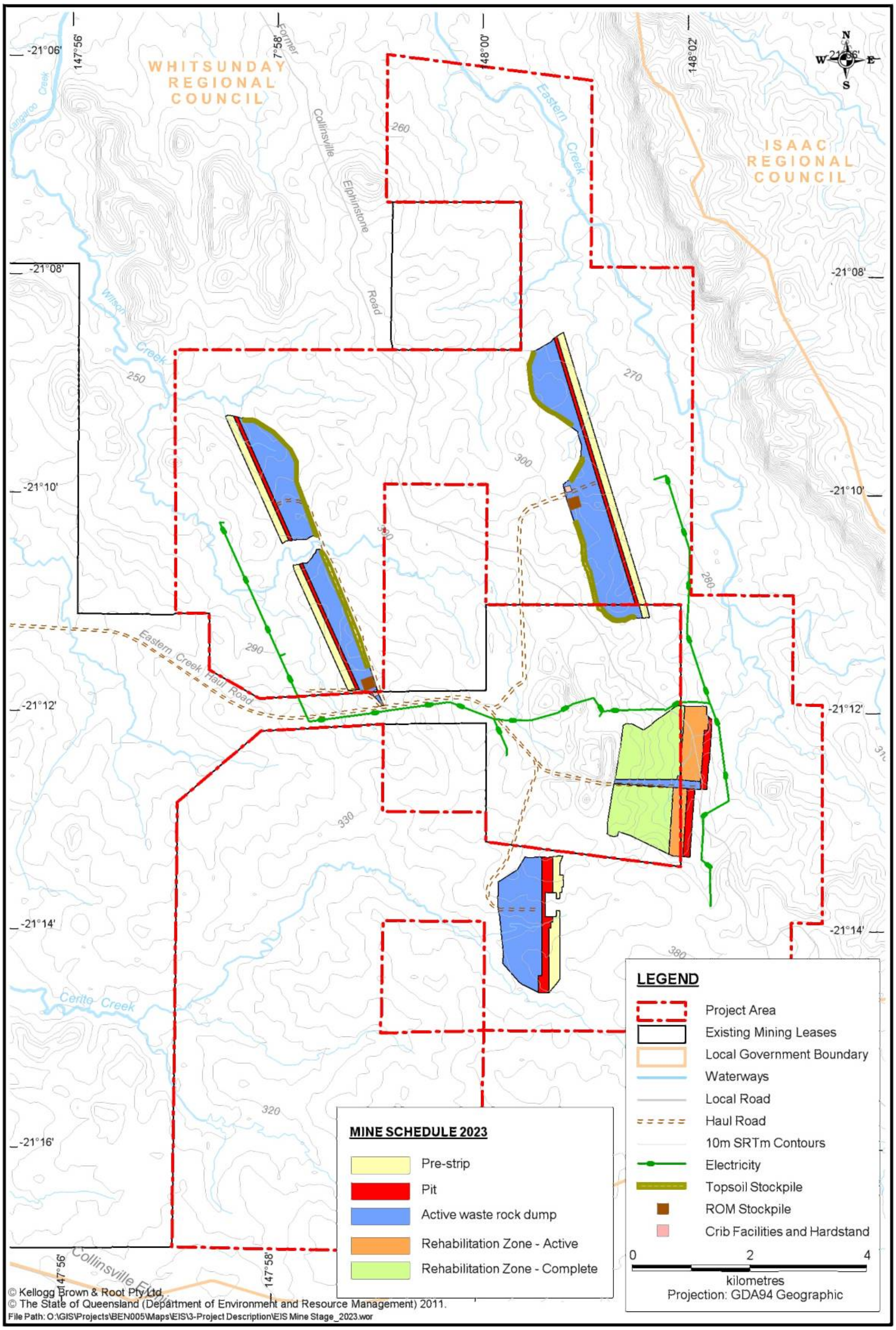

Figure 1.3
MINE STAGING PLAN 2023

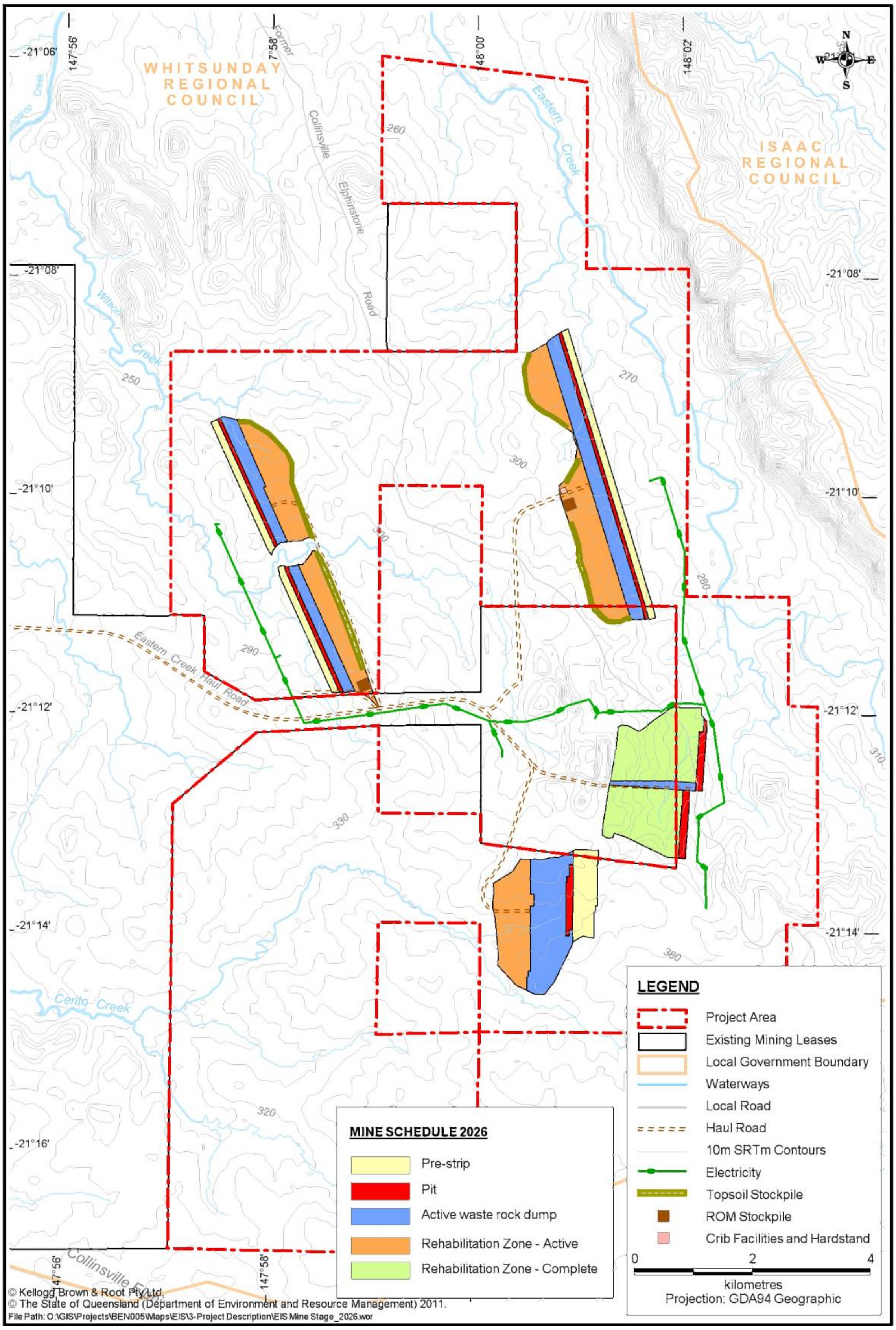

Figure 1.4
MINE STAGING PLAN 2026

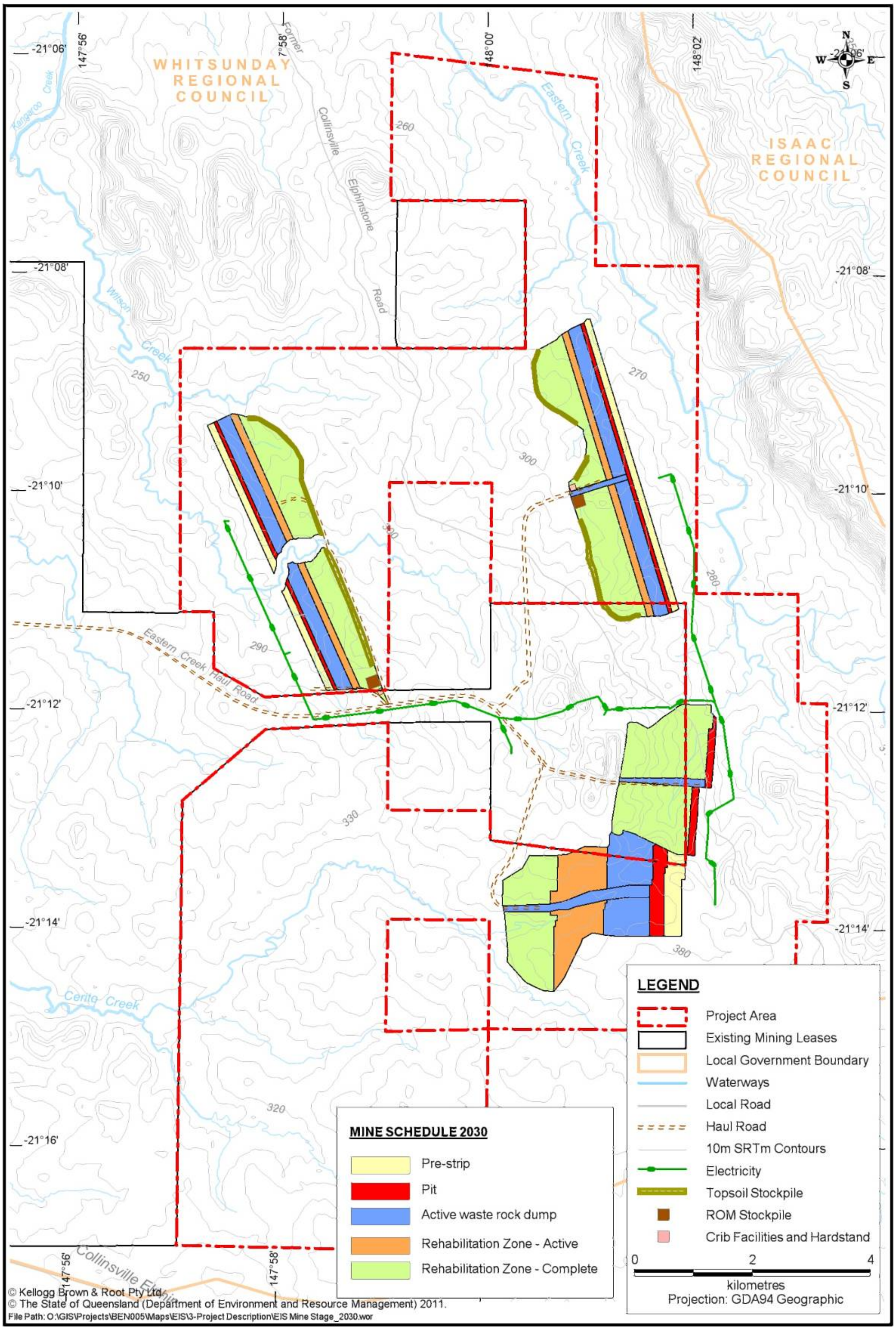

Figure 1.5
MINE STAGING PLAN 2030

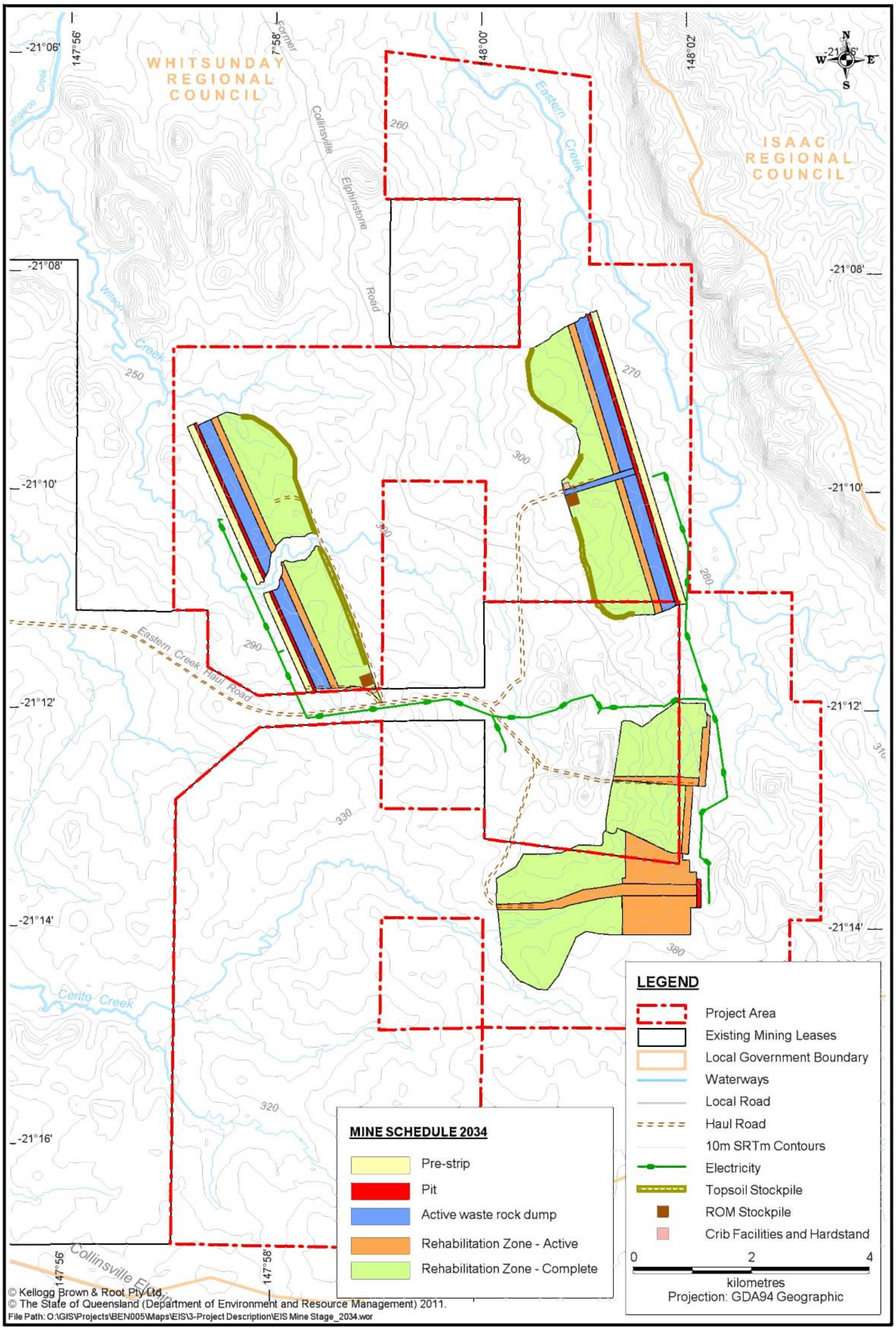

Figure 1.6
MINE STAGING PLAN 2034

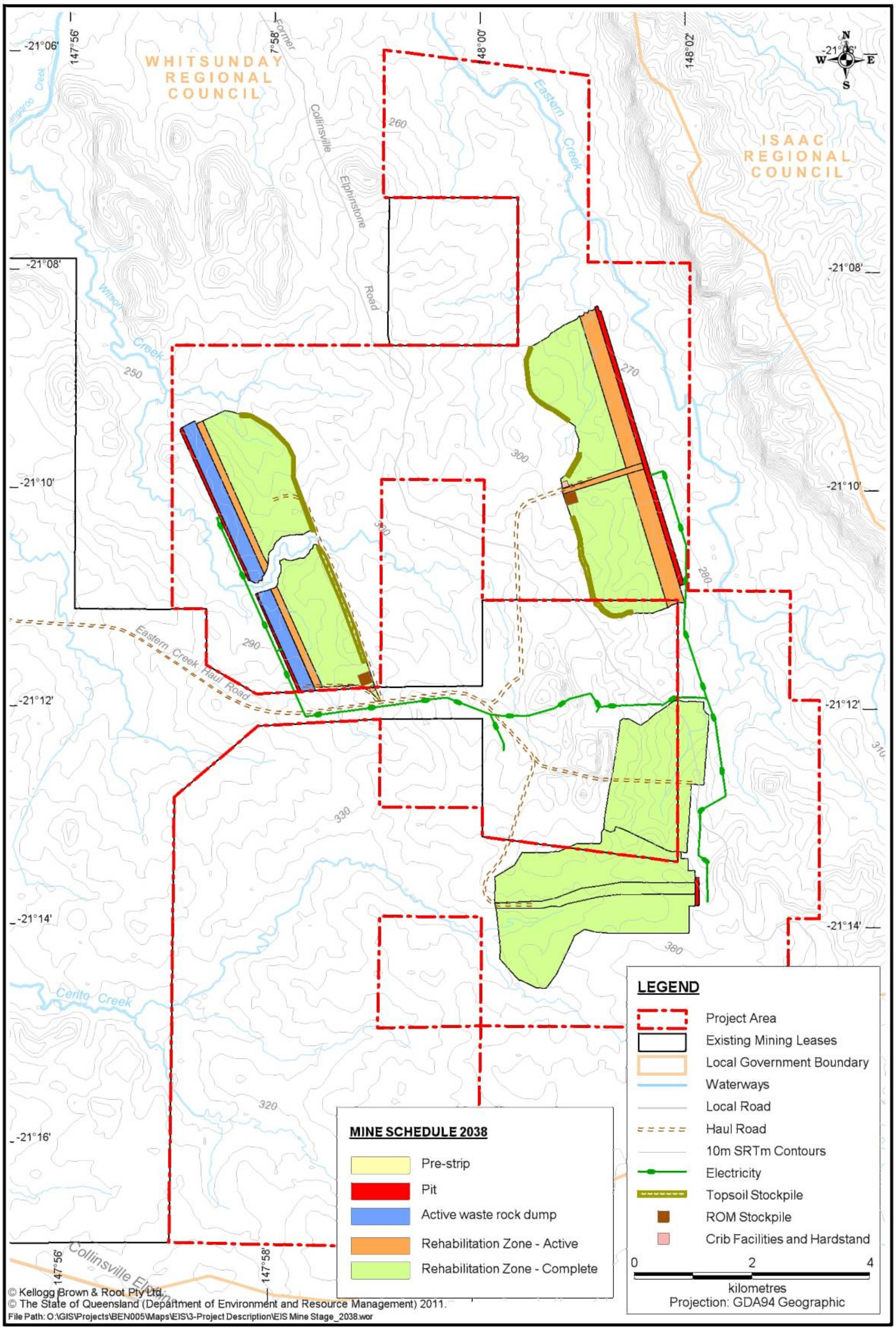

Figure 1.7
MINE STAGING PLAN 2038

1.2.3 Water supply

The major water demands for the existing mine include:

- dust suppression
- Coal Handling Preparation Plant (CHPP) (coal washing)
- truck wash and industrial usage
- miscellaneous usage such as wash down and cleaning, crib facilities etc.

Water inputs to the existing operation include:

- runoff from mine affected catchments
- groundwater inflow to pits and dewatering of the underground workings (4.4 million litres per day)
- local undisturbed catchments (0.8 million litres per day)
- imported water from the Bowen River (allocation 6.2 million litres per day, although use is typically 2 to 3 million litres per day).

There is also the option of taking water from the available SunWater allocation to the Proponent which is 2,820 million litres per year for its mining and town facilities.

The water demand for the Project will comprise water for dust suppression on haul roads and stockpiles, plus minor usage in crib facilities. The predicted demand for water by the Project (i.e. excluding the existing mine) varies over the life of the Project, but peaks in 2030 at 2.4 million litres per day. This demand will normally be met by water captured within the new open cut pits or from groundwater derived from the extension of the underground mine. In the event of prolonged drought, the Project may draw on the available SunWater allocation to the Proponent. The Proponent has reviewed water demands across their various Projects and determined that the existing allocations are sufficient to meet any additional water requirements for the Project.

During a drought up to 80% of the Project demand will need to be supplied from external sources (up to 2.1 million litres per day). However, in wet and average rainfall periods the water balance indicates that the demand from external sources will be negligible (less than 3% of water demand).

Refer to Section 3 for details of the mine water balance model.

2 Water management strategy

2.1 INTEGRATION OF WATER MANAGEMENT BETWEEN THE PROJECT AND EXISTING MINE

The existing mine operates a water management system that covers Newlands, Eastern Creek, Suttor Creek and Wollombi. The existing Environmental Authority specifies how and where water is to be stored, monitored and released to the environment.

The existing mine has 23 release points, 12 of which lie within the Rosella Creek catchment (in which the Project is situated) with the remainder in the Suttor River catchment.

The Project, if approved, will be incorporated into a revised Environmental Authority. Water will be managed using the same approach and framework as the existing mine. This involves water segregation based on quality and undertaking controlled release to the environment.

The Project will not utilise any of the existing release points, since these are not situated in appropriate locations for the Project. Six new release points are proposed for the Project, as described further in Section 2.3.1.

Water management for the existing mine within the Rosella Creek portion of the catchment utilises a downstream compliance point in Kangaroo Creek (WQS5). A small part of the Project will drain towards this location and can be incorporated into the overall management strategy to ensure compliance at this location. However, the majority of the Project disturbance and water releases will occur in the Wilson Creek and Eastern Creek portions of the broader Rosella Creek catchment, for which compliance points do not currently exist. Two new compliance points are therefore proposed.

The Project has the ability to manage water independently of the existing mine, although there may be benefits that could be achieved by linking water management across the mining areas. Newlands Coal will explore these opportunities closer to the time the new open cut mining areas come online in consultation with regulators and site operators.

2.2 WATER SEGREGATION

Water within the Project area will be segregated based on quality. This will maximise opportunities for water reuse, minimise the mine water inventory and minimise changes to the hydrological regime (e.g. by allowing clean water to pass around the disturbed areas). It also provides an opportunity to undertake controlled blending of different water types, which might be desirable to dilute saline waters for example.

Three water classifications have been nominated for the Project:

- mine-affected water, which will be water from disturbed catchments, potentially unsuitable for direct discharge primarily due to salt concentration. It may also contain sediment that requires removal prior to release
- sediment-affected water, which will be water from disturbed catchments, suitable for discharge after sediment removal in accordance with a water management plan prepared for the Project, as required by the Environmental Authority
- clean water, which will be water from undisturbed catchments, suitable for direct discharge in accordance with a water management plan prepared for the Project, as required by the Environmental Authority.

These are described in more detail below. Figures showing specific dams referenced below are provided in Section 2.4.

2.2.1 Mine-affected water circuit

Mine-affected water is water not suitable for direct release, primarily due to elevated salinity. This water may be generated from:

- groundwater ingress to open cut pits
- groundwater ingress to the underground mine
- groundwater extraction during degasification in advance of the underground mine
- pit wall runoff
- fresh waste rock prior to rehabilitation.

Mine-affected water will be contained on site in dams until sufficient dilution can be achieved either in the receiving environment or by blending water within the mining area.

The current Environmental Authority permits mine-affected water to be released from site when salinity falls within pre-determined end-of-pipe and receiving environment concentrations and when water is flowing or has recently flowed in the receiving environment. The same approach will be adopted for the Project and a water balance has been developed to size water storages and demonstrate that the proposed design can cater for a range of climate scenarios. Refer to Section 3 for further details of the water balance model.

Water management associated with the CHPP, mine industrial area and other aspects of the existing mine are not included as they do not form part of the Project.

2.2.2 Sediment-affected water circuit

Areas that drain rehabilitated waste rock dumps, access roads and laydown areas have the potential to generate sediment laden runoff. Sediment-affected water will pass through sedimentation dams prior to release to the environment, once the applicable sediment concentrations, as stated in the Environmental Authority, have been satisfied. Releases will be made in accordance with a water management plan prepared for the Project, as required by the Environmental Authority.

Soil characterisation has been completed as part of the EIS which identified that soils are typically fine grained and dispersive and therefore most likely to erode and contribute sediment to the local waterways.

A geochemistry assessment was undertaken of the waste rock and rejects. From a soil chemistry viewpoint, the waste rock is alkaline, has relatively low salinity concentrations, and moderate cation exchange capacity values. The main issue with waste rock likely to report to emplacement facilities is that it typically has an elevated exchangeable sodium percentage (ESP) value. Where the electrical conductivity is low, such as in the tested samples, an ESP value of 6% or greater indicates that materials are sodic and may be prone to dispersion (Isbell, 2002). Soil with an ESP value greater than 14% is regarded as strongly sodic (Northcote and Skene 1972). The ESP range in the samples analysed ranges from 3% to 25%. One sample recorded an ESP less than 7%, 42% of samples (five samples) recorded an ESP between 7% to 14%, and 50% of sample (six samples) recorded an ESP of more than 14%.

On the basis of the soil and waste rock characteristics, it is likely the waste rock will have structural stability problems related to potential dispersion. Sedimentation basins will therefore be required until the disturbed areas are sufficiently rehabilitated and stabilised.

The design and operation of sedimentation basins will be similar to that used for the existing mine.

2.2.3 Clean water circuit

In most cases runoff from undisturbed catchments upstream of the mining area will be diverted around the disturbed area and released directly to the environment. In some cases a clean water dam is proposed either to facilitate the diversion, or to provide a source of clean water that can be used to blend with mine water.

The location and extent of out-of-pit dumps and other infrastructure has been designed to maximise the ability to drain clean water around disturbed areas. There are two locations where mining pits intersect a tributary and a clean water pump-out arrangement is required. This occurs as follows:

- Eastern Creek South pit – A clean water dam (Dam C1) will be required on the upslope side of the active mining pit. The location of the dam will shift up the catchment as the mining face progresses. The extent of the clean water catchment will diminish as mining progresses, until at the end of mining none will remain. A permanent diversion will be implemented for the catchment upslope of the mined extent (catchment draining to Dam C2). This diversion will be constructed at the beginning of mining in this area.
- Eastern Creek East pit – A clean water dam (Dam C3) will be required to drain an undisturbed tributary intersected by the Eastern Creek East pit. The location of the dam will be fixed for the duration of mining, but removed at the end of mining in order to re-instate the tributary over the rehabilitated waste rock.

Water quality of the clean water circuit will be typical of the existing waterways. The clean water circuit will flow to the receiving waterway when runoff occurs, except in situations where a dam is proposed. Releases will be made in accordance with a water management plan prepared for the Project, as required by the Environmental Authority.

2.3 CONTROLLED RELEASE STRATEGY

It will be necessary for the Project to release water to the receiving environment to balance the mine water inventory. This will be achieved through a controlled release strategy that allows discharge into waterways only when specific flow and water quality criteria have been satisfied.

It is proposed that discharge of mine-affected water to the environment will be permitted on the basis of:

- end-of-pipe water quality. This controls the water quality that enters the environment. A range of water quality indicators will be used to ensure the water quality is suitable for release. The salinity limits (measured as electrical conductivity) vary based on the flow in the receiving waterway
- receiving waterway (downstream) water quality. This controls the water quality in the receiving environment at a downstream location, below a mixing zone. This provides an opportunity to utilise dilution in the receiving waterway, while ensuring that the water quality in the receiving waterway is maintained within a range experienced in the natural environment.

2.3.1 Release points

Six new release points are proposed for the Project. These are located at the outlet of selected water storage dams in Eastern Creek, Wilson Creek and Cerito Creek catchments. The proposed release points are presented in Table 2.1 and shown in Figure 2.1.

Table 2.1 Proposed release points

Release Point	Latitude	Longitude	Mine-affected water source and location	Monitoring point	Receiving waters description
M1	-21° 11' 46"	148° 2' 31"	M1	At discharge location	Eastern Creek
M2	-21° 12' 50"	148° 0' 40"	M2	At discharge location	Wilson Creek
M3	-21° 8' 2"	148° 0' 58"	M3	At discharge location	Eastern Creek
M4	-21° 9' 25"	147° 57' 4"	M4	At discharge location	Wilson Creek
M5	-21° 11' 24"	147° 57' 40"	M5	At discharge location	Wilson Creek
S3	-21° 13' 59"	148° 0' 4"	S3	At discharge location	Cerito Creek

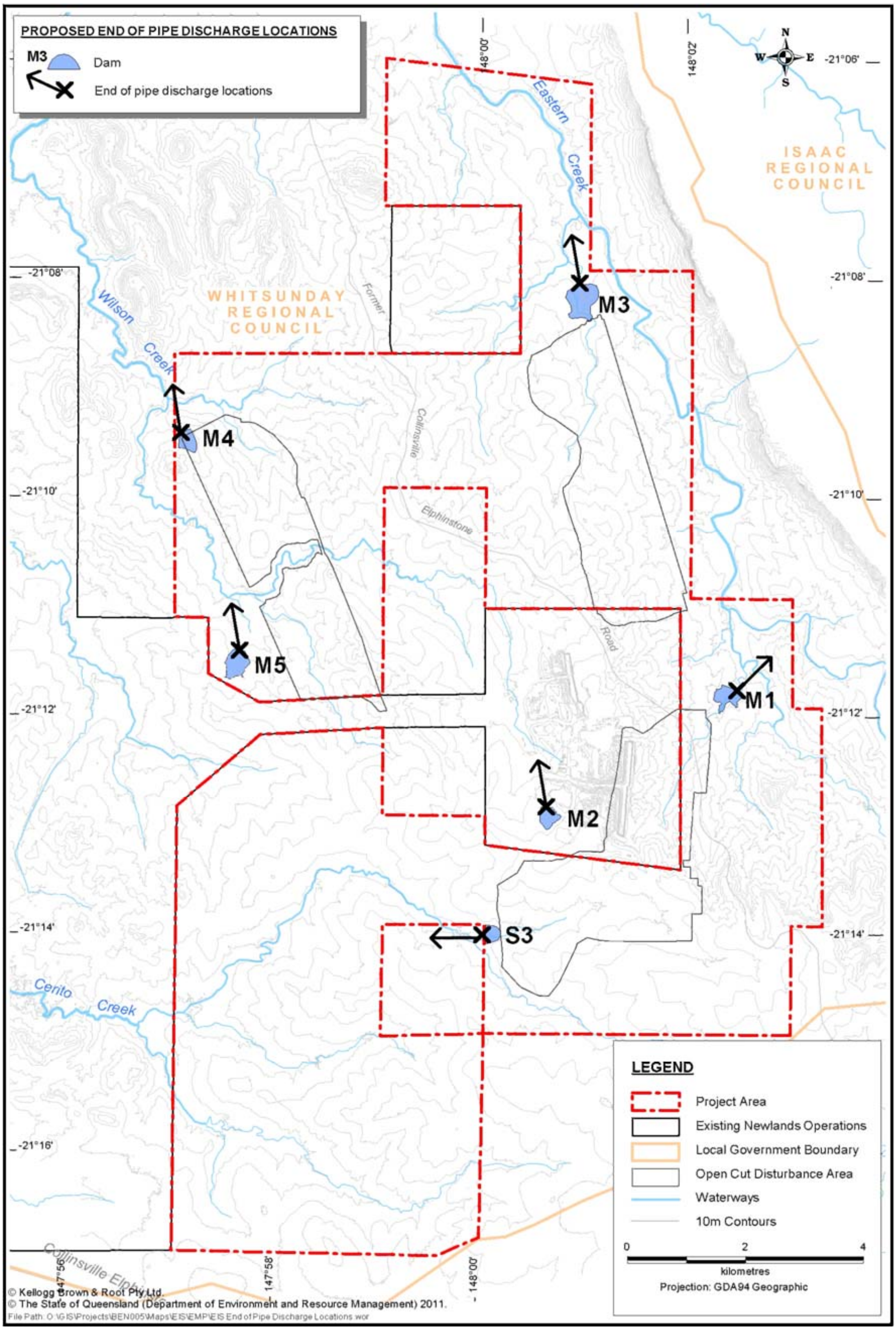

Figure 2.1
PROPOSED WATER RELEASE POINTS

2.3.2 Downstream compliance points

Three downstream compliance points will be used for the Project. Two of these are new compliance points that are located in Eastern Creek and Wilson Creek. An existing compliance point (WQS5) in Kangaroo Creek will be used for discharges to Cerito Creek that eventually drain to the compliance point. The proposed compliance points are presented in Table 2.2 and shown in Figure 2.2.

Table 2.2 Locations of proposed compliance points

Compliance point	Mining area	Latitude	Longitude
Eastern Creek downstream (CP1)	Ramp 10 (extended)	-21° 6' 3"	147° 59' 46"
	Eastern Creek East pit		
Wilson Creek above confluence with Kangaroo Creek (CP2)	Eastern Creek South pit	-21° 7' 22"	147° 55' 55"
	Eastern Creek West pit		
Kangaroo Creek downstream (WQS5)	Existing mine	-21° 7' 34"	147° 54' 32"

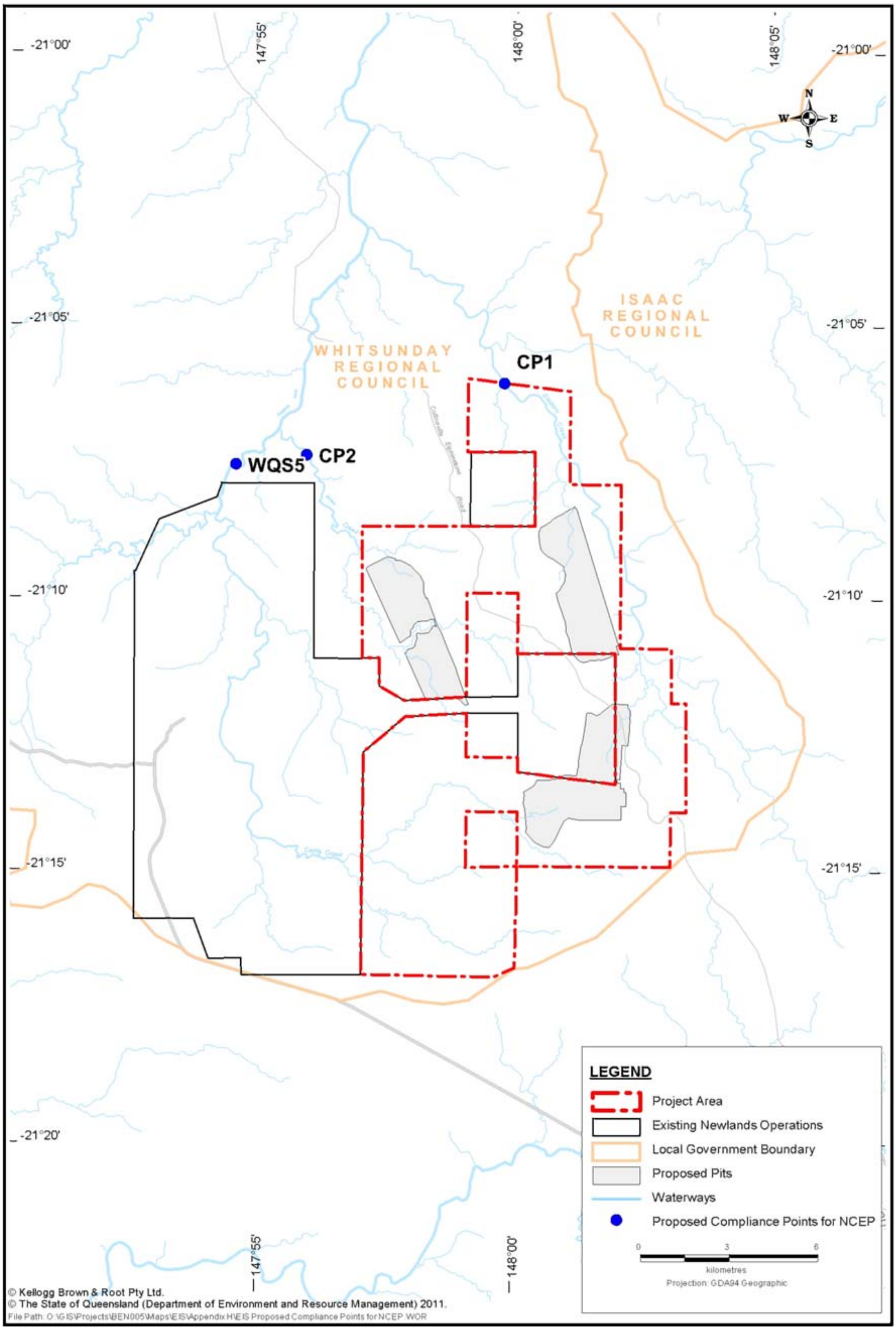

Figure 2.2
PROPOSED DOWNSTREAM COMPLIANCE POINTS

2.3.3 Release limits and trigger investigation levels

The proposed controlled release conditions for the Project have been developed based on the existing mine Environmental Authority. The conditions have been customised to suit the local catchment of the Project area.

In alignment with the Environmental Authority for the existing mine, release limits applicable to the Project will be specified for electrical conductivity, pH and sulfate. Release limits are maximum values that cannot be exceeded.

Trigger investigation levels will also apply, which are values that if exceeded, trigger further investigation and reporting processes. This normally includes comparing upstream and downstream water quality data and assessing the risk of causing environmental harm. Trigger investigation levels apply to aluminium, cadmium, chromium, copper, iron, lead, nickel, zinc, boron, manganese, selenium, silver, uranium, vanadium, ammonia, nitrate, hydrocarbons and sodium.

These release limits and trigger investigation levels will apply at the six release points identified Table 2.1.

Receiving water contaminant trigger levels will apply at the downstream compliance points identified in Table 2.2. Trigger levels will be specified for pH, electrical conductivity, turbidity, suspended solids, sulfate and sodium.

The critical factor constraining release to the environment at the existing mine, and most likely also for the Project, is salinity (measured as electrical conductivity). Proposed end-of-pipe electrical conductivity limits and receiving environment electrical conductivity triggers are presented in Table 2.3.

Table 2.3 Electrical conductivity release limits and receiving environment electrical conductivity triggers

Receiving environment flow	EC Release limit (µS/cm)	Trigger level EC in receiving environment (µS/cm)	
		Eastern Creek downstream (CP1)	Wilson Creek above confluence with Kangaroo Creek (CP2)
Low (<0.5 m3/s)*	1,500	2,250	1,835
Med (0.5–1.0 m3/s)	3,500	2,250	1,835
High (>1.0 m3/s)	6,500	2,250	1,835

** After a flow event exceeding 0.5 cubic metres per second (m^3/s), release of high quality water (<1,500 microsiemens per centimetre (µS/cm) electrical conductivity) is permitted for a period of up to 42 days beyond reaching the recessional flow trigger of 0.1 cubic metres per second.*

The trigger levels for releases to Cerito Creek will be managed through the existing Environmental Authority conditions that apply to the existing downstream compliance point (WQS5).

Flow and electrical conductivity monitoring in the receiving waterway is measured at downstream compliance points. The electrical conductivity trigger values are based on the 80th percentile electrical conductivity values observed in the baseline monitoring program.

The release locations will be configured to enable the mine to respond to release opportunities as soon as possible. This is likely to involve gravity release systems (e.g. sluice gates or weirs) that are controlled by telemetry systems. This should overcome some of the difficulties experienced at the existing mine associated with accessing release dams during wet weather, missing the flow peak in the receiving waterway or having insufficient pumping capacity during release windows.

2.4 WATER MANAGEMENT INFRASTRUCTURE

The proposed mine water management infrastructure consists of dams, pumped transfers and diversions. The infrastructure requirements will change through the mine development as the disturbance area expands and the rehabilitation activities progress.

Three types of dams are proposed, being clean water dams, sediment dams and mine water dams. The Project will require 12 dams. The function of some of these dams will change over the life of the mine, for example, mine water dams may be converted to sediment dams. Dams will be established prior to disturbance of the catchment in which it lies, and decommissioned (or retained for future landholders) when the disturbed catchment has been rehabilitated.

The location of the dams is shown in Figure 2.3. Some of the dams will move as mining progresses and therefore the locations shown on the figure are indicative only.

There are 10 pumped transfers to move water from sumps in the open cut pits to mine water dams at the surface, as well as move water between storages.

Four diversions are required to re-route the flow path of waterways to prevent water from entering the active mining area.

Details of how the water management infrastructure will develop and function in each pit are described below. This is also shown schematically on Figures 2.4 to 2.10 which depict the catchment composition (clean, sediment-affected, mine-affected), proposed dam locations and water flow paths for years 2017, 2020, 2023, 2026, 2030, 2034 and 2038.

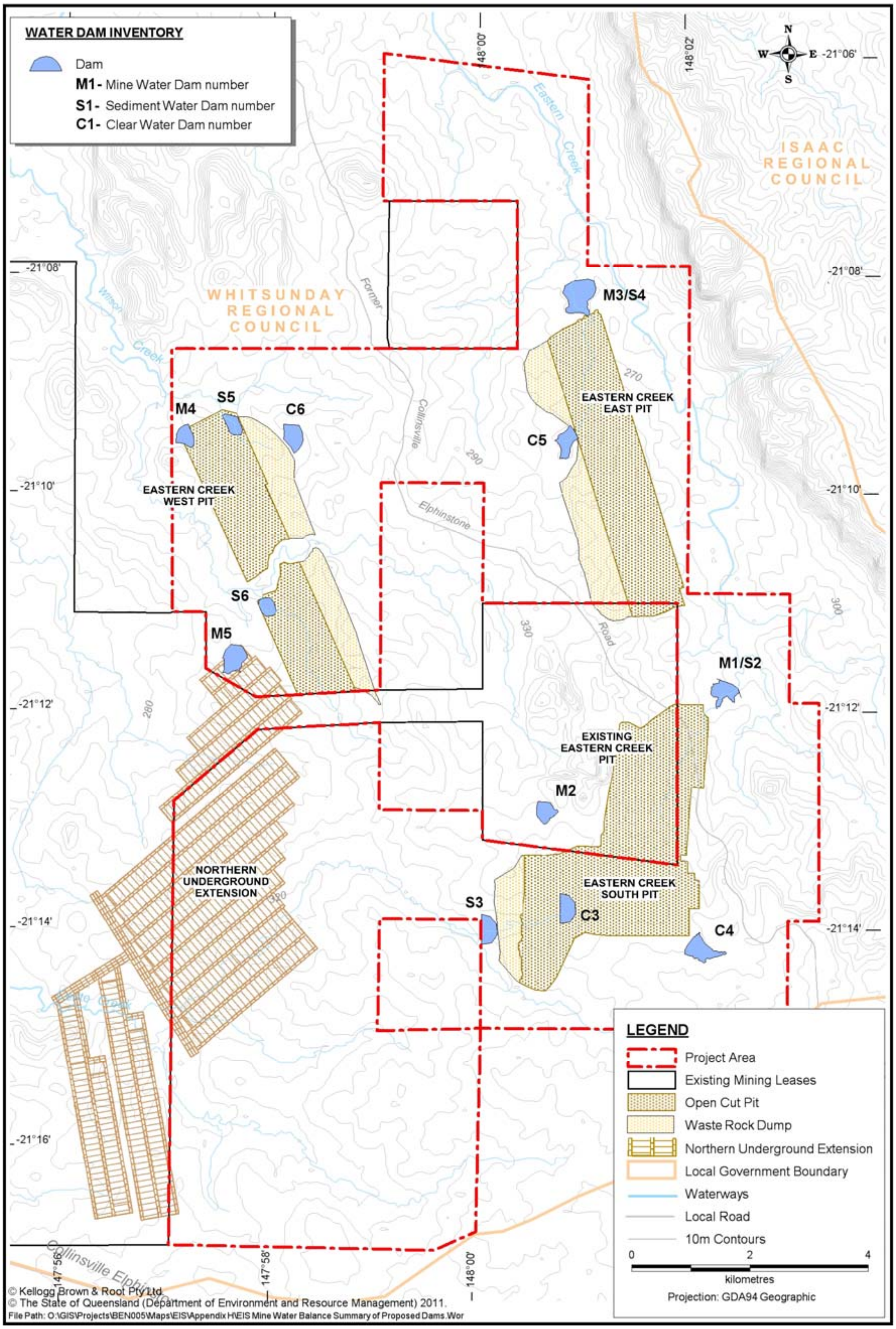

Figure 2.3
SUMMARY OF PROPOSED WATER DAMS

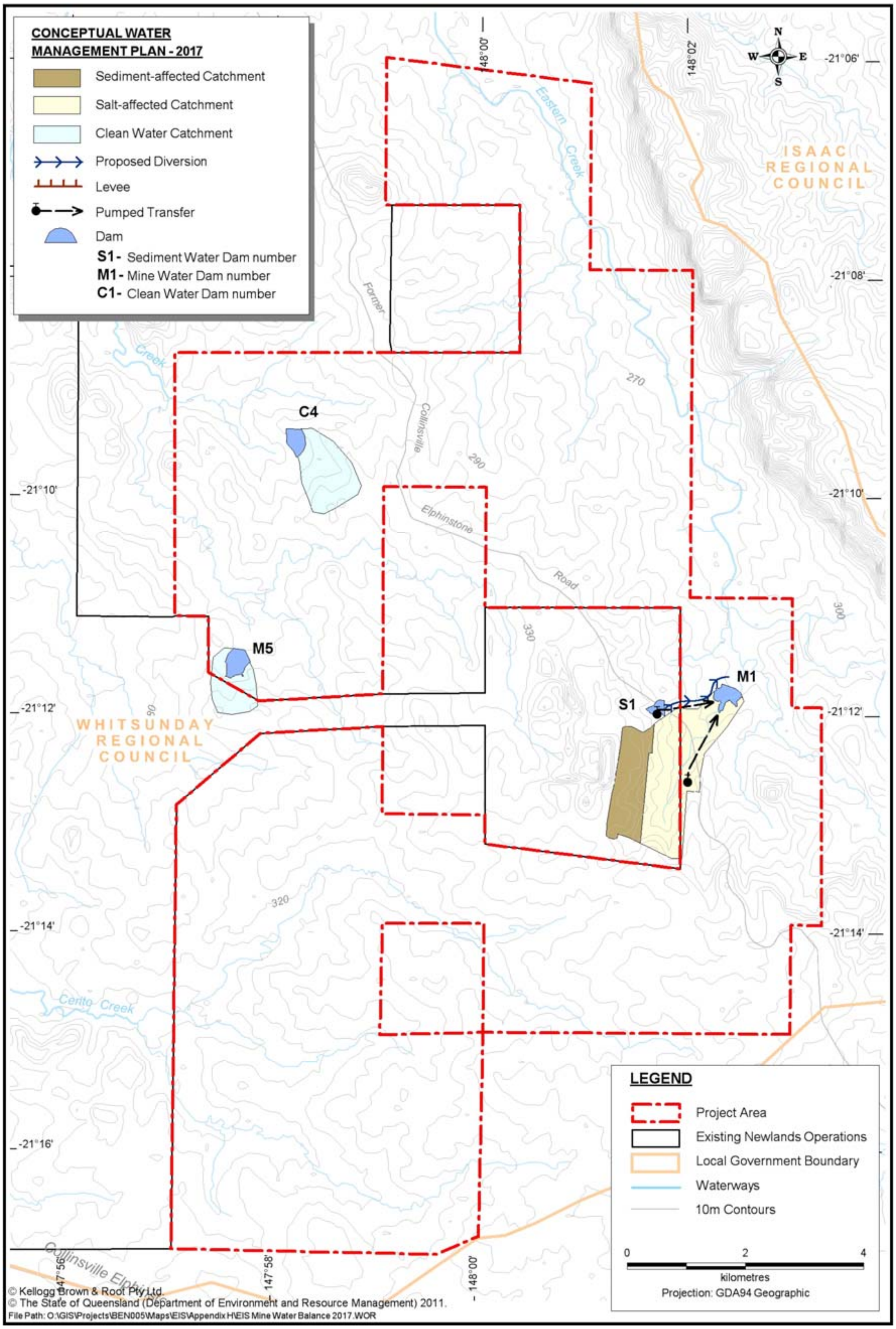

Figure 2.4
CONCEPTUAL WATER MANAGEMENT PLAN – 2017

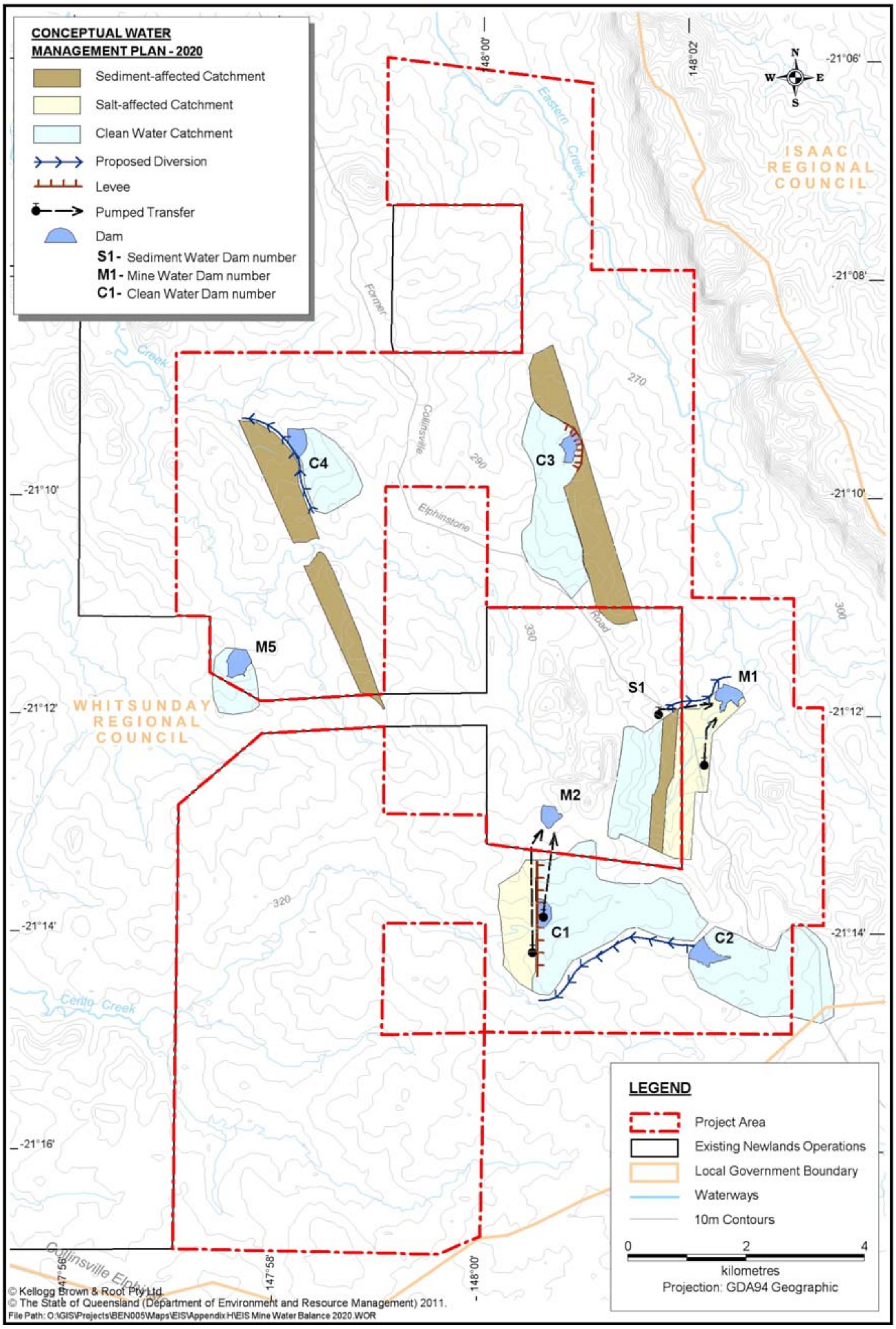

Figure 2.5
CONCEPTUAL WATER MANAGEMENT PLAN – 2020

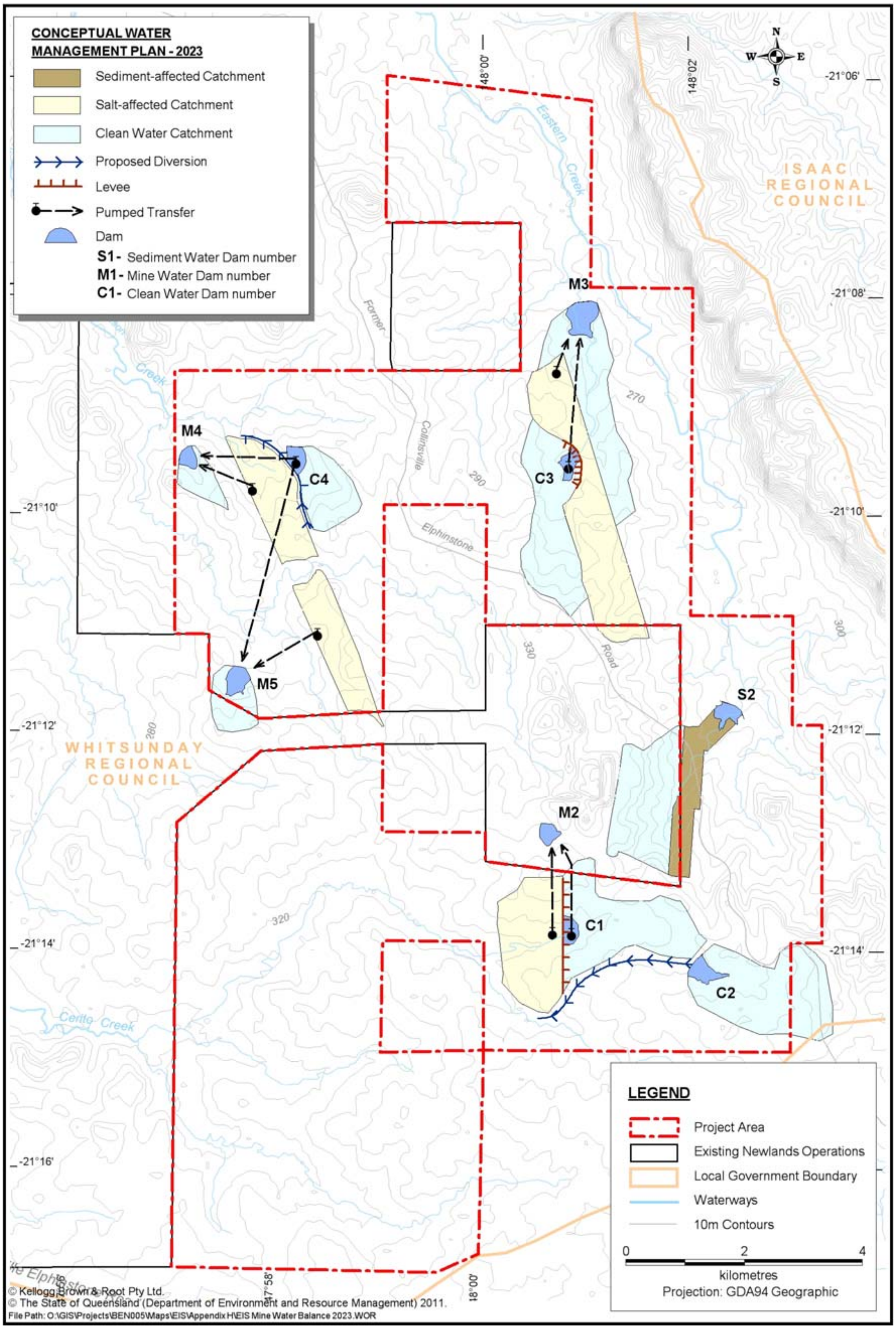

Figure 2.6
CONCEPTUAL WATER MANAGEMENT PLAN – 2023

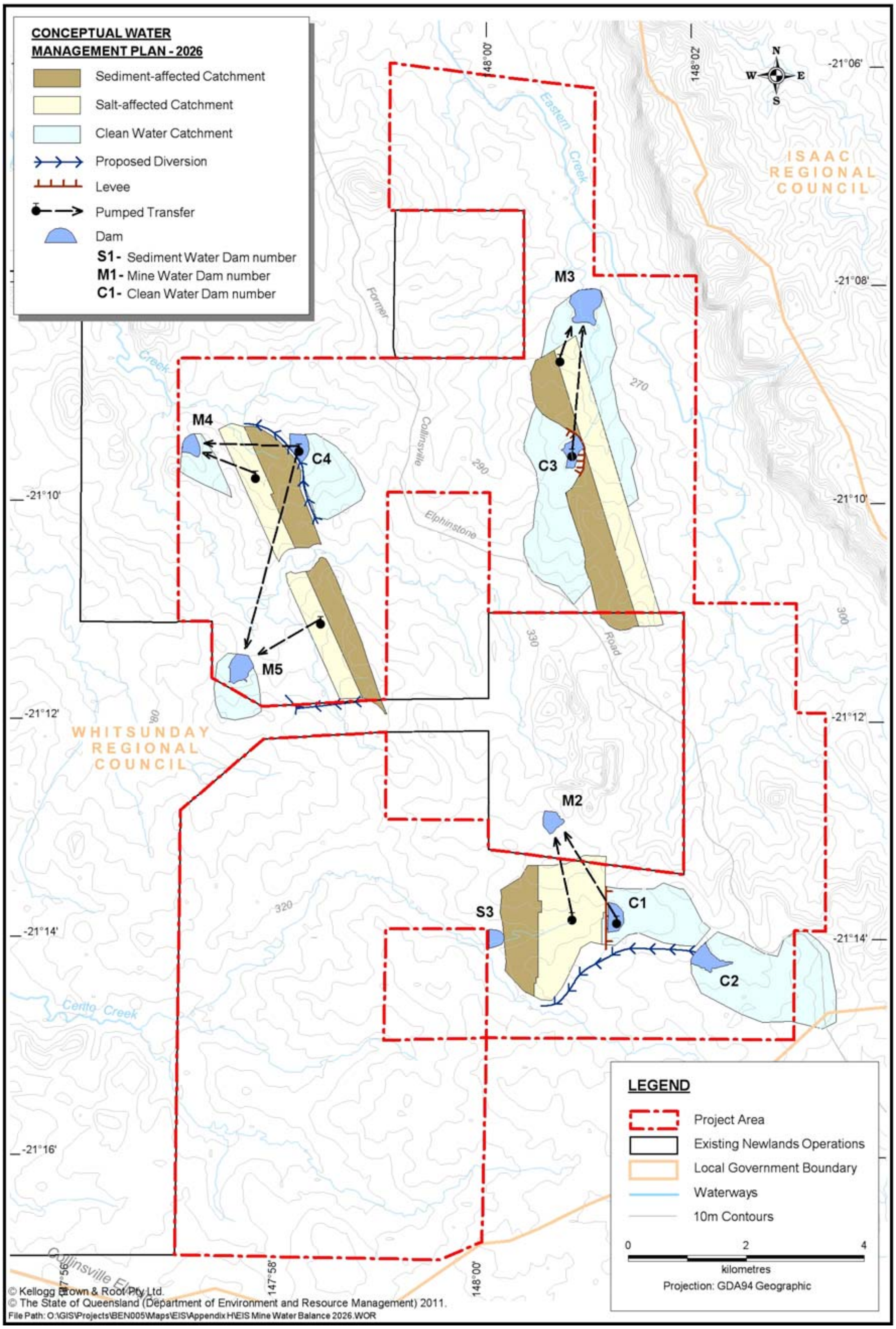

Figure 2.7
CONCEPTUAL WATER MANAGEMENT PLAN – 2026

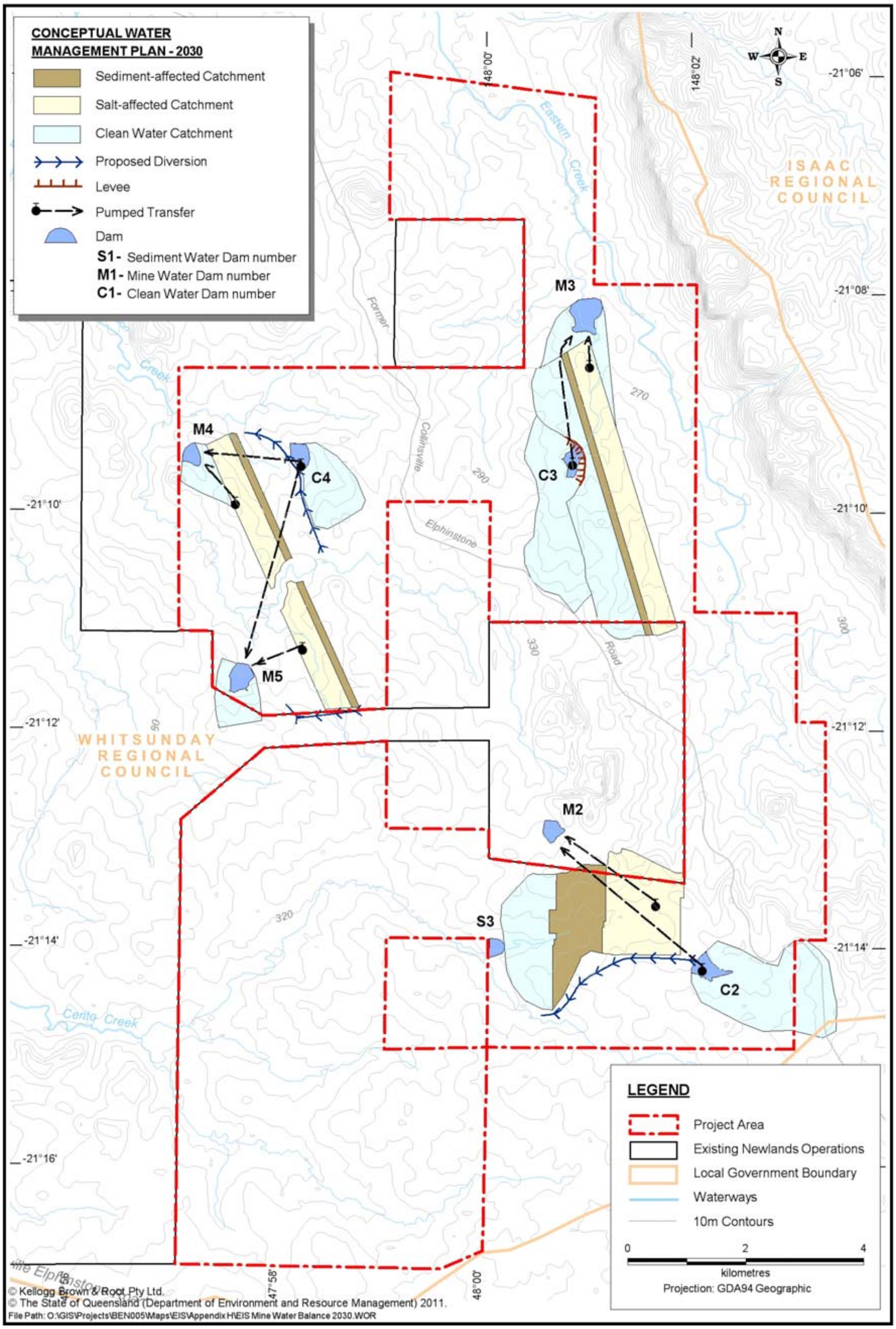

Figure 2.8
CONCEPTUAL WATER MANAGEMENT PLAN – 2030

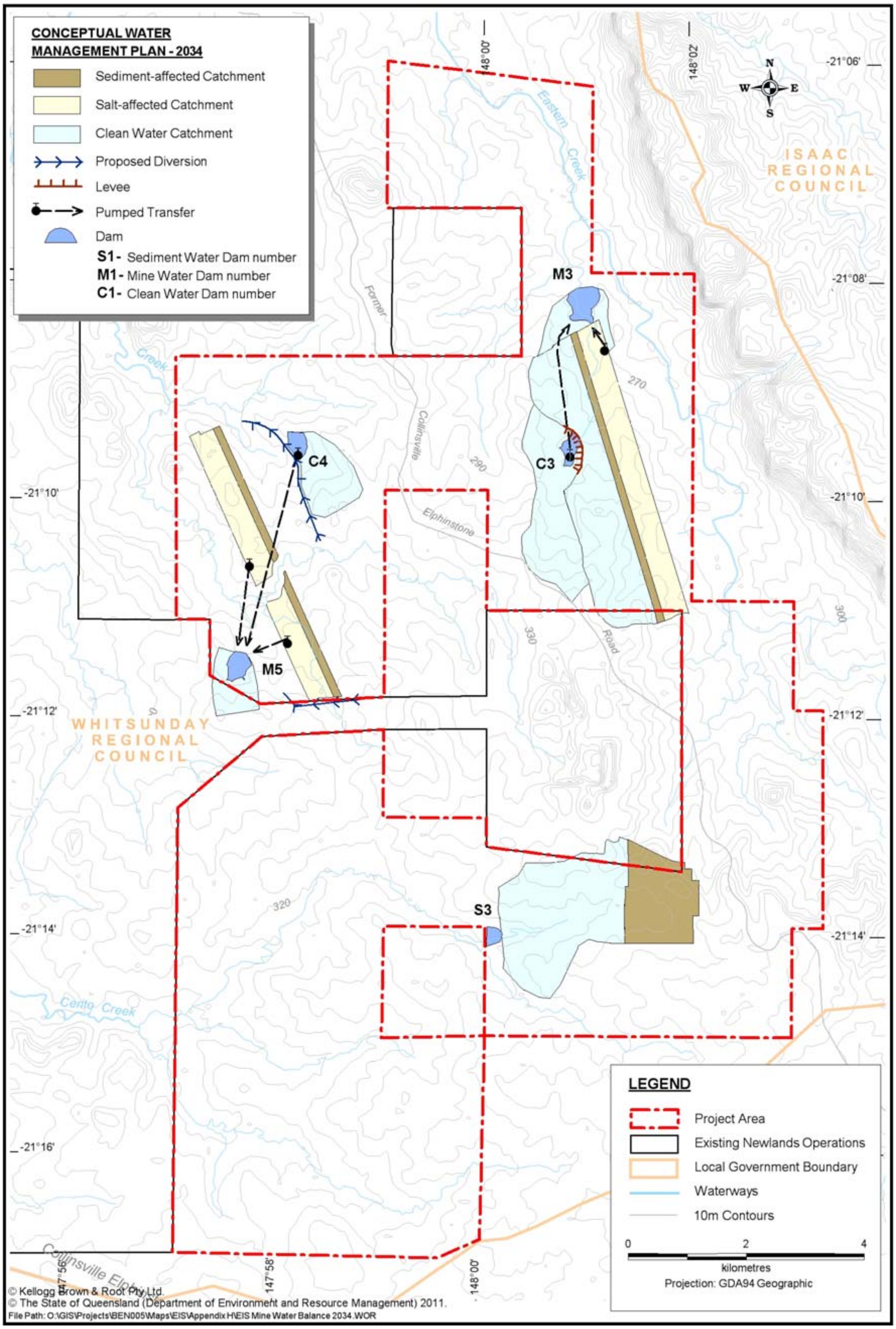

Figure 2.9
CONCEPTUAL WATER MANAGEMENT PLAN – 2034

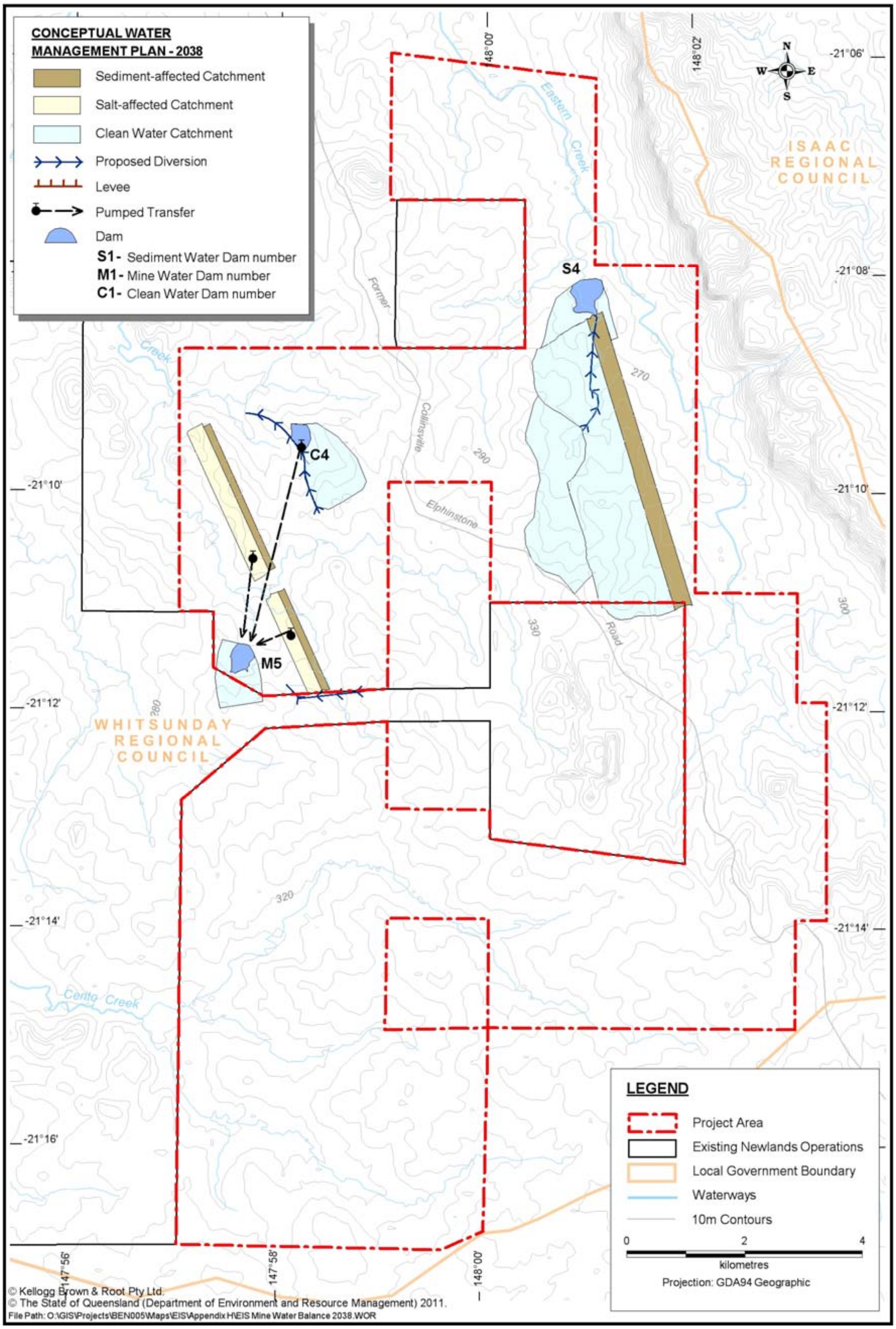

Figure 2.10
CONCEPTUAL WATER MANAGEMENT PLAN – 2038

Eastern Creek West pit

Dam M5 and Dam C4 are the first dams to be constructed for the Project. These are required early in the mine schedule to cater for the water produced from the extension of the underground mine. Water from the underground mine is expected to have a high salinity and be unsuitable for direct discharge. The water will be directed to Dam M5, where it could be diluted with clean water from Dam C4.

Due to the elevated salinity expected to be presented in Dam M5, it will be a regulated structure under the EP Act (refer Section 4.2 for further information).

Development of the open cut pit at Eastern Creek West will commence in 2020. Dam M4 will be constructed to accept water from the northern pit. A pumped transfer from the pit to the dam will be required, as will a pumped transfer from the clean water dam (Dam C4) for dilution purposes. A pumped transfer from the southern pit to Dam M5 will also be required to dewater the pit.

Two sediment dams will be provided to treat runoff from the waste rock dump areas. These are Dams S5 and S6 and will be commissioned in 2020. These dams will move as the mining face progresses and eventually become redundant around 2040 at which time they will be decommissioned.

Two diversions are required, one (Tributary B) around 2020 and the other (Tributary C) around 2026.

Mining will progress with little change to the water management infrastructure until around 2034, when the northern pit encroaches on Dam M4, requiring it to be decommissioned. At this time, water from the northern pit will be directed to Dam M5 that is already receiving water from the southern pit.

A summary of the mine water infrastructure development at Eastern Creek West pit is provided in Table 2.4.

Table 2.4 Mine water infrastructure at Eastern Creek West pit

Commissioning date (indicative)	Infrastructure required	Type	Decommissioning date (indicative)
2014	Dam M5	Mine water dam Release point	2038
2014	Dam C4	Clean water dam	2038
2020	Diversion (Tributary B): Dam C4 – Wilson Creek	Diversion to allow mining at Eastern Creek West (north pit)	n/a
2020	Dam S5	Sediment dam (dam relocates as rehabilitation progresses)	2040
2020	Dam S6	Sediment dam (dam relocates as rehabilitation progresses)	2040
2023	Dam M4	Mine water dam Release point	2034
2023	Pumped transfer Pit – Dam M4	Dewatering of open cut pit (mine water)	2030
2023	Pumped transfer Pit – Dam M5	Dewatering of open cut pit (mine water)	2038
2023	Pumped transfer C4 – Dam M4	Transfer for dilution purposes (clean water)	2038
2026	Drainage diversion (Tributary C)	Diversion to allow mining at Eastern Creek West (south pit)	n/a
2034	Pumped transfer Pit – Dam M5	Dewatering of open cut pit (mine water)	2038

Eastern Creek South pit

The existing Eastern Creek mine currently drains towards Wilson Creek, however as the mine face moves further east, it will breach the catchment divide and begin to drain towards Eastern Creek. This will occur around 2016, at which time Dam S1 and Dam M1 will be required.

Dam S1 is primarily intended to remove sediment from water draining newly established rehabilitation. A pit dewatering system will be installed in the open cut pit to direct mine water to Dam M1. Dilution of mine water will be possible using water from Dam S1.

Dam M1 will continue to operate until the void is backfilled (around 2023), at which time it will be converted to a sediment dam (Dam S2) and then ultimately decommissioned (around 2026).

Eastern Creek South pit requires various water management controls to be implemented prior to development of the pit in 2020. This includes installation of two clean water dams (Dams C1 and C2), a diversion from Dam C2 to Upper Cerito Creek and installation of Dam M2 which is a mine water dam located in the Wilson Creek catchment. Two pumped transfers will be required: one from the pit to Dam M2; and one from Dam C1 to Dam M2.

As the mining face progresses to the east, the clean catchment between Dams C1 and C2 will reduce. Dam C1 will need to be regularly relocated to allow the progression of mining up the catchment.

Eventually the catchment of Dam C1 will be mined out, and the dam will no longer be required. This is expected to occur around 2030. A clean water transfer from Dam C2 to Dam M2 will be installed for dilution purposes.

Dam S3 will be required from 2026 when rehabilitation is establishing. Dam S3 discharges into Upper Cerito Creek. This dam will be present until rehabilitation is complete at Eastern Creek South pit around 2034.

Other dams, pumped transfers and water management infrastructure will be decommissioned when mining is complete at Eastern Creek South pit around 2036.

A summary of the mine water infrastructure development at Eastern Creek South pit is provided in Table 2.5.

Table 2.5 Mine water infrastructure at Eastern Creek South pit

Commissioning date (indicative)	Infrastructure required	Type	Decommissioning date (indicative)
2016	Dam M1	Mine water dam Release point	2023
2016	Pumped transfer Pit – Dam M1	Dewatering of open cut pit (mine water)	2034
2016	Dam S1	Sediment dam	2020
2017	Pumped transfer Dam S1 – Dam M1	Transfer for dilution purposes (sediment water)	2020
2020	Dam C1	Clean water dam (that moves up the catchment behind the highwall as mining progresses)	2030
2020	Pumped transfer Dam C1 – Dam M2	Transfer for dewatering and dilution purposes (clean water)	2030
2020	Dam C2	Clean water dam	2034
2020	Diversion (Tributary D): Dam C2 – Upper Cerito Creek	Diversion to allow mining at Eastern Creek South pit	n/a
2020	Dam M2	Mine water dam Release point	2034
2023	Dam M1 converted to Dam S2	Conversion of mine water dam to sediment dam	2026
2026	Dam S3	Sediment dam	2036
2030	Pumped transfer Dam C2 – Dam M2	Transfer for dilution purposes (clean water)	2034

Eastern Creek East pit

The first dam required at Eastern Creek East pit is Dam C3, a clean water dam that will be pumped around the open cut pit. Water from Dam C3 will either be discharged directly to the tributary of Eastern Creek downstream of the mining disturbance, or may be used to dilute mine water.

Mine water will be directed to Dam M3. This dam will accept water from the open cut pit, as well as a small section of undisturbed catchment from which runoff cannot be practically diverted around the dam.

As mining progresses to the east, the proposed reinstated tributary will be formed in the waste rock, vegetated and stabilised. When the waterway is completely formed and ready to accept runoff, Dam C3 will be breached and decommissioned. Dam M3 will be converted to a sediment dam (Dam S4) and retained until rehabilitation is complete at Eastern Creek East pit around 2040.

A summary of the mine water infrastructure development at Eastern Creek East pit is provided in Table 2.6.

Table 2.6 Mine water infrastructure at Eastern Creek East pit

Commissioning date (indicative)	Infrastructure required	Type	Decommissioning date (indicative)
2020	Dam C3	Clean water dam	2038
2020	Pumped transfer Dam C3 – Dam M3	Transfer for dewatering and dilution purposes (clean water)	2038
2023	Dam M3	Mine water dam Release point	2036
2023	Pumped transfer Pit – Dam M3	Dewatering of open cut pit (mine water)	2036
2036	Dam M3 converted to Dam S4	Conversion of mine water dam to sediment dam	2040
2020	Diversion (Tributary A)	Diversion in operation (construction phase approximately 18 years)	n/a

3 Water balance model

3.1 MODEL DESCRIPTION

A water balance model of the Project was developed using OPSIM software, a package designed specifically for mine site water balance studies.

The model was run many times (119), each time sampling different climatic sequences from the 122 year historical climate dataset. The model duration runs from 2017 to 2038, based on selected snapshots of Project development phases.

The model includes all major components of the water balance including:

- Water inputs:
  - incident rainfall to dams
  - groundwater inflow to open pits
  - surface runoff from open pits
  - surface runoff from waste rock dumps
  - coal moisture
  - groundwater ingress to the underground mine
  - groundwater extracted as part of de-gasification works.
- Water losses:
  - evaporative losses from dams
  - seepage losses from dams
  - dust suppression
  - releases to the environment.

The scope of the water balance model covers the mine-affected and clean water circuits of the Project only. The sediment-affected water circuit is not represented as the design basis for these dams was based on containment of a design storm event.

An existing water balance model has been developed by Water Solutions for the existing mine and is the subject of ongoing revision to reflect evolving Environmental Authority conditions, water management infrastructure and site conditions.

Water management at the Project will operate independently of the existing operation, and therefore this strategy considers the Project only. There may be benefits that could be achieved by linking water management at the existing mine with the Project, which may be explored closer to the time the new open cut mining areas come online, in consultation with regulators and site operators.

The diagram showing the components of the water balance reflected in the model is shown in Figure 3.1. This figure provides a visual representation to illustrate the mine water management strategy proposed for the Project and is for conceptual purposes only, for detail on how the mine water management infrastructure will interact refer to Section 2.4.

3.2 WATER BALANCE INPUTS

3.2.1 Climate

Climate data used in the water balance model was based on 122 years (1889–2011) of patched-point daily data. The patched-point data was sourced from the DataDrill database. DataDrill accesses grids of data interpolated (using splining and kriging techniques) from point observations by the Bureau of Meteorology. The patched-point data is considered superior to site observations for modelling purposes because it provides greater temporal and spatial detail than using individual site records.

The DataDrill record was sourced for the Project location (–21.21 lat, 148.01 long) as of 19 December 2011.

Evaporation data was corrected to account for the difference between measured 'pan evaporation' and evaporation that occurs from an open water body (lake evaporation). Pan evaporation is measured in a small dish that takes extra heat in through the sides of the pan and tends to overestimate lake evaporation. Evaporation rates from large water bodies are also diminished by the accumulation of humidity above the water surface (amongst other factors). The pan factor adopted for this assessment is based on the calibrated existing mine model (Water Solutions 2011).

Evaporative surface area has been determined based on the stage-storage relationships presented in Appendix A.

3.2.2 Stream hydrology

Stream gauge monitoring has been undertaken in Kangaroo Creek and Suttor Creek in the vicinity of the mine since 2001. This data is reported by Footprints (2011). Unfortunately there are significant data gaps, particularly during low flow conditions that are problematic for calibration of a hydrology model that adequately represents low flow conditions. The main purpose of the hydrology model is to represent low flows in the receiving environment, as the frequency and magnitude of these flow conditions influences the opportunities to release from the site.

Stream gauging data is collected in the vicinity of the Project by the Department of Heritage and Heritage Protection (formerly Department of environment and Resource Management and Department of Natural Resources) and the Bureau of Meteorology. The available data within 50 km of the Project is shown in Table 3.1, along with comments regarding suitability of the gauge for calibration of the hydrology model.

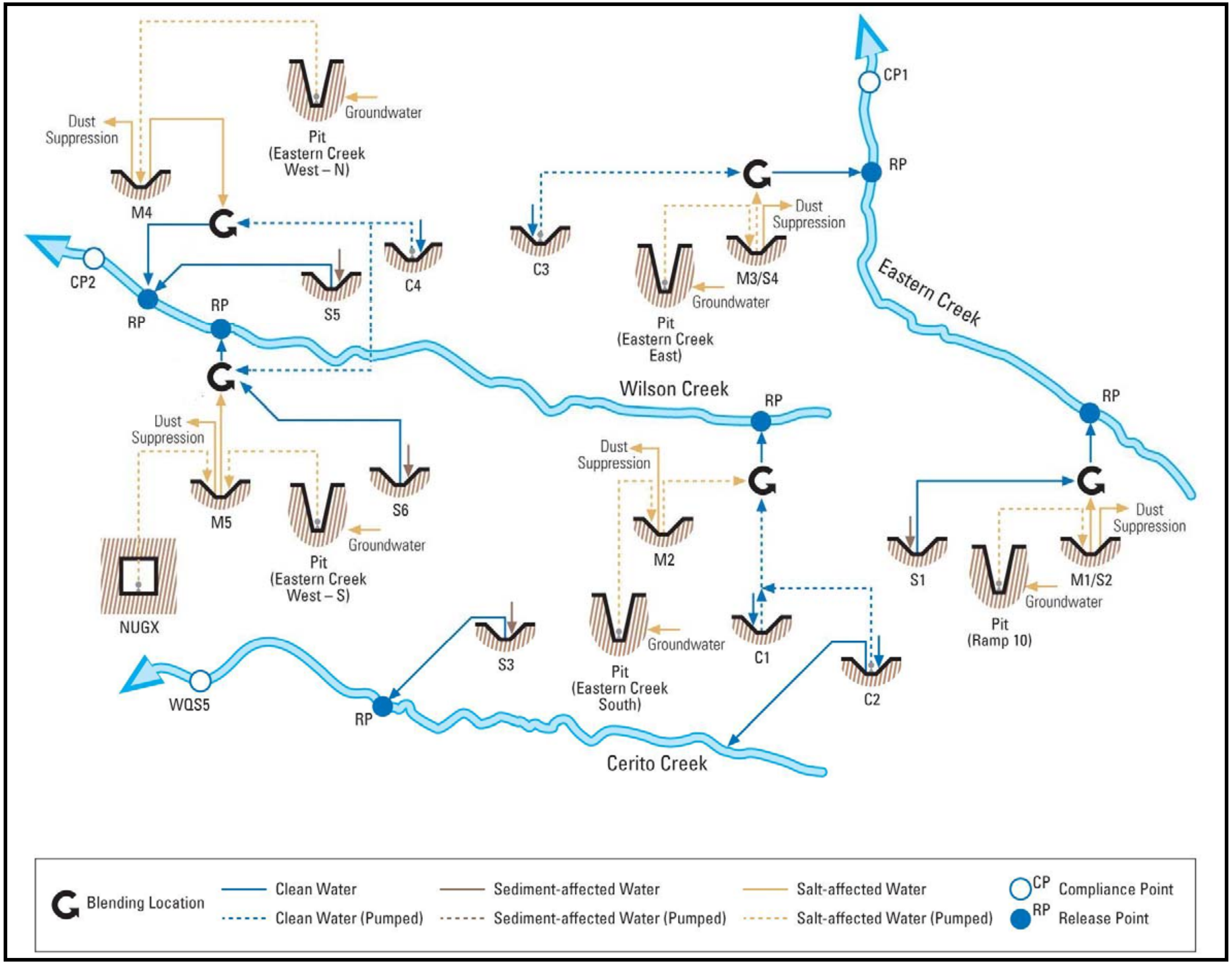

Figure 3.1
CONCEPTUAL DIAGRAM OF THE WATER BALANCE

Table 3.1 Stream flow gauges within 50 km of the Project

Distance from the Project (km)	Station No	Station Name	Watercourse	Catchment Area (km^2)	Missing (%)	Comments
14	120218A	Byerwen	Kangaroo	390	63.9	High proportion missing data
28	120210A	Exmoor	Bowen	1,255	28.4	Catchment too large
40	120211A	Eungella Dam	Broken	142		Affected by dam
40	120215A	Eungella Dam T/W	Broken	142	7.8	Affected by dam
40	120208A	Eungella Camp	Broken	142	5.8	Affected by dam
41	120304A	Eaglefield	Suttor	1,890	22.3	Catchment too large
44	120214A	Mt. Sugarloaf	Broken	2,280	5.8	Catchment too large
45	120216	Old Racecourse TM				No data available
45	120216A	Old Racecourse	Broken	78	0.6	No data available
46	120207A	Urannah	Broken	1,100	2.5	Catchment too large
48	120203A	Upsan Downs	Bee	16	2.6	Catchment too small
48	130402A	Burton Gorge	Isaac	551	47.7	High proportion missing data
48	120212A	The Saddle	Emu	415	29.9	Located in higher rainfall environment

As noted in the table, the only suitable stream gauge is Kangaroo Creek at Byerwen (Station No. 120218A). The gauge was operational over the period 1980 to 1989, although there is a very high proportion of missing data (64% missing). The flow data is plotted in Figure 3.2.

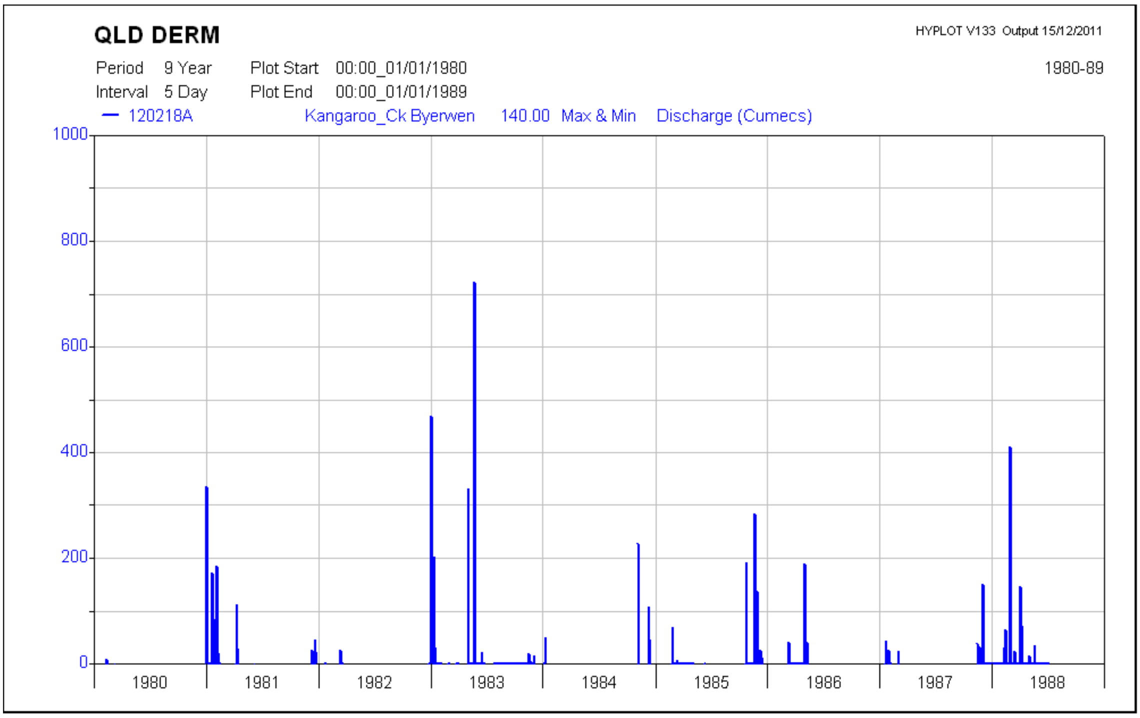

Figure 3.2
FLOW HISTORY (KANGAROO CREEK AT BYERWEN)

Figure 3.3 shows the periods over the gauge history during which normal readings were made. There are two discrete periods when reasonably complete records are available: 22/12/82 – 10/12/83 and 12/11/87 – 7/7/88.

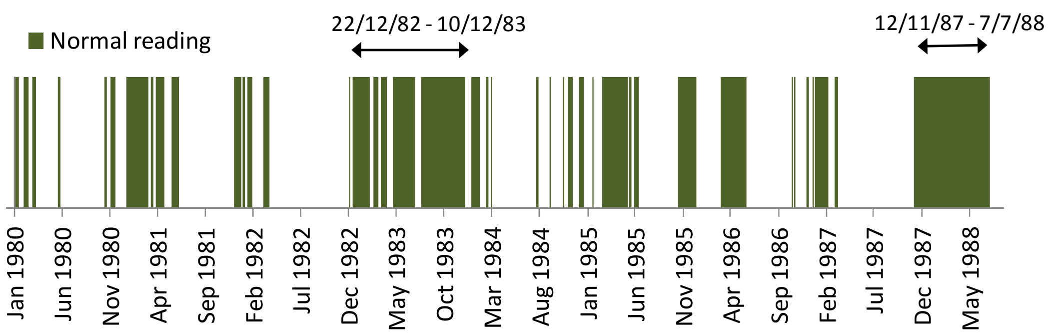

Figure 3.3
MISSING DATA FOR KANGAROO CREEK AT BYERWEN

The December 1982 to December 1983 period (when the longest period of reasonably complete data is available) was an above average wet period. The December–November rainfall totals over 122 years of rainfall data (patched-point) is shown in Figure 3.4, with the two periods highlighted.

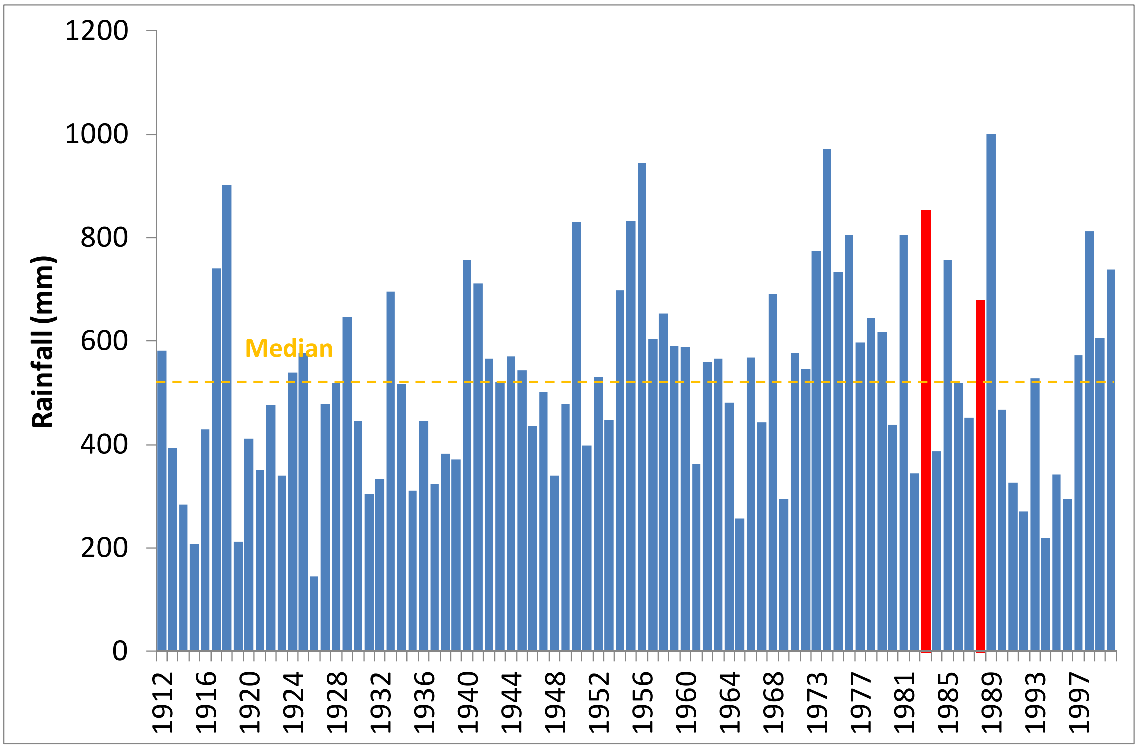

Figure 3.4
BYERWEN STATION DEC-NOV RAINFALL TOTALS

The flow duration curve based on the December 1982 to December 1983 period of record is shown in Figure 3.5. This is the most suitable dataset on which to calibrate the hydrology model.

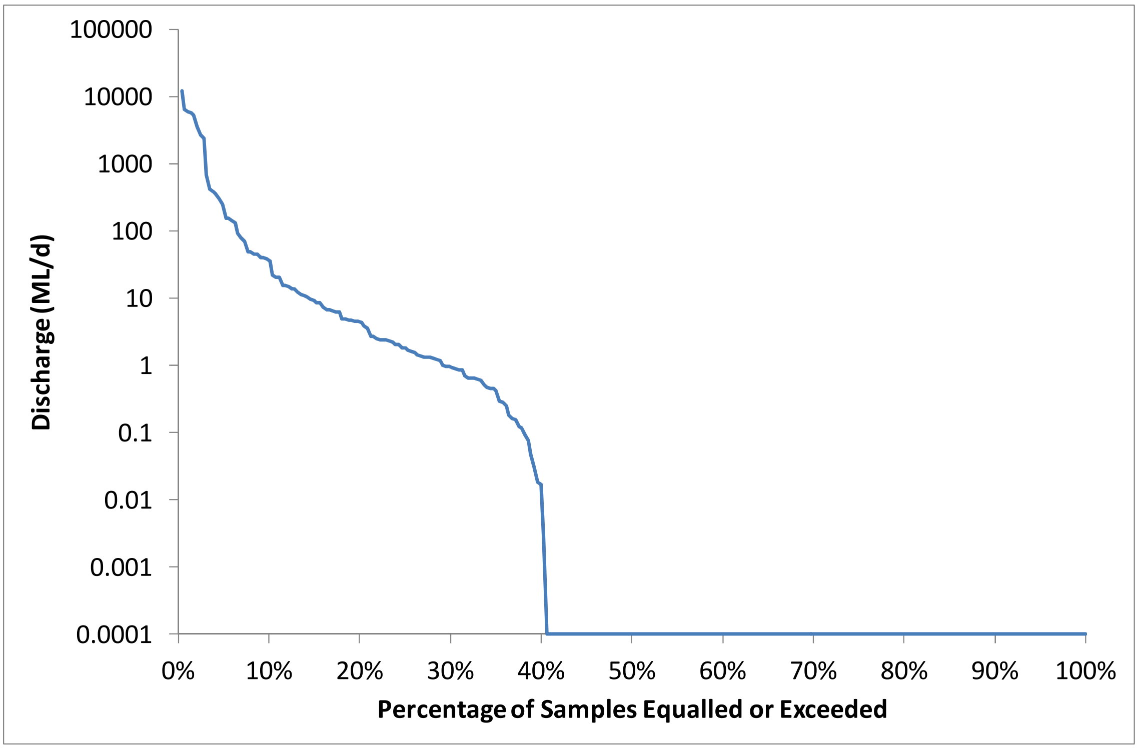

Figure 3.5
KANGAROO CREEK (22/12/82 – 10/12/83) FLOW DURATION CURVE

The flow duration curve indicates that Kangaroo Creek is ephemeral, with no flow ~60% of the time. It is expected that the duration of zero flow will be higher over the long term, because the curve is based on data from an above-average rainfall period.

The volumetric runoff coefficient (VRC), which is the proportion of rainfall that produces runoff, is 0.19. It is also expected that this runoff coefficient is higher than the long term average because of the above-average rainfall.

The Australian Water Balance Model (AWBM) has been used to derive catchment runoff time series for use in the water balance. AWBM is a partial area saturation overland flow model. The use of partial areas divides the catchment into regions that produce runoff (contributing areas) during a rainfall-runoff event and those that do not. These contributing areas vary within a catchment according to antecedent catchment conditions, allowing for the spatial variability of surface storage in a catchment. The use of the partial area saturation overland flow approach is simple, and provides a good representation of the physical processes occurring in most Australian catchments (Boughton, 1993). This is because daily infiltration capacity is rarely exceeded, and the major source of runoff is from saturated areas.

The calibrated hydrology model was able to match the flow duration curve and catchment yield very closely to the recorded data. The relative difference between observed and modelled runoff volume was –13.7%. The flow duration curves, shown comparing observed versus modelled runoff for the 1982/83 and 1987/88 periods are provided in Figures 3.6 and 3.7 respectively.

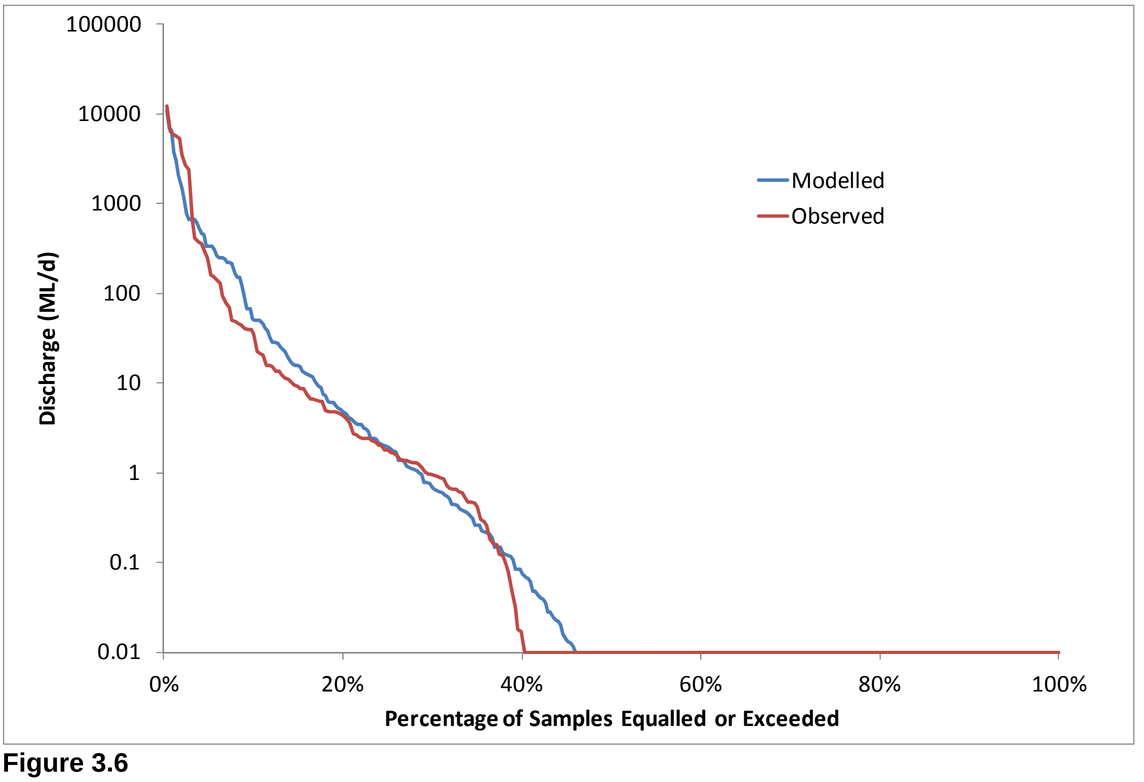

Figure 3.6
CALIBRATION RESULTS – FLOW DURATION CURVE FOR STATION 120218A – 22/12/82 – 10/12/83

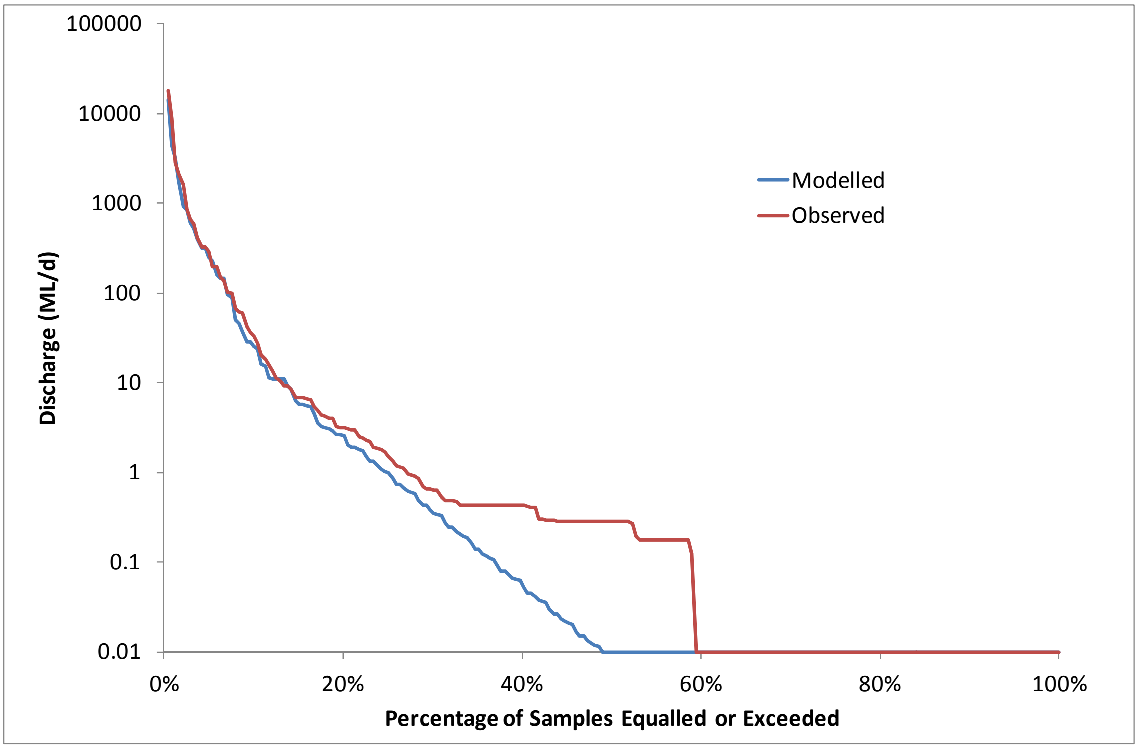

Figure 3.7
VERIFICATION RESULTS – FLOW DURATION CURVE FOR STATION 120218A – 12/11/87 – 7/7/88

The volumetric runoff coefficient based on the 122 year DataDrill rainfall time series is 0.11. This means 11% of rainfall appears as streamflow, with the remainder lost through evapotranspiration or deep groundwater recharge. The calibrated AWBM parameters are shown in Table 3.2.

Table 3.2 AWBM parameters

Parameter	Explanation of parameter	Kangaroo Creek Calibrated
A1 A2	Partial areas represented by surface Storages	0.134 0.433
BFI	Baseflow index – indicates the ratio of base flow to total stream flow.	0.100
C1 C2 C3	Surface storage capacities	2.2 76.1 170.6
Kbase Ksurf	Recession constants - simulates the delay of baseflow and stormflow reaching the outlet.	0.573 0.050

3.2.3 Local surface runoff

Water Solutions have developed a hydrological model of the mine-affected catchments for the existing mine. These parameters in the hydrological model have been based on calibration against recorded data. The calibration achieved a close match between recorded and modelled runoff volumes and timing, and the calibrated hydrological parameters have therefore been used for this assessment.

The AWBM parameters are shown in Table 3.3.

Table 3.3 AWBM parameters

	Explanation of parameter	Undisturbed	Pre-strip	Pit	Active Waste rock dump	Rehabilitated Waste rock dump
A1 A2	Partial areas represented by surface storages	0.1 0.9	0.1 0.9	0.1 0.9	0.1 0.9	0.109 0.891
BFI	Baseflow index – indicates the ratio of base flow to total stream flow.	0.1	0	0	0.9	1
C1 C2	Surface storage capacities	12 120	12 54	12 38	12 38	12 221
Kbase Ksurf	Recession constants – simulates the delay of baseflow and stormflow reaching the outlet.	0.98 0	1 0	1 0	0.7 0	0.7 0

Catchment areas used for the calculation of catchment runoff are presented in Appendix B.

3.2.4 Hydrogeology

Groundwater yields into the open pits and underground workings have been predicted by a hydrogeological model. The volume entering sumps in the pits and underground mine (or during degasification) will be less than the net loss from the aquifer due to:

- evaporative losses from the pit face
- coal moisture
- humidity losses associated with the underground mine ventilation system.

Corrections have not been made to groundwater yields to account for these losses, so the predictions of groundwater flows needing to be managed in the site water system are likely to be conservative. The predicted flow rates from open cut and underground sources are summarised in Table 3.4.

Table 3.4 Groundwater Inflow (kL/d)

Year	Eastern Creek East Pit	Eastern Creek South Pit	Eastern Creek West Pit (North)	Eastern Creek West Pit (South)	Northern Underground Extension
2017	0	464	0	0	494
2020	7	249	1	0	368
2023	37	139	1	3	43
2026	64	449	5	19	28
2030	123	128	13	40	0
2034	231	129	18	64	0
2038	360	184	33	68	0

Note: The underground mine representation in the groundwater model does not separate the Northern Underground Extension and NUG. The flow for the Northern Underground Extension is estimated based on the proportion of the underground mine extension overlapping the lease extent. This includes 20% from drain 9 (proposed underground) and 50% of drain 10 (proposed underground).

The predictions indicate that:

- *Eastern Creek East pit:* Inflows gradually increase to a peak of around 0.4 ML/d towards the end of the pit life.
- *Eastern Creek South pit:* Inflows peak at around 0.5 ML/d at 2017 and 2026.
- *Eastern Creek West (south and north) pit:* Low inflows gradually increasing over the mining period to a combined maximum of approximately 0.1 ML/d.
- *Northern Underground Extension:* Maximum inflow of approximately 0.5 ML/d will occur in 2017, declining in later years.

The above estimates do not include recirculated water from the old open cut pit that enters the existing underground mine, and will continue to be managed through the existing water management arrangements

3.2.5 Water demands

Haul road watering

The existing water demand in the Newlands mining area has been determined by Water Solutions (2011) to be 1.7 ML/d, and for the whole existing mine to be 3.7 ML/d. The water demands are based on metered flow over the period June 2010 to December 2010. At the time, the length of the main haul road was approximately 32 km, which equates to an application rate of approximately 3 mm/d. This is consistent with application rates at other coal mines in the Bowen Basin, which are typically 3–4 mm/d, varying based on the exposed haul road area, climatic conditions and road usage patterns.

Mining recommenced at existing Eastern Creek mining area in 2011, increasing the haul road length to 47 km, as a result dust suppression water demand is expected to have increased to 5.4 ML/d. Water demand for existing haul roads will continue to be serviced by the existing mine. The water demand required for new haul roads associated with the Project will be met by water collected from the Project area.

The indicative haul road length attributed to the Project is shown in Table 3.5.

Table 3.5 Haul Road Length and Water Demand

Period	Project Haul Road Length (km)				Project Dust Suppression Demand (ML/d)
	Existing Eastern Creek pit & Eastern Creek South pit	Eastern Creek East pit	Eastern Creek West pit	Project Total	
2017	0.5	0.0	0.0	0.4	0.1
2020	4.5	5.3	6.0	15.8	1.9
2023	5.3	5.6	6.4	17.3	2.1
2026	5.6	5.8	6.8	18.2	2.2
2030	7.1	6.0	7.1	20.3	2.4
2034	0.0	6.4	7.5	13.9	1.7
2038	0.0	0.0	7.9	7.9	0.9

The haul road length and width for the Project is expected to be similar to that at the existing operations. The dust suppression demands based on a typical irrigated width of 40 m is also shown in Table 3.5. The dust suppression demand peaks at approximately 2.4 ML/d in 2030. It is proposed that dust suppression water will be sourced from mine water dams.

Workshop and truck washdown

The workshop and truck washdown facilities at the existing area will be utilised for the Project. These facilities will continue to be fed by existing established supplies.

3.2.6 Storages

As described in Section 2.2, there are three types of dams proposed within the Project as follows:

- mine-affected water
- sediment-affected water
- clean water.

The dams will be established prior to disturbance in the catchment occurring, and decommissioned (or retained for future landholders) when the disturbed catchment has been rehabilitated. The location of all proposed dams is shown in Figure 3.8. A summary of the dams required and timing of dam construction/decommissioning is shown in Table 3.6.

Table 3.6 Mine dam requirements and timing

Dam	Type	Location	Year (2017 – 2020 – 2023 – 2026 – 2030 – 2034 – 2038)
M1	Mine-Affected	Fixed	M1 converted to S2
S2	Sediment-Affected	Fixed	Decommissioned
M2	Mine-Affected	Fixed	Decommissioned
M3	Mine-Affected	Fixed	M3 converted to S4
S4	Sediment-Affected	Fixed	Decommissioned
M4	Mine-Affected	Fixed	Decommissioned
M5	Mine-Affected	Fixed	Decommissioned
C1	Clean	Moving	Decommissioned
C2	Clean	Fixed	Decommissioned
C3	Clean	Fixed	Decommissioned
C4	Clean	Fixed	Decommissioned
S1	Sediment-Affected	Fixed	Decommissioned
S3	Sediment-Affected	Fixed	Decommissioned
S5	Sediment-Affected	Moving	Decommissioned
S6	Sediment-Affected	Moving	Decommissioned

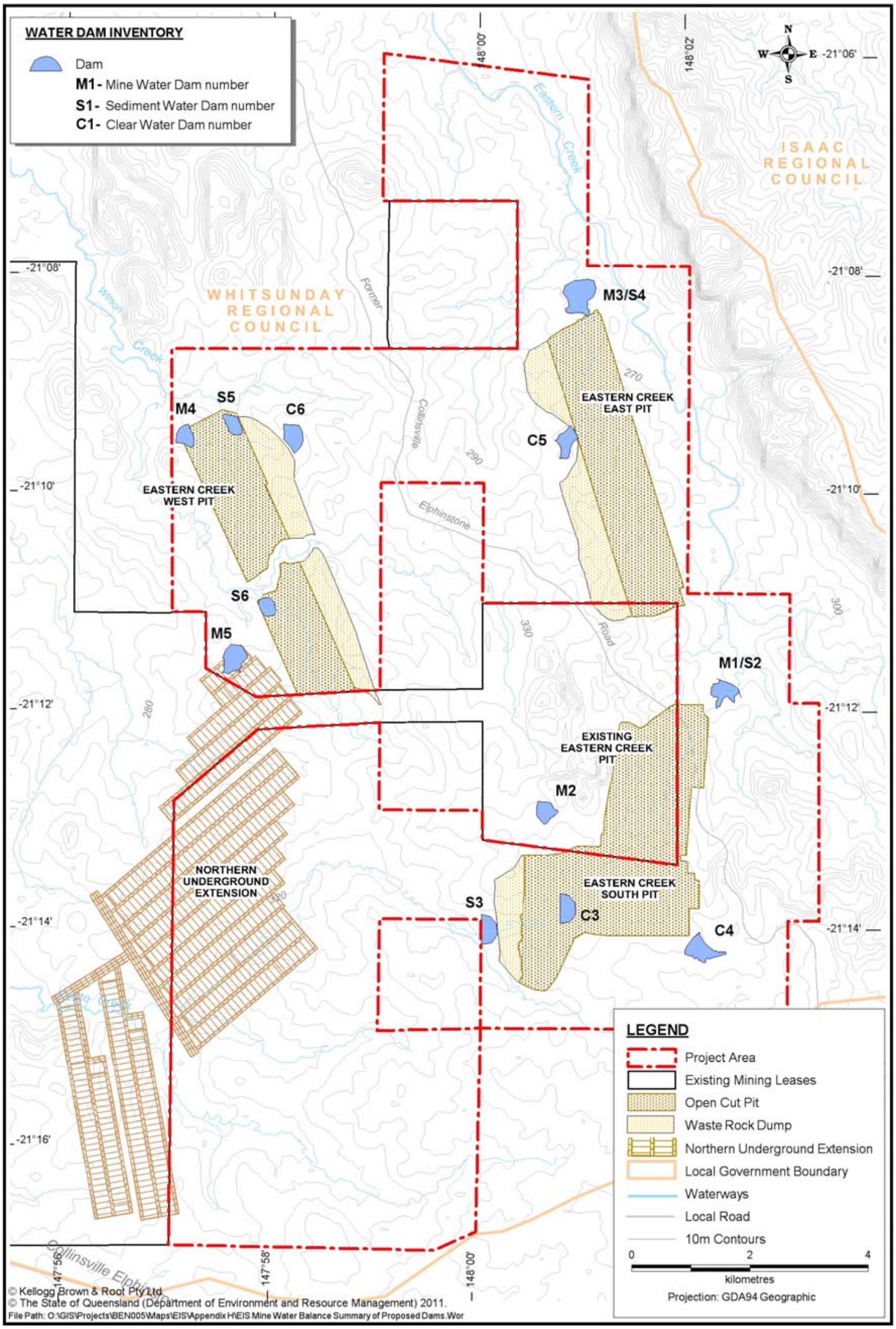

Figure 3.8
SUMMARY OF PROPOSED WATER DAMS

3.3 SALT BALANCE INPUTS

3.3.1 TDS – EC conversion

Much of the historical water quality data has measured Electrical Conductivity (EC) as a proxy for salinity. In order to model movement of salt through the mine site, it is necessary to express salt in term of concentrations (mass per volume) measured as Total Dissolved Salts. An empirical conversion was adopted to convert the available data from EC to TDS.

The relationship between TDS and EC is specific to the ion composition of water. An empirical relationship between TDS and EC at the existing mine has been developed based on the laboratory analysis of 690 data points where both EC and TDS were measured over the TDS range 10 mg/l to 5,200 mg/l (Water Solutions, 2005).

The data points and line of best fit are shown in Figure 4.8. The derived relationship based on the line of best fit is shown below:

TDS (mg/l) = 0.63 x EC (µS/cm)

with r^2=0.91 for laboratory data which indicates the relationship provides a good fit

This relationship has been adopted for conversion between EC and TDS in this assessment.

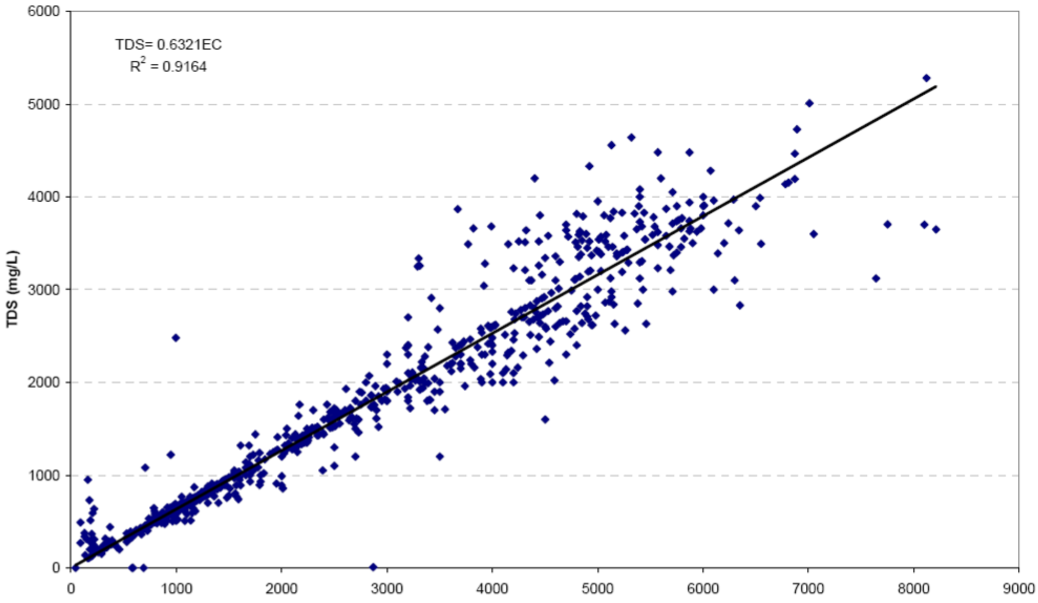

Figure 3.9
RELATIONSHIP BETWEEN TDS AND EC

3.3.2 Source salinity

The existing mine water balance model includes a salt balance, predicting salinity in dams and when release to the environment is permissible. The model has not previously been calibrated for salt due to limited reliable monitoring information. The adopted salinity assumptions based in the existing mine model are provided in Table 3.7.

Table 3.7 Source salinity assumptions for existing mine (Water Solutions, 2011)

Catchment type	TDS (mg/L)
Natural/undisturbed	300
Cleared/disturbed	500
Industrial/Roads	1,500
Rehabilitated WRD	800
Mining Pit/WRD	2,800
Groundwater	
Underground	5,000
Mining pit	2,500

It is likely that the Project will have similar salinity export characteristics to the existing mine, given its proximity and similar geological setting. However, there have been some specific investigations for the Project that provide a more robust basis for developing salinity assumptions for the Project. The main work that has been done is geochemical testing of the waste rock which identified:

- The concentration of 'ions in run-off and seepage is expected to decrease over time as salts are flushed from the system'.
- Waste rock EC varies over the range 92 to 877 µS/cm, with only two of 12 samples above 250 µS/cm, indicating the waste rock is not likely to produce high salinity runoff.
- Waste rock EC increased over time during the kinetic testing program.

In addition to geochemical testing, there is also some physical evidence from existing water quality data. 'Darrens Dam' is a monitoring location at the existing Eastern Creek mine. The catchment of this dam contains a mixture of inactive WRDs, rehabilitated areas as well as a small ROM pad. When the mine was inactive during 2010, the TDS varied between 300–600 mg/L. The TDS in the dam increased up to 2,000–2,500 mg/L in 2011 when active mining re-commenced. It appears that the increase was primarily associated with groundwater inflows to the dam as a result of dewatering.

Based on the discussion above, a salinity of 1,000 mg/L has been assumed for runoff from WRDs. This incorporates a substantial factor of safety when compared to both the geochemical analysis and environmental monitoring, and therefore is considered to be a conservative assumption.

The highest salinity water is likely to be derived from the coal seam. The open cut pits will intercept water from the coal seam as well as overlying aquifers, which will reduce the salinity of the groundwater reporting to the pit sump. The expected water quality from these sources is presented below:

- *Open Cut Pits* – EC 4,000 µS/cm (TDS 2,500 mg/L).
- *Underground* – EC 10,000 µS/cm (TDS 6,300 mg/L).

A sensitivity analysis was also undertaken to assess the impact of encountering higher salinity waters in the coal seam because there is some uncertainty regarding the quality of the water that will be encountered. The sensitivity analysis is based on the following groundwater assumptions:

- *Open Cut Pits* – EC 4,000 µS/cm (TDS 2,500 mg/L)
- *Underground* – EC 15,000 µS/cm (TDS 9,500 mg/L).

A summary of the adopted salinities from all sources represented in the model is shown in Table 3.8.

Table 3.8 Adopted Source Salinity

Catchment type	TDS (mg/l)	Comments
Eastern Creek downstream	700	50th percentile Rosella Ck
Wilsons Creek downstream	300	Existing mine model Wilson Ck
Undisturbed	300	Existing mine model
Pre-strip	500	Existing mine model
Pit	2,800	Existing mine model
Active WRD	1,000	the Project geochemistry analysis
Rehab Zone – Active	800	Transition between active dump and rehabilitation complete
Rehab Zone – Complete	600	Existing mine model
Groundwater – underground	6,300^	Refer Appendix K – Groundwater
Groundwater – open cut pits	2,500	Refer Appendix K – Groundwater

^ sensitivity analysis has also been conducted based on a salinity of 9,500 mg/l from the underground mine

3.4 DESIGN CRITERIA

3.4.1 Sediment-affected water

Sediment dam volumes will be designed based on containment of a 10 year Average Recurrence Interval 24 hour design storm event.

3.4.2 Mine-affected water

The proposed water management system for mine-affected catchments has been designed such that there are no unplanned releases to the environment. This will be achieved by:

- a probabilistic approach to design, such that all dams can cater for a 1 in 20 annual exceedance probability wet season
- viable contingency measures that may be used for extreme climate scenarios.

The adopted design criteria exceeds the minimum standards required for low hazard structures, and meet the design criteria for significant hazard containment structures.

This means that there is a low risk that a contingency measure will be required. The design basis has been selected as this represents an appropriate balance between dam size and inconvenience to the mining operation associated with utilising a contingency measure.

Consideration was also given to the fact that the Project will operate three open cut mining pits for the majority of the extension life, providing an opportunity for emergency storage in one pit while still being able to maintain mining operations in the remaining pits.

3.5 RESULTS

3.5.1 Dam M1 – Existing Eastern Creek Pit

Dam M1 has a design operating capacity of 145 ML which has been sized based on a 5% Annual Exceedance Probability design criteria. Figure 3.9 presents the predicted water volume in the storage over the life of the dam. The figure shows 1%, 2.5%, 5%, 10% and 20% AEP volume predictions.

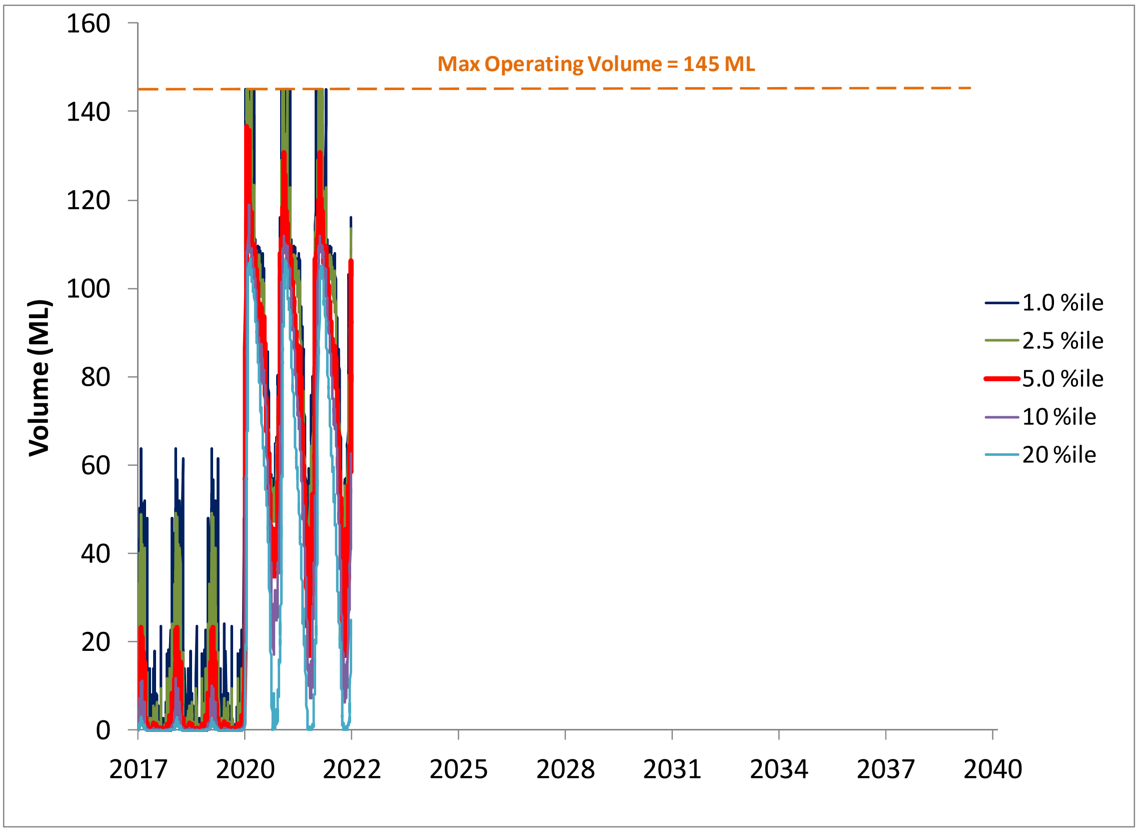

Figure 3.9
DAM M1 – WATER LEVEL PROFILE

Table 3.9 reviews the maximum water level that is projected to occur during each mining phase modelled in the water balance assessment. This demonstrates that the dam satisfies the 5% AEP design criteria while the dam is present and is able to exceed a 1% AEP design standard in the early years of the Project.

Table 3.9 Maximum storage volume (ML) – Dam M1

AEP	Year						
	2017	2020	2023	2026	2030	2034	2038
1%	64	**145***	N/A	N/A	N/A	N/A	N/A
2.5%	49	**145***	N/A	N/A	N/A	N/A	N/A
5%	23	137	N/A	N/A	N/A	N/A	N/A
10%	12	119	N/A	N/A	N/A	N/A	N/A
20%	3	107	N/A	N/A	N/A	N/A	N/A
25%	1	104	N/A	N/A	N/A	N/A	N/A
50%	0	76	N/A	N/A	N/A	N/A	N/A
75%	0	19	N/A	N/A	N/A	N/A	N/A

*Note: * **bold** numbers indicate that the dam capacity is exceeded, and a contingency measure (such as emergency pit storage) will be required*

3.5.2 Dam M2 – Eastern Creek South

Dam M2 has a design operating capacity of 200 ML and has been sized to cater for the 5% AEP design criteria. Figure 3.10 presents the predicted water volume in the storage over the life of the dam. The figure shows 1%, 2.5%, 5%, 10% and 20% AEP volume predictions.

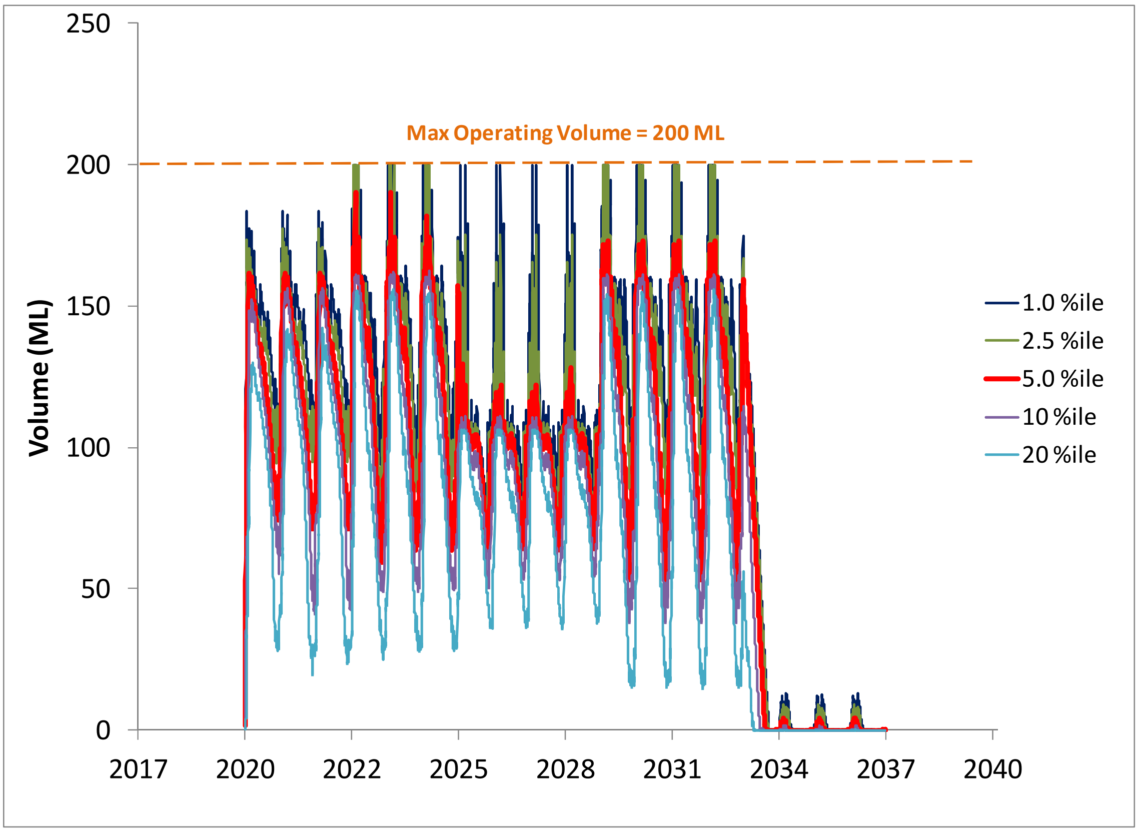

Figure 3.10
DAM M2 (EASTERN CREEK SOUTH) – WATER LEVEL PROFILE

Table 3.10 reviews the maximum water level that is projected to occur during each mining phase modelled in the water balance assessment. This demonstrates that the dam satisfies the 5% AEP design criteria throughout the mine life, and is also able to satisfy a 2.5% AEP design standard in Years 2020, 2026 and 2034.

Table 3.10 Maximum storage volume (ML) – Dam M2

AEP	Year						
	2017	2020	2023	2026	2030	2034	2038
1%	N/A	184	**200***	**200***	**200***	158	N/A
2.5%	N/A	178	**200***	175	**200***	158	N/A
5%	N/A	161	190	154	173	158	N/A
10%	N/A	156	162	111	161	113	N/A
20%	N/A	142	156	106	156	54	N/A
25%	N/A	129	151	106	152	38	N/A
50%	N/A	56	111	95	111	0	N/A
75%	N/A	17	26	41	29	0	N/A

Note: **** bold** numbers indicate that the dam capacity is exceeded, and a contingency measure (such as emergency pit storage) will be required*

3.5.3 Dam M3 – Eastern Creek East

Dam M3 has a design operating capacity of 185 ML and has been sized to cater for the 5% AEP design criteria. Figure 3.11 presents the predicted water volume in the storage over the life of the dam. The figure shows 1%, 2.5%, 5%, 10% and 20% AEP volume predictions.

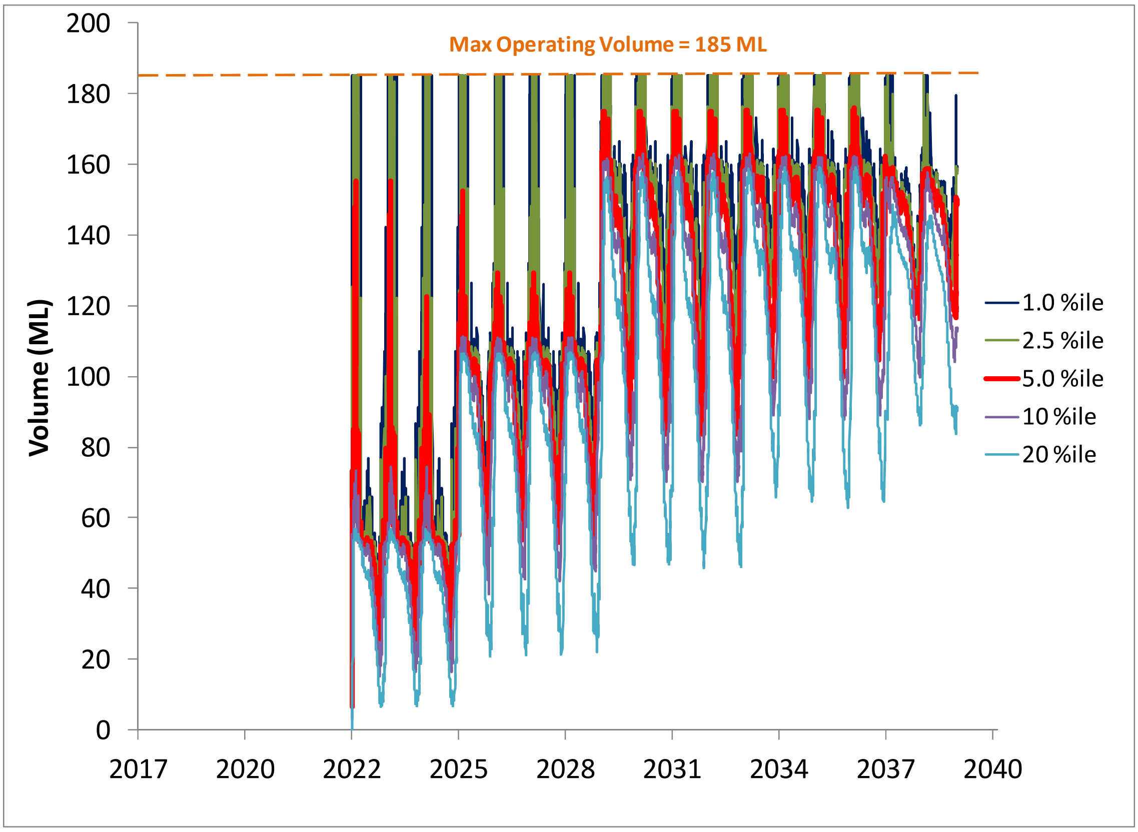

Figure 3.11
DAM M3 (EASTERN CREEK EAST) – WATER LEVEL PROFILE

Table 3.11 reviews the maximum water level that is projected to occur during each mining phase modelled in the water balance assessment. This demonstrates that the dam satisfies the 5% AEP design criteria throughout the mine life.

Table 3.11 Maximum storage volume (ML) – Dam M3

AEP	Year						
	2017	2020	2023	2026	2030	2034	2038
1%	N/A	N/A	**185***	**185***	**185***	**185***	**185***
2.5%	N/A	N/A	**185***	**185***	**185***	**185***	**185***
5%	N/A	N/A	155	152	175	176	159
10%	N/A	N/A	74	111	163	163	158
20%	N/A	N/A	57	107	158	159	149
25%	N/A	N/A	55	106	155	158	140
50%	N/A	N/A	49	94	129	139	92
75%	N/A	N/A	37	47	43	53	43

Note: * **bold** *numbers indicate that the dam capacity is exceeded, and a contingency measure (such as emergency pit storage) will be required*

3.5.4 Dam M4 – Eastern Creek West (North)

Dam M4 has a design operating capacity of 170 ML and has been sized to cater for the 5% AEP design criteria. Figure 3.12 presents the predicted water volume in the storage over the life of the dam.

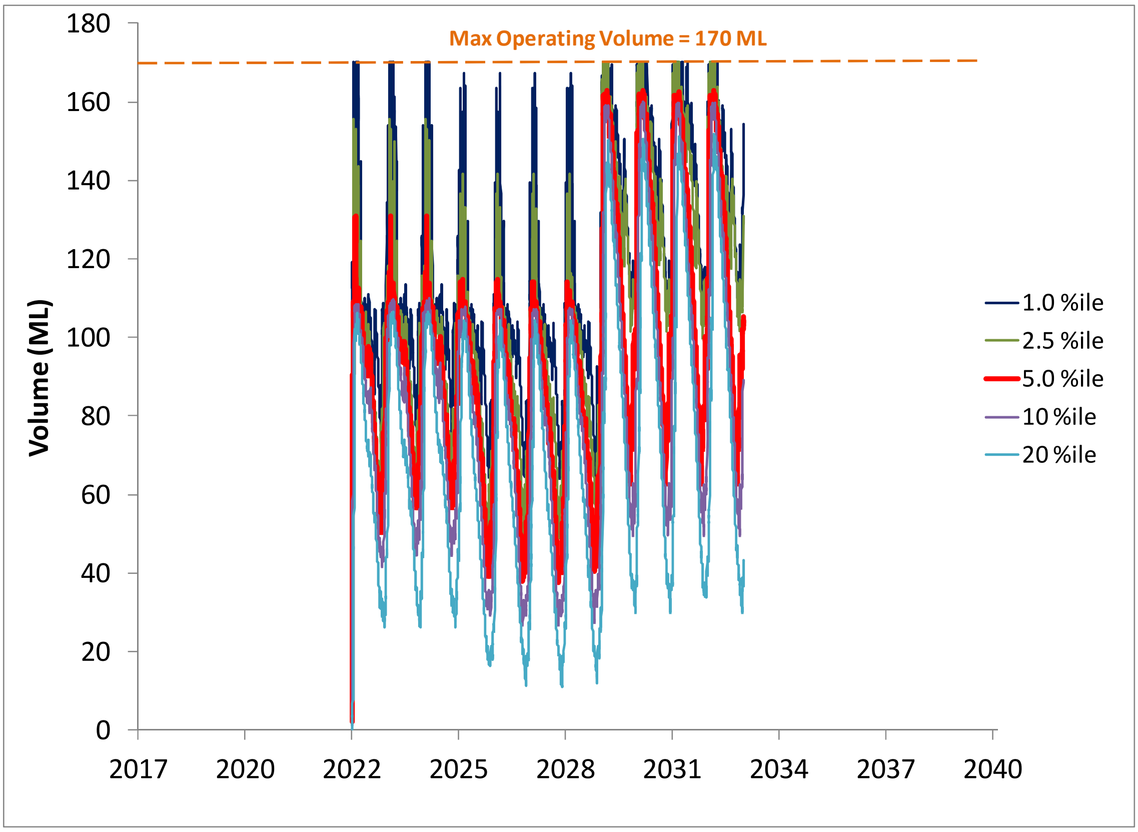

Figure 3.12
DAM M4 (EASTERN CREEK WEST) – WATER LEVEL PROFILE

Table 3.12 reviews the maximum water level that is projected to occur during each mining phase modelled in the water balance assessment. This demonstrates that the dam satisfies the 5% AEP design criteria throughout the mine life, and meets less than a 2.5% AEP design standard in 2023 and 1% AEP design standard in 2026.

Table 3.12 Maximum storage volume (ML) – Dam M4

AEP	Year						
	2017	2020	2023	2026	2030	2034	2038
1%	N/A	N/A	**170***	167	**170***	N/A	N/A
2.5%	N/A	N/A	155	142	**170***	N/A	N/A
5%	N/A	N/A	131	115	163	N/A	N/A
10%	N/A	N/A	110	108	160	N/A	N/A
20%	N/A	N/A	106	104	152	N/A	N/A
25%	N/A	N/A	105	101	142	N/A	N/A
50%	N/A	N/A	87	65	64	N/A	N/A
75%	N/A	N/A	28	11	14	N/A	N/A

Note: **** bold** numbers indicate that the dam capacity is exceeded, and a contingency measure (such as emergency pit storage) will be required*

3.5.5 Dam M5 – Eastern Creek West (South)

Dam M5 has a design operating capacity of 240 ML and has been sized to cater for the 5% AEP design criteria. Figure 3.13 presents the predicted water volume in the storage over the life of the dam.

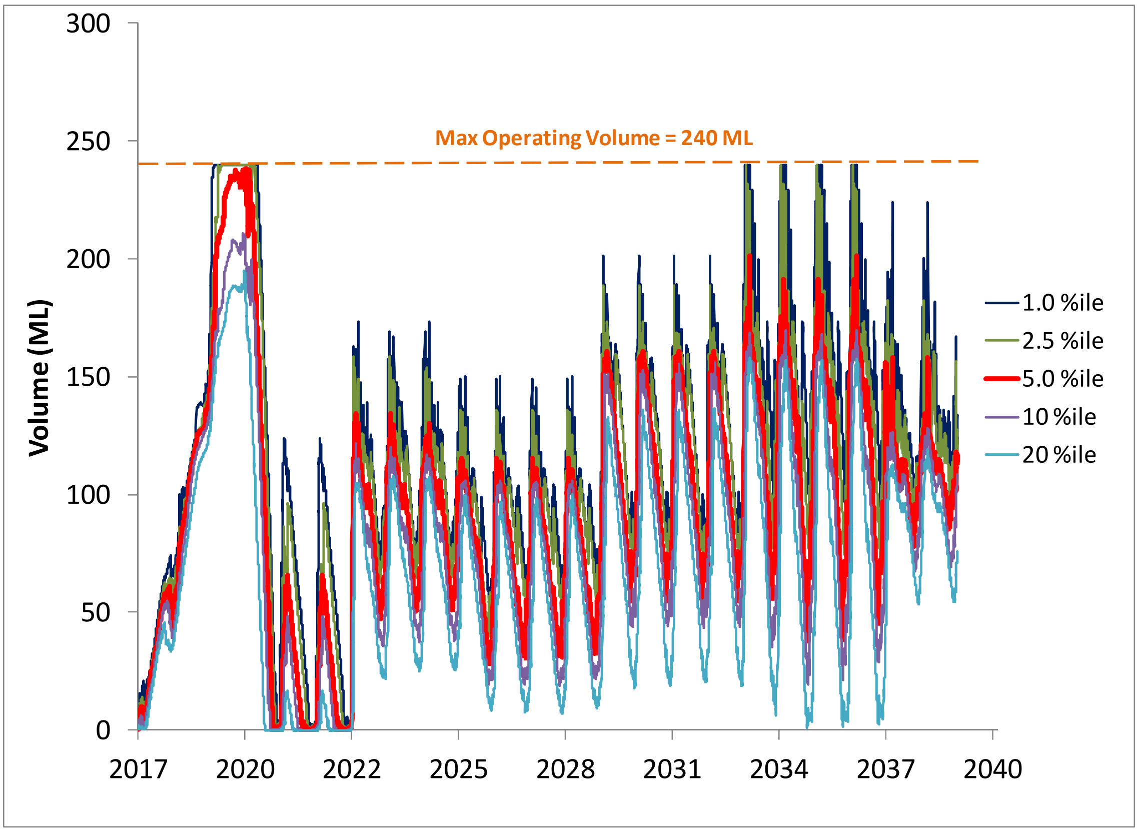

Figure 3.13
DAM M5 (EASTERN CREEK WEST) – WATER LEVEL PROFILE

Table 3.13 reviews the maximum water level that is projected to occur during each mining phase modelled in the water balance assessment. This demonstrates that the dam satisfies the 5% AEP design criteria required throughout the mine life, and is also able to satisfy a 1% AEP standard in Years 2023, 2026, 2030 and 2038.

Table 3.13 Maximum storage volume (ML) – Dam M5

AEP	Year						
	2017	2020	2023	2026	2030	2034	2038
1%	**240***	**240***	173	150	202	**240***	224
2.5%	**240***	**240***	159	136	188	**240***	182
5%	238	238	134	115	161	201	158
10%	211	209	121	106	156	169	128
20%	195	194	108	100	137	158	119
25%	189	188	105	95	129	154	113
50%	174	173	78	46	49	102	99
75%	162	162	21	5	9	22	43

Note: ***bold** *numbers indicate that the dam capacity is exceeded, and a contingency measure (such as emergency pit storage) will be required*

3.6 WATER SOURCES

As noted in Section 3.2.5, the main water demand for the Project will be associated with dust suppression. This water will be sourced from water collected within the catchments disturbed by mining and water from the proposed underground operations. However, in the event of low rainfall conditions there may be a need to source water from outside the Project area, utilising the existing supplies established for the existing mine. Table 3.14 summarises the demand for water from sources external to the Project. Table 3.15 presents the same results expressed as a proportion of the Project demand.

Table 3.14 Average demand from external sources (ML/d)

	Percentile				
	5% (dry)	20%	50%	80%	95% (wet)
2017	0.0	0.0	0.0	0.0	0.0
2020	1.2	1.0	0.1	0.0	0.0
2023	1.9	1.3	0.1	0.0	0.0
2026	0.2	0.1	0.0	0.0	0.0
2030	2.1	1.7	0.0	0.0	0.0
2034	1.4	1.0	0.1	0.0	0.0
2038	0.4	0.0	0.0	0.0	0.0

Table 3.15 Proportion of Project demand supplied from external sources

	Percentile				
	5% (dry)	20%	50%	80%	95% (wet)
2017	0%	0%	0%	0%	0%
2020	76%	62%	7%	0%	0%
2023	91%	66%	7%	0%	0%
2026	75%	55%	1%	0%	0%
2030	87%	69%	1%	0%	0%
2034	81%	58%	6%	0%	0%
2038	40%	1%	0%	0%	0%
Whole Project	80%	59%	3%	0%	0%

The results indicate that under average or high rainfall conditions the demand for water from external sources will be negligible.

Under low rainfall conditions (20th percentile) around 60% of the Project demand will need to be supplied from external sources. In drought conditions (5th percentile) 80% of the Project demand will need to be supplied from external sources, with up to 2.1 ML/d required.

3.7 ANNUAL FLOW SUMMARIES

Appendix C provides annual flow summaries of each dam represented in the water balance model. The annual flow summaries are presented for various rainfall conditions as follows:

- Low rainfall conditions (1943 to 1945, 20th percentile 3 year rainfall).
- Average rainfall conditions (1970 to 1972, 50th percentile 3 year rainfall).
- High rainfall conditions (1972 to 1974, 80th percentile 3 year rainfall).

The summaries demonstrate that the water balance model conserves mass and is therefore reliable.

3.8 SENSITIVITY ASSESSMENT

A sensitivity assessment was completed on the effect of groundwater salinity assumptions on the model. The salinity from the underground mine extension was increased from 6,300 mg/L to 9,500 mg/L. This change only affects Dam M5, since that dam receives water from the proposed underground mine. The results are presented in Figure 3.14 and Table 3.16.

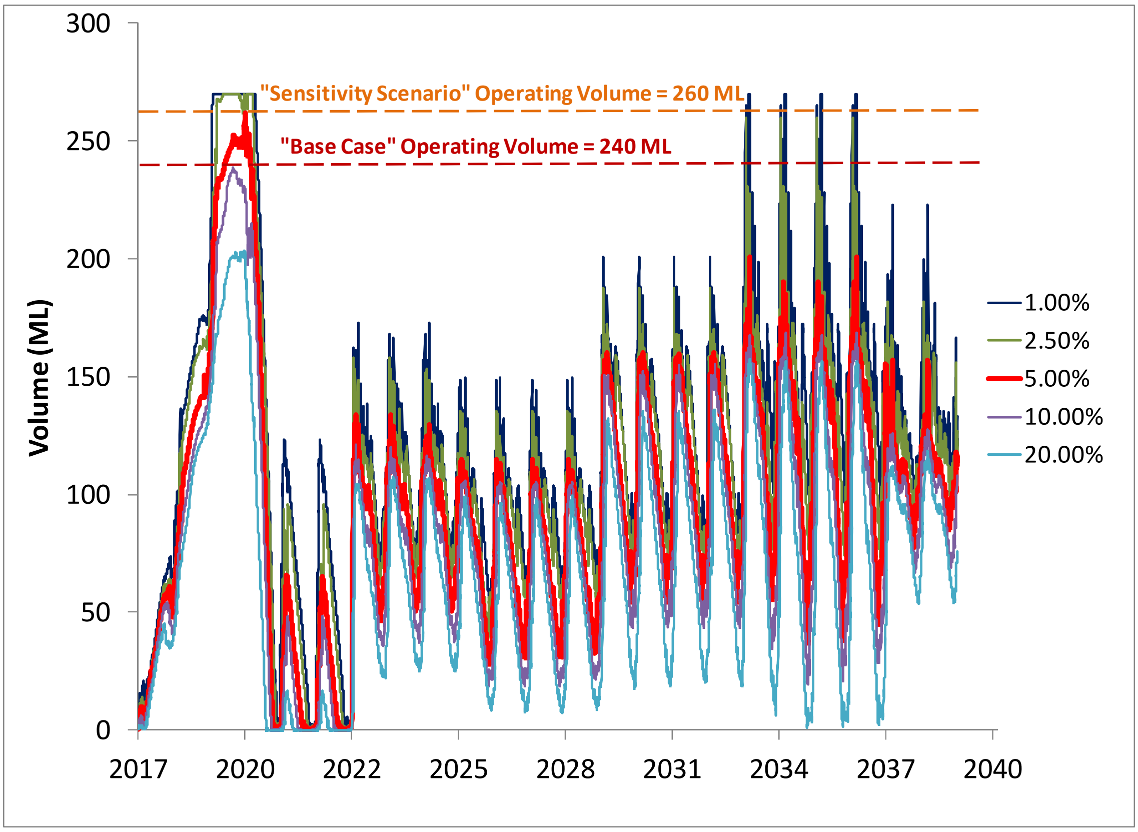

Figure 3.14
DAM M5 (EASTERN CREEK WEST) – WATER LEVEL PROFILE

Table 3.16 Maximum storage volume (ML) – Dam M5 – Sensitivity Analysis

AEP	Year						
	2017	2020	2023	2026	2030	2034	2038
1%	**240***	**240***	173	149	201	**240***	223
2.5%	**240***	**240***	158	135	188	**240***	182
5%	**240***	**240***	134	115	160	201	157
10%	239	230	121	106	155	169	127
20%	203	203	107	99	136	158	119
25%	199	198	105	95	129	153	112
50%	180	180	77	46	49	102	99
75%	166	166	21	5	9	22	43

Note: ***bold** numbers indicate that the dam capacity is exceeded, and a contingency measure (such as emergency pit storage) will be required*

The results indicate that the water balance is not particularly sensitive to an increase in salinity from the coal seam. This is because the water sourced from the underground is primarily used for dust suppression requirements, except in the early years when there are minimal new haul roads associated with the Project.

The higher salinity coal seam water increases the AEP from 5% to 10% in the initial stages of the Project. In order to maintain the 5% AEP design criteria, it will be necessary to increase the capacity of the storage from 240 ML to 260 ML. This decision could be made during operation if the need arises, and could be relatively easily accommodated by integrating with the existing underground mine water management infrastructure, or modifying Dam M5.

4 Water storage requirements

4.1 DAM SIZING

The proposed mine water management system for the Project involves the construction of 12 dams, three of which will change function as the Project progresses (i.e. conversion of mine water dams to sediment dams). The indicative dam volumes are presented in Table 4.1.

Table 4.1 Dam Inventory

ID	Type	Indicative Volume (ML)*
M1	Mine-affected	145
M2	Mine-affected	200
M3	Mine-affected	185
M4	Mine-affected	170
M5	Mine-affected	240
C1	Clean	50
C2	Clean	150
C3	Clean	170
C4	Clean	150
S1	Sediment-affect	55
S2	Sediment-affect	145
S3	Sediment-affect	214
S4	Sediment-affect	185
S5	Sediment-affect	72
S6	Sediment-affect	65

** dam volume has been based on conceptual design and is therefore indicative only*

4.2 REGULATED STRUCTURES

4.2.1 Introduction

The Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (DERM 2012) sets out the requirements of the administering authority, for hazard category assessment and certification of the design of 'regulated structures', constructed as part of environmentally relevant activities (ERAs) under the Environmental Protection Act 1994 (EP Act).

The term regulated structures includes land-based containment structures, levees, bunds and voids. Structures may be assessed as being in one of three hazard categories: low, significant or high. Where categorised as a significant or high hazard, the structure is referred to as a regulated structure.

DERM (2012) describes the assessment process to determine the hazard category of the dams. Two failure event scenarios need to be considered in the assessment as follows:

- failure to contain
- dam break.

The following considerations need to be made when evaluating the failure scenarios:

- loss of life or harm to humans
- general environmental harm
- loss of stock
- general economic loss or property damage.

The assessment must include a Failure Impact Assessment in accordance with DERM (2010) if the dam being considered meets the following criteria:

- more than 8 m in height and have a storage capacity of more than 500 ML or
- more than 8 m in height and have a storage capacity of more than 250 ML and a catchment area that is more than three times its maximum surface area.

The minimum hazard category of a dam is at least 'significant' if a dam will contain, or could potentially contain, contaminants at concentrations which exceed the values or range shown in Table 4.2 at any time when the contained volume equals the dam volume (the level at which it will overflow across the spillway), and the dam volume is greater than that indicated in the table.

Table 4.2 Contaminant concentrations and minimum dam volumes

Contaminant	Liquor	Total solids	Dam volume (ML)
Arsenic	1.0 mg/L	500 mg/kg	2.5
Boron	5.0 mg/L	15,000 mg/kg	2.5
Cadmium	0.01 mg/L	100 mg/kg	2.5
Cobalt	1.0 mg/L	500 mg/kg	2.5
Copper	1.0 mg/L	5,000 mg/kg	2.5
Lead	0.5 mg/L	1,500 mg/kg	2.5
Mercury	0.002 mg/L	75 mg/kg	2.5
Nickel	1.0 mg/L	3,000 mg/kg	2.5
Selenium	0.02 mg/L	150 mg/kg	2.5
Zinc	20 mg/L	35,000 mg/kg	2.5
Cyanide (un-ionised HCN)	10 mg/L	2,500 mg/kg	2.5
pH	Outside 5 to 9 (range)	Net acid generation pH < 4.5	2.5
TPH C6 – C36	90 mg/L	–	2.5
TPH C6 – C14	60 mg/L	–	2.5
Benzene	0.1 mg/L	–	2.5
Phenol	3 mg/L	–	2.5
Benzo(a)Pyrene	0.001 mg/L	–	2.5
Chloride	2500 mg/L	–	25

Contaminant	Liquor	Total solids	Dam volume (ML)
Fluoride	2.0 mg/L	–	25
Sulphate	1000 mg/L	–	25
Salinity (electrical conductivity)	4000 µS/cm	–	25

4.2.2 Hazard category assessment

Based on the indicative dam volumes presented in Table 4.1 none of the proposed dams meet the criteria that trigger the need for a Failure Impact Assessment.

All of the proposed dams are deemed to fall within the Low Hazard category for 'failure to contain' and 'dam break' scenarios, using the following rationale:

- Loss of life or harm to humans – The downstream waterways are predominantly rural and people are rarely present in the riparian zone. The dam volumes are relatively small resulting in relatively low failure flow rates, equivalent to relatively frequent flood events in the receiving environment. Using the empirical dam break peak discharge relationship presented in DERM (2010) for a typical dam present (150 ML), the peak failure discharge is 175 m^3/s. This equivalent to approximately 10 year ARI flood flow in Wilson Creek or less than 1 year ARI flood flow in Eastern Creek in the vicinity of the mining pits.
- General environmental harm – As noted above, dam failure flow rates are expected to be equivalent to relatively frequent flood events in the receiving environment, so should not cause excessive scour or damage to riparian vegetation. Contaminants are not expected to be present in the stored water. Salinity of stored water is expected to be within the range naturally observed in the receiving environment. The medians in the receiving environment vary between 433 µS/cm and 4,762 µS/cm, depending on location.
- Loss of stock – The closest stock present to the Project (that are not agisted on the holder's land) is at Wataliba Station, approximately 4 km downstream from Dam M3 at Eastern Creek East pit. The station has a low stocking rate, and given the separation distance and relatively low failure flow rates it is not anticipated that any loss of stock would occur. Water quality is expected to be within an allowable range for stock, of particular note is Australia & New Zealand Environment and Conservation Council guidelines for livestock which recommend a TDS below 2,500 mg/L. None of the dams are expected to contain water with this TDS, with the exception of dam M5. In the event of release of higher salinity water than the ANZECC guidelines, it is not expected stock would choose to consume the water or if they did, would be unlikely to result in stock loss.
- General economic loss or property damage – As noted above, there is no or minimal infrastructure in the riparian zone downstream of the proposed dams. In addition, the failure flow rate is expected to be equivalent to relatively frequent flood events in the receiving environment.

Current geochemical data suggests the waste rock is non acid generating with low salinity. Therefore none of the runoff entering the dams is expected to exceed the contaminant thresholds presented in Table 4.2. Dam M5 is planned to receive water from the underground operations, and therefore has the potential to exceed the EC threshold of 4,000 µS/cm on some occasions.

On the basis of the above discussion all dams fall into the 'low' hazard category and are not regulated structures, with the exception of Dam M5 which falls into the 'significant' hazard category and is therefore a regulated structure. A summary of the hazard category assessment outcomes is presented in Table 4.3.

Table 4.3 Hazard category assessment

Dam	Indicative volume (ML)	Failure to contain scenario	Dam break scenario	Contaminant threshold	Hazard category	Regulated structure
M1	145	Low	Low	Satisfied	Low	No
M2	200	Low	Low	Satisfied	Low	No
M3	185	Low	Low	Satisfied	Low	No
M4	170	Low	Low	Satisfied	Low	No
M5	240	Low	Low	Exceeded	Significant	Yes
C1	50	Low	Low	Satisfied	Low	No
C2	150	Low	Low	Satisfied	Low	No
C3	170	Low	Low	Satisfied	Low	No
C4	150	Low	Low	Satisfied	Low	No
S1	55	Low	Low	Satisfied	Low	No
S2	145	Low	Low	Satisfied	Low	No
S3	214	Low	Low	Satisfied	Low	No
S4	185	Low	Low	Satisfied	Low	No
S5	72	Low	Low	Satisfied	Low	No
S6	65	Low	Low	Satisfied	Low	No

** Dam volume (in millions of litres) has been based on conceptual design and is therefore indicative only.*

This assessment is based on conceptual design of the water management systems and is therefore of a preliminary nature. The hazard category assessment will need to be re-assessed during detailed design and then regularly during operation.

4.2.3 Hydraulic performance of Regulated Structures

As noted above there is one Regulated Structure associated with the Project. The design criteria for the structure is presented in Table 4.4.

Table 4.4 Design criteria of proposed Regulated Structures

Dam	M5
Hazard category	Significant
Wet season containment (DSA)	1:20 AEP
Storm event containment (MRL)	1:10 AEP 72 hr duration
Spillway capacity	1:100 AEP To 1:1000 AEP
Flood level for embankment crest levels	1: 100 AEP + 0.5 m freeboard

The Disturbed Soil Area (DSA) for the site requires containment of the 5% AEP three month cumulative rainfall. Based on 85 years of record at Byerwen Station, the 5% AEP three month cumulative rainfall is approximately 500 mm.

The catchment area of Dam M5, including ponded area, is approximately 40 ha resulting in a DSA of 200 ML. This means that the dam should be drawn down to 40 ML by 1 November each year in preparedness for the upcoming wet season.

4.2.4 Regular assessment

Dam M5 will be subject to the normal obligations that must be satisfied for Regulated Structures, as shown below:

- submission of detailed designs and documentation by a suitably qualified engineer
- annual inspections by a suitably qualified engineer
- design of a spillway to cater for a specific ARI based on the hazard category assigned to the dams
- inclusion of a suitable Design Storage Allowance and Mandatory Reporting Limits (MRL)
- assessment of the potential impacts of any failure of the dam embankments.

5 Conclusions

The water management strategy for the Project will involve segregation of water into three types: mine-affected, sediment-affected and clean. Water from sediment-affected catchments will be suitable for release after passing through sedimentation basins. Water collected from mine-affected catchments will be released from site when there is sufficient flow in the receiving waterway, and when water quality objectives can be satisfied.

Discharge limit and receiving environment trigger values have been proposed based on baseline environmental monitoring, as well as consideration of EA conditions for the existing mine.

A water balance model has been developed to assess the ability of the proposed water management infrastructure to meet the design and environmental compliance objectives. A 5% AEP design standard has been adopted for dam sizing. The result of this is that in extreme rainfall scenarios it may be necessary to utilise contingency measures to temporarily store or remove excess accumulated water. These may include:

- emergency storage of surplus water in the open pit (this may temporarily suspend or slow mining)
- enhanced evaporation (e.g. mist irrigation over waste rock dumps or dirty water dams)
- connection with existing mine water management infrastructure, providing access to additional storage areas, water treatment (reverse osmosis) infrastructure and potentially a new evaporation dam.

The water balance model demonstrates that the design objectives can be satisfied by the proposed water management infrastructure.

6 References

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Appendix A

STAGE–STORAGE RELATIONSHIPS

Appendix A

Stage–Storage Relationships

Table A1 Dam M1

Elevation (m)	Area (ha)	Volume (ML)
288.49	0	0
288.99	0.76	1.91
289.49	1.15	6.68
289.99	2.2	15.03
290.49	2.96	27.92
290.99	3.82	44.87
291.49	4.96	66.82
291.99	5.63	93.31
292.49	7.06	125.05
292.99	8.21	163.23
293.49	9.83	208.34
293.99	11.26	261.08
294.49	12.7	320.98
294.99	15.46	391.38
295.49	18.42	476.09
295.99	20.91	574.42
296	24.53	575.94

Table A2 Dam M2

Elevation (m)	Area (ha)	Volume (ML)
357.28	0	0
357.78	0.19	0.48
358.28	1.43	4.53
358.78	2.2	13.6
359.28	2.96	26.49
359.78	3.72	43.19
360.28	4.58	63.96
360.78	5.06	88.06
361.28	5.92	115.5
361.78	6.59	146.77
362.28	7.06	180.89
362.78	8.02	218.6
363.28	8.69	260.36
363.78	9.83	306.66
364.28	10.88	358.44
364.78	11.65	414.76
365	14.41	443.31

Table A3 Dam M3

Elevation (m)	Area (ha)	Volume (ML)
253.85	0	0
254.35	2.29	5.73
254.85	3.63	20.52
255.35	4.77	41.52
255.85	6.2	68.97
256.35	7.35	102.86
256.85	10.98	148.68
257.35	14.22	211.68
257.85	17.56	291.15
258.35	19.86	384.69
258.85	22.62	490.89
259.04	23.67	534.91

Table A4 Dam M4

Elevation (m)	Area (ha)	Volume (ML)
265.45	0	0
265.95	0.19	0.48
266.45	0.19	1.43
266.95	0.48	3.1
267.45	0.67	5.97
267.95	0.86	9.78
268.45	0.95	14.32
268.95	1.62	20.76
269.45	2.29	30.55
269.95	2.86	43.43
270.45	3.53	59.42
270.95	4.2	78.75
271.45	4.68	100.95
271.95	5.44	126.24
272.45	5.92	154.64
272.95	6.11	184.71
273.45	6.78	216.93
273.95	7.54	252.72
274.45	7.92	291.38
274.95	8.4	332.19
275.45	9.35	376.58
275.95	9.83	424.55
276.45	10.5	475.38
276.95	11.17	529.55
277.45	11.74	586.82
277.95	12.5	647.44
278.45	13.36	712.11
278.95	14.32	781.32
279.45	15.27	855.3
279.73	15.66	898.07

Table A5 Dam M5

Elevation (m)	Area (ha)	Volume (ML)
288.45	0	0
288.95	0.29	0.72
289.45	0.57	2.86
289.95	0.95	6.68
290.45	1.34	12.41
290.95	1.91	20.52
291.45	2.29	31.02
291.95	2.96	44.15
292.45	3.63	60.62
292.95	4.68	81.38
293.45	6.01	108.11
293.95	7.06	140.8
294.45	8.3	179.22
294.95	9.64	224.09
295.45	10.88	275.39
295.95	11.74	331.95
296.45	13.36	394.72
296.95	14.03	463.21
297.45	15.37	536.71
297.95	16.51	616.42
298	20.91	625.72

Table A6 Dam C2

Elevation (m)	Area (ha)	Volume (ML)
375.99	0	0
376.49	3.91	9.78
376.99	6.68	36.27
377.49	8.3	73.74
377.99	9.55	118.37
378.49	11.36	170.63
378.99	12.22	229.58
379.49	13.75	294.49
379.99	14.99	366.32
380.49	16.51	445.07
380.99	18.23	531.94
381.49	19.95	627.39
381.99	21.67	731.44
382.49	23.58	844.56
382.99	26.16	968.89
383.49	28.54	1105.64
383.99	31.31	1255.27
384.49	33.03	1416.11
384.99	36.37	1589.61
385	40.86	1592.63

Table A7 Dam C3

Elevation (m)	Area (ha)	Volume (ML)
286.12	0	0
286.62	2.58	6.44
287.12	3.82	22.43
287.62	5.06	44.63
288.12	6.4	73.26
288.62	7.45	107.87
289.12	8.78	148.44
289.62	11.17	198.31
290.12	14.22	261.79
290.62	16.71	339.11
291.12	19.76	430.27
291.62	21.29	532.89
292.12	23.58	645.05
292.62	25.39	767.48
293.12	27.11	898.73
293.62	29.02	1039.05
294.12	30.83	1188.68
294.62	32.93	1348.1
295	41.14	1489.4

Table A8 Dam C4

Elevation (m)	Area (ha)	Volume (ML)
272.9	0	0
273.4	0.38	0.95
273.9	1.24	5.01
274.4	2.48	14.32
274.9	3.15	28.4
275.4	4.01	46.3
275.9	4.96	68.73
276.4	6.78	98.08
276.9	8.02	135.07
277.4	9.64	179.22
277.9	10.6	229.81
278.4	11.93	286.13
278.9	13.36	349.37
279.4	14.6	419.3
279.9	15.37	494.23
280.4	16.9	574.89
280.9	18.52	663.43
281.4	19.57	758.65
281.6	20.52	796.96

Appendix B

CATCHMENT DATA

Appendix B

Catchment Data

Table B1 Catchment Details – 2017

Storage	Set	Model Node	Area [ha]	Salinity Set
Eastern Creek	Undisturbed	EC1.01	24631	Undisturbed
Dam M1	WRD (Unrehab)	SP1.01	58.3	WRD
Dam M1	WRD (Unrehab)	SP1.09	49.85	WRD
Dam M1	WRD (Unrehab)	SP1.10	10.67	WRD
Dam M1	Pit	SP1.07	30	Pit
Dam M1	Undisturbed	SP1.03	10.75	Undisturbed
Dam M1	Pre-Strip	SP1.14	50.85	Pre-Strip
Dam C4	Undisturbed	WP1.11	96.22	Undisturbed
Dam C4	Undisturbed	WP1.12	8.93	Undisturbed
Dam C2	Undisturbed	SP1.04	369.3	Undisturbed
Dam C2	Undisturbed	WP1.11	96.22	Undisturbed
Dam C2	Undisturbed	WP1.12	8.93	Undisturbed

Table B2 Catchment Details – 2020

Storage	Set	Model Node	Area [ha]	Salinity Set
Eastern Creek	Undisturbed	EC1.01	24631	Undisturbed
Wilson Creek	Undisturbed	WC1.01	5008	Undisturbed
Dam C2	Undisturbed	EP1.02	5.5	Undisturbed
Dam C2	Undisturbed	EP1.03	227	Undisturbed
Dam M1	WRD (Unrehab)	SP1.01	62.88	WRD
Dam M1	WRD (Unrehab)	SP1.09	40.94	WRD
Dam M1	WRD (Unrehab)	SP1.10	5.69	WRD
Dam C2	Undisturbed	SP1.04	369.3	Undisturbed
Dam C2	Undisturbed	SP1.02	361.8	Undisturbed
Dam C2	Undisturbed	SP1.03	7.5	Undisturbed
Dam M1	Pit	SP1.07	12.96	Pit
Dam M1	Pit	SP1.08	13.92	Pit
Dam M1	Undisturbed	SP1.03	10.75	Undisturbed
Dam M2	WRD (Unrehab)	SP1.11	75.95	WRD
Dam M2	Pre-Strip	SP1.12	7.19	Pre-Strip
Dam M2	Pit	SP1.13	9.09	Pit
Dam M2	Undisturbed	SP1.14	8	Undisturbed

Table B3 Catchment Details – 2023

Storage	Set	Model Node	Area [ha]	Salinity Set
Eastern Creek	Undisturbed	EC1.01	24631	Undisturbed
Wilson Creek	Undisturbed	WC1.01	5008	Undisturbed
Dam M3	Pit	EP1.01	29	Pit
Dam C2	Undisturbed	EP1.02	5.5	Undisturbed
Dam C2	Undisturbed	EP1.03	227	Undisturbed
Dam M3	WRD (Unrehab)	EP1.05	239	WRD
Dam M3	Pre-Strip	EP1.06	61.4	Pre-Strip
Dam M3	Undisturbed	EP1.07	299.22	Undisturbed
Dam M3	Undisturbed	EP1.08	12.5	Undisturbed
Dam M2	WRD (Unrehab)	SP1.01	136.1	WRD
Dam M2	Pre-Strip	SP1.02	30.7	Pre-Strip
Dam M2	Undisturbed	SP1.03	8	Undisturbed
Dam C2	Undisturbed	SP1.04	369.3	Undisturbed
Dam C2	Undisturbed	SP1.05	447.5	Undisturbed
Dam C2	Undisturbed	SP1.06	7.5	Undisturbed
Dam M2	Pit	SP1.07	31.42	Pit
Dam M4	Pit	WP1.01	13.91	Pit
Dam M5	WRD (Unrehab)	WP1.02	94.54	WRD
Dam M5	Pre-Strip	WP1.03	27.99	Pre-Strip
Dam M5	Undisturbed	WP1.05	5.95	Undisturbed
Dam M5	Pit	WP1.06	13.96	Pit
Dam M5	Undisturbed	WP2.01	43.74	Undisturbed
Dam M4	WRD (Unrehab)	WP1.07	109.61	WRD
Dam M4	Pre-Strip	WP1.08	29.04	Pre-Strip
Dam M4	Undisturbed	WP1.09	7.68	Undisturbed
Dam M4	Undisturbed	WP1.10	65.25	Undisturbed
Dam C4	Undisturbed	WP1.11	96.22	Undisturbed
Dam C4	Undisturbed	WP1.12	8.93	Undisturbed

Table B4 Catchment Details – 2026

Storage	Set	Model Node	Area [ha]	Salinity Set
Eastern Creek	Undisturbed	EC1.01	24631	Undisturbed
Wilson Creek	Undisturbed	WC1.01	5008	Undisturbed
Dam D3	Pit	EP1.01	29.2	Pit
Dam C2	Undisturbed	EP1.02	5.5	Undisturbed
Dam C2	Undisturbed	EP1.03	227	Undisturbed
Dam M3	WRD (Rehab)	EP1.04	209	Rehab (Active)
Dam M3	WRD (Unrehab)	EP1.05	121	WRD
Dam M3	Pre-Strip	EP1.06	61.5	Pre-Strip
Dam M3	Undisturbed	EP1.07	195.817	Undisturbed
Dam M3	Undisturbed	EP1.08	12.5	Undisturbed
Dam M2	WRD (Unrehab)	SP1.01	136.9	WRD
Dam M2	Pre-Strip	SP1.02	60.46	Pre-Strip
Dam M2	Undisturbed	SP1.03	8	Undisturbed
Dam C2	Undisturbed	SP1.04	447.5	Undisturbed
Dam C2	Undisturbed	SP1.05	148.1	Undisturbed
Dam C2	Undisturbed	SP1.06	7.5	Undisturbed
Dam M2	Pit	SP1.07	12.1	Pit
Dam M4	Pit	WP3.01	14.48	Pit
Dam M5	Pit	WP1.01	14.05	Pit
Dam C4	Undisturbed	WP1.11	96.22	Undisturbed
Dam C4	Undisturbed	WP1.12	8.93	Undisturbed
Dam M5	WRD (Unrehab)	WP1.02	41.81	WRD
Dam M5	Pre-Strip	WP1.03	27.91	Pre-Strip
Dam M5	Undisturbed	WP1.05	5.95	Undisturbed
Dam M5	Undisturbed	WP2.01	43.74	Undisturbed
Dam M4	WRD (Unrehab)	WP1.07	48.42	WRD
Dam M4	Pre-STrip	WP1.08	29.18	Pre-Strip
Dam M4	Undisturbed	WP1.09	7.68	Undisturbed
Dam M4	Undisturbed	WP1.10	65.25	Undisturbed

Table B5 Catchment Details – 2030

Storage	Set	Model Node	Area [ha]	Salinity Set
Eastern Creek	Undisturbed	EC1.01	24631	Undisturbed
Wilson Creek	Undisturbed	WC1.01	5008	Undisturbed
East Pit	Pit	EP1.01	30.09	Pit
Dam C2	Undisturbed	EP1.02	5.5	Undisturbed
Dam C2	Undisturbed	EP1.03	227	Undisturbed
Dam M3	WRD (Unrehab)	EP1.05	62.23	WRD
Dam M3	WRD (Unrehab)	EP2.01	56.7	WRD
Dam M3	WRD (Unrehab)	EP2.02	9.27	WRD
Dam M3	Pre-Strip	EP1.06	61.77	Pre-Strip
Dam M3	Undisturbed	EP1.08	12.5	Undisturbed
Dam M3	Undisturbed	EP1.09	57.03	Undisturbed
Dam M2	WRD (Unrehab)	SP1.01	66.59	WRD
Dam M2	WRD (Unrehab)	SP2.01	49.79	WRD
Dam M2	Pre-Strip	SP1.02	43.35	Pre-Strip
Dam M2	Undisturbed	SP1.03	8	Undisturbed
Dam C2	Undisturbed	SP1.04	447.5	Undisturbed
Dam C2	Undisturbed	SP1.06	7.5	Undisturbed
Dam M2	Pit	SP1.07	35.19	Pit
Dam M4	Pit	WP1.01	15.04	Pit
Dam M5	Pit	WP3.01	12.33	Pit
Dam M5	WRD (Unrehab)	WP1.02	54.62	WRD
Dam M5	Pre-Strip	WP1.03	22.79	Pre-Strip
Dam M5	Undisturbed	WP1.05	5.95	Undisturbed
Dam M5	Undisturbed	WP2.01	43.74	Undisturbed
Dam M4	WRD (Unrehab)	WP1.07	58.36	WRD
Dam M4	Pre-STrip	WP1.08	32.62	Pre-Strip
Dam M4	Undisturbed	WP1.09	7.68	Undisturbed
Dam M4	Undisturbed	WP1.10	65.25	Undisturbed
Dam C4	Undisturbed	WP1.11	96.22	Undisturbed
Dam C4	Undisturbed	WP1.12	8.93	Undisturbed
Dam M2	WRD (Rehab)	SP2.02	66.98	Rehab (Active)

Table B6 Catchment Details – 2034

Storage	Set	Model Node	Area [ha]	Salinity Set
Eastern Creek	Undisturbed	EC1.01	24631	Undisturbed
Wilson Creek	Undisturbed	WC1.01	5008	Undisturbed
Dam M3	Pit	EP1.01	30.4	Pit
Dam C2	Undisturbed	EP1.02	5.5	Undisturbed
Dam C2	Undisturbed	EP1.03	227	Undisturbed
Dam M3	WRD (Unrehab)	EP1.05	56.47	WRD
Dam M3	WRD (Unrehab)	EP2.01	65.15	WRD
Dam M3	Pre-Strip	EP2.02	61.9	Pre-Strip
Dam M3	Undisturbed	EP1.06	57.03	Undisturbed
Dam M3	Undisturbed	EP1.08	12.5	Undisturbed
Dam C2	Undisturbed	SP1.04	414.73	Undisturbed
Dam C2	Undisturbed	SP1.06	7.5	Undisturbed
Dam M4	Pit	WP1.01	16.81	Pit
Dam M5	Pit	WP3.01	10.33	pit
Dam M5	WRD (Unrehab)	WP1.02	46.67	WRD
Dam M5	Pre-Strip	WP1.03	20.24	Pre-Strip
Dam M5	Undisturbed	WP1.05	5.95	Undisturbed
Dam M5	Undisturbed	WP2.01	43.74	Undisturbed
Dam M4	WRD (Unrehab)	WP1.07	64.11	WRD
Dam M4	Pre-STrip	WP1.08	36.89	Pre-Strip
Dam M4	Undisturbed	WP1.09	7.68	Undisturbed
Dam M4	Undisturbed	WP1.10	65.25	Undisturbed
Dam C4	Undisturbed	WP1.11	96.22	Undisturbed
Dam C4	Undisturbed	WP1.12	8.93	Undisturbed

Table B7 Catchment Details – 2038

Storage	Set	Model Node	Area [ha]	Salinity Set
Eastern Creek	Undisturbed	EC1.01	24631	Undisturbed
Wilson Creek	Undisturbed	WC1.01	5008	Undisturbed
Dam M3	Pit	EP1.01	40.84	Pit
Dam C2	Undisturbed	EP1.02	5.5	Undisturbed
Dam C2	Undisturbed	EP1.03	227	Undisturbed
Dam M3	WRD (Rehab)	EP2.02	80.92	Rehab (Active)
Dam M3	Undisturbed	EP1.06	57.03	Undisturbed
Dam M3	Undisturbed	EP1.08	12.5	Undisturbed
Dam M4	Pit	WP1.01	14.89	Pit
Dam M5	Pit	WP1.13	6.88	Pit
Dam M5	WRD (Unrehab)	WP1.02	43.73	WRD
Dam M5	Undisturbed	WP1.05	5.95	Undisturbed
Dam M5	Undisturbed	WP2.01	43.74	Undisturbed
Dam M4	WRD (Unrehab)	WP1.07	71.45	WRD
Dam M4	Undisturbed	WP1.09	7.68	Undisturbed
Dam M4	Undisturbed	WP1.10	65.25	Undisturbed
Dam C4	Undisturbed	WP1.11	96.22	Undisturbed
Dam C4	Undisturbed	WP1.12	8.93	Undisturbed

Appendix C

FLOW SUMMARIES

Appendix C
Flow Summaries

Table C1 Flow summary (ML/yr) for Dam C2 – 20th percentile rainfall (1943-1945)

	Inflows	Outflows				Change in Storage
	Runoff	Evaporation	Dust	Spill	Discharge	
2017	323.7	156.4	0.0	147.1	7.7	12.5
2020	309.6	89.7	110.3	127.3	7.0	-24.7
2023	308.8	95.4	99.9	117.5	6.6	-10.5
2026	308.7	95.4	101.8	114.5	7.3	-10.4
2030	307.7	88.5	107.8	115.0	6.7	-10.4
2034	308.6	91.9	107.0	120.0	0.0	-10.4
2038	321.3	137.2	54.8	139.1	0.0	-9.9

Table C2 Flow summary (ML/yr) for Dam C2 – 50th percentile rainfall (1970-1972)

	Inflows	Outflows				Change in Storage
	Runoff	Evaporation	Dust	Spill	Discharge	
2017	431.6	164.0	0.0	227.6	14.7	25.3
2020	412.6	94.5	108.0	201.2	14.7	-5.7
2023	414.8	99.1	100.8	193.1	24.5	-2.6
2026	415.0	100.2	100.7	206.6	9.6	-2.1
2030	412.8	92.6	109.8	191.0	23.0	-3.6
2034	412.9	92.2	107.9	215.6	0.0	-2.8
2038	424.9	137.1	54.5	222.9	0.0	10.4

Table C3 Flow summary (ML/yr) for Dam C2 – 80th percentile rainfall (1972-1974)

	Inflows	Outflows				Change in Storage
	Runoff	Evaporation	Dust	Spill	Discharge	
2017	962.9	172.6	0.0	745.1	12.8	32.3
2020	952.9	123.4	101.8	705.1	15.8	6.8
2023	952.2	122.7	108.3	688.2	25.8	7.0
2026	952.8	122.0	108.1	704.3	13.0	5.4
2030	951.4	117.7	118.2	688.6	23.6	3.2
2034	952.0	120.8	111.0	715.7	0.0	4.6
2038	962.8	157.6	54.8	733.0	0.0	17.4

Table C4 Flow summary (ML/yr) for Dam C3 – 20th percentile rainfall (1943-1945)

	Inflows	**Outflows**				**Change in Storage**
	Runoff	Evaporation	Dust	Spill	Discharge	
2017	104.6	64.1	0.0	0.0	39.7	0.8
2020	106.8	67.0	0.0	0.0	44.2	-4.5
2023	97.7	24.4	44.1	0.0	34.6	-5.3
2026	96.8	23.0	45.4	0.0	31.4	-3.1
2030	96.5	21.7	46.7	0.0	31.1	-3.0
2034	96.5	22.0	45.5	0.0	32.0	-3.0
2038	97.2	25.7	43.0	0.0	31.4	-3.0

Table C5 Flow summary (ML/yr) for Dam C3 – 50th percentile rainfall (1970-1972)

	Inflows	**Outflows**				**Change in Storage**
	Runoff	Evaporation	Dust	Spill	Discharge	
2017	139.0	66.2	0.0	0.0	68.9	3.9
2020	139.8	67.0	0.0	0.0	70.6	2.3
2023	130.9	26.5	46.2	0.0	59.9	-1.6
2026	130.8	25.9	46.5	0.0	58.8	-0.4
2030	130.7	24.7	48.3	0.0	57.9	-0.3
2034	130.8	25.4	47.0	0.0	58.5	-0.2
2038	131.4	28.5	42.8	0.0	60.3	-0.2

Table C6 Flow summary (ML/yr) for Dam C3 – 80th percentile rainfall (1972-1974)

	Inflows	**Outflows**				**Change in Storage**
	Runoff	Evaporation	Dust	Spill	Discharge	
2017	317.9	84.7	0.0	0.0	226.6	6.6
2020	320.0	85.7	0.0	0.0	230.0	4.3
2023	310.3	43.8	55.0	0.0	213.1	-1.6
2026	309.6	42.3	56.0	0.0	211.4	-0.1
2030	309.2	41.4	59.6	0.0	208.3	-0.1
2034	309.2	41.7	57.5	0.0	209.8	0.1
2038	308.8	44.6	51.8	0.0	212.3	0.1

Table C7 Flow summary (ML/yr) for Dam C4 – 20th percentile rainfall (1943-1945)

	Inflows	**Outflows**				**Change in Storage**
	Runoff	Evaporation	Dust	Spill	Discharge	
2017	40.8	0.5	0.0	0.0	40.2	0.0
2020	41.0	0.5	7.0	0.0	33.4	0.0
2023	42.9	9.9	33.0	0.0	1.1	-1.2
2026	42.9	9.8	33.8	0.0	0.4	-1.1
2030	42.7	9.2	34.6	0.0	0.0	-1.1
2034	43.1	10.7	32.9	0.0	0.6	-1.1
2038	43.5	12.3	24.2	0.0	8.2	-1.2

Table C8 Flow summary (ML/yr) for Dam C4 – 50th percentile rainfall (1970-1972)

	Inflows	**Outflows**				**Change in Storage**
	Runoff	Evaporation	Dust	Spill	Discharge	
2017	55.5	0.7	0.0	0.0	54.8	0.0
2020	55.6	0.7	8.4	0.0	46.5	0.0
2023	58.7	13.9	38.3	0.0	6.5	0.0
2026	58.9	14.8	42.1	0.0	2.0	0.0
2030	58.9	14.6	44.1	0.0	0.3	0.0
2034	58.8	15.6	39.3	0.0	4.0	0.0
2038	59.3	19.3	29.2	0.0	10.8	0.0

Table C9 Flow summary (ML/yr) for Dam C4 – 80th percentile rainfall (1972-1974)

	Inflows	**Outflows**				**Change in Storage**
	Runoff	Evaporation	Dust	Spill	Discharge	
2017	129.6	1.5	0.0	0.0	128.3	-0.1
2020	130.2	1.5	15.4	0.0	113.3	0.0
2023	140.6	38.0	58.4	0.0	6.8	37.4
2026	140.7	38.1	63.7	0.0	1.9	37.1
2030	140.5	36.4	67.6	0.0	0.2	36.4
2034	141.0	40.0	55.9	0.0	4.5	40.7
2038	141.7	45.3	31.6	0.0	16.8	47.9

Table C10 Flow summary (ML/yr) for Dam M1 – 20th percentile rainfall (1943-1945)

	Inflows	Outflows				Change in Storage
	Runoff	Evaporation	Dust	Spill	Discharge	
2017	182.6	1.8	0.0	0.0	180.7	0.0
2020	218.9	28.3	146.3	0.0	44.3	0.0
2023	-	-	-	-	-	-
2026	-	-	-	-	-	-
2030	-	-	-	-	-	-
2034	-	-	-	-	-	-
2038	-	-	-	-	-	-

Table C11 Flow summary (ML/yr) for Dam M1 – 50th percentile rainfall (1970-1972)

	Inflows	Outflows				Change in Storage
	Runoff	Evaporation	Dust	Spill	Discharge	
2017	206.1	2.0	0.0	0.0	204.1	0.0
2020	237.6	30.9	125.6	0.0	81.2	0.0
2023	-	-	-	-	-	-
2026	-	-	-	-	-	-
2030	-	-	-	-	-	-
2034	-	-	-	-	-	-
2038	-	-	-	-	-	-

Table C12 Flow summary (ML/yr) for Dam M1 – 80th percentile rainfall (1972-1974)

	Inflows	Outflows				Change in Storage
	Runoff	Evaporation	Dust	Spill	Discharge	
2017	358.6	3.5	0.0	0.0	355.1	0.0
2020	372.8	44.2	145.1	0.0	183.1	0.4
2023	-	-	-	-	-	-
2026	-	-	-	-	-	-
2030	-	-	-	-	-	-
2034	-	-	-	-	-	-
2038	-	-	-	-	-	-

Table C13 Flow summary (ML/yr) for Dam M2 – 20th percentile rainfall (1943-1945)

	Inflows	**Outflows**				**Change in Storage**
	Runoff	Evaporation	Dust	Spill	Discharge	
2017	-	-	-	-	-	-
2020	160.3	36.1	124.2	0.0	0.0	0.0
2023	284.6	59.1	172.7	0.0	57.9	-5.1
2026	405.2	62.3	233.6	0.0	120.2	-11.1
2030	286.4	52.8	177.6	0.0	66.9	-11.0
2034	5.2	4.1	12.6	0.0	0.0	-11.5
2038	-	-	-	-	-	-

Table C14 Flow summary (ML/yr) for Dam M2 – 50th percentile rainfall (1970-1972)

	Inflows	**Outflows**				**Change in Storage**
	Runoff	Evaporation	Dust	Spill	Discharge	
2017	-	-	-	-	-	-
2020	174.0	44.8	126.7	0.0	2.6	0.0
2023	309.0	55.0	144.0	0.0	110.0	0.0
2026	430.0	58.5	208.2	0.0	162.2	1.2
2030	312.8	50.6	148.8	0.0	114.1	-0.7
2034	4.4	0.4	4.0	0.0	0.0	0.0
2038	-	-	-	-	-	-

Table C15 Flow summary (ML/yr) for Dam M2 – 80th percentile rainfall (1972-1974)

	Inflows	**Outflows**				**Change in Storage**
	Runoff	Evaporation	Dust	Spill	Discharge	
2017	-	-	-	-	-	-
2020	268.1	63.8	129.5	0.0	68.4	6.4
2023	492.4	75.1	160.8	0.0	249.1	7.4
2026	621.5	75.0	201.7	0.0	326.8	18.0
2030	534.5	71.1	168.1	0.0	289.4	6.0
2034	10.9	2.0	9.3	0.0	0.0	-0.4
2038	-	-	-	-	-	-

Table C16 Flow summary (ML/yr) for Dam M3 – 20th percentile rainfall (1943-1945)

	Inflows	Outflows				Change in Storage
	Runoff	Evaporation	Dust	Spill	Discharge	
2017	-	-	-	-	-	-
2020	-	-	-	-	-	-
2023	509.0	45.4	85.4	0.0	377.6	0.6
2026	347.9	65.8	118.1	0.0	180.7	-16.6
2030	316.5	87.2	151.4	0.0	91.9	-14.0
2034	365.5	111.4	160.0	0.0	103.1	-9.1
2038	235.0	127.6	121.2	0.0	3.9	-17.7

Table C17 Flow summary (ML/yr) for Dam M3 – 50th percentile rainfall (1970-1972)

	Inflows	Outflows				Change in Storage
	Runoff	Evaporation	Dust	Spill	Discharge	
2017	-	-	-	-	-	-
2020	-	-	-	-	-	-
2023	589.7	45.0	80.2	0.0	463.4	1.1
2026	400.9	59.1	100.6	0.0	245.4	-4.1
2030	352.0	78.3	127.8	0.0	148.1	-2.2
2034	399.3	95.6	141.4	0.0	156.2	6.0
2038	243.7	106.0	121.5	0.0	0.0	16.2

Table C18 Flow summary (ML/yr) for Dam M3 – 80th percentile rainfall (1972-1974)

	Inflows	Outflows				Change in Storage
	Runoff	Evaporation	Dust	Spill	Discharge	
2017	-	-	-	-	-	-
2020	-	-	-	-	-	-
2023	1098.7	54.8	84.9	0.0	956.5	2.6
2026	738.8	80.0	115.7	0.0	546.8	-3.8
2030	594.5	110.8	149.2	0.0	336.6	-2.0
2034	646.3	133.2	149.4	0.0	354.6	9.1
2038	339.7	131.8	112.5	0.0	72.2	23.2

Table C19 Flow summary (ML/yr) for Dam M4 – 20th percentile rainfall (1943-1945)

	Inflows	Outflows				Change in Storage
	Runoff	Evaporation	Dust	Spill	Discharge	
2017	-	-	-	-	-	-
2020	-	-	-	-	-	-
2023	202.5	34.2	100.7	0.0	68.3	-0.7
2026	134.3	28.6	88.7	0.0	25.8	-8.8
2030	153.6	40.2	115.3	0.0	3.6	-5.5
2034	-	-	-	-	-	-
2038	-	-	-	-	-	-

Table C20 Flow summary (ML/yr) for Dam M4 – 50th percentile rainfall (1970-1972)

	Inflows	Outflows				Change in Storage
	Runoff	Evaporation	Dust	Spill	Discharge	
2017	-	-	-	-	-	-
2020	-	-	-	-	-	-
2023	230.6	30.8	81.2	0.0	118.6	0.0
2026	155.5	27.2	76.8	0.0	51.9	-0.3
2030	177.7	42.7	101.8	0.0	32.4	0.8
2034	-	-	-	-	-	-
2038	-	-	-	-	-	-

Table C21 Flow summary (ML/yr) for Dam M4 – 80th percentile rainfall (1972-1974)

	Inflows	Outflows				Change in Storage
	Runoff	Evaporation	Dust	Spill	Discharge	
2017	-	-	-	-	-	-
2020	-	-	-	-	-	-
2023	418.7	45.5	105.0	0.0	267.7	0.5
2026	290.7	36.9	95.6	0.0	158.7	-0.5
2030	325.6	53.9	119.4	0.0	148.4	3.8
2034	-	-	-	-	-	-
2038	-	-	-	-	-	-

Table C22 Flow summary (ML/yr) for Dam M5 – 20th percentile rainfall (1943-1945)

	Inflows	**Outflows**				**Change in Storage**
	Runoff	Evaporation	Dust	Spill	Discharge	
2017	179.8	78.3	0.0	0.0	48.5	53.0
2020	21.4	5.3	28.4	0.0	0.0	-12.3
2023	176.2	35.0	93.3	0.0	48.3	-0.4
2026	121.4	30.5	87.2	0.0	11.4	-7.6
2030	137.2	35.1	106.8	0.0	0.0	-4.7
2034	296.7	42.6	172.4	0.0	86.9	-5.1
2038	255.9	67.3	85.3	0.0	104.5	-1.1

Table C23 Flow summary (ML/yr) for Dam M5 – 50th percentile rainfall (1970-1972)

	Inflows	**Outflows**				**Change in Storage**
	Runoff	Evaporation	Dust	Spill	Discharge	
2017	190.0	80.2	0.0	0.0	55.2	54.7
2020	28.1	5.0	31.6	0.0	0.0	-8.5
2023	200.3	32.9	76.5	0.0	90.8	0.0
2026	139.1	29.6	76.2	0.0	33.3	0.0
2030	157.9	46.5	104.9	0.0	6.4	0.0
2034	338.2	41.4	150.5	0.0	146.4	0.0
2038	287.7	62.3	78.4	0.0	136.9	10.0

Table C24 Flow summary (ML/yr) for Dam M5 – 80th percentile rainfall (1972-1974)

	Inflows	**Outflows**				**Change in Storage**
	Runoff	Evaporation	Dust	Spill	Discharge	
2017	232.8	96.6	0.0	0.0	57.2	78.9
2020	68.9	21.9	56.9	0.0	0.0	-9.9
2023	358.3	46.8	98.1	0.0	213.1	0.4
2026	250.8	38.9	92.9	0.0	119.1	-0.1
2030	276.7	57.6	119.0	0.0	97.2	3.0
2034	601.2	59.7	182.2	0.0	358.5	0.8
2038	498.5	74.9	77.8	0.0	328.5	17.3