



Bowen River Coal Pty Ltd

Cows Coal Mine Progressive Rehabilitation and Closure Plan

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1. Project Planning

1.1. Introduction

The Cows Coal Mine (CCM) is an open cut coal mine within the northern Bowen Basin in Central Queensland, located within the Whitsunday Regional Council (WRC) Local Government Area. It is approximately 9km south of the town of Collinsville, and 82km southwest of the regional centre of Bowen (see **Figure 1**). The CCM is situated on the western side of the state-controlled Bowen Development Road (which is the primary access to the site) and the Newlands Rail line.

The CCM is one of four adjoining coal mines managed by QCoal, the others being the Sonoma Coal Mine (SCM), the Drake Coal Mine (DCM) and the Jax Coal Mine (JCM). Each mine has a separate Environmental Authority (EA) and EA holder. However the four mines are collectively operated and managed under a co-development agreement as an integrated mining operation by QCoal Pty Ltd (QCoal), referred to as the QCoal Northern Hub (QNH), with pits, dumps, haul roads and other infrastructure spanning the tenure boundaries of the sites. Mining operations are conducted by a single mining contractor, with planning, management, operational and environmental resources also integrated across the QNH. **Figure 1** also shows the location of the CCM relative to the other QNH mines.

The CCM is wholly contained within Mining Lease (ML) 10345, a 211Ha ML over a road reserve between the SCM to the north and the DCM to the south. The granting of ML 10345 enabled the mining of a small coal resource (~2.5mt) within the CCM area and allowed for continuous mining of the same coal seams to span across the boundaries of the SCM, CCM and DCM MLs. Further details on ML 10345 are provided in **Section 1.1.5**.

Mining commenced at the CCM in January 2013, using conventional open-cut mining methods to target the Q seam and B seam of the Moranbah Coal Measures in two pits (i.e. Q-Pit and B-Pit respectively). Both pits were a southward continuation of mining from the SCM into the CCM and in the case of B-Pit, continuing into the DCM. Mine waste was placed in out-of-pit waste rock dumps until sufficient void was available within the pits to allow for in-pit dumping via and advancing low-wall (progressively backfilling). B-Pit has been progressively backfilled by continued advancement of the pit into the DCM, while Q-Pit has been directly backfilled since the reaching the economic limit of coal recovery by a specific backfilling campaign using additional waste rock from the DCM. As such, no voids currently exist on ML 10345. The out of pit dumps and other infrastructure on ML 10345 (such as haul roads) continue to be utilised by activities on the QNH.

The QNH mines utilise processing and support infrastructure at the SCM, including the Coal Handling and Preparation Plant (CHPP), rejects management system (co-disposal facility), train load-out, Run of Mine (ROM) pad, product stockpile area, heavy vehicle workshop, offices and fuel storage. Infrastructure on the CCM is limited to haul roads and access tracks to support the mining activities on the QNH, particularly continued haulage of ROM coal from the JCM and DCM into the SCM for processing and train loading of product coal. During mining, ROM coal from the CCM was

also hauled to the SCM for processing and train loading of product coal for transport to the Abbott Point Coal terminal.

Ongoing activities at the CCM include the continued haulage of ROM coal via existing haul roads as part of the wider QNH operations, facilitating movement of light vehicles across the QNH via existing access tracks, continued dumping of waste rock from the DCM on existing CCM waste rock dumps, rehabilitation activities in available areas and environmental monitoring. The use of haul roads through the CCM to support the wider QNH operations will be required to provide access to the SCM from the southern DCM and JCM mines for the life of mine of the DCM and JCM. Therefore, areas required for the continued haulage will not be available for rehabilitation until the completion of mining activities at the DCM and JCM.

1.1.1. Project Ownership

The QNH sites have ownership makeups as follows:

- CCM is owned by Bowen River Coal Pty Ltd (BRC).
- SCM is a joint venture between QCoal Sonoma Pty Ltd, JS Sonoma Pty Ltd, CSC Sonoma Pty Ltd and Watami (Qld) Pty Ltd.
- DCM is owned by Northern Hub (Drake) Pty Ltd and Drake Coal Pty Ltd.
- JCM is owned by Jax Coal Pty Ltd.

BRC, QCoal Sonoma Pty Ltd, Northern Hub (Drake) Pty Ltd, Drake Coal Pty Ltd, and Jax Coal Pty Ltd, are wholly or majority owned subsidiaries of QCoal Pty Ltd. The owner and Managing Director of QCoal Pty Ltd is Mr Christopher Wallin.

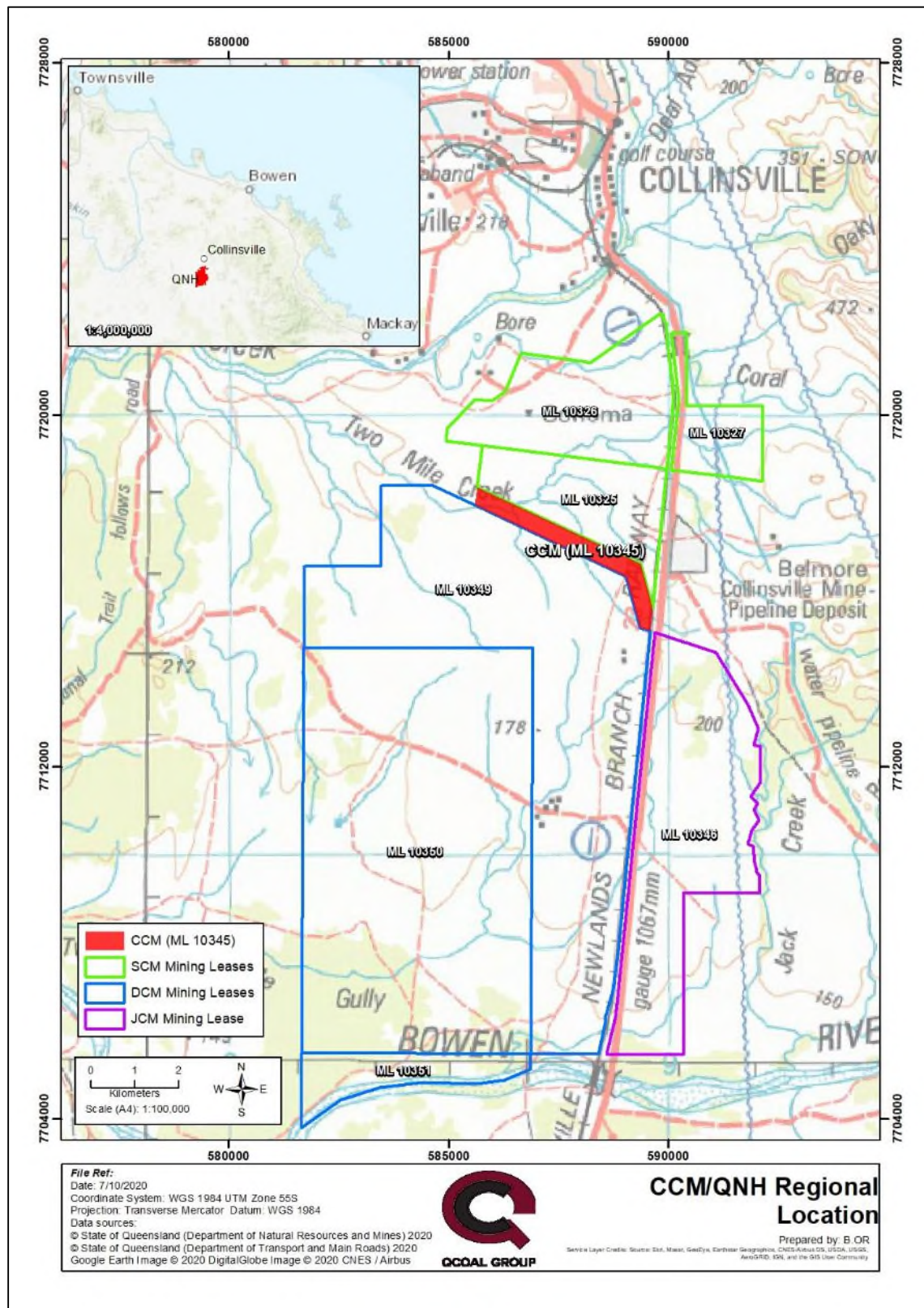


Figure 1 – CCM Regional Location

1.1.2. Progressive Rehabilitation and Closure Plan Legislation and Guideline

The *Mineral and Energy Resources (Financial Provisioning) Act 2018* (MERFP Act) was passed by the Queensland Parliament on 30 November 2018 which, amongst other changes, amended the *Environmental Protection Act 1994* (EP Act). One of the key changes introduced by this legislation was to the requirement for new and existing mines to develop and submit a Progressive Rehabilitation and Closure Plan (PRC Plan) detailing how rehabilitation will be planned, scheduled and progressed to bring mine-disturbed land to a stable condition, as defined in Section 111A of the EP Act:

111A Meaning of stable condition

*Land is in a **stable condition** if –*

- (a) the land is safe and structurally stable; and*
- (b) there is no environmental harm being caused by anything on or in the land; and*
- (c) the land can sustain a post-mining land use.*

A PRC Plan must address the requirements in sections 126C and 126D of the EP Act, pursuant to section 754 of the EP Act. Further guidance on the required content is contained in the *Guideline Progressive Rehabilitation and Closure Plans* (DES, 2019) (PRCP Guideline).

The PRC Plan comprises two components (as required by the EP Act):

- The PRC Plan – Rehabilitation Planning Part, which provides information on:
 - o site characteristics;
 - o pre-mining conditions;
 - o post-mining land-uses (PMLUs);
 - o community consultation;
 - o rehabilitation methodology and criteria;
 - o a risk assessment; and
 - o a monitoring program.
- The PRC Plan - Schedule, which:
 - o Allocates all mine disturbance to a designated rehabilitation area which has a specific PMLU;
 - o nominates rehabilitation milestones (which when all achieved represents completed rehabilitation);
 - o provides a detailed schedule for the progressive rehabilitation of all rehabilitation areas to achieve the rehabilitation milestones.

The EP Act includes transitional provisions for the application of the PRC Plan requirement to existing mines. Holders of an existing site-specific mining EA will be issued with a notice from the administering authority within the first three years following the PRC Plan start date (being 1 November 2019). The notice will specify a date by which a PRC Plan must be developed and submitted to the Department of Environment and Science (DES) as the administering authority.

A Progressive Rehabilitation and Closure Plan Transition Notice (the Notice) for the CCM was issued to BRC by DES on 30 June 2020. The Notice requires BRC to submit a PRC Plan to the administering authority by 29 January 2021.

1.1.3. Document Purpose and Interaction Between the PRC Plan Components

This document in its entirety (including appendices) represents the PRC Plan for the CCM, developed in accordance with the requirements of the EP Act and PRCP Guideline. The components of the PRC Plan within this document are as follows:

- the “PRC Plan – Rehabilitation Planning Part” which is provided as the body of this document; and
- the “PRC Plan – Schedule” is provided as Appendix A of this document.

The PRC Plan – Rehabilitation Planning Part and the PRC Plan – Schedule can be considered, reviewed, and implemented separately. Additionally, both components can be amended independently without requiring amendment of the to the other; however, where such an amendment results in an inconsistency between the two components, that inconsistency requires resolution.

Where the PRC Plan - Schedule is amended and as a result the PRC Plan – Rehabilitation Planning Part requires amendment to resolve an inconsistency between the components, a copy of the amended PRC Plan – Rehabilitation Planning Part will be provided to the administering authority within 10 business days as required by section 316H of the EP Act.

1.1.4. Land Outcome Documents

The CCM is an existing mine that was approved and commenced prior to the PRC Plan start date (1 November 2019); therefore, the transitional arrangements detailed in Section 6 of the PRCP Guideline apply to this PRC Plan. This includes the use of existing Land Outcome Documents (LODs), the purpose of which is to facilitate existing mines with existing landforms and mine plans into the PRC Plan framework, by nominating pre-existing documents related to rehabilitation and closure, the contents of which the regulatory authority gives continued approval for implementation on the site. As such the contents and findings of an LOD can be relied upon as stated and adopted into the PRC Plan framework. Relevant content examples in an LOD include nominated PMLUs, non-use-management-areas (NUMA), rehabilitation methodologies, completion criteria and the related antecedent studies.

LODs are defined under section 750 of the EP Act as:

land outcome document, for land, means the following documents relating to the land—

- (a) an environmental authority for a resource activity on the land;
- (b) a document made under a condition of an environmental authority mentioned in paragraph (a), if—
 - (i) the document relates to the management of a void within the meaning of section 126D on the land, or the rehabilitation of the land; and

- (ii) the document was received by the administering authority before the assent date; and
- (iii) the administering authority has not, within 20 business days after the assent date, given notice to the holder of the environmental authority that the document is insufficient in a material particular relevant to a matter mentioned in subparagraph (i); and
- (iv) before the assent date, the document had not been superseded;
- (c) a document made under a condition of an environmental authority mentioned in paragraph (a) if—
 - (i) the document relates to the management of a void within the meaning of section 126D on the land, or the rehabilitation of the land; and
 - (ii) the environmental authority requires the document to be given to the administering authority on a stated day that is on or after the assent date, or does not state a day when the document must be given; and
 - (iii) the document is received by the administering authority within 3 years after the assent date; and
 - (iv) the administering authority does not, within 20 business days after receiving the document, give the holder of the environmental authority notice that the document is insufficient in a material particular to a matter mentioned in subparagraph (i);
- (d) a report evaluating an EIS under the State Development and Public Works Organisation Act 1971, section 34D;
- (e) an EIS assessment report;
- (f) a written agreement between the holder of an environmental authority mentioned in paragraph (a) and the State that is in force on the assent date.

Following this hierarchy, the relevant LODs for the CCM are detailed in **Table 1**.

Table 1 – CCM Land Outcome Documents

Land Outcome Document	Approval Date	Disturbance Area	Document Reference	Outcome and Detail
EA EPML00334613	Granted: 05/06/2012 Current 9/03/2020	Residual Void	Condition H13 / Table H1	Condition H13/Table H1 nominates that the B-Pit and Q-Pit voids will be backfilled
		'All other areas'	Condition H1	Condition H1 nominates that all areas other than residual voids will have a PMLU of grazing pasture
QNH Rehabilitation Management Plan	Notification of DES Acceptance: 2/07/2020	-	-	Subordinate LoD to the EA but provides further detail regarding the rehabilitation methodology, completion criteria, etc.

The EP Act requires that all areas disturbed for mining activities under an EA within a relevant mining tenure be rehabilitated to either a specified PMLU (see **Section 3**), or where a PMLU cannot be sustained, rehabilitated to a NUMA (see **Section 3.1** and **Section 4**).

Under **Condition H1** of the CCM EA, all areas significantly disturbed by mining activities must be rehabilitated to achieve a PMLU of grazing pasture, with the exception of residual voids (which are addressed in **Table H1** and **Condition H13** of the EA). Under **Table H1** of the CCM EA, both the B-Pit and Q-Pit voids are to be backfilled (i.e. there are no residual voids to remain in these areas). In the absence of any residual voids, the adopted PMLU for the CCM for all areas (except for any areas requested to remain unrehabilitated by the landholder) is grazing pasture.

The QNH Rehabilitation Management Plan (QNH RMP) includes the approved rehabilitation methodology, adopted parameters for design of the final landforms, and acceptance and completion criteria to demonstrate achievement of the PMLU for rehabilitated areas at the CCM. The QNH RMP reflects the approach that has been adopted for rehabilitation works to date at the CCM. The QNH RMP was submitted to DES on 27 April 2020 and was subsequently approved on 2 July 2020. Relevant content from the QNH RMP is detailed in **Section 3**.

1.1.5. Site History and Existing Approvals

QCoal has held Exploration Permit Coal (EPC) 586 and 639, which were the exploration tenements underlying the QNH including the CCM, since 1995 and 2001 respectively. Exploration within these EPCs defined coal resources which has led to the progressive development of the QNH (SCM, CCM, DCM and JCM) since 2006. This progressive development, along with the different ownership structure for each of the QNH mines, has required separate MLs and EAs for each mine, with the approval process required dependent on the proposed scale and the level of impact to environmental values for each individual mine. The completed QNH approval processes include the following:

- SCM – Level 1 Non-Code Compliant EA application assessed by Environmental Impact Statement (EIS), process completed in 2006;
- CCM – Level 1 Non-Code Compliant EA application assessed by Environmental Management Plan (EMP), process completed in 2012;
- JCM – Level 1 Non-Code Compliant EA application assessed by EMP, process completed in 2013;
- DCM – Level 1 Non-Code Compliant EA application assessed by EMP, process completed in 2014.

BRC obtained Prospecting Parcel Permit PP 10762 (the pre-requisite tenure for the CCM) over Lot A on AP2839 in 2009, enabling a Mining Lease Application (MLA) to be lodged. MLA 10345 was submitted to the Department of Natural Resources and Mine (DNRM) in November 2009 and was subsequently granted in August 2012. A Level 1, Non-Code Compliant EA application for MLA 10345 with an EMP was also submitted to the (then) Department of Environment and Resource Management (DERM) in November 2009. The Environmental Authority for the CCM was subsequently granted in June 2012. **Table 2** provides further details on the CCM ML and EA.

Table 2 – CCM ML and EA Details

Details	ML 10345	EA EPML00334613
Permit Type	Mining Lease	Environmental Authority
Permit Status	Granted	Granted
Lodgement Date	4/11/2009	04/11/2012
Grant Date	16/08/2012	05/06/2012 (current 9/03/2020)
Expiry Date	31/08/2027	-
Authorised Holder	Bowen River Coal Pty Ltd	Bowen River Coal Pty Ltd
Area	210.5 ha	-
Permit ID	108636	EPML00334613 (previously MIN100942709)
Native Title Category	Exclusive Land	-

The Environmentally Relevant Activities (ERAs) authorised to be undertaken under EA EPML00334613 are listed in **Table 3**:

Table 3 – CCM ERAs

ERA	Description	Status
Resource Activity, Schedule 3, 09	A mining activity involving drilling, costeaning, pitting or carrying out geological surveys causing significant disturbance	This ERA has been undertaken at the CCM
Resource Activity, Schedule 3, 13	Mining black coal	This ERA has been undertaken at the CCM
Resource Activity, Ancillary 15 - Fuel burning	Using fuel burning equipment that is capable of burning at least 500kg of fuel in an hour	No equipment capable of burning 500kg/hour has been utilised at the site, other than mobile plant for Resource Activity, Schedule 3, 13, therefore this ERA has not been undertaken at the CCM
Resource Activity, Ancillary 16 - Extraction and Screening, 2	Extracting, other than by dredging, in a year, the following quantity of material, (b) more than 100,000t but not more than 1,000,000t	Extraction and screening has not been undertaken at the CCM to date (other than under ERA 13), therefore this ERA has not been undertaken at the CCM
Resource Activity, Ancillary 33 - Crushing, milling, grinding or screening,	Crushing, grinding, milling or screening more than 5000t of material in a year	Crushing, milling, grinding and screening has not been undertaken at the CCM, therefore this ERA has not been undertaken at the CCM
Resource Activity, Ancillary 60 - Waste disposal, 1:	Operating a facility for disposing of, in a year, the following quantity of waste mentioned in subsection (1)(a), (a) less than 50,000t	No waste has been disposed of within the CCM, therefore this ERA has not been undertaken at the CCM
Resource Activity, Ancillary 63 - Sewage Treatment, 1	Operating sewage treatment works, other than no release works, with a total daily peak design capacity of, (b-i) more than 100 but not more than 1500EP if treated effluent is discharged from the works to an infiltration trench or through an irrigation scheme	Sewage treatment works have not been installed or operated at the CCM, therefore this ERA has not been undertaken at the CCM

The CCM was referred to the (then) Department of Environment, Water, Heritage and the Arts in November 2009 under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). BRC was notified in March 2010 that the CCM was determined to be 'not a controlled action'.

The CCM previously operated under a Plan of Operations (latest version valid from: 13 March 2019 – 13 March 2021) and associated financial assurance calculator. BRC subsequently received Deemed Estimated Rehabilitation Cost Decision for the CCM confirming the amount of existing financial assurance to be the deemed ERC. The existing ERC period for the CCM expires on 13 March 2021, to that end, an Application for a new ERC Application was submitted by BRC to DES on 11 December 2020 as required.

Due to the CCM being a continuation of the integrated QNH (i.e. adjoining MLs, the overlapping catchments and study areas, contiguous geology, soils, vegetation, groundwater and other matters across the sites), information from the adjoining mines within the QNH is routinely utilised as a source of baseline and impact assessment. This approach has been accepted by DES as appropriate across the QNH.

Technical studies and data from operational activities within the four QNH mines are also applied across the QNH, including geological, hydrogeological, geochemical, and soil assessments. This is especially appropriate considering that a single mining pit on the QNH can span two or three individual mines, and that the QNH mines share common upstream and downstream hydrology and catchments. Due to the integrated nature of the operations, a number of key management plans required under the various QNH EAs have been developed as integrated QNH-wide documents in consideration of cumulative impact assessment, rather than as an individual document for each mine. Documents which encompass the entire QNH operations include:

- QNH Rehabilitation Management Plan (2020, See **Appendix C**)
- QNH Weed Management Plan (2020)
- QNH Water Management Plan (2020)
- QNH Receiving Environmental Management Program (2015)
- QNH Final Void Report (2020)
- QNH Groundwater Assessment (2020)
- QNH Mine Waste Management Plan (2013)

1.2. Pre-Mining Land Use

The CCM is located within the Collinsville region which has been utilized for the production of beef, sugar and gold since the late 1800s. Coal mining commenced at Collinsville in the early 1900s and has continued in the region through to the current day. Other land uses in the region include quarrying and power generation (coal-fired and solar). As a result of these land uses, the natural landscape in the region has undergone considerable disturbance and modification.

The CCM is situated in an unformed road reserve which was previously a gazetted stock route. The site was previously used over a prolonged period for beef cattle grazing and as a result, the natural landscape had undergone considerable disturbance and modification prior to the

commencement of mining activities. The land had previously been largely cleared for grazing in the 1950s and 1960s, with property improvements undertaken on the land including fencing, thinning of the remnant vegetation and the establishment of improved pasture. There were a number of areas of retained vegetation and regrowth, with the vegetation communities including mixed eucalypt woodlands and acacia shrublands. **Figure 2** shows the pre-mining aerial imagery of the site, demonstrating the extent of historical disturbance prior to the grant of the CCM ML. The existing mining operations at the SCM to the immediate north are also clearly visible.

The CCM area was previously assessed as being Land Suitability Class 3 (fair) for beef cattle grazing prior to the commencement of mining activities (refer to **Section 1.14.5**).

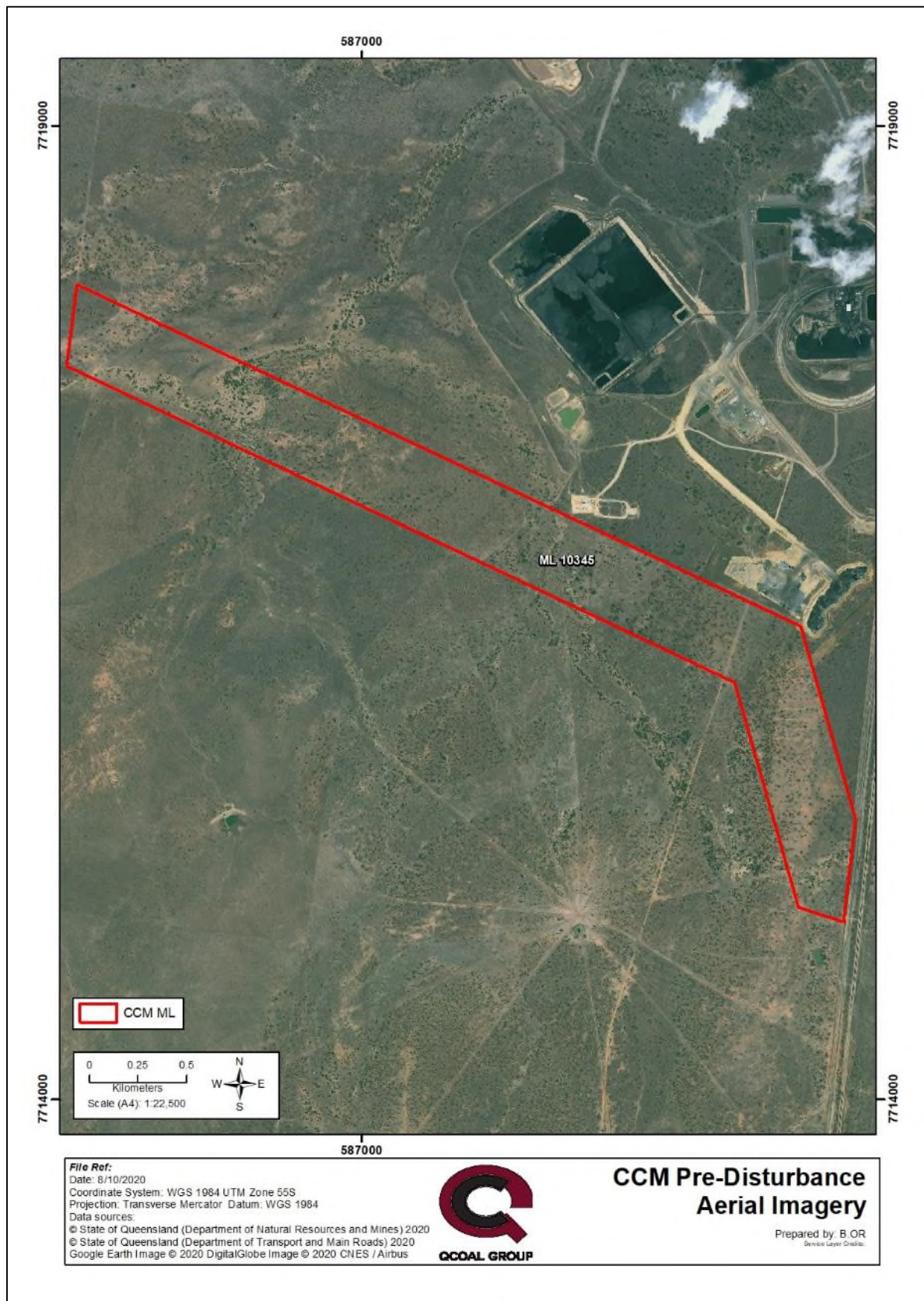


Figure 2 – CCM Pre-Disturbance Aerial Imagery

1.3. Underlying Properties and Landholders

Land tenure details for the real property within the CCM are shown in **Table 4**. **Figure 3** shows the location of the property boundaries and land tenure within and adjoining the CCM.

ML 10345 is located over part of Lot A on AP2839, which is a road parcel that has never been utilised as a road, having previously been a declared stock route under the LP (PSRM) Act and having been utilised for grazing since the 1950s. Since 1981, the property has been utilised for grazing activities under successive Permits to Occupy.

The current Permit to Occupy has been held by Mr Christopher Wallin (owner and Managing Director of QCoal, of which BRC is a wholly owned subsidiary) since 20 June 2008 and has no fixed term. The conditions of the Permit to Occupy authorise the Permit Holder to use the property for grazing purposes.

Table 4 – CCM Land Tenure

Lot/Plan	Tenure	Holder
Lot A on AP2839	Permit to Occupy for grazing purposes (Title Reference 40056806, No Term)	Mr Christopher Wallin
	Road	Department of Natural Resources Mines and Energy

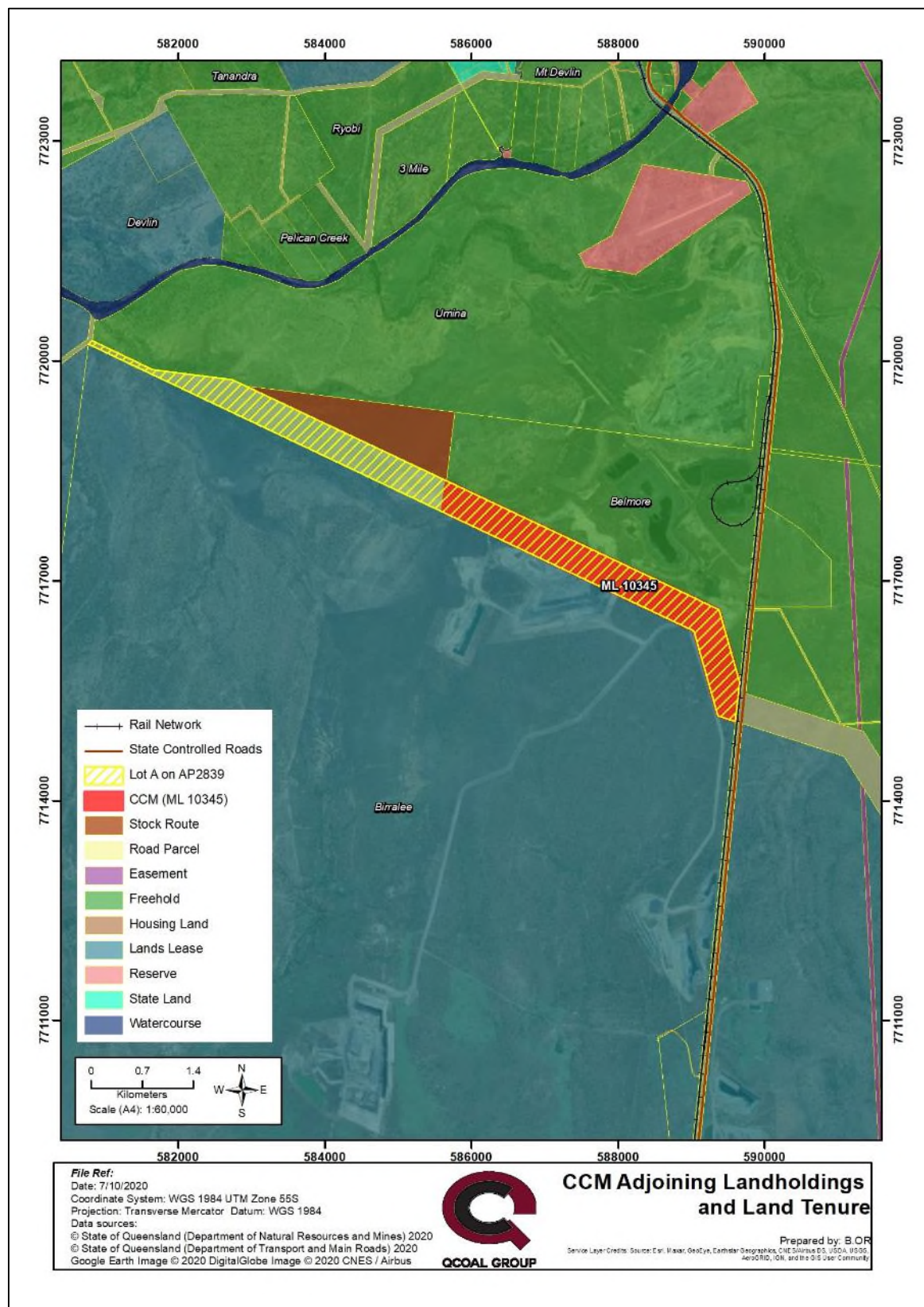


Figure 3 – Adjoining Landholdings and Land Tenure

1.3.1. Sensitive Places

The CCM is bordered by active QNH MLs to the north (SCM), south (DCM) and south-east (JCM). *Sensitive Places* and *Commercial Places* relevant to the CCM are defined in the CCM EA as follows:

‘sensitive place’ means:

- a) *A dwelling, residential allotment, mobile home or caravan park, residential marina or other residential premises; or*
- b) *A motel, hotel or hostel; or*
- c) *An educational institution; or*
- d) *A medical centre or hospital; or*
- e) *A protected area under the Nature Conservation Act 1992, the Marine Parks Act 1992 or a World Heritage Protection Area; or*
- f) *A public park or gardens.*

‘commercial place’ means a workplace used as an office or for business or commercial purposes, which is not part of the mining activity and does not include employees’ accommodation or public roads

The nearest sensitive and commercial places to the CCM are detailed in **Table 5** and **Figure 4**, along with the closest population centres.

Table 5 - Proximity of Sensitive and Commercial Places to the CCM

Description	Type	Distance from Operational Area	Notes
Belmore Homestead	Sensitive Place	3.1km	Privately Owned
Sonoma Homestead	Sensitive Place	3.2km	Privately Owned
Collinsville Airport	Commercial Place	4.7km	Operated by WRC
Pelican Creek Residence #1	Sensitive Place	5.1km	Privately Owned
Pelican Creek Residence #2	Sensitive Place	5.2km	Privately Owned
Pelican Creek Residence #3	Sensitive Place	5.5km	Privately Owned
Pelican Creek Residence #4	Sensitive Place	6.0km	Privately Owned
Scottsville	Township	7.3km	Within WRC area
Collinsville	Township	8.9km	Within WRC area

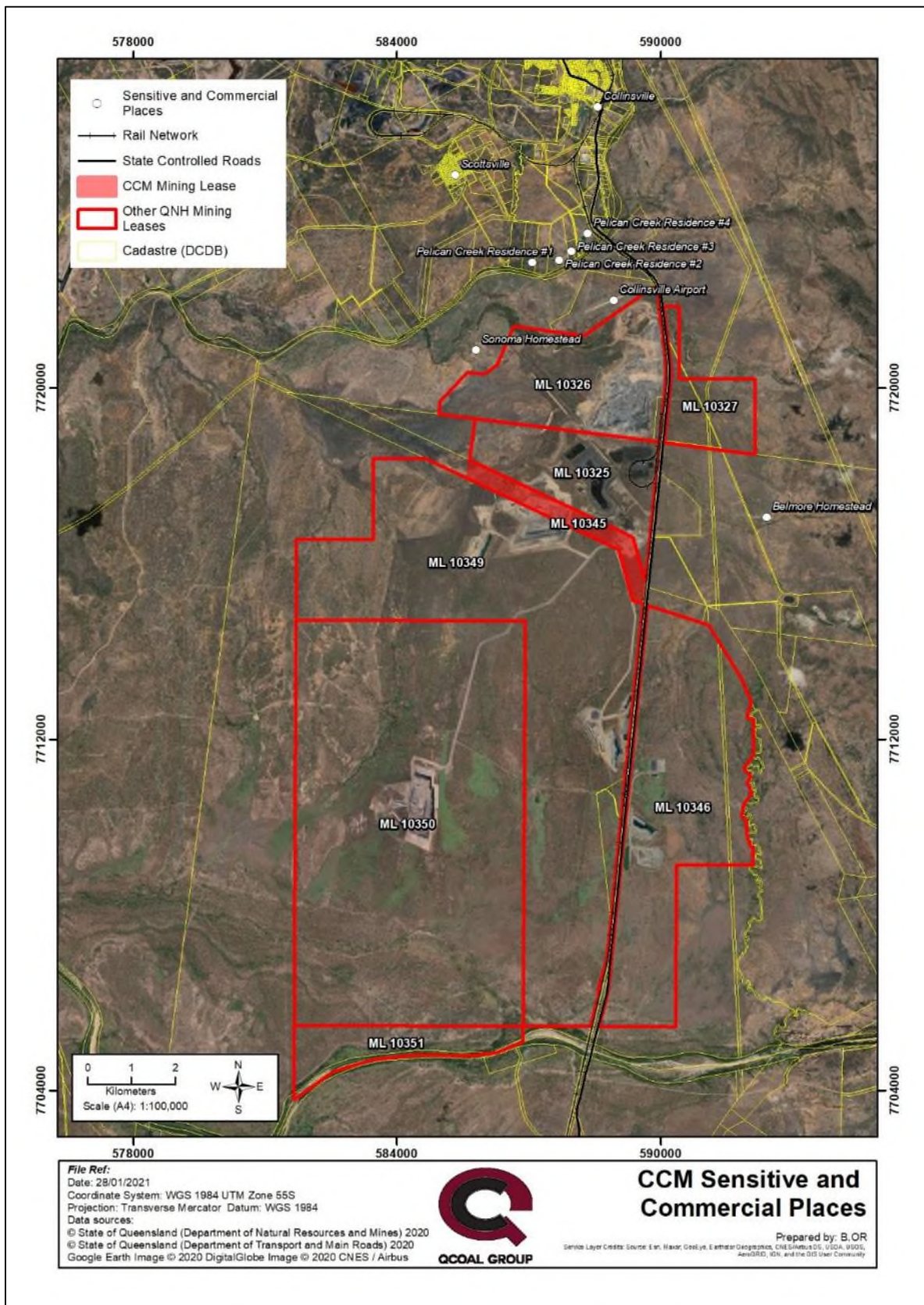


Figure 4 – CCM Sensitive and Commercial Places

1.4. Operational Site Layout

The extent and type of disturbance that is authorised at the CCM is detailed in Conditions A3 and A4 of the CCM EA as follows:

- A3 *In carrying out the mining activity authorised by this environmental authority, disturbance of land on Figure 1- Site map, domains and groundwater monitoring locations:*
- a) *may occur in the areas marked 'A';*
 - b) *must not occur in the areas marked 'B'; and*
 - c) *may occur in the areas marked 'C', but only in accordance with Condition A4.*
- A4 *Any disturbance within the areas marked 'C' on Figure 1- Site map, domains and groundwater monitoring locations:*
- a) *is only authorised to the extent reasonably necessary for exploration activities, roads, fences, underground services, low-impact telecommunications facilities, electrical sub-stations, transmission grid works and supply network works, storage depots, similar minor infrastructure and ancillary facilities for any of the above; and*
 - b) *any disturbance within areas marked 'A' or 'C' is not to impact adversely on areas marked 'B'.*

Figure 5 shows the extent of EA disturbance categories A, B and C permitted at the CCM, as per CCM EA *Figure 1 – Site Map, domains and groundwater monitoring bores*

Figure 6 shows the site layout with imagery from February 2020, with key operational areas labelled.

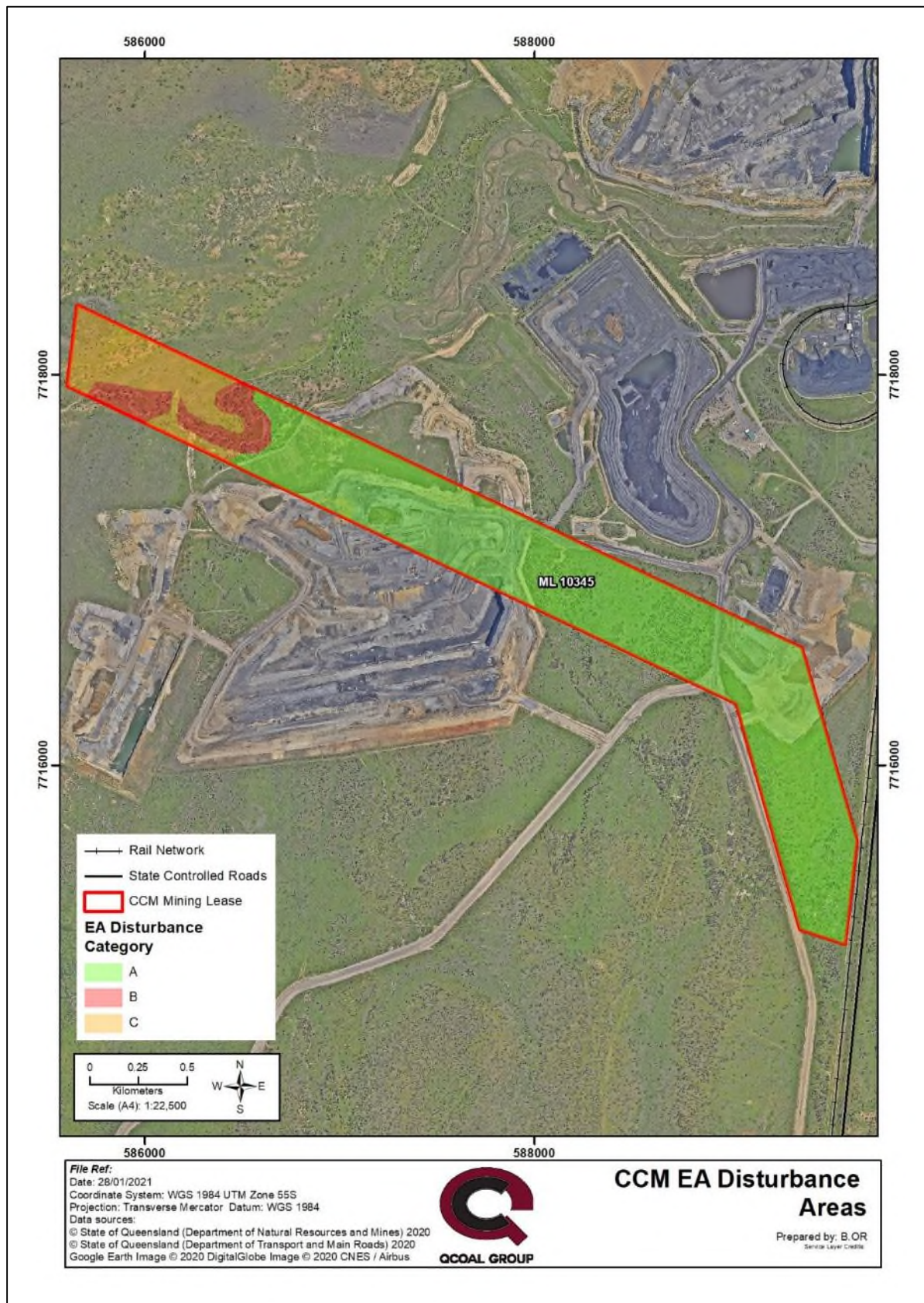


Figure 5 - EA Disturbance Areas

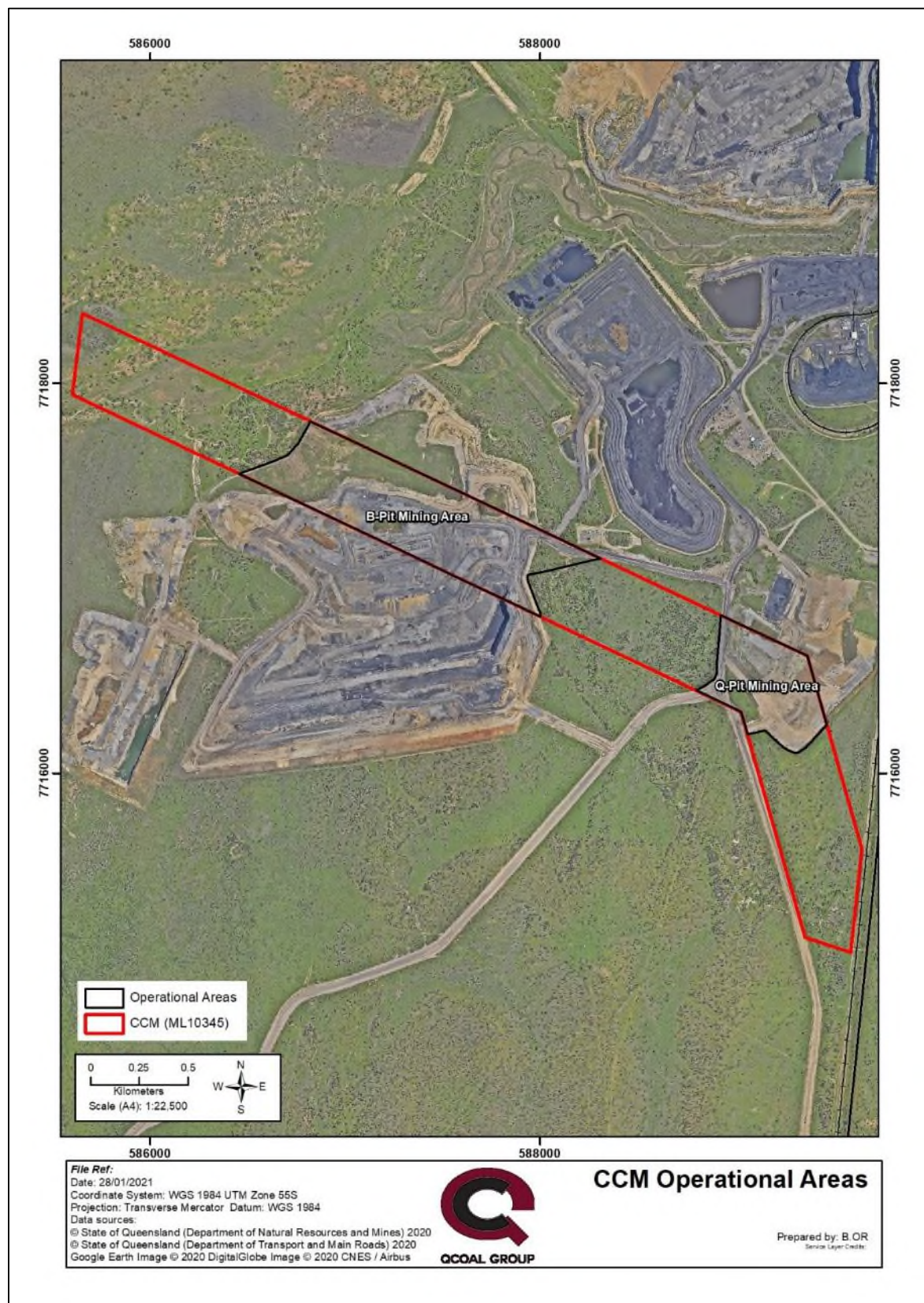


Figure 6 – CCM Operational Areas

1.4.1. Rehabilitation Areas

When an area of disturbance is no longer required for any operational usage it becomes available for rehabilitation. Where an area is still required for any operational purpose (including roads, tracks and support infrastructure) it remains un-available for rehabilitation.

A Rehabilitation Area (RA) within the PRC Plan framework is defined as a geographically delineated parcel of land within which any mining related disturbance is subject to the same PMLU and the same rehabilitation milestones. As mining progresses through the RA, sub-sections of land become available for rehabilitation at different times, which is captured in the PRC Plan – Schedule.

Refer to **Section 5.2.1** for a description of the rehabilitation activities undertaken to date at the CCM.

To date only part of the area authorised for disturbance at the CCM (as shown in **Figure 5**) has been (or is planned to be) disturbed for the mining activities. The mining related disturbance which has been undertaken has been allocated into three separate RAs, as detailed in **Table 6** and shown in **Figure 7**. The extent of disturbance shown in the RAs in **Figure 7** represents the maximum planned disturbance for the life of mine (LOM) on the CCM.

Table 6 – Rehabilitation Areas at the CCM

Domain	Description	Area (Ha)
RA1	B-Pit (backfilled), B-Pit dump and Haul Roads	61.35
RA2	Q-Pit (backfilled), Q-Pit dump and Haul Roads	25.49
RA3	Clean Water Drain	0.28
Total Disturbance		87.12

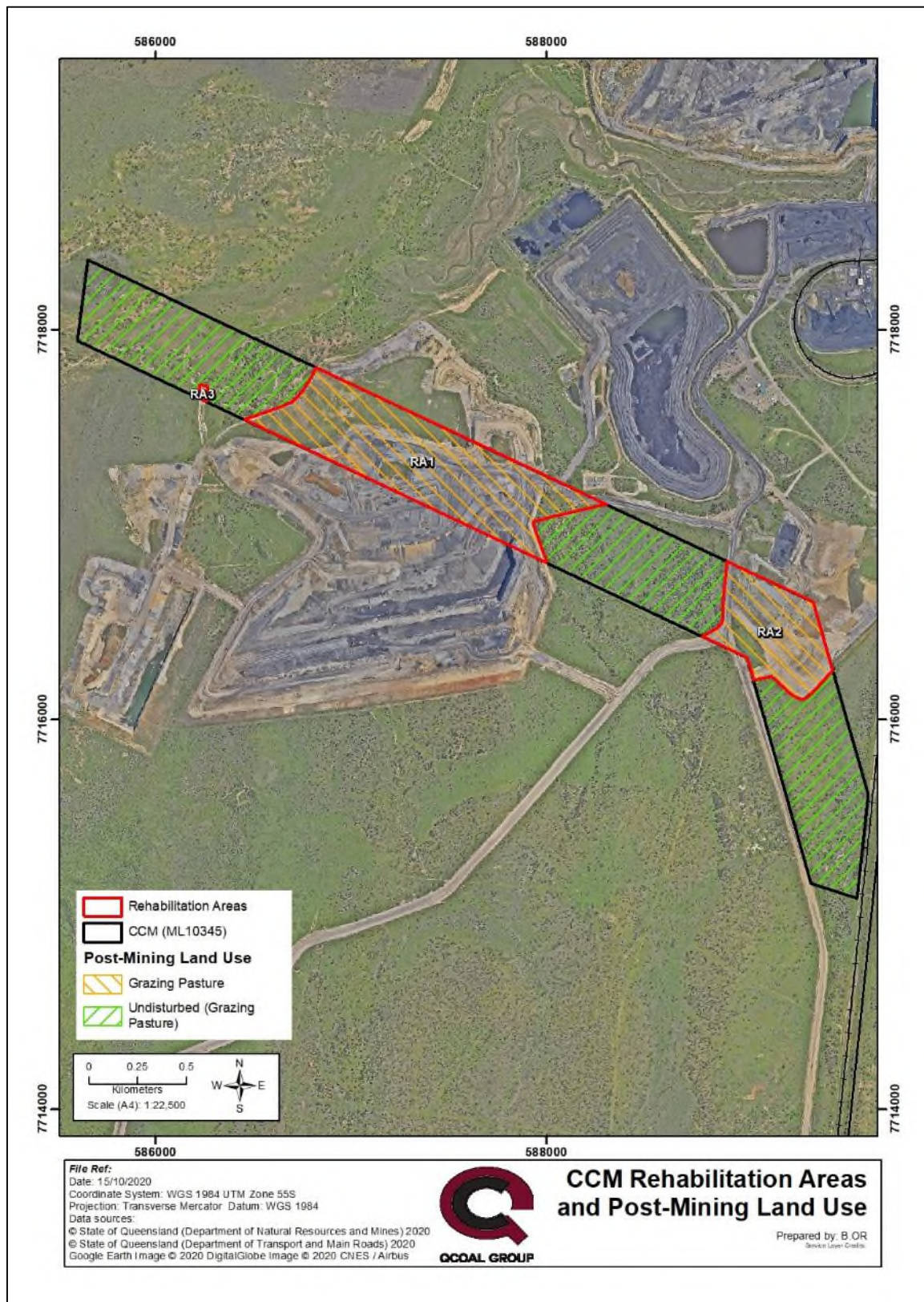


Figure 7 – Rehabilitation Areas and PMLU

1.5. Mining Methods

Mining activities at the CCM have generally occurred in the following general sequence:

- Ongoing coal resource definition (code-compliant exploration activities);
- Vegetation clearing (where required);
- Topsoil removal and stockpiling;
- Construction of haul roads;
- Construction of drainage structures (where required);
- Removal of waste rock by drill and blast and truck and excavator and initial placement in out-of-pit waste rock dumps;
- Extraction of coal from the active mining area with ROM coal transported directly from the CCM to the SCM ROM Pad (i.e. offsite);
- Transition to in-pit waste rock dumping once sufficient void was created for sustained mining operations;
- Completion of coal mining within the CCM Pits and backfilling of the final voids using mine waste from later mining areas;
- Rehabilitation in line with the nominated PMLU.

The QNH including the CCM operates as a conventional truck and excavator mining operation, using the industry standard model of contract mining. On the CCM the surface Cenozoic waste material was free dug, while the remaining waste was blasted and excavated by large hydraulic excavators and rear dump trucks. ROM Coal was excavated by hydraulic excavator and hauled by dump truck to the SCM ROM for washing at the SCM CHPP, and for subsequent transport of product coal via the SCM rail load-out. An additional fleet of ancillary equipment (dozers, graders, water trucks, etc) is also used in the mining operations as required.

Generally pits on the QNH commence as an initial box cut and follow the dip of the coal seam by advancing the high wall in an advancing high-wall bench process. Waste rock is initially placed in an out-of-pit dump located adjacent to the box-cut pit, until sufficient void is created by advancing the high-wall to allow in-pit dumping to commence behind the advancing mining area (advancing the low-wall by progressive backfilling). The pit advances until an economic limit is reached at which point the remaining pit is either retained as a residual void or actively backfilled with a specific backfilling campaign.

1.5.1. Q-Pit

Mining within the CCM Q-Pit commenced in February 2013, when the SCM Q-Pit advanced into CCM ML10345 (CCM Q-Pit). Progressive backfilling was ongoing during operation. Q-Pit reached the economic limit in December 2013, leaving a void on the SCM and CCM. That void was utilised as bulk water storage for the QNH until 2018, at which time a specific active backfilling campaign commenced (using waste material from a separate DCM pit) which was completed in 2019.

1.5.2. B-Pit

Mining within the CCM B-Pit commenced in December 2013, when the SCM B-Pit advanced into CCM ML10345 (CCM B-Pit). The CCM B-Pit continued to advance southward through the CCM and into the DCM (November 2014), where the pit was referred to as the “Drake 1 Pit”. Final coal from the CCM B-Pit was recovered in 2018. Progressive backfilling was ongoing during operation and continues within the Drake 1 Pit, such that the CCM B-Pit was fully backfilled by 2020.

1.6. Site Topography

The CCM is located in the northern Bowen Basin, which extends over approximately 60,000km² (60,000,000 ha) of Central Queensland from the town of Collinsville in the north to Theodore in the south. The QNH MLs cover approximately 13,500 ha of that area, of which the CCM (ML10345) covers approximately 211 ha. The topography of the broader QNH is characterized as a flat-to-undulating landscape of alluvial plains and terraces bordering Coral Creek in the north, Two Mile Creek in the centre and the Bowen River in the south.

The topography within the CCM area is flat to slightly undulating, with elevation ranging from 189 m AHD in the east to 153 m AHD in the west. The CCM is located to the north of a low ridgeline which runs east-west and represents a sub-catchment boundary between the Two Mile Creek sub-catchment to the north and the Twelve Mile Gully sub-catchment to the south. Several un-named drainage features traverse the CCM and drain to the north-east towards Two Mile Creek, an ephemeral drainage system which forms an upper tributary of the Bowen River catchment (refer to **Section 1.12.2** for further details).

The pre-mining contours and drainage lines (overlain with the February 2020 aerial photography for context) within the CCM area are shown in **Figure 8**. Slopes within the CCM generally are less than 3%, with slightly steeper slopes present in some areas adjacent to drainage lines and watercourses.

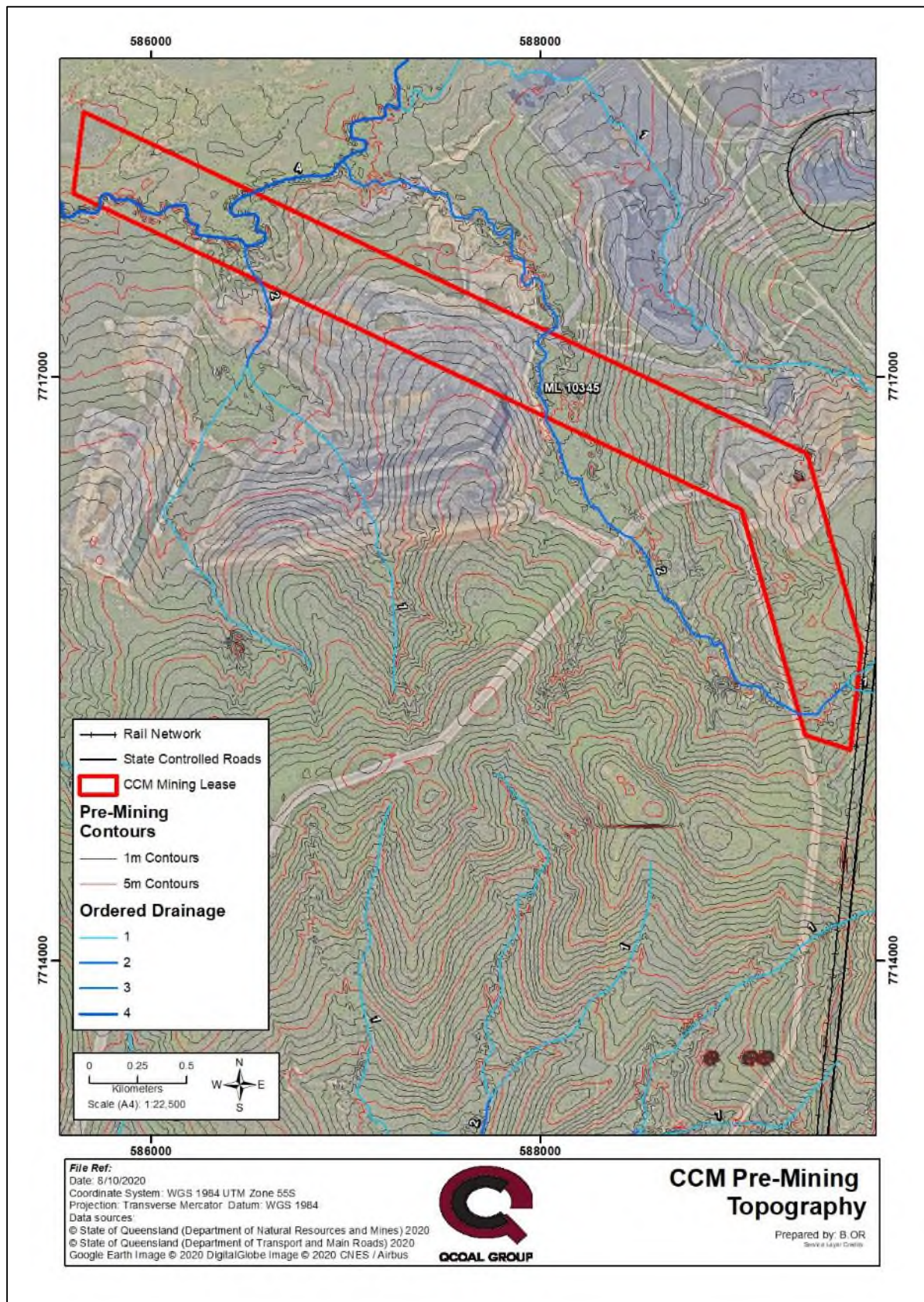


Figure 8 – Pre-Mining Topography

1.7. Climate

The region is characterised by distinct wet and dry seasons, with the majority of rainfall occurring during the summer months, along with higher temperatures and evaporation rates. Average monthly temperature, rainfall and evaporation statistics, as collected at the Bureau of Meteorology's (BoM) Collinsville Post Office Station (no. 033013) are presented in Figure 9 – CCM Climate Averages **Figure 9**.

The average annual rainfall for the CCM area is 701.6 mm and the average annual evaporation is 1,861.5 mm (BoM, 2019). As such, the region is subject to net annual evaporation, and is dry for much of the year. The rainfall averages indicate a distinct wet season between December and March and dry season between June and October. Predominant winds are south-easterly for the majority of the year.

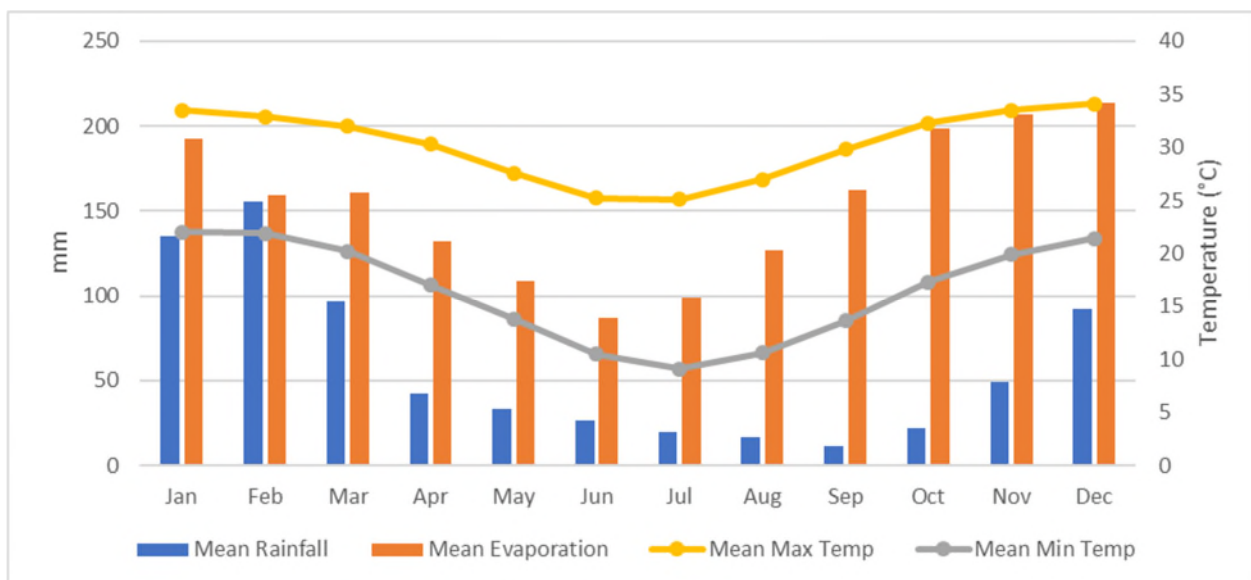


Figure 9 – CCM Climate Averages

1.8. Geological Setting

The CCM is located in the northern Bowen Basin, with the target seams forming part of the Moranbah Coal Measures (MCM). The stratigraphic sequence for the CCM represents a continuation of the same geology from the SCM through the CCM and into the DCM and JCM (as evidenced by Q-Pit and B-Pit targeting the same coal seams across ML boundaries). As such the stratigraphy (coal seams, overburden and interburden sequences) and the associated characteristics of the various stratigraphic units is generally consistent across the four QNH mines. Geotechnical, geochemical and coal quality characteristics observed in one QNH mine can therefore be adopted for the same material in another of the QNH mines.

1.8.1. Regional Geology

The CCM is located in the northern Bowen Basin, where active subsidence and deposition during the Permo-Triassic was centred within an extensional terrain known as the Taroom Trough. This deposition centre was situated marginal to the Collinsville Shelf in the west, which typically behaved as a stable platform throughout. The deformed Taroom Trough is defined by the Nebo Synclinorium, where contained sediments and volcanics of the western two-thirds dip gently toward the major synclinal axis in the east. Post-depositional compression has resulted in a fold-and-thrust style of deformation, particularly on the eastern side of the basin where sediments along this margin tend to dip steeply westward.

Economic coal measures within the Bowen Basin have been classified into four groups (Mutton, 2003):

- I. The oldest (Early Permian) coals are restricted to the southwest areas of the Bowen Basin (e.g. at Minerva, south of Emerald).
- II. The Group II (Early Permian) coal measures comprise several unconnected deposits around the northern and western margins of the Bowen Basin which have been mined by open-cut and underground methods. They include the Blair Athol Coal Measures near Clermont, the Rugby Coal Measures southwest of Moranbah and the Collinsville Coal Measures at Collinsville.

Martini and Johnson (1987) identified six sedimentary environments in the Collinsville Coal Measures: fluvial, fluvial to paralic, barrier-strand plain, back-barrier, tidal flat and open marine. The basal coal formed from peat of swamps of abandoned areas of gravelly braided streams; the coals are massive, dull and sulphur contents are low (1%). Overlying coals developed from peats formed in fluvial to paralic and paralic environments; these thicker coal seams are generally brighter and have moderate to high total sulphur contents (1-6%). Seams associated with coastal deposits show high sulphur levels (up to 21%).

- III. The Group III (Late Permian) coals were deposited on the Collinsville Shelf under conditions which fluctuated between marine-influenced deltaic environments to a fluvial flood-plain environment (Moranbah Coal Measures). The former Belmore Pipeline Mine (Glencore) and the QNH operation (comprising the SCM, CCM, JCM and DCM) occur within the MCM.

The MCM were deposited in a deltaic environment during the early stage of foreland basin development (Hodgkinson, 2008). The MCM were overlain by the heavily tuff banded Fort Cooper Coal Measures.

Geochemical analyses for the MCM have shown significantly lower total sulphur content in comparison to the Group II Collinsville Coal Measures described above.

- IV. Group IV (Late Permian) coal measures are the most widely distributed in the Basin and were deposited under fluvial, lacustrine and paludal environments. They include the Rangal Coal Measures, Baralaba Coal Measures and equivalents which have been extensively mined since the 1960s.

The wide variety of depositional environments is reflected in the diversity of coal measures (seam thickness, lateral extent and coal quality) within the Bowen Basin, however for the Group III coals (as targeted at the QNH), the physical and chemical characteristics of the non-productive geological sequences (waste rock or spoil materials) are similar throughout the basin.

1.8.2. Site Geology

The local stratigraphy in the CCM area comprises the basal Blenheim Formation overlain by the marine Exmoor Formation, non-marine Blackwater Group, and Tertiary sediments of the Sutor Formation and equivalents (**Figure 10**). The Blackwater Group includes the target Moranbah Coal Measures.

As previously noted, the stratigraphic sequence for the CCM is mirrored at each of the four QNH mines. The coal seams, together with the waste rock, are readily correlated between all four sites. Accordingly, analysis of the waste rock at each of the mines has confirmed similar waste rock characteristics (see **Section 1.10**). In the specific case of the CCM, both the B-Pit and Q-Pit were continuations of pits from the adjoining SCM (and for the B-Pit further continuation into the DCM). Pits and waste rock dumps span the MLs and consequentially the material being mined in the CCM is the same as the adjoining SCM and DCM for each respective pit.

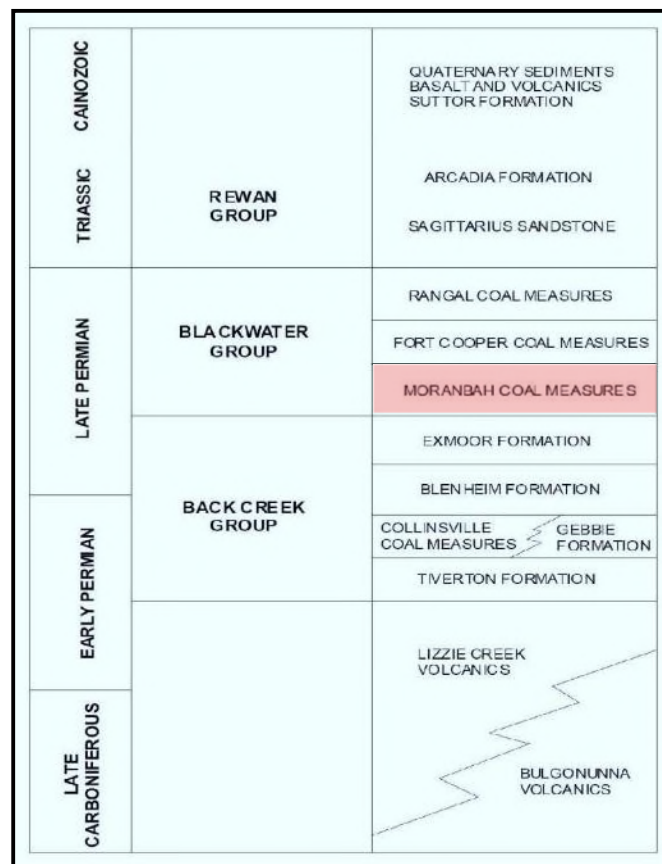


Figure 10 – Bowen Basin Stratigraphy

Geological detail in the QNH area is intermittently obscured by a cover of alluvium and gravel, particularly adjacent to drainage lines and watercourses. This recent (Cainozoic) cover comprises unconsolidated fine to very coarse-grained sand, along with occasional irregularly interbedded silt, clay and gravel lenses. The most persistent gravel bed occurs at the base of the unit and generally comprises markedly rounded pebble to cobble-sized clasts of predominantly andesitic to basaltic composition, set in a silt to clay-rich matrix. The alluvial unit ranges in thickness from a thin veneer in the CCM area to a maximum of 24m to the north of the SCM.

1.8.3. Coal Geology

The MCM contain between three and eight major seams, two of which have been mined at the CCM (refer to **Figure 11**). Historically, the seams have been given the letter designations from A (deepest) to R in accordance with stratigraphic order for seams in the Bowen River area. The relatively thick, low-ash seams distinguish the MCM unit from the overlying Fort Cooper Coal Measures. Interburden rocks consist of quartz-poor lithic sandstones, siltstone, shale, and mudstone. The waste rock sequences have been named based on the underlying and overlying coal seam nomenclature for identification purposes.

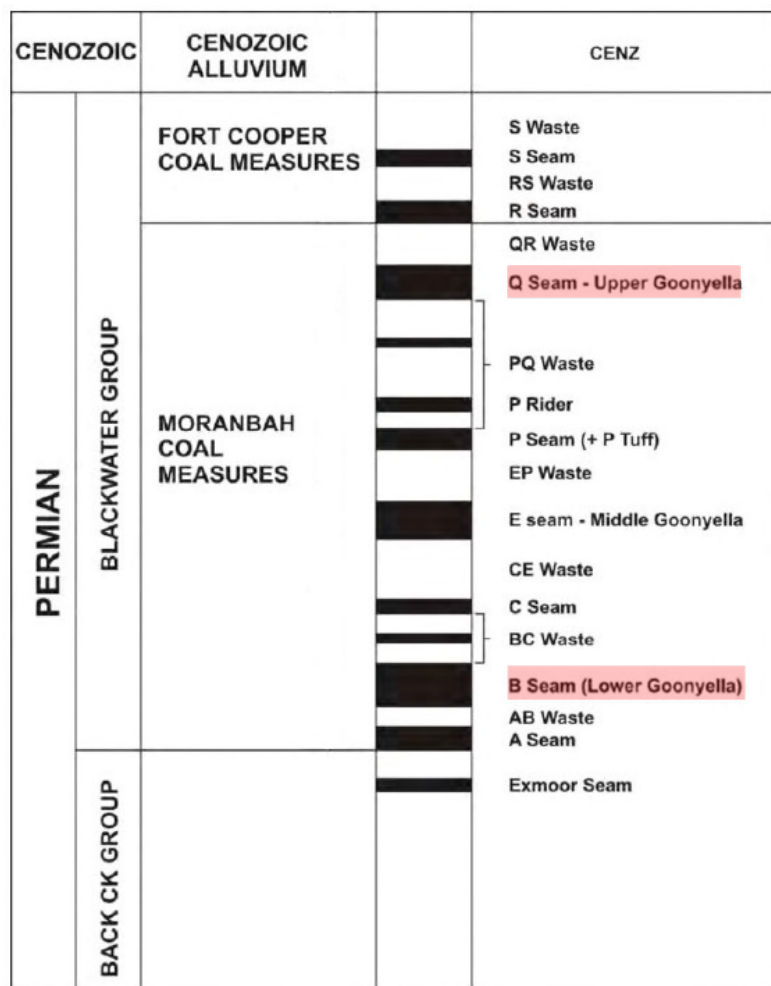


Figure 11 – MCM Coal Seams within the CCM Area

Throughout the QNH area, the geological structure has been subject to igneous intrusions which, where present, have either intruded or otherwise rendered sections of the MCM seams uneconomic. Exploration programs (including airborne magnetic surveys, radiometric surveys, and in particular, exploration drilling) were successful in defining several areas of sub-cropping shallow un-intruded coal.

Figure 12 shows a representative cross-section of the seams present at the CCM (note the underlying A seam is uneconomic and has not been mined at the CCM). A full sequence of MCM seams (refer to **Figure 11**) is not present within the CCM due to northwest trending faulting through the central part of the lease. The target seams at the CCM are described as follows:

- The Q seam (known elsewhere as the Upper Goonyella seam) was identified as subcropping in the north-western corner of the CCM. Q Seam deposits are typically small (<2Mt) deposits of hard coking coal, with an example being the Belmore – Pipeline deposit which is located to the immediate east on the eastern side of the Bowen Development Road, which was mined by the Collinsville Coal Company (owned by Mt Isa Mines, later Xstrata/Glencore) in the early 2000s. A single deposit of high-quality Q seam resource (known as Q-Pit) was identified in the eastern area of the CCM. The Q-Pit was the initial focus of the mining activities at the CCM;
- The B seam (known elsewhere as the Lower Goonyella seam) is separated from the underlying A seam by 15m to 24m of dark grey, fine-grained sandstone, siltstone and carbonaceous mudstone. The B seam at the QNH subcrops at the northern end of the adjacent SCM in the vicinity of Coral Creek. The seam consistently dips at approximately 5° to 7° towards the south and south-southeast. In the area of the CCM, the B seam was approximately 4.5m thick. A single deposit of high-quality B seam resource (known as B-Pit) was identified in the western area of the CCM;

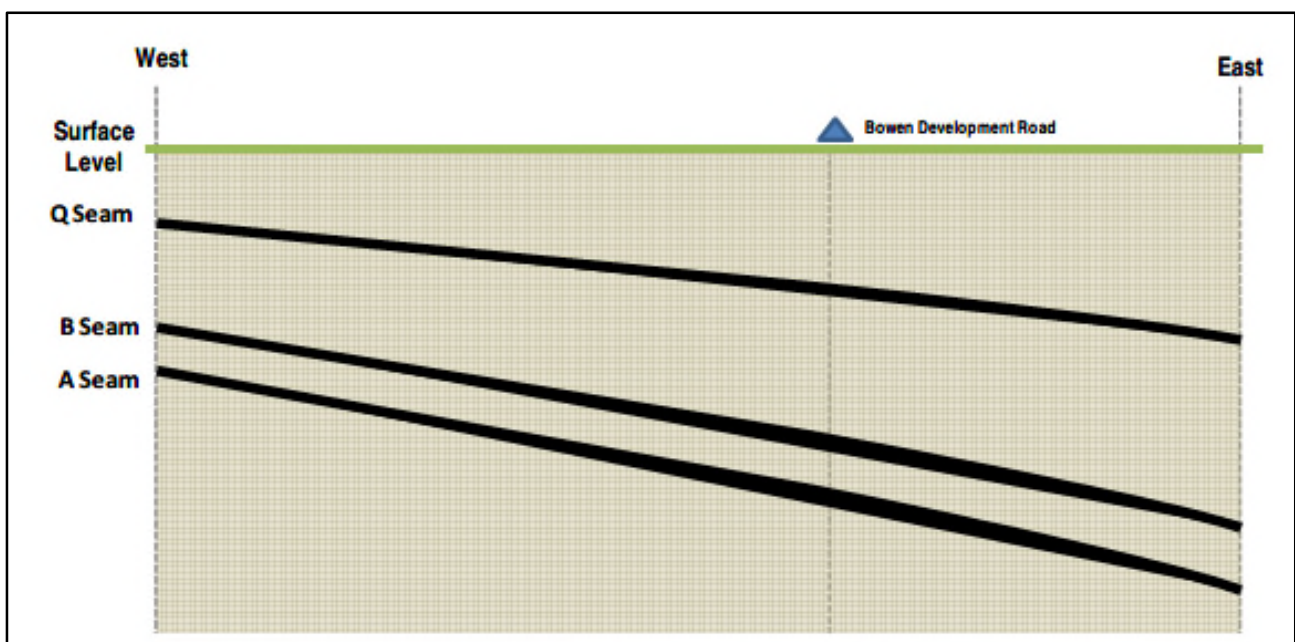


Figure 12 – Representative Cross Section of the Moranbah Coal Seams within the CCM

1.9. Coal and Waste Rock Volumes

Table 7 outlines the mined coal quantities and waste rock volumes for the LOM of the CCM.

Table 7 – CCM LOM Coal and Waste Rock Figures

Pit	Seam	Coal Mined (ROM t)	Total Mined Volume* (bank cubic metres - bcm)	Total Waste Rock Volume** (loose cubic metres - lcm)
Q-Pit	Q	246,788	1,985,285	2,604,285
B-Pit	B	2,211,036	24,246,250	31,147,652
Total		2,457,824	26,231,535	33,752,201***

*Represents the total volume of the excavated mine pits at the CCM, including coal volumes.

**Includes waste rock used to backfill the voids and waste rock stockpiles.

***Includes 3.5m LCM of waste rock yet to be placed.

A pre-mining estimate was made of the relative proportions for each lithology comprising the waste rock materials at the CCM by reviewing the drill logs of 30 bore holes for a transect across the MCM in the DCM area. With the continuity of the stratigraphic profiles between the DCM and the CCM (as evidenced by the continuation of CCM B-Pit into DCM Drake 1-Pit), this estimate for relative proportion was also utilised at the CCM. Applying the waste rock lithology relative proportions to the total waste rock volume for the CCM (as shown in **Table 7**) gives an estimate for total waste rock volumes for each lithology at the CCM, as presented in **Table 8**.

Table 8 –CCM Waste Rock Volume Estimate by Lithology

Waste Rock Lithologies	Sandstone	Siltstone	Mudstone (Carbonaceous)	Igneous	Coal	Total
Ratio to Total Depth Drilled (%)	53.5	21.0	9.0	6.6	9.9	100
Proportion of Waste Rock (%)	59.3	23.3	10.0	7.3	-	100
Indicative Waste Rock Volume (Mlcm)	18.1	7.1	3.0	2.2	-	33.7
Number of Samples	42	23	6	4	0	75

The waste rock at the CCM comprises mainly interbedded quartzose sandstones and siltstones (82.6%), with far lesser quantities of finer-grained sediments such as mudstone/shale/ carbonaceous shale (10.0%) and intrusive lithologies (7.3%).

1.10. Waste Rock Characterisation

A number of geochemical investigations have been undertaken on the QNH sites and other adjoining third-party mines which have provided an understanding of the nature of mining waste to be generated at the QNH mines (including the CCM).

As previously stated, the coal seams and waste rock geology is contiguous through the QNH mines. In the specific case of the CCM, both the B-Pit and Q-Pit were continuations of pits from the adjoining SCM (with the B-Pit further continuing into the DCM). Those pits and waste rock dumps span the MLs and consequentially the material being mined in the CCM is the same as the adjoining SCM and DCM for each respective pit.

Waste rock characterisation investigations/assessments that have been undertaken for the QNH mines and other relevant adjoining mines include, but are not limited to, the following:

- *Cows Coal Project – Waste Rock Report* (Tecsol, 2011)
- *Sonoma Coal Project – Overburden Assessment Report* (Parsons Brinckerhoff, 2006)
- *Drake Coal Project EIS Waste Rock Characterisation Report*. (GHD, 2012)
- *Drake Coal Project SEIS Excavated Waste Characterisation Report* (GHD, 2013)
- *Geochemical Assessment of Mining Waste and Coal Reject Materials, Sonoma Coal Mine* (Terrenus, 2012)
- *Mining Waste and Coal Rejects Management Plan – Sonoma Coal Mine* (Terrenus, 2013)
- *Environmental Management Overview Strategy, Belmore Project - Pipeline Deposit** (Collinsville Coal Company, 1999)

* The Pipeline deposit was geologically contiguous to the CCM/SCM, being a Q-seam deposit located on the eastern side of the Bowen Development Road within ML10250 in close proximity to the CCM/SCM Q-Pit.

The results of these investigations are summarised in the QNH RMP (a LOD), which included geochemical laboratory testing. Those results have informed management of mine waste as is also presented in the QNH RMP.

Results of waste rock analysis undertaken to date across the QNH have been collated to provide a characterisation to assist in the management of mine wastes. **Table 9** details the various geochemical characterisation programs that have been undertaken across the QNH to date.

Table 9 – QNH Geochemical Programs

Year	Site	Bores	Samples Analysed	Study Reference
1999	Belmore (Third-Party Dataset)	7	26	Collinsville Coal Company, 1999
2006	Sonoma	8	14	Parsons Brinckerhoff, 2006
2008	Drake	8	21	GHD, 2012
2008	Jax	22	55	GHD, 2012

2011	Sonoma	4	25	Tecsol, 2011
2012	Drake	16	329	GHD, 2013
Total Samples			444	

Waste rock across the QNH has been found to be non-acid forming (NAF), with only one sample found in carbonaceous shale returning an Uncertain classification (see **Figure 13**). Waste rock was also found to have a low potential for metal leaching and saline runoff. Therefore, the waste rock materials on site are generally classified as low risk for acid mine drainage.

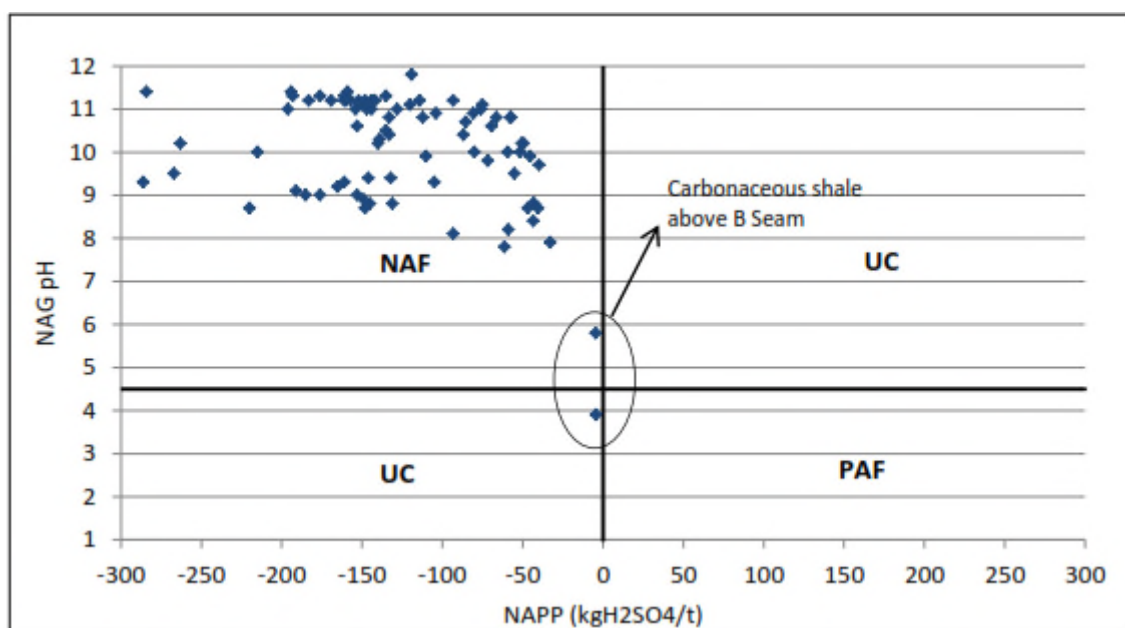


Figure 13 – QNH Waste Rock Characterisation

1.10.1. CCM Waste Rock Characterisation

A review of previous waste rock characterisation studies for the adjacent SCM, DCM as well as the adjacent former Belmore-Pipeline Coal Mine was undertaken to inform CCM waste rock characterisation investigations, as both mines had been developed in the identical and continuous geological formations and stratigraphic sequences to those to be mined at the CCM. These previous investigations had shown that the waste rock is slightly alkaline and has a negligible potential for formation of AMD as follows:

- Waste rock was typically non-acid forming (NAF); however, as a conservative measure, rocks within 1m of coal seams should not be concentrated near the surface of waste rock dumps.
- Tertiary/Quaternary soils were generally slightly alkaline (pH between 7.8 and 8.6) and had low salinity (Electrical Conductivity (EC) of 200 $\mu\text{S/cm}$) to moderate salinity (EC of 675 $\mu\text{S/cm}$). A single sample returned moderately high salinity (EC of 924 $\mu\text{S/cm}$).
- Alluvial soils were found to have low to moderate salinity.

- Weathered Permian rocks were found to have similar salinity, sodicity and alkalinity characteristics to the overlying alluvial soils.
- Fresh Permian rocks had moderately high alkalinity levels and low to moderate salinity.

In order to confirm the above findings and provide CCM specific data as part of the Cows EA application, BRC undertook further testing to assess the geochemical characteristics for a wide range of lithologies from the operating Q-seam pit at Sonoma which abuts the northern boundary (and continued into) the CCM area, and also from the adjoining DCM area.

Results from this additional testing indicated:

- The acid-base accounting (ABA) analyses indicated that waste rock or spoil materials from the Moranbah Coal Measures for the Project area would be non-acid forming (NAF). Coal and other carbonaceous sediments (siltstone and mudstone) have a low potential for acid formation (PAF); however, the impacts of any PAF materials would be negated by the significantly higher neutralising capacity of other lithologies (e.g. quartzose sandstone) placed in the overburden dumps or spoil heaps. Carbonaceous sediments (siltstone and mudstone) which occur interbedded in the coal seams were potentially saline but were intended to be removed from site as a component of the ROM coal.
- Immediately south of the CCM, overburden materials from the DCM and adjacent JCM areas recorded an average EC value of 281.1 $\mu\text{S}/\text{cm}$, which is within the low salinity range of 150 to 450 $\mu\text{S}/\text{cm}$ (DME, 1995b). In view of the stratigraphic similarities between mining operations in this region, specific requirements to manage salinity have not been required for overburden dumps in the CCM area, or elsewhere at the QNH mines.
- Total sulphate levels were found to be low. Together, the low sulphate and low EC values provide evidence to support the findings that the overburden materials are not saline.
- Waste rock/soil materials are more likely to disperse when calcium (Ca) / magnesium (Mg) ratios are less than 2 and exchangeable sodium percentages (ESP) are greater than 6%. The analyses confirmed the presence of high Ca/Mg ratios and low ESPs, and therefore significant dispersion of fine materials from overburden dumps is not expected to occur.

Potential environmental risks associated with mining waste (overburden) and coal rejects are mainly associated with Acid Mine Drainage (AMD), the related mobilisation of metals, and saline drainage.

Overburden generated at the CCM is relatively benign and is expected to generate slightly alkaline and low-to-moderately saline runoff and seepage, following surface exposure. No reject material has been generated, handled or disposed of at the CCM, as all coal processing and rejects management occurred offsite at the SCM. Regardless of the classification, waste rock across the four QNH mines sites is managed in accordance with the QNH Mine Waste Management Plan (2020), from which the procedures for managing waste rock have been detailed in **Section 5.2.5**.

Runoff from the CCM is managed under the QNH Water Management Plan (QNH WMP) which includes a specific Erosion and Sediment Control Plan (ESCP), as described in **Section 5.2.8**. Specifically, the runoff from waste rock dumps at the CCM is managed at the SCM for Q-Pit and on both the SCM and DCM for Q-Pit, as the waste rock dump areas on the CCM are shaped to direct

runoff to existing dams on the DM and SCM. However, the non-dispersive nature of the waste rock is such that dispersion of fine materials from overburden dumps is not expected to occur.

These findings have been previously presented in the QNH RMP (a LOD).

1.11. Geotechnical Stability

Assessment of the geotechnical stability of the final landforms is most relevant to walls of any final voids and the slopes of rehabilitated waste rock dumps.

In the case of the CCM there are no final voids requiring consideration, with both pits having been backfilled. When a void is backfilled, waste rock generally fills the void to an elevation which is either a) above the surrounding natural topography in which case by definition the landform becomes a waste rock dump, or b) slightly below the surrounding natural topography to retain a designed and constructed dam. Both the CCM Q-Pit and B-Pit were backfilled to become waste rock dumps.

As such, for the CCM, only the slopes of the rehabilitated waste rock dumps require consideration of geotechnical stability.

Completion criteria for rehabilitation of the QNH mine domains have been developed and are presented in the QNH RMP (a LOD) as measurable/quantifiable criteria which, once achieved, demonstrate that rehabilitated final landforms are (1) safe to humans and wildlife, (2) structurally stable, (3) non-polluting and not causing any environmental harm, and (4) able to self-sustain the agreed post-mining land use).

Specifically Table 12 of the QNH RMP (a LOD) includes approved completion criteria to achieve a geotechnically stable slope of a waste rock dump on the QNH (including the CCM) and states that: *"The nominated maximum slope on dumps is 20% (11.5°), unless otherwise advised by an RPEQ."* Additional completion criteria for slopes also includes groundcover and addressing any observed issues.

Upon completion of the final landform at the CCM, a geotechnical assessment will be undertaken to certify the landform is geotechnically stable and meets the required factor of safety (refer to **Section 7.3**).

1.12. Surface Water

1.12.1. Regional Catchment Description

The CCM is located within the Burdekin catchment, which is the second largest in Queensland occupying some 133,000km². The Burdekin catchment itself comprises eight major catchments and 52 sub-catchments. Typical annual average rainfalls are 600-700 mm in the upper Burdekin catchment and 800-1000 mm in the lower catchment coastal plains. Dominated by wet summers

and dry winters, waterways in the catchment are generally ephemeral and experience peak flows from December to April, with low or negligible flows from May to November.

As shown in **Figure 14**, the CCM is situated within the Pelican Creek sub-catchment of the Bowen Broken Bogie basin, which is located in the upper reaches of the Burdekin catchment. Waterways in the Pelican Creek sub-catchment are highly ephemeral, with flow only occurring after sufficient rainfall events.

The *Burdekin Region Water Quality Improvement Plan 2016* defines priority actions for the management of the Pelican Creek sub-catchment including the management of grazing, mining, industry, and other infrastructure. These actions have been addressed as part of the management of rehabilitation activities at the CCM (refer to **Section 5.1.1**).

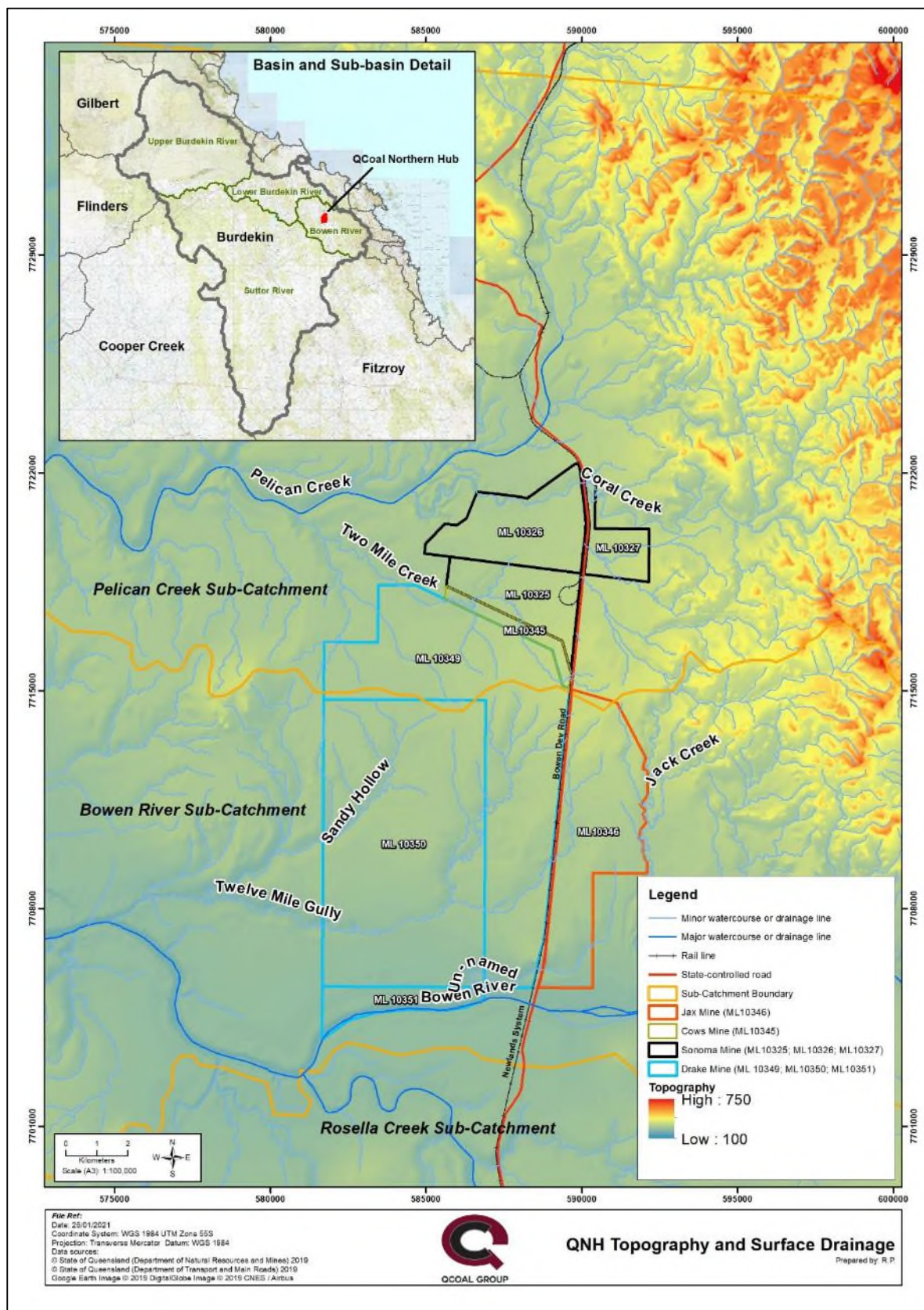


Figure 14 – QNH Topography and Drainage Catchments

1.12.2. Local Catchment Description

The drainage features within the CCM are shown in **Figure 15** and described as follows:

- **Two Mile Creek**

Local surface drainage within the CCM flows to the north-west into Two Mile Creek. Two Mile Creek is an upland ephemeral freshwater stream, only flowing during and immediately after heavy rainfall. Upstream (north) of the CCM, Two Mile Creek previously flowed through the center of the SCM MLs and a section was diverted in 2012 to allow for ongoing mining activities in the southern extent of the SCM Main Pit. This diversion is located entirely upstream of the CCM boundary and the confluences of the drainage lines that traverse the CCM with Two Mile Creek, as shown in **Figure 15**.

The reach of Two Mile Creek which flows through the CCM is classed as Stream Order 4 under the Strahler Method. The waters of Two Mile Creek flow generally northwest from the western boundary of ML 10345, joining Pelican Creek approximately 6km downstream of the CCM. Pelican Creek (also a highly ephemeral creek that contains occasional intermittent senescing waterholes which dry out during the dry season) then joins the Bowen River approximately 30 km downstream of the Two Mile Creek confluence.

- **Eastern Drainage Feature** The eastern drainage feature is a Stream Order 2 with a catchment size upstream of the CCM of approximately 500 ha. This drainage feature occurs within a shallow, low-lying area of alluvium which has resulted in a number of braided channels running approximately parallel. The channel upon which the on the mapped stream is aligned is the more minor of these channels, with a more significant channel running parallel but further east. During operations, the approximately 450m length of the eastern drainage feature within the CCM is crossed by a haul road crossing which will ultimately be removed and rehabilitated when the haul road is no longer required (see **Section 5.3.6**).
- **Western Drainage Feature**

The western drainage feature is a Stream Order 2 with a catchment size upstream of the CCM of approximately 400 Ha. The original alignment of the western drainage feature has been permanently realigned due to the progression of mining activities at the DCM to the south. A 70m length of this realigned drain extends into the CCM area immediately before the confluence with Two Mile Creek (shown as RA3 in **Figure 7**).

All drainage features within the CCM area were inspected by the (then) Department of Environment and Resource Management (DERM) during the CCM EA application process. At that time DERM confirmed that only Two-Mile Creek was classified as a 'watercourse' under the *Water Act 2000*, and the other drainage features were not considered to be 'watercourses'.

The drainage features within the site were observed during the field investigations undertaken as part of the CCM approvals process prior to the commencement of mining activities. The drainage

features were observed to be significantly degraded due to long term grazing, with high levels of soil compaction evident across the site.

1.12.3. Flood Modelling

Section 3.4 of the PRCP Guideline requires flood plain modelling to be undertaken for all sites with a void proposed as a NUMA to determine if the void is located within a flood plain (defined as the 0.1% Annual Exceedance Probability (AEP) peak water level for a relevant watercourse). The reach of Two Mile Creek within the CCM is a mapped Stream Order 4 and is therefore classed as a relevant watercourse for which flood plain modelling would be required; however, the EA EPML00334613 (**Condition H13** and **Table H1**) does not authorise residual voids to be retained within the Q-Pit or B-Pit areas at the CCM. Accordingly, flood plain modelling is not required and has not been undertaken specifically for this PRC Plan.

As noted above the CCM final landforms do not include voids (as the CCM mining pits have been backfilled) and as such the following information is not directly applicable to the CCM PRC Plan, but is provided for QNH contextual reference purposes only.

Previous flood modelling is available for the CCM site which adequately outlined the pre-mining flood plain on the CCM, for the purposes of mine planning and rehabilitation design. Modelling studies include the *Sonoma Coal Mine Flood Study* (Engeny, 2013), which was undertaken post-construction of the permanent Two Mile Creek Diversion at the SCM (but pre-development of the CCM). Specifically, Engeny (2013) provided an improved understanding of flooding risk to infrastructure at the SCM, with the spatial coverage of this flood study extending to the reach of Two Mile Creek (and its associated tributaries) within the CCM prior to the construction of any artificial features (e.g. waste rock dumps, haul road crossings, etc) during the development of the CCM.

The Engeny (2013) modelling scope included the development of an URBS hydrologic model of the Two Mile Creek system to obtain design hydrographs; and the development of a two-dimensional (2D) TUFLOW hydraulic model through the SCM and CCM areas. The digital terrain model of the site, which formed the basis of the hydraulic model, was generated using a range of photogrammetric and ground survey. Simulations were then undertaken for various flow events to produce flood maps detailing the flood extent and depth.

The extent of the modelled 0.1% Annual Exceedance Probability (AEP) flood plain within the CCM is shown in **Figure 16**. The flood extent within the CCM is largely limited to within and immediately adjacent to the defined channel of Two Mile Creek and its tributaries (the eastern and western drainage features). Mining activities at the CCM have largely taken place outside the modelled flood plain, with temporary haul road crossings, realigned drainage channels and minor areas of the B-Pit spoil dump footprint the only artificial features located within the modelled flood plain. The footprints of the now-backfilled CCM Q-Pit and B-Pit are located outside the mapped 0.1% AEP flood extent.

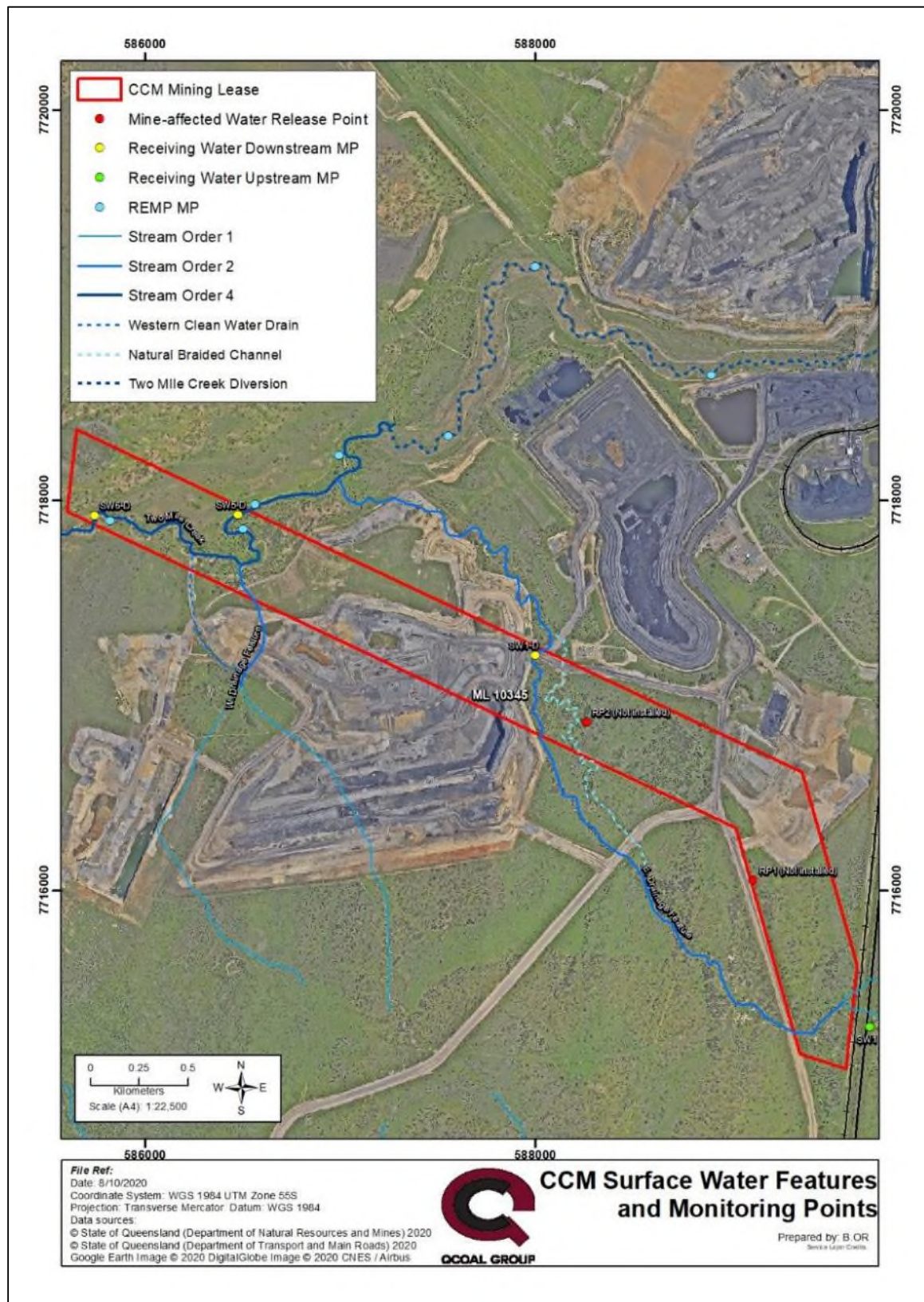


Figure 15 – CCM Surface Water Features

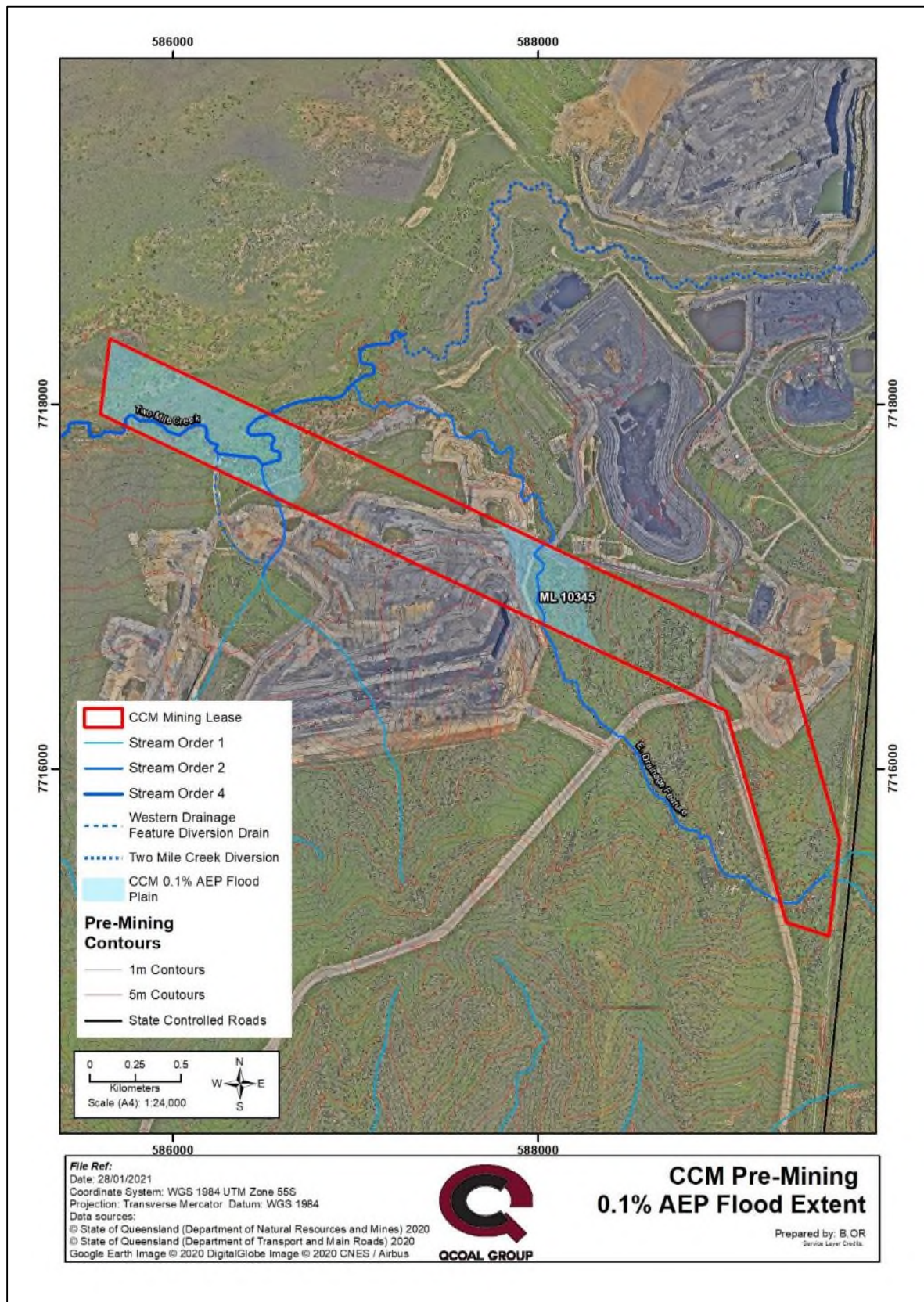


Figure 16 – Pre-Mining 0.1% AEP Flood Extent

1.12.4. Surface Water Values

Environmental Values (EVs) for surface waters are the pre-existing hydrological processes, ecological functions and human uses, which are present either within the area or downstream and which rely upon the surface water system. Where site activities have the potential to affect any material changes within the surface water system, an assessment is required to determine whether those changes will have any material negative impact on the EV. Monitoring, management, and mitigation is required where material negative impacts on EVs can potentially occur.

Draft EVs for the Pelican Creek sub-catchment are described in the *Burdekin Region Water Quality Improvement Plan 2016* (BWQIP), based on the *Environmental Protection (Water and Wetland Diversity) Policy 2019* (EPP Water). The EVs have an associated set of water quality objectives (WQOs) based on the ANZECC (Australian and New Zealand Environment and Conservation Council) *Guidelines for Fresh and Marine Water Quality* (ANZECC, 2000). The CCM EA prescribes the water quality monitoring parameters for the site based on ANZECC, 2000.

The Draft EVs for the Pelican Creek sub-catchment and their relevance to the CCM are detailed in **Table 10**.

Table 10 – Pelican Creek Sub-Catchment Surface Water Environmental Values

Environmental Value	Description	Relevance to CCM
Aquatic Ecosystem	Supporting pristine or modified Aquatic Ecosystems	The local area around the CCM has been cleared and used for long-term grazing and mining, modifying the landscape which has affected the volume and rate of runoff, the flow characteristics of the creeks, and the recharge of groundwater. As such, the aquatic ecosystems near the CCM, including the receiving environment, are considered to be highly disturbed.
Primary Industries - Irrigation	Irrigating crops such as sugar cane, lucerne, etc.	The ephemeral nature and variable water quality of the local drainage features and watercourses near the CCM provide minimal opportunities for usage in irrigation. The land underlying the CCM has been assessed as being of low land suitability for cropping (see 1.14.5).
Primary Industries - Farm Use	Water for farm use such as in fruit packing or milking sheds, etc.	The ephemeral nature and variable water quality of the local drainage features and watercourses near the CCM provide minimal opportunities for farm usage.

Environmental Value	Description	Relevance to CCM
Primary Industries - Stock Watering	Water for stock watering	The ephemeral nature of the local drainage features and watercourses near the CCM provides only opportunistic water supply for production of healthy livestock.
Primary Industries - Human Consumption	Human Consumption of wild or stocked fish or crustaceans	The ephemeral nature and variable water quality of the local drainage features and watercourses near the CCM provide limited opportunities for the provision of fish or crustaceans for human consumption.
Recreation - Secondary	Activities with indirect contact with water such as boating, canoeing or sailing	The ephemeral nature of the local drainage features and watercourses near the CCM provide limited recreational opportunities.
Recreation - Visual	Activities with no contact with water such as picnicking, bushwalking, sightseeing	The ephemeral nature of the local drainage features and watercourses near the CCM provide limited recreational opportunities.
Drinking Water	Raw Drinking Water supplies	Town water for Collinsville is supplied from Eungella dam via the Gattinvale Off stream Storage (and the Bowen River Weir). This is upstream of the Pelican Creek confluence with the Bowen River and therefore upstream of the CCM receiving waters.
Industrial Uses	Water for Industrial Use such as power generation, manufacturing plants	There are potential demands around Scottville and Collinsville for industrial use of water including for possible expansions in power generation and for coal mining. These would be upstream of the CCM and are unlikely to be sourced directly from Pelican Creek or its tributaries.
Cultural and Spiritual	Cultural and Spiritual values.	The ephemeral nature and variable water quality of the local drainage features and watercourses near the CCM limit potential use of downstream water resources by the Birri traditional owners.

Water is managed onsite at the CCM in accordance with the QNH WMP. As mine-affected water has not been actively released from the CCM since the commencement of mining, the EVs for the waterways downstream of the CCM are unlikely to have been affected by the mining activities.

1.12.5. Operational Water Management and Monitoring

Water is managed at the CCM in accordance with the QNH WMP which is integrated across the SCM, CCM and DCM with regard to Pelican Creek sub-catchment.

No water management structures (dams) were required for construction on the CCM during mining operations, with only the Q-Pit void utilised for a period as bulk water storage until it was backfilled. Ongoing water management on the CCM relies upon dams located on the adjacent DCM (for CCM B-Pit and SCM (for CCM Q-Pit).

There are two mine-affected water release points nominated in the CCM EA located on and adjacent to the Eastern Drainage Feature. These release points are shown in **Figure 15** but have not been established or utilised during mining operations at the CCM (i.e. the CCM has not required the release of water during operations). The associated upstream and downstream receiving water monitoring points nominated in the CCM EA as well as the relevant Receiving Environment Monitoring Program (REMP) monitoring points are also shown in **Figure 15**.

A detailed description of the immediate receiving waters of the CCM and the broader QNH can be found in the *QCoal Northern Hub Receiving Environment Monitoring Program* (QNH REMP) (Freshwater Ecology, 2016) and the current version of the *QNH Water Management Plan* (QNH WMP) (Engeny, 2020).

The QNH REMP outlines the requirements for ongoing collection of baseline monitoring results, including water quality and macroinvertebrate surveys within the watercourses surrounding the QNH. The QNH WMP outlines the requirements for water quality monitoring within watercourses, creeks and drainage channels in and surrounding the QNH, and describes the catchments, water storage and water movement infrastructure on the sites. The QNH WMP is reviewed annually and updated to reflect any relevant changes across the site and also contains the Erosion and Sediment Control Plan (ESCP) for the QNH sites.

No mine-affected water has been actively released from the CCM release points since the commencement of mining. Ongoing water management for the CCM is reliant of runoff being directed to the DCM and SCM where it is managed as part of those mines, respectively (as per the QNH WMP). No restriction to flow in either of the identified drainage features has occurred as a result of the placement of the CCM landforms.

1.12.6. Surface Water Quality

There is no historical water quality monitoring data available for Two Mile Creek prior to the establishment of the QNH. Previous monitoring data for the wider Pelican Creek sub-catchment indicates that water quality parameters display a high degree of spatial and temporal variability (GHD, 2009). This variability is likely due to seasonal changes in flow, the ephemeral nature of the flow, high rates of evaporation, stagnation and senescence of retained pools, differences in local geological conditions, and adjacent agricultural activity.

Table 11 details pre-mining water quality data for monitoring at two locations (upstream and downstream as shown in **Figure 15**) within the CCM area which was conducted between March 2010 and Jan 2011 as part of the DCM EIS, prior to the commencement of mining activities at the CCM.

Table 11 – CCM Pre-Mining Surface Water Quality

Parameter	Units	SW1 (E. Drainage Feature)*	SW6 (Two Mile Creek)**
Sampling Events	#	12	4
pH Value	pH	8	7.6–8.5
Electrical Conductivity	µS/cm	390	185-807
Total Dissolved Solids	mg/L	283	157-463
Total Suspended Solids	mg/L	30	11–1000
Total Solids	mg/L	354	456–1180
Turbidity	NTU	36	15–1000
Total Hardness as CaCO ₃	mg/L	145	46-306
Sulphate as SO ₄ ²⁻	mg/L	4	6-7
Chloride	mg/L	9	7-44
Calcium	mg/L	44	11-40
Magnesium	mg/L	9	4-50
Sodium	mg/L	24	21-65
Potassium	mg/L	5	2-4
Aluminium ^M	mg/L	0.02	0.01–0.06
Antimony ^M	mg/L	0.001	0.001
Arsenic ^M	mg/L	0.001	0.001–
Boron ^M	mg/L	0.05	0.050–
Cadmium ^M	mg/L	0.0001	0.0001
Chromium ^M	mg/L	0.001	0.001
Copper ^M	mg/L	0.002	0.001–
Iron ^M	mg/L	0.05	0.05–0.06
Lead ^M	mg/L	0.001	0.001
Manganese ^M	mg/L	0.004	0.001–
Nickel ^M	mg/L	0.001	0.001
Selenium ^M	mg/L	0.01	0.01
Zinc ^M	mg/L	0.005	-
Fluoride	mg/L	0.2	0.2–0.3
Ammonia as N	mg/L	0.03	0.03-0.04
Nitrate as N	mg/L	0.04	0.01-0.09
Nitrite + Nitrate as N	mg/L	0.04	0.01-0.09
Total Kjeldahl Nitrogen as N	mg/L	0.3	0.2-0.8
Total Nitrogen as N	mg/L	0.3	0.8
Total Phosphorus as P	mg/L	0.12	0.02-0.61

^M – dissolved metals

* Average

**Range (insufficient sampling events for average)

As part of operations, surface water monitoring is undertaken to directly and indirectly satisfy conditions of the four QNH EAs, including during periods of mine affected water releases, during periods of creek flow, and as part of REMP sampling (as per the QNH REMP).

Monitoring data has indicated that natural surrounding waters contain high levels of nitrogen and phosphorus levels attributed to the long-term agricultural activities within the catchment area. Due to the ephemeral and sandy nature of Two Mile Creek, turbidity levels are also consistently high and are highly variable. Some heavy metals such as aluminium and magnesium are also consistently high within the whole catchment, which may also be attributed to the high sediment loads carried by the creeks within the Collinsville area.

Material impacts to water quality or aquatic ecology have not been identified in association with QNH activities to date. The final landforms are not anticipated to impact adjacent surface water EVs once the rehabilitation criteria are achieved.

1.13. Groundwater

As previously noted, the QNH mines are four adjacent mines located across the same contiguous geology and associated hydrogeology, targeting the same coal measures. Numerous groundwater studies have been undertaken across the QNH, including but not limited to the following:

- *Cows Coal Project Groundwater Impact Assessment* (Geoaxiom, 2011);
- *Drake Coal Project Groundwater Resources Assessment* (GHD, 2012)
- *Groundwater Monitoring and Management Plan – Drake Coal Project* (QCoal, October 2014);
- *Northern Hub Groundwater Assessment* (AGE, 2018);
- *Residual Voids on the QCoal Northern Hub Mining Complex – Sonoma Cows, Drake and Jax Coal Mines* (QCoal June 2020); and
- *Northern Hub Groundwater Assessment* (AGE, 2020).

Recognizing that groundwater impacts from mining activities at the QNH sites are interrelated, the more recent groundwater assessments (QCoal October 2014, Age 2018 and AGE 2020), addressed the cumulative aspect of adjacent pits.

1.13.1. Aquifers and Conceptual Groundwater Model

Groundwater has been observed to be present at the CCM intermittently within the quaternary alluvial strata and within the Permian coal measures. The water bearing capacity of these units is highly variable as follows:

- **Quaternary Alluvium**

Geological detail in the CCM area is generally obscured by a cover of quaternary alluvium and gravel, particularly in the vicinity of Two Mile Creeks and drainage tributaries. This alluvial cover comprises unconsolidated fine to very coarse-grained sand with occasional

and irregularly interbedded silt clay and gravel lenses. The alluvial profile ranges from a thin veneer in the east of the CCM to a maximum thickness of 5m in the central and western portions of the site, as reflected by the thickness of the quaternary strata. The groundwater aquifers within the quaternary alluvium are unconfined, but not laterally wide-spread or continuous and are confined to low areas incised in the Permian sediments primarily within and adjacent to the drainage lines through the site.

- **Permian Coal Measures**

The coal seams identified within the CCM were identified as the principal groundwater bearing unit in the Permian sediments in the area. The coal seams are of low porosity and permeability, and thrust faulting in the QNH area has resulted in displacements of 20- 40m (AGE, 2005) with minimal associated brecciation. This has resulted in a limited capacity for transmission of groundwater laterally within and between coal seams, effectively confining the aquifer.

QCoal (2014) summarised the findings of the above in consideration of the geology of the area (further detailed in AGE (2015)), operational pit groundwater inflow data, and, importantly, ongoing groundwater monitoring of bores across the QNH since 2007.

DCM EIS, SCM EIS and QCoal (2014) concluded that there is limited connectivity between alluvium (where present) and the underlying Permian coal measures across the QNH. This observation is considered consistent with the expected low permeability of the majority of the coal measure's strata. In addition, the major ion chemistry results indicate a difference between groundwater sampled from the coal measures and surface water samples, further suggesting limited interaction between groundwater and surface water.

Conceptually, the above studies conclude that:

- there is limited inter-aquifer connectivity; and
- surface water channels across the QNH are losing-disconnected streams (see **Figure 17**) with no notable interconnection between the surface drainage systems and groundwater.

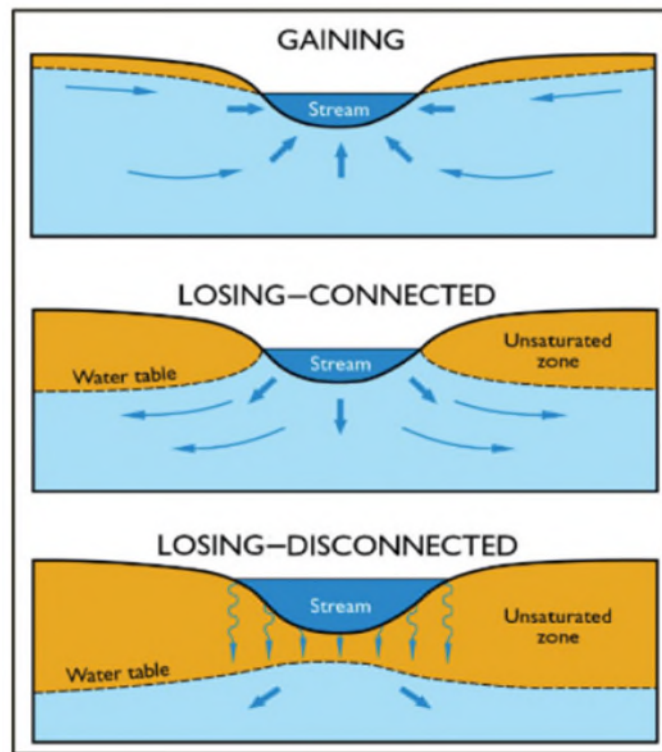


Figure 17 – Groundwater to surface water connectivity (NSW Government 2010)

1.13.2. Pre-Mining Yields, Levels & Flow Direction

Significant groundwater resources were not encountered during exploration drilling in the CCM area. Groundwater yields were measured during exploration activities and were found to be relatively low (<2 L/s) and variable. Groundwater monitoring to the north at the SCM has demonstrated highly variable yields, ranging from 0 to 5 L/s, with an average yield of 1 L/s. At the DCM to the south, of 601 exploration bores for which flow data was measured, 94% or 565 bores recorded yields of less than or equal to 0.1 L/s (litres per second). The maximum yield recorded was 5L/s. The results indicate that while the coal seams are the principal aquifers in the MCM, they are of low porosity and permeability.

In 2010, a number of monitoring bores were established at the DCM in the coal seam and alluvial aquifers present within that site. The monitoring indicated very limited connectivity within the alluvium related to significant flow events in the Bowen River which is located over 11km to the south of the CCM. The groundwater monitoring at the DCM indicates that the connectivity with the Bowen River alluvium is not laterally wide-spread and thus, was not expected to extend to the CCM in the north. Similarly, the groundwater investigation conducted at the SCM during its EIS phase, noted that groundwater monitoring across the alluvium in the area suggested that the alluvial aquifer was not continuous and is confined to low areas incised in the Permian sediments.

The direction of groundwater flow indicated by the recorded water levels as a composite of both coal seam and alluvial aquifers is to the west and is generally consistent with the surface topography and surface drainage features. Due to the ephemeral nature of the local watercourses and drainage lines, the quaternary alluvium is likely to be dry for the majority of the year.

The standing groundwater level across the CCM area was found to vary from 150 mAHD in the south, to 170 mAHD in the east, and 154-158 mAHD to the north.

1.13.3. Groundwater Recharge

Hydraulic conductivity has previously been measured in four bores at the QNH using falling head tests. These tested zones were within various lithologies with the MCM, including the upper coal seams, intrusive sills, sandstones and sandy siltstones. The estimated hydraulic conductivity ranged from 0.1 m/day to 0.7 m/day. These estimates are considered an upper bound to the Permian due to the shallow depth of the respective lithologies. Hydraulic conductivity is known to decline with depth in coal as increasing overburden pressure closes up fractures or cleats in coal seams reducing permeability.

- No data was obtained for the alluvium and the weathered zone; however, the alluvium is expected to have a higher permeability than the measured coal seams due to its unconsolidated nature. The hydraulic conductivity of the weathered zone is expected to be highly variable depending on clay and silt content and fracture networks, but it is not considered to form an aquifer.
- The overburden and interburden units between the coals seams typically have a lower hydraulic conductivity than the coal seams, and thus act as confining layers for the coal seams. This is consistent with observations during mining that these units are particularly dry and tight, and are indicative of a hydraulic conductivity several orders of magnitude lower than the coal seams.

In the CCM area, recharge to the alluvium is likely to occur directly through the base of Two Mile Creek and its tributaries and to a lesser extent through deep drainage through overlying soils. Recharge through the clay soils encountered at the CCM is likely to be minimal due to the swelling of the clays after rainfall. The varying thickness and discontinuous nature of the gravel and sand lenses within the quaternary alluvium will limit the lateral recharge within this aquifer.

Recharge to the coal seam aquifers is expected to primarily occur via drainage from the alluvial aquifer and also directly through the base of major creeks. Given the low permeability of the overburden, it is expected that vertical recharge is minimal with the dominant recharge mechanism being direct recharge to sub-cropping seams in creek beds (Geoaxiom Pty Ltd, May 2011).

1.13.4. Groundwater Quality

Groundwater quality for the identified groundwater units within the CCM and other QNH mines is summarized as follows:

- **Quaternary Alluvium**

The groundwater in local alluvial aquifers is relatively fresh and has a neutral pH. Water quality sampling of bores within the alluvium has historically been difficult due to the frequency in which the alluvium bores are dry (as previously noted, due to the ephemeral

nature of the local watercourses and drainage lines, the quaternary alluvium is generally dry for the majority of the year).

- **Coal Seam Aquifer**

The groundwater in the coal seam aquifers is unsuitable for domestic, irrigation or stock watering use due to the high chloride, sodium and Total Dissolved Solids (TDS) levels. Concentrations of metals are typically below guideline levels for livestock, irrigation and human health, with the exception of barium, selenium and manganese levels in some sampling events.

1.13.5. Groundwater Values

The EPP (Water) identifies the environmental values of groundwater that are to be protected or enhanced in Queensland. The groundwater environment in the CCM area was assessed against these values as detailed in **Table 12**.

Table 12 – CCM Groundwater EVs

Environmental Value	Description	Relevance to CCM
Aquatic Ecosystem	Supporting pristine or modified Aquatic Ecosystems	The local area around the CCM has been cleared and used for long-term grazing and mining, modifying the landscape which has affected the volume and rate of runoff, the flow characteristics of the creeks, and the recharge of groundwater. As such, the aquatic ecosystems within the CCM area were modified prior to mining activities commencing. No Groundwater Dependent Ecosystems (GDEs) have been identified within the CCM or the wider QNH area and are not considered likely to be present due to the vegetation species/communities present, the regional soils and geology, the depth to measured groundwater levels and the lack of springs or seeps in the area. Stygofauna have not been identified in the CCM area.
Primary Industries - Irrigation	Irrigating crops such as sugar cane, lucerne, etc.	The groundwater quality data obtained from the monitoring bores installed on and around the CCM indicate that the groundwater contains elevated levels of sodium, chloride and phosphorus and other that exceed health and/or irrigation guideline values. As such, the CCM is not expected to have any impact on irrigation water environmental values.
Primary Industries - Farm Use	Water for farm use such as in fruit packing or milking sheds, etc.	It is believed that there are no significant users of groundwater for farm usage within the local area. Farm users tend to require large volumes of water which would be unsustainable in the CCM area due to the low sustainable yield reported in the aquifers.

Environmental Value	Description	Relevance to CCM
Primary Industries - Stock Watering	Water for stock watering	Groundwater from the quaternary alluvium is generally suitable for stock watering but the alluvium is dry for the majority of the year due to the ephemeral nature of the local watercourses and drainage lines which recharge the unit. The lack of continuity within the alluvium and low sustainable yield makes usage of the quaternary alluvium for stock watering unlikely. Groundwater from the coal seam aquifer is generally unsuitable for cattle watering.
Primary Industries - Human Consumption	Human consumption of wild or stocked fish or crustaceans	There are no groundwater springs or seeps that supply surface water bodies in the area that are used for primary industries.
Recreation - Secondary	Activities with indirect contact with water such as boating, canoeing or sailing	There are no groundwater springs or seeps that supply surface water bodies in the area that are used for recreational use.
Recreation - Visual	Activities with no contact with water such as picnicking, bushwalking, sightseeing	There are no groundwater springs or seeps that supply surface water bodies in the area that are used for recreational use.
Drinking Water	Raw drinking water supplies	The groundwater quality data obtained from the monitoring bores installed on and around the CCM indicate that the groundwater contains elevated levels of sodium, chloride and phosphorus that exceed health and/or irrigation guideline values. As such, the CCM is not expected to have any impact on drinking water environmental values.
Industrial Uses	Water for Industrial Use such as power generation, manufacturing plants	It is believed that there are no industrial users of groundwater within the local area. Industrial users tend to require large volumes of water which would be unsustainable in the CCM area due to the low sustainable yield reported in the aquifers.
Cultural and Spiritual	Cultural and Spiritual values.	There are no known groundwater springs or seeps that supply surface water bodies in the area that may have significant indigenous and/or non-indigenous cultural heritage.

There are 53 registered bores within a 10km radius of the CCM, of which the majority are monitoring or investigation bores, or have been abandoned or destroyed. Only four of the bores are nominated as water supply bores, with the closest bore located approximately 5km to the north-east of the CCM. Notably, the four water supply bores are located in geological formations that are not present at the CCM (Coral Creek alluvium, granite intrusions).

Based on the nature of the groundwater units present and searches of registered licensed groundwater bores and pre-mining landholder bore surveys, groundwater use (including, but not limited to pastoral, irrigation, mining, stock, domestic, and town water) is not considered a groundwater value across or in the immediate vicinity of the CCM.

1.14. Soils and Land Suitability

A soil and land suitability assessment was undertaken for the CCM during the EA application process, summarised in the *Cows Project Soils Report* (Tecsol, 2011), to determine topsoil resources suitable for salvage and reuse in rehabilitation activities, and to inform the PMLU for the site.

1.14.1. Soil Assessment

The soil assessment (Tecsol 2011) for the CCM was undertaken in reference to the *Guideline for Land Suitability Assessment Techniques* (DME, 1995) using the following method:

- Initial desktop review of available land resource data and preliminary mapping of the soils and terrain;
- Review of previous soil profile information collected for the neighbouring sites;
- Field survey of the site to characterise the soils and landscapes, including laboratory analysis of selected soil samples and classification of the soils in accordance with the Australian Soil Classification; and
- Mapping of the Land Units based on the units of common soils, landforms, geology and vegetation communities;

The below field survey was undertaken within EPC586 (which included the CCM area), the results of which were relied upon and reported in the CCM soil assessment (Tecsol 2011):

- 2009 Soil Survey: 16 Ground observations, 3 soil profile descriptions, sampling and laboratory analysis.

A further field survey was undertaken for the DCM EIS in 2011 and reported in the DCM *Soils and Land Suitability Assessment* (GHD, 2011). This field survey was undertaken in close proximity to, and encountering the same Land Units (LUs) as, the CCM, and included the following:

- 2011 Soil Survey: 158 Ground observations, 50 soil profile descriptions, sampling and laboratory analysis.

The CCM soil assessment (Tecsol, 2011) identified the presence of the following LUs within and adjacent to the CCM:

- **Land Unit 1 (LU1): Vertosols on Low Lying Areas**

This land unit is easily identified on the site as the primary soil order in low lying areas with its distinctive cracking clay Vertosol soils. The topography of this land unit is relatively low lying between 130 and 150 m AHD, with level to gently inclined slopes less than 3%. The main vegetation is improved pasture (Rhodes and buffel grass). The main evidence of erosion is in drainage lines; however this tends to be partially stabilized to stabilized.

- **Land Unit 5 (LU5): Dermosols & Vertosols on Undulating Terrain**

This land unit is present on the higher ground along the eastern and central portion of ML10345 at elevations between 150 and 210 m AHD. It mostly contains level to gently

inclined slopes less than 3%. The dominant soil orders are Dermosols, with Vertosols occurring secondary and tending to occur in bands in a north south direction. The dominant pre-clearing vegetation cover is open eucalypt woodland. The occurrence of erosion is considered minor, with sheet erosion being the primary form.

The mapped distribution of these LUs within the CCM area are shown in **Figure 18**.

The field surveys included soil testing on representative topsoil samples for a range of parameters which influence the suitability of the soil to be salvaged for use in rehabilitation. Details of key soil quality parameters for the identified LUs from a number of representative sampling locations are summarised in **Table 13**.

Table 13 –Soil Quality Assessment (Tecsol, 2011)

Mapped Land unit	Depth (m)	Texture	Clay Content Estimate	pH	Electrical Conductivity (uS/cm)	Soil Salinity Rating
LU1 – Vertosols on Low Lying Areas	0-0.1	Medium clay	45-55%	7.3	180	Low
	0.2-0.3	Medium clay	45-55%	8.4	150	Low
	0.5-0.6	Medium clay	45-55%	8.7	260	Medium
	0.8-0.9	Medium clay	45-55%	8.1	1040	Very High
	1.1-1.2	Medium clay	45-55%	8	970	Very High
LU5 – Dermosols & Vertosols on Undulating Terrain	0-0.08	Sandy clay loam	20-30%	6.4	50	Very Low
	0.08-0.16	Sandy clay loam	20-30%	6.2	40	Very Low
	0.16-0.31	Light clay	35-40%	6.2	30	Very Low
	0.40-0.50	Light clay	35-40%	6.4	40	Very Low
	0.7-0.86	Weathered sandstone	5-10%	6.8	40	Very Low

LU1 soils have a neutral to moderately alkaline pH at the surface and become moderately to strongly alkaline with depth. These pH levels would not be expected to limit plant growth. Salinity was low in the A-horizon (0-0.3m) but increased throughout the B-horizon from medium to very high. Root development would be expected to be limited at depths below 0.8 m due to salinity.

The LU5 soil pH ranged from slightly acidic at the surface A-horizon (0-0.3m depth) to neutral at depth in the B horizon. The soil pH levels are not expected to be limiting to plant growth. Salinity was very low throughout the profile and would not be expected to effect plant growth.

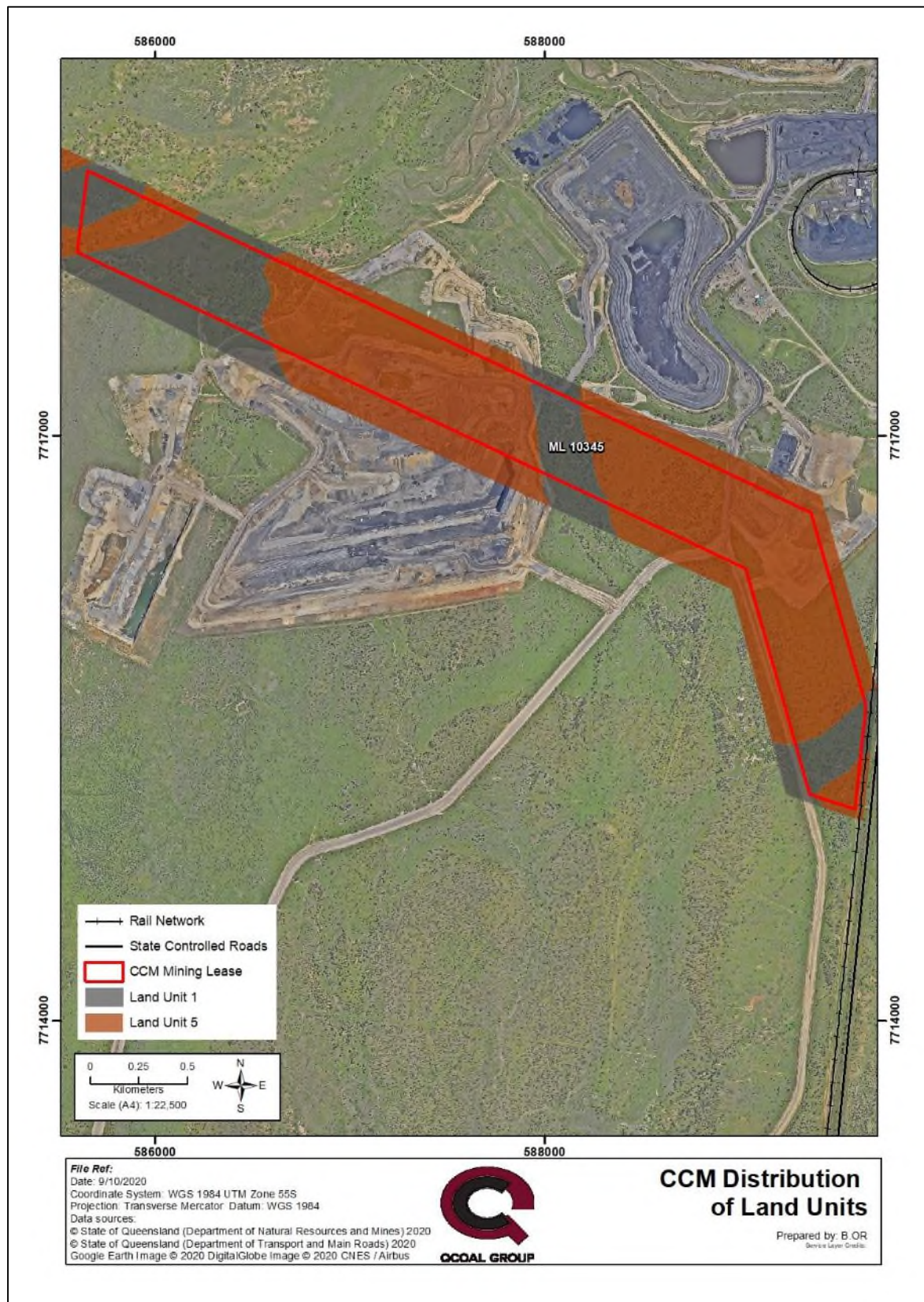


Figure 18 – Distribution of Land Units

1.14.2. Erosional Stability

During the DCM EIS field survey, testing was undertaken on representative topsoil samples for the land units encountered within the CCM for a range of parameters which influence the erosional stability of the soil. This testing included:

- Exchangeable Sodium Percentage (ESP) - a soil is considered sodic when sodium reaches a concentration where it starts to affect soil structure, when sodic soils are wet the sodium weakens the bonds between soil particles, resulting in clay swelling causing slaking or dispersion. A soil is considered sodic when the ESP is >6%.
- Cation Exchange Capacity (CEC) - the total capacity of a soil to hold exchangeable cations, which influences the soil's ability to retain essential nutrients and buffer against soil acidification.
- Calcium/Magnesium Ratio (Ca/Mg Ratio) - this ratio is used as an indication of dispersion potential. Soils that are high in sodium and magnesium tend to show more dispersion than soils that are high in sodium and calcium. The potential for dispersion may be increased in soils with calcium / magnesium ratios less than 2.
- Emerson crumb test - used as a general guide to sodicity and is used to classify the potential for soils to slake and disperse. The Emerson Crumb test categorises soils into seven classes on the basis of their coherence in water.

Analytical results from the erosional stability testing on representative topsoil samples for the land units identified within the CCM are summarised in **Table 14**.

Table 14 –Erosional Stability Assessment (GHD, 2011)

Mapped Land Unit	Depth (m)	ESP Ratio (%)	CEC (meq%)	Ca/Mg Ratio (%)	Emerson Crumb Test
LU1 – Vertosols on Low Lying Areas	0-0.1	1.8	37.6	3.5	
	0.2-0.3	4.4	45.2	2.8	5
	0.5-0.6	11.2	40.4	1.7	5
	0.8-0.9	14.1	36	1.2	
	1.1-1.2	15.7	31.6	1.1	
LU5 – Dermosols & Vertosols on Undulating Terrain	0-0.08	0.7	14.8	2.4	6
	0.08-0.16	0.8	17	2.6	
	0.16-0.31	1.2	22.5	2.2	
	0.40-0.50	1.7	31.6	2.5	5
	0.7-0.86	1.9	34.8	3.1	

Results for LU1 indicate the soils become marginally sodic to sodic at depths below 0.3 m and increase to strongly sodic at 0.8 m. They have a low erodibility rating when left in-situ but they are susceptible to slaking and may disperse after being worked when wet and become susceptible to erosion. The main evidence of in-situ erosion was noted adjacent to drainage lines.

Results for LU5 indicate that the soils are non-sodic and have a low erodibility rating. The topsoil is susceptible to slaking but not susceptible to dispersion. The subsoil is also susceptible to slaking and may disperse after being worked when wet.

As previously noted in **Section 1.10.1**, analyses of mine waste confirmed the presence of low ESPs and high Ca/Mg ratios within the mine waste lithologies, therefore significant dispersion of fine materials from waste rock dumps is not expected to occur.

1.14.3. Soil Fertility

Testing was undertaken as part of the DCM EIS field survey on representative topsoil samples from the A1 Horizon (0-0.1m depth) for the land units identified within the CCM. Testing was for a range of parameters (nutrients, exchangeable cations and trace elements) which influence the overall fertility of the soil. Analytical results from the fertility testing are summarised in **Table 15**.

Table 15 –Topsoil Fertility Analysis - A1 Horizon (GHD 2011)

Analyte	Unit	LU1 Range	LU5 Range
Organic Matter	%	1.9 – 4.0	0.9 - 3.8
Nitrate	mg/kg	8.5	1.7
Total Nitrogen	%	0.07 – 0.22	0.08 - 0.21
Phosphorus	mg/kg	8.0 – 52.0	<5.0 - 71
Potassium	Meq/100g	0.2 – 0.6	0.13 - 0.59
Magnesium	Meq/100g	7.88	8.52
Calcium	Meq/100g	27.66	21.6
Aluminium	mg/kg	25	26
Sulfate	mg/kg	3.4 - 11.0	1.3 - 7.5
Boron	mg/kg	0.73 – 1.1	0.31 - 1.5
Copper	mg/kg	0.56 – 1.7	0.17 - 1.7
Iron	mg/kg	11 – 26	3.9 - 57
Manganese	mg/kg	3.4 – 17	1.8 - 60
Zinc	mg/kg	0.14 – 0.69	0.13 - 1.4
Chloride	mg/kg	22.0	17.0

Analytical results for LU1 indicated that surface soil nitrate is low to medium. Phosphorus concentrations were low to very high, with soils at the lower end potentially being limiting for improved pasture growth. It is expected that blending of topsoil into stockpiles will aggregate total nitrogen and phosphorus levels to a narrower range which is suited to improved pasture growth for rehabilitation. Soil aluminium is the dominant cation accounting for about 50% of the CEC,

approaching the limit of 60% aluminium saturation. LU1 soils also have a high water storage capacity and will readily support the germination and growth of grasses and trees.

Analytical results for LU5 indicated that topsoil nitrate and phosphorus concentrations were low and may be limiting for improved pasture growth but again it is expected that blending of topsoil into stockpiles will aggregate total nutrient levels to a narrower range which is suited to improved pasture growth for rehabilitation. These soils also have a moderate water storage capacity and will readily germinate and support grasses and trees.

1.14.4. Topsoil Stripping

As evident in **Figure 18**, LU5 was the predominant land unit within the disturbance areas at the CCM and therefore represented the majority of the topsoil resources available to be salvaged. The soil assessments undertaken indicated that both LU1 and LU5 were suitable for salvaging to a depth of approximately 300 mm (where available) for use in rehabilitation at the CCM.

As such, a nominal 300mm topsoil stripping depth was adopted for all disturbance areas at the CCM for use in rehabilitation of the site to the proposed grazing pasture PMLU. Due to a lack of progressive rehabilitation areas available during topsoil stripping campaigns, stripped topsoil was generally stockpiled rather than directly respread.

1.14.5. Land Suitability

A land suitability assessment of the land units encountered in the CCM area (refer to **Section 1.14.1**) was conducted during the EA application for the project in 2011. Findings of the assessment were compared against land suitability criteria published in the *Land Suitability Assessment Techniques (LSAT) Guidelines* within the *Technical Guidelines for Environmental Management of Exploration and Mining in Queensland* (DME, 1995).

Previous land suitability assessments undertaken for the QNH mines noted that:

- Large areas of the properties underlying the QNH were cleared historically for grazing.
- Logging and ringbarking have been undertaken historically in riparian zones, and mixed woodlands have been thinned, with understories removed to facilitate grazing.
- Soils and landforms are generally suitable for cattle grazing.
- Ongoing pastoral activities by landholders across the QNH MLs and the surrounding region have included agistment/grazing, clearing, regrowth and weed control, and control of feral animals (dogs, pigs, etc).

Results of the CCM pre-mining land suitability assessment are summarised in **Table 16**.

Table 16 - Pre-mining Land Suitability Assessment for Beef Cattle and Broadacre Cropping

Land Unit	Beef Cattle Land Suitability		Broadacre Cropping Land Suitability	
	Land Suitability Rating	Limiting Factors	Land Suitability Rating	Limiting Factors
LU1 – <i>Vertosols on Low Lying Areas</i>	Class 3 – Fair	Water Availability Nutrient Deficiency (P)	Class 4 – Low	Water Availability Water Erosion Susceptibility
LU5 – <i>Dermosols and Vertosols on undulating terrain</i>	Class 3 – Fair	Water Availability Nutrient Deficiency (P) Soil pH	Class 4 - Low	Water Availability Water Erosion Susceptibility

The land underlying the CCM was characterised as Land Suitability Class 3 (Fair) for beef cattle grazing, with limitations being water availability and nutrient deficiency and, in some instances, high soil pH. Class 3 land is defined as being typically suitable for the land-use with moderate limitations.

The land was further classified as Land Suitability Class 4 (Low) for broadacre cropping, with limitations being water availability and water erosion. As such, it was concluded that the land was marginal and typically not suited to cultivation. It should be noted that ML 10345 previously overlapped an area of mapped Strategic Cropping Land under the now-repealed *Strategic Cropping Land Act 2011* but a validation decision was issued for this area in 2012 advising that the subject property did not meet the requirements necessary to satisfy the cropping history test.

1.15. Terrestrial Ecology

The CCM is located within the Brigalow Belt Bioregion which covers a total area of 135,500 km² and includes coastal areas, rugged ranges and alluvial plains (Young et al., 1999). The Brigalow Belt Bioregion supports a range of flora and fauna including a number of rare and threatened species. Finer variations within bioregions in geology, geomorphology and climate produce characteristic patterns of landforms, soils and vegetation. These distinctive provinces are mapped as subregions (Sattler and Williams, 1999).

The CCM is located within the Northern Bowen Basin Sub-Bioregion, which contains the major areas of outcropping of Triassic and Permian sediments of the Bowen Basin. The regional landscape is predominately undulating, with *Acacia harpophylla* (brigalow) and *Eucalyptus cambageana* (Dawson gum) communities dominant on clay soils, and an open woodland of *Eucalyptus crebra* (narrow-leaved ironbark) or *Eucalyptus populnea* (poplar box), often with a shrubby understorey, typically present on the shallower texture-contrast soils. There are also areas of *Dichanthium sericeum* (bluegrass) (Young et al., 1999).

As previously noted, cattle grazing has been ongoing within the CCM area and surrounds since the 1950s. During the 1950s and 1960s, significant areas of native vegetation were cleared to promote the establishment of grazing pasture. As a consequence, the majority of ML 10345 comprises Buffel Grass (*Cenchrus ciliaris*) improved pasture.

A number of studies relating to vegetation communities, flora and fauna have been undertaken within and adjacent to the CCM as part of the application processes for the QNH mines, including:

- *Cows Coal Project Ecological Assessment Report* (Tecsol 2011)
- *Drake Coal Project Ecological Assessment Technical Report* (GHD, 2012)
- *Birrilee (EPC 586) Ecological Assessment* (ERM, 2007)
- *Flora and fauna of the proposed Sonoma Coal Mining Lease near Collinsville, Central Queensland* (Central Queensland University, 2004)

The *Cows Coal Project Ecological Assessment Report* included both a desktop assessment of the site, and summarised the relevant findings of a previously undertaken field survey of the vegetation communities, flora, fauna and weed species present within the wider EPC 586 area (in which ML 10345 is located). Further analysis of flora species present in the area was undertaken as part of the DCM EIS, which included targeted field surveys undertaken in April 2010 which identified 192 plant species from 50 families (GHD, 2010).

1.15.1. Vegetation Communities

Table 17 and **Figure 19** detail the remnant regional ecosystems (REs) currently mapped within the CCM, including biodiversity status (BD status), *Vegetation Management Act 1999* (VM Act) status, Environmentally Sensitive Area (ESA) category and Matters of State Environmental Significance (MSES) category) within the CCM. The majority of the CCM site has been historically cleared of remnant vegetation, with minimal mining-related disturbance occurring within the mapped remnant vegetation communities (and that being limited to within No Concern at Present REs).

Prior to the initial clearing for grazing purposes in the 1950s, the available pre-clearance mapping for the CCM site shows these regional ecosystems extended across the CCM area. Ongoing vegetation management since the initial clearing has periodically thinned regrowth within the site.

Table 17 – Mapped Remnant REs within the CCM

Regional Ecosystem	Description	Total Area (Ha)	BD Status	VM Act Status	ESA	MSES
11.9.9/11.9.2	Eucalyptus crebra woodland on fine-grained sedimentary rocks/ Eucalyptus melanophloia +/- E. orgadophila woodland on fine-grained sedimentary rocks	36.2	No Concern at Present	Least Concern	-	-
11.9.10	Eucalyptus populnea open forest with a secondary tree layer of Acacia harpophylla and sometimes Casuarina cristata on fine-grained sedimentary rocks	3.3	Endangered	Of Concern	Category B	Regulated Vegetation Category B

No further clearing is expected to be required for the mining activities within ML 10345. As such, the remnant regional ecosystems within ML 10345 will not be further impacted by the mining activities.

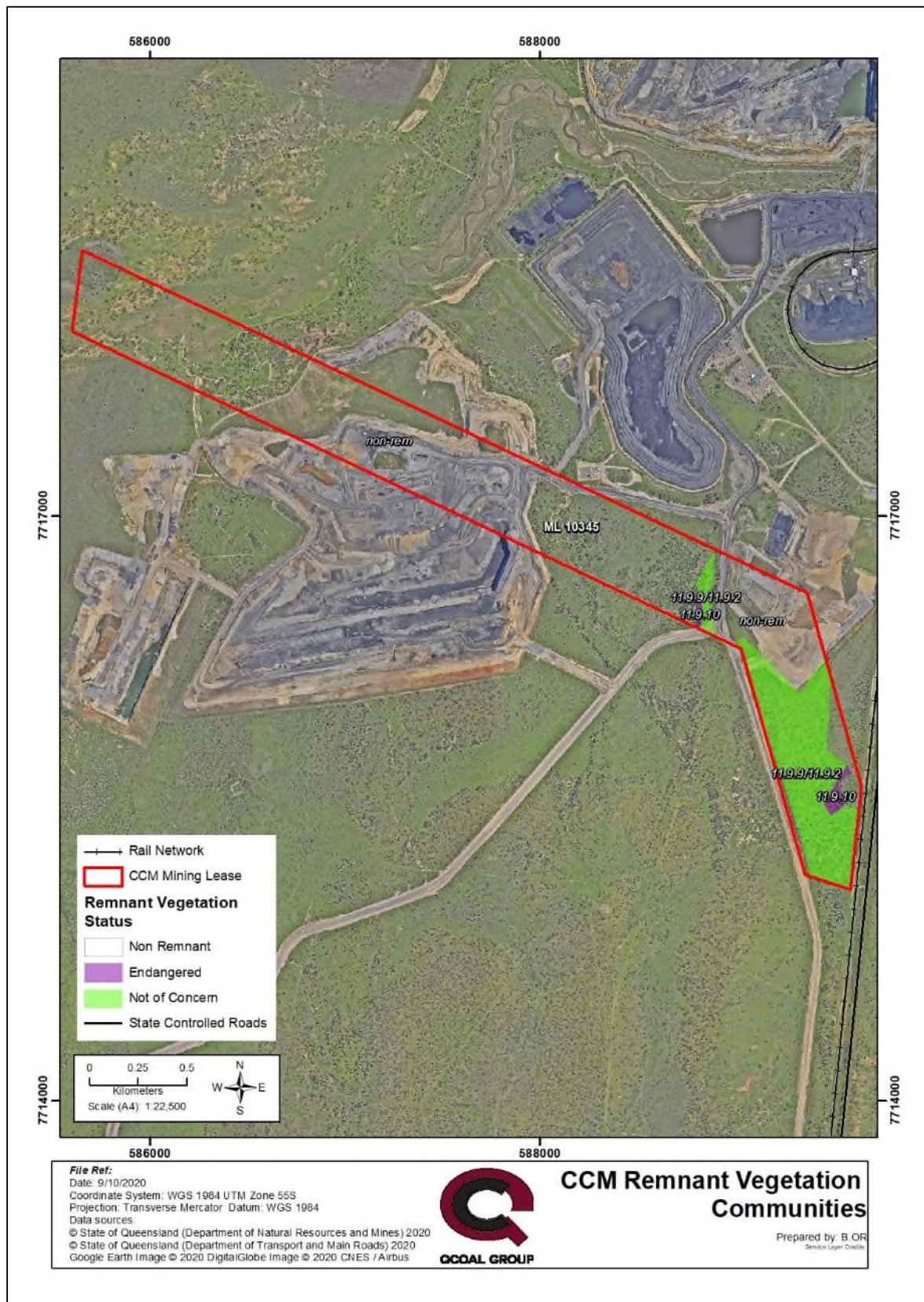


Figure 19 – CCM Mapped Remnant Vegetation Communities

1.15.2. Flora

No individual Endangered, Vulnerable or Near Threatened (EVNT) species under the *Nature Conservation Act 1992* (NC Act) or species of ecological significance under the *EPBC Act* were identified within the CCM prior to the commencement of mining. Native species associated with the previously described vegetation communities formed the bulk of the native flora noted within the CCM site.

Due to the highly disturbed nature of the vegetation within the CCM area, introduced species including pasture grasses and a variety of weed species were present within and adjacent to the CCM, as listed in **Table 18**.

Table 18 – Introduced Species Within the CCM

Family	Species	Common Name	LP (PSRM) Act * Declared (Class)	Biosecurity Act 2014 Restricted Matter (Category)	Weed of National Significance
Amaranthaceae	<i>Gomphrena celosioides</i>	Gomphrena Weed	No	No	-
Asteraceae	<i>Parthenium hysterophorus</i>	Parthenium	Yes (2)	Yes (3)	Yes
Asteraceae	<i>Tridax procumbens</i>	-	No	No	-
Asteraceae	<i>Xanthium pungens</i>	Noogoora Burr	No	No	-
Cactaceae	<i>Eriocereus spp.</i>	Harrisia Cactus	Yes (2)	Yes (3)	Yes
Cactaceae	<i>Opuntia stricta</i>	Prickly Pear	Yes (2)	Yes (3)	-
Malvaceae	<i>Sida spinosa</i>	-	No	No	-
Mimosaceae	<i>Acacia farnesiana</i>	Prickly Mimosa	No	No	-
Mimosaceae	<i>Acacia nilotica</i>	Prickly Acacia	Yes (1)	Yes (3)	Yes
Papaveraceae	<i>Argemone ochroloca</i>	Prickly Poppy	No	No	-
Poaceae	<i>Cenchrus ciliaris</i>	Buffel Grass	No	No	-
Poaceae	<i>Dichanthium annulatum</i>	-	No	No	-
Poaceae	<i>Dichanthium aristatum</i>	-	No	No	-
Poaceae	<i>Echinochloa colona</i>	-	No	No	-
Poaceae	<i>Macroptilium lathyroides</i>	-	No	No	-
Poaceae	<i>Sorghum halepense</i>	-	No	No	-
Poaceae	<i>Urochloa mosambicensis</i>	-	No	No	-
Rhamnaceae	<i>Ziziphus mauritiana</i>	Chinee Apple	Yes (2)	Yes (3)	-

*The *Land Protection (Pest and Stock Route Management) Act 2002* has been superseded by the *Biosecurity Act 2014*

1.15.3. Fauna

No mapped essential habitat is present within the CCM area, and no individual species of ecological significance under the NC Act or EPBC Act were identified within the CCM area during the pre-mining ecological surveys. Within the wider QNH area, the only species of conservation significance observed during the various ecological surveys were:

- Squatter Pigeon (*Geophaps scripta scripta*) was the only species of conservation significance identified in the greater area of EPC 586. The Squatter Pigeon is classed as Vulnerable under both the Qld *Nature Conservation (Wildlife) Regulation 2006* (NC Regulation) and the Commonwealth EPBC Act. The southern sub-species of the Squatter Pigeon (*Geophaps scripta scripta*) have long been identified in the Collinsville-Mount Coolon region. Its preferred habitat consists of grassy woodlands, foothills, river flats and grassy plains, and always near water. Whilst the Squatter Pigeon was identified in areas adjacent to but not within ML 10345, suitable habitat for the species was identified on ML 10345. In the vicinity of the CCM, Two Mile Creek and its tributaries are highly ephemeral, therefore the presence of the species on the site was deemed likely to be temporary and opportunistic. There have been no sightings of the squatter pigeon within the CCM since the commencement of mining activities.
- The Little Pied Bat (*Chalinolobus picatus*) is listed as Near Threatened under the NC Regulation but is not protected under the EPBC Act. This species has been identified at the neighbouring SCM and therefore has the potential to inhabit the CCM area; however there have been no sightings of the little pied bat within the CCM since the commencement of mining activities.

Pest species observed within and adjacent to the CCM area included the following:

- European Rabbit (*Oryctolagus cuniculus*),
- Cane Toad (*Rhinella marinus*)
- Pig (*Sus scrofa*).

Since the commencement of mining activities, significant populations of these pests have not been noted and control programs have not been required within the CCM.

2. Community Consultation

Section 126C(1)(c) of the EP Act includes the following requirements regarding community consultation in relation to the PRC Plan:

- (iii) requires that the PRC Plan – Rehabilitation Planning Part include details of any community consultation undertaken in development of the PRCP Plan; and
- (iv) requires that the PRC Plan – Rehabilitation Planning Part include details as to how ongoing community consultation will be undertaken regarding rehabilitation.

The DES information sheet “*Community Consultation for Progressive Rehabilitation and Closure Plan – ESR/20196/5101*” (the Consultation Guideline) provides more detail on identifying relevant parties and the nature of their interest, to enable relevant community consultation as required.

Community consultation refers to engagement with relevant parties, where a relevant party is identified as being:

- directly influenced by the rehabilitation of the mine; and
- having a demonstrable and legitimate genuine interest regarding:
 - o the land where the activities are occurring,
 - o the land adjacent to where the activities are occurring,
 - o the land/amenities surrounding where the activity will occur that are likely to be impacted by the activity (e.g. groundwater/drinking water users within the surrounding area or community located upstream or downstream of the activity).

The Consultation Guideline provides a list of genuine interests (which must be demonstrable and legitimate) which have been considered for the CCM as follows:

- **Direct interest** (e.g. underlying and adjacent landholders):
 - o Underlying and adjacent landholders have been identified (Section 1.3).
- **Cultural interest** (e.g. indigenous communities, traditional owners including Native Title Holders):
 - o The land underlying the CCM is a dedicated road reserve. The road has been ‘constructed’ and ‘established’ for the purposes of the *Native Title Act 1993* and Native Title had therefore been extinguished prior to the development of the CCM. As such there is no cultural interest identified for the CCM.
- **Heritage interest** (e.g. state or local government or relevant community groups where heritage value is identified on the land the activity is to occur):
 - o There is no heritage value identified for the CCM.
- **Environmental interest** (e.g. state or local government or relevant community groups where environmental value is identified on the land the activity is to occur):
 - o There are no identified environmental values within the CCM site of relevance to State or local government or relevant community groups.
 - o All disturbance to date (and any subsequent disturbance undertaken) has and will be within the approved disturbance area of the EA (a LOD).

- **Recreational interest** (e.g. relevant community groups who use the immediate, adjacent, upstream or downstream land for recreational purposes):
 - o The land immediately upstream and downstream of the CCM is privately held and used for grazing (**Section 1.2** and **Section 1.3**).
 - o There are no community groups that use the immediate adjacent, upstream or downstream land for recreational purposes.
- **Land use interest** (e.g. overlapping tenure holders, agricultural entities or local government where a planning scheme for the land is in place):
 - o There are no overlapping Petroleum or Mineral tenure holders or agricultural entities for the CCM. There are however, adjoining coal MLs associated with the QNH.
 - o The CCM area is subject to the WRC Planning Scheme, which has zoned Lot A on AP2839 (in which the CCM is located) as a 'road' and the adjacent properties as 'rural'. The 'road' zoning for Lot A on AP2839 is consistent with the longstanding underlying land tenure. However, Lot A on AP2839 has never been utilised as a road, having previously been a declared stock route under the LP (PSRM) Act and having been utilised for grazing since the 1950s. Since 1981, the property has been utilised for grazing activities under successive Permits to Occupy. As the grazing PMLU is consistent with the pre-mining land-use and the conditions of the Permit to Occupy (which authorise the Permit Holder to use the property for grazing purposes), the WRC Planning Scheme zoning will have no impact on the rehabilitation and final land outcomes for the CCM.
- **Health Interest** (e.g. state or local government or relevant community groups who have health concerns relating to the rehabilitation processes and final land outcomes for the project):
 - o There are no relevant community groups or government who have health concerns relating to the rehabilitation processes and final land outcomes for the CCM.

The members of the community identified to have a genuine interest in the rehabilitation and closure of the CCM are the underlying landholder, the adjoining landholders and the adjoining tenure holders, as nominated in **Table 19**. The list of identified community consultation members is subject to change in the event of a change in the landholdings or tenure arrangement for the nominated parties.

Table 19 – Identified Community Consultation Members

Community Member	Interest Description	Interest Type
Mr Christopher Wallin	Landholder - Lot A on AP2839 (Road Reserve)	Direct - Underlying/ Adjacent Landholder (Holder of Permit to Occupy)
Mr Christopher Wallin	Landholder – Belmore West - Lot 1 on SP190745, Freehold	Direct - Adjacent Landholder

Captain Nominees Pty Ltd (owned by Mr Christopher Ian Wallin)	Landholder – Birralelee Station - Lot 618 on SP271121, Lands Lease	Direct - Adjacent Landholder
Sonoma Coal Mine JV (QCoal Sonoma Pty Ltd, JS Sonoma Pty Ltd, CSC Sonoma Pty Ltd and Watami (Qld) Pty Ltd)	Owner of adjoining coal mine (MLs 10325, 10326 and 10327)	Land use – Adjacent Tenure Holder
Drake Coal Mine JV (Northern Hub (Drake) Pty Ltd and Drake Coal Pty Ltd)	Owner of adjoining coal mine (MLs 10349, 10350 and 10351)	Land use – Adjacent Tenure Holder

2.1. Community Consultation Plan

A Community Consultation Plan (CCP) is presented in **Table 20**. The purpose of the CCP is to provide a plan for BRC to engage with the identified relevant parties (see **Table 19**). The objective of engagement is to enable those parties to provide input into the PRC Plan development and subsequent implementation, as well as any potential amendments.

Table 20 – CCM PRC Plan Community Consultation Plan

Item	Details
Identified Community Members	The identified community members are those relevant parties which are: - directly influenced by the rehabilitation of the mine; and - having a demonstrable and legitimate genuine interest regarding: - the land where the activities are occurring, - the land adjacent to where the activities are occurring, - the land/amenities surrounding where the activity will occur that are likely to be impacted by the activity (e.g. groundwater/drinking water users within the surrounding area or a community located upstream or downstream of the activity). The identified community members are identified in Table 19 of the PRC Plan. For the CCM the identified community members listed in Table 19 of the PRC Plan are all directly associated with QCoal. As such engagement and consultation regarding the PRC Plan with the identified community members is assumed, is implicit and does not require specific documentation.
Consultation Objective and Approach – applicable to identified	It is noted that the identified community members listed in Table 19 is subject to change in the event of a change in the landholdings or tenure arrangement. Where such a change occurs, and a community member is identified that is not

community member not associated with QCoal	associated with QCoal, consultation will be undertaken with the objective of enabling the identified community member to provide input into the PRC Plan development and subsequent implementation, as well as any potential amendments. Such consultation may include the following approaches as appropriate or requested by the member: • engagement via telephone; • engagement via face to face meetings; • engagement via written contact; and • existing QNH General Community Consultation (see Section 2.3) which is a minuted open community meeting held in Collinsville on a quarterly basis.
Frequency – applicable to identified community member not associated with QCoal	- PRC Plan Development - To take place a minimum of 1 month prior to PRC Plan submission. - PRC Plan Implementation - Every 5 years following initial PRC Schedule approval. - PRC Plan Amendment - During preparation of PRC Plan / PRC Schedule amendments which have a material impact on the community member (as required). To take place a minimum of 1 month prior to PRC Plan amendment submission.
Information to be Provided – applicable to identified community member not associated with QCoal	- PRC Plan Development - Presentation detailing PRC Plan – Rehabilitation Planning Part and PRC Plan - Schedule. - PRC Plan Implementation - Progress against PRC Plan - Schedule. - PRC Plan Amendment - Presentation detailing PRC Plan – Rehabilitation Planning Part and PRC - Schedule, and proposed schedule of amendment.
Feedback Consideration – applicable to identified community member not associated with QCoal	- PRC Plan Development – Feedback to be noted. A response to feedback including details of how it has been addressed will be provided to the relevant community member. - PRC Plan Implementation - Feedback to be noted. A response to feedback including details of how it has been addressed will be provided to the relevant community member. - PRC Plan Implementation - Feedback to be noted. A response to feedback including details of how it has been addressed will be provided to the relevant community member.
Consultation Records – applicable to identified community member not associated with QCoal	- PRC Plan Development - Meeting records. Consultation to be included in PRC Plan Consultation Register. - PRC Plan Implementation - Meeting records. Consultation to be included in PRCP Consultation Register. - PRC Plan Amendment - Meeting records. Consultation to be included in PRCP Consultation Register.

2.2. PRC Plan Community Consultation Register

A PRC Plan Community Consultation Register has been developed which will be utilised to record consultation with identified community members which are not associated with QCoal, which is undertaken for the development and implementation of this PRC Plan. The PRP Plan Community Consultation Register is a stand-alone document which will be updated as required independent of this PRC Plan.

2.3. QNH General Community Consultation

As previously noted, the CCM is operated as part of the integrated QNH operations (albeit having a different ownership structure and EA), sharing a common boundary with the SCM to the north and the DCM to the south. Mining pits and waste rock dumps (in-pit and out-of-pit) have progressed across the boundaries between the three mines, with shared infrastructure and a single mining contractor utilised by all four QNH mines.

As such, other than for the initial consultation during the application stage for each mine, ongoing community consultation in relation to the QNH mines has typically been undertaken for the QNH as a whole.

A significant amount of community consultation has been undertaken at the QNH since the initial development of the SCM in 2006 (the first QNH mine). This includes consultation regarding the development of the CCM; as well as ongoing consultation regarding the operation and progressive rehabilitation of the QNH mines.

Current ongoing community consultation for the QNH includes the following:

- Participation in the Collinsville Development and Industry Group (DIG) which was founded by QCoal in 2012 to facilitate local community and industry engagement. The DIG meets on a quarterly basis and membership is made up of representatives from local businesses, local and state government, and local services providers/industries. In addition to the quarterly DIG meeting, regular community forums organised by the DIG are also held which are open to all community members to attend. A standing item at the DIG meetings is the provision of an update on QNH activities. DIG minutes are taken by the Department of State Development;
- Attendance at ad-hoc community events/information sessions in Collinsville and other proximate population centres.

A separate Complaints Register is also maintained for the QNH, which records any issues raised by stakeholders regarding the CCM, including in relation to progressive rehabilitation. To date no complaints relating to progressive rehabilitation have been received for the CCM.

3. Post-mining Land Use

As detailed in **Section 1.1.4**, the PMLUs for the CCM are outlined within EA EPML00334613, which is the primary LOD for the CCM. **Table 21** outlines the PMLU for each disturbance type/domain at the CCM, as detailed in **Figure 7**.

Table 21 – Post Mining Land use by Domain for the CCM

Domain Number	Domain	PMLU on CCM	LOD
1	Residual Voids	N/A (Backfilled)	EA
2	Overburden /Waste Rock Dumps	Grazing pasture	EA
3	Mine Infrastructure	N/A (Nil onsite)	-
4a	Co-disposal dams (out-of-pit)	N/A (Nil onsite)	-
4b	Co-disposal dams (in-pit)	N/A (Nil onsite)	-
5	ROM and product stockpiles	N/A (Nil onsite)	-
6	Haul Roads and Access tracks	Grazing pasture or retained*	EA
7	Sediment dams and water management infrastructure	Grazing pasture**	EA
8	Creek diversions	N/A (Nil onsite)	-
9	Undisturbed Land	Grazing pasture / Native Ecosystem	***

*May be retained by written agreement with the landholder

**This domain only applies to the CCM western diversion drain (RA3) which is a permanent drainage feature within the surrounding grazing pasture. It will function in the same way a natural ephemeral drainage feature would and will therefore be retained as part of the grazing pasture PMLU rather than as retained infrastructure

***A LOD is not relevant for land that has not been disturbed by mining activities

EA EPML00334613 (**Condition H13** and **Table H1**) does not authorise residual voids to be retained within the Q-Pit or B-Pit areas at CCM. When mining in an area was completed and backfilling commenced, these areas continued to be classed as Domain 1 (residual voids) until such time the dumping transitioned from in-pit dumping to out-of- or above-pit dumping, at which time the area was reclassified as Domain 2 (overburden/waste rock dump). The PMLU for these landforms is identified in the relevant sections of **Table 21** above.

The agreed post-mining land use for the CCM, as per **Condition H1** of the CCM EA (as the primary Land Outcome Document for the CCM), is grazing pasture for all domains. An agreement to retain haul roads and/or access tracks is not currently in place with the landholder but may be agreed in the future, in which event to haul roads/access tracks will have a post-mining land use specific to the landholder.

For rehabilitation to be considered successful, the land must be returned to a “stable condition” as defined in Section 111A of the EP Act:

111A Meaning of stable condition

*Land is in a **stable condition** if –*

- (d) the land is safe and structurally stable; and*
- (e) there is no environmental harm being caused by anything on or in the land; and*
- (f) the land can sustain a post-mining land use.*

All land within the CCM will be rehabilitated to a stable condition. Areas within the CCM that are undisturbed by mining will have a PMLU consistent with the pre-mining land-use (grazing pasture).

3.1. Rehabilitation Goals

Broad rehabilitation goals for the CCM are defined in **Condition H1** of the CCM EA (the primary LOD), which generally align with the rehabilitation goals summarised in the *Rehabilitation Requirements for Mining Projects* (EHP, 2014). The **Condition H1** rehabilitation goals in all QNH EAs are:

- safe to humans and wildlife;
- stable (referring specifically and only to geotechnical stability);
- non-polluting; and
- self-sustaining for the post-mining land use of grazing pasture, with the exception of residual voids.

However, this definition of “stable” for rehabilitated landforms is distinct from the from the definition of “stable condition” in Section 111A of the EP Act (applicable to mines under EAs). Section 111A of the EP Act defines land as being in “stable condition” only if it meets all the following conditions:

- safe and structurally stable (i.e. geotechnical wall/slope stability); and
- there is no environmental harm being caused by anything on or in the land; and
- the land can sustain a post-mining land use (i.e. self-sustain a specified use for the landform after rehabilitation).

Accordingly final landforms will achieve one of two outcomes:

- rehabilitated to a “stable condition” as per Section 111A of EP Act in which case the rehabilitation is considered successful; or
- rehabilitated to a condition which does not satisfy all three of the requirements to be considered in “stable condition” as per Section 111A of the EP Act (i.e. the final landform is unable to meet all of the criteria to be considered in “stable condition”). Section 112 of the EP Act defines such landforms as NUMAs, which are discussed in **Section 4**.

All disturbed land within the CCM will be rehabilitated to a stable condition as per Section 111A of EP Act, with the exception of any infrastructure retained by the landholder (by written agreement). Areas within the CCM that are undisturbed by mining do not require consideration.

3.2. Requirements for Grazing Pasture

Land to be rehabilitated to a grazing pasture PMLU at the CCM is to be returned to a Class 4 land suitability or better, based on the *Guidelines for Agricultural Land Evaluation in Queensland* (DSITI & DNRM, 2015). The acceptance criteria for Class 4 grazing land on the QNH (encompassing the CCM) are presented in the QNH RMP (a LOD) and replicated in **Table 22**.

Table 22 – Acceptance criteria – Class 4 Land Suitability

Parameter	Acceptance criteria
Plant Available Water Capacity (PAWC)	>50 mm
Salinity	EC _{1:5} <1.2 mS/cm or Cl _{1:5} <1,500 ppm in the root zone (60 cm depth)
Rockiness	<100% (% coarse fragments at soil surface)
Soil pH	<10 and >4 as measured at any part of the root zone.
Exchangeable Sodium Percentage (ESP %)	<30% (0-10 cm depth)
Water erosion (a function of slope % and ESP %)	Mean Slope <15% on cracking clay soils Mean Slope <12% on sodic soils (ESP >15% within 500 mm of surface) rigid soils Mean Slope <45% on non-sodic (ESP <15% within 500 mm of surface) rigid soils
Grazing Criteria	≥70% of the productivity (or carrying capacity) of non-mined land in the lease area or, Carrying capacity within the range of values reported for the region, taken as 15 ha/head
Groundcover	Mean groundcover ≥50% or > than the reference site mean minus one standard deviation.
Grazing Trials	Undertaken following groundcover establishment to confirm carrying capacity.
Species Mix and Composition	Proportion of non-preferred species not increasing. Proportion class will not be more than one class* greater than the grazed reference sites. Proportion of declared plant pest species not increasing, and proportion class* will not be more than one class greater than the grazed reference sites.

* - Classes based on *State Rural Leasehold Land Strategy: Guidelines for determining land condition* prepared by DNRM (2013): Class 1 = 0%, Class 2 = 0-10%, Class 3 = 10-30%, Class 4 = >30% for declared plant pest (weed) species. Class 1 = >80%, Class 2 = 61-80%, Class3 = 10-60%, Class 4 = <10% for preferred species composition.

In order to achieve these acceptance criteria, a range of rehabilitation strategies have been developed to assist in the planning and execution of rehabilitation activities (see **Section 5**).

3.3. Completion Criteria

Completion criteria for rehabilitation of the QNH mine domains have been developed and presented in the QNH RMP (a LOD) as measurable/quantifiable criteria which once achieved, demonstrate that the rehabilitated final landforms are (1) safe to humans and wildlife, (2) stable, (3) non-polluting, and (4) able to self-sustain the agreed post-mining land use.

The relevant completion criteria for the CCM are established and approved in the QNH RMP (a LOD) and are presented in **Table 23**. As such the derivation and justification of these criteria is not required to be included in the CCM PRC Plan – Rehabilitation Planning Part.

Table 23 – QNH Rehabilitation Completion Criteria

Domain	Objective	Completion Criteria	Performance Verification
Domain 1 - Residual Voids	Not relevant to the CCM		
Domain 2 - Overburden dumps	Safe to humans and wildlife	Appropriate remediation of slope failures or rock falls.	If slope failure has occurred, it is rectified and ongoing design accounts for the previous failure.
	Structurally stable	The nominated maximum slope on dumps is 20% (11.5°), unless otherwise advised by an RPEQ. Mean groundcover ≥50%, or > the reference site mean minus one standard deviation. Appropriate remediation of slope failures or rock falls. Appropriate remediation of rill and gully erosion.	As-built/survey information retained with rehabilitation documentation. Rehabilitation monitoring reports to verify groundcover. If slope failure has occurred, it is rectified and ongoing design accounts for the previous failure. If rill or gully erosion is identified, it is rectified, and additional erosion controls implemented as appropriate.
	Non-polluting and not causing any environmental harm	Spoil is to be dumped in accordance with the <i>QNH Mining Waste and Coal Rejects Management Plan</i> (Terrenus, 2013). Run-off or seepage water is not to diminish the EVs of the receiving environment including surrounding groundwater.	<i>Mining Waste and Coal Rejects Management Plan</i> (Terrenus, 2013) to be retained with rehabilitation documentation. As-built/survey information to be retained with rehabilitation documentation. REMP reporting during operations. Post-closure surface and groundwater quality monitoring reports.
	Self-sustaining for the post-mining land use of grazing pasture, with the exception of residual voids	Class 4 land suitability and light cattle grazing target (see Section 5.3 of QNH RMP)	Rehabilitation monitoring reports verify soil/land suitability standards are met. Rehabilitation monitoring reports verify productivity standards are met. Rehabilitation monitoring reports verify species mix and community composition standards are met.
Domain 3 - Mine Infrastructure including CHPP, Train Load out facility and rail loop.	Not relevant to the CCM		

Domain	Objective	Completion Criteria	Performance Verification
Domain 4a - Co-disposal dams (out-of-pit)	Not relevant to the CCM		
Domain 4b - Co-disposal dams (in-pit)	Not relevant to the CCM		
Domain 5 - ROM and Product stockpile areas	Not relevant to the CCM		
Domain 6 - Haul roads and tracks	Safe to humans and wildlife	Appropriate remediation of slope failures or rock falls.	If slope failure has occurred, it is rectified and ongoing design accounts for the previous failure.
	Structurally stable	Agreement from landholder regarding infrastructure allowed to remain on site For all roads and tracks not being retained the adopted slope completion criteria will be 11.5° (20%), unless otherwise advised by an RPEQ. Mean groundcover ≥50%, or > the reference site mean minus one standard deviation. Appropriate remediation of slope failures or rock falls. Appropriate remediation of rill and gully erosion.	Evidence of landholder agreement. As-built/survey information retained with rehabilitation documentation. Rehabilitation monitoring reports to verify groundcover. If slope failure has occurred, it is rectified and ongoing design accounts for the previous failure. If rill or gully erosion is identified, it is rectified, and additional erosion controls implemented as appropriate.
	Non-polluting and not causing any environmental harm	Run-off or seepage water is not to diminish the EVs of the receiving environment and local aquifers.	REMP reporting during operations. Post-closure surface and groundwater quality monitoring reports.
	Self-sustaining for the post-mining land use of grazing pasture, with the exception of residual voids	Class 4 land suitability and light cattle grazing target (see Section 5.3 of QNH RMP)	Rehabilitation monitoring reports verify soil/land suitability standards are met. Rehabilitation monitoring reports verify productivity standards are met. Ongoing pasture management measures documented in the PMCP. Rehabilitation monitoring reports verify species mix and community composition standards are met.
Domain 7 - Sediment dams and other water management infrastructure	Safe to humans and wildlife	Appropriate remediation of slope failures or rock falls.	If slope failure has occurred, it is rectified and ongoing design accounts for the previous failure.
	Structurally stable	Agreement from landholder regarding infrastructure allowed to remain on site. For all dams and water management infrastructure on the QNH the adopted slope completion criteria will be advised by an RPEQ. Mean groundcover ≥50%, or > the reference site mean minus one standard deviation. Appropriate remediation of slope failures or rock falls. Appropriate remediation of rill and gully erosion.	Evidence of landholder agreement Remediation of identified contaminated areas is verified and/or approved Site Management Plan is in place. As-built/survey information retained with rehabilitation documentation. Rehabilitation monitoring reports to verify groundcover. If slope failure has occurred, it is rectified and ongoing design accounts for the previous failure. If rill or gully erosion is identified, it is rectified, and additional erosion controls implemented as appropriate.

Domain	Objective	Completion Criteria	Performance Verification
	Non-polluting and not causing any environmental harm	Hazardous material is identified and managed. Run-off or seepage water is not to diminish the EVs of the receiving environment and local aquifers.	REMP reporting during operations. Post-closure surface and groundwater quality monitoring reports.
	Self-sustaining for the post-mining land use of grazing pasture, with the exception of residual voids	Class 4 land suitability and light cattle grazing target (see Section 5.3 of the QNH RMP)	Rehabilitation monitoring reports verify soil/land suitability standards are met. Rehabilitation monitoring reports verify productivity standards are met. Ongoing pasture management measures documented in the PMCP. Rehabilitation monitoring reports verify species mix and community composition standards are met.
Domain 8 - Creek diversions	Not relevant to the CCM		

4. Non-Use Management Areas

As stated in **Section 3**, final landforms will achieve one of two outcomes:

- rehabilitated to a “stable condition” as per Section 111A of EP Act in which case the rehabilitation is considered successful; or
- rehabilitated to a condition which does not satisfy all three of the requirements to be considered in “stable condition” as per Section 111A of the EP Act (i.e. the final landform is unable to meet all of the criteria to be considered in a “stable condition”).
 - o Section 112 of the EP Act defines such landforms as “non-use management areas” (NUMAs) – specifically defining a NUMA as an area of land the subject of a Progressive Rehabilitation and Closure Plan (PRC Plan) that cannot be rehabilitated to a “stable condition” after all relevant activities for the PRC Plan carried out on the land have ended.

All disturbed land within the CCM will be rehabilitated to a stable condition as per Section 111A of the EP Act, with the exception of any infrastructure retained by the landholder (by written agreement). As all land will be rehabilitated to a stable condition, no NUMAs are proposed for the CCM.

Areas within the CCM that are undisturbed by mining will continue to be utilised as grazing pasture and do not require further consideration as part of this PRC Plan.

5. Rehabilitation Management Methodology

5.1. Mine Planning for Operations and Closure

Mining activities at the CCM have been planned and undertaken to maximise the recovery of the economic coal resources while also enabling the timely and cost-effective rehabilitation of the site. Planning for progressive rehabilitation and closure of the CCM has been incorporated into the mine layout and the mining methodology utilised at the site.

5.1.1. Mine Design and Layout

The mine layout at the CCM was developed to maximise extraction of the identified coal resources with the minimum amount of overall disturbance footprint. The implementation of a co-development agreement to enable the use of shared infrastructure at other QNH mines (e.g. SCM CHPP and co-disposal) as an alternative to developing stand-alone infrastructure, was a key factor in significantly reducing the overall disturbance footprint required for the CCM.

The mine design, layout and proposed final landforms were approved as part of the CCM approval and is detailed in the EA and the QNH RMP (LODs), as such the derivation and justification of design, layout and final landforms is not required to be included in the CCM PRC Plan – Rehabilitation Planning Part.

However it is noted that a range of aspects were considered in the development of the design, layout and final landforms, which included:

- **Ecological Values**

The disturbance footprint was designed to minimise impacts to the mapped (REs) within the CCM area, in particular avoiding mapped Endangered REs. Remnant and non-remnant vegetation communities within the riparian zone of Two Mile Creek and its associated tributaries within the site were also avoided where possible.

- **Sensitive Places**

Section 1.3.1 details the closest sensitive places to the CCM, with the nearest being located 3.1km east and 3.2km north from the nearest part of the CCM mining footprint. Other sensitive and commercial places are located closer to Collinsville, some 8km from the CCM; however other mining operations are located between the CCM and these sensitive places and as such the potential for impact to these is considered negligible.

The proposed PMLU at the CCM will result in all mining disturbance being rehabilitated to grazing pasture, with the exception of any infrastructure retained by the landholder (by written agreement).

As such, the rehabilitated final landform will not cause any impacts at the sensitive places.

- **Surrounding Land Use**

As noted in **Section 1.3**, the land uses surrounding the CCM predominantly comprise mining and cattle grazing activities. The approved grazing pasture PMLU at the CCM will re-establish the pre-mining land use, as will the PMLU for the surrounding QNH mines (with the exception of final voids on other QNH mines and infrastructure retained by the landholder). No impacts on the surrounding land-use are expected from the final landform at the CCM.

- **Surface Water (see also Section 5.2.3 and Section 5.5.8)**

Surface water values applicable to the CCM are detailed in **Section 1.12.4**.

The CCM disturbance footprint is generally located outside the modelled Two Mile Creek 0.1% AEP flood extent, with the exception of haul road crossings and the clean water diversions of minor drainage mines (refer to **Section 1.12.3**). The CCM mining areas were designed such that the majority of surface water reporting to the mining pits was run-off from within the mining disturbance footprint, with upstream catchment excluded from the mining areas where possible. Surface water ingress into mining areas was managed with a small sump for collection of pit water and pumping was only required sporadically (primarily following rainfall events). As no areas of open pit currently remain on the CCM, this practice is no longer required, as runoff from the CCM generally reports to the DCM for B-Pit waste rock dump (the adjacent Drake 1 pit which is the southern extension of B-Pit), or the SCM for Q-Pit waste rock dump (the Q-Pit sediment dam).

The CCM has approved mine-affected water release points (subject to EA conditions); however, during operations no releases were undertaken, with mine-affected water instead retained for dust suppression for the broader QNH operations.

At closure, surface water runoff from the CCM rehabilitated (topsoiled and vegetated) areas will be considered clean (as is the intent of rehabilitation) and as such not requiring of any management. As previously noted, the overall risk of poor-quality runoff is low regardless of rehabilitation status because the waste rock at the CCM is generally benign.

The CCM PMLUs and final landforms are not expected to impact surface water quality or flow downstream of the CCM. As such there is minimal risk of impact to the surface EVs downstream of the CCM.

- **Groundwater (see also Section 5.2.2)**

As noted in **Section 1.13.5**, there are no notable ground water values applicable to the CCM.

The B-Pit and Q-Pit were mined through the quaternary alluvium and the B and Q coal seams. Groundwater seepage from the groundwater bearing units while the pits were open was observed to be minimal, with no notable seepage from the alluvium or the Q-seam and only a small amount of seepage from the B-seam. During operation any seepage which did occur into the pits was managed with a small sump for collection and pumping was only required sporadically (primarily following rainfall events where surface run-off was the main component of the pumped water).

Due to the continuous nature of mining areas and geology at the QNH, the CCM has been included in the regional groundwater modelling and assessments undertaken for the post-mining conditions across the QNH (see **Section 5.2.2**).

Groundwater monitoring undertaken during operation did not identify any changes in level resulting from the open CCM pits. Since both pits are now backfilled there exists no mechanism by which the CCM final landforms can impact groundwater levels. There is no water storage proposed for final landform on the CCM and as such the only potential mechanism by which groundwater quality could be affected by final landforms on the CCM would be if seepage from the CCM waste rock dumps were to be acidic – as stated in **Section 1.10.1**, the waste rock characteristics on the CCM are benign. As such there exists no mechanism by which the CCM final landforms can impact groundwater quality.

- **Local and Regional Topography (Gradients) (see also Section 5.2.6)**

As previously noted (**Section 1.6**), the natural topography surrounding the CCM is flat to slightly undulating, with an average slope of less than 3%.

The waste rock dumps at the CCM are the most prominent features within the active mining and rehabilitation area footprint. Waste rock dump height ranges from 25m to 40m above the natural topography, and the dumps have been progressively benched during placement to enable efficient shaping and battering to the final landform during progressive rehabilitation. The designed final landform will have uniform batter slopes but the heights of the top/crest of the dumps (and thus the slope length) varies in a number of places, creating an undulating effect. The toes of the dump batters have been designed to tie into the natural topography without impacting drainage pathways or other natural features. As such, the rehabilitated final landform will blend into the surrounding terrain. As stated in **Section 3.3**, the slopes of the final landforms for waste rock dumps are established and approved as a maximum of 20% (unless otherwise advised by an RPEQ) in the EA and the QNH RMP (LODs). As such the derivation and justification of this slope is not required to be included in the CCM PRC Plan – Rehabilitation Planning Part.

- **Geotechnical Conditions and Suitability for Structure Type**

Section 1.7.4 details the waste rock characterisation studies undertaken at the CCM and adjacent QNH mines. Assessment of the waste rock included determining the sodicity and dispersivity of the component lithologies, which are key factors in the geotechnical and erosional stability of the final landform.

As stated in **Section 3.3**, the maximum adopted slope for the rehabilitation of waste rock dumps to a geotechnically stable landform is established and approved as 20% (unless otherwise advised by an RPEQ) in the QNH RMP (a LOD). As such the derivation and justification of this slope or material suitability is not required to be included in the CCM PRC Plan – Rehabilitation Planning Part.

It is noted that the QNH RMP provides a summary of the geotechnical investigations previously undertaken from the which the approved slope value was derived.

The adopted slopes, dump heights and other design parameters, together with the physical properties of the waste rock, will result in a final landform that is geotechnically stable. Regardless, a geotechnical assessment and certification will be undertaken upon completion of the final landform at the CCM to confirm this.

5.1.2. Mining Methods

As a result of the challenging nature of the QNH coal geology (e.g. areas of intrusions) and the extreme fluctuations in coal price over the last 5-10 years, flexibility in the mine planning and scheduling at QNH (including the CCM) has been required. Fluctuations in coal price are driven by the global demand for seaborne coking and thermal coal, and the economic extraction of coal resources depends on the prevailing coal price combined with the cost to extract, process and transport the coal. Onsite factors which can impact the cost of extraction for a particular part of the coal resource include strip ratio (at the CCM these typically increased as the pits advanced to the east due to the dip of the coal seams), haulage distance (in-pit vs out-of-pit dumping), coal quality (e.g. yield, coking/thermal coal split), and geology (presence of intrusions and faults).

The mining methods utilised at the CCM have minimised the overall disturbance footprint while facilitating the efficient mining of the economic coal resources and the progressive rehabilitation of the site. The mining method at the CCM incorporates the following practices which have/will assist in the rehabilitation and closure of the site:

- Mining was undertaken utilising hydraulic excavator and dump trucks, giving more flexibility for the size and orientation of the final landform than other potential methods (e.g. dragline).
- Mining commenced in each pit with a box-cut at the coal subcrop in each pit (i.e. the shallowest area of the coal resource) with mine waste initially reporting to a small out-of-pit dump before transitioning to in-pit dumping once sufficient void was created for efficient mining operations. It is noted that the box cuts themselves were not on the CCM, but rather the SCM to the north, with the pit progressing south through the CCM ML.
- The pits were advanced using benching of the highwall for each consecutive mine strip, following the coal down-dip. The extent to which the pits progressed depended on geological and economic factors.
- Mine waste was placed in out-of-pit waste rock dumps until sufficient void was available within the pits to allow for in-pit dumping via an advancing low-wall (progressive backfilling). B-Pit has been progressively backfilled by continued advancement of the pit into the DCM, while Q-Pit has been directly backfilled since reaching the economic limit of coal recovery

by a specific backfilling campaign using additional waste rock from the DCM. As such no voids currently exist on ML 10345.

- Where practical, waste rock dumps are placed in 10-12m lifts, with a minimum 10m offset provided between the crest of a lift and the toe of the next lift above to facilitate the eventual battering of the dump slope to the design grade during rehabilitation earthworks. Battering is undertaken using large mining-class bulldozers.
- The waste rock dumps have been constructed such that where possible, a relatively flat plateau is provided at the top of each lift, reducing the effective slope length for surface run-off.
- Haul roads have been located within the pit/dump disturbance footprint where possible.

5.1.3. Voids in Flood Plains

The mining pits at the CCM were located outside the pre-development 0.1% AEP floodplain of Two Mile Creek, being the only watercourse within the site (refer to **Section 1.12.3**). Since the completion of coal extraction, the mining pits have been backfilled with waste rock and no voids have been retained at the CCM. As such voids in flood plains are not a relevant consideration for this PRC Plan.

5.2. General Rehabilitation Management

Rehabilitation activities at the CCM are planned and undertaken with the objective of establishing a final landform which achieves and maintains a stable condition (as defined in the EP Act) and supports the grazing pasture PMLU. Achieving a stable landform is demonstrated by meeting the completion criteria (**Section 3.3**).

The rehabilitation methodology utilised at the CCM has been developed in accordance with the outcomes of various technical studies that have been undertaken since the development of the QNH mines commenced in 2006. Many of the technical studies have been undertaken for the QNH as an integrated operation, rather than a single mine in isolation. This approach is appropriate given the contiguous nature of the operation and the need to consider cumulative impacts.

5.2.1. Rehabilitation Areas

Disturbance areas at the CCM have been divided into rehabilitation areas (RAs) to support the development of the PRC Plan - Schedule and rehabilitation milestones (refer to **Figure 7**).

Rehabilitation Area 1

RA1 consists of the B-Pit area. Extraction activities have been completed in B-Pit and the void has been backfilled; however, the RA1 area continues to be utilised as an active waste rock dump in

support of DCM Drake Pit 1. As the B-Pit waste rock dump is progressively completed to the designed levels, sections will progressively become available for rehabilitation.

A number of active haul roads linking the DCM and SCM traverse the RA1 waste rock dump/backfilled pit area. These haul roads are required for the life of mine of the DCM (including rehabilitation and closure activities) and, as such, will not be available for progressive rehabilitation until 2037. The presence of the active haul roads also precludes some areas of the adjoining/underlying waste rock dump from being available for rehabilitation due to the future earthworks requirements to cut/fill the angle of repose spoil batters adjacent to the haul roads to establish the final landform.

Rehabilitation Area 2

RA2 consists of the Q-Pit area. Extraction activities have been completed in Q-Pit and the void has been backfilled. The backfilled area of Q-Pit is currently being progressively rehabilitated.

A number of active haul roads linking the DCM, JCM and SCM traverse the RA2 waste rock dump/backfilled pit area. These haul roads are required for the life of mine of the DCM and JCM (including rehabilitation and closure activities) and, as such, will not be available for progressive rehabilitation until 2037. The presence of the active haul roads also precludes some areas of the adjoining/underlying waste rock dump from being available for rehabilitation due to the future earthworks requirements to cut/fill the angle of repose batters adjacent to the haul roads to establish the final landform.

Rehabilitation Area 3

RA3 consists of 70m of a drainage line, which is the outlet of a clean water drain which originates in the DCM and directs clean runoff into Two Mile Creek (see **Section 1.12.2**). The clean water drain diverts the western drainage feature (see **Section 1.12.2**) around the CCM B-Pit/DCM Drake 1 Pit waste rock dumps and is intended to be retained as a drainage channel within the final landform. Rehabilitation within RA3 will be limited to the stabilisation of the bed and banks of the in-situ drainage channel within the CCM.

Error! Reference source not found. details the type and status of mining activities undertaken within each Rehabilitation Area as at December 2020.

Table 24 – Rehabilitation Area Status as at December 2020

Rehabilitation Area	Activity Size (ha)	Domain	Operational Activity Duration	Progressive Rehabilitation Availability	Status
RA1	61.35	B-Pit	2013-2019	Yes	• Mining completed • Backfilling completed (in-pit dump) • Ongoing use as waste rock dump (out-of-pit)

Rehabilitation Area	Activity Size (ha)	Domain	Operational Activity Duration	Progressive Rehabilitation Availability	Status
		Waste Rock Dump	2013-2037*	Partial	- Dumping ongoing (out-of-pit) 17 ha reshaped to date 7 ha surface preparation completed to date - Areas adjoining haul roads/ramps not available for the LOM of the DCM
		Haul Roads	2013-2037*	No	Required for the LOM of the DCM
RA2	25.49	Q-Pit	2013	Yes	- Mining completed - Backfilling completed (in-pit dump) - Ongoing use as waste rock dump (out-of-pit)
		Waste Rock Dump	2013-2037*	Partial	- Dumping ongoing (out-of-pit) 13 ha reshaped to date - Areas adjoining haul roads not available for the LOM of the DCM/JCM
		Haul Roads	2013-2037*	No	Required for the LOM of the DCM/JCM
RA3	0.28	Clean Water Drain	Permanent Drain	Yes	- Drain constructed and in use since ~2015 0.28 ha shaped (full extent of drain)

* Required for the LoM of the DCM/JCM

5.2.2. Hydrogeology

The pre-mining hydrogeological regime for the CCM area is detailed in **Section 1.13**. As previously noted, there are no groundwater values present within the CCM and surrounds, and minimal groundwater was encountered during mining of the Q-Pit and B-Pit at the CCM.

A number of groundwater studies have been undertaken during the development and operation of the QNH mines since 2006. A QNH-wide approach to groundwater assessment is appropriate given the contiguous geological units and the integrated nature of the QNH mining operations, the fact that pits span site boundaries, and to facilitate a cumulative approach to potential impact assessment.

The QNH does not extract or undertake any injection activities in relation to groundwater, accordingly impacts to groundwater from the QNH, once rehabilitated, can only occur through the following potential mechanisms:

- Permanent impacts to levels:
 - o drawdown associated with voids acting as a groundwater sink,
- Permanent impacts to quality:
 - o drawdown associated with voids acting as a groundwater sink having a resultant effect on quality under specific geochemical conditions;
 - o infiltration into the surrounding groundwater of contaminated void water from voids acting as a groundwater source;
 - o direct infiltration of contaminated surface water into groundwater (such as from dams or fuel depots);
 - o direct infiltration of contaminated leachate from waste rock dumps or co-disposal facilities into the groundwater.

As previously noted, the CCM final landforms do not include voids (as the CCM mining pits have been backfilled), dams or infrastructure where potential contaminants can be stored. Therefore the only potential mechanism by which the CCM landforms can impact groundwater, is if B-Pit and Q-Pit waste rock dumps generate contaminated leachate which then infiltrates into the groundwater; however, waste rock has been shown to be generally low risk (see **Section 1.10.1**) and is considered unlikely to generate poor quality runoff or leachate. Furthermore, during operations no evidence of poor quality leachate was observed from any of the QNH waste rock dumps. Regardless of any potential impact there are no notable groundwater EVs which can be negatively affected by the CCM final landforms.

5.2.2.1. QNH Final Voids

In order to provide broader QNH context, it is noted that the final landforms on the DCM, JCM and SCM have final voids approved as final landforms.

Numerous numerical groundwater and water balance modelling assessments have previously been undertaken for the QNH pits and final voids. The most recent QNH final void numerical groundwater and water balance modelling assessments were undertaken to inform (and were presented in) the QNH RMP (a LOD). That assessment comprised a final void assessment report which was included as part of the QNH RMP (Appendix A), *Residual Voids on the QCoal Northern Hub Mining Complex – Sonoma, Cows Drake and Jax Coal Mines* (QCoal, 2020).

A summary of what is presented in the QNH RMP with regard to groundwater and water balance modelling is provided in this CCM PRC Plan – Rehabilitation Planning Part for context and reference purposes only.

Technical studies undertaken to inform (QCoal, 2020), included:

- *Jax Coal Mine Final Void Hydrology Study Main Pit* (Engeny, 2018)
- *Long Term Water Quality of Jax Coal Mine Residual Voids* (Engeny, 2018 Supplementary Memo)
- *Residual Void Hydrogeology Study QCoal Northern Hub Mines* (Engeny, 2020); and
- *Report on QCoal Northern Hub Groundwater Model Update* (AGE, 2020)

5.2.2.1.1. QNH Final Void Groundwater Modelling

QCoal, 2020 reported that the 3D numerical groundwater model for the QNH complex was updated and utilised QCoal's detailed geological model from the extensive exploration activities undertaken within the QNH MLs and the surrounding EPCs which are held by QCoal subsidiaries. The model represents the weathered regolith and underlying Permian strata. Each key coal seam is represented as an individual model layer, as well as the interburden units that separate the coal seams. Most coal seams simulated are within the MCM, but also include the lower seam of the Fort Cooper Coal Measures. The base model layer represents the Exmoor Formation.

The modelling uses the unstructured version of the industry standard MODFLOW model (MODFLOW-USG). MODFLOW-USG uses a control volume finite difference scheme to represent the groundwater flow equation. The model is transient and simulates pre mining water levels through a steady state timestep, followed by transient annual timesteps representing both historical and future mining. The model has been calibrated against historical groundwater monitoring data. The model also simulates recovery of the groundwater system post mining, where hydraulic properties are changed within the pits to represent spoil emplacements and final voids.

The open cut mining at QNH is represented in the model using the Drain package. The drains are applied to each model layer within the mined-out areas and groundwater is removed to create the desaturated conditions within the open cut pits. This drawdown then propagates away from the pits as water from the surrounding groundwater system flows through the ground towards the pits due to the gradients created by the desaturated conditions. The coal seam (and model layer) that the pit floor is in varies across the site due to the basin shape and accessibility of seams in different areas.

The mining is conservatively represented in the model by maintaining the dewatering (leaving the drain boundary on) once mining has started. This is done also to simplify the model setup, with all pits changed to spoil / void properties at the same time. This means that for pits such as Drake 3Q and 3R, which have completed mining and recovered, they continue to be dewatered in the model until all other pits have completed mining.

The current and predicted future groundwater levels at the CCM are driven by the proximity to the active/final voids at the DCM and SCM (as CCM voids have been backfilled). Layer 1 in the model is representative of the water table, with some areas across the model domain layer 1 being fully unsaturated, in which case the predicted level resides in lower model layers. **Figure 20** shows the current extent of groundwater drawdown in layer 1 at the QNH, showing localised drawdown around the previous and current mining pits. **Figure 21** shows the predicted drawdown in layer 1 for the end of mining at the QNH (2034) with all pits dewatered. Due to the low permeability of the geology, predicted (and observed) impacts to the surrounding groundwater system remain local to the pits. The water levels in this figure become the starting point for the recovery simulation.

The recovery process is simulated by assuming recharge to the spoil and voids and factoring in evaporative losses from the void lakes. The level of recovery is controlled by the balance of water entering from rainfall derived recharge and groundwater inflow as inputs and the loss due to evaporation from the void lake.

Recharge rates into the void and into the in-pit spoil are higher than the undisturbed recharge rate calibrated for the model, which is conceptually expected as backfilled spoil has higher porosity and permeability than undisturbed material.

Presented in **Figure 22** is the predicted groundwater level in layer 1 at equilibrium, which shows the following results and conclusions:

- the extent of groundwater change within the QNH area is largest at equilibrium due to the continued dewatering offered by evaporation from void lakes that equilibrate below the pre mining water levels;
- the majority of residual voids showed hydraulic gradients flowing into each respective void (groundwater sinks);
- several of the pits show results with a hydraulic gradient back into the surrounding geology (a net outflow) particularly where they have been completely backfilled or where the void footprint is small. Those pits are Drake 3Q, Drake 3R and Sonoma East 2:
 - o A potential issue with such modelling outputs is the assumption that it indicates a migrating of water away from void. This assumption is not correct in the case of the QNH voids due to the proximity and influence of adjacent final voids. With this in mind, the predicted equilibrium water levels have been forensically interrogated to identify that all these potential sources are predicted to be intercepted by the larger and deeper voids (such as Drake 1, Drake 5, Sonoma East 1, and Jax 1), and will not migrate away from the QNH.
- more broadly the model identifies some minor movement of water between some of the smaller voids towards adjacent larger voids, while all other voids remain as groundwater sinks. In summary, the QNH voids when assessed as complexes are all groundwater sinks and the QNH when assessed cumulatively is a groundwater sink with no migration away from the QNH. To illustrate this outcome groundwater flow directions have been added to **Figure 22**.

Groundwater levels and flow direction at the CCM are primarily driven by the proximity to the DCM Drake 1 void (which represents a southern extension of the backfilled CCM B-Pit). The groundwater flow direction from the backfilled CCM voids will be to the south/south-west towards the Drake 1 void and to a lesser extent the Jax Main Pit Void, with migration into the surrounding groundwater aquifers unlikely to occur.

Groundwater drawdown across the QNH is limited by the low permeability and poor connectivity of the coal measures, being the primary groundwater bearing unit. At the completion of mining at the QNH, there are 14 registered bores which are predicted to have a drawdown of 1m or more, all of which are mine monitoring bores in close proximity to the QNH mining activities, with none located within the CCM. **Figure 23** shows the closest registered water supply bores to the QNH, along with

the predicted groundwater level in layer 1 at equilibrium. All water supply bores are located outside of the cone of depression and are therefore not expected to be impacted by final voids at the QNH.

As previously stated, there are no groundwater values which have the potential to be impacted by the modelled steady state drawdown extents of the final voids approved in the QNH.

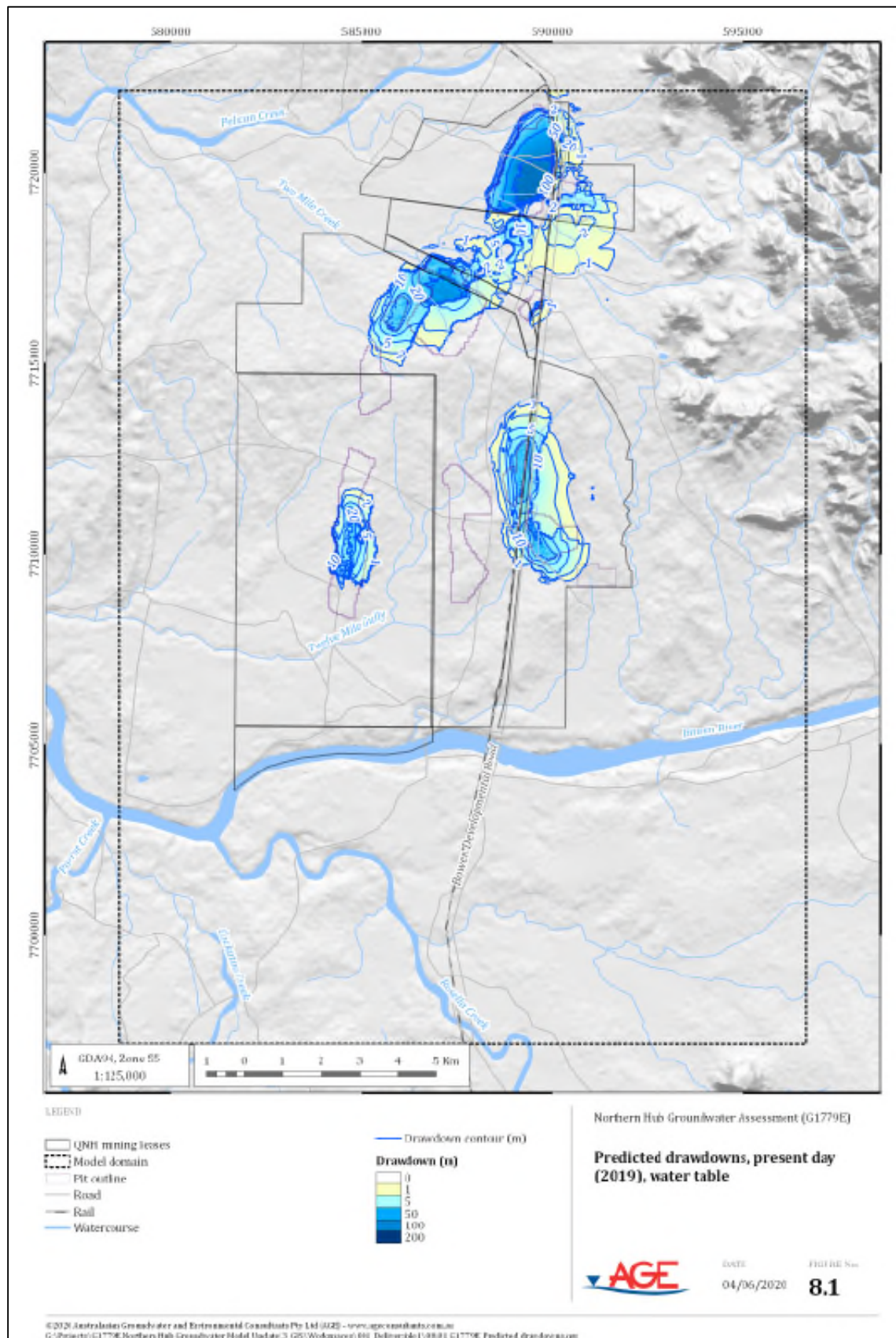


Figure 20 – Predicted Water Table Drawdown (2019)

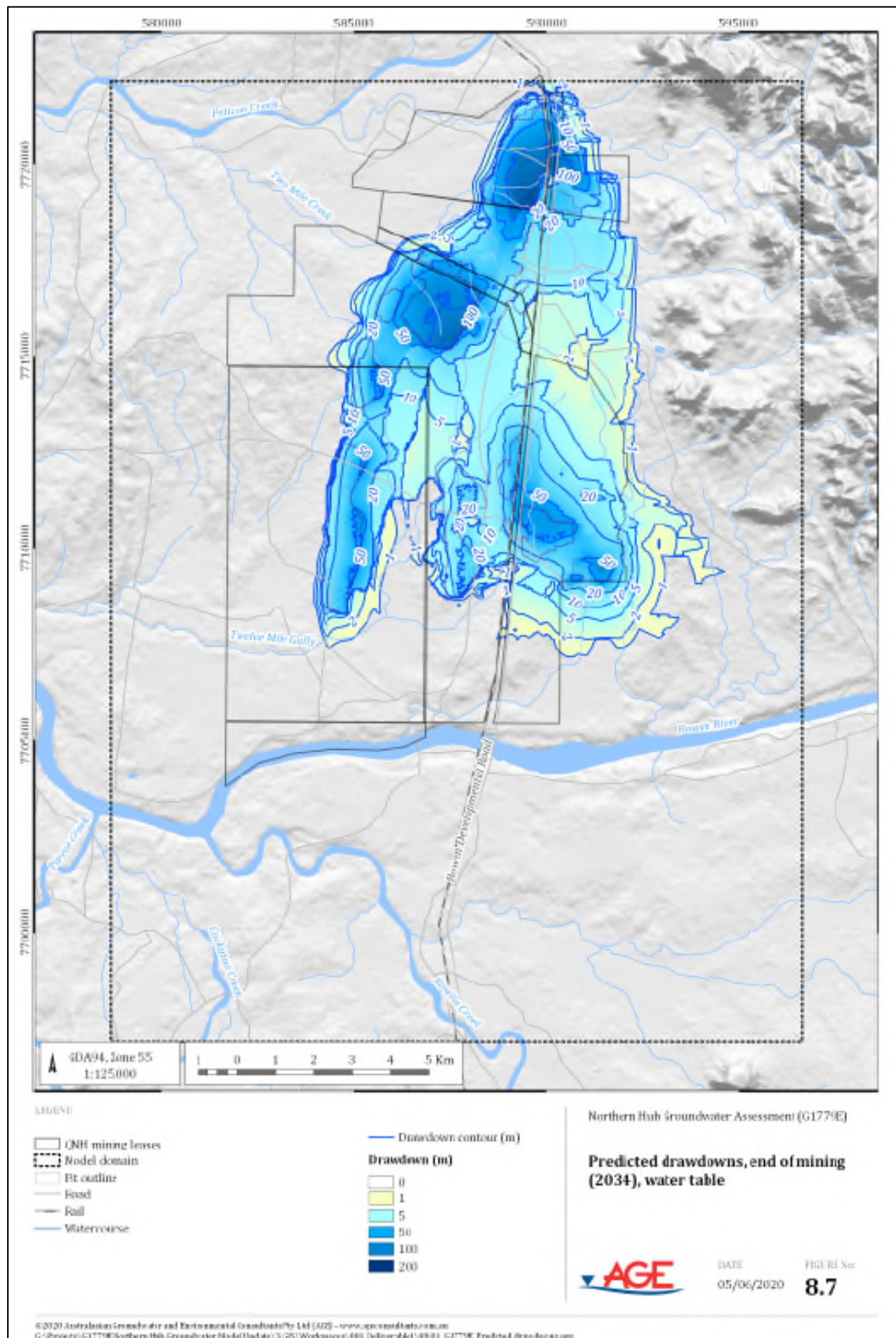


Figure 21 - Predicted Groundwater Table Drawdown at the End of Mining at the QNH (2034)

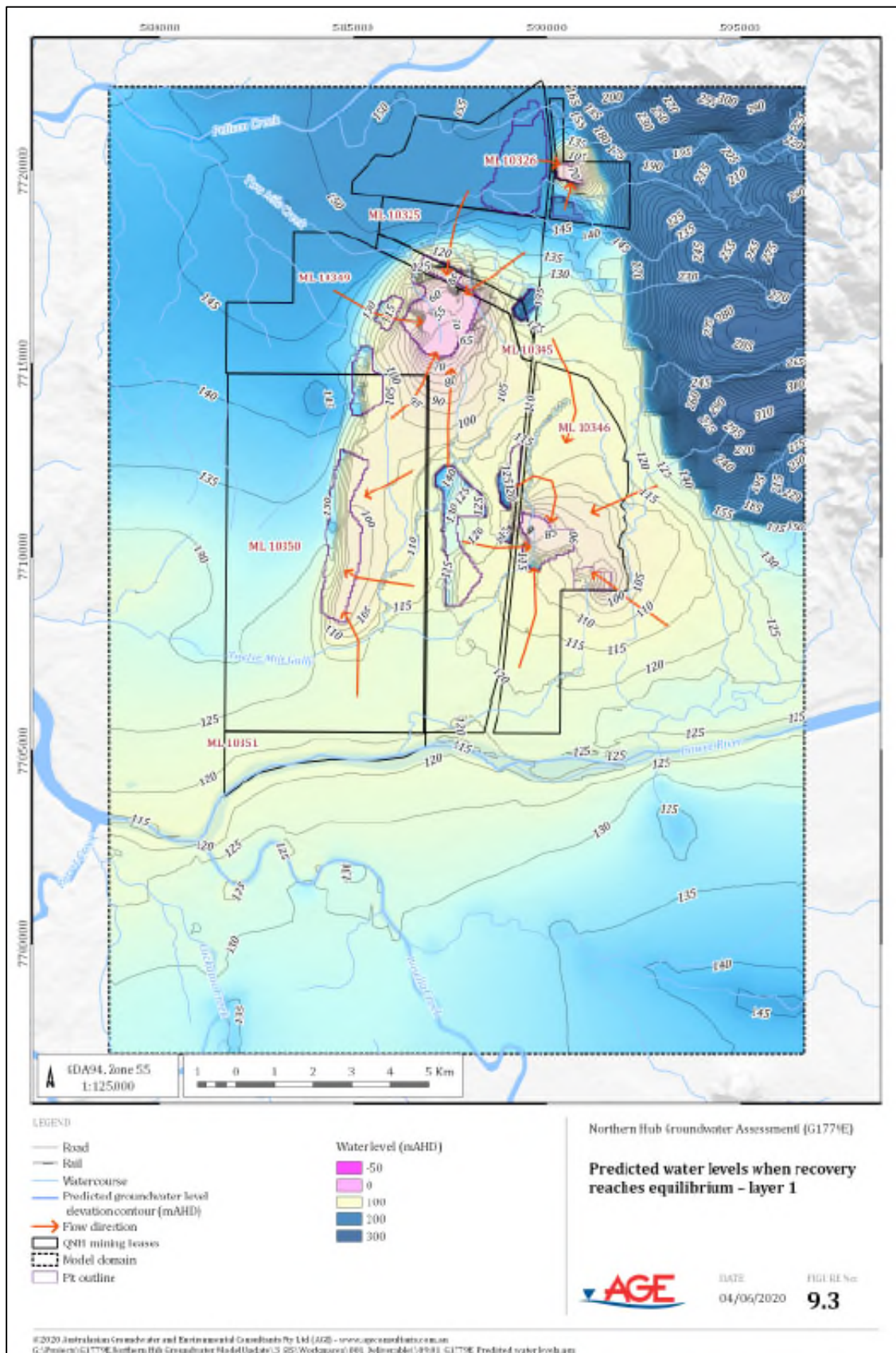


Figure 22 - Predicted Groundwater Table at Equilibrium

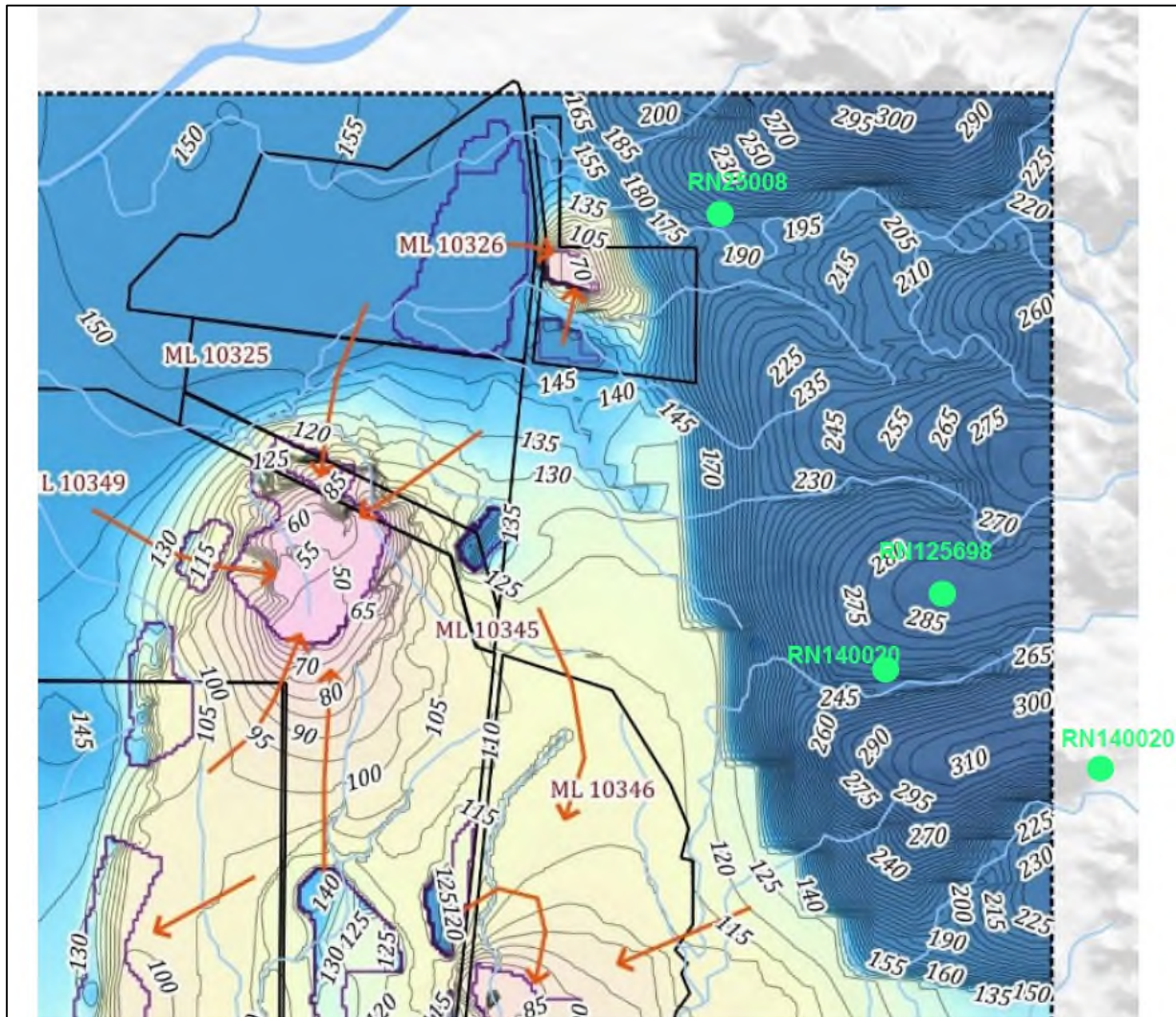


Figure 23 – Predicted Groundwater Table at Equilibrium and Registered Supply Bores

5.2.2.1.2. QNH Final Void Water Balance and Quality Modelling

In addition to the numerical groundwater model discussed above, QCoal (2020) also included the results of a water balance model to predict the final void lake levels and quality for all voids at the QNH.

The results of the final void lake volume and level modelling for all QNH voids are presented in QCoal (2020), with the detailed final void lake volume and level modelling (including sensitivity analysis) for all QNH voids appended to the report (as Engeny (2018) and Engeny (2020)). The results presented in QCoal (2020) included the following key information for each void:

- the simulation period:
 - o 500 years for Jax Main Pit and Jax East Pit (presented for the first 100 years and the full 500 year simulation separately for both final voids)

- o 200 years for all other QNH final voids
- minimum, median and max levels and volumes presented for each day of the simulation period for all final voids;
- the observable oscillations are the normal concentration and dilution cycles associated with normal seasonal and climactic variations;
- the median, as used to define the equilibrium levels in the assessment;
- all results reported are from modelling of the “base case” which is the catchment extent provided by the LOMP.

Void Lake Levels

No voids at the QNH are projected to overtop at any time.

As stated in Section 5.2.2.1.1 the QNH voids when assessed as complexes are all groundwater sinks and the QNH when assessed cumulatively is a groundwater sink with no migration away from the QNH. Therefore, no migration of water from the voids into the surround groundwater aquifers is likely.

Void Lake Water Quality

Engeny (2020) concluded that the salinity of all residual voids modelled as part of the assessment is forecast to continue to increase over time due to the ongoing concentration resulting from evaporation with no significant outflow of salts from either net outflow, seepage or overflow. It should be noted that pits with net outflow (see Section 5.2.2.1.2) were still shown to accumulate salts throughout the model duration. The reason for this occurrence is that predicted net outflow rates into the surrounding geology at all levels of rating curves for all pits were significantly smaller in magnitude than flows associated with rainfall, runoff, and evaporation.

The results indicate significant variation in the EC of the voids as a result of differing pit storage curves and catchment sizes. However, all void lakes are forecast to exceed 10,000 $\mu\text{S}/\text{cm}$ after 200 years (with the exception of Jax Main Pit which is closer to 220 years), with some pits reaching 10,000 $\mu\text{S}/\text{cm}$ after 40 years. The overall water quality outcome is consistent for all void lakes (i.e. high levels of salinity that continue to increase over time). Ultimately, salts will continue to concentrate with the maximum concentration only limited by the solubility of the constituent salts within the lake. This is conceptually the case for any comparable water body receiving inflow, which experiences evaporation as either the only outflow, or at a rate exceeding all other outflows. As such, the water quality in all QNH voids is predicted to ultimately be unsuitable for any use.

As a comparison, typical guidelines for livestock water quality are presented in **Figure 24**, (note the values are in mg/L for TDS).

Livestock	Total dissolved solids (mg/L)		
	No adverse effects on animals expected	Animals may have initial reluctance to drink or there may be some scouring, but stock should adapt without loss of production	Loss of production and a decline in animal condition and health would be expected. Stock may tolerate these levels for short periods if introduced gradually
Beef cattle	0–4000	4000–8000	8000–10 000
Dairy cattle	0–2500	2500–4000	4000–7000
Sheep	0–5000	5000–10 000	10 000–13 000 ^a
Horses	0–4000	4000–6000	6000–7000
Pigs	0–4000	4000–6000	6000–8000
Poultry	0–2000	2000–3000	3000–4000

a From ANZECC (1992), adapted to incorporate more recent information
b Sheep on lush green feed may tolerate up to 13 000 mg/L TDS without loss of condition or production

Figure 24 – Livestock Water Quality Guidelines

Additionally, “Draft Environmental Values and Water Quality Guidelines for Burdekin Basin and fresh estuarine waters” (Department of Science, Information Technology and Innovation March 2017) identified a guideline EC for aquatic ecosystems in the Pelican Creek sub-catchment of 1,800 $\mu\text{S}/\text{cm}$.

As the residual voids on the QNH have degrading lake water quality, and are therefore unable to sustain a PMLU, they cannot be rehabilitated to a stable condition as defined in Section 111A of the EP Act. As per the definitions in Section 112 of the EP Act, land that cannot be rehabilitated to a stable condition is considered a NUMA. As such, the QNH RMP (a LOD) states that all residual voids at the QNH will be managed as NUMAs.

Summary

The results of the water balance model are therefore summarised as:

- there are no groundwater values which have the potential to be impacted by the modelled steady state drawdown extents of the final voids at the QNH.
- the water quality in the voids will continue to degrade, as such the voids cannot be rehabilitated to a stable condition and they will be managed as NUMAs.
- the voids will continue to act as a sink and the void lake waters will not seep into the surrounding regional groundwater.
- no voids at the QNH will overtop.

With specific regard to the CCM, the groundwater flow is towards the Drake 1 void rather than into the surrounding aquifers, meaning the final landforms are not anticipated to affect the surrounding regional groundwater quality.

Routine groundwater monitoring is undertaken across the QNH to identify fluctuations in water level or quality in accordance with the EAs. To date, monitoring has shown the operations have not had a material effect on groundwater level or quality.

5.2.3. Flooding

As discussed in **Section 1.12.3**, hydraulic modelling of Two Mile Creek was previously undertaken (Engeny, 2013) following the diversion of an upstream reach of Two Mile Creek (a relevant watercourse) within the SCM. The extent of that modelling included the pre-development CCM. As no residual voids for B-Pit or Q-Pit are authorised at the CCM, the PRC Plan only requires consideration of flooding as it relates to potential influences on the final landforms (the B-Pit and Q-Pit waste rock dumps and the western drainage feature outlet). As such the relevant results of Engeny, 2013 are provided below.

The modelled 0.1% AEP flood plain within the CCM is largely limited to the western extent of ML 10345 within the defined channel and adjacent low-lying land to the west of Two Mile Creek, as well as extending into and adjacent to the channels of the eastern and western drainage features. The waste rock dumps at the CCM were sited to minimise influence on the adjoining drainage lines and have been partially progressively shaped and rehabilitated to the final landform. **Figure 25** shows the extent of the overlap of the CCM final landform into the modelled 0.1% AEP flood plain.

The proximity of the final landform features to the 0.1% AEP flood plain are described as follows:

- The Q-Pit final landform is entirely located outside the flood plain, with the lowest point of the final landform being >6m above the modelled level.
- The B-Pit final landform is predominantly located outside the 0.1% AEP flood plain, with the exception of the following areas:
 - o Part of the toe of the western batter of the B-Pit waste rock dump is located within the 0.1% AEP flood plain. The western batter has previously been shaped to the final landform and is being progressively rehabilitated. The extent of the western batter final landform was associated with the original alignment of the western drainage feature, which has been permanently realigned (see below).
 - o The toe of the eastern batter of the B-Pit waste rock dump. The eastern batter will remain in its current configuration until the haul roads which traverse it are no longer required at which time it will become available for progressive rehabilitation. The toe of the batter extends into the 0.1% AEP flood plain.
 - o The haul road crossing of the eastern drainage line. As the haul road crossing will be removed and the area reinstated to the original ground profile and stabilised (refer to 5.3.6), no change to flood levels or other impacts would be expected.
- The outlet and channel of the western clean water drain, which was constructed to replace the section of drainage line removed by the B-Pit/Drake 1 dump.

The lack of final voids and infrastructure to be retained, together with the minimal extent of the CCM final landform that is located within the modelled 0.1% AEP flood plain, mean that flood influence on the CCM final landforms is negligible. As such, flooding is not a significant consideration for the rehabilitation and closure of the CCM and flood modelling specifically for this PRC Plan is not required.

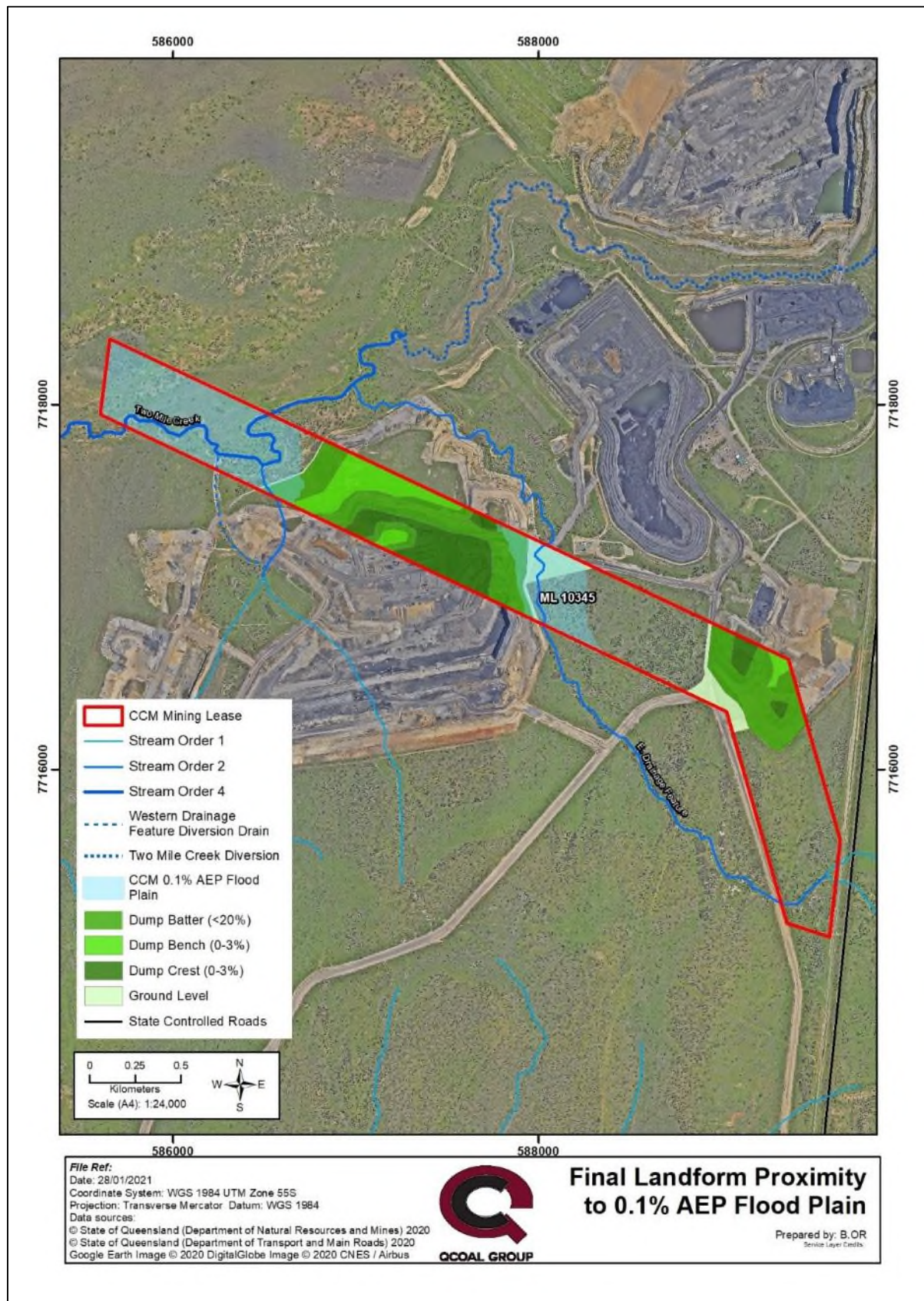


Figure 25 – CCM Final Landform Proximity to 0.1% AEP Flood Plain

5.2.4. Soil and Capping Material Assessment

As previously detailed in **Section 1.10.1** the waste rock generated at the CCM is relatively benign and is expected to generate slightly alkaline and low-to-moderately saline runoff and seepage following surface exposure. Accordingly, capping of waste rock emplacements has not been undertaken on rehabilitated landforms to date at the QNH and is not required or proposed for the completion of rehabilitation at the CCM. This approach is supported by rehabilitation monitoring to date at the QNH.

The placement of cover material at the CCM is limited to the application of previously salvaged topsoil to a minimum depth of 100 mm (as per the QNH RMP), to act as a growing medium for the establishment of grazing pasture. The surface layer of the waste rock dump consists of a blend of the component waste rock lithologies, which, as identified by the waste rock characterization and rehabilitation monitoring at the QNH, is a suitable substrate for the topsoil (and demonstrably effective as the subsoil for rehabilitation).

This methodology is outlined in the QNH RMP (a LOD) and has been the approach for all rehabilitation of waste rock dumps at the QNH to date.

The QNH Topsoil Management Plan (QNH TMP) details the requirements for management of the topsoil resources at the CCM. As previously discussed in **Section 1.14.1**, land units encountered at the CCM include the following:

- **LU1:** Vertosols on Low Lying Areas
- **LU5:** Dermosols & Vertosols on Undulating Terrain

During mine development activities on the CCM, topsoil from disturbance areas (i.e. pits, dumps, haul roads etc.) was progressively removed to a nominal depth of 0.3m and placed into stockpiles. A topsoil register for the QNH is maintained to track topsoil quantities and locations for the available topsoil resources against planned rehabilitation across the QNH mines.

The topsoil resources available at the CCM are detailed in **Table 25**, with the available volumes sufficient to complete the rehabilitation of the site in accordance with the methodologies outlined in **Section 5.3**. For broader context, the other QNH mines also have sufficient topsoil available for the completion of rehabilitation of all disturbed areas, however those quantities have not been presented in this CCM PRC Plan – Rehabilitation Planning Part as they are not relevant to the requirements for the CCM.

Table 25 – Topsoil Resources available within the CCM

QNH Topsoil Register Stockpile Identifier	Location	Volume (BCM)	Predominant Land Unit in Stockpile	Haul Distance to Rehabilitation Area (m)
42	B-Pit Waste Rock Dump	33,251	5	<1000
43	B-Pit Waste Rock Dump	79,448	5	<1000

QNH Topsoil Register Stockpile Identifier	Location	Volume (BCM)	Predominant Land Unit in Stockpile	Haul Distance to Rehabilitation Area (m)
44	Q-Pit Waste Rock Dump	30,641	5	<1000
Total		143,340		

The mixed vertosols and dermosols that make up LU5 form the bulk of the available stockpiled topsoil resources at the CCM (estimated at >95% based on the disturbance footprint and land unit mapping). This material is suitable for use as a growing medium in rehabilitation at the site due to the following characteristics:

- LU5 topsoil is a non-sodic, neutral-slightly acidic, sandy clay loam of moderate water holding capacity;
- The pre-mining land use for the majority of the areas from which LU5 was stripped was improved pasture in the CCM area and, as a result, the stripped topsoil retains a significant seed bank of the desired pasture species. reliance on the natural seedbank has resulted in a good strike and establishment, with additional seeding not required (see also **Section 5.2.9.1**). This approach is supported by the findings of the QNH rehabilitation monitoring program outlined in **Section 7.1.1**.

Respreding of stockpiled topsoil has been undertaken on 17Ha of rehabilitation areas to date at the CCM, as well as approximately 204Ha in total across the QNH since 2010 and establishment of ground cover in the form of the desired grazing pasture has generally been successful (as periodically assessed by rehabilitation monitoring – See **Section 7.1.1**). Amelioration of applied topsoil has not been required or undertaken to date during initial rehabilitation of any areas at the QNH, with the rehabilitation monitoring not making any recommendations to ameliorate topsoil.

5.2.5. Waste Rock and Rejects Management

5.2.5.1. AMD Classification

Characterisation of waste rock is generally based on the potential for materials to generate AMD, as follows:

- **Non-Acid Forming (NAF) material:** where geochemical testing of mining waste and coal rejects (coal rejects are not generated or disposed of at the CCM) shows that materials have a very low likelihood of generating AMD.
- **Material with some capacity to generate AMD:** This is referred to as Potentially Acid Forming – Low Capacity (PAF-LC). Geochemical testing of these materials indicate that these wastes may or will generate small quantities of AMD. A medium risk classification applies to all mining waste and coal rejects material not classed as low or high risk.
- **Potentially Acid Forming (PAF) material:** Geochemical testing of these materials shows that these materials will almost certainly generate AMD. This classification may also apply

to materials of less acid generating capacity, but with a short lag period until the onset of AMD.

As stated in **Section 1.10**, waste rock characterisation studies have been undertaken across the QNH on all lithologies that are encountered during mining. The results of these investigations are summarised in the QNH RMP (a LOD), which included geochemical laboratory testing. Those results have informed management of mine waste as is also presented in the QNH RMP.

No waste rock material at the CCM (or the wider QNH) has been classified as PAF.

One type of waste rock material has conservatively been considered as having PAF-LC (some capacity to generate AMD), specifically *fine-grained and carbonaceous material associated with coal seams*. This is because some waste materials, typically those found adjacent to coal seams (i.e. within 1-2 m of coal) are commonly carbonaceous (e.g. carbonaceous siltstone). These carbonaceous materials can potentially contain reactive sulphide materials and are therefore classified as Medium Risk. It is noted that this material represents a small proportion of the waste rock material handled at the QNH.

All remaining waste rock types are classified as having NAF and represent the significant bulk of the waste rock materials handled at the QNH.

Waste rock is blasted, excavated, hauled and dumped in bulk, with the minor volumes of potentially medium risk waste rock mitigated by the significant majority of the volume being low risk waste rock. As such waste rock dumps on the QNH are classified as NAF with relatively low salt and metals concentrations.

5.2.5.2. QNH Waste Rock Risk Categories and Management

Waste rock at all QNH sites is managed in accordance with the QNH Mine Waste Management Plan (2020), the key findings of which are included in the QNH RMP (a LOD).

Mining waste is grouped into five (5) categories as defined in **Table 26**.

Table 26 – Waste Rock Categories and Risk

Category	AMD Characterisation	Risk Classification	Material
Topsoil	NAF	Low	Soil (including sub-soil) to a nominal depth of 1 m below natural surface. Refer to Section 1.10 for characterisation of soil materials identified at the CCM.
Category 1	NAF	Low	Waste Rock – Upper: - Non-coal and non-carbonaceous material above the coal seams, and not within 1 m above or below ROM coal. - Typically weathered or moderately weathered.
Category 2	NAF to PAF-LC	Low to Medium	Waste Rock – Lower: - Non-coal and non-carbonaceous material below the upper seam, and not within 1 m above or below ROM coal. - Typically fresh or slightly weathered.
Category 3	PAF-LC	Medium	Carbonaceous waste rock and unsuitable coal: - Carbonaceous material, material located within 1 m of ROM coal seams. - Sub-economic coal, intruded coal or heat-affected coal.
Coal Rejects	NAF	Low	CHPP rejects (coarse and fine) as co-disposal slurry*.

*Waste category not generated/encountered at the CCM

A conceptual schematic of the categorised mining wastes at the QNH is presented in Figure 26 – Conceptual QNH Mining Waste Classification **Figure 26**. Colour coding in the figure is as follows:

- Green** = low risk = Topsoil and Category 1 Materials
- Orange** = low-to-medium risk = Category 2 Materials
- Red** = medium risk = Category 3 Materials

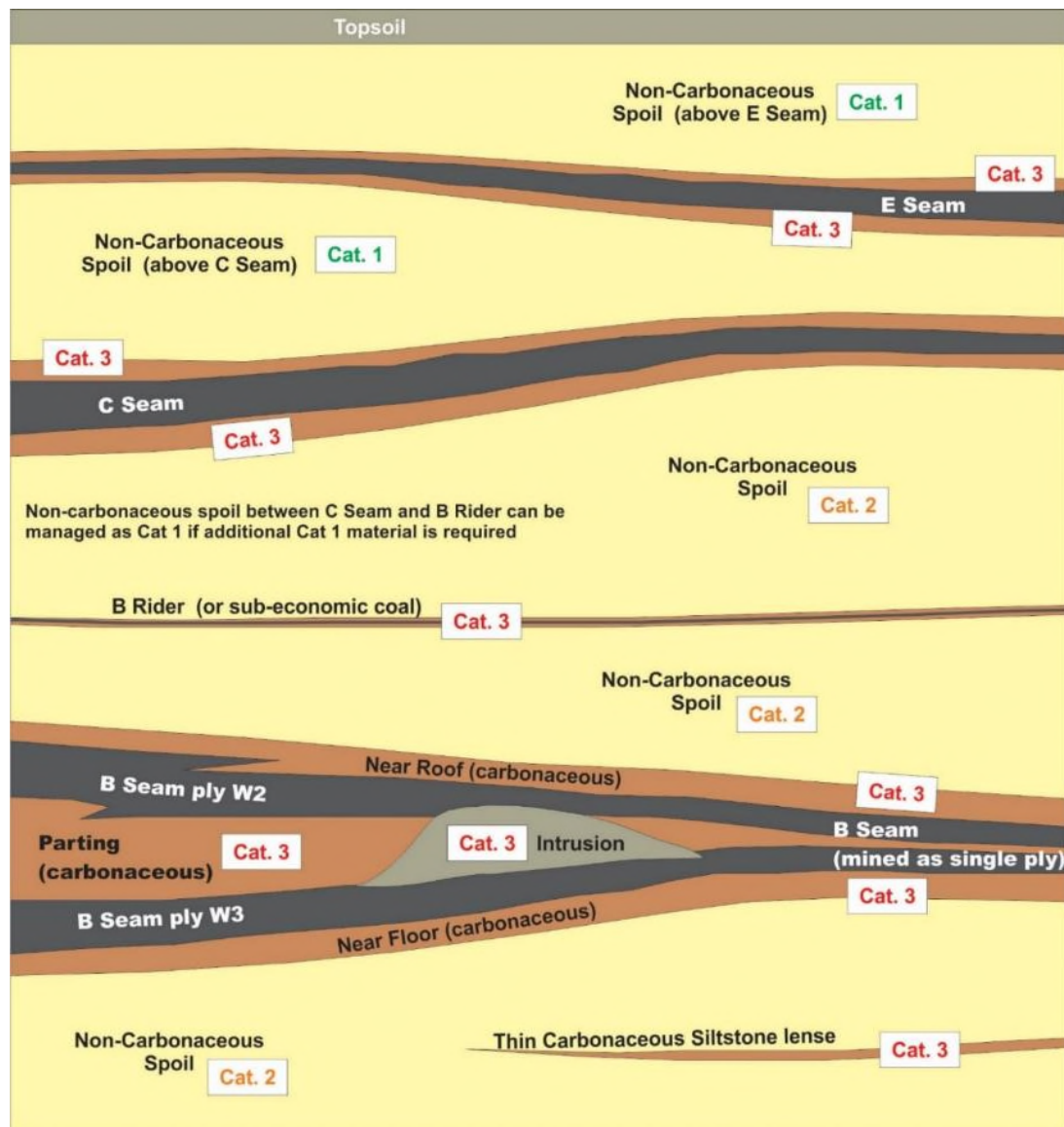


Figure 26 – Conceptual QNH Mining Waste Classification

The geochemical characteristics of mine waste materials inform their management and placement during operations. Materials that have potential geochemical risks are typically encapsulated within materials categorised as lower risk. The laboratory testing that has been undertaken to date at the QNH (the results of which are summarised in the QNH RMP) demonstrate the significant majority of the waste rock material is strongly NAF (as shown in **Figure 13**).

The impacts of any acid generation from the Category 2 or Category 3 material is negligible because:

- Category 2 and Category 3 material represents a minor proportionate volume of waste rock relative to the NAF Category 1, which itself has an acid neutralising capacity.

- Category 2 and 3 material is generally blended/mixed with Category 1 during normal blasting, excavation, loading and dumping during mining operations.
- Where necessary, Category 2 or Category 3 can be encapsulated within Category 1 material.

Due to the lack of trace elements within all lithological units of waste rock, the risk of trace element or saline drainage is considered to be minimal.

The inert nature of the waste rock lithologies has been further demonstrated by ongoing water quality monitoring of dams which receive run-off from active and rehabilitated waste rock dumps throughout the QNH. This monitoring program commenced in 2007 and is intended to continue until surrender of the various QNH EAs. Those results do not indicate the occurrence of saline drainage or AMD. The demonstrated run-off water quality from waste rock stockpiles within and adjacent to the CCM gives further confidence in the conclusions of the geochemical characterisation conducted on the waste rock material.

The results of waste rock characterisation and laboratory testing (as summarised in the QNH RMP), supplemented by the water quality/run-off data available, conclusively show the waste rock at the QNH is inert and that acid mine drainage has not and is not expected to occur.

5.2.6. Landform Design

The final landform at the CCM is designed to be consistent with the requirements for Class 4 suitability grazing land, and the surrounding topography of the land to the extent possible. Landform stability is typically achieved by achieving a desired slope length and angle, correct material selection and establishment of groundcover to improve erosion resistance.

Final landforms (slope, height, size/footprint etc) for waste rock dumps are designed taking into account the designed size/footprint, height and operational slopes at the completion of operation of the dump. In this way the waste rock dump at cessation of operation is as close as possible to the approved final landform design, which reduces the bulk earthwork requirements to achieve the desired final landform.

Landform design plans are produced commensurate with the operational requirements to ensure as much of the bulk earthworks can be undertaken during regular operation as is possible. The maximum final landform slopes for the various rehabilitation domains are detailed in **Section 3.3**.

The final landform design at the CCM reflects the planning approach taken for mine operations and closure outlined in **Section 5.1**, and has been developed in consideration of the following constraints:

- Location of Two Mile Creek and the associated tributaries within the CCM and the extent of the riparian zones and floodplain;
- Location of mapped remnant ecosystems;

- Size and location of the waste rock dumps within the CCM, and their integration with the contiguous waste rock dumps on the SCM and DCM;
- Ongoing requirement for use of haul roads/ramps within the dump footprint for the LOM of the DCM and JCM;

Figure 27 shows the topography of the active mining areas at the CCM from an aerial survey undertaken in February 2020. The contours demonstrate the progression of the mining activities to that point in time, with active mining having been completed and the voids progressively backfilled. A small area of the B-Pit void remained at that time, but in-pit dumping has subsequently been completed and the area continues to be utilised as an out-of-pit dump for the continuation of the DCM Drake 1 Pit. The contours demonstrate where shaping and battering of the waste rock dumps has already been undertaken, as well as the areas that are continuing to be utilised as haul roads/access ramps.

Figure 28 shows the designed final landform for RA1 and RA2 at the CCM in plan view with the final landform surface delineated for visualisation into crests, batters and benches.

Figure 29 and **Figure 30** show cross-sections along Section A-A (as shown in **Figure 28**) of the CCM B-Pit and Q-Pit final landforms, along with the current topography and natural ground level. The true scale along with a vertical exaggeration of 3V:1H are shown for clarity.

An oblique 3D view of the CCM is shown in **Figure 31**, showing the existing landform against the designed final landform. The Q-Pit and B-Pit/Drake 1 waste rock dump final landforms extend between the SCM, CCM and DCM and have been designed as a single integrated landform.

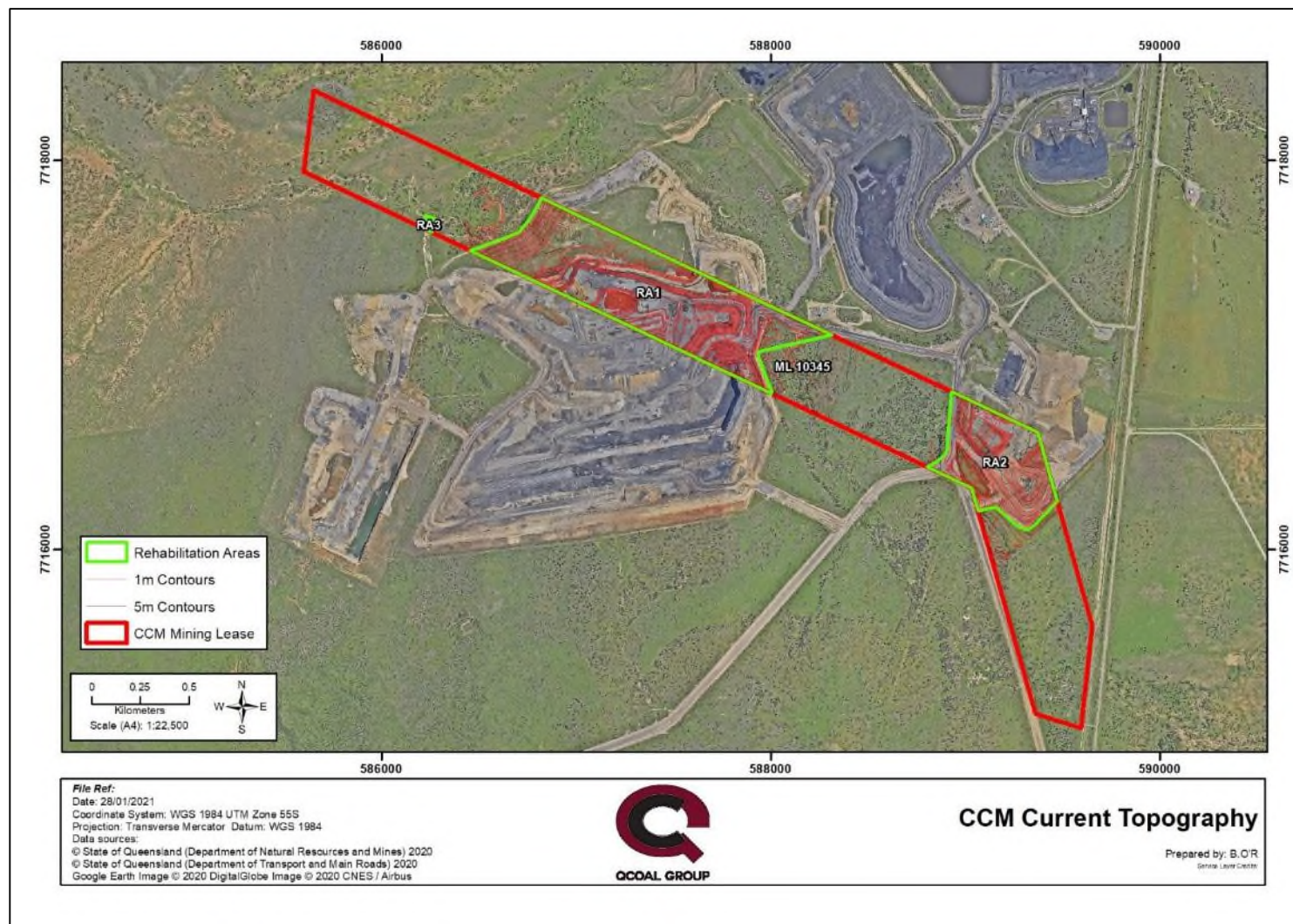


Figure 27 – CCM Current Topography (Feb 2020)

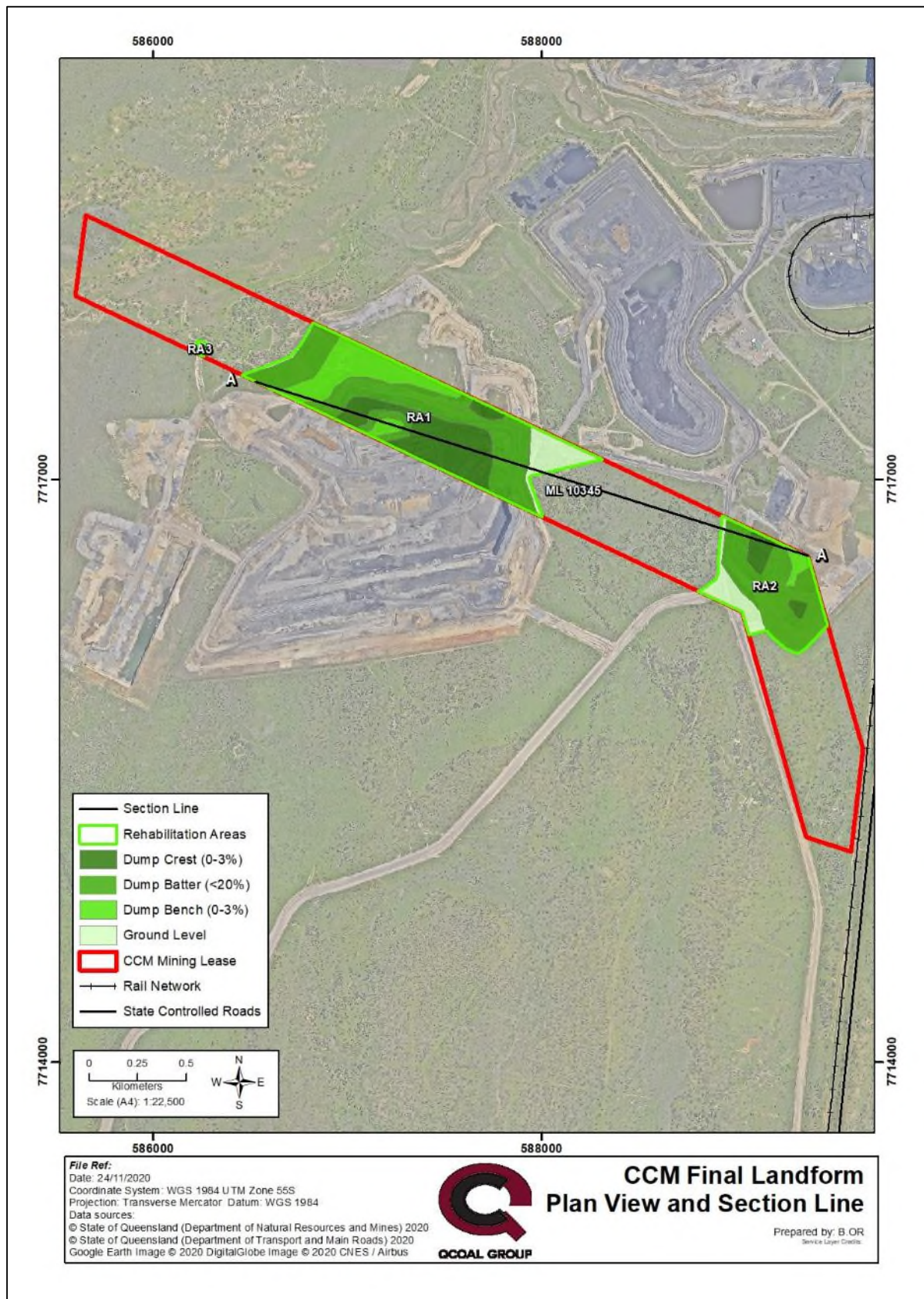


Figure 28 – CCM Final Landform

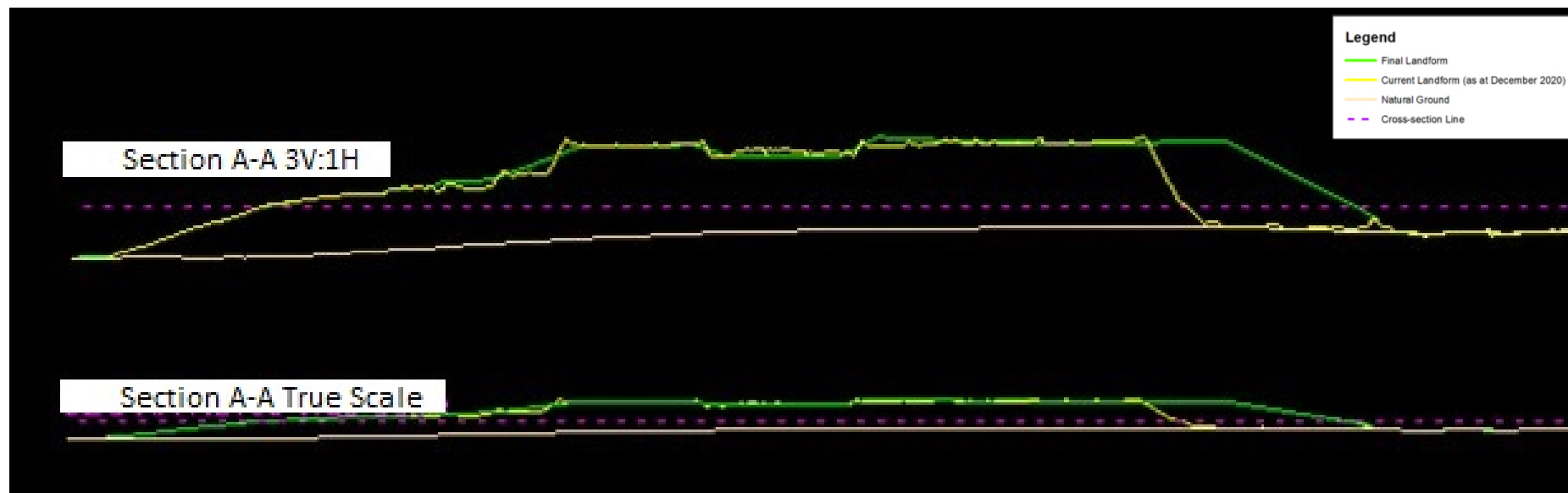


Figure 29 – B-Pit Section A-A

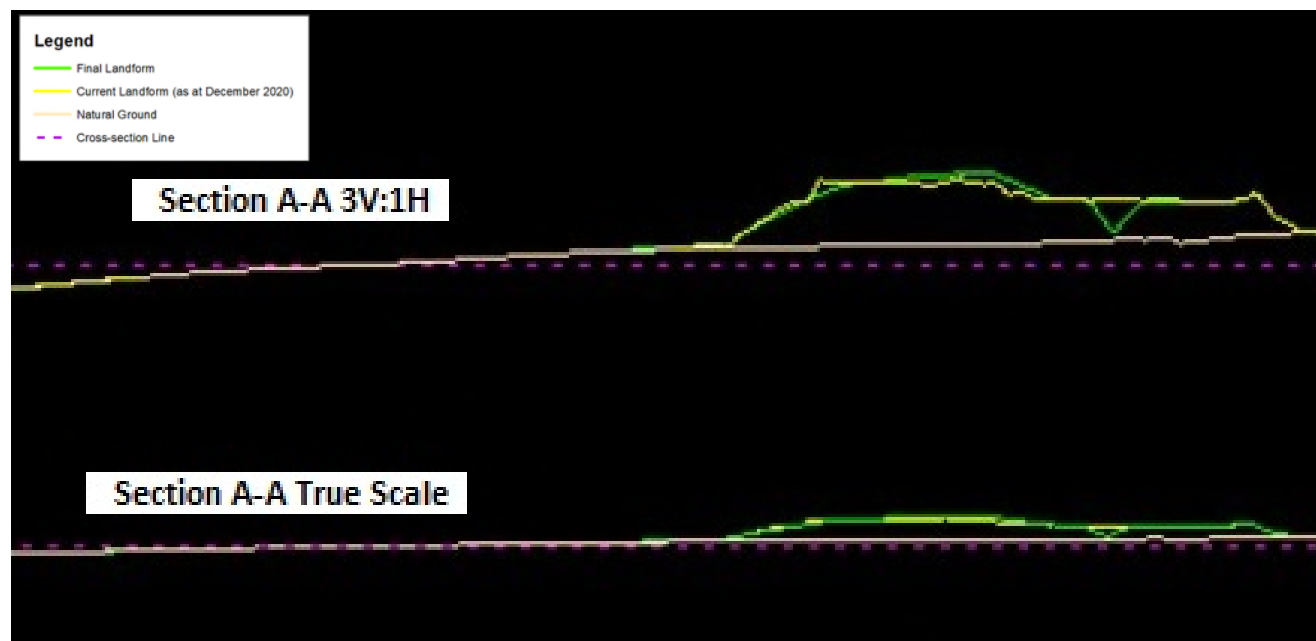


Figure 30 – Q-Pit Section A-A

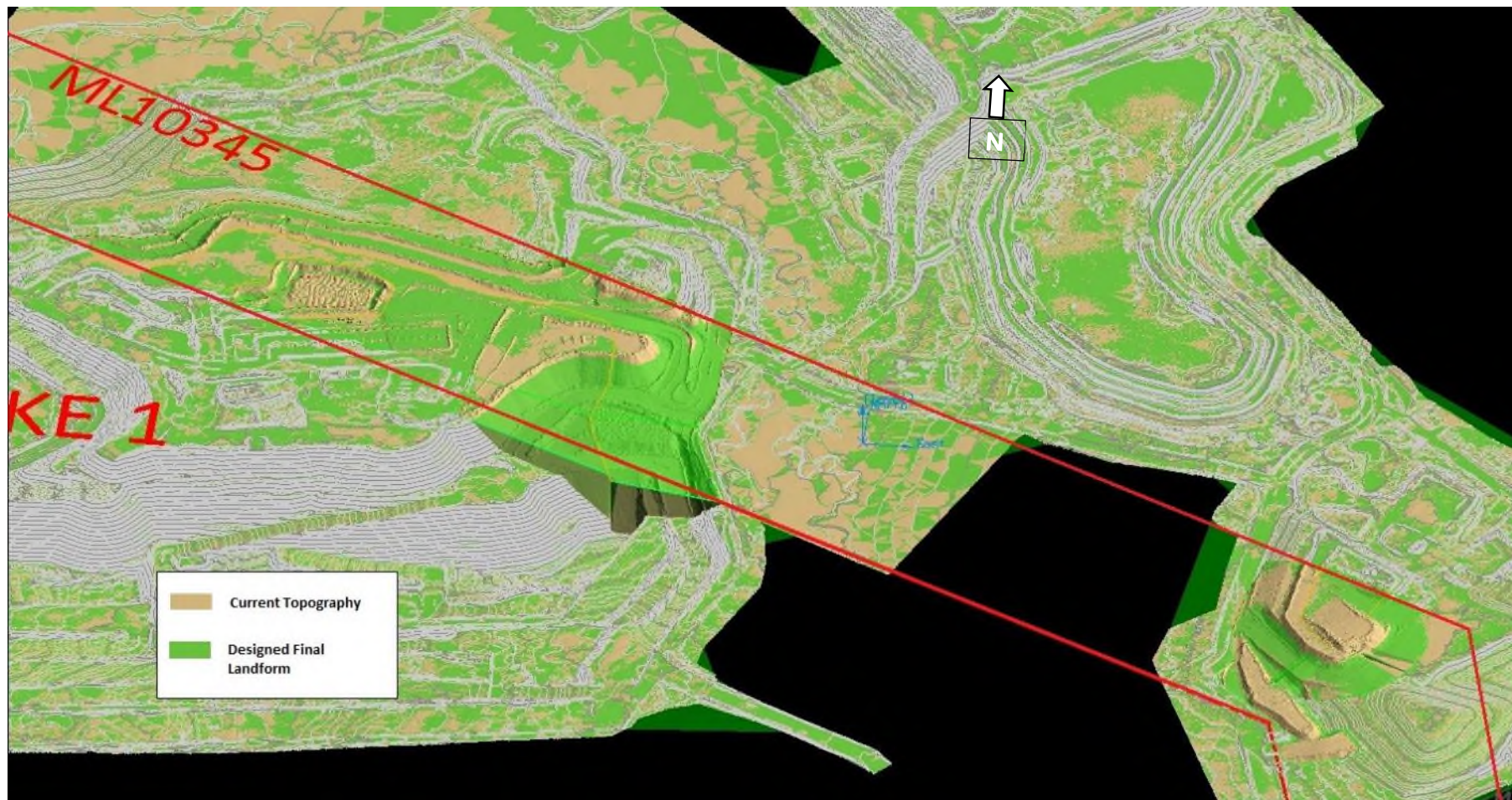


Figure 31 – Oblique View of CCM Current Topography vs Designed Final Landform

5.2.7. Topsoil / Capping Design

As previously noted, capping of waste rock emplacements has not been undertaken on rehabilitated landforms to date at the CCM and is not proposed for the completion of rehabilitation at the CCM. This approach is detailed in the QNH RMP (a LOD) and is due to the inert due to the benign nature and significant neutralising capacity of the waste rock lithologies as well as observed success (vegetation strike, survival and rates of coverage with designed species) in rehabilitation completed to date. The only 'capping' material proposed to be utilised in rehabilitation at the CCM is topsoil.

The QNH TMP details the requirements for management of topsoil resources at the CCM. The QNH RMP (a LOD) specifies that topsoil will be placed to a minimum depth of 0.1m for all rehabilitation areas.

5.2.7.1. Subsoil preparation

Where compaction of subsoil has occurred, such as in infrastructure areas, roads, and other heavily trafficked areas, the surface is ripped to between 0.5 and 1 metres prior to topsoiling. This relieves any compaction, 'keys' the topsoil and subsoil soil layers together, assists with rainfall infiltration and allows vegetation to establish more readily. In order to prevent degradation of soils with high clay content, ripping is only undertaken when the material is sufficiently dry. In areas where compaction has not been identified, ripping may still be undertaken on a case-by-case basis to assist in establishing a soil bed.

As the prepared surface must be suitable for equipment access for placement of topsoil, in some circumstances a light grade may be undertaken to smooth over the elevated furrows from ripping of the subsoil. Drainage and erosion and sediment controls for the final landform will typically be installed at this point, although this may be deferred until after topsoil placement if the drainage structures will impact access for mobile plant used for topsoil placement.

5.2.7.2. Topsoil Placement

As the CCM PMLU is consistent with the pre-mining grazing pasture land-use, and all topsoil resources at the CCM were deemed suitable for salvage, the stripped topsoil is inherently a suitable growing medium for use in rehabilitation. Topsoil is typically placed directly in-situ by scrapers or paddock-dumped at the top of batters and dozer-pushed to the required coverage and thickness. Spot-checks are undertaken during topsoil application to ensure that the minimum thickness of topsoil has been placed.

5.2.7.3. Topsoil Amelioration

Following the application of topsoil, the need for fertiliser application is informally assessed. Previous rehabilitation programs at the QNH have successfully established robust pastures without

fertiliser application. Consideration is given to the application of fertiliser in the following circumstances:

- Where anaerobic conditions within topsoil stockpiles are identified during resspreading. This can occur in the lower section of topsoil stockpiles, limiting oxygen penetration and ultimately causing nitrogen loss from the soil. Anaerobic conditions within a topsoil stockpile are typically identified by a strong odour of decomposing organic matter when re-disturbing the stockpile.
- Where rehabilitation monitoring or periodic inspections identify failed or stressed rehabilitation, and the cause of the failure is assessed as being due to poor nutrient loading.

In these situations, a low phosphate fertiliser may be applied at a nominal application rate of up to 250 kg per hectare or as otherwise appropriate. The potential for run-off from fertilised areas into drainage catchments, as well as weed growth within rehabilitation areas are considerations when determining if fertiliser application is appropriate.

As identified in the topsoil quality assessment outlined in **Section 1.14.1**, no other soil amelioration is required during rehabilitation activities at the CCM.

Based on the currently available topsoil volumes onsite (see **Section 5.2.4**), there will likely be a surplus of topsoil following the completion of rehabilitation at the CCM. Any surplus topsoil at the CCM may be utilised in rehabilitation at other QNH sites if required.

5.2.8. Water Management

During operations, water is managed at the CCM in accordance with the QNH WMP, which is updated periodically as mining progresses at the QNH.

The final landforms at the CCM are designed to be water shedding, with no dams or other water retention structures retained as part of the final landform. The final landforms have been designed to allow the installation of erosion and sediment controls to minimise erosion risk to the final landform. As previously noted, neither the waste rock nor the topsoil at the CCM are dispersive which reduces the likelihood of significant erosion of the final landform occurring or the sedimentation of receiving waters.

The final landforms at the CCM will have permanent drainage and erosion and sediment control (ESC) structures installed as required, as determined by landform slope, slope length and the reporting catchment. As the final landform at the CCM is a continuation of the eventual final landforms within the SCM and DCM, the surface water flow paths and structures are also continuous across the site boundaries.

The Q-Pit area final landform has been designed such that the majority of run-off will report to the SCM to the north, where it will be managed by existing ESC structures. The B-Pit area final landform has been designed such that the majority of run-off will report to ESC structures in the SCM and DCM, with the exception being the eastern and western batters which will report directly to Two Mile Creek and the eastern drainage feature via ESC structures.

Installation of drainage and ESC structures is typically undertaken prior to the application of topsoil but in certain instances it may be undertaken after topsoil application (e.g. due to the erosion structures preventing access/potentially being damaged by the large earthmoving equipment used to apply topsoil).

The most effective way to control surface flow (and therefore erosion) in rehabilitated areas is to construct contour furrows or contour banks at regular intervals down the slope, effectively dividing long slopes into a series of shorter slopes. Where there is no or minimal slope, such erosion controls are typically not required. As slope angle increases, contour banks or furrows are spaced closer together.

Contour banks are typically the preferred erosion control option for relevant domains with slopes that may be subject to sheet or rill erosion (e.g. waste rock dumps, out-of-pit co-disposal facilities, etc.). Contour banks are typically constructed with a small dozer (civil scale) with a 0.5-1% fall to divert run-off to nominated channels to ultimately convey the run-off down-slope. These channels are sized and frequently rock stabilised depending on the expected run-off flow rates and velocities.

The ESC controls for the final landform are designed and installed during rehabilitation establishment such that no ongoing management of surface water run-off (e.g. capture, storage or treatment) will be required following the completion of rehabilitation at the CCM.

To date no persistent seepage has been observed from any rehabilitated landforms or other waste rock dumps at the QNH. Should any such seepage from waste rock dumps occur at the CCM, water quality monitoring will be undertaken to confirm the seepage does not constitute saline drainage or AMD, the occurrence of which has been deemed unlikely based on previous laboratory testing of waste rock.

5.2.9. Revegetation

As per **Section 3**, the approved PMLU for areas disturbed by mining activities at the CCM is grazing pasture. This PMLU is reflective of the pre-mining land-use within and surrounding the CCM (where not otherwise utilised for mining). The focus of revegetation activities at the CCM is therefore to establish a suitable vegetation cover to ensure a stable (as defined by Section 111A of the EP Act) and productive landform. Vegetative cover significantly reduces the erosivity of rehabilitated landforms, particularly waste rock dumps with long slopes.

Vegetation at the CCM is established by either a reliance on a viable seedbank within previously stripped topsoil, or direct seeding if the natural seedbank is found to not be viable.

Direct seeding or planting of native shrub or tree species is not undertaken as it is expected that individual native shrubs and trees will propagate from the natural seed bank and adjacent undisturbed areas. These trees and shrubs will be retained as shade vegetation within the rehabilitated grazing pasture.

5.2.9.1. Natural Seedbank

The stripped and stockpiled topsoils at the QNH have been shown to contain a viable seedbank which contains a representative diversity of the dominant grass, shrub and tree species present on the land prior to disturbance. Viability has been demonstrated by the strike and survival of grasses, shrubs and trees on areas of QNH rehabilitation. Rehabilitation monitoring has quantified such revegetation and tracked its health over several years in some areas of rehabilitation.

As such the reliance on the natural seedbank is considered an appropriate approach and has been detailed as the primary method of revegetation in the QNH RMP (a LOD).

5.2.9.2. Direct Seeding

Where the natural seedbank has failed to produce an appropriate level of groundcover or species diversity, direct seeding may be required.

Seed can be purchased from a Central Queensland-based commercial supplier or collected from the local area. Collection of seed may only take place where the collector has the relevant permission and/or permits for the area from which they are collecting. Any seed requiring storage prior to planting is kept in a cool, dry area and protected from insects.

Based on surrounding undisturbed pasture, native grass and preferred pasture species composition will consider, but not necessarily be limited to, the list presented in **Table 27** (as is included in QNH RMP). These species have been observed in paddocks either surrounding the QNH, or within undisturbed areas of the QNH, and will help facilitate the PMLU of grazing pasture. Other suitable improved pasture and native grass species may also be used in seeding mixes.

Table 27 - Seed Mix Utilised at the CCM

Species Name	Common Name
Preferred grazing species	
<i>Urochloa mosambicensis</i>	Sabi Grass
<i>Cenchrus ciliaris</i>	Buffel Grass
<i>Heteropogon contortus</i>	Black Speargrass
<i>Dichanthium sp.</i>	Bluegrass
<i>Rhynchosia minima</i>	Rhynchosia
<i>Macroptilium lathyroides</i>	Phasey Bean
<i>Clitoria ternatea</i>	Butterfly Pea
<i>Sorghum halepense</i>	Johnson Grass
Intermediate grazing species	
<i>Neptunia gracilis</i>	Native Sensitive Plant
<i>Chloris inflata</i>	Purple-top Rhodes Grass
Legumes	
<i>Chamaecrista rotundifolia</i>	Wynn Cassia
<i>Macroptilium astropurpureum</i>	Siratro
<i>Stylosanthes humilis</i>	Stylo
<i>Stylosanthes scabra</i>	Seca Stylo

Seeding, where required, will ideally be undertaken immediately prior to the onset of the wet season (i.e. December or January). This gives seed the best chance of striking, as soil moisture will be at its highest in the late wet season. Seeding is undertaken utilising an agricultural-class tractor and spreader.

5.2.9.3. Establishment Monitoring

Regardless of reliance on the seedbank or direct seeding, the establishment period for species can vary, so progress is regularly monitored following spreading of topsoil or any seeding undertaken. Monitoring typically commences one month from spreading of topsoil (reliance on seedbank) or from application of seed (direct seeding), in order to assess germination. Reseeding may be required if germination does not occur; however, it should not be undertaken outside of the wet season unless suitably wet weather is forecast.

Formal monitoring of rehabilitated areas commences after at least one wet season has passed following completion of rehabilitation works and is undertaken in conjunction with monitoring of non-mine affected reference sites as is detailed in the QNH RMP (see **Section 7.1.1** of the RMP).

Weed management is undertaken during establishment of rehabilitation based on the QNH Weed Management Plan and results of rehabilitation monitoring.

5.2.10. Void Closure Plan

As previously stated, no voids will be retained at the CCM as the Q-Pit and B-Pit voids have been progressively backfilled with mine waste.

The *QNH Final Void Report* (QCoal, 2020) incorporates the combined impacts of the proposed final voids within the SCM, DCM and JCM. The extent of the impacts from voids on the adjacent QNH sites on the CCM is limited to groundwater drawdown, as discussed in **Section 5.2.2**.

5.2.11. Built Infrastructure

As previously discussed in Section 1.4, minimal built infrastructure has been constructed at the CCM, with infrastructure at the adjoining QNH mines utilised to support the CCM mining activities. The only infrastructure in place at the CCM is as follows:

- Haul roads (refer to **Section 5.3.6**)
- Water management infrastructure (refer to **Section 5.3.5**)

5.3. Activity Specific Strategies

Each RA at the CCM incorporates a number of domains/activities including residual voids, waste rock dumps, haul roads and water management infrastructure. The domains/activities which have been undertaken in a given area often overlap during the LoM, for example where a residual void becomes a waste rock dump, or an area of waste rock dump is utilised as a haul road. Rehabilitation strategies for each area are specific to the most recent domain activity but also account for the previous domain/activities where relevant.

Specific rehabilitation strategies for each domain at the CCM are outlined in the following sections.

5.3.1. Waste Rock Dumps

In-pit dumping occurred both during active mining and to backfill the final voids at the CCM. In-pit dumping has been completed at the CCM, with both the B-Pit and Q-Pit progressively backfilled with waste rock to ground level and subsequently progressing into out-of-pit (i.e. above pit) dumps. As such, no specific rehabilitation requirements are required for in-pit dumps at the CCM. Any settlement of the in-pit dumping area will be negated by the presence of the out-of-pit dump above.

Out-of-pit waste rock dumps are designed and placed to be geotechnically safe and stable during the mining operations, with the 37° angle of repose slope for dumped waste rock materials

considered to be geotechnically stable. Where possible, out-of-pit dumps are constructed in 10-12m high benches. This approach minimises the need for major earthworks during rehabilitation, other than battering the outer batters of the dumps to the design slope/landform.

The methodology generally followed when rehabilitating waste rock dumps at the CCM is as follows:

- Shape and grade the final landform to a geotechnically stable slope, in accordance with the final slope completion criteria as per **Section 3.3** and the landform designs outlined in **Section 5.2.6**.
- Rip surface material on the contour at a spacing of 1 m to between 0.5 and 1.0 metres as required.
- Establish drainage and erosion controls through ripping, profiling and/or construction of control structures.
- Apply topsoil to a minimum depth of 100 mm.
- Scarify the surface immediately prior to any required seeding.
- Seed with an appropriate species mix (see **5.2.9.2**) where natural seedbanks have been identified as unsuitable.
- Control weeds and pest animals.
- Exclude livestock during establishment of groundcover.

During mining in-situ waste rock is blasted and extracted using excavators and dump trucks. This handling results in the waste rock 'swelling' in volume. Some subsequent compaction occurs during waste rock dumping due to heavy equipment (e.g. haul trucks, dozers); however, due to the height of the benches during waste rock dumping and the variable size and nature of the materials, the dumped material remains somewhat 'swollen'. Waste rock dumps are typically subject to ongoing gradual settlement following dumping, with the rate of settlement at its greatest during the initial years following dumping while the material consolidates. While the actual rate and extent of settlement of waste rock materials is difficult to predict, the final landforms at the CCM have been designed such that whole-of-dump settlement is unlikely to compromise the stability or suitability of the structure for the grazing pasture PMLU. Localised areas of significant settlement have not been experienced at the QNH to date, however, should these occur they will be identified during monitoring and addressed on a case-by case basis. Any identified settlement that interferes with drainage pathways will be addressed as a priority.

5.3.2. Co-Disposal Facilities

No co-disposal facilities have been or are proposed to be located on the CCM. As such, specific consideration of co-disposal facilities in the CCM PRC Plan is not required.

5.3.3. Voids

EA EPML00334613 (**Condition H13** and **Table H1**) does not authorise a residual void within the B-Pit or Q-Pit areas on the CCM as a final landform. The B-Pit and Q-Pit voids have been backfilled. As such, specific consideration of voids within the CCM PRC Plan is not required.

5.3.4. Built Infrastructure

As previously stated, there is no built infrastructure located at the CCM. Built infrastructure to support the mining activities at the QNH is primarily located on the adjacent SCM. The decommissioning and rehabilitation of the SCM built infrastructure will be addressed in the SCM PRC Plan as required. As such, specific consideration of built infrastructure in the CCM PRC Plan is not required.

5.3.5. Water Management Infrastructure

All water management infrastructure at the CCM is constructed and operated as part of the wider QNH mine water infrastructure. The QNH WMP details the operating philosophy for water management at the QNH. The WMP also incorporates the erosion and sediment control plan for the site. Due to the limited scale of the mining activities at the CCM, minimal water management infrastructure has been constructed on the CCM.

5.3.5.1. Dams

No dams have been constructed or are proposed to be constructed at the CCM. All mine-affected water was pumped (during mining) or diverted (in the case of surface run-off from waste rock dumps) to dams/voids on the adjoining SCM and DCM. As such, there are no dams requiring rehabilitation at the CCM. The rehabilitation of the dams at the SCM and DCM will be addressed as required in the SCM and DCM PRC Plans respectively.

5.3.5.2. Drains and Levees

Other than ESC structures constructed as part of the final rehabilitated landforms (e.g. contour banks on waste rock dump batters), drainage structures constructed at the CCM are limited to a permanent clean water diversion of the western drainage feature (refer to **Section 1.12.2**), and a number of haul road crossings of natural drainage features. No levees have been constructed or are proposed to be constructed at the CCM due to the pits being located outside of the defined floodplain.

The western drainage feature has been permanently realigned within the DCM, with a small ~70m section of the alignment (including the confluence with Two Mile Creek) extending into the CCM (refer to **Figure 16**). The catchment reporting to this drainage line has been progressively reduced by the progression of the Drake 1 Pit. The drainage line will be retained in its current alignment/ dimensions as part of the final landform, functioning as an ephemeral drainage structure which is otherwise suitable for the grazing pasture PMLU. Further revegetation will be completed to stabilise the bed and batters of the drain to enable the grazing pasture PMLU completion criteria to be met. The presence of the realigned drain outlet within the Two Mile Creek 0.1% AEP flood extent will not cause afflux as it is an excavated channel with no fill placed in the floodplain.

5.3.5.3. Diversions

No diversions of watercourses (as defined under the *Water Act 2000*) have been constructed or are proposed to be constructed during the mining activities at the CCM. The upstream diversion of Two Mile Creek for the SCM was wholly contained within the SCM MLs.

5.3.6. Haul Roads and Access Tracks

A number of haul roads and access tracks have been constructed to support the CCM mining activities and also for haulage and access between the DCM, JCM and SCM. Constructed haul roads, access roads and tracks (including paved and dirt roads) at the QNH are typically intended for rehabilitation; however, any roads or tracks which are considered beneficial to the final land use or which are requested to be retained by the landholder under formal written agreement, may be retained. To date, no formal agreements with the underlying landholder are in place for the haul roads within the CCM.

Haul roads used for moving coal are subject to contaminated land investigations and potential associated remediation works.

A contaminated land assessment is to be undertaken to determine the requirement for any remediation activities prior to the commencement of rehabilitation activities. As haul roads are routinely graded, it is considered likely that the only areas of potential contamination are the haul road drains, and therefore only these areas are intended for assessment. Any remediation activities required will typically be undertaken prior to the commencement of rehabilitation activities.

The rehabilitation strategy for haul roads and tracks below only applies in instances where they are not being retained, and assumes that physical components such as sheeting, culverts etc., have been lifted and removed:

- Final slope to be as per completion criteria outlined in **Section 3.3**.

- Rip surface material on the contour at a spacing of 1 m to between 0.5 and 1.0 metres as required.
- Establish drainage and erosion controls as required.
- Apply topsoil to a minimum depth of 100 mm.
- Scarify the surface immediately prior to seeding (if seeding is required).
- Seed with an appropriate species mix (see **Section 5.2.9.2**) where natural seedbanks have been identified as unsuitable if required.
- Control weeds and pest animals.
- Exclude livestock during establishment of groundcover.

Where haul roads and access tracks cross drainage features (e.g. the eastern drainage feature crossing within RA1), additional rehabilitation actions may require:

- Removal of paving/sheeting material.
- Removal of culverts/drainage structures.
- Earthworks to reinstate bed and banks of drainage feature.
- Stabilisation of disturbed area of bed and banks of drainage feature. Stabilisation measures will be site-specific but may include topsoiling and revegetation, rock armouring or other measures as required.

5.3.7. Exploration

Exploration areas generally comprise an access track, and a cleared drill pad (typically 20m by 30m) within which the drill hole, drill sump and associated v-drain are located, and as such do not represent a significant area of disturbance.

Exploration activities undertaken at the CCM are not considered a mining domain but are areas of disturbance requiring rehabilitation.

The CCM EA (the primary LOD) includes conditions H16 and H17 which directly address the requirements for rehabilitation of boreholes as follows:

- Condition H16: Land subject to exploration activities previously approved under EPC586 that subsequently became ML10345, must be rehabilitated in accordance with the *Code of Environmental Compliance for Exploration and Mineral Development Projects (EM586)*.
- Condition H17: Land subject to exploration activities carried out on ML10345 subsequent to the grant of the relevant mining lease, must be rehabilitated in accordance with the *Code of Environmental Compliance for Exploration and Mineral Development Projects (EM586)*.

The *Code of Environmental Compliance for Exploration and Mineral Development Projects (EM586)* is superseded by *ESR/2016/1985 Eligibility criteria and standard conditions for exploration and mineral development projects – Version 2 (EHP, 2016)*.

ESR/2016/1985 *Eligibility criteria and standard conditions for exploration and mineral development projects – Version 2 (EHP, 2016)* provides specific requirements and timeframes for completion, of rehabilitation of boreholes. Specifically, that rehabilitation of boreholes be completed within 6 months of the completion of drilling activities at that borehole. As such boreholes do not require specific inclusion as RAs in the PRC Plan – Schedule, as the EA specifically legislates the rehabilitation timeframe relevant for each individual borehole.

Regarding rehabilitation methodologies, the QNH RMP (a LOD) includes the adopted approach for rehabilitation of boreholes to satisfy the requirements EHP (2016) as follows:

- Boreholes are to be backfilled with cuttings, sealed and capped.
- Shape and grade the drill pads to match the grade of the surrounding area.
- If required, rip any compacted surface material to between 0.5 and 1.0 metres.
- Establish drainage and erosion controls as required.
- Any stripped topsoil is to be replaced to a minimum depth of 100 mm.
- Scarify the surface immediately prior seeding (if seeding is required).
- Seed with an appropriate species mix (See **Section 5.2.9.2**) where natural seedbanks have been identified as unsuitable.
- Control weeds and pest animals.
- Exclude livestock during establishment of groundcover.

6. Risk Assessment

Section 126C(1)(f) of the EP Act requires the PRC Plan to include the identification of risks to achieving a stable (as defined in the EP Act) condition for land with a designated PMLU, and any proposed management or mitigations to address those identified risks.

As previously stated in **Section 3.1**, in order to be considered stable (as defined by the EP Act), rehabilitation has to meet the following conditions:

- safe and structurally stable (i.e. geotechnical wall/slope stability); and
- there is no environmental harm being caused by anything on or in the land; and
- the land can sustain a post-mining land use (i.e. self-sustain a specified use for the landform after rehabilitation).

As previously stated in **Section 3.3**, completion criteria for rehabilitation of the QNH mine domains have been developed and are presented in the QNH RMP (a LOD) as measurable/quantifiable criteria which, once achieved, demonstrate that rehabilitated landform is stable (as the above).

The physical rehabilitation works undertaken on site in consideration of meeting the completion criteria (and this demonstrating that a stable landform has been achieved) are broken up into rehabilitation milestones. Accordingly, this PRC Plan – Rehabilitation Planning Part, has undertaken the required risk assessment by identifying risks in completing the rehabilitation milestones, so as to better relate to actual on-site rehabilitation works.

The QCoal risk assessment matrix (as shown in **Figure 32**) has been utilised in conducting the required risk assessment.

		Risk Assessment Matrix				
		Consequences				
Loss Type		Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
People Injury or Illness		Slight injury or health effects – First aid / minor medical treatment level	Minor injury or health effects – restricted work or minor lost workday case	Major injury or health effects – major lost workday case / permanent disability	Permanent total disabilities, single fatality	Multiple fatalities
Damage and Consequential Losses		Easily addressed or rectified by immediate corrective action. No loss of production. No Damage to equipment	Minor or superficial damage to equipment and/or facility. No loss of production	Moderate damage to equipment and/or facility. Loss of production < one week	Major damage to facility requiring significant corrective / preventative action. Loss of production < six months	Future operations at site seriously affected. Urgent corrective / remedial action. Loss of production > six months
Reputation, Community Regulatory Compliance		Slight impact – public awareness may exist but no public concern. Slight impact – Traditional Owner awareness may exist but no Traditional owner concern	Limited impact – some local public concern. Limited impact – some Traditional Owner concern	Considerable impact – regional public concern. Considerable impact – Traditional Owner concern	National impact – National public concern. Major impact – Traditional Owner Elders involved	International impact – International public concern Major impact – Stop Work Direction from Traditional Owners
Environmental Impact		Environmental nuisance, no clean up, aesthetic impact only.	Minor clean up, no legal breach, minimal impact, minor non-conformance	Major clean up, license breach, Business disruption at site level.	Local Ecosystem damage, Legal / Statutory breach	Regional Ecosystem damage, Major rehab failure, Mine closure
Financial / Commercial		<AUS \$10,000	AUS \$10,000 to \$100,000	AUS \$100,000 to \$1M	AUS \$1M to \$10M	>AUS \$10M

Likelihood		Risk Rating				
Almost Certain (A)	This event is expected to occur in most circumstances (once per month)	M (15)	H (10)	H (6)	E (2)	E (1)
Likely (B)	Will probably occur in most circumstances (once per year)	M (19)	M (14)	H (9)	E (4)	E (3)
Possible (C)	Might occur at some time (once per 10 years)	L (22)	M (18)	H (13)	H (8)	E (5)
Unlikely (D)	Could occur at some time (once per 100 years)	L (24)	L (21)	M (17)	H (12)	H (7)
Rare (E)	May occur only in exceptional circumstances (once per 1000 years)	L (25)	L (23)	M (20)	M (16)	H (11)

Figure 32 – QCoal Risk Assessment Matrix

6.1. Risk Treatment Options

Table 28 details the risks to the completion of the Rehabilitation Milestones (and achievement of stable landforms with the approved PMLU) at the CCM, as well as the controls to be applied to manage, mitigate or reduce those impacts.

Table 28 – Risk Assessment

Risk	Impact	Untreated Risk			Selected Control/ Treatment	Control/Treatment Justification	Resources Required	Performance Measures	Reporting and Monitoring	Residual Risk		
		Consequences	Likelihood	Risk Rating						Consequences	Likelihood	Risk Rating
RM1: Landform Development, Shaping and Profiling												
Delays in RAs becoming progressively available	RM not completed in the required timeframes, non-compliance with PRCP Schedule	3	C	H	Inclusion of rehabilitation activities in QNH Annual Budget	All mining activity is driven by the budget and associated schedule, and rehabilitation activities are to be included in the budget to align with the PRCP Schedule.	-	Achievement of Acceptance and Completion Criteria as per Section 5 of the PRCP	Monitoring and reporting as outlined in Section 7 of the PRCP	2	D	L
					Inclusion of rehabilitation activities in QNH Mine Schedule/Forecast	Inclusion of rehabilitation activities in the schedule ensures that resources, personnel and equipment are available to undertake the required scope	-					
					6-monthly QNH PRCP progress Technical Services meetings	6-monthly (or as required) meeting to track progress against PRCP Schedules for QNH mines	QNH Technical Services Personnel QCoal Environmental Personnel					
					PRCP Schedule Amendment	A PRCP Schedule amendment would only be undertaken where the schedule for land becoming available has slipped and there is no reasonable possibility of recovery	QCoal Environmental Personnel					
Landform design does not conform to acceptance criteria	Designed landform does not meet RM criteria	3	C	H	Completion of QA check for landform design	QA check of the landform design against the landform design criteria	QNH Technical Services Personnel			3	E	L
Designed ESC/drainage structures are inadequately sized/configured	Failure of drainage structures, erosion of final landform, RM not achieved	2	C	H	Completion of QA check for landform design	QA check of the landform design against the landform criteria	QNH Technical Services Personnel			2	E	L
Constructed landform does not conform to design	Constructed landform does not meet RM criteria	3	C	H	Completion of QA check for landform design	QA check of the constructed landform against the landform criteria.	QNH Technical Services Personnel			3	E	L
					'As Constructed' Survey	The 'as constructed' survey of the completed landform is checked for compliance with the designed landform	QNH Technical Services Personnel					
Previously unidentified contaminated land	- Remediation work required, delay to completion of RM	2	C	M	No bulk fuel or oil storages are located onsite at the CCM	All bulk storages are located off-site at the SCM	-			2	C	L
					Spill reporting processes and remedial actions during operations	Fuel and oil spills are required to be contained, reported and cleaned up during operations. Records maintained in site incident reports	-					
					Stage 1 Contaminated Land Assessment to be undertaken	Contamination is most likely to occur on or adjacent to haul road and park-up areas so these areas will be the main priority	Contaminated Land Consultant					
					Specific actions to be developed to address identified contamination	Remediation actions will depend on extent, location and risk of identified contamination.	QCoal Environmental Personnel Contaminated Land Consultant					
	Earthworks not completed, RM not completed in the	3	C	H	Inclusion of rehabilitation activities in QNH Annual Budget	All mining activity is driven by the budget and associated schedule, and rehabilitation activities	-			2	D	L

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Risk	Impact	Untreated Risk			Selected Control/ Treatment	Control/Treatment Justification	Resources Required	Performance Measures	Reporting and Monitoring	Residual Risk		
		Consequences	Likelihood	Risk Rating						Consequences	Likelihood	Risk Rating
PRCP Schedule non-conformance / non-achievement of Milestone	required timeframes, non-compliance with PRCP Schedule					are to be included in the budget to align with the PRCP Schedule.						
					Inclusion of rehabilitation activities in QNH Mine Schedule/Forecast	All mining activity is driven by the budget and associated schedule, and rehabilitation activities are to be included in the budget to align with the PRCP Schedule.	-					
					6-monthly QNH PRCP progress Technical Services meetings	6-monthly (or as required) meeting to track progress against PRCP Schedules for QNH mines	QNH Technical Services Personnel					
					PRCP Schedule Amendment	A PRCP Schedule amendment would only be undertaken where the schedule for land becoming available has slipped and there is no reasonable possibility of recovery	QCoal Environmental Personnel					
RM2: Surface Preparation												
Inadequate topsoil volumes available	Inadequate topsoil available for rehabilitated landform to meet RM criteria,	2	C	M	CCM topsoil inventory managed via QNH Topsoil Management Plan and Register	Adequate topsoil is currently available at the QNH for rehabilitation of all disturbed areas. Managing existing resources will minimise the likelihood of a deficit in the future.	QNH Survey Personnel	Achievement of Acceptance and Completion Criteria as per Section 5 of the PRCP	Monitoring and reporting as outlined in Section 7 of the PRCP	2	D	L
					Implementation of additional topsoil management measures if <10% surplus identified at the CCM at any point	If a topsoil deficit is identified, additional measures such as cartage of surplus topsoil from another QNH site will be considered	QCoal Environmental Personnel					
Inadequate topsoil volumes placed	Inadequate topsoil for rehabilitated landform to meet RM criteria, rework required	2	C	M	QNH topsoil inventory managed via Topsoil Management Plan and Register	Adequate topsoil is currently available at the QNH for rehabilitation of all disturbed areas. Managing existing resources will minimise the likelihood of a deficit in the future.	QNH Survey Personnel			2	D	L
					Spot-checks of depth during respreading	Random spot checks of applied topsoil thickness within rehabilitation areas will be undertaken during spreading to ensure an adequate depth is respread.	QCoal Environmental Personnel QNH Survey Personnel					
					Survey of topsoil stockpiles post-spreading and confirmation of total volume removed is within 20% of calculated required volume	Topsoil stockpile surveys are used to calculate the topsoil volume removed, which together with the spreading area, can be used to calculate an average spreading depth. Allowing a 20% variance allows for the swelling of the topsoil during rehandling.	QNH Survey Personnel					
Topsoil quality non-conformance with acceptance criteria	Topsoil quality compromises rehabilitation establishment, completion criteria unable to be achieved	2	C	M	Pre-disturbance topsoil assessments	The topsoil assessments undertaken to date indicate the topsoil available at the CCM is primarily LU5 (Mixed vertosols and dermosols), with some LU1 (low-lying vertosols) which are both suitable for use in rehabilitation. The topsoil has been previously used successfully in rehabilitation at the QNH.	-			2	D	L

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Risk	Impact	Untreated Risk			Selected Control/ Treatment	Control/Treatment Justification	Resources Required	Performance Measures	Reporting and Monitoring	Residual Risk		
		Consequences	Likelihood	Risk Rating						Consequences	Likelihood	Risk Rating
					Scheduled topsoil assessments in rehabilitation areas	Future topsoil assessments are expected to confirm the pre-disturbance assessment findings	Rehabilitation Monitoring Consultant					
					Specific actions to be developed to address any identified topsoil issues	Remedial actions will depend on the location, extent and type of issue identified but may include amelioration, etc	QCoal Environmental Personnel Rehabilitation Monitoring Consultant					
Weed contamination from respread topsoil	Excessive growth of non-desired species within prepared areas	2	C	M	QNH Topsoil Management Plan incorporates weed management requirements for topsoil stockpiles	Management of weed establishment on topsoil stockpile reduces likelihood of establishment following respreading	QCoal Environmental Personnel Weed Control Contractor			2	D	L
Weed contamination -from vehicles / equipment	Excessive growth of non-desired species within prepared areas	2	C	M	Weed hygiene requirements outlined in QNH Weed Management Plan to be followed for all plant and equipment	Existing QNH weed hygiene requirements	QCoal Environmental Personnel Weed Control Contractor			2	D	L
PRCP Schedule non-conformance, non-achievement of Milestone	Milestone timeframes not achieved, potential non-compliance with PRCP Schedule	3	C	H	Inclusion of rehabilitation activities in QNH Annual Budget	All mining activity is driven by the budget and associated schedule, and rehabilitation activities are to be included in the budget to align with the PRCP Schedule	-			2	D	L
					Inclusion of rehabilitation activities in QNH Mine Schedule/Forecast	Inclusion of rehabilitation activities in the schedule ensures that resources, personnel and equipment are available to undertake the required scope	-					
					6-monthly QNH PRCP progress Technical Services meetings	6-monthly (or as required) meeting to track progress against QNH PRCP Schedule	QNH Technical Services Personnel QCoal Environmental Personnel					
					PRCP Schedule Amendment	A PRCP Schedule amendment would only be undertaken where the schedule for land becoming available has slipped and there is no reasonable possibility of recovery	QCoal Environmental Personnel					
RM3: Achievement of surface requirements (grazing pasture)												
Natural seedbank providing inadequate strike, species diversity, groundcover	Rehabilitation does not meet ground cover requirements, acceptance criteria unable to be achieved	2	C	M	Ad-hoc and 6-monthly visual inspections following topsoil spreading	Routine documented inspections will note any issues with ground cover establishment	QCoal Environmental Personnel	Achievement of Acceptance and Completion Criteria as per Section 5 of the PRCP	Monitoring and reporting as outlined in Section 7 of the PRCP	2	D	L
					Seeding (if required) to be undertaken before following wet season	Given the past success with relying on the natural seedbank in the topsoil, it is considered unlikely that the topsoil will require further seeding	QCoal Environmental Personnel Seeding Contractor					
Poor establishment, die-off of first strike due to drought conditions	Rehabilitation does not meet ground cover requirements, acceptance criteria unable to be achieved	2	C	M	Ad-hoc and 6-monthly visual inspections following topsoil spreading	Routine documented inspections will note any issues with ground cover establishment	QCoal Environmental Personnel					2
					Seeding (if required) to be undertaken before following wet season	Given the past success with relying on the natural seedbank in the topsoil, it is considered unlikely that the topsoil will require further seeding	QCoal Environmental Personnel Seeding Contractor					

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Risk	Impact	Untreated Risk			Selected Control/ Treatment	Control/Treatment Justification	Resources Required	Performance Measures	Reporting and Monitoring	Residual Risk		
		Consequences	Likelihood	Risk Rating						Consequences	Likelihood	Risk Rating
Settlement of landform impacting flow paths	Installed drainage not functioning to design leading to erosion of final landform, completion criteria unable to be achieved	2	C	M	Ad-hoc and 6-monthly visual inspections includes drainage structures	Routine documented inspections will note any issues with constructed flow paths	QCoal Environmental Personnel			2	D	L
					Noted issues to be included in QNH Environmental Actions Register	QNH Environmental Actions Register is utilised to track and close-out remedial actions in rehabilitated areas	QCoal Environmental Personnel Resources for remedial actions as required					
Failure of ESC structures due to lack of groundcover during establishment	Erosion of final landform, sedimentation of receiving waters, completion criteria unable to be achieved	2	C	M	Drainage/ESC to be designed for the no ground-cover scenario	Design for 'worst case' scenario, as ground cover establishes risk reduces	QNH Technical Services Personnel QCoal Environmental Personnel			2	D	L
					Ad-hoc and 6-monthly visual inspections includes drainage structures	Routine documented inspections will note any issues with constructed flow paths	QCoal Environmental Personnel					
					Noted issues to be included in QNH Environmental Actions Register	QNH Environmental Actions Register is utilised to track and close-out remedial actions in rehabilitated areas	QCoal Environmental Personnel Resources for remedial actions as required					
Surface water contamination from unexpected waste rock material geochemical issue	Run-off/seepage to surface waters exceeds water quality requirements, completion criteria unable to be achieved	3	D	M	Previous geochemical testing programs	Geochemical testing and previous rehabilitation of waste rock dumps at the QNH indicates that issues with run-off/seepage to surface water from waste rock dumps are unlikely	-			3	E	L
					Run-off sampling at nominated locations	Geochemical testing and previous rehabilitation of waste rock dumps at the QNH indicates that run-off/leachate issues from waste rock dumps are unlikely	QCoal Environmental Personnel					
					Specific actions to be developed to address identified geochemical issues	Remedial actions will depend on the location, extent and type of geochemical issue identified	QCoal Environmental Personnel Geochemical Consultants					
Groundwater contamination from unexpected waste rock geochemical issue	Run-off/seepage to groundwater exceeds water quality requirements, completion criteria unable to be achieved	3	D	M	Previous geochemical testing programs	Geochemical testing and previous rehabilitation of waste rock dumps at the QNH indicates that issues with leachate to groundwater from waste rock dumps are unlikely	-			3	E	L
					Groundwater sampling at nominated locations	Ongoing groundwater monitoring program will identify trends that would indicate a geochemical issue	QCoal Environmental Personnel					
					Specific actions to be developed to address identified geochemical issues	Remedial actions will depend on the location, extent and type of geochemical issue identified	QCoal Environmental Personnel Geochemical Consultants					
Weeds - proportion/increase/species of concern	Acceptance criteria unable to be achieved	2	C	M	Ad-hoc and 6-monthly visual inspections includes weed establishment	Generally, weed establishment is most likely to occur following topsoil placement when there is minimal ground cover present. Some establishment is expected, however declared/controlled weeds and weeds that may impact growth of pasture grasses (e.g. dense areas of weeds) will be monitored	QCoal Environmental Personnel			2	D	L

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Risk	Impact	Untreated Risk			Selected Control/ Treatment	Control/Treatment Justification	Resources Required	Performance Measures	Reporting and Monitoring	Residual Risk		
		Consequences	Likelihood	Risk Rating						Consequences	Likelihood	Risk Rating
					Annual rehabilitation monitoring to identify weeds species present and trends/issues and recommend actions	The presence and spread of weeds within rehabilitation areas will be noted during rehabilitation monitoring	Rehabilitation Monitoring Consultant					
					Noted actions to be included in QNH Environmental Actions Register	QNH Environmental Action Register is utilised to track and close-out remedial actions in rehabilitated areas	QCoal Environmental Personnel Resources for remedial actions as required					
					Weed control program to be implemented	An ongoing weed control program is in place at the QNH	Weed Control Contractor					
Fire in rehabilitation areas	Reduction of groundcover, acceptance criteria unable to be achieved	2	C	M	Maintenance of on-lease and off-lease firebreaks	Existing disturbances act as fire breaks (e.g. SCM and DCM disturbed areas, haul roads, access tracks along toe of batters, Bowen Development Rd). Off-lease fire breaks have been put in place to the west by the landholder as a routine property management activity	Fire Break Maintenance Contractor			2	D	L
					Mine water carts available onsite 24/7 for firefighting if required	Mine water carts have a high water capacity and are equipped with cannons and spray bars to make them suitable for firefighting where required	-					
					Ad-hoc and 6-monthly visual monitoring of fire-impacted areas to ensure reestablishment of pasture species is occurring and determine if reseeding is required	Fire impacted areas would be expected to re-establish from residual seed in the topsoil. Monitoring will determine if any intervention is required						
Ground-disturbing pests - pigs, rabbits, etc.	Damage to rehabilitation/landform, RM criteria unable to be achieved	2	C	M	Ad-hoc and 6-monthly visual inspections include noting any pest species present	Pests are not expected to an issue based on rehabilitation monitoring to date, the lack of permanent water sources within the CCM and the active pest control programs implemented by the surrounding land holders	QCoal Environmental Personnel			2	D	L
					Annual rehabilitation monitoring to identify evidence of pest species present and trends/issues and recommend actions	The presence of pest species within rehabilitation areas will be noted during rehabilitation monitoring	Rehabilitation Monitoring Consultant					
					Noted actions to be included in QNH Environmental Actions Register	QNH Environmental Actions Register is utilised to track and close-out remedial actions in rehabilitated areas	QCoal Environmental Personnel Resources for remedial actions as required					
					Pest control program to be implemented	A pest control program will be implanted at the QNH if required	Pest Control Contractor					

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Risk	Impact	Untreated Risk			Selected Control/ Treatment	Control/Treatment Justification	Resources Required	Performance Measures	Reporting and Monitoring	Residual Risk		
		Consequences	Likelihood	Risk Rating						Consequences	Likelihood	Risk Rating
Damage to rehabilitation from premature livestock grazing	Permanent reduction of ground cover, acceptance criteria unable to be achieved	2	C	M	Livestock to be excluded until <50% groundcover has been maintained for a minimum of 2 successive years, as measured by annual rehabilitation monitoring.	Sufficient time is required for pasture to become established and self-sustaining prior to the introduction of cattle onto rehabilitated areas.	-			2	E	L
PRCP Schedule non-conformance	Milestone timeframes not achieved, potential non-compliance with PRCP Schedule	3	C	H	Annual rehabilitation monitoring to quantify progressive establishment of grazing pasture against the Milestone Criteria	Monitoring will be used to track the progress of ground cover establishment, project where grazing pasture unlikely to meet the Milestone in the required timeframe and recommend remedial actions as required.	Rehabilitation Monitoring Consultant			2	D	L
RM4: Achievement of post-mining land use to stable condition (grazing pasture)												
Settlement of landform impacting flow paths	Installed drainage not functioning to design leading to erosion of final landform, completion criteria unable to be achieved	2	C	M	Ad-hoc and 6-monthly visual inspections includes drainage structures	Routine documented inspections will note any issues with constructed flow paths	QCoal Environmental Personnel	Achievement of Acceptance and Completion Criteria as per Section 5 of the PRCP	Monitoring and reporting as outlined in Section 7 of the PRCP	2	D	L
					Noted issues to be included in QNH Environmental Actions Register	QNH Environmental Actions Register is utilised to track and close-out remedial actions in rehabilitated areas	QCoal Environmental Personnel Resources for any remedial actions					
Failure of ESC structures post-establishment	Erosion of final landform, completion criteria unable to be achieved	2	C	M	Drainage/ESC to be designed for the no ground-cover scenario	Design for 'worst case' scenario, as ground cover establishes risk reduces	QNH Technical Services Personnel QCoal Environmental Personnel			2	D	L
					Ad-hoc and 6-monthly visual inspections includes drainage structures	Routine documented inspections will note any issues with constructed flow paths	QCoal Environmental Personnel					
Surface water contamination from unexpected waste rock material geochemical issue	Run-off/seepage to surface waters exceeds water quality requirements, completion criteria unable to be achieved	3	D	M	Previous geochemical testing programs	Geochemical testing and previous rehabilitation of waste rock dumps at the QNH indicates that issues with run-off/seepage to surface water from waste rock dumps are unlikely	QCoal Environmental Personnel			3	E	M
					Sampling at nominated locations in EA	Geochemical testing and previous rehabilitation of waste rock dumps at the QNH indicates that run-off/leachate issues from waste rock dumps are unlikely	QCoal Environmental Personnel					
					Specific actions to be developed to address identified geochemical issues	Remedial actions will depend on the location, extent and type of geochemical issue identified	QCoal Environmental Personnel Geochemical Consultants					

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Risk	Impact	Untreated Risk			Selected Control/ Treatment	Control/Treatment Justification	Resources Required	Performance Measures	Reporting and Monitoring	Residual Risk		
		Consequences	Likelihood	Risk Rating						Consequences	Likelihood	Risk Rating
Weed establishment - proportion/ increase of non-preferred species/declared weeds	Acceptance criteria unable to be achieved	2	C	M	Ad-hoc and 6-monthly visual inspections includes identifying weed establishment	Weed establishment is most likely to occur following topsoil placement when there is minimal ground cover present. Some establishment is expected, however declared weeds and weeds that may impact growth of pasture grasses (e.g. dense areas of weeds)	QCoal Environmental Personnel			2	D	L
					Annual rehabilitation monitoring to identify weeds species present and trends/issues and recommend actions	The presence and spread of weeds within rehabilitation areas will be noted during rehabilitation monitoring.	Rehabilitation Monitoring Consultant					
					Noted issues to be included in QNH Environmental Actions Register	QNH Environmental Actions Register is utilised to track and close-out remedial actions in rehabilitated areas	QCoal Environmental Personnel					
					Weed control program to be implemented	An existing weed control program is in place at the QNH	Weed Control Contractor					
Fire in rehabilitation areas	Reduction of ground cover, acceptance criteria unable to be achieved	2	C	M	Maintenance of on-lease (and off-lease where land is held by QCoal) firebreaks.	Existing disturbances act as fire breaks (e.g. SCM and DCM disturbed areas, haul roads, access tracks along toe of batters, Bowen Development Rd). Off-lease fire breaks have been put in place to the west by the landholder as a routine property management activity.	Fire Break Maintenance Contractor			2	D	L
					Mine water carts available onsite 24/7 for firefighting if required.	Mine water carts have a large capacity and are equipped with cannons and spray bars to make them suitable for firefighting if required.	-					
Established pasture die-off due to drought conditions	Reduction of ground cover, acceptance criteria unable to be achieved	2	C	M	Ad-hoc and 6-monthly visual inspections includes identification of die-off areas	Routine documented inspections will note any issues with pasture die-off in rehabilitated areas	QCoal Environmental Personnel			2	D	L
					Noted actions to be included in QNH Environmental Actions Register	QNH Environmental Actions Register is utilised to track and close-out remedial actions in rehabilitated areas	Rehabilitation Monitoring Consultant					
					Remedial actions for pasture die-off areas to be implemented	Remedial actions will depend on the location and extent of pasture die-off identified	Weed Control Contractor					
PRCP Schedule non-conformance	Milestone timeframes not achieved, potential non-compliance with PRCP Schedule	3	C	H	Annual Rehabilitation monitoring to quantify achievement of grazing pasture to stable condition against the Milestone Criteria	Monitoring will be used to track the progress of ground cover establishment, project where grazing pasture unlikely to meet the Milestone in the required timeframe and recommend remedial actions.	Rehabilitation Monitoring Consultant			2	D	L

6.2. Rehabilitation Trials

The QNH mines have been progressively developed since 2006 and progressive rehabilitation has been ongoing at the QNH since 2010 as mining areas have become available. Since 2017, rehabilitation has commenced on 31Ha of disturbance at the CCM, representing 33% of the total mining disturbance.

Rehabilitation monitoring at the QNH more broadly, and the CCM specifically, commenced in 2012 and 2017 respectively; and has been undertaken annually since that time (see **Section 7.1**). The rehabilitation monitoring program provides data relating to actual completed rehabilitation at various locations across the QNH and CCM, including the effectiveness of the methodologies adopted in the QNH RMP (a LOD) and the progression of rehabilitated areas towards meeting the completion criteria. As such rehabilitation monitoring negates the need for rehabilitation trials (which are limited in scale, time and location).

Where ongoing rehabilitation monitoring identifies potential improvements or adjustments to the rehabilitation methodology, those improvements or adjustments will be implemented as part of the continuous improvement of the rehabilitation methodology.

7. Monitoring and Maintenance

Following completion of rehabilitation in an area, its progress towards achieving the completion criteria and rehabilitation milestones will be monitored over the proceeding years. The ongoing monitoring activities will identify any maintenance that is required to be undertaken to enable the completion criteria to be met, these maintenance actions will be scheduled and undertaken within set timeframes.

7.1. Monitoring

Monitoring of rehabilitation progress against the completion criteria has been ongoing at the QNH since 2012. At the CCM, the initial round of rehabilitation monitoring was undertaken in 2017 and has continued on an annual basis since that time.

Requirements, frequencies and methods of rehabilitation monitoring are detailed in the following subsections, and are as per the QNH RMP (a LOD).

Monitoring will continue at the CCM until such time as the disturbed areas are either progressively certified or the EA is surrendered, both of which can only occur when the rehabilitation at the site has been certified as being in a stable condition with a PMLU of grazing pasture.

7.1.1. Rehabilitation Monitoring

7.1.1.1. Timing

Rehabilitation monitoring is undertaken annually following the wet season, or at an alternate frequency based on recommendations from a SQP.

Soil assessments at both monitoring and reference sites (to allow comparison) are undertaken five (5) yearly; however, an SQP may recommend an increase or decrease in the frequency of these assessments.

Monitoring of progressive rehabilitation areas will only commence after at least one wet season has passed following completion of rehabilitation works. This will allow monitoring to better assess the performance of the seedbank, rates of growth, areas of erosion, and other issues.

7.1.1.2. Survey Intensity

A 1:15,000 monitoring scale (or approximately one (1) observation per nine (9) hectares) has been adopted, as this allows for a detailed assessment of the land (McKenzie *et al.* 2008). This may be scaled up or down, depending on the level of detail required as recommended by an SQP.

Rehabilitation areas are broken into discrete management units to facilitate data management and planning for rehabilitation monitoring. Management units are to be delineated based on the age of the rehabilitation, waste type, and rehabilitation methodology.

7.1.1.3. Reference Sites

Reference sites are used as a non-mine affected point of comparison to assess performance of the rehabilitated areas with regard to groundcover, carrying capacity (productivity), weed proportion, and species mix and composition.

Monitoring reference sites have been chosen to be appropriate analogues to the areas being monitored and on-the-ground assessments are required to select the most appropriate locations. The land use of the reference site aligns with the intended PMLU of the rehabilitation area(s) being monitored. The location of reference sites have been determined during monitoring works but can be altered based on the dynamic nature of ephemeral landscapes that are, and have historically been, used for cattle grazing. The location of reference sites may also change based on landholder access restrictions.

Current reference sites used for monitoring of progressive rehabilitation on the QNH are presented in **Table 29**.

Table 29 – QNH Rehabilitation Reference Sites

Reference Site	Start		End	
	Latitude	Longitude	Latitude	Longitude
V19	-20.6168	147.8346	-20.6164	147.8346
V20	-20.6187	147.8352	-20.6182	147.8351
V21	-20.6143	147.8323	-20.6139	147.8324
V33	-20.6157	147.8336	-20.6153	147.8335

7.1.1.4. Parameters

Land Suitability and Vegetation

Vegetation assessments are conducted using 50 m transects to confirm land suitability has been achieved. Sites have been chosen by the SQP undertaking the work and are landform dependent. Any photographs taken during vegetation assessment follow the methodology found in the *Pasture photo standards* (DPIF, 2003). The following parameters are measured:

- Species present in for each transect to determine species composition and proportion of preferred species.

- Groundcover within 1 m square quadrats and is averaged to assess compliance with the groundcover completion criteria (see **Section 3.2**). This measurement also includes characterisation of the groundcover (e.g. vegetation, woody debris, rock, etc.).
- Stock carrying capacity as head/ha based on grass load.
- Vegetation structure.
- Species showing evidence of fruiting or flowering are to be noted.
- Prescribed weed species are to be noted.

Carrying capacity is calculated as per previous advice from the Queensland Department of Agriculture Fisheries and Forestry (NRA, 2015), as follows:

- One adult equivalent (450 kg beast) requires 2.2% of live body weight of dry biomass per day (3,650 kg per annum).
- A utilisation rate of 25% to 30% should be applied to prevent degradation.
- Therefore, one beast requires between 12,167 and 14,600 kg of dry biomass per annum.

The number of hectares required per beast is calculated by dividing the dry biomass required per annum by the measured mean pasture biomass (in kg/ha) of each management unit. To determine the carrying capacity, the number of hectares per beast is then converted to head/ha.

Soils

Where soil monitoring is undertaken, profiles are excavated to a depth of at least 1 m below the soil surface, with samples collected at intervals of 10 cm, except where an SQP recommends that sampling be undertaken to a different depth or at different intervals. The following parameters are to be assessed:

- Plant Available Water Capacity (PAWC)
- Exchangeable Sodium Percentage (ESP)
- Soil Salinity (1:5)
- Soil pH (1:5)
- Water erosion, calculated as a function of slope % and ESP
- Rockiness

Analysis is to be undertaken by a laboratory that is NATA-accredited for the given parameter.

The following information is also gathered in accordance with the methods and categories in the *Australian Soil and Land Survey Field Handbook* (NCST, 2009):

- Slope
- Surface condition
- Depth of topsoil and other horizons
- Soil colour per horizon (as per the Munsell Soil Colour Charts)
- Soil structure per horizon
- Coarse fragment content at the soil surface and in each horizon
- Root depth
- Presence of waterlogging features

- Presence of free carbonate and other segregations.

Other

Other data collected during monitoring is as follows:

- Evidence of any slope failure or rock falls
- Evidence of any rill or gully erosion
- Evidence of pest animals
- Note any leachate observed originating from rehabilitated co-disposal facilities.

7.1.1.5. Reporting

Following annual monitoring (or any other frequency as proposed by an SQP), a report is prepared providing a summary of data collected and an update on the progress towards meeting completion criteria. These reports are reviewed to assess the progression of rehabilitation establishment and to determine the readiness of the rehabilitated areas for certification. Monitoring reports are also used to identify the need to amend or optimise rehabilitation practices, prior to future rehabilitation works.

7.1.2. Rehabilitation Milestone Tracking

The progress of rehabilitation works against the rehabilitation milestones will be monitored to ensure the timeframes in the PRC Plan - Schedule are achieved. **Table 30** details the monitoring, documentation and assurance activities to be undertaken for each rehabilitation milestone to document and track the timely completion of rehabilitation at the CCM.

Table 30 – Rehabilitation Milestone Tracking

Milestone Criteria	Monitoring	Records/ Documentation	Review and Assurance
Rehabilitation Milestone 1: Landform Development, Shaping and Profiling			
a) 20% (11.5°) slope achieved unless an alternate slope is recommended by an RPEQ	- Detailed survey to be undertaken at the completion of RM1 in an area. Survey to be to an accuracy of +/-0.2m and may be obtained by ground or aerial means.	- 'As constructed' survey plan showing surveyed area contours, finished slope and conformance to designed landform for each sub-area - GIS shapefile created for areas that have been shaped and contoured within CCM ArcGIS Rehabilitation map file	- Progress reporting against Milestone in Annual Return - 3-Yearly PRCP Schedule Audits
b) All major earthworks completed			
c) Drainage works completed			
d) Undertake any required remediation of contaminated land (supervised by a suitably qualified person)	- Phase 1 Contaminated Land Assessment - Phase 2 Contaminated Land Assessment if required - Validation sampling as required post-remediation	- Stage 1 Contaminated Land Assessment, including remediation requirements - Records of contaminated land remediation - Validation sampling results - Certification from SQP	
Rehabilitation Milestone 2: Surface Preparation			
a) Ripping of compacted surfaces as required	- Qualitative assessment of compaction and ripping recommendation - Spot-checks of topsoil application area respreading thickness	- GIS shapefile of topsoil spreading area to be updated within CCM ArcGIS Rehabilitation map file - Topsoil Register to be updated with respreading date and volume	- Progress reporting against Milestone in Annual Return - 3-Yearly PRCP Schedule Audits
b) Placement of a minimum of 100 mm of topsoil			
Rehabilitation Milestone 3: Achievement of surface requirements (grazing pasture)			
a) Seeding undertaken where natural seedbank has proven to be unsuccessful in establishing vegetation	- Scheduled and ad-hoc inspections of rehabilitation establishment to determine reseeding requirements - Rehabilitation Monitoring (refer to 7.1.1) for groundcover and erosion. - Aerial surveys (e.g. LiDAR) of landform surface as required to identify erosion / slope failure areas	- GIS shapefile of reseeding area to be updated within CCM ArcGIS Rehabilitation map file - Seed provenance records including weed declaration - Rehabilitation Monitoring reports detailing groundcover establishment and erosion issues - Aerial survey CAD files	- Progress reporting against Milestone in Annual Return - 3-Yearly PRCP Schedule Audits
b) Mean groundcover ≥50% or > the grazed reference site mean minus one standard deviation			
c) No significant slope failure or erosion features present in the rehabilitated area, and any historical significant slope failure or erosion features have been appropriately remediated.			

Milestone Criteria	Monitoring	Records/ Documentation	Review and Assurance
Rehabilitation Milestone 4: Achievement of PMLU to Stable Condition (grazing pasture)			
Certification from an appropriately qualified person that the area has achieved stable condition (as defined in the EP Act), with regard to the following: a) Plant Available Water Capacity (PAWC) >50 mm b) Electrical Conductivity (1:5 dilution) <1.2 mS/cm or Chloride (1:5 dilution) <1,500 ppm in the root zone (60 cm depth) c) Rockiness <100% (% coarse fragments at soil surface) d) Soil pH <10 and >4 as measured at any part of the root zone e) Exchangeable Sodium Percentage (ESP %) <30% (0-10 cm depth) f) ≥70% of the productivity (carrying capacity) of grazed reference sites g) Mean groundcover ≥50% or > the grazed reference site mean minus one standard deviation h) Proportion of non-preferred species not increasing i) Proportion class of non-preferred species not more than one class greater than the grazed reference sites (see Table 11 of the QNH RMP for class descriptions) j) Proportion of declared plant pest species not increasing k) Proportion class of declared plant pest species not more than one class greater than the grazed reference sites (see Table 11 of the QNH RMP for class descriptions) l) Slope <20% (11.5°) unless an alternate slope is recommended by an RPEQ m) No contamination causing the land to be unsuitable for the use is present n) Groundwater and surface water monitoring has indicated no contamination to the surrounding ground or surface waters from rehabilitated landforms	- Rehabilitation Monitoring (refer to 7.1.1) for groundcover and erosion - Soil monitoring program - Surface and groundwater monitoring program	- Monitoring program records - Rehabilitation Monitoring reports detailing progress against acceptance criteria and erosion issues	- Progress reporting against Milestone in Annual Return - 3-Yearly PRCP Schedule Audits

7.1.3. Surface and Groundwater Monitoring

Surface and groundwater monitoring will continue to be undertaken at the locations specified in the CCM EA, as well as at other suitable identified locations within the CCM and the adjacent QNH sites as identified by a SQP. The intention of the surface and groundwater monitoring program is to identify long-term trends within the surface and groundwater quality within the site, and to ultimately provide evidence that the CCM has been rehabilitated to a condition that does not have a significant impact on the downstream surface water values present at the CCM (with no groundwater EVs having been identified for the CCM).

7.2. Maintenance

Maintenance requirements for completed rehabilitation areas are identified during ongoing rehabilitation monitoring, as well as during scheduled and ad-hoc inspections of rehabilitation areas. Where issues are noted, they are assessed on a case by case basis to determine appropriate remedial actions.

Table 31 details examples of potential issues that may arise and possible remedial actions which would be considered should these occur.

Table 31 – Potential Issues and Remedial Action

Issue	Remedial Action
Seedbank fails to germinate or groundcover dies following early establishment when using the seedbank present in topsoil.	Investigate topsoil quality. Considering supplementary seeding of future rehabilitation using this topsoil. Reseed rehabilitated areas as required.
Rapid die-off of groundcover.	Investigate cause, and reseed rehabilitation as required.
Groundcover species are failing to thrive.	Investigate soil quality, consider the suitability of applying fertilisers
Water stress – wilting foliage, heavy insect damage, die back.	Apply water to the rehabilitation area until signs of stress have been alleviated.
Water logging – stem rot, fungal infection	Ensure that drainage features are installed correctly. Where additional drainage is required, instate drainage features. Cease, or cut back, any watering regime being undertaken. Reassess the use of fertiliser (if it had been applied)
Extensive exotic weed cover	Assess the viability of undertaking additional weed management actions in order to ensure that the groundcover seedbank can undertake secondary succession.
No germination or die-off of direct seeding	Assess the seed being used and consider reseeding with a different stock. Assess soil quality and consider the requirement for fertilisation.
Erosion or Slippage in rehabilitation areas	Investigate for failures in drainage features and reinstate or add additional drainage as required. Repair rill erosion by ripping and re-contouring. Repair gully erosion by filling and recontouring.

Rehabilitation maintenance actions are recorded in the QNH Environmental Actions Register, where they are allocated to a responsible person, scheduled, and tracked through to completion.

Where appropriate, the outcomes/learnings from rehabilitation issues which require maintenance will be used to inform future rehabilitation programs, for example where a standard practice can be modified to prevent recurrence.

7.3. Rehabilitation Completion

Rehabilitation is considered functionally complete once the completion criteria set out in **Section 3.3** have been achieved, and the associated performance verification works have been undertaken. Assessments and certifications that will be undertaken for the CCM RAs are outlined in Section 6 of the QNH RMP (a LOD) and are outlined in **Table 32**.

Table 32 – Assessments and Certifications

Task	Description	Timing
Contaminated Land Assessment	Requirement for a Phase 1 for all sites, using ERC to inform the Phase 1. Phase 1 informs any required Phase 2, which in turn informs any remediation and verification. Remediation of identified contaminated areas is verified and/or approved Site Management Plan is in place. Certification that any identified contaminated land has been managed appropriately and in accordance with the relevant administering authority guideline/s.	Prior to rehabilitation of relevant areas (e.g. MIAs, Infrastructure areas, CHPPs etc.).
Geotechnical studies	Certification that the final landforms are stable/geotechnically sound, and there is a low risk of rock falls with serious environmental or safety consequences.	Following completion of all rehabilitation works with associated geotechnical or rock-fall related risks.
Surface and groundwater monitoring	Monitoring is to be undertaken to identify occurrence of any potential downstream impacts.	During rehabilitation works and following completion of works until rehabilitation is certified.
Soils Assessment	Monitoring of topsoil is to be undertaken in order to determine chemical, physical and biological properties remain appropriate for the proposed land use.	Following completion of rehabilitation works and 5-yearly until certification of rehabilitation completion.
Final Rehabilitation Report	Report outlining compliance with conditions of the EA, achievement against completion criteria, the extent and success of the rehabilitation, ongoing environmental management and monitoring requirements, and residual risk.	Following completion of rehabilitation works, to be submitted in order to discharge Financial Assurance.
Compliance Statement	Details compliance with EA conditions and confirms the accuracy of the Final Rehabilitation Report.	To be submitted with the Final Rehabilitation Report.

Once completion criteria have been met to a satisfactory level and the performance verification has been completed, the final rehabilitation report will be provided to the administering authority. The final rehabilitation report outlines compliance with conditions of the CCM EA (the primary LOD) and the QNH RMP (a LOD), specifically against the completion criteria, the extent and success of the rehabilitation, any ongoing environmental management and monitoring requirements, as well as any residual risk. A compliance statement must also be provided with the final rehabilitation report, detailing compliance of the report against the requirements of the EA, as well as the accuracy of the report itself.

Additionally, any land that has previously been on the Environmental Management Register (such as contaminated land) must be removed or have an appropriate Site Management Plan approved and in place.

Upon receipt of the final rehabilitation report, the administering authority can certify the rehabilitation and subsequently allow for the surrender of the site EA, at which time the PRCP schedule will cease to have effect.

8. References

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Appendix A PRC Plan - Schedule



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Memo information

Date	29 January 2021
To	Department of Environment and Science
Prepared by	Bowen River Coal Pty Ltd
Subject	Cows Coal Mine Progressive Rehabilitation and Closure Plan Schedule

The Progressive Rehabilitation and Closure Plan Schedule (PRC Plan – Schedule) for the Cows Coal Mine (CCM) has been developed in accordance with the requirements of the Environmental Protection Act 1994 (EP Act) with reference to the Department of Environment and Science's *Guideline Progressive rehabilitation and closure plans (PRC plans)* (ESR/2019/4964 – Version 1.00).

Accordingly, PRC Plan – Schedule, is comprised of the following (and is submitted as an appendix to the PRC Plan – Rehabilitation and Planning Part):

- Rehabilitation Area 1 Schedule Table – Rehabilitation activities related to disturbance on the Cows B Pit area.
- Rehabilitation Area 2 Schedule Table – Rehabilitation activities related to disturbance on the cows Q Pit area.
- Rehabilitation Area 3 Schedule Table – Rehabilitation activities related to the clean water drain disturbance area.
- Rehabilitation Area Milestones Table – Details the rehabilitation milestones reference in the Rehabilitation Area Schedule tables above.
- CCM Final Site Design Figure – Visualises the final site design for the CCM and the post-mining land use (PMLU). As stated in **Section 1.12.3** of the CCM PRC Plan – Rehabilitation Planning Part, flood plain modelling is not applicable for the CCM as the final landforms do not include voids and accordingly flood plain modelling is not applicable for this figure. However, previously undertaken flood plain modelling has been included in this figure for completeness and QNH contextual reference purposes (as discussed in **Section 1.12.3** of the CCM PRC Plan – Rehabilitation Planning Part).
- CCM Reference Map Figure – Visualises the rehabilitation areas (i.e. RA1, RA2 and RA3) and the PMLU for the entire CCM Mining Lease area.

Post-mining land uses (PMLU)										
Rehabilitation area	RA1									
Relevant activities	B Pit Dump, back-filled B Pit and haul roads									
Total rehabilitation area size (ha)	61.35									
Commencement of first milestone: <insert milestone reference>	First rehabilitation milestone completed for part of RA prior to PRCP transition									
PMLU	Grazing Pasture									
Date area is available	10/12/21	10/12/23	10/12/25	10/12/37	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx
Cumulative area available (ha)	32	32	32	61						
Milestone completed by	10/12/23	10/12/25	10/12/27	10/12/40	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx
Milestone Reference	Cumulative area achieved (ha)									
RM1	32	32	32	61.35						
RM2	32	32	32	61.35						
RM3	17	32	32	61.35						
RM4			32	61.35						
RM5										
RM6										
RM7										

- 1) Insert new columns to the yellow table to include further rehabilitation milestone dates.
- 2) Insert new columns to the blue table to match rehabilitation milestone dates.
- 3) Insert new rows to the blue table to include additional rehabilitation milestone references.
- 4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Post-mining land uses (PMLU)										
Rehabilitation area	RA2									
Relevant activities	Backfilled Q-Pit, Q-Pit Dump and Haul Roads									
Total rehabilitation area size (ha)	25.49									
Commencement of first milestone: <insert milestone reference>	First rehabilitation milestone completed for part of RA prior to PRCP transition									
PMLU	Grazing Pasture									
Date area is available	10/12/21	10/12/23	10/12/25	10/12/37	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx
Cumulative area available (ha)	14	14	14	25						
Milestone completed by	10/12/23	10/12/25	10/12/27	10/12/40	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx
Milestone Reference	Cumulative area achieved (ha)									
RM1	14	14	14	25.49						
RM2	14	14	14	25.49						
RM3	2	14	14	25.49						
RM4			14	25.49						
RM5										
RM6										
RM7										

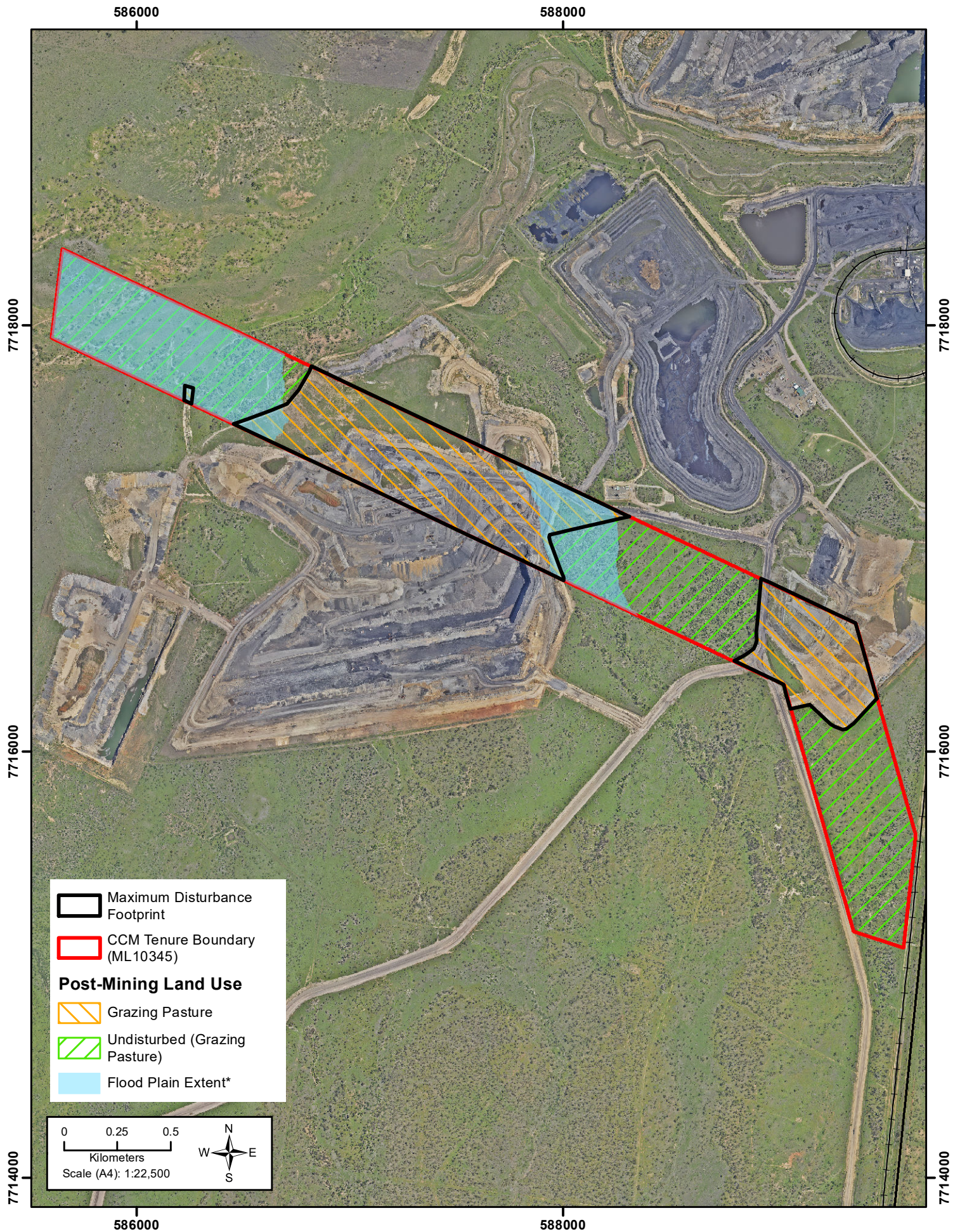
- 1) Insert new columns to the yellow table to include further rehabilitation milestone dates.
- 2) Insert new columns to the blue table to match rehabilitation milestone dates.
- 3) Insert new rows to the blue table to include additional rehabilitation milestone references.
- 4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Post-mining land uses (PMLU)										
Rehabilitation area	RA3									
Relevant activities	Clean Water Drain									
Total rehabilitation area size (ha)	0.28									
Commencement of first milestone: <insert milestone reference>	First rehabilitation milestone completed for RA prior to PRCP transition									
PMLU	Grazing Pasture									
Date area is available	10/12/21	10/12/23	10/12/25	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx
Cumulative area available (ha)	0.28	0.28	0.28							
Milestone completed by	10/12/23	10/12/25	10/12/27	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx
Milestone Reference	Cumulative area achieved (ha)									
RM1	0.28	0.28	0.28							
RM2	0.28	0.28	0.28							
RM3		0.28	0.28							
RM4			0.28							
RM5										
RM6										
RM7										

- 1) Insert new columns to the yellow table to include further rehabilitation milestone dates.
- 2) Insert new columns to the blue table to match rehabilitation milestone dates.
- 3) Insert new rows to the blue table to include additional rehabilitation milestone references.
- 4) Insert the relevant number in the "Milestone reference" column (i.e. RM1).

Milestone reference	Rehabilitation milestone	Milestone criteria
RM1	Landform development, shaping and profiling	a) 20% (11.5°) slope achieved unless an alternate slope is recommended by an RPEQ b) All major earthworks completed c) Drainage works completed d) Undertake any required remediation of contaminated land (supervised by a suitably qualified person)
RM2	Surface preparation	a) Ripping of compacted surfaces as required b) Placement of a minimum of 100 mm of topsoil
RM3	Achievement of surface requirements (grazing pasture)	a) Seeding undertaken where natural seedbank has proven to be unsuccessful in establishing vegetation b) Mean groundcover ≥50% or > the grazed reference site mean minus one standard deviation c) No significant slope failure or erosion features present in the rehabilitated area, and any historical significant slope failure or erosion features have been appropriately remediated.
RM4	Achievement of post-mining land use to stable condition (grazing pasture)	Certification from an appropriately qualified person that the area has achieved stable condition (as defined in the EP Act), with regard to the following: a) Plant Available Water Capacity (PAWC) >50 mm b) Electrical Conductivity (1:5 dilution) <1.2 mS/cm or Chloride (1:5 dilution) <1,500 ppm in the root zone (60 cm depth) c) Rockiness <100% (% coarse fragments at soil surface) d) Soil pH <10 and >4 as measured at any part of the root zone e) Exchangeable Sodium Percentage (ESP %) <30% (0-10 cm depth) f) ≥70% of the productivity (carrying capacity) of grazed reference sites g) Mean groundcover ≥50% or > the grazed reference site mean minus one standard deviation h) Proportion of non-preferred species not increasing i) Proportion class of non-preferred species not more than one class greater than the grazed reference sites (see Table 11 of the QNH RMP for class descriptions) j) Proportion of declared plant* pest species not increasing k) Proportion class of declared plant* pest species not more than one class greater than the grazed reference sites (see Table 11 of the QNH RMP for class descriptions) l) Slope <20% (11.5°) unless an alternate slope is recommended by an RPEQ m) No contamination causing the land to be unsuitable for the use is present n) Groundwater and surface water monitoring has indicated no contamination to the surrounding ground or surface waters from rehabilitated landforms o) Results of grazing trials within rehabilitated areas at the QNH *Per the requirements of the superceded <i>Land Protection (Pest and Stock Route Management) Act 2002</i>

- 1) Insert new rows below the table to record more Rehabilitation Area Milestones for the project
- 2) Ensure all Rehabilitation Milestones recorded in this table align with those included in the RA sheets in this form.
- 3) See the PRCP guideline before developing site-specific Rehabilitation Area Milestones



File Ref:

Date: 29/01/2021

Coordinate System: WGS 1984 UTM Zone 55S

Projection: Transverse Mercator Datum: WGS 1984

Data sources:

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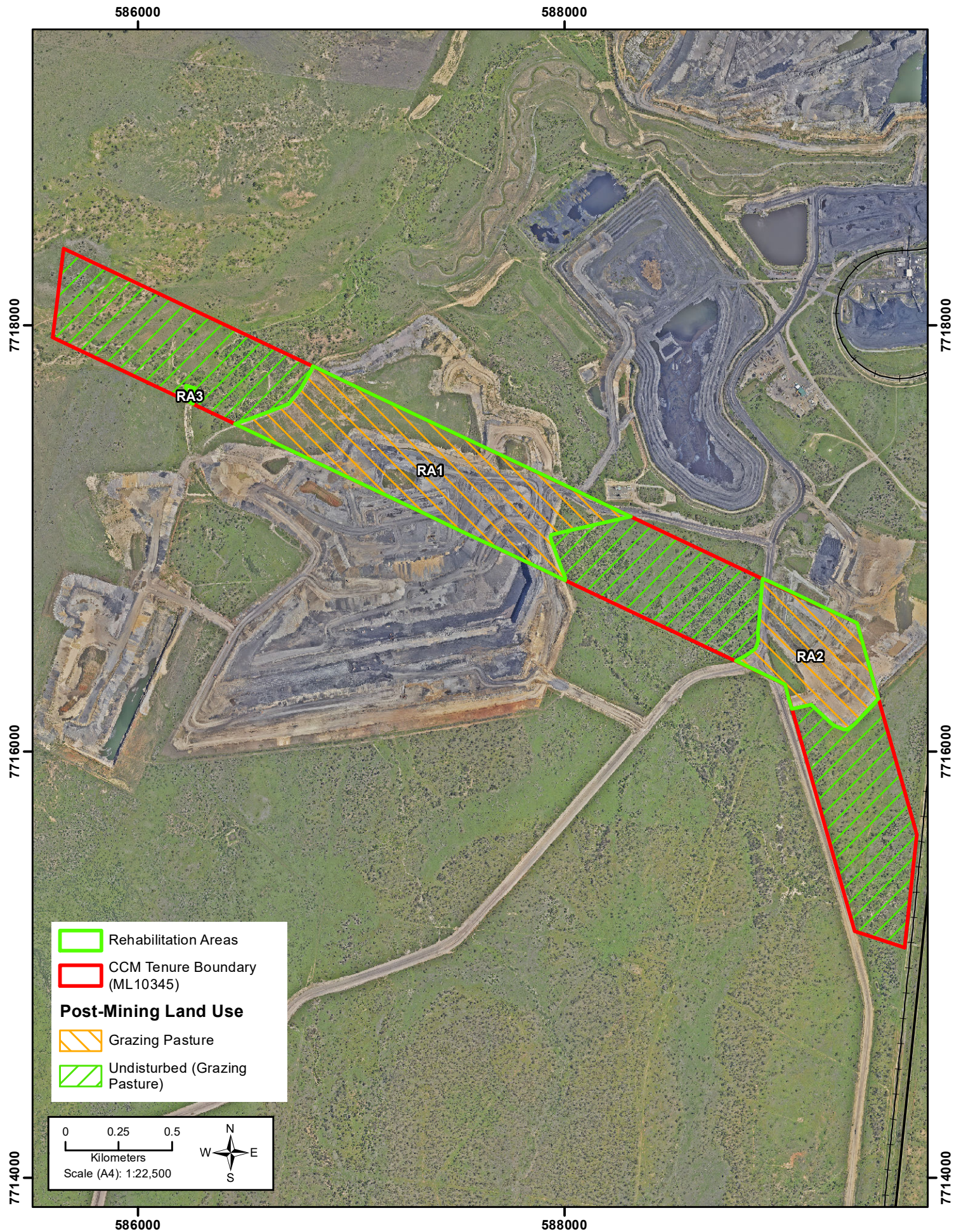
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QCOAL GROUP

CCM Final Site Design

Prepared by: B. OR
Service Layer Credits:



File Ref:

Date: 29/01/2021

Coordinate System: WGS 1984 UTM Zone 55S

Projection: Transverse Mercator Datum: WGS 1984

Data sources:

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CCM Reference Map

Prepared by: B. OR
Service Layer Credits:

Appendix B Environmental Authority

Permit

Environmental Protection Act 1994

Environmental authority EPML00334613

This environmental authority is issued by the administering authority under Chapter 5 of the Environmental Protection Act 1994.

Environmental authority number: EPML00334613

Environmental authority takes effect on 9 March 2020

Environmental authority holder(s)

Name(s)	Registered address
Bowen River Coal Pty Ltd	Level 15 40 Creek Street BRISBANE QLD 4001

Environmentally relevant activity and location details

Environmentally relevant activity/activities	Location(s)
Resource Activity, Ancillary 33 - Crushing, milling, grinding or screening, Crushing, grinding, milling or screening more than 5000t of material in a year	ML10345
Resource Activity, Schedule 3, 13: Mining black coal	ML10345
Resource Activity, Ancillary 16 - Extraction and Screening, 2: Extracting, other than by dredging, in a year, the following quantity of material, (b) more than 100,000t but not more than 1,000,000t	ML10345
Resource Activity, Ancillary 63 - Sewage Treatment, 1: Operating sewage treatment works, other than norelease works, with a total daily peak design capacity of, (b-i) more than 100 but not more than 1500EP if treated effluent is discharged from the works to an infiltration trench or through an irrigation scheme	ML10345
Resource Activity, Ancillary 15 - Fuel burning, Using fuel burning equipment that is capable of burning at least 500kg of fuel in an hour	ML10345
Resource Activity, Schedule 3, 09: A mining activity involving drilling, costeaning, pitting or carrying out geological surveys causing significant disturbance	ML10345
Resource Activity, Ancillary 60 - Waste disposal, 1: Operating a facility for disposing of, in a year, the	ML10345

Environmentally relevant activity/activities	Location(s)
following quantity of waste mentioned in subsection (1) (a), (a) less than 50,000t	

Additional information for applicants

Environmentally relevant activities

The description of any environmentally relevant activity (ERA) for which an environmental authority (EA) is issued is a restatement of the ERA as defined by legislation at the time the EA is issued. Where there is any inconsistency between that description of an ERA and the conditions stated by an EA as to the scale, intensity or manner of carrying out an ERA, the conditions prevail to the extent of the inconsistency.

An EA authorises the carrying out of an ERA and does not authorise any environmental harm unless a condition stated by the EA specifically authorises environmental harm.

A person carrying out an ERA must also be a registered suitable operator under the *Environmental Protection Act 1994* (EP Act).

Contaminated land

It is a requirement of the EP Act that an owner or occupier of contaminated land give written notice to the administering authority if they become aware of the following:

- the happening of an event involving a hazardous contaminant on the contaminated land (notice must be given within 24 hours); or
- a change in the condition of the contaminated land (notice must be given within 24 hours); or
- a notifiable activity (as defined in Schedule 3) having been carried out, or is being carried out, on the contaminated land (notice must be given within 20 business days)

that is causing, or is reasonably likely to cause, serious or material environmental harm.

For further information, including the form for giving written notice, refer to the Queensland Government website www.qld.gov.au, using the search term 'duty to notify'.

Take effect

Please note that, in accordance with section 200 of the EP Act, an EA has effect:

- a) if the authority is for a prescribed ERA and it states that it takes effect on the day nominated by the holder of the authority in a written notice given to the administering authority-on the nominated day; or
- b) if the authority states a day or an event for it to take effect-on the stated day or when the stated event happens; or
- c) otherwise- one the day the authority is issued.

However, if the EA is authorising an activity that requires an additional authorisation (a relevant tenure for a resource activity, a development permit under the *Planning Act 2016* or an SDA Approval under the *State Development and Public Works Organisation Act 1971*), this EA will not take effect until the additional authorisation has taken effect.

If this EA takes effect when the additional authorisation takes effect, you must provide the administering authority written notice within 5 business days of receiving notification of the related additional authorisation taking effect.

If you have incorrectly claimed that an additional authorisation is not required, carrying out the ERA without the additional authorisation is not legal and could result in your prosecution for providing false or misleading information or operating without a valid environmental authority.

Gillian Naylor
Department of Environment and Science
Delegate of the administering authority
Environmental Protection Act 1994

Enquiries:
Coal & Gemstone Mining
Department of Environment and Science

Phone: 07 4987 9320
Email: crmining@des.qld.gov.au

Date issued: 09 March 2020

Obligations under the *Environmental Protection Act 1994*

In addition to the requirements found in the conditions of this environmental authority, the holder must also meet their obligations under the EP Act, and the regulations made under the EP Act. For example, the holder must comply with the following provisions of the Act:

- general environmental duty (section 319)
- duty to notify environmental harm (section 320-320G)
- offence of causing serious or material environmental harm (sections 437-439)
- offence of causing environmental nuisance (section 440)
- offence of depositing prescribed water contaminants in waters and related matters (section 440ZG)
- offence to place contaminant where environmental harm or nuisance may be caused (section 443)

Other permits required

This permit only provides an approval under the *Environmental Protection Act 1994*. In order to lawfully operate you may also require permits / approvals from your local government authority, other business units within the department and other State Government agencies prior to commencing any activity at the site. For example, this may include permits / approvals with your local Council (for planning approval), the Department of Transport and Main Roads (to access state controlled roads), the Department of Natural Resources, Mines and Energy (to clear vegetation), and the Department of Agriculture and Fisheries (to clear marine plants or to obtain a quarry material allocation).

Obligations under the *Mining and Quarrying Safety and Health Act 1999*

If you are operating a quarry, other than a sand and gravel quarry where there is no crushing capability, you will be required to comply with the *Mining and Quarrying Safety and Health Act 1999*. For more information on your obligations under this legislation contact Mine Safety and Health at www.dnrme.qld.gov.au, or phone 13 QGOV (13 74 68) or your local Mines Inspectorate Office.

Development Approval

This permit is not a development approval under the *Planning Act 2016*. The conditions of this environmental authority are separate, and in addition to, any conditions that may be on the development approval. If a copy of this environmental authority is attached to a development approval, it is for information only, and may not be current. Please contact the Department of Environment and Science to ensure that you have the most current version of the environmental authority relating to this site.

Legislative Requirements and Conditions of Environmental Authority

Legislative requirements

Other permits required

This permit only provides an approval under the Environmental Protection Act 1994. In order to lawfully operate you may also require permits / approvals from your local government authority, other business units within the department and other State Government agencies prior to commencing any activity at the site.

Obligations under the Mining and Quarrying Safety and Health Act 1999

If you are operating a quarry, other than a sand and gravel quarry where there is no crushing capability, you will be required to comply with the Mining and Quarrying Safety and Health Act 1999. For more information on your obligations under this legislation contact Mine Safety and Health at www.dnrme.qld.gov.au, or phone 13 QGOV (13 74 68) or your local Mines Inspectorate Office.

Work diary

The environmental authority holder is required under section 318X of the Environmental Protection Act 1994 to maintain a work diary. The work diary is available at www.qld.gov.au using the publication number ESR/2015/1696 as a search term.

Agency interest: General	
Condition number	Condition
A1	Coal extraction The environmental authority holder is approved for the extraction of ROM (run-of-mine) coal.
A2	This environmental authority authorises environmental harm referred to in the conditions. Where there is no condition or this environmental authority is silent on a matter, the lack of a condition or silence does not authorise environmental harm.
A3	In carrying out the mining activity authorised by this environmental authority, disturbance of land on Figure 1- Site map, domains and groundwater monitoring locations: a) may occur in the areas marked 'A'; b) must not occur in the areas marked 'B'; and c) may occur in the areas marked 'C', but only in accordance with Condition A4.
A4	Any disturbance within the areas marked 'C' on Figure 1- Site map, domains and groundwater monitoring locations: a) is only authorised to the extent reasonably necessary for exploration activities roads, fences, underground services, low-impact telecommunications facilities, electrical sub-stations, transmission grid works and supply network works, storage depots, similar minor infrastructure and ancillary facilities for any of the above; and b) any disturbance within areas marked 'A' or 'C' is not to impact adversely on areas marked 'B'.
A5	The holder of this environmental authority must: a) install all measures, plant and equipment necessary to ensure compliance with the conditions of this environmental authority; b) maintain such measures, plant and equipment in a proper and efficient condition; c) operate such measures, plant and equipment in a proper and efficient manner; and d) ensure all instruments and devices used for the measurement or monitoring of any parameter under any condition of this environmental authority are properly calibrated.
A6	Monitoring Except where specified otherwise in another condition of this environmental authority, all monitoring records or reports required by this environmental authority must be kept for a period of not less than five (5) years.

A7	Risk management The holder of this environmental authority must develop and implement a risk management system for mining activities which mirrors the content requirements of the Standard for Risk Management (ISO31000:2009), or the latest edition of an Australian Standard for risk management, to the extent relevant to the environmental management, prior to the commencement of mining activities.
A8	Notification of emergencies, incidents and exceptions The holder of this environmental authority must notify the administering authority by written notification within 24 hours, after becoming aware of any emergency or incident which results in the release of contaminants not in accordance, or reasonably expected to be not in accordance with, the conditions of this environmental authority.
A9	Within ten (10) business days following the initial notification of an emergency or incident, or receipt of monitoring results, whichever is the latter, further written advice must be provided to the administering authority, including the following: a) results and interpretation of any samples taken and analysed; b) outcomes of actions taken at the time to prevent or minimise unlawful environmental harm; and c) proposed actions to prevent a recurrence of the emergency or incident.
A10	Complaints The holder of this environmental authority must record all environmental complaints received about the mining activities including the following details: a) name, address and contact number for/of the complainant; b) time and date of complaint; c) reasons for the complaint; d) investigations undertaken; e) conclusions formed; f) actions taken to resolve the complaint; g) any abatement measures implemented; and h) person responsible for resolving the complaint.
A11	The holder of this environmental authority must, when requested by the administering authority, undertake relevant specified monitoring within a reasonable timeframe nominated or agreed to by the administering authority to investigate any complaint of environmental harm. The results of the investigation (including an analysis and interpretation of the monitoring results) and abatement measures, where implemented, must be provided to the administering authority within ten (10) business days of completion of the investigation, or no later than ten (10) business days after the end of the timeframe nominated by the administering authority to undertake the investigation.

A12	Third Party Reporting The holder of this environmental authority must: a) within one (1) year of the commencement of this authority, obtain from a suitably qualified and experienced third party a report on compliance with the conditions of this environmental authority; b) obtain further such reports at regular intervals not exceeding three years from the completion of the report referred to above; and c) provide each report to the administering authority within 90 days of its completion.
A13	Where a condition of this environmental authority requires compliance with a standard, policy or guideline published externally to this environmental authority and the standard is amended or changed subsequent to the issue of this environmental authority, the holder of this environmental authority must: a) comply with the amended or changed standard, policy or guideline within two (2) years of the amendment or change being made, unless a different period is specified in the amended standard or relevant legislation, or where the amendment or change relates specifically to regulated structures referred to in Schedule I: Dams and Levees the time specified in that condition; and b) until compliance with the amended or changed standard, policy or guideline is achieved; continue to remain in compliance with the corresponding provision that was current immediately prior to the relevant amendment or change.
Agency interest: Air	
Condition number	Condition
B1	Dust nuisance The release of dust or particulate matter or (both) resulting from the mining activity must not cause an environmental nuisance at any sensitive or commercial place.

B2	When requested by the administering authority or as a result of a complaint (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the authorised officer), dust and particulate monitoring must be undertaken, and the results thereof notified to the administering authority within 14 days following completion of monitoring. Monitoring must be carried out at a place or places relevant to the potentially affected dust sensitive place as agreed upon with the administering authority. Dust and particulate matter must not exceed the following levels when measured at the agreed locations: a) Dust deposition of 120 milligrams per square metre per day, averaged over one (1) month, when monitored in accordance with the most recent version of Australian Standard <i>AS3580.10.1 Methods for sampling and analysis of ambient air—Determination of particulate matter—Deposited matter – Gravimetric method</i>; b) A concentration of total particulate matter suspended in the atmosphere of 90 micrograms per cubic metre over a one (1) year averaging time, when monitored in accordance with the most recent version of <i>AS/NZS3580.9.3:2003 Methods for sampling and analysis of ambient air—Determination of suspended particulate matter—Total suspended particulate matter (TSP)—High volume sampler gravimetric method</i>; c) A concentration of particulate matter with an aerodynamic diameter of less than 10 micrometres (PM₁₀) suspended in the atmosphere of 50 micrograms per cubic metre over a 24-hour averaging time, when monitored in accordance with the most recent version of either: i) Australian Standard <i>AS3580.9.6 Methods for sampling and analysis of ambient air—Determination of suspended particulate matter— PM₁₀ high volume sampler with size-selective inlet – Gravimetric method</i>; or ii) Australian Standard <i>AS3580.9.9 Methods for sampling and analysis of ambient air—Determination of suspended particulate matter— PM₁₀ low volume sampler—Gravimetric method</i>; or iii) Any alternative method of monitoring PM₁₀ which may be permitted by the 'Air Quality Sampling Manual' as published from time to time by the administering authority. NOTE: The exceedances of PM₁₀ above 50 micrograms per cubic metre over a 24-hour averaging time as a result of bushfires, dust storms and fuel reduction burning for fire management purposes are not considered a breach of Condition B2 (b).
B3	If the monitoring undertaken as per Condition B2 indicates an exceedance of the relevant limits in Condition B2, then the environmental authority holder must 1) investigate whether the exceedance is due to emissions from the mining activities and if the exceedance is due to mining activities the environmental authority holder must immediately implement dust abatement measures so that emissions of dust from the activity do not result in further environmental nuisance; and 2) notify the administering authority within seven (7) days of the exceedance occurring. The notification must also include the actions taken in accordance with Condition B3(1).

B4	Dust Management Plan A Dust Management Plan must be developed and implemented by an appropriately qualified person for all stages of the authorised mining activities. The Dust Management Plan must be submitted to the administering authority for review and comment by 30 June 2019.
B5	The Dust Management Plan required by Condition B4 must include: a) a preventative management system for dust control; b) Trigger Action Response Program; c) Site background (contextual information); d) Proposed works and potential impacts & impact analysis; e) Site risk assessment; f) Design of an internal operational monitoring program including objectives, separate from any compliance monitoring or limits/levels required by Condition B2; g) Performance criteria and monitoring methods; h) Number and location of monitoring sites; i) Quality assurance/quality control (QA/QC) requirements; j) Stakeholder consultation; k) Roles and responsibilities; and l) Reporting
B6	The dust management plan required by Condition B4 must be reviewed annually and submitted to the administering authority upon request.

Agency interest: Waste Management	
Condition number	Condition
C1	Burning Waste Unless otherwise permitted by the conditions of this environmental authority or with prior approval from the administering authority and in accordance with a relevant standard operating procedure, waste must not be burnt.
C2	The holder of this environmental authority may burn vegetation cleared in the course of carrying out extraction activities provided that the activity does not cause environmental harm at any sensitive place or commercial place.
C3	Disposing of scrap tyres generated from the mining activities undertaken in spoil emplacements located on ML10345 is acceptable, provided tyres are placed as deep in spoil located on ML10345 as reasonably practicable.
C4	The holder of the environmental authority must keep a record of the number and location of scrap tyres disposed of in accordance with Condition C4 .
C5	Scrap tyres resulting from the mining activities disposed within the operational land must not impede saturated aquifers or compromise the stability of the consolidated landform.
C6	Storage of Tyres Scrap tyres stored awaiting disposal or transport for take-back and recycling, or waste-to-energy options must be stored in stable stacks and at least ten (10) metres from any other scrap tyre storage area, or combustible or flammable material, including vegetation.
C7	All reasonable and practicable fire prevention measures must be implemented, including removal of grass and other materials within a ten (10) metre radius of the scrap tyre storage area.

C8	Waste Management A Waste Management Plan, in accordance with the <i>Waste Reduction and Recycling Act 2011</i>, must be implemented and must cover: a) describe how Byerwen Coal Mine recognise and apply the waste and resource management hierarchy; b) identify the waste streams from the project; c) a program for safe recycling or disposal of all wastes- reusing and recycling where possible; d) the waste management control strategies must consider: 1. the type of wastes; 2. segregation of the wastes; 3. storage of the wastes; 4. transport of the wastes; 5. monitoring and reporting matters concerning the waste; 6. emergency response planning; 7. disposal, reused and recycling options; e) detail the hazardous characteristics of the waste generated (if any); f) cover a disposal procedure for hazardous wastes; g) outline the process to be implemented to allow for continuous improvement of the waste management systems h) identify responsible staff (positions) for implementing, managing and reporting the Waste Management Plan; and i) cover a staff awareness and induction program that encourages re-use and recycling.
C9	Regulated waste records must be kept for five (5) years, and must include the following information: a) date of pickup of waste; b) description of waste; c) cross reference to relevant waste transport documentation; d) quantity of waste; e) origin of the waste; f) destination of the waste; and g) intended fate of the waste, for example, type of waste treatment, reprocessing or disposal. Note: <i>Records of documents maintained in compliance with a waste tracking system established under the Environmental Protection Act 1994 or any other law for regulated waste will be deemed to satisfy this condition.</i>

C10	Records of trade and regulated wastes or material leaving the mining lease for recycling or disposal, including the final destination and method of treatment, must be in accordance with the Waste Reduction and Recycling Act 2011
C11	All regulated waste received at and removed from the site must be transported by a person who holds a current authority to transport such waste under the provisions of the <i>Environmental Protection Act 1994</i> .
C12	Except as otherwise provided by the conditions of this authority, all waste removed from the site must be taken to a facility that is lawfully allowed to accept such waste under the provisions of the <i>Environmental Protection Act 1994</i> .

Agency interest: Noise and Vibration	
Condition number	Condition
D1	Noise Noise resulting from the authorised mining activities must not cause an environmental nuisance at any sensitive or commercial place.
D2	When requested by the administering authority, or as a result of a complaint noise monitoring must be undertaken and the results must be notified within 14 days to the administering authority following completion of monitoring. Monitoring must be carried out at a place or places relevant to the potentially affected noise sensitive place as agreed upon with the administering authority.
D3	Low Frequency Noise Noise emissions from the activity, when including substantial low frequency noise, must not cause an overall sound pressure level at a noise sensitive place exceeding 55 dB(Z). NOTE: “<i>Substantial low frequency noise</i>” means a noise emission that has an unbalanced frequency spectrum shown in a one-third octave band measurements, with a predominant component located within the frequency range 10 to 200 Hz.
D4	All noise monitoring which is conducted as per Condition D2 must be completed in accordance with the following noise monitoring requirements: a) All noise monitoring must be conducted in accordance with the administering authority's most recent version of the Noise Measurement Manual. b) Source noise levels must be expressed as component noise levels for the purposes of comparison with noise limits. c) All noise monitoring devices must be calibrated in accordance with AS IEC 61672.1-2004. d) Monitoring location(s) must be relevant to the matter(s) under investigation.
D5	If the administering authority request for noise monitoring is in relation to a complaint and results exceed the limits in Table D1 - Noise limits, then the environmental authority holder must: a) address the complaint including the use of appropriate dispute resolution if required; and b) implement noise abatement measures so that emissions of noise from the activity do not result in further environmental nuisance.
D6	Blasting Peak particle velocity and/or air blast overpressure resulting from blasting must not cause an environmental nuisance at any sensitive or commercial place.

D7	The holder of this environmental authority must develop and implement a blast monitoring program to monitor compliance with Table D2 – Blasting noise limits for: a) at least 50% of all blasts undertaken on this site in each month at the nearest and most affected sensitive place(s) or commercial place(s). b) all blasts conducted during any time period specified by the administering authority at the nearest and most affected sensitive place(s) or commercial place(s) or another such place to investigate an allegation of environmental nuisance caused by blasting.
D8	If the results of blast monitoring undertaken as per Condition D7 exceed the limits in Table D2 – Blasting noise limits, then the environmental authority holder must investigate and report to the administering authority within 14 days following completion of monitoring.

Table D1 – Noise limits

Noise level dB(A)	Monday to Sunday (including public holidays)		
	7am – 6pm	6pm – 10pm	10pm – 7am
	Noise measured at a nuisance sensitive or commercial place		
LA_{eq adj,10}	Background Plus 5	Background Plus 5	Background Plus 3
LA_{1adj,10}	Background Plus 10	Background Plus 10	Background Plus 5

NOTE - Associated notes and requirements:

- a) "Background" means background noise level, measured in the absence of the noise under investigation, as **LA_{90,T}** being the A-weighted sound pressure level exceeded for ninety (90) per cent of the time period of 15 minutes, using Fast response.
- b) "**LA_{eq adj,T}**" means the equivalent continuous A-weighted sound pressure level, adjusted for noise character, measured in the presence of the noise under investigation over a time period of 10 minutes, using Fast response.
- c) "**LA_{1 adj,T}**" means the A-weighted sound pressure level, adjusted for noise character, measured in the presence of the noise under investigation and exceeded for one (1) per cent of the time period of 10 minutes, using Fast response.

Table D2 – Blasting noise limits

Blasting noise limits	Sensitive or commercial Blasting noise limits place limits	
	Daytime 7am to 6pm	Evening/Night/Early Morning 6pm to 7am
Airblast overpressure	115 dB (Linear) Peak for nine (9) out of ten (10) consecutive blasts initiated and not greater than 120 dB (Linear) Peak at any time	No blasting is allowed during these times
Ground vibration peak particle velocity	5mm/second peak particle velocity for nine (9) out of ten (10) consecutive blasts and not greater than 10 mm/second peak particle velocity at any time	No blasting is allowed during these times

Agency interest: Groundwater	
Condition number	Condition
E1	The holder of this environmental authority must not release contaminants to groundwater.
E2	Groundwater Monitoring All determinations of groundwater quality and biological monitoring must be performed by an appropriately qualified person.
E3	Groundwater quality Groundwater must be monitored at the locations and frequencies described in Table E1 - Groundwater monitoring locations and frequency and Figure 1- Site map, domains and groundwater monitoring locations .
E4	The quality characteristics and/or trigger levels must be reviewed in relation to immediately adjacent operating coal mines by 30 June 2021 to adequately determine the water quality characteristics and trigger levels for inclusion in this environmental authority.

E5	Groundwater standing water level In the event that groundwater fluctuations in excess of two (2) metres per year are detected at the monitoring bores in Table E1 - Groundwater monitoring locations and frequency, the holder of this environmental authority must compare the groundwater fluctuation results to a suitable reference bore for that location and aquifer and: 1) if the bore result is less than the reference bore data, then no action is to be taken; or 2) if the fluctuation in the bore result is greater than the reference bore data, undertake an investigation within 14 days; and a) Within ten (10) business days of receiving the result of the investigation, complete, and submit a report via WaTERS outlining: i. Details of the investigations carried out, ii. Whether the result is directly associated with mining activities, and, if so: 1. Whether environmental harm has occurred, and 2. Any action required to mitigate environmental harm.
E6	Annual Groundwater Monitoring Review The groundwater monitoring data must be reviewed on an annual basis. The review must include the assessment of groundwater levels and quality data, and the suitability of the monitoring network. The assessment must be submitted to the administering authority within 28 days of receiving the report.
E7	Bore construction and maintenance and decommissioning The construction, maintenance and management and decommissioning of groundwater bores (including groundwater monitoring bores) must be undertaken in a manner that prevents or minimises impacts to the environment and ensures the integrity of the bores to obtain accurate monitoring.

Table E1 - Groundwater monitoring locations and frequency

Monitoring Point	Location		Aquifer	Screen depth (m) ¹	Surface RL (m) ²	Monitoring Frequency ³
	Latitude	Longitude				
CW075	-20.647660	147.848871	Moranbah Coal measures	TBD	174.18	Quarterly
CW079	-20.648400	147.850805	Moranbah Coal measures	TBD	179.38	
CW053	-20.634205	147.826788	Moranbah Coal measures	TBD	156.71	
CW061	-20.635930	147.826884	Moranbah Coal measures	TBD	156.90	

NOTE:

¹Screen depths are to be installed and will be included in this EA following the review in accordance with condition E6.

²RL must be calculated from the nearest 5cm from the top of the bore casing.

³Monitoring is not required where a bore has been removed as a direct result of the mining activity.

Agency interest: Water	
Condition number	Condition
F1	Contaminants that will, or have the potential to cause environmental harm, must not be released directly or indirectly to any waters as a result of the authorised mining activities, except as permitted under the conditions of this environmental authority.
F2	The release of mine affected water to waters must only occur from the release points specified in Table F1- Mine affected water release points, sources and receiving waters and depicted in Figure 2 - Mine affected water release points, sources and receiving waters attached to this environmental authority.
F3	The release of mine affected water to waters from the release points must be monitored at the locations specified in Table F1- Mine affected water release points, sources and receiving waters for each quality characteristic and at the frequency specified in Table F2 Mine affected water release limits and Table F3 - Release contaminant trigger investigation levels, potential contaminants. NOTE: The administering authority will take into consideration any extenuating circumstances prior to determining an appropriate enforcement response in the event Condition F5 is contravened due to a temporary lack of safe or practical access. The administering authority expects the environmental authority holder to take all reasonable and practicable measures to maintain safe and practical access to designated monitoring locations.
F4	The release of mine affected water to waters in accordance with Condition F2 must not exceed the release limits stated in Table F2 - Mine affected water release limits when measured at the monitoring points specified in Table F1- Mine affected water release points, sources and receiving waters for each quality characteristic.

F5	If quality characteristics of the release exceed any of the trigger levels specified in Table F3 - Release contaminant trigger investigation levels, potential contaminants during a release event, the environmental authority holder must compare the downstream results in the receiving waters (Table F6 - Receiving water upstream background sites and downstream monitoring points) to the trigger values specified in Table F3 - Release contaminant trigger investigation levels, potential contaminants and: 1) where the trigger values are not exceeded then no action is to be taken; or 2) where the downstream results exceed the trigger values specified in Table F3 - Release contaminant trigger investigation levels, potential contaminants for any quality characteristic, compare the results of the downstream site to the data from background monitoring sites (Table F6 - Receiving water upstream background sites and downstream monitoring points); and a. if the result is less than the background monitoring site data, then no action is to be taken; or b. if the result is greater than the background monitoring site data, notify the administering authority via WaTERS within 24 hours of receiving the result, and complete an investigation and provide a written report to the administering authority via WaTERS within 28 days of receiving the result, outlining i. details of the investigations carried out; and ii. whether the result is directly associated with mining activities, and, if so: 1. whether environmental harm has occurred, and 2. actions taken to prevent environmental harm. NOTE: Where an exceedance of a trigger level has occurred and is being investigated, in accordance with F5(2)(b) of this condition, no further reporting is required for subsequent trigger events for that quality characteristic.
F6	Mine affected water release events The holder must ensure a stream flow gauging station/s is installed, operated and maintained to determine and record stream flows at the locations and flow recording frequency specified in Table F4 - Mine affected water release during flow events.
F7	The release of mine affected water to waters in accordance with Condition F2 must only take place during periods of natural flow in accordance with the receiving water flow criteria for discharge specified in Table F4 - Mine affected water release during flow events for the release point(s) specified in Table F1 - Mine affected water release points, sources and receiving waters.

Table F1 - Mine Affected Water Release Points, Sources and Receiving Waters

Release Point (RP) ¹	Latitude	Longitude	Mine Affected Water Source and Location	Monitoring Point	Receiving waters description
RP1	-20.652768	147.855504	Control Sediment Dam 1	Spillway	Two Mile Creek
RP2	-20.645445	147.847256	Control Sediment Dam 2	Spillway	Two Mile Creek

NOTE: 1. Where fixed release infrastructure is not currently installed portable pipes and pumps will be utilised.

F8	The daily quantity of mine affected water released from each release point must be measured and recorded.
F9	Releases to waters must be undertaken so as not to cause erosion of the bed and banks of the receiving waters, or cause a material build-up of sediment in such waters.
F10	Notification of release event The environmental authority holder must notify the administering authority via WaTERS as soon as practicable and no later than 24 hours after commencing to release mine affected water to the receiving environment. Notification must include the submission of written advice to the administering authority of the following information: a) release commencement date/time; b) release point/s; c) release rate; d) release salinity and/or electrical conductivity; e) receiving water/s including the natural flow rate; and f) details regarding the compliance of the release with the conditions of Schedule F – Water.
F11	The environmental authority holder must notify the administering authority via WaTERS as soon as practicable, and no later than 24 hours after cessation of a release notified under Condition F10. The cessation notification must include the following information: a) release cessation date and time; b) release point/s; c) release rate; d) water quality of release; e) total volume of water released; f) natural flow rate in the receiving water; and g) details regarding the compliance of the release with the conditions of this environmental authority. Note: Successive or intermittent releases from a Release Point occurring within 24 hours of the cessation of any individual release can be considered part of a single release event and do not require individual notification for the purpose of compliance with conditions F10, F11 and F12, provided the relevant details of the release are included within the notification provided in accordance with conditions F10, F11 and F12.
F12	The environmental authority holder must within twenty-eight (28) days after cessation of a release event notified under Condition F10 provide a report to the administering authority via WaTERS, which must include the following information: a) all continuous and in-situ water quality monitoring results (including laboratory analyses); and b) any further matters pertinent to the water release event.

F13	Notification of release event exceedance If the release limits defined in Table F2 - Mine affected water release limits are exceeded, the holder of the environmental authority must notify the administering authority within 24 hours of receiving the results.
F14	The environmental authority holder must, within 28 days of a release that is not compliant with the conditions of this environmental authority, provide a report to the administering authority via WaTERS detailing: a) the reason for the release; b) the location of the release; c) the total volume of the release and which (if any) part of this volume was non-compliant; d) the total duration of the release and which (if any) part of this period was non-compliant; e) all water quality monitoring results (including all laboratory analyses); f) identification of any environmental harm as a result of the non-compliance; g) all calculations; h) any other matters pertinent to the water release event.
F15	Receiving environment monitoring and contaminant trigger levels The quality of the receiving waters must be monitored at the locations specified in Table F6 - Receiving water upstream background sites and downstream monitoring points and Figure 2 Mine affected water release points, sources and receiving waters for each quality characteristic and at the monitoring frequency stated in Table F5 - Receiving waters contaminant trigger levels.

F16	If quality characteristics of the receiving water at the downstream monitoring points (Table F6 - Receiving water upstream background sites and downstream monitoring points) exceed any of the trigger levels specified in Table F5 - Receiving waters contaminant trigger levels during a release event, the environmental authority holder must compare the downstream results to the results from the upstream monitoring points (Table F6 - Receiving water upstream background sites and downstream monitoring points) in the receiving waters and: 1) if the result is less than the upstream monitoring data, then no action is to be taken; or 2) if the result is greater than the upstream monitoring data, notify the administering authority via WaTERS within 24 hours of receiving the result, and complete an investigation and provide a written report to the administering authority via WaTERS within 28 days of receiving the result, outlining a. details of the investigations carried out; and b. whether the result is directly associated with the release, and, if so: i. whether environmental harm has occurred, and ii. actions taken to prevent environmental harm. NOTE: Where an exceedance of a trigger level has occurred and is being investigated, in accordance with Condition F16(2) of this condition, no further reporting is required for subsequent trigger events for that quality characteristic.
F17	All determinations of water quality and biological monitoring must be performed by an appropriately qualified person.

Table F2 - Mine Affected Water Release Limits

Quality Parameter [^]	Release Limits	Monitoring frequency ¹	Comment
Electrical conductivity (µS/cm)	Release limits specified in Table F4	Daily during release (the first sample must be taken within 2 hours of commencement of release)	-
pH (pH Unit)	6.5 (minimum) 9.0 (maximum)	Daily during release (the first sample must be taken within 2 hours of commencement of release)	-
Turbidity (NTU)	300	At commencement and prior to cessation of release (at a minimum) and weekly during a release ³	Turbidity is required to assess ecosystem impacts and can provide instantaneous results.

NOTE:

[^]The quality characteristics required to be monitored as per **Table F2** must be reviewed in relation to immediately adjacent operating coal mines by **30 June 2021** to adequately demonstrate negligible environmental risk.

¹The determination of suitability for release of water should be informed by monitoring undertaken prior to release.

Table F3 - Release contaminant trigger investigation levels, potential contaminants

Quality Parameter	Trigger Levels (µg/L)	Comment on Trigger Level	Monitoring Frequency
Aluminium	82	80 th percentile of background	Commencement of release and thereafter weekly during release
Arsenic	13	For aquatic ecosystem protection, based on SMD guideline	
Cadmium	0.2	For aquatic ecosystem protection, based on SMD guideline	
Chromium	1	For aquatic ecosystem protection, based on SMD guideline	
Copper	2	For aquatic ecosystem protection, based on LOR for ICPMS	
Iron	300	For aquatic ecosystem protection, based on low reliability guideline	
Lead	4	For aquatic ecosystem protection, based on SMD guideline	
Mercury	0.2	For ecosystem protection based on LOR for CVFIMS	
Nickel	11	For aquatic ecosystem protection, based on SMD guideline	
Zinc	8	For aquatic ecosystem protection, based on SMD guideline	
Boron	370	For aquatic ecosystem protection, based on SMD guideline	
Cobalt	90	For aquatic ecosystem protection, based on low reliability guideline	
Manganese	1,900	For aquatic ecosystem protection, based on SMD guideline	
Molybdenum	34	For aquatic ecosystem protection, based on low reliability guideline	
Selenium	10	For aquatic ecosystem protection, based on LOR for ICPMS	
Silver	1	For aquatic ecosystem protection, based on LOR for ICPMS	
Uranium	1	For aquatic ecosystem protection, based on LOR for ICPMS	
Vanadium	10	For aquatic ecosystem protection, based on LOR for ICPMS	
Ammonia	900	For aquatic ecosystem protection, based on SMD guideline	
Nitrate	1,100	For aquatic ecosystem protection, based on ambient Qld WQ Guidelines (2006) for TN	
Petroleum hydrocarbons (C6-C9)	20	For aquatic ecosystem protection, based on LOR	
Petroleum hydrocarbons (C10-C36)	100	For aquatic ecosystem protection, based on LOR	
Fluoride (total)	2,000	Protection of livestock and short term irrigation guideline	
Sodium	250,000	Based on Australian Drinking Water Guidelines	

NOTE:

- i) All metals and metalloids must be measured as total (unfiltered) and dissolved (filtered). Trigger levels for metal/metalloids apply if dissolved results exceed trigger.
- ii) The quality characteristics required to be monitored as per **Table F3** must be reviewed in relation to immediately adjacent operating coal mines by **30 June 2021** to adequately demonstrate negligible environmental risk, and it may be determined that a reduced monitoring frequency is appropriate or that certain quality characteristics can be removed from **Table F3** by amendment.
- iii) SMD – slightly moderately disturbed level of protection, guideline refers ANZECC & ARMCANZ (2000).
- iv) LOR – typical reporting for method stated. ICPMS/CV FIMS – analytical method required to achieve LOR.

F18	Receiving Environment Monitoring Program (REMP) The environmental authority holder must develop and implement a Receiving Environment Monitoring Program (REMP) to monitor, identify and describe any adverse impacts to surface water environmental values, quality and flows due to the authorised mining activity. This must include monitoring the effects of the mine on the receiving environment periodically (under natural flow conditions) and while mine affected water is being discharged from the site. For the purposes of the REMP, the receiving environment is the waters of Two Mile Creek and connected or surrounding waterways within 15km downstream of the release. The REMP should encompass any sensitive receiving waters or environmental values downstream of the authorised mining activity that will potentially be directly affected by an authorised release of mine affected water.
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F19	The REMP must address (but not necessarily be limited to) the following: a) description of potentially affected receiving waters including key communities and background water quality characteristics based on accurate and reliable monitoring data that takes into consideration any temporal variation (e.g. seasonality); and b) description of applicable environmental values and water quality objectives to be achieved (i.e. as scheduled pursuant to the Environmental Protection (Water) Policy 2009); and c) any relevant reports prepared by other governmental or professional research organisations that relate to the receiving environment within which the REMP is proposed; and d) water quality targets within the receiving environment to be achieved, and clarification of contaminant concentrations or levels indicating adverse environmental impacts during the REMP. e) monitoring for any potential adverse environmental impacts caused by the release f) monitoring of stream flow and hydrology; g) monitoring of toxicants should consider the indicators specified in Table F3 to assess the extent of the compliance of concentrations with water quality objectives and/or the ANZECC and ARMCANZ 2000 guidelines for slightly to moderately disturbed ecosystems; h) monitoring of physico-chemical parameters as a minimum those specified in Table G2 (in addition to dissolved oxygen saturation and temperature); i) monitoring biological indicators (for macroinvertebrates in accordance with the AusRivas methodology) and metals/metalloids in sediments (in accordance with ANZECC and ARMCANZ 2000, BATLEY and/or the most recent version of AS5667.1 Guidance on Sampling of Bottom Sediments) for permanent, semi-permanent water holes and water storages j) the locations of monitoring points (including the locations specified in Table F6 which are background and downstream impacted sites for each release point); k) the frequency or scheduling of sampling and analysis sufficient to determine water quality objectives and to derive site specific reference values within two (2) years (depending on wet season flows) in accordance with the Queensland Water Quality Guidelines 2006. For ephemeral streams, this should include periods of flow irrespective of mine or other discharges; l) specify sampling and analysis methods and quality assurance and control; m) any historical datasets to be relied upon; n) description of the statistical basis on which conclusions are drawn, and o) any spatial and temporal controls to exclude potential confounding factors.
F20	A REMP Design Document that addresses the requirements of Conditions F18 and F19 must be prepared and made available to the administering authority upon request.

F21	A report outlining the findings of the REMP, including all monitoring results and interpretations in accordance with Condition F19 must be prepared and submitted to the administering authority via WaTERS for each year during which a release from a release point occurs. This should include an assessment of background water quality, any assimilative capacity for those contaminants monitored and the suitability of current discharge limits to protect downstream environment values. All REMP water quality data associated with the relevant report must be submitted to the administering authority via WaTERS. Where no releases are made from the release points in any given year (1 November to 31 October), a summary report of the findings of the REMP must be prepared and submitted to the administering authority via WaTERS. The summary report must include the following: a) Introduction; b) Rainfall data; and c) Water course flow data.
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Table F4 –Mine affected water release during flow events

Receiving waters/stream	Release Point (RP)	Gauging station	Latitude	Longitude	Receiving water flow recording frequency	Receiving water flow criteria for discharge (m ³ /s)	Maximum release rate (for all combined RP flows)	Electrical conductivity and Sulfate release limits
Pelican Creek	RP1 RP2	Gauging Station 1	-20.585721	147.851138	Continuous (minimum daily)	Low Flow less than 5m ³ /s for a period of 4 weeks after natural flow events that exceed 5 m ³ /s	Volume/rate to be determined on a case by case basis	Electrical Conductivity: 75 th percentile of long term background reference data Sulfate: 250 mg/L
						Medium Flow more than 5 m ³ /s	Volume/rate to be determined on a case by case basis or at a 5:1 flow to discharge basis	Electrical Conductivity: <1,500 µS/cm Sulfate: 1,000 mg/L

NOTE:

¹The characteristics required to be monitored as per **Table F4** must be reviewed in relation to immediately adjacent operating coal mines by **30 June 2021** to adequately demonstrate negligible environmental risk.

Table F5 - Receiving waters contaminant trigger levels

Quality Characteristic ¹	Trigger Level	Monitoring Frequency
pH	6.5 – 9.0	Daily during the release
Electrical Conductivity (µS/cm)	1,000	
Suspended solids (mg/L)	110	
Sulfate (SO ₄ ²⁻) (mg/L)	250	
Sodium (mg/L)	250	

NOTE:

¹The receiving waters trigger level quality characteristic required to be monitored as per **Table F5** must be reviewed in relation to immediately adjacent operating coal mines by **30 June 2021** to adequately demonstrate negligible environmental risk.

F22	Water re-use Mine affected water may be piped or trucked or transferred by some other means that does not contravene the conditions of this environmental authority and deposited into artificial water storage structures, such as farm dams or tanks, or used directly at properties owned by the environmental authority holder or a third party (with the consent of the third party).
F23	If the responsibility of the water contaminated by mining activities (the water) is given or transferred to another person in accordance with Condition F22, then: a) the responsibility of the water must only be given or transferred in accordance with a written agreement (the third party agreement); and b) include in the third party agreement a commitment from the person utilising the water to use water in such a way as to prevent environmental harm or public health incidences and specifically make the persons aware of the General Environmental Duty (GED) under section 319 of the <i>Environmental Protection Act 1994</i>, environmental sustainability of the water disposal and protection of environmental values of waters.
F24	Annual Water Monitoring Data Submission The following information must be recorded in relation to all water monitoring required under the conditions of this environmental authority and submitted to the administering authority via WaTERS with each annual return: a) the date on which the sample was taken; b) the time at which the sample was taken; c) the monitoring point at which the sample was taken; d) the measured or estimated daily quantity of mine affected water released from all release points; e) the release flow rate at the time of sampling for each release point; and f) the results of all monitoring and details of any exceedances of the conditions of this environmental authority
F25	Water Management Plan A Water Management Plan must be developed by an appropriately qualified person and implemented for all stages of mining activities.

F26	The Water Management Plan must: a) provide for effective water management of actual and potential environmental impacts resulting from water management associated with the mining activities carried out under this environmental authority; and b) be developed in accordance with the administering authority's most recent version of the guideline for 'Preparation of water management plans for mining activities' (EM324) or any updates that become available from time to time and must include at least the following components: i. a study of the source on contaminants; ii. a water balance model for the site; iii. a map showing the water management system for the site; iv. measures to manage and prevent saline drainage; v. measures to manage and prevent acid rock drainage; and vi. contingency procedures for incidents and emergencies.
F27	On an annual basis the Water Management Plan must be updated and re-issued (in accordance with the requirements of Conditions F25 and F26) or reviewed. The update or review must be commenced by 30 November each calendar year. Where a review is undertaken, the review must: a) include a statement that the review has been undertaken by an appropriately qualified person; b) assess the plan against the requirements under Condition F25 and F26; c) identify any actual or potential environmental impacts which are not effectively managed by the Water Management Plan; vii. if required make recommendations to ensure actual or potential environmental impacts are effectively managed viii. if required provide details and timelines to implement the recommendations; and d) make recommendations to amend the Water Management Plan, where required.
F28	Stormwater and water sediment controls An Erosion and Sediment Control (ESC) Plan must be developed by an appropriately qualified person and implemented for all stages of the mining activities.

F29	The ESC Plan must: a) demonstrate how ESC control measures adequately minimise the release of sediment to receiving waters and must include at least the following: b) assessment of all catchment areas; c) assessment of soil types, including sodic dispersive soils; d) specify design criteria for ESC structures; e) detail the locations and descriptions of all ESC measures; f) provide an audit schedule to ensure ESC controls are being maintained.
F30	A revision or review of the Erosion and Sediment Control Plan must be undertaken by 30 November for each calendar year. The revision must: a) include a statement that the Erosion and Sediment Control Plan has been prepared by an appropriately qualified person; b) assess the plan against the requirements under Condition F29; c) include recommended actions to ensure actual and potential environmental impacts are effectively managed; d) provide details and timelines of the actions to be taken; and e) identify any amendments made to the Erosion and Sediment Control Plan.
F31	A copy of the Erosion and Sediment Control Plan must be provided to the administering authority on request.
F32	Stormwater, other than mine affected water, is permitted to be released to waters from: a) erosion and sediment control structures that are installed and operated in accordance with the erosion and sediment control plan required by Condition F28; b) water management infrastructure that is installed and operated, in accordance with a water management plan that complies with Condition F25, for the purpose of ensuring water does not become mine affected water.

Table F6 - Receiving water upstream background sites and downstream monitoring points

Monitoring Points	Receiving Waters Location Description	Latitude	Longitude
Upstream Monitoring Points			
SW1	Un-named tributary of Two Mile Creek	-20.659498	147.861292
SW6	Two Mile Creek	-20.630927	147.865133
BG1	Pelican Creek	-20.587343	147.850063
Downstream Monitoring Points			
SW1-D	Un-named tributary of Two Mile Creek	-20.642358	147.844743
SW5-D	Two Mile Creek	-20.635933	147.830051
SW6-D	Two Mile Creek	-20.636003	147.822988
PC1	Pelican Creek	-20.600134	147.755450

NOTE:

- a) The upstream monitoring point should be within 5 km of the release point.
- b) The downstream point should not be greater than 5 km from the release point.
- c) The data from background monitoring points must not be used where they are affected by releases from other mines.

Agency interest: Sewage Treatment	
Condition number	Condition
G1	Treated sewage effluent may only be released to land in accordance with the conditions of this approval at the following locations: a) within a suitable irrigation area to be selected based on the location of mine infrastructure areas and associated sewage treatment plant(s); b) haul roads and areas of mining activity for the purpose of dust suppression; c) re-use in coal processing; d) firefighting.
G2	All effluent released from the treatment plant into the nominated irrigation area identified in Condition G1 must be monitored at the frequency and for all the parameters specified in Table G1 - Contaminant release limits to land.
G3	Irrigation with treated effluent must be carried out in a manner such that: a) vegetation is not damaged; b) there is no surface ponding of effluent; and c) there is no run-off of effluent.
G4	If irrigation areas are accessible to employees or the general public, prominent signage must be provided advising that effluent is present and care should be taken to avoid consuming or otherwise coming into unprotected contact with the effluent.

G5	The daily volume of treated effluent used for irrigation must be measured and records kept of the volumes of effluent released.
G6	When circumstances prevent the irrigation or beneficial reuse of treated sewage effluent such as during or following rain events, waters must be directed to a wet weather storage or alternative measures must be taken to store/lawfully dispose of effluent.
G7	Water or stormwater contaminated by irrigation activities must not be released to any waters or the bed and banks of any waters.
G8	A minimum area of one (1) ha of land, excluding any necessary buffer zones, must be utilised for the irrigation of treated sewage effluent.
G9	Treated sewage effluent must only be supplied to another person or organisation that has a written plan detailing how the user of the treated sewage effluent will comply with their general environmental duty under section 319 of the Act whilst using the treated sewage effluent. NOTE: The supply of treated wastewater for re-use is regulated under <i>the Water Supply (Safety and Reliability) Act 2008</i>.

Table G1 - Contaminant release limits to land

Contaminant	Unit	Release limit	Limit type	Monitoring Frequency
5 day Biochemical oxygen demand (BOD)	mg/L	20	Maximum	Monthly
Total suspended solids	mg/L	30	Maximum	Monthly
Nitrogen	mg/L	30	Maximum	Monthly
Phosphorus	mg/L	15	Maximum	Monthly
E-coli	Organisms/100ml	1000	Maximum	Monthly
pH	pH units	6.0 – 9.0.	Range	Monthly

Agency interest: Land and Rehabilitation	
Condition number	Condition
H1	All areas significantly disturbed by mining activities must be rehabilitated to achieve the following rehabilitation goals: a) safe to humans and wildlife; b) stable; c) non-polluting; and d) self-sustaining for the post mining land use of grazing pasture, with the exception of residual voids
H2	A Rehabilitation Management Plan must be developed by 24 April 2020 by a suitably qualified person and submitted to the administering authority for review and comment.
H3	Within 20 business days of the receipt of comments from the administering authority, the updated Rehabilitation Management Plan must be submitted to the department for approval.
H4	The Rehabilitation Management Plan must include: a) Rehabilitation objectives to achieve the rehabilitation goals for all disturbance areas; b) Detailed rehabilitation methods for each disturbance area; c) Rehabilitation indicators to measure the success of the rehabilitation against the rehabilitation objectives; d) Final completion criteria that will achieve the rehabilitation goals and objectives; e) Details of appropriate monitoring and maintenance of rehabilitation; f) Identification of 3 reference sites to be used to develop rehabilitation success criteria for each disturbance domain; and g) A description of monitoring of reference sites inclusive of statistical design. h) A description of progressive rehabilitation planning
H5	All areas significantly disturbed by mining activities must be rehabilitated in accordance with the Rehabilitation Management Plan to achieve the final completion criteria.
H6	The environmental authority holder must notify the administering authority of any changes to the Rehabilitation Management Plan, and submit the updated document to the administering authority.

H7	Mining waste management A waste rock and spoil disposal plan must be developed and include, where relevant, at least: a) effective characterisation of the waste rock and spoil to predict under the proposed placement and disposal strategy the quality of runoff and seepage generated concerning potentially environmentally significant effects including salinity, acidity, alkalinity and dissolved metals, metalloids and non-metallic inorganic substances; b) a program of progressive sampling and characterisation to identify dispersive and non-dispersive spoil and the salinity, acid and alkali producing potential and metal concentrations of waste rock; c) a materials balance and disposal plan demonstrating how potentially acid forming and acid forming waste rock will be selectively placed and/or encapsulated to minimise the potential generation of acid mine drainage; d) where relevant, a sampling program to verify encapsulation and/or placement of potentially acid-forming and acid-forming waste rock; e) how often the performance of the plan will be assessed; f) the indicators or other criteria on which the performance of the plan will be assessed; and g) rehabilitation strategy. Monitoring or rehabilitation, research and/or trials to verify the requirements and methods for decommissioning and final rehabilitation of the placed materials, including the prevention and management of acid mine drainage, erosion minimisation and establishment of vegetation cover.
H8	Contaminated Land Before applying for surrender of a mining lease, the holder must (if applicable) provide to the administering authority a site investigation report under the Act, in relation to any part of the mining lease which has been used for notifiable activities or which the holder is aware is likely to be contaminated land, and also carry out any further work that is required as a result of that report to ensure that the land is suitable for its final land use.
H9	Before applying for progressive rehabilitation certification for an area, the holder must (if applicable) provide to the administering authority a site investigation report under the Act, in relation to any part of the area the subject of the application which has been used for notifiable activities or which the holder is aware is likely to be contaminated land, and also carry out any further work that is required as a result of that report to ensure that the land is suitable for its final land use under Condition H1.
H10	Minimise the potential for contamination of land by hazardous contaminants.
H11	Chemicals and flammable or combustible liquids All flammable and combustible liquids must be contained within an on-site containment system and controlled in a manner that prevents environmental harm and maintained in accordance with the current edition of <i>AS 1940 – Storage and Handling of Flammable and Combustible Liquids</i>.

H12	All chemicals and flammable or combustible liquids stored on site that have the potential to cause environmental harm must be stored in or serviced by an effective containment system that is impervious to the materials stored and managed to prevent the release of liquids to waters or land. Where no relevant Australian standard exists store such materials within an effective on-site containment system, the environmental authority holder must, at a minimum: a) minimise the potential for contamination of land and waters by diverting stormwater around contaminated areas and facilities used for the storage of chemicals and flammable or combustible liquids.
H13	Residual void outcome Residual voids must comply with the following outcomes: a) Residual voids must not cause any serious environmental harm to land, surface waters or any recognised groundwater aquifers, other than the environmental harm constituted by the existence of the residual void itself and subject to any other condition within this environmental authority; b) Residual voids must comply with Table H1 – Residual void outcomes; and c) At the completion of decommissioning and rehabilitation, all residual voids must demonstrably have the appropriate level of flood protection from nearby watercourses as approved by the administering authority, such that the protection is sustainable for the foreseeable future.
H14	All reasonable and practical measures must be taken to minimise the size of the void remaining after mining activities cease.
H15	Weed Management A weed management plan must be developed and implemented for this site outlining: a) areas of control priority and the methods used to determine such areas; b) strategies to promote dense grass growth (which out-competes weeds) through reduced disturbance; c) monitoring methodologies that document the spread of weeds and any new outbreaks; d) methods for the control of weeds. These methods should include best practice management; e) stringent wash-down and inspection procedures for both machinery involved in clearing/construction activities and those operating outside of designated roads during mine operation; and f) promotion of the awareness of weed management issues at the site.
H16	Exploration Land subject to exploration activities previously approved under EPC586 that subsequently became ML10345, must be rehabilitated in accordance with the <i>Code of Environmental Compliance for Exploration and Mineral Development Projects</i>.

H17	Land subject to exploration activities carried out on ML10345 subsequent to the grant of the relevant mining lease, must be rehabilitated in accordance with the <i>Code of Environmental Compliance for Exploration and Mineral Development Projects</i> .
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Table H1 – Residual Void Outcomes

Residual Void	Void Area	Maximum Slope
B Seam Pit	Backfilled	N/A
Q Seam Pit	Backfilled	

Agency interest: Dams and Levees	
Condition number	Condition
I1	Consequence Category The consequence category of any structure must be assessed by a suitably qualified and experienced person in accordance with the <i>Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1933)</i> at the following times: a) prior to the design and construction of the structure, if it is not an existing structure; or b) prior to any change in its purpose or the nature of its stored contents.
I2	A consequence assessment report and certification must be prepared for each structure assessed and the report may include a consequence assessment for more than one structure.
I3	Certification must be provided by the suitably qualified and experienced person who undertook the assessment, in the form set out in the <i>Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1933)</i> .
I4	Design and Construction of a Regulated Structure All regulated structures must be designed by, and constructed under the supervision of, a suitably qualified and experienced person in accordance with the requirements of the <i>Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1933)</i>.
I5	Construction of a regulated structure is prohibited unless: a) the holder has submitted a consequence category assessment report and certification to the administering authority; and b) certification of the design plan and operating procedures (except where the structure does not require operating procedures such as for levees) has been certified by a suitably qualified and experienced person for compliance with the relevant condition of this authority.
I6	Certification must be provided by the suitably qualified and experienced person who oversees the preparation of the design plan in the form set out in the <i>Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1933)</i> , and must be recorded in the Register of Regulated Structures.
I7	Regulated structures must:

	a) be designed and constructed in accordance with and conform to the requirements of the <i>Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1933)</i>; 1. be designed and constructed with due consideration given to ensuring that the design integrity would not be compromised on account of: 2. floodwaters entering the regulated dam from any watercourse or drainage line; and b) wall failure due to erosion by floodwaters arising from any watercourse or drainage line. c) for dams associated with a failure to contain; have the floor and sides of the dam designed and constructed to prevent or minimise the passage of the wetting front and any entrained contaminants through either the floor or sides of the dam during the operational life of the dam and for any period of decommissioning and rehabilitation of the dam.
I8	Certification by the suitably qualified and experienced person who supervises the construction must be submitted to the administering authority on the completion of construction of the regulated structure, and state that: a) the 'as constructed' drawings and specifications meet the original intent of the design plan for that regulated structure; b) construction of the regulated structure is in accordance with the design plan.
I9	Operation of a regulated structure a) Operation of a regulated structure, except for an existing structure, is prohibited unless: i. the holder has submitted to the administering authority: ii. one paper copy and one electronic copy of the design plan and certification of the 'design plan' in accordance with Conditions I4 to I6; iii. a set of 'as constructed' drawings and specifications; iv. certification of those 'as constructed drawings and specifications' in accordance with Condition I8; v. where the regulated structure is to be managed as part of an integrated containment system for the purpose of sharing the Design Storage Allowance (DSA) volume across the system, a copy of the certified system design plan; vi. the requirements of this authority relating to the construction of the regulated structure have been met; vii. the holder has entered the details required under this authority, into a Register of Regulated Structures; and viii. there is a current operational plan for the regulated structure (except where the structure does not require operating procedures such as for levees).
I10	Each regulated structure must be maintained and operated, for the duration of its operational life until decommissioned and rehabilitated, in a manner that is consistent with the current operational plan and, if applicable, the current design plan and associated certified 'as constructed' drawings.

I11	Mandatory Reporting Level Conditions I12 to I15 inclusive only apply to Regulated Structures which have not been certified as low consequence category for ‘failure to contain – overtopping’.
I12	The Mandatory Reporting Level (the MRL) must be marked on a regulated dam in such a way that during routine inspections of that dam, it is clearly observable.
I13	The holder must, as soon as practical and within forty-eight (48) hours of becoming aware, notify the administering authority when the level of the contents of a regulated dam reaches the MRL.
I14	The holder must, immediately on becoming aware that the MRL has been reached, act to prevent the occurrence of any unauthorised discharge from the regulated dam.
I15	The holder must record any changes to the MRL in the Register of Regulated Structures.
I16	Design storage allowance The holder must assess the performance of each regulated dam or linked containment system over the preceding November to May period based on actual observations of the available storage in each regulated dam or linked containment system taken prior to 1 July of each year.
I17	By 1 November of each year, storage capacity must be available in each regulated dam (or network of linked containment systems with a shared DSA volume), to meet the DSA volume for the dam (or network of linked containment systems).
I18	The holder must, as soon as possible and within forty-eight (48) hours of becoming aware that the regulated dam (or network of linked containment systems) will not have the available storage to meet the DSA volume on 1 November of any year, notify the administering authority.
I19	The holder must, immediately on becoming aware that a regulated dam (or network of linked containment systems) will not have the available storage to meet the DSA volume on 1 November of any year, act to prevent the occurrence of any unauthorised discharge from the regulated dam or linked containment systems.

I20	Annual Inspection Each regulated structure must be inspected each calendar year by a suitably qualified and experienced person.
I21	At each annual inspection, the condition and adequacy of all components of the regulated structure must be assessed and a suitably qualified and experienced person must prepare an annual inspection report containing details of the assessment and include recommended actions to ensure the integrity of the regulated structure. Regulated structures must be assessed: a) against the most recent hazard assessment report and design plan (or system design plan); b) against recommendations contained in previous annual inspections reports; c) against recognised dam safety deficiency indicators; d) for changes in circumstances potentially leading to a change in hazard category; e) for conformance with the conditions of this authority; f) for conformance with the 'as constructed' drawings; g) for the adequacy of the available storage in each regulated dam, based on an actual observation or observations taken after 31 May each year but prior to 1 November of that year, of accumulated sediment, state of the containment barrier and the level of liquids in the dam (or network of linked containment systems); and h) for evidence of conformance with the current operational plan.
I22	The suitably qualified and experienced person who prepared the annual inspection report must certify the report in accordance with the <i>Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1933)</i>.
I23	The environmental authority holder must: a) within twenty (20) business days of receipt of the annual inspection report, provide to the administering authority: 1. the recommendations section of the annual inspection report; and 2. if applicable, any actions being taken in response to those recommendations; and b) if, following receipt of the recommendations and (if applicable) actions, the administering authority requests a full copy of the annual inspection report from the holder, provide this to the administering authority within ten (10) business days of receipt of the request.
I24	Transfer arrangements The holder must provide a copy of any reports, documentation and certifications prepared under this authority, including but not limited to any Register of Regulated Structures, consequence assessment, design plan and other supporting documentation, to a new holder on transfer of this authority.

I25	Register of Regulated Structures A Register of Regulated Structures must be established and maintained by the holder for each regulated dam.
I26	The holder must provisionally enter the required information in the Register of Regulated Structures when a design plan for a regulated dam is submitted to the administering authority.
I27	The holder must make a final entry of the required information in the Register of Regulated Structures once compliance with Conditions I9 and I10 has been achieved.
I28	The holder must ensure that the information contained in the Register of Regulated Structures is current and complete on any given day.
I29	All entries in the Register of Regulated Structures must be approved by the chief executive officer for the holder of this authority, or their delegate, as being accurate and correct.
I30	The holder must, at the same time as providing the annual return, supply to the administering authority a copy of the records contained in the Register of Regulated Structures, in the electronic format required by the administering authority.

END OF CONDITIONS

Definitions

Words and phrases used throughout this environmental authority are defined below. Where a definition for a term used in this environmental authority is not provided within this environmental authority, but is provided in the EP Act 1994 or subordinate legislation, the definition in the EP Act or subordinate legislation must be used.

‘acid mine drainage’ means any contaminated discharge emanating from a mining activity formed through a series of chemical and biological reactions, when geological strata is disturbed and exposed to oxygen and moisture.

‘affected person’ is someone whose drinking water can potentially be impacted as a result of discharges from a dam or their life can be put at risk due to dwellings or workplaces being in the path of a dam break flood.

‘airblast overpressure’ means energy transmitted from the blast site within the atmosphere in the form of pressure waves. The maximum excess pressure in this wave, above ambient pressure is the peak airblast overpressure measured in decibels linear (dBL).

‘annual exceedance probability or AEP’ the probability that at least one event in excess of a particular magnitude will occur in any given year.

‘annual inspection report’ means an assessment prepared by a suitably qualified and experienced person containing details of the assessment against the most recent consequence assessment report and design plan (or system design plan);

- against recommendations contained in previous annual inspections reports;
- against recognised dam safety deficiency indicators;
- for changes in circumstances potentially leading to a change in consequence category;
- for conformance with the conditions of this authority;
- for conformance with the ‘as constructed’ drawings;
- for the adequacy of the available storage in each regulated dam, based on an actual observation or observations taken after 31 May each year but prior to 1 November of that year, of accumulated sediment, state of the containment barrier and the level of liquids in the **dam** (or network of linked containment systems);
- for evidence of conformance with the current operational plan.

‘appropriately qualified person’ means a person who has professional qualifications, training, skills or experience relevant to the nominated subject matter and can give authoritative assessment, advice and analysis on performance relating to the subject matter using the relevant protocols, standards, methods or literature.

‘assessed or assessment’ by a suitably qualified and experienced person in relation to a consequence assessment of a dam, means that a statutory declaration has been made by that person and, when taken together with any attached or appended documents referenced in that declaration, all of the following aspects are addressed and are sufficient to allow an independent audit of the assessment:

- a) exactly what has been assessed and the precise nature of that determination;
- b) the relevant legislative, regulatory and technical criteria on which the assessment has been based;
- c) the relevant data and facts on which the assessment has been based, the source of that material, and the efforts made to obtain all relevant data and facts; and
- d) the reasoning on which the assessment has been based using the relevant data and facts, and the relevant criteria.

‘associated works’ in relation to a dam, means:

- 1) operations of any kind and all things constructed, erected or installed for that dam; and
- 2) any land used for those operations.

‘authority’ means an environmental authority or a development approval.

‘background’, with reference to the water schedule means the average of samples taken prior to the commencement of mining from the same waterway that the current sample has been taken.

‘certification’, **‘certifying’** or **‘certified’** by an appropriately qualified and experienced person in relation to a design plan or an annual report regarding dams/structures, means that a statutory declaration has been made by that person and, when taken together with any attached or appended documents referenced in that declaration, all of the following aspects are addressed and are sufficient to allow an independent audit at any time:

- a) exactly what is being certified and the precise nature of that certification;
- b) the relevant legislative, regulatory and technical criteria on which the certification has been based;
- c) the relevant data and facts on which the certification has been based, the source of that material, and the efforts made to obtain all relevant data and facts; and
- d) the reasoning on which the certification has been based using the relevant data and facts, and the relevant criteria.

‘blasting’ means the use of explosive materials to fracture:

- a) rock, coal and other minerals for later recovery; or
- b) structural components or other items to facilitate removal from a site or for reuse.

‘chemical’ means:

- a) an agricultural chemical product or veterinary chemical product within the meaning of the *Agricultural and Veterinary Chemicals Code Act 1994* (Commonwealth); or
- b) a dangerous good under the Australian Code for the Transport of Dangerous Goods by Road and Rail approved by the Australian Transport Council; or
- c) a lead hazardous substance within the meaning of the *Workplace Health and Safety Regulation 1997*;
- d) a drug or poison in the Standard for the Uniform Scheduling of Drugs and Poisons prepared by the Australian Health Ministers’ Advisory Council and published by the Commonwealth; or
- e) any substance used as, or intended for use as:
 - i. a pesticide, insecticide, fungicide, herbicide, rodenticide, nematocide, miticide, fumigant or related product; or
 - ii. a surface active agent, including, for example, soap or related detergent; or
 - iii. a paint solvent, pigment, dye, printing ink, industrial polish, adhesive, sealant, food additive, bleach, sanitiser, disinfectant, or biocide; or
 - iv. a fertiliser for agricultural, horticultural or garden use; or
 - v. a substance used for, or intended for use for mineral processing or treatment of metal, pulp and paper, textile, timber, water or wastewater; or
 - vi. manufacture of plastic or synthetic rubber.

‘commercial place’ means a workplace used as an office or for business or commercial purposes, which is not part of the mining activity and does not include employees’ accommodation or public roads.

‘consequence’ in relation to a structure as defined, means the potential for environmental harm resulting from the collapse or failure of the structure to perform its primary purpose of containing, diverting or controlling flowable substances.

‘consequence category’ means a category, either low, significant or high, into which a dam is assessed as a result of the application of tables and other criteria in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635)*.

‘construction’ or **‘constructed’** in relation to a regulated structure includes building a new regulated structure and lifting or otherwise modifying an existing regulated structure, but does not include investigations and testing necessary for the purpose of preparing a design plan.

‘dam’ means a land-based structure or a void that contains, diverts or controls flowable substances, and includes any substances that are thereby contained, diverted or controlled by that land-based structure or void and **associated works**.

‘dam crest volume’ means the volume of material (liquids and/or solids) that could be within the walls of a dam at any time when the upper level of that material is at the crest level of that dam. That is, the instantaneous maximum volume within the walls, without regard to flows entering or leaving (for example, via spillway).

‘design plan’ is a document setting out how all identified consequence scenarios are addressed in the planned design and operation of a regulated structure.

‘design storage allowance or DSA’ means an available volume, estimated in accordance with the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635)* published by the administering authority, must be provided in a dam as at 1 November each year in order to prevent a discharge from that dam to an **annual exceedance probability (AEP)** specified in that Manual.

‘designer’ for the purposes of a regulated dam, means the certifier of the design plan for the regulated dam.

‘disturbance’ of land includes:

- a) compacting, removing, covering, exposing or stockpiling of earth;
- b) removal or destruction of vegetation or topsoil or both to an extent where the land has been made susceptible to erosion;
- c) carrying out mining within a watercourse, waterway, wetland or lake;
- d) the submersion of areas by tailings or hazardous contaminant storage and dam/structure walls;
- e) temporary infrastructure, including any infrastructure (roads, tracks, bridges, culverts, dam/structures, bores, buildings, fixed machinery, hardstand areas, airstrips, helipads etc) which is to be removed after the mining activity has ceased; or
- f) releasing of contaminants into the soil, or underlying geological strata.

However, the following areas are not included when calculating areas of ‘disturbance’:

- a) areas off lease (e.g. roads or tracks which provide access to the mining lease);
- b) areas previously disturbed which have achieved the rehabilitation outcomes;
- c) by agreement with the administering authority, areas previously disturbed which have not achieved the rehabilitation objective(s) due to circumstances beyond the control of the mine operator (such as climatic conditions);

- d) areas under permanent infrastructure. Permanent infrastructure includes any infrastructure (roads, tracks, bridges, culverts, dam/structures, bores, buildings, fixed machinery, hardstand areas, airstrips, helipads etc) which is to be left by agreement with the landowner; or
- e) disturbance that pre-existed the grant of the tenure.

'effluent' treated waste water released from sewage treatment plants.

'emergency action plan' means documentation forming part of the operational plan held by the holder or a nominated responsible officer, that identifies emergency conditions that sets out procedures and actions that will be followed and taken by the dam owner and operating personnel in the event of an emergency. The actions are to minimise the risk and consequences of failure, and ensure timely warning to downstream communities and the implementation of protection measures. The plan must require dam owners to annually update contact information.

'existing structure' means a structure that prior to 18 September 2014 meets any or both of the following, a structure:

- a) with a design that is in accordance with the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams* and that is considerably in progress;
- b) that is under considerable construction or that is constructed.

'extreme storm storage' – means a storm storage allowance determined in accordance with the criteria in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635)* published by the administering authority.

'flowable substance' means matter or a mixture of materials which can flow under any conditions potentially affecting that substance. Constituents of a flowable substance can include water, other liquids fluids or solids, or a mixture that includes water and any other liquids fluids or solids either in solution or suspension.

'hazard category' means a category, either low significant or high, into which a dam is assessed as a result of the application of tables and other criteria in '*Manual for Assessing Hazard Categories and Hydraulic Performance of Dams*'.

'holder' means:

- a) where this document is an environmental authority, any person who is the holder of, or is acting under, that environmental authority; or
- b) where this document is a development approval, any person who is the registered operator for that development approval.

'hydraulic performance' means the capacity of a regulated dam to contain or safely pass flowable substances based on the design criteria specified for the relevant consequence category in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635)*.

'infrastructure' means water storage dams, levees, roads and tracks, buildings and other structures built for the purpose of the mining activity.

'land' in 'Schedule H – Land and rehabilitation' of this document means land excluding waters and the atmosphere, that is, the term has a different meaning from the term as defined in the *Environmental Protection Act 1994*. For the purposes of the *Acts Interpretation Act 1954*, it is expressly noted that the term 'land' in this environmental authority relates to physical land and not to interests in land.

'land use' –means the selected post mining use of the land, which is planned to occur after the cessation of mining operations.

‘leachate’ means a liquid that has passed through or emerged from, or is likely to have passed through or emerged from, a material stored, processed or disposed of at the operational land which contains soluble, suspended or miscible contaminants likely to have been derived from the said material.

‘levee’ means an embankment that only provides for the containment and diversion of stormwater or flood flows from a contributing catchment, or containment and diversion of flowable materials resulting from releases from other works, during the progress of those stormwater or flood flows or those releases; and does not store any significant volume of **water** or **flowable substances** at any other times.

‘low consequence dam’ means any dam that is not a high or significant consequence category as assessed using the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635)*.

‘m’ means metres.

‘mandatory reporting level or MRL’ means a warning and reporting level determined in accordance with the criteria in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/933)* published by the administering authority.

‘manual’ means the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635)* published by the administering authority.

‘measures’ includes any measures to prevent or minimise environmental impacts of the mining activity such as bunds, silt fences, diversion drains, capping, and containment systems.

‘mine affected water’:

- a) means the following types of water:
 - i) pit water, tailings dam water, processing plant water;
 - ii) water contaminated by a mining activity which would have been an environmentally relevant activity under Schedule 2 of the *Environmental Protection Regulation 2008* if it had not formed part of the mining activity;
 - iii) rainfall runoff which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated, excluding rainfall runoff discharging through release points associated with erosion and sediment control structures that have been installed in accordance with the standards and requirements of an Erosion and Sediment Control Plan to manage such runoff, provided that this water has not been mixed with pit water, tailings dam water, processing plant water or workshop water;
 - iv) groundwater which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated;
 - v) groundwater from the mine’s dewatering activities;
 - vi) a mix of mine affected water (under any of paragraphs i)-v) and other water.
- b) does not include surface water runoff which, to the extent that it has been in contact with areas disturbed by mining activities that have not yet been completely rehabilitated, has only been in contact with:
 - i) land that has been rehabilitated to a stable landform and either capped or revegetated in accordance with the acceptance criteria set out in the environmental authority but only still awaiting maintenance and monitoring of the rehabilitation over a specified period of time to demonstrate rehabilitation success; or
 - ii) land that has partially been rehabilitated and monitoring demonstrates the relevant part of the landform with which the water has been in contact does not cause environmental harm to waters or groundwater, for example:

1. areas that are been capped and have monitoring data demonstrating hazardous material adequately contained with the site;
 2. evidence provided through monitoring that the relevant surface water would have met the water quality parameters for mine affected water release limits in this environmental authority, if those parameters had been applicable to the surface water runoff; or
- iii) both.

‘mining waste’ means waste rock, spoil, overburden and interburden.

‘modification or modifying’ (see definition of ‘construction’).

‘natural flow’ means the flow of water through waters caused by nature.

‘non polluting’ means having no adverse impacts upon the receiving environment.

‘operational plan’ includes:

- a) normal operating procedures and rules (including clear documentation and definition of process inputs in the DSA);
- b) contingency and emergency action plans including operating procedures designed to avoid and/or minimise environmental impacts including threats to human life resulting from any overtopping or loss of structural integrity of the regulated structure.

‘register of regulated structure’ includes:

- a) date of entry in the register;
- b) name of the structure, its purpose and intended/actual contents;
- c) the consequence category of the dam as assessed using the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (EM635);
- d) dates, names, and reference for the design plan plus dates, names, and reference numbers of all document(s) lodged as part of a design plan for the dam;
- e) name and qualifications of the suitably qualified and experienced person who certified the design plan and 'as constructed' drawings;
- f) for the regulated dam, other than in relation to any levees –
 - a. the dimensions (metres) and surface area (hectares) of the dam measured at the footprint of the dam;
 - b. coordinates (latitude and longitude in GDA94) within five metres at any point from the outside of the dam including its storage area
 - c. dam crest volume (megalitres);
 - d. spillway crest level (metres AHD).
 - e. maximum operating level (metres AHD);
 - f. storage rating table of stored volume versus level (metres AHD);
 - g. design storage allowance (megalitres) and associated level of the dam (metres AHD);
 - h. mandatory reporting level (metres AHD);
- g) the design plan title and reference relevant to the dam;
- h) the date construction was certified as compliant with the design plan;

- i) the name and details of the suitably qualified and experienced person who certified that the constructed dam was compliant with the design plan;
- j) details of the composition and construction of any liner;
- k) the system for the detection of any leakage through the floor and sides of the dam;
- l) dates when the regulated dam underwent an annual inspection for structural and operational adequacy, and to ascertain the available storage volume for 1 November of any year;
- m) dates when recommendations and actions arising from the annual inspection were provided to the administering authority;
- n) dam water quality as obtained from any monitoring required under this authority as at 1 November of each year.

‘peak particle velocity (ppv)’ means a measure of ground vibration magnitude which is the maximum rate of change of ground displacement with time, usually measured in millimetres/second (mm/s).

‘protected area’ means – a protected area under the *Nature Conservation Act 1992*; or

- a) a marine park under the *Marine Parks Act 1992*; or
- b) a World Heritage Area.

‘receiving environment’ in relation to an activity that causes or may cause environmental harm, means the part of the environment to which the harm is, or may be, caused. The receiving environment includes (but is not limited to):

- a) a watercourse;
- b) groundwater; and
- c) an area of land that is not specified in of this environmental authority.

The term does not include land that is specified in Authorised Activities of this environmental authority.

‘receiving waters’ means the waters into which this environmental authority authorises releases of mine affected water.

‘regulated structure’ means any structure in the significant or high consequence category as assessed using the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (EM635)* published by the administering authority. A regulated structure does not include:

- a) a fabricated or manufactured tank or container, designed and constructed to an Australian Standard that deals with strength and structural integrity of that tank or container;
- b) a sump or earthen pit used to store residual drilling material and drilling fluid only for the duration of drilling and well completion activities;
- c) a flare pit.

‘rehabilitation’ the process of reshaping and revegetating land to restore it to a stable landform.

‘release event’ means a surface water discharge from mine affected water storages or contaminated areas on the licensed place meaning the mining activities carried out at the mining tenements detailed in **Figure 1 – Site map, domains and groundwater monitoring locations** of this environmental authority.

‘residual drilling material’ means waste drilling materials including muds and cuttings or cement returns from well holes and which have been left behind after the drilling fluids are pumped out.

‘RL’ means reduced level, relative to mean sea level as distinct from depths to water.

‘representative’ means a sample set which covers the variance in monitoring or other data either due to natural changes or operational phases of the mining activities.

‘sensitive place’ means:

- a) a dwelling, residential allotment, mobile home or caravan park, residential marina or other residential premises; or
- b) a motel, hotel or hostel; or
- c) an educational institution; or
- d) a medical centre or hospital; or
- e) a protected area under the *Nature Conservation Act 1992*, the *Marine Parks Act 1992* or a World Heritage Area; or
- f) a public park or gardens.

Note: The definition of ‘sensitive place’ and ‘commercial place’ is based on Schedule 1 of EPP Noise. That is, a sensitive place is inside or outside on a dwelling, library & educational institution, childcare or kindergarten, school or playground, hospital, surgery or other medical institution, commercial & retail activity, protected area or an area identified under a conservation plan under *Nature Conservation Act 1992* as a critical habitat or an area of major interest, marine park under *Marine Parks Act 2004*, park or garden that is outside of the mining lease and open to the public for the use other than for sport or organised entertainment. A commercial place is inside or outside a commercial or retail activity.

A mining camp (i.e., accommodation and ancillary facilities for mine employees or contractors or both, associated with the mine the subject of the environmental authority) is not a sensitive place for that mine or mining project, whether or not the mining camp is located within a mining tenement that is part of the mining project the subject of the environmental authority. For example, the mining camp might be located on neighbouring land owned or leased by the same company as one of the holders of the environmental authority for the mining project, or a related company. Accommodation for mine employees or contractors is a sensitive place if the land is held by a mining company or related company, and if occupation is restricted to the employees, contractors and their families for the particular mine or mines which are held by the same company or a related company.

For example, a township (occupied by the mine employees, contractors and their families for multiple mines that are held by different companies) would be a sensitive place, even if part or all of the township is constructed on land owned by one or more of the companies.

‘spillway’ means a weir, channel, conduit, tunnel, gate or other structure designed to permit discharges from the dam, normally under flood conditions or in anticipation of flood conditions.

‘structure’ means dam or levee.

‘suitably qualified and experienced person’ in relation to regulated structures means a person who is a Registered Professional Engineer of Queensland (RPEQ) under the provisions of the *Professional Engineers Act 2002*, and has demonstrated competency and relevant experience:

- a) for regulated dams, an RPEQ who is a civil engineer with the required qualifications in dam safety and dam design.
- b) for regulated levees, an RPEQ who is a civil engineer with the required qualifications in the design of flood protection embankments.

Note: It is permissible that a suitably qualified and experienced person obtain subsidiary certification from an RPEQ who has demonstrated competence and relevant experience in either geomechanics, hydraulic design or engineering hydrology.

‘system design plan’ means a plan that manages an integrated containment system that shares the required DSA and/or ESS volume across the integrated containment system.

‘the Act’ means the *Environmental Protection Act 1994*.

‘µS/cm’ means micro Siemens per centimetre.

‘void’ means any constructed, open excavation in the ground.

‘watercourse’ has the same meaning given in the *Water Act 2000*.

‘water quality’ means the chemical, physical and biological condition of water.

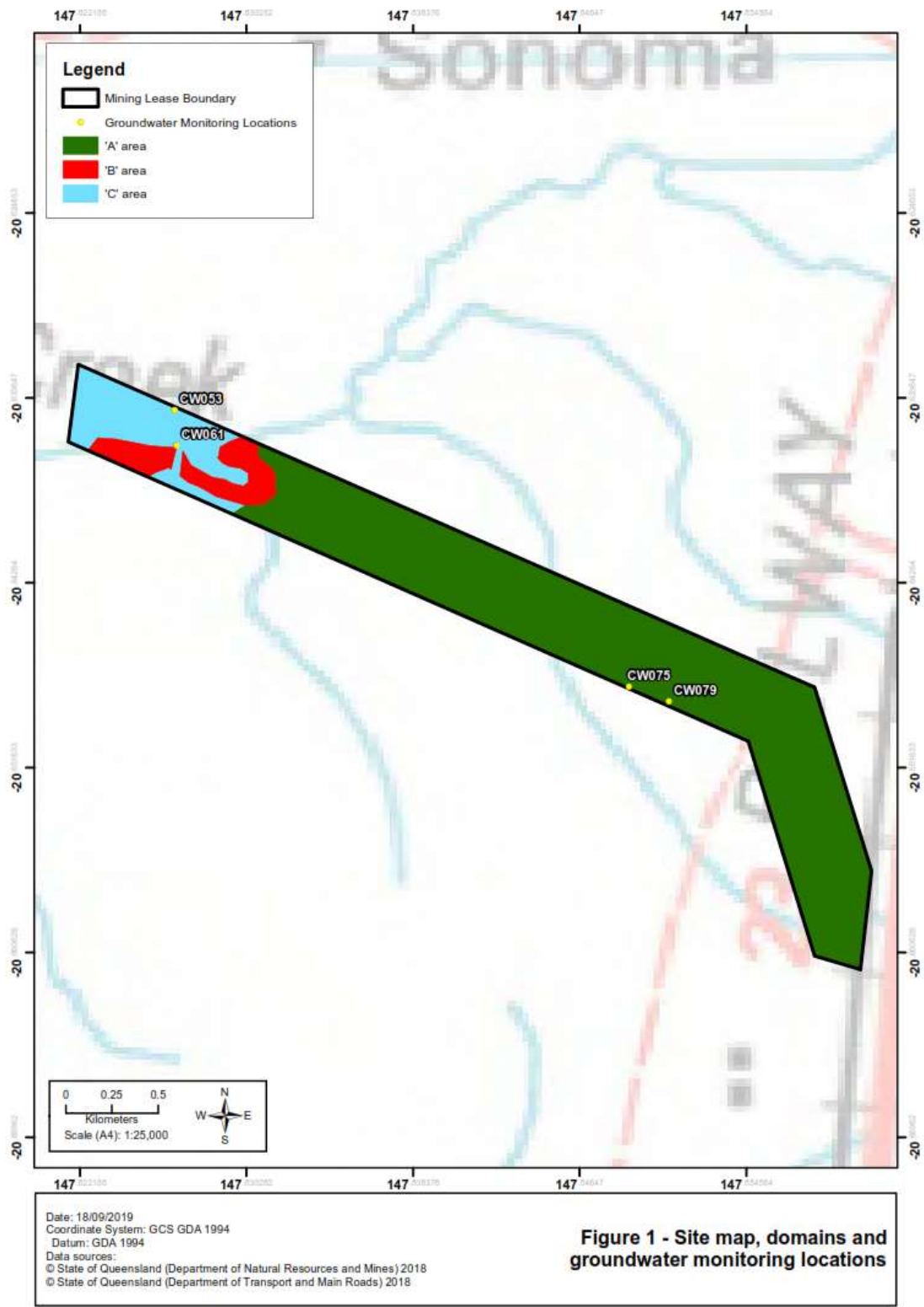
‘water year’ means the 12-month period from 1 July to 30 June.

‘waters’ includes river, stream, lake, lagoon, pond, swamp, wetland, unconfined surface water, unconfined natural or artificial watercourse, bed and bank of any waters, dams, non-tidal or tidal waters (including the sea), storm water channel, storm water drain, and groundwater and any part thereof.

‘WaTERS’ means the Queensland Government's WaTERS database system.

‘wet season’ means the time of year, covering one or more months, when most of the average annual rainfall in a region occurs. For the purposes of DSA determination this time of year is deemed to extend from 1 November in one year to 31 May in the following year inclusive.

END OF DEFINITIONS





END OF PERMIT

Appendix C Rehabilitation Management Plan

QCoal Northern Hub

Rehabilitation Management Plan



(Draft) April 2020

Submitter information	
Report type	Rehabilitation Management Plan
Author(s)	Environment – QCoal Group
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Project(s)	Sonoma Coal Mine Cows Coal Mine Drake Coal Mine Jax Coal Mine
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Revision summary		
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1 Introduction

QCoal Pty Ltd (QCoal) manages four (4) adjacent open cut coal mines located approximately six (6) km south of the town of Collinsville in Central Queensland. The four mines are Sonoma Coal Mine (SCM), Cows Coal Mine (CCM), Drake Coal Mine (DCM), and Jax Coal Mine (JCM), with pits, dumps, haul roads and water management infrastructure spanning the boundaries of the various mining leases (MLs). Each mine has its own approval, being an environmental authority (EA); however, as with physical infrastructure, operational and environmental management and resources are integrated across the four mines.

The mines that make up the QNH are directly adjacent to one another on the western side of Bowen Development Road and the parallel Newlands rail line, with the exception of JCM, which is on the eastern side (see **Figure 1**).

Accordingly, these four (4) mines are collectively managed and operated as a single multi-pit operation, which is referred to as the QCoal Northern Hub (QNH).

1.1 Rehabilitation Management Plan Objectives

Presented in **Section 2.5** are the details of the four (4) QNH EAs. Condition H3 of all four (4) site EAs requires the development of an RMP, due for submission by **24 April 2020**. As such, this QNH Rehabilitation Management Plan (QNH RMP) has been developed to:

- Satisfy the EA conditions within each of the four (4) QNH mines which require an RMP;
- Present a consistent approach to rehabilitation across the QNH, which will:
 - Improve final landform planning and design (especially for landforms that cross EA boundaries),
 - Maximise efficiency in undertaking rehabilitation activities, and
 - Allow for assessment of rehabilitation success on a whole-of-operation basis.

This QNH RMP will supersede any existing rehabilitation management plan applicable to any of the QNH mines.

In preparing the QNH RMP, reference has been made to previous QNH investigations and reports, as well as regulatory documents which provide direction on rehabilitation (e.g. requirements, methods, or outcomes), including, but not limited to, the following:

- Relevant conditions of site EAs.
- Commitments made by individual sites in other statutory documentation.
- *Design of Two Mile Creek Diversion* (BSM, 2012)
- *North Sonoma Creek Diversion Design Plan* (Engeny, 2018)
- *Investigation into Residual Void Sonoma Coal Mine* (QCoal, 2016)
- *Residual Voids on the QCoal Northern Hub Mining Complex* (QCoal, 2020)

- *Rehabilitation requirements for mining projects* (EHP, 2014)¹.
- *Groundwater Monitoring and Management Plan – Drake Coal Pty Ltd – Drake Coal Project* (QCoal, 2014)
- *Northern Hub Groundwater Assessment* (AGE, 2018)
- *Northern Hub Groundwater Assessment* (AGE, 2020)
- *Residual Void Hydrology Study QCoal Northern Hub Mines June 2020* (Engeny, 2020)
- *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland* (DME, 1995).

The QNH RMP presents the rehabilitation strategies and objectives for closure to achieve agreed post-mine land uses (PMLUs). Rehabilitation strategies have been developed for all relevant areas of disturbance (domains) across the QNH. These strategies have been developed to ensure the requirements of the four (4) QNH EAs have been satisfied.

A monitoring and reporting framework has been developed to demonstrate achievement of the relevant rehabilitation completion criteria.

¹ This guideline describes the policy framework and assessment process for determining the acceptability of rehabilitation outcomes and strategies. It provides EA holders with a clear structure for the development of objectives and targets that should be presented in approvals and mine management documents such as PoOs and rehabilitation plans.

2 Project Overview

2.1 Location

The QNH is located approximately 6 km south of the town of Collinsville, and 78 km southwest of the regional centre of Bowen (see **Figure 1**). Access to all four QNH sites is by the state-controlled Bowen Development Road.

2.2 Ownership

The QNH sites have ownership makeups as follows:

- SCM is a joint venture between QCoal Sonoma Pty Ltd, JS Sonoma Pty Ltd, CSC Sonoma Pty Ltd and Watami (Qld) Pty Ltd.
- DCM is owned by Northern Hub (Drake) Pty Ltd and Drake Coal Pty Ltd.
- CCM is owned by Bowen River Coal Pty Ltd.
- JCM is owned by Jax Coal Pty Ltd.

QCoal Sonoma Pty Ltd, Northern Hub (Drake) Pty Ltd, Drake Coal Pty Ltd, Bowen River Coal Pty Ltd and Jax Coal Pty Ltd, are wholly or majority owned subsidiaries of QCoal Pty Ltd. The owner and Managing Director of QCoal Pty Ltd is Mr Christopher Wallin.

2.3 Mining Tenures

The ML tenure details for the QNH mines are provided in **Table 1**, **Table 2**, **Table 3** and **Table 4**.

Table 1 – SCM Mining Lease Details

Details	ML10325	ML10326	ML10327
Permit Type	Mining Lease	Mining Lease	Mining Lease
Permit Status	Granted	Granted	Granted
Permit Sub-Status	None	None	None
Lodgment Date	21/11/2005	21/11/2005	21/11/2005
Grant Date	12/4/2007	13/09/2007	13/09/2007
Expiry Date	30/04/2037	30/09/2037	30/09/2037
Authorised Holder Name	QCoal Sonoma Pty Ltd	QCoal Sonoma Pty Ltd	QCoal Sonoma Pty Ltd
Area	716.7 ha	1,063 ha	360.4 ha
Permit ID	108618	108619	108620
Native Title Category	Exclusive Land	Exclusive Land	Exclusive Land

Table 2 – CCM Mining Lease Details

Details	ML10345
Permit Type	Mining Lease
Permit Status	Granted
Permit Sub-Status	None
Lodgment Date	11/04/2009
Grant Date	16/08/2012
Expiry Date	31/08/2027
Authorised Holder Name	Bowen River Coal Pty Ltd
Area	210.5 ha
Permit ID	108636
Native Title Category	Exclusive Land

Table 3 – DCM Mining Lease Details

Details	ML10349	ML10350	ML10351
Permit Type	Mining Lease	Mining Lease	Mining Lease
Permit Status	Granted	Granted	Granted
Permit Sub-Status	None	None	None
Lodgment Date	21/04/2010	21/04/2010	21/04/2010
Grant Date	2/11/2014	2/11/2014	2/11/2014
Expiry Date	29/02/2044	29/02/2044	29/02/2044
Authorised Holder Name	Northern Hub (Drake) Pty Ltd	Northern Hub (Drake) Pty Ltd	Northern Hub (Drake) Pty Ltd
Area	3,982 ha	4,805 ha	427.9
Permit ID	108640	108641	108642
Native Title Category	Right To Negotiate Agreement	Right to Negotiate Agreement	Right to Negotiate Agreement

Table 4 – JCM Mining Lease Details

Details	ML10346
Permit Type	Mining Lease
Permit Status	Granted
Permit Sub-Status	None
Lodgment Date	11/12/2009
Grant Date	20/12/2013
Expiry Date	31/12/2034
Authorised Holder Name	Jax Coal Pty Ltd
Area	1,943 hectares
Permit ID	108637
Native Title Category	Right to Negotiate Agreement

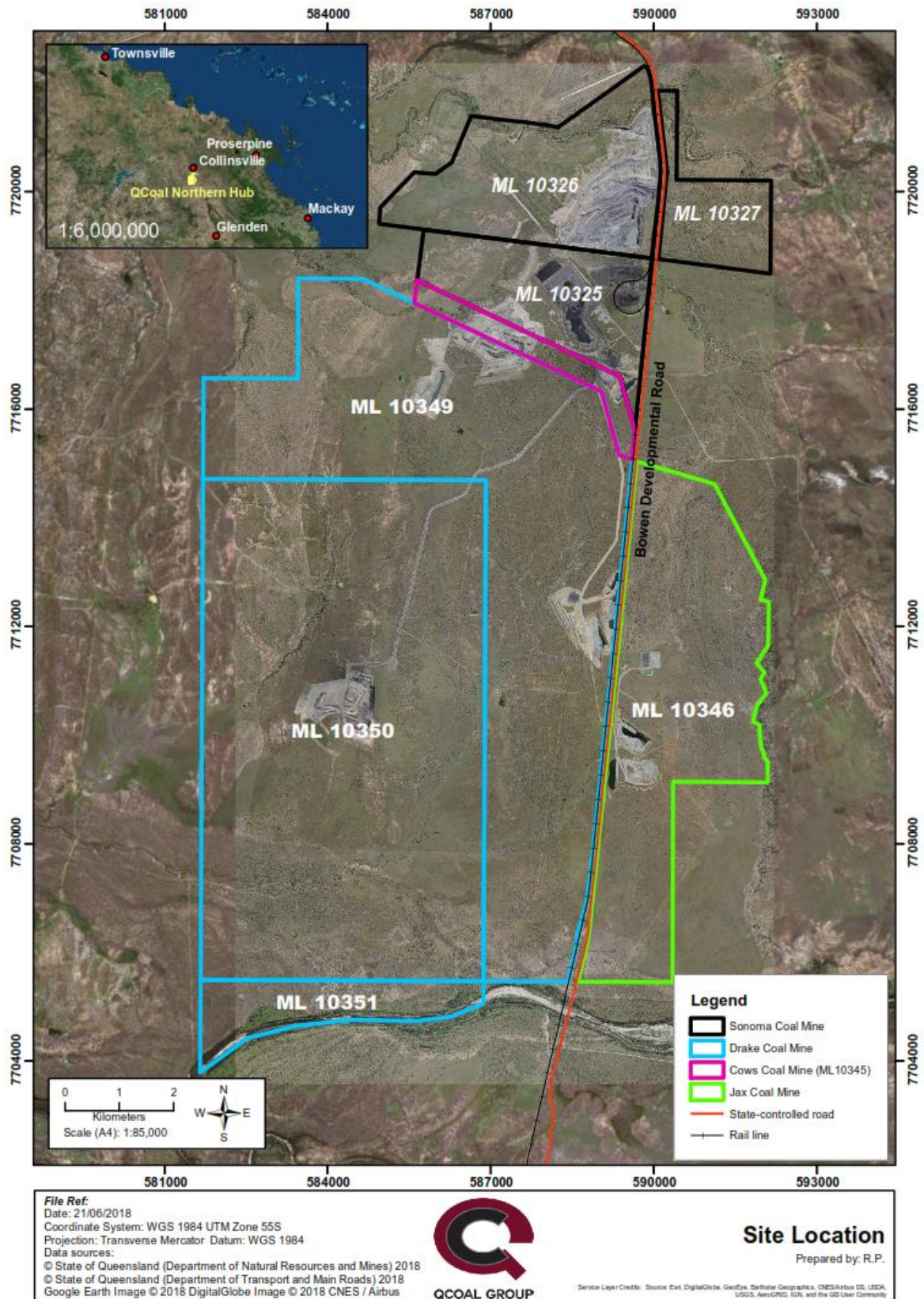


Figure 1 – QCoal Northern Hub Location

2.4 Underlying Landholders

The QNH spans eight (8) MLs, as described in **Section 2.3**. The MLs are located on land with several landholders, as summarised below and presented in **Figure 2**:

- **SCM:**
 - ML10325: The land underlying ML10325 is owned by Mr Christopher Wallin.
 - ML 10326: The land underlying ML10326 is “Sonoma” station, which is privately owned by a third party, apart from the land underlying the SCM rail spur, which is owned by Mr Christopher Wallin.
 - ML10327: The land underlying ML10327 is “Sonoma” station, which is privately owned by a third party.
- **CCM:**
 - ML10345: the land underlying ML10345 is a historic stock route which is no longer declared for that purpose. The land is held under a permit to occupy by Mr Christopher Wallin.
- **DCM:**
 - ML10349, ML10350, and ML10351: The land underlying these MLs is “Birralelee” station, owned by Mr Christopher Wallin.
- **JCM:**
 - ML10346: The land underlying ML10346 is “Birralelee” station, owned by Mr Christopher Wallin.

2.5 Environmental Authorities

EA numbers and primary holders for the QNH mines are provided in **Table 5**.

Table 5 – QCoal Northern Hub Environmental Authorities

Mine	MLs	EA Number	Grant	Primary EA Holder	Current version
SCM	ML10325, ML10326, ML10327	EPML00707713	13/9/2007	QCoal Sonoma Pty Ltd	6/03/2020
CCM	ML10345	EPML00334613	16/8/2012	Bowen River Coal Pty Ltd	9/03/2020
DCM	ML10349, ML10350, ML10351	EPML00393013	2/11/2014	Northern Hub (Drake) Pty Ltd	6/03/2020
JCM	ML10346	EPML00337613	20/12/2013	Jax Coal Pty Ltd	14/04/2020

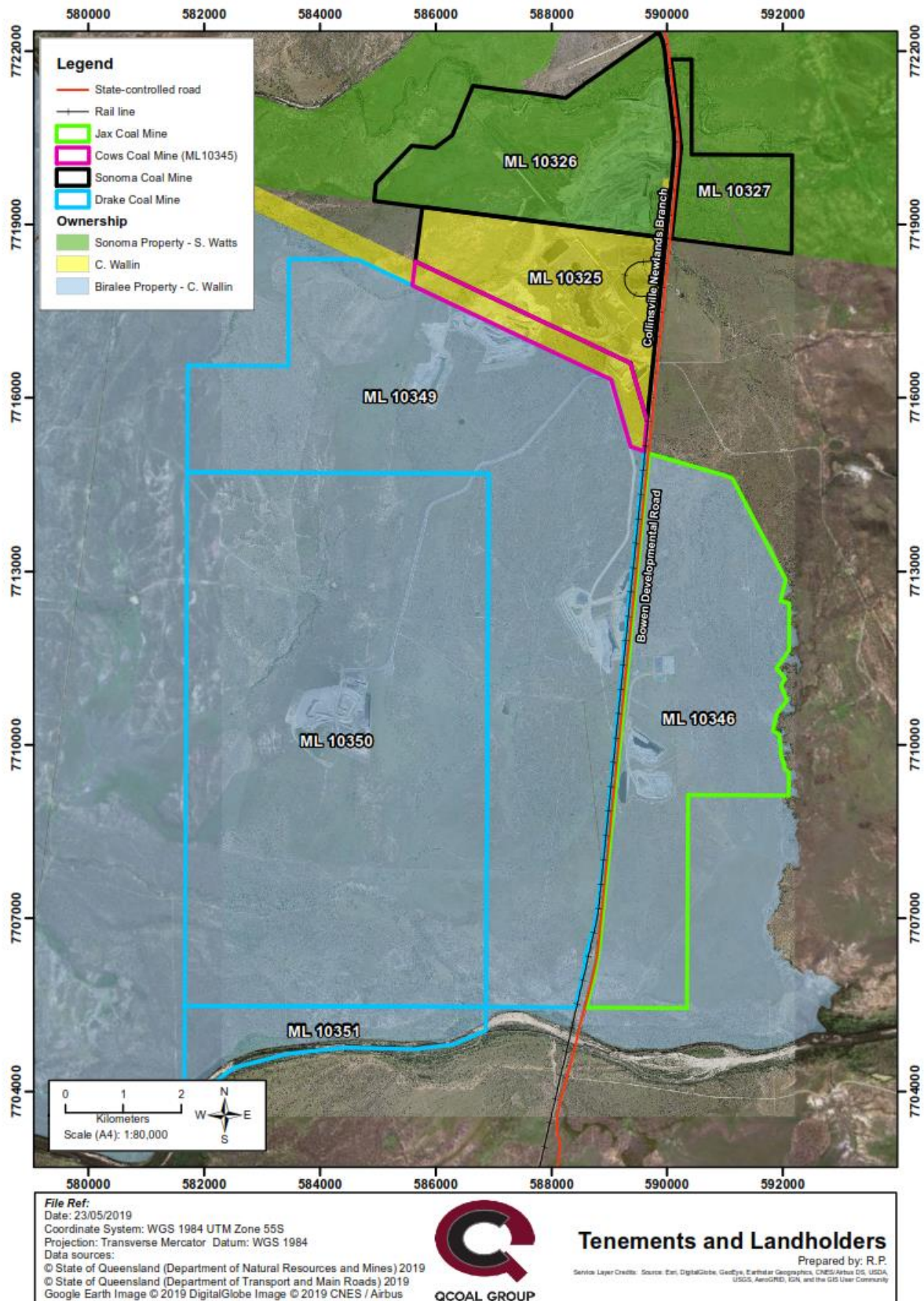


Figure 2 – Tenements and Underlying Landholders

2.6 Activities and Mining Methods

Mining operations on the QNH involve extraction of Run of Mine (ROM) coal using conventional drill and blast, and excavator and truck methodology. ROM coal is then processed and shipped as product coal (coking and thermal).

Topsoil stripped ahead of mine-related activities is either stockpiled for later use in rehabilitation or placed directly on areas already prepared for rehabilitation works. Waste rock materials are placed in either out-of-pit dumps or in-pit dumps.

The QNH mines share water management infrastructure, haul roads, equipment, resources, and other infrastructure. ROM coal from all four QNH mines is sent to the Coal Handling and Processing Plant (CHPP) and train load-out facility located on the SCM. Processed coal is transported to Abbot Point Coal Terminal for shipment to customers.

Coal rejects material generated during processing at the CHPP are placed into co-disposal facilities located on the SCM.

3 Environmental Values

3.1 Climate

The region is characterised by distinct wet and dry seasons, with the majority of rainfall occurring during the summer months, along with higher temperatures and evaporation rates. Average monthly temperature, rainfall and evaporation statistics, as collected at the Bureau of Meteorology's (BoM) Collinsville Post Office Station (no. 033013) are presented in **Figure 3**.

The average annual rainfall for the QNH is 701.6 mm and the average annual evaporation is 1,861.5 mm (BoM, 2019). As such, the region is subject to net annual evaporation, and is dry for much of the year. Predominant winds are south-easterly for the majority of the year.

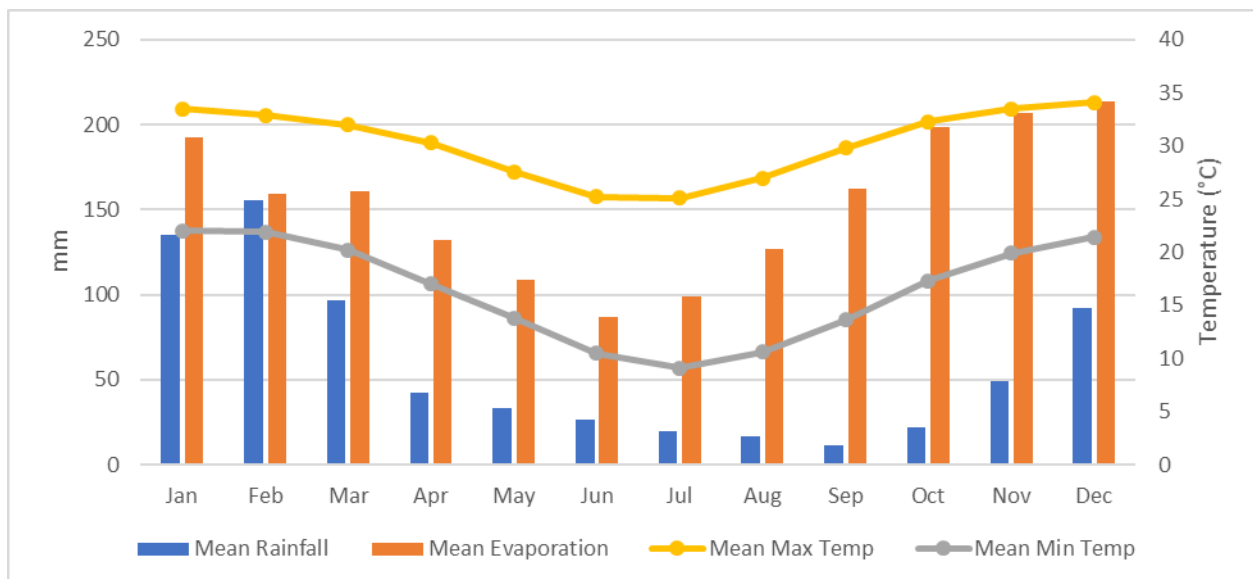


Figure 3 – QCoal Northern Hub Climate Averages

3.2 Topography

The QNH is situated in a flat-to-undulating landscape between the Bowen River (which curves to the south and west of the QNH), Pelican Creek to the north, and the northern sections of the Clarke Ranges to the east. Pre-mining topography in the region was described by GSSE (2005) as alluvial plains and terraces bordering Coral Creek in the north and the Bowen River in the south, and plains and low hills bordered by Two Mile Creek in the middle of the area. Pre-mining elevations ranged from 200 mAHD in the east to 160 mAHD in the west. Undisturbed areas of the QNH MLs typically have a slope of less than 10%.

3.3 Land Use and Suitability

Land suitability classification is assessed based on the *Guidelines for Agricultural Land Evaluation in Queensland* (DSITI & DNRM, 2015). The majority of the land on which the QNH MLs are held has been historically cleared for grazing activities; however, there are scattered areas of remnant vegetation. Current land use in the region is predominantly low intensity grazing on native and improved pastures, with other land uses including coal mining (including exploration), quarrying, and power generation (coal-fired and solar).

Previous land suitability assessments undertaken during the SCM and DCM EIS processes noted that:

- Large areas of the QNH were cleared historically for grazing;
- Logging and ringbarking have been undertaken historically in riparian zones, and mixed woodlands have been thinned, with understories removed to facilitate grazing;
- Soils and landforms are generally suitable for cattle grazing.
- Ongoing pastoral activities by landholders across the QNH MLs and the surrounding region have included agistment/grazing, clearing, regrowth and weed control, and control of feral animals (dogs, pigs, etc.).

The land underlying the SCM, and, by extension, the CCM was characterised as Class 2 for beef cattle grazing prior to the commencement of operations, and it has been concluded that the land was typically not suited to cultivation due to limitations of slope, soil, erosion and climate (GSSE, 2005).

The land underlying the DCM was assessed during the DCM EIS process and typically found to be Class 3 suitability for beef cattle grazing, with limitations to its suitability for broad acre cropping, typically due to water availability, workability, erosion and dissected topography (GHD, 2012).

The *State Rural Leasehold Land Strategy* (NRM, 2013) provides a framework for the management of leasehold land used for agricultural or pastoral pursuits, with a focus on managing land condition and sustaining productive use of leased land. Although mining activities are outside this land use, the rehabilitation strategies and post-mine land use targets for mined land must consider the impacts of rehabilitation on the condition of surrounding pastoral land and any obligations as a lessee.

The *Land Act 1994* obliges leaseholders to take all reasonable actions to:

- Maintain pastures dominated by perennial and productive species
- Maintain native grasslands free of encroachment
- Protect riparian vegetation
- Manage declared pests
- Avoid causing or contributing to salinity that reduces the productivity of leased land, or causes damage to surrounding land
- Conserve soil, water resources, and biodiversity.

3.4 Soils and Geology

The DCM EIS (GHD, 2012) describes the soil profile and geology of the land underlying the DCM and the broader QNH area and has been used to inform this section.

The QNH is located in the northern Bowen Basin. The regional geology documented by the 1:250,000 Geological Series (Bowen, Sheet SF55-3) indicates the QNH is underlain by the Later Permian Blackwater Group consisting of lithic sandstone, siltstone, shale, conglomerate, dolomite and tuff, and minor coal. This is surrounded and underlain by the Early to Late Permian Bienheim Sub-group described as a succession of siltstone, sandstone, coquinite, and limestone.

Overburden and reject materials generated by the QNH are likely to be relatively benign and are expected to generate slightly alkaline and low-to-moderately saline runoff and seepage following surface exposure (see **Section 3.5**).

The majority of the soil and subsoil materials tested were characterised as sodic and alkaline, which is typical of the region. Sodic soils are typically observed at 0.3 m below surface soils. The topsoil horizon depth varies between 0.2m and 1.0m in depth.

3.5 Mine Waste Characteristics

The geochemical characteristics of mine waste materials inform their placement during operations. Materials that have potential geochemical risks are to be encapsulated within materials categorised as lower risk. A number of geochemical investigations have been undertaken on the QNH, including, but not limited to, the following:

- *Sonoma Coal Project – Overburden Assessment Report* (Parsons Brinckerhoff, 2006)
- *Drake Coal Mine EIS – Chapter 7 Mining Waste* (2012)
- *Geochemical Assessment of Mining Waste and Coal Reject Materials, Sonoma Coal Mine* (Terrenus, 2012)
- *Mining Waste and Coal Rejects Management Plan – Sonoma Coal Mine* (Terrenus, 2013)

The findings of these assessments have provided an understanding of the nature of mining waste on the QNH, as detailed in the following sub-sections.

3.5.1 Mine Waste Risk Categories

Based on the geochemical analysis of spoils and coal rejects, a *Mining Waste and Coal Reject Management Plan* (Terrenus, 2013), was developed for the SCM. This plan establishes spoil categories for management of waste rock materials across the QNH. These categories have been visualised in **Figure 4**.

- **Topsoil and subsoil (low risk).** Topsoil (and subsoil) to nominal depth of 1 m below natural surface. Three types of topsoil are defined: Grey uniform clay, brown gradational sandy loam and red duplex sandy loam. Of these types, grey uniform clay is the most prevalent within the existing and future disturbance areas of the mine. This material is defined as Non-Acid Forming (NAF).

- **Category 1 (low risk).** Includes non-coal and non-carbonaceous material above C Seam, not including topsoil/sub-soil, and not within 1 m above and below ROM coal. Typically weathered or moderately weathered. This material is defined as NAF.
- **Category 2 (low to medium risk).** Includes non-coal and non-carbonaceous material below C Seam and not within 1 m above and below ROM coal. Generally fresh or slightly weathered and is defined as material with some capacity to generate Acid and Metalliferous Drainage (AMD). This material is classified as Potentially Acid Forming – Low Capacity (PAF-LC).
- **Category 3 (medium risk).** Includes coal and carbonaceous material, including material within 1 m above and below ROM coal seams, sub-economic coal, intruded coal and heat-affected coal. This material is defined as having some capacity to generate AMD, and is classified as PAF-LC.

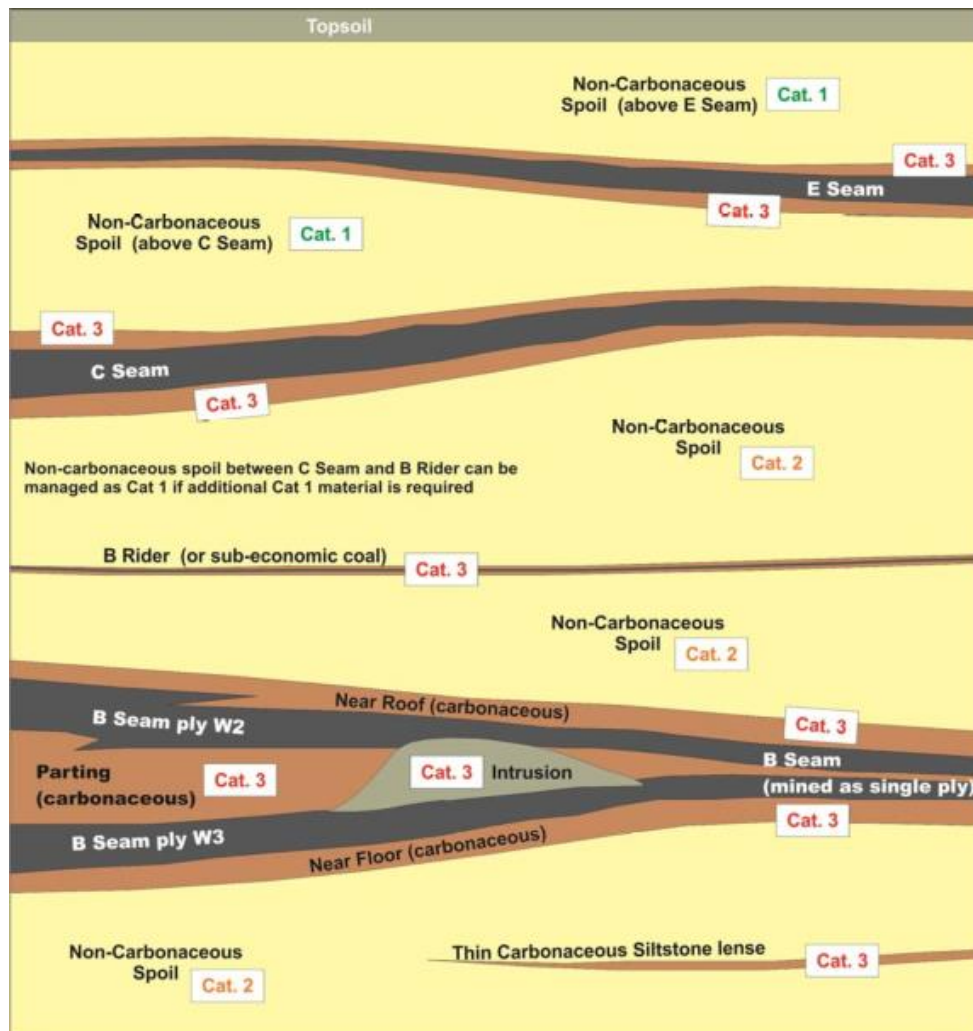


Figure 4 – Conceptual Representation of Spoil Categories (Terrenus, 2013)

3.5.2 QNH Waste Rock Characterisation

A summary of the findings of PB (2006) has been presented below:

- Waste rock was typically non-acid forming (NAF); however, rocks within 5m of coal seams should not be concentrated near the surface of waste rock dumps.
- Tertiary/Quaternary soils were generally slightly alkaline (pH between 7.8 and 8.6) and had low salinity (electrical conductivity (EC1:5) of 200 $\mu\text{S}/\text{cm}$) to moderate salinity (EC1:5 of 675 $\mu\text{S}/\text{cm}$). A single sample returned moderately high salinity (EC1:5 of 924 $\mu\text{S}/\text{cm}$).
- Alluvial soils were found to have low to moderate salinity.
- Weathered Permian rocks were found to have similar salinity, sodicity and alkalinity characteristics to the overlying alluvial soils. This material is considered suitable for capping.
- Fresh Permian rocks had moderately high alkalinity levels and low-to-moderate salinity. This material is considered unsuitable for capping.

A summary of the Terrenus (2013) waste rock findings is presented below:

- Spoil is likely to generate alkaline, low-salinity runoff and seepage following surface exposure.
- The total sulphur concentration of spoil is generally very low, and almost negligible. The majority of spoil materials are classified as NAF, with most spoil further classified as 'barren' (i.e. $<0.1\%$ sulphur) with respect to sulfuretted content.
- Total metal and metalloid concentrations in spoils are low.
- There is potential for spoil to produce leachate containing slightly elevated soluble molybdenum and selenium concentrations, which is common for materials from the Moranbah Coal Measures.
- Spoil materials are expected to be moderately to highly sodic; however, they are not expected to be dispersive in their current condition. Following weathering or exposure, dispersion may occur.
- Waste rock at the QNH is anticipated to be mostly low risk.

3.5.3 Coal Rejects

Findings of the Terrenus (2013) investigation into the properties of coal rejects likely to be generated at the QNH are summarised below:

- Coal rejects are expected to generate low salinity, neutral to alkaline pH run-off and seepage following surface exposure.
- The total sulphur and sulphide concentrations are generally low. Fine rejects generally have higher sulphur and sulphide concentrations compared to coarse rejects.
- The coal reject materials as a whole are expected to have little capacity to generate acid.
- Total metal and metalloid concentrations are generally low.
- Some coal reject materials *may* produce leachate containing slightly elevated concentrations of soluble elements (particularly aluminium and arsenic).

3.6 Flora

The QNH is located in the northern section of the Brigalow Belt Bioregion. A desktop analysis of flora was undertaken as part of the Drake EIS (GHD, 2012), and a targeted survey was undertaken by GHD in April 2010, identifying 192 plant species from 50 families.

In the northern section of the QNH, the Coral Creek Riparian Management Zone has been established to protect a population of Black ironbox (*Eucalyptus raveretiana*), which is listed in the *Environmental Protection and Biodiversity Conservation Act 1999* (Commonwealth) as vulnerable.

3.7 Weeds

Weeds identified during surveys at the QNH (formerly covered by exploration permit EPC586) have been provided in **Table 6** below (TECSol, 2011). The *QCoal Northern Hub Weed Management Plan* has been developed as per the relevant conditions within the QNH EAs; however, general weed management practices on the QNH are also addressed in **Section 7.3.3** of this document.

Weed species are classified at the state level by the *Land Protection (Pest and Stock Route Management) Act 2002*, and regionally by the *Whitsunday Regional Council Biosecurity Plan 2016-2020* (WRC, 2016).

Table 6 – Significant Weeds identified on EPC 586 (TECSol, 2011)

Family	Species	Common Name	Biosecurity QLD Declared (Class)	Whitsunday Regional Council Biosecurity Plan Class
Amaranthaceae	<i>Gomphrena celosioides</i>	Gromphrena Weed	No	No
Apocynaceae	<i>Cryptostegia grandiflora</i>	Rubber Vine	Yes (2)	Yes (2)
Asteraceae	<i>Parthenium hysterophorus</i>	Parthenium	Yes (2)	Yes (2), WoNS
Asteraceae	<i>Xanthium pungens</i>	Noogoora Burr	No	No
Cactaceae	<i>Eriocereus spp.</i>	Harrisia Cactus	Yes (2)	Yes (2)
Cactaceae	<i>Opuntia stricta</i>	Prickly Pear	Yes (2)	No
Mimosaceae	<i>Acacia farnesiana</i>	Prickly Mimosa	No	No
Mimosaceae	<i>Acacia nilotica</i>	Prickly Acacia	Yes (1)	Yes (2); WoNS
Papaveraceae	<i>Aremone ochraluca</i>	Prickly Poppy	No	No
Poaceae	<i>Cenchrus ciliaris</i>	Buffel Grass	No	No
Rhamnaceae	<i>Ziziphus mauritiana</i>	Chinee Apple	Yes (2)	Yes (2)

3.8 Surface Water

A detailed description and general characterisation of the receiving waters of the QNH can be found in the *QCoal Northern Hub Receiving Environment Monitoring Program* (REMP) (Freshwater Ecology, 2016) and the current version of the *QNH Water Management Plan* (WMP) (Engeny, 2020). The REMP outlines the requirements for ongoing collection of baseline monitoring results, including water quality and macroinvertebrate surveys within the

watercourses surrounding the QNH. The WMP outlines the requirements for water quality monitoring within watercourses, creeks and drainage channels in and surrounding the QNH, and describes the catchments, water storage and movement infrastructure on the sites. The WMP is updated annually to reflect changes in water management across the site and contains the Erosion and Sediment Control Plan for the QNH sites.

The QNH is located within the Bowen Broken Bogie Basin, in the upper reaches of the broader Burdekin River catchment. The QNH MLs extend over two sub-catchments, namely the Bowen River sub-catchment and the Pelican Creek sub-catchment. There are twenty-five (25) release points in the various site EAs; however, many of these have not been established and are not currently being used.

Apart from the Bowen River, the majority of waterways in the region are highly ephemeral, with flow typically only associated with significant regional rainfall events.

Two Mile Creek, which previously flowed through the middle of the SCM, was diverted in 2012 to allow for ongoing mining activities in the southern extent of the Sonoma Main Pit. Coral Creek, north of SCM, was diverted in 2018 to allow for the extraction of coal from Sonoma North Pit, the northern extension of the Sonoma Main Pit.

Priority actions for sub-catchments have been defined in the *Burdekin Water Quality Improvement Plan 2016* for both the Bowen River and Pelican Creek sub-catchments. These include the management of grazing, mining, industry, and other infrastructure, and they have been addressed as part of the management of rehabilitation activities.

The defined environmental values (EVs) for both the Bowen River and Pelican Creek are based on the *Environment Protection Policy (Water and Wetlands)* (DES). These EVs have their own associated set of water quality monitoring criteria based on the ANZECC (Australian and New Zealand Environment and Conservation Council) *Guidelines for Fresh and Marine Water Quality* (ANZECC, 2000); however, the sites have prescribed monitoring parameters.

Bowen River EVs

- Aquatic Ecosystems
- Irrigation
- Farm Supply
- Stock Watering
- Human Consumer
- Primary, Secondary and Visual Recreation
- Drinking Water
- Industrial Use
- Cultural and Spiritual Values

Pelican Creek EVs

- Aquatic Ecosystems
- Irrigation
- Farm Supply
- Stock Watering
- Human Consumer
- Secondary and Visual Recreation
- Drinking Water
- Industrial Use
- Cultural and Spiritual Values

Routine surface water monitoring is undertaken to satisfy conditions of the four (4) QNH EAs and the REMP. Material impacts to water quality or aquatic ecology have not been identified in association with QNH activities to date. Final landforms are not anticipated to impact adjacent surface water EVs once the rehabilitation criteria are achieved.

3.9 Groundwater

Numerous groundwater studies have been undertaken across the QNH, including *Groundwater Monitoring and Management Plan – Drake Coal Pty Ltd – Drake Coal Project* (QCoal, October 2014), *Northern Hub Groundwater Assessment* (AGE, 2018) and *Northern Hub Groundwater Assessment* (AGE, 2020).

Findings of these studies indicate the following:

- Groundwater values:
 - There are no known groundwater springs or seeps in the QNH area.
 - Stygofauna have not been identified in the area.
 - Groundwater Dependent Ecosystems (GDEs) are not considered likely to exist in the QNH area.
 - Based on searches of registered licensed groundwater bores and a landholder bore survey, groundwater use (including, but not limited to pastoral, irrigation, mining, stock, domestic, and town water) is not considered a groundwater value across or in the immediate vicinity of the QNH.
 - The quality of groundwater is generally described as marginal, with typically poorer quality groundwater encountered within coal-bearing strata.
- Hydrogeological regime (see **Appendix A** for further detail)
 - Groundwater has been found to be present intermittently within alluvial strata and within the Permian coal measures.
 - There is limited connectivity between surface water, alluvium and the Permian coal measures (as evidenced by hydrograph data and major ion chemistry)
 - No significant interactions are expected between ephemeral creeks or the Bowen River and the Permian Coal measures.
 - Some direct interaction between the Bowen River and groundwater within the immediate alluvial banks is likely and would be associated with flooding/receding cycles.

Impact on groundwater from the QNH, once rehabilitated, can only occur through two mechanisms: 1) direct infiltration of contaminated runoff or leachate into groundwater, and/or 2) drawdown associated with voids reducing groundwater levels, which can have a secondary effect on quality under specific geochemical conditions.

Waste rock (including reject material) has been shown to be generally low risk (see **Section 3.5**) and is considered unlikely to generate poor quality runoff or leachate. Rehabilitation (includes capping for co-disposal facilities) and revegetation further reduces leachate and runoff risks.

Drawdown of water associated with the QNH voids is specifically addressed in the *Investigation into Residual Void Sonoma Coal Mine* (QCoal, 2020) report (see **Appendix A**), supported by Engeny, 2020 and AGE, 2020, which determined that the QNH voids will either remain perpetual groundwater sinks or groundwater sources which do not feed surrounding aquifers, but rather the other QNH void sinks, and, therefore, no migration of water from the voids into the surround groundwater aquifers is likely.

Based on the nature of regional groundwater characteristics, and its current level of use, the QNH is assumed to have minimal impact on groundwater values following rehabilitation.

Routine groundwater monitoring is undertaken across the QNH to identify fluctuations in water level or quality. To date, monitoring has shown the operations have not had a materially effect on groundwater level or quality. Accordingly, final landforms are not anticipated to affect the surrounding regional groundwater levels or EVs.

4 Environmental Authority Rehabilitation Conditions

The QNH EAs are the primary approval documents that stipulate rehabilitation requirements. The conditions related to rehabilitation in each of the four (4) QNH EAs are identical, apart from void outcomes. As such, the rehabilitation conditions for all four (4) QNH mines are presented in **Table 7** and the rehabilitation requirements for the QNH final voids (as detailed in **Table H1** of each of the EAs) has been summarised as **Table 8**.

Table 7 – QNH EA Rehabilitation Conditions

Condition	Condition Wording
H1	All areas significantly disturbed by mining activities must be rehabilitated to achieve the following rehabilitation goals: a) safe to humans and wildlife; b) stable; c) non-polluting; and d) self-sustaining for the post-mining land use of grazing pasture, with the exception of residual voids
H2	Rehabilitation must commence progressively in accordance with the Plan of Operations.
H3	A Rehabilitation Plan must be developed by 24 April 2020 by a suitably qualified person and submitted for approval prior to implementing.
H4	Within 20 business days of the receipt of comments from the administering authority, the updated Rehabilitation Plan must be submitted to the department for approval.
H5	The Rehabilitation Plan must include: a) Rehabilitation objectives to achieve the rehabilitation goals for all disturbed areas; b) Detailed rehabilitation methods for each disturbed area; c) Rehabilitation indicators to measure the success of the rehabilitation against the rehabilitation objectives; d) Final completion criteria that will achieve the rehabilitation goals and objectives; e) Details of appropriate monitoring and maintenance of rehabilitation; f) Identify 3 reference sites to be used to develop rehabilitation success criteria for each disturbance domain; and g) Include a description of monitoring of reference sites inclusive of statistical design. h) For rehabilitation of watercourse diversion, details of the required methods of rehabilitation stated in the relevant approved Design Plans
H6	All areas significantly disturbed by mining activities must be rehabilitated in accordance with the Rehabilitation Plan to achieve the final completion criteria.
H7	The environmental authority holder must notify the administering authority of any changes to the Rehabilitation Plan and submit the updated document to the administering authority.
H10	Contaminated Land Before applying for surrender of a mining lease, the holder must (if applicable) provide to the administering authority a site investigation report under the Act, in relation to any part of the mining lease which has been used for notifiable activities or which the holder is aware is likely to be contaminated land, and also carry out any further work that is required as a result of that report to ensure that the land is suitable for its final land use.
H11	Before applying for progressive rehabilitation certification for an area, the holder must (if applicable) provide to the administering authority a site investigation report under the Act, in relation to any part of the area the subject of the application which has been used for notifiable activities or which the holder is aware is likely to be contaminated land, and also carry out any further work that is required as a result of that report to ensure that the land is suitable for its final land use under the approved Rehabilitation Plan as per Condition H3 .

H15	Residual void outcome Residual voids must comply with the following outcomes: a) Residual voids must not cause any serious environmental harm to land, surface waters or any recognized groundwater aquifers, other than the environmental harm constituted by the existence of the residual void itself and subject to any other condition within this environmental authority; b) Residual voids must comply with Table H1 – Residual void outcomes ; and c) At the completion of decommissioning and rehabilitation, all residual voids must demonstrably have the appropriate level of flood protection from nearby watercourses as approved by the administering authority, such that the protection is sustainable for the foreseeable future.
H16	All reasonable and practical measure must be taken to minimize the size of the void remaining after mining activities cease.
H18	Exploration Land subject to exploration activities previously approved under EPC586 that subsequently became... (QCoal Comment: relevant site-specific MLs) must be rehabilitated in accordance with the <i>Code of Environmental Compliance for Exploration and Mineral Development Projects</i> .
H19	Land subject to exploration activities carried out on... (QCoal Comment: relevant site-specific MLs) subsequent to the grant of the relevant mining lease, must be rehabilitated in accordance with the <i>Code of Environmental Compliance for Exploration and Mineral Development Projects</i> .

Table 8 – EA Table H1 Summary

Site	Residual Void	Void Area	Void Outcome	Maximum Slope
Sonoma Coal Mine	Sonoma Main Pit	120 ha	Unspecified in SCM EA Table H1	High wall – 70° with top 10m max 45° including a 1m bund
	Sonoma East Pit 1	14 ha		
	Sonoma East Pit 2	15 ha		
	Sonoma Q-Pit	n/a backfilled		n/a backfilled
	Sonoma B-Pit	n/a backfilled		n/a backfilled
Drake Coal Mine	Drake Pit 5	59 ha	Unspecified in DCM EA Table H1	High Wall – 65° Low wall – 45°
	Drake Pit 1	258 ha		
	Drake Pit 2			
	Drake Pit 2 Expansion			
	Central Pit 3	50 ha		
	Central Pit 4	16 ha		
	East Pit 1	14 ha		
	Drake Pit 3-Q	61 ha		
	Drake Pit 3-R			
Jax Coal Mine	Jax Main Pit	70 ha	Residual void unable to sustain a post-mining land use	High wall – 60°
	Jax East Pit	27 ha		Low wall – 32°
Cows Coal Mine	B Seam Pit	Backfilled	Unspecified in CCM EA Table H1-	N/A
	Q Seam Pit	Backfilled	Unspecified in CCM EA Table H1-	

5 Rehabilitation Objectives and Targets

5.1 Domains of Disturbance

Disturbance by mining activities at the QNH has been split into eight (8) domains, each with individual rehabilitation requirements, as detailed in **Table 9**.

Table 9 – Rehabilitation Domains

Domain	Description	Applicable Mine
1	Residual voids	SCM, DCM, JCM
2	Overburden dumps	SCM, CCM, DCM, JCM
3	Mine Infrastructure	SCM, DCM, JCM
4a	Co-disposal dams	SCM
4b	In-Pit Co-disposal	SCM
5	ROM and product stockpiles	SCM, DCM, JCM
6	Haul roads and access tracks	SCM, CCM, DCM, JCM
7	Sediment dams and water management infrastructure	SCM, DCM, JCM
8	Creek diversions	SCM

5.2 Rehabilitation Goals

Broad rehabilitation goals for the QNH sites are defined in **Condition H1** of the QNH EAs. These rehabilitation goals generally align with the rehabilitation goals summarised in the *Rehabilitation Requirements for Mining Projects* (EHP, 2014), and are as follows:

- Safe to humans and wildlife
- Stable
- Non-polluting
- Self-sustaining for the post-mining land use of grazing pasture, with the exception of residual voids.

EHP (2014) also includes a range of suggested strategies to aid in achieving the rehabilitation goals, which have informed the development of the rehabilitation strategies presented in this RMP (see **Section 7**).

5.3 Agreed Post-Mining Land Use

The post-mining land use is agreed between the mining company and the administering authority. Generally, the agreed post-mining land use considers both the historical use(s) of the land underlying the operations and the current use(s) of the land surrounding the operations.

Post-mining land use in the context of the Progressive Rehabilitation and Closure Plan (PRC Plan) for transitional sites is determined by Land Outcome Documents (LODs), as defined in the EP Act as follows:

land outcome document, for land, means the following documents relating to the land—

- (a) an environmental authority for a resource activity on the land;
- (b) a document made under a condition of an environmental authority mentioned in paragraph (a), if—
 - (i) the document relates to the management of a void within the meaning of section 126D on the land, or the rehabilitation of the land; and
 - (ii) the document was received by the administering authority before the assent date; and
 - (iii) the administering authority has not, within 20 business days after the assent date, given notice to the holder of the environmental authority that the document is insufficient in a material particular relevant to a matter mentioned in subparagraph (i); and
 - (iv) before the assent date, the document had not been superseded;
- (c) a document made under a condition of an environmental authority mentioned in paragraph (a), if—
 - (i) the document relates to the management of a void within the meaning of section 126D on the land, or the rehabilitation of the land; and
 - (ii) the environmental authority requires the document to be given to the administering authority on a stated day that is on or after the assent date, or does not state a day when the document must be given; and
 - (iii) the document is received by the administering authority within 3 years after the assent date; and
 - (iv) the administering authority does not, within 20 business days after receiving the document, give the holder of the environmental authority notice that the document is insufficient in a material particular relevant to a matter mentioned in subparagraph (i);
- (d) a report evaluating a EIS under the State Development and Public Works Organisation Act 1971, section 34D;
- (e) an EIS assessment report;
- (f) a written agreement between the holder of an environmental authority mentioned in paragraph (a) and the State that is in force on the assent date.

Post mining land use by domain and the relevant LOD to that post-mining land use has been presented in **Table 10**.

Table 10 – Post Mining Land Use by Domain

Domain	Sonoma Coal Mine		Drake Coal Mine		Jax Coal Mine		Cows Coal Mine	
	PMLU	LOD	PMLU	LOD	PMLU	LOD	PMLU	LOD
Residual voids	Residual void unable to sustain a post-mining land use.	QNH RMP	Residual void unable to sustain a post-mining land use.	QNH RMP	Residual void unable to sustain a post-mining land use.	QNH RMP and EA	-	-
Overburden Dumps	Grazing pasture	EA	Grazing pasture	EA	Grazing pasture	EA	Grazing pasture	EA
Mine Infrastructure	Grazing pasture or retained*	EA	Grazing pasture or retained*	EA	Grazing pasture or retained*	EA	-	-
Co-disposal dams	Grazing pasture	EA	-	-	-	-	-	-
In-pit co-disposal	Part of the Sonoma Main Pit Void complex	-	-	-	-	-	-	-
ROM and product stockpiles	Grazing pasture	EA	Grazing Pasture	EA	Grazing Pasture	EA	-	-
Haul Roads and Access tracks	Grazing pasture or retained*	EA	Grazing pasture or retained*	EA	Grazing pasture or retained*	EA	Grazing pasture or retained*	EA
Sediment dams and water management infrastructure	Grazing pasture or retained*	EA	Grazing pasture or retained*	EA	Grazing pasture or retained*	EA	-	-
Creek diversions	Grazing Pasture and Permanent Watercourse	EA and Diversion Design Documents	-	-	-	-	-	-

* These domains may be retained by the landholder only in the presence of written agreement

The agreed post-mining land use for all QNH mines, as per **Condition H1** in each of the QNH EAs (considered in the legislation as the highest Land Outcome Document), is self-sustaining grazing pasture for all domains with the exception of residual voids, creek diversions, and any infrastructure retained by the landholder (such as dams, hardstand areas, buildings, haul roads/access tracks, etc.) which will have a post-mining land use specific to the landholder.

When mine pits are backfilled, no residual void remains, and those areas no longer classified as Domain 1 (residual voids). Areas of backfilled pit (i.e. in-pit waste rock dumps) are classified as Domain 2 (overburden dump), and sediment control structures constructed within areas of backfilled pit are captured by Domain 7 (sediment dams and water management infrastructure). The PMLU for these landforms is identified in the relevant sections of **Table 10** above.

The residual voids permitted on the QNH are stated in the QNH EA's (presented in **Table 8**). The JCM EA stipulates a void outcome for the JCM voids as "Residual unable to sustain a post mining land use"; however, the DCM and SCM EAs do not stipulate a post-mining land use. As the DCM and SCM voids are not sources of groundwater to surrounding aquifers, and have perpetually degrading void lake water quality, they are also considered to be unable to sustain a post-mining land use (see **Appendix A**).

For rehabilitation to have been considered successful, the land must be returned to a "stable condition" as defined in Section 111A of the EP Act:

111A Meaning of stable condition

*Land is in a **stable condition** if –*

- (a) the land is safe and structurally stable; and*
- (b) there is no environmental harm being caused by anything on or in the land; and*
- (c) the land can sustain a post-mining land use.*

As the residual voids on the QNH have degrading lake water quality, and are therefore unable to sustain a PMLU, they cannot be rehabilitated to a stable condition as per the EP Act. As per the definitions in section 112 of the EP Act, land that cannot be rehabilitated to a stable condition is considered a non-use management area (NUMA):

non-use management area means an area of land the subject of a PRC plan that can not be rehabilitated to a stable condition after all relevant activities for the PRC plan carried out on the land have ended.

As the QNH mines transition into to the Progressive Rehabilitation and Closure Plan (PRC Plan) framework, residual voids will be managed as NUMAs. The primary LOD for this land outcome will be the QNH RMP; however, for JCM, these void outcomes are presented in the EA (see **Appendix A** for further detail).

5.3.1 Requirements for Grazing Pasture

QNH land to be rehabilitated to a grazing post mining land-use is to be returned to Class 4 suitability or better, based on the *Guidelines for Agricultural Land Evaluation in Queensland* (DSITI & DNRM, 2015). The acceptance criteria for Class 4 land are presented in **Table 11**.

Table 11 – Acceptance criteria – Class 4 Land Suitability

Parameter	Acceptance criteria
Plant Available Water Capacity (PAWC)	>50 mm
Salinity	EC _{1.5} <1.2 mS/cm or Cl _{1.5} <1,500 ppm in the root zone (60 cm depth)
Rockiness	<100% (% coarse fragments at soil surface)
Soil pH	<10 and >4 as measured at any part of the root zone.
Exchangeable Sodium Percentage (ESP %)	<30% (0-10 cm depth)
Water erosion (a function of slope % and ESP %)	Mean Slope <15% on cracking clay soils Mean Slope <12% on sodic soils (ESP >15% within 500 mm of surface) rigid soils Mean Slope <45% on non-sodic (ESP <15% within 500 mm of surface) rigid soils
Grazing Criteria	≥70% of the productivity (or carrying capacity) of non-mined land in the lease area or, Carrying capacity within the range of values reported for the region, taken as 15 ha/head
Groundcover	Mean groundcover ≥50% or > than the reference site mean minus one standard deviation.
Grazing Trials	Undertaken following groundcover establishment to confirm carrying capacity.
Species Mix and Composition	Proportion of non-preferred species not increasing Proportion class will not be more than one class* greater than the grazed reference sites. Proportion of declared plant pest species not increasing, and proportion class* will not be more than one class greater than the grazed reference sites.

* - Classes based on *State Rural Leasehold Land Strategy: Guidelines for determining land condition* prepared by DNRM (2013): Class 1 = 0%, Class 2 = 0-10%, Class 3 = 10-30%, Class 4 = >30% for declared plant pest (weed) species. Class 1 = >80%, Class 2 = 61-80%, Class 3 = 10-60%, Class 4 = <10% for preferred species composition.

In order to achieve these acceptance criteria, a range of rehabilitation strategies have been developed for site personnel to assist in the planning and execution of rehabilitation activities (see **Section 7**).

5.4 Landform Design

The design of rehabilitated landforms (other than voids or infrastructure retained by the landholder) is to be consistent with Class 4 suitability grazing, and the surrounding topography of the land. The rehabilitation process may include shaping of the landform to the designed slope, encouraging groundcover and any required works for drainage, and erosion control. Scheduling of works is discussed in **Section 7.4**.

Landform stability is typically achieved by achieving a desired slope length and angle, correct material selection and establishment of groundcover to improve erosion resistance. Mining operational requirements, particularly for waste rock dumps and co-disposal facilities, inform the size (footprint), height, and operational slopes, and other parameters related to the final landform. These operational requirements consider the need to leave domains in a state that

minimises the bulk earthwork requirements to achieve the desired landform design (i.e. geotechnical stability as a function of slope design) once they are released from operational use. Landform design plans are produced commensurate with the operational requirements to ensure as much of the bulk earthworks can be undertaken during regular operation as is possible. Slope ranges are detailed in **Table 12**.

5.5 Completion Criteria

Completion criteria for rehabilitation of the QNH mine domains have been developed to enable measurable/quantifiable criteria, which once achieved demonstrate that rehabilitation is complete and that the rehabilitated final landforms are (1) safe to humans and wildlife, (2) stable, (3) non-polluting, and (4) able to self-sustain the agreed post-mining land use. The criteria have been presented in **Table 12**.

Table 12 – QCoal Northern Hub Rehabilitation Completion Criteria

Domain	Objective	Completion Criteria	Performance Verification																
Domain 1 - Residual Voids	Safe to humans and wildlife	Access to the high wall will be restricted by bunds and/or fencing. Appropriate remediation of slope failures or rock falls.	Photographic evidence of bunding/fencing. If slope failure has occurred, it is rectified and ongoing design accounts for the previous failure.																
	Stable	Maximum slope: <table><tr><th>Site</th><th>EA reference</th><th>Highwall / Competent Rock</th><th>Low wall / Incompetent Rock</th></tr><tr><td>SCM</td><td>Table H1</td><td>Top 10m = 45° Thereafter = 70°</td><td>17° to 37°</td></tr><tr><td>DCM</td><td>Table H1</td><td>65°</td><td>45°</td></tr><tr><td>JCM</td><td>Table H1</td><td>60°</td><td>45°</td></tr></table> Appropriate remediation of slope failures or rock falls. Appropriate remediation of rill and gully erosion.	Site	EA reference	Highwall / Competent Rock	Low wall / Incompetent Rock	SCM	Table H1	Top 10m = 45° Thereafter = 70°	17° to 37°	DCM	Table H1	65°	45°	JCM	Table H1	60°	45°	Slope measurements retained with rehabilitation documentation. If slope failure has occurred, it is rectified and ongoing design accounts for the previous failure. If rill or gully erosion is identified, it is rectified, and additional erosion controls implemented as appropriate.
	Site	EA reference	Highwall / Competent Rock	Low wall / Incompetent Rock															
	SCM	Table H1	Top 10m = 45° Thereafter = 70°	17° to 37°															
	DCM	Table H1	65°	45°															
JCM	Table H1	60°	45°																
Non-polluting	Hydrogeological assessment completed. Void water balance completed and confirms 'no overtopping' in final design. Void water quality will not diminish the EVs of the surrounding groundwater.	Hydrogeology and water balance report. Groundwater monitoring/modelling shows no risk to local aquifer EVs.																	
Self-sustaining for the post-mining land use of grazing pasture, with the exception of residual voids	Not applicable to residual voids that are groundwater sinks, which are classified as "Residual void unable to sustain a post mining land use". See Appendix A .	Not applicable to residual voids that are groundwater sinks. See Appendix A .																	
Domain 2 - Overburden dumps	Safe to humans and wildlife	Appropriate remediation of slope failures or rock falls.	If slope failure has occurred, it is rectified and ongoing design accounts for the previous failure.																

Domain	Objective	Completion Criteria	Performance Verification
	Stable	The nominated maximum slope on dumps is 20% (11.5°), unless otherwise advised by an RPEQ. Mean groundcover ≥50%, or > the reference site mean minus one standard deviation. Appropriate remediation of slope failures or rock falls. Appropriate remediation of rill and gully erosion.	As-built/survey information retained with rehabilitation documentation. Rehabilitation monitoring reports to verify groundcover. If slope failure has occurred, it is rectified and ongoing design accounts for the previous failure If rill or gully erosion is identified, it is rectified, and additional erosion controls implemented as appropriate.
	Non-polluting	Spoil is to be dumped in accordance with the <i>QNH Mining Waste and Coal Rejects Management Plan</i> (Terrenus, 2013). Run-off or seepage water is not to diminish the EVs of the receiving environment including surrounding groundwater.	<i>Mining Waste and Coal Rejects Management Plan</i> (Terrenus, 2013) to be retained with rehabilitation documentation. As-built/survey information to be retained with rehabilitation documentation. REMP reporting during operations. Post-closure surface and groundwater quality monitoring reports.
	Self-sustaining for the post-mining land use of grazing pasture, with the exception of residual voids	Class 4 land suitability and light cattle grazing target (see Section 5.3)	Rehabilitation monitoring reports verify soil/land suitability standards are met. Rehabilitation monitoring reports verify productivity standards are met. Rehabilitation monitoring reports verify species mix and community composition standards are met.
Domain 3 - Mine Infrastructure including CHPP, Train Load out facility and rail loop.	Safe to humans and wildlife	Hazardous material is identified and managed Only infrastructure remaining on-site is as per an agreement with the landholder and the State. Appropriate remediation of slope failures or rock falls	Remediation of identified contaminated areas is verified and/or approved Site Management Plan is in place. All unwanted infrastructure is removed. Evidence of agreement is held with rehabilitation documentation. If slope failure has occurred, it is rectified and ongoing design accounts for the previous failure.
	Stable	For all infrastructure on the QNH the adopted maximum slope completion criteria will be 20% (11.5°), unless otherwise advised by an RPEQ. Mean groundcover ≥50%, or > the reference site mean minus one standard deviation. Appropriate remediation of slope failures or rock falls. Appropriate remediation of rill and gully erosion.	As-built/survey information retained with rehabilitation documentation. Rehabilitation monitoring reports to verify groundcover. If slope failure has occurred, it is rectified and ongoing design accounts for the previous failure. If rill or gully erosion is identified, it is rectified, and additional erosion controls implemented as appropriate.
	Non-polluting	Hazardous material is identified and managed. Run-off or seepage water is not to diminish the EVs of the receiving environment and local aquifers.	REMP reporting during operations. Post-closure surface and groundwater quality monitoring reports.
	Self-sustaining for the post-mining land use of grazing pasture, with the exception of residual voids	Class 4 land suitability and light cattle grazing target (see Section 5.3)	Rehabilitation monitoring reports verify soil/land suitability standards are met. Rehabilitation monitoring reports verify productivity standards are met. Rehabilitation monitoring reports verify species mix and community composition standards are met.
Domain 4a - Co-disposal	Safe to humans and wildlife	Appropriate remediation of slope failures or rock falls.	If slope failure has occurred, it is rectified and ongoing design accounts for the previous failure.

Domain	Objective	Completion Criteria	Performance Verification
dams (out-of-pit)	Stable	For all co-disposal facilities on the QNH the adopted slope completion criteria will be 11.5°, unless otherwise advised by an RPEQ. Mean groundcover ≥50%, or > the reference site mean minus one standard deviation. Appropriate remediation of rill and gully erosion.	Approved Site Management Plan is in place. Remediation of identified contaminated areas is verified and/or approved Site Management Plan is in place. As-built/survey information retained with rehabilitation documentation. Rehabilitation monitoring reports to verify groundcover. If slope failure has occurred, it is rectified and ongoing design accounts for the previous failure. If rill or gully erosion is identified, it is rectified, and additional erosion controls implemented as appropriate.
	Non-polluting	Hazardous material is identified and managed. Run-off or seepage water is not to diminish the EVs of the receiving environment and local aquifers.	Remediation of potentially contaminated areas is verified. REMP reporting during operations. Post-closure surface and groundwater quality monitoring reports.
	Self-sustaining for the post-mining land use of grazing pasture, with the exception of residual voids	Class 4 land suitability and light cattle grazing target (see Section 5.3)	Rehabilitation monitoring reports verify soil/land suitability standards are met. Rehabilitation monitoring reports verify productivity standards are met. Rehabilitation monitoring reports verify species mix and community composition standards are met.
Domain 4b - Co-disposal dams (in-pit)	Safe to humans and wildlife	Pit access is restricted as part of Void rehabilitation actions; therefore, no further action is required to make the in-pit co-disposal safe.	Residual void acceptance criteria met.
	Stable	As there are no batters associated with the in-pit co-disposal, there is no risk of slope failures or rock falls. The in-pit co-disposal is to be capped with appropriate waste material.	Residual void acceptance criteria met.
	Non-polluting	The in-pit co-disposal makes up a part of the SCM Main Pit complex, which is a groundwater sink, and will not have any impacts on groundwater or surface water EVs.	Residual void acceptance criteria met.
	Self-sustaining for the post-mining land use of grazing pasture, with the exception of residual voids	As the in-pit co-disposal becomes part of the residual void floor, and the Sonoma Main Pit is a groundwater sink, there will be no PMLU, and the in-pit co-disposal will make up part of the void NUMA.	N/A
Domain 5 - ROM and Product stockpile areas	Safe to humans and wildlife	Hazardous material is identified and managed. Appropriate remediation of slope failures or rock falls.	Remediation of identified contaminated areas is verified and/or approved Site Management Plan is in place. If slope failure has occurred, it is rectified and ongoing design accounts for the previous failure.

Domain	Objective	Completion Criteria	Performance Verification
	Stable	For all ROM/Product Stockpiles on the QNH the adopted slope completion criteria will be 11.5° (20%), unless otherwise advised by an RPEQ. Mean groundcover ≥50%, or > the reference site mean minus one standard deviation. Appropriate remediation of slope failures or rock falls. Appropriate remediation of rill and gully erosion.	As-built/survey information retained with rehabilitation documentation. Rehabilitation monitoring reports to verify groundcover. If slope failure has occurred, it is rectified and ongoing design accounts for the previous failure. If rill or gully erosion is identified, it is rectified, and additional erosion controls implemented as appropriate.
	Non-polluting	Hazardous material is identified and managed. Run-off or seepage water is not to diminish the EVs of the receiving environment and local aquifers.	REMP reporting during operations. Post-closure surface and groundwater quality monitoring reports.
	Self-sustaining for the post-mining land use of grazing pasture, with the exception of residual voids	Class 4 land suitability and light cattle grazing target (see Section 5.3)	Rehabilitation monitoring reports verify soil/land suitability standards are met. Rehabilitation monitoring reports verify productivity standards are met. Rehabilitation monitoring reports verify species mix and community composition standards are met.
Domain 6 - Haul roads and tracks not being retained for post-mining use	Safe to humans and wildlife	Appropriate remediation of slope failures or rock falls.	If slope failure has occurred, it is rectified and ongoing design accounts for the previous failure.
	Stable	Agreement from landholder regarding infrastructure allowed to remain on site For all roads and tracks not being retained the adopted slope completion criteria will be 11.5° (20%), unless otherwise advised by an RPEQ. Mean groundcover ≥50%, or > the reference site mean minus one standard deviation. Appropriate remediation of slope failures or rock falls. Appropriate remediation of rill and gully erosion.	Evidence of landholder agreement. As-built/survey information retained with rehabilitation documentation. Rehabilitation monitoring reports to verify groundcover. If slope failure has occurred, it is rectified and ongoing design accounts for the previous failure. If rill or gully erosion is identified, it is rectified, and additional erosion controls implemented as appropriate.
	Non-polluting	Run-off or seepage water is not to diminish the EVs of the receiving environment and local aquifers.	REMP reporting during operations. Post-closure surface and groundwater quality monitoring reports.
	Self-sustaining for the post-mining land use of grazing pasture, with the exception of residual voids	Class 4 land suitability and light cattle grazing target (see Section 5.3)	Rehabilitation monitoring reports verify soil/land suitability standards are met. Rehabilitation monitoring reports verify productivity standards are met. Ongoing pasture management measures documented in the PMCP. Rehabilitation monitoring reports verify species mix and community composition standards are met.
Domain 7 - Sediment dams and other water	Safe to humans and wildlife	Appropriate remediation of slope failures or rock falls.	If slope failure has occurred, it is rectified and ongoing design accounts for the previous failure.

Domain	Objective	Completion Criteria	Performance Verification
management infrastructure not retained for post-mining use	Stable	Agreement from landholder regarding infrastructure allowed to remain on site For all dams and water management infrastructure on the QNH the adopted slope completion criteria will be advised by an RPEQ. Mean groundcover $\geq 50\%$, or $>$ the reference site mean minus one standard deviation. Appropriate remediation of slope failures or rock falls. Appropriate remediation of rill and gully erosion.	Evidence of landholder agreement Remediation of identified contaminated areas is verified and/or approved Site Management Plan is in place. As-built/survey information retained with rehabilitation documentation. Rehabilitation monitoring reports to verify groundcover. If slope failure has occurred, it is rectified and ongoing design accounts for the previous failure. If rill or gully erosion is identified, it is rectified, and additional erosion controls implemented as appropriate.
	Non-polluting	Hazardous material is identified and managed Run-off or seepage water is not to diminish the EVs of the receiving environment and local aquifers.	REMP reporting during operations. Post-closure surface and groundwater quality monitoring reports.
	Self-sustaining for the post-mining land use of grazing pasture, with the exception of residual voids	Class 4 land suitability and light cattle grazing target (see Section 5.3)	Rehabilitation monitoring reports verify soil/land suitability standards are met. Rehabilitation monitoring reports verify productivity standards are met. Ongoing pasture management measures documented in the PMCP. Rehabilitation monitoring reports verify species mix and community composition standards are met.
Domain 8 - Creek diversions	Safe to humans and wildlife	RPEQ designed and certified	As-built drawings and ongoing monitoring show no safety issues.
	Stable	Total ground cover on the creek banks is sufficient to minimize erosion (70% protective foliage cover in the absence of rock or armouring at the surface) Maximum bank slope: $\leq 25\%$ (<i>Design of Two Mile Creek Diversion</i> (BSM, 2012) and <i>North Sonoma Creek Diversion Design Plan</i> (Engeny, 2018)) RPEQ designed and certified Revegetation works completed using the species lists found in the relevant design documents Appropriate remediation of rill and gully erosion.	As-built/survey information retained with rehabilitation documentation. Rehabilitation monitoring reports to verify groundcover. If rill or gully erosion is identified, it is rectified, and additional erosion controls implemented as appropriate.
	Non-polluting	Creek diversions do not impact the EVs of the receiving environment and local aquifers.	REMP reporting during operations. Post-closure surface and groundwater monitoring reports.
	Self-sustaining for the post-mining land use of grazing pasture, with the exception of residual voids	At least 50% of tree and shrub species located in analogue areas are growing in the diversion area. Abundance of tree species are at least 80% of analogue species abundance. Plant cover is stable or increasing. Class 4 land suitability and light cattle grazing target (see Section 5.3) for at least 60% of the land area. Index of Diversion Condition (IDC) score of the diversion is consistent with the creek control reaches.	Rehabilitation monitoring reports verify soil/land suitability standards are met. Rehabilitation monitoring reports verify productivity standards are met. Ongoing pasture management measures documented in the PMCP. Rehabilitation monitoring reports verify species mix and community composition standards are met. Annual monitoring reports show that diversion reaches score equally or better than reference reaches based on the methodology of IDA, 2001. <i>Monitoring and evaluation program for Bowen Basin river diversion</i>, ID&A Pty Ltd. Australian Coal association Research Program C9068 (IDA 2001).

6 Required Assessments and Certifications

In order to determine the efficacy of rehabilitation and compliance with various EA conditions, the tasks presented in **Table 13** are to be undertaken by an Appropriately Qualified Person (AQP) (as defined in the QNH EAs) relevant to each task.

Table 13 – Assessments, Designs, and Certifications

Task	Description	Timing
Contaminated Land Assessment	Requirement for a Phase 1 for all sites, using ERC to inform the Phase 1. Phase 1 informs any required Phase 2, which in turn informs any remediation and verification. Remediation of identified contaminated areas is verified and/or approved Site Management Plan is in place. Certification that any identified contaminated land has been managed appropriately and in accordance with the relevant administering authority guideline/s.	Prior to rehabilitation of relevant areas (e.g. MIAs, Infrastructure areas, CHPPs etc.).
Geotechnical studies	Certification that the final landforms are stable/geotechnically sound, and there is a low risk of rock falls with serious environmental or safety consequences.	Following completion of all rehabilitation works with associated geotechnical or rock-fall related risks.
Surface and groundwater monitoring	Monitoring is to be undertaken to identify occurrence of any downstream impacts.	During rehabilitation works and following completion of works until rehabilitation is certified.
Capping material assessment	Assessment of suitable materials and depth for capping of co-disposal facilities	As part of capping of the co-disposal facilities
Soils Assessment	Monitoring of topsoil is to be undertaken in order to determine chemical, physical and biological properties remain appropriate for the proposed land use.	Following completion of rehabilitation works and 5-yearly until certification of rehabilitation completion.
Final Rehabilitation Report	Report outlining compliance with conditions of the EA, achievement against completion criteria, the extent and success of the rehabilitation, ongoing environmental management and monitoring requirements, and residual risk.	Following completion of rehabilitation works, to be submitted in order to discharge Financial Assurance.
Compliance Statement	Details compliance with EA conditions and confirms the accuracy of the Final Rehabilitation Report.	To be submitted with the Final Rehabilitation Report.
Diversion Monitoring Reports	A report on monitoring of diversion stretches to assess Index of Diversion Condition (IDC) and process towards revegetation goals.	Annually during operations. The requirement to continue following relinquishment will be assessed based on operational monitoring.

7 Rehabilitation Strategies

Strategies for undertaking rehabilitation to achieve the completion criteria provided in **Section 5.5** are provided in the following sections, with the general objective to achieve a post-mining land suitability of Class 4 for grazing.

7.1 Mining Domains

7.1.1 Residual Voids (Domain 1)

The design of operational mining pits is such that they are generally geotechnically stable and meet slope requirements prior to being released for rehabilitation works. A number of pits on the QNH have been and will be backfilled during normal mining operations; however, the majority of pits will not be backfilled and will remain as final voids.

It is critical to note that although residual voids on the QNH are unable to sustain a PMLU, this does not remove the requirement for them to be safe, structurally stable and non-polluting.

The rehabilitation process for residual voids is as follows:

- The final landform is to be shaped and graded to be geotechnically stable. Re-profiling (including blasting of void walls) may be required.
- Establish drainage and erosion controls.
- Final slope (completion criteria) as per **Section 5.5**.
- Signage, fencing, and/or safety bunds (specification based on DME (1995)) are to be placed as required to limit access to the void lakes for people, stock and fauna.

QNH voids are to have the following characteristics based on a final hydrogeological assessment:

- Acceptable (low) risk of overtopping.
- Isolated from surface water flows (non-flushing).
- Void water is unlikely to impact the EVs of any surrounding groundwater.
- Voids are to have no intended or planned access for livestock or any other uses.

7.1.2 Overburden Dumps (Domain 2)

Waste Rock Management

The waste rock categories and characteristics for the QNH are detailed in **Section 3.5**. Placement of waste rock in overburden dumps is to be undertaken in accordance with the current version of the *QCoal Northern Hub Mine Waste Management Plan*.

Waste Rock Dump Landforms

The general strategy to be followed when rehabilitating waste rock dumps is as follows:

- Shape and grade the final landform to be geotechnically stable. Final slope completion criteria as per **Section 5.5**.
- Rip surface material on the contour at a spacing of 1 m to between 0.5 and 1.0 metres as required.
- Establish drainage and erosion controls through ripping, profiling and/or construction of control structures.
- Apply topsoil to a minimum depth of 100 mm.
- Scarify the surface immediately prior to any required seeding.
- Seed with an appropriate species mix (see **Section 7.3.2**) where natural seedbanks have been identified as unsuitable.
- Control weeds and pest animals.
- Exclude livestock during establishment of groundcover.

Note that waste rock dumps are typically designed to be geotechnically stable and safe during the operation of the mine, which minimises the need for major stabilisation works during rehabilitation.

Topsoil Stockpiles

During routine mine operations, topsoil will be stripped, typically to a depth of 300 mm, and either used immediately on rehabilitation works (stripped and then placed) or stockpiled separately for use in future rehabilitation. These stockpiles will be tracked, inventoried and seeded where required to minimise erosion.

Topsoil will be recovered from stockpiles and spread during rehabilitation works, with depth of spreading based on the nature/condition of the surface on which the topsoil is spread.

Areas where topsoil was previously stockpiled will be rehabilitated once the stockpiled topsoil has been recovered for use, with the following methodology:

- Recover topsoil for use in rehabilitation elsewhere, leaving a minimum of 100 mm of topsoil.
- Establish drainage and erosion controls as required.
- Rip/scarify any compacted topsoil material.
- Final slope completion criteria as per **Section 5.5**.
- Scarify the surface immediately prior to any required seeding.
- Seed with an appropriate seed mix (see **Section 7.3.2**) where natural seedbanks have been identified as unsuitable.
- Control weeds and pest animals.
- Exclude livestock during establishment of groundcover.

7.1.3 Mine Infrastructure (Domain 3)

Constructed infrastructure is typically to be removed from site when the infrastructure areas are decommissioned and demolished. This includes, but is not limited to, demountable offices, CHPPs, sewage treatment systems, etc. However, any infrastructure (or components of infrastructure) considered beneficial to the subsequent landholder or the final land use, may be retained upon formal agreement. Examples of constructed infrastructure that could be retained include hardstand areas, concrete pads, shipping containers, sheds, workshops, tanks, etc.

A contaminated land assessment (see **Section 6**) is to be undertaken to determine the requirement for any remediation activities prior to the commencement of rehabilitation activities.

Below are rehabilitation strategies for infrastructure areas where infrastructure is not to be retained, and assumes that physical structures including foundations and concrete slabs have been removed:

- Contaminated land assessment completed as per **Section 6**.
- Final slope completion criteria as per **Section 5.5**.
- Rip compacted surface material on the contour at a spacing of 1 m to between 0.5 and 1.0 metres as required.
- Establish drainage and erosion controls as required.
- Apply topsoil to a minimum depth of 100 mm.
- Scarify the surface immediately prior to seeding
- Seed with an appropriate seed mix (see **Section 7.3.2**) where natural seedbanks have been identified as unsuitable.
- Control weeds and pest animals.
- Exclude livestock during establishment of groundcover.

7.1.4 Co-disposal Facilities (Domain 4)

Out-of-Pit

The general strategy for decommissioning and rehabilitating out-of-pit co-disposal facilities on the QNH involves capping of the facility followed by rehabilitation activities. The top and upper slopes would be capped first (reducing ongoing infiltration) in order to allow the co-disposal to drain residual leachate prior to capping the lower slopes and shaping.

The capping materials for co-disposal dams should consider the following elements:

- *Trafficability* – If the dams are not suitable for direct vehicle access at the time of decommissioning, a layer of stable material is required to allow heavy vehicles to access the dams safely when undertaking rehabilitation works (nominal thickness of 0.5-1m).
- *Impeding infiltration* – To reduce the infiltration of surface water into the body of the co-disposal and reduce capillary rise should that be identified as a likely issue (nominal thickness of 0.5 – 1 m).

- *Growth* – Provide a suitable substrate for revegetation and be constructed of non-dispersive material with a nominal thickness of 0.5 – 1 m. Topsoil should be spread to a minimum of 0.1m above this.

The geochemical and geotechnical properties required for capping material, as well as the depth and any compaction requirements are to be determined by an SQP (see **Section 6**), and, where necessary, materials on-site that can be used in this application should be stockpiled for this use during normal operations. Shaping and capping is necessary to reduce rainwater infiltration into the body of the co-disposal, which reduces minimises the phreatic surface within the decommissioned co-disposal facilities and reduces the potential for leaching of water from the body of the co-disposal through the rehabilitated slopes

Monitoring of shaped slopes is required to determine whether seepage is reporting through the capping material, which can a) affect geotechnical stability, and b) in the case of acidic leachate, pose a potential environmental risk. Therefore, geotechnical stability should be assessed to identify any slippage risks, and with regard to the potential for acid leachate, the rejects material is non-acid forming (see **Section 3.5**).

Rehabilitation works for co-disposal facilities following capping are as follows:

- Final slope completion criteria as per **Section 5.5**.
- Establish drainage and erosion controls.
- Apply topsoil to a minimum depth of 100 mm.
- Scarify the surface immediately prior to seeding (if seeding is required).
- Seed with an appropriate seed mix (see **Section 7.3.2**) where natural seedbanks have been identified as unsuitable.
- Control weeds and pest animals.
- Exclude livestock during establishment of groundcover.

In-Pit

Currently, one in-pit co-disposal facility is proposed on the QNH, being the SCM Main Pit in-pit co-disposal. Similar to out-of-pit co-disposal facilities, the general strategy for decommissioning and rehabilitation in-pit co-disposal facilities on the QNH involves capping of the facility followed by rehabilitation activities; however, as there are no outer batters associated with the in-pit facility, only the top needs to be capped. As this facility is completely within the Sonoma Main Pit void, and will ultimately be inundated, no further rehabilitation actions are required, and the in-pit co-disposal will make up part of the Sonoma Main Pit residual void.

7.1.5 ROM and Product Stockpile Areas (Domain 5)

Rehabilitation of ROM and product stockpile areas is similar to other infrastructure areas and is subject to the contaminated land assessment outcomes discussed in **Section 6**.

A contaminated land assessment (see **Section 6**) is to be undertaken to determine the requirement for any remediation activities prior to the commencement of rehabilitation activities.

Rehabilitation works are as follows:

- Final slope completion criteria as per **Section 5.5**.
- Rip surface material on the contour at a spacing of 1 m to between 0.5 and 1.0 metres as required.
- Establish drainage and erosion controls as required.
- Apply topsoil to a minimum depth of 100 mm.
- Scarify the surface immediately prior to seeding (if seeding is required).
- Seed with an appropriate species mix (see **Section 7.3.2**) where natural seedbanks have been identified as unsuitable.
- Control weeds and pest animals.
- Exclude livestock during establishment of groundcover.

7.1.6 Haul Roads and Tracks (Domain 6)

Constructed haul roads, access roads and tracks (including paved and dirt roads) are typically rehabilitated; however, any roads or tracks which are considered beneficial to the underlying landholder or the final land use may be retained upon formal agreement. Haul roads used for moving coal are subject to contaminated land investigations and potential associated remediation works.

A contaminated land assessment (see **Section 6**) is to be undertaken to determine the requirement for any remediation activities prior to the commencement of rehabilitation activities. As haul roads are routinely graded, it is considered likely that the only areas of potential contamination are the haul road drains, and therefore only these areas require assessment.

The rehabilitation strategy for haul roads and tracks below only applies in instances where they are not being retained, and assumes that physical components such as pavement and culverts etc., have been lifted and removed:

- Final slope completion criteria as per **Section 5.5**.
- Rip surface material on the contour at a spacing of 1 m to between 0.5 and 1.0 metres as required.
- Establish drainage and erosion controls as required.
- Apply topsoil to a minimum depth of 100 mm.
- Scarify the surface immediately prior to seeding (if seeding is required).
- Seed with an appropriate species mix (see **Section 7.3.2**) where natural seedbanks have been identified as unsuitable.
- Control weeds and pest animals.
- Exclude livestock during establishment of groundcover.

7.1.7 Water Management Infrastructure (Domain 7)

Sediment Dams

Dams (mine affected, sediment affected, or raw water) can be decommissioned, demolished and rehabilitated; however, any dams considered beneficial to the underlying landholder, or

would be necessary or beneficial to the final land use, may be retained based on formal agreement with the landholder.

For mine-affected sediment dams (i.e. those dams that have come into contact with coal) or dams which have contained other contaminated water (such as hydrocarbons), a contaminated land assessment is to be undertaken to determine the requirement for any remediation (see **Section 6**) prior to the commencement of rehabilitation activities.

For those dams being retained, some minor rehabilitation works may be required prior to hand-over to the landholder. As such, the rehabilitation strategy has been split into two categories: (1) retained or (2) demolished then rehabilitated. The rehabilitation strategy assumes that dams are dry (or drained) prior to commencing rehabilitation works, as inflows will be restricted to rainfall once production ceases, and water from dams will be used for dust suppression during rehabilitation works.

Dams retained:

- Sediment within drained mine affected dams are subject to a contaminated land assessment (as per **Section 6**), and any contaminated material removed is to be encapsulated within a waste rock dump. This does not apply to sediment affected or raw water dams.
- Embankments, dam walls and spillways should be repaired where required (i.e. where rill erosion is observed). Following any repairs:
 - Apply topsoil to a minimum depth of 100 mm.
 - Scarify the surface immediately prior seeding (if seeding is required)..
 - Seed with an appropriate species mix (see **Section 7.3.2**) where natural seedbanks have been identified as unsuitable.
 - Control weeds and pest animals.
 - Exclude livestock during establishment of groundcover.

Dams demolished and rehabilitated:

- Sediment within drained mine affected dams are subject to a contaminated land assessment (as per **Section 6**), and any contaminated material removed is to be encapsulated within a waste rock dump. This does not apply to sediment affected or raw water dams.
- Final slope completion criteria as per **Section 5.5**.
- The final landform must not retain water.
- Rip surface material on the contour at a spacing of 1 m to between 0.5 and 1.0 metres as required.
- Establish drainage and erosion controls.
- Apply topsoil to a minimum depth of 100 mm.
- Scarify the surface immediately prior to seeding (if seeding is required).
- Seed with an appropriate species mix (see **Section 7.3.2**) where natural seedbanks have been identified as unsuitable.
- Control weeds and pest animals.
- Exclude livestock during establishment of groundcover.

Levees and Drains

Levees and drains are in place on a mine site to manage surface water runoff and, in the specific case of a co-disposal facility, the decant water cycle. More specifically, they are in place to manage surface water runoff from mine-affected areas, sediment-affected areas, and unaffected areas (clean run-off) in a controlled/designed manner. This avoids adverse impacts on pits/dumps/roads/dams or any other infrastructure. Accordingly, the decision whether a drain or levee is retained post-closure (and therefore the level of rehabilitation required for that drain or levee) depends on a number of factors including:

- What infrastructure the landholder is retaining. If the landholder requests that infrastructure be retained, then any drain or levee associated with that infrastructure should also be retained to ensure its ongoing functionality and safety.
- The specific design of rehabilitated final landforms. For example, during operation, waste rock dumps have drains to collect and manage runoff, so the post-closure design of drainage must consider:
 - whether the runoff from a rehabilitated waste rock dump would flow down the slopes to the toe and then onto the surrounding land without control (thereby carving its own flow path ultimately into a local watercourse); or
 - whether the drain should be retained to control the runoff post-closure along a designated flow path into a designated watercourse.
- How the removal of some drains or levees might affect the hydraulic functionality of those that are retained.

In addition, any drains or levees not associated with retained infrastructure, but which are considered directly beneficial to the subsequent landholder or would be directly necessary/beneficial to the final land use, may be retained upon formal agreement.

For drains or levees being retained, some minor rehabilitation works may be required prior to hand-over to the landholder. As such, the below rehabilitation strategy is separated into those being retained and those being demolished and rehabilitated.

Drains or levees retained:

- Mine affected drains (co-disposal decant, ROM/Product pad drains, etc.): Sediment within mine-affected drains is subject to a contaminated land assessment (as per **Section 6**), with any contaminated material removed encapsulated within a waste rock dump. This does not apply to sediment affected or un-affected drains/levees.
- All drains: where required, remove sediment build-up and/or reeds to ensure hydraulic functionality.
- Drain or levee walls should be repaired where required (e.g. where rill erosion is observed).
- Drain beds should be repaired where required (e.g. where scouring is observed)
- Following any required repair works:
 - Apply topsoil to external drain batters and levee walls to a minimum depth of 100 mm and where required.
 - Scarify the surface immediately prior seeding (if seeding is required).

- Seed with an appropriate species mix (see **Section 0.0.0**) where natural seedbanks have been identified as unsuitable.
- Control weeds and pest animals.
- Exclude livestock during establishment of groundcover.

Drains or levees being demolished:

- Mine affected drains (co-disposal decant, ROM/Product pad drains, etc.): Sediment within mine-affected drains is subject to a contaminated land assessment (as per **Section 6**), with any contaminated material removed encapsulated within a waste rock dump. This does not apply to sediment affected or un-affected drains/levees.
- Drains backfilled.
- Drain walls and levees graded to final slope (completion criteria) as per **Section 5.5**.
- Rip surface material on the contour at a spacing of 1 m to between 0.5 and 1.0 metres as required.
- Establish drainage and erosion controls.
- Apply topsoil to a minimum depth of 100 mm.
- Scarify the surface immediately prior seeding (if seeding is required).
- Seed with an appropriate species mix (See **Section 7.3.2**) where natural seedbanks have been identified as unsuitable.
- Control weeds and pest animals.
- Exclude livestock during establishment of groundcover.

7.1.8 Creek Diversions (Domain 8)

Creek diversions are to be permanent landforms following mine closure. Rehabilitation works (particularly along the banks) may be required to achieve the requirements of the diversion design (i.e. stable, non-polluting and ecologically functional).

As at the time of this RMP, there are two creek diversions as follows:

- Two Mile Creek diversion:
 - Design: Design of Two Mile Creek Diversion (BSM, 2012)
 - Construction completed in 2013
- Coral Creek diversion
 - Design: North Sonoma Creek Diversion Design Plan (Engeny, 2018)
 - Construction completed in 2018

Any other creek diversion works undertaken on the QNH will be subject to the revegetation and rehabilitation requirements presented in their relevant design plans.

Diversions become non-polluting and able to sustain their agreed post-mining land use through appropriate design, material selection, construction methods and revegetation. Low-flow channels in both diversions are designed with rock lining and therefore, revegetation within the low flow channel is not required. Any imported or native rock material should be geochemically inert to ensure that no pollution to the surrounding environment occurs. Revegetation of benches above the low flow channel or on the upper banks is required, as they are not rock lined. Revegetation strategies vary between creek diversions, as the nature of the flow regime and vegetation diversity/abundance are specific to each creek.

Two Mile Creek Diversion Revegetation

Construction of the Two Mile Creek Diversion was completed in 2013. The natural seedbank present in the topsoil spread has continued to support a self-sustaining population of groundcover species (such as grasses), shrubs, and small and large trees. The requirement for future revegetation works is assessed during annual creek diversion inspections (see **Section 6**).

Coral Creek Diversion Revegetation

Construction of the Coral Creek Diversion was completed in 2018. After construction activities were completed, the bench above the low flow channel and adjacent batters of the diversion were hydromulched with a seed mix comprising grasses, shrubs and trees as per Engeny, 2018. The requirement for potential future revegetation works is assessed during annual creek diversion inspections (see **Section 6**).

7.2 Supporting Activities

7.2.1 Exploration

Exploration activities undertaken on the granted mining leases are not considered a mining domain, and they do not represent a significant area of disturbance. Exploration areas generally comprise an access track, a small cleared drill pad (e.g. 50m by 50m), a sump, drill cuttings and the drill hole. Disturbance associated with exploration is to be rehabilitated as follows:

- Boreholes are to be backfilled with cuttings, sealed and capped.
- Shape and grade the drill pads to match the grade of the surrounding area.
- If required, rip any compacted surface material to between 0.5 and 1.0 metres.
- Establish drainage and erosion controls as required.
- Any stripped topsoil is to be replaced to a minimum depth of 100 mm.
- Scarify the surface immediately prior seeding (if seeding is required).
- Seed with an appropriate species mix (See **Section 7.3.2**) where natural seedbanks have been identified as unsuitable.
- Control weeds and pest animals.
- Exclude livestock during establishment of groundcover.

Under the relevant conditions of the QNH EAs, lands previous subject to exploration under Exploration Permit Coal (EPC) 586 are to be rehabilitated in general accordance with Conditions B24 to B31 of ESR/2016/1985 *Eligibility criteria and standard conditions for exploration and mineral development projects – Version 2* (EHP, 2016). The rehabilitation status of legacy boreholes will be assessed on a case by case to prioritise a program of rehabilitation based on environmental risk.

The conditions of the Code also apply to any additional exploration activities undertaken on the now granted mining leases. These criteria have been extracted and presented in **Table 14**.

Table 14 – Rehabilitation Conditions for Exploration

Condition	Description
B24	In Riverine Areas, the holder of the environmental authority must complete the Rehabilitation Processes on all areas disturbed by mining activities, apart from those areas currently being utilised for mining activities, as soon as practical and prior to the onset of the wet season
B25	For all other areas on the mining tenement, the holder of the environmental authority must complete the rehabilitation processes on all areas disturbed by mining activities, apart from those areas currently being utilised for mining activities, as soon as practical and at least within six months of the completion of works in those areas.
B26	The holder of the environmental authority must backfill all excavations, drill holes or sampling sites as soon as practical following the completion of exploration activities.
B27	Condition B26 does not apply to any excavations, drill holes or sampling sites that are to remain after the completion of exploration activities, by agreement with the land owner.
B28	The holder of the environmental authority must rehabilitate areas disturbed by mining activities to a stable landform similar to that of surrounding undisturbed areas.
B29	The holder of the environmental authority must spread seeds or plant species that will promote vegetation of a similar species and density of cover to that of the surrounding undisturbed areas or vegetation that is appropriate for providing erosion control and stabilisation of the disturbed areas.
B30	For any Mine Infrastructure to remain after all mining activities have ceased, the holder of the environmental authority must obtain the written agreement of the land owner stating they will take over responsibility for that infrastructure.
B31	The holder of the environmental authority must complete rehabilitation of disturbed areas to the satisfaction of the administering authority.

7.3 General Rehabilitation Strategies

7.3.1 Establishing Drainage and Erosion Controls

Final landform surfaces are to be contoured, and the final drainage features installed, along with permanent sediment control structures.

The most effective way to control surface flow in rehabilitated areas is to construct contour furrows or contour banks at regular intervals down the slope, effectively dividing a long slope into a series of short slopes. As slope angle increases, these banks or furrows must be spaced closer together. Contour banks are typically the preferred erosion control option for relevant domains (e.g. waste rock dumps, out-of-pit co-disposal facilities, etc.). Construction plant required to establish contour banks is a small dozer (civil scale) with a multi-tined, rear-mounted ripper and a front angle-and-tilt blade.

7.3.2 Establishing Vegetation

Establishment of vegetation is required to ensure a stable and productive landform following rehabilitation activities. Vegetation is to be established by either a reliance on a viable seedbank existing within previously stripped and stockpiled topsoil, or direct seeded if the seedbank found to not be viable.

Natural Seedbank

The stripped and stockpiled topsoils on the QNH have shown to be laden with viable seed, and minimising the maximum height of stockpiles ensures that the seedbank remains viable until it is respread on rehabilitated areas. The natural seedbank contains a representative

diversity of the dominant grass, shrub and tree species present on the land prior to disturbance and is therefore inherently suitable for the rehabilitated use.

To ensure the greatest potential for rehabilitation success when using the existing seedbank in the topsoil, the subsoils are ripped to between 0.5 and 1 metres immediately prior to spreading topsoil (see the **Soil Preparation** subsection for further detail). This breaks up any potential soil compaction and allows the roots of newly sprouted plants to penetrate the subsoils more readily.

Direct Seeding

Where topsoil stockpiles have been observed to have unsuitable seedbanks from previous rehabilitation works, or where the topsoil seedbank has failed to produce an appropriate level of groundcover or species mix, direct seeding may be required.

Sourcing Seed and Suitable Species

Seed can be purchased from a commercial supplier or collected from the local area. Collection of seed may only take place where the collector has the relevant permission and/or permits for the area from which they are collecting. Any seeds requiring storage prior to planting should be maintained in cool, dry conditions and protected from insects.

Based on surrounding pasture, native grass and pasture species composition should be considered, but not necessarily be limited to, the list of species in **Table 15**. These species have been observed in paddocks either surrounding the QNH, or within undisturbed areas of the QNH, and will help facilitate the final land use of cattle grazing. Other suitable improved pasture and native grass species may also be used in seeding mixes.

Table 15 – Suitable Grass Species

Species Name	Common Name
Preferred grazing species	
<i>Urochloa mosambicensis</i>	Sabi Grass
<i>Cenchrus ciliaris</i>	Buffel Grass
<i>Heteropogon contortus</i>	Black Speargrass
<i>Dichanthium sp.</i>	Bluegrass
<i>Rhynchosia minima</i>	Rhynchosia
<i>Macroptilium lathyroides</i>	Phasey Bean
<i>Clitoria ternatea</i>	Butterfly Pea
<i>Sorghum halepense</i>	Johnson Grass
Intermediate grazing species	
<i>Neptunia gracilis</i>	Native Sensitive Plant
<i>Chloris inflata</i>	Purple-top Rhodes Grass
Legumes	
<i>Chamaecrista rotundifolia</i>	Wynn Cassia
<i>Macroptilium astropurpureum</i>	Siratro
<i>Stylosanthes humilis</i>	Stylo
<i>Stylosanthes scabra</i>	Seca Stylo

Soil preparation

Where compaction of subsoil has occurred, such as in infrastructure areas, roads, and other heavily trafficked areas, the surface will need to be ripped to between 0.5 and 1 metres prior to topsoiling and seeding. This will break up the compaction and allow vegetation to establish more easily. In order to prevent degradation of soils with high clay content, ripping should be undertaken after a dry period. In areas where compaction has not been identified, scarification could still be undertaken on a case-by-case basis to assist in establishing a soil bed.

The need for fertilisation will be informally assessed prior to the commencement of rehabilitation, or following any failed rehabilitation, where the cause of the failure is assessed as being due to poor nutrient loading. Typically, a low phosphate fertiliser at a nominal application rate of up to 250 kg per hectare is appropriate. Care should be taken when using fertilisers to minimise runoff into drainage channels. Fertilisers can also promote weed growth.

Seed Application

Seeding, where required, should ideally be undertaken immediately prior to the onset of the wet season (i.e. December or January). This gives seeds the best chance of taking hold, as soil moisture will be at its highest in the late wet season.

Establishment period

Regardless of reliance on the seedbank or direct seeding, the establishment period for species can vary, so progress should be regularly monitored following spreading of topsoil or any seeding undertaken. Monitoring typically commences one month from spreading of topsoil (reliance on seedbank) or from application of seed (direct seeding), in order to assess germination. Reseeding may be required if germination does not occur; however, it should not be undertaken outside of the wet season unless suitably wet weather is forecast.

Weed management may be required during the establishment period (see **Section 7.3.3**).

7.3.3 Weed Control and Pest Management

Weeds

Weeds that pose the highest risk to sustaining cattle grazing productivity are those that limit stocking rate, are toxic to animals and/or may potentially outcompete pasture grasses. These include, but are not limited to Parthenium, Lantana, Chinee Apple, and Prickly Mimosa. As light cattle grazing is the agreed post-mining land use, the control of these weeds should be prioritised. See **Section 3.7** for a complete list of expected weed species.

Weed management is to be undertaken as per the *Thiess Weed Management Plan QCoal Northern Hub* (Thiess, 2016), the *Sonoma Coral Creek Weed Management Plan* (NRA, 2013), and any other relevant QNH weed management document, or any updates thereof.

Where weed control is required, a licenced and qualified professional should undertake herbicide treatment (including selection of appropriate herbicides and application) with a focus on priority weed species (see **Section 3.7**). Weed control is an ongoing process and will likely require repeated treatments.

Weed prevention is more effective and economical than weed treatment; therefore, efforts should be made to prevent the spread of weeds into rehabilitation areas. These include:

- Limiting the area of soil disturbed at any one time to minimise exposure of bare ground.
- Use mulches and establish preferred groundcover as quickly as practicable
- Avoid importing or using soils where their origins and seedbanks are unknown.
- Avoid re-using weed infested topsoils if possible
- Ensure that any seed mixes used for rehabilitation are weed free
- Ensure stockpiled topsoil material is weed-free prior to use.

Pest Animals

Pest animals considered relevant to rehabilitation efforts at the QNH include feral pigs, rabbits, and goats. During rehabilitation activities, active pest management should be undertaken where impacts are observed during routine monitoring of rehabilitation works. Methods of control should consider how the QNH manages pest species during active mining operation, as well as how the underlying landholder manages pest species in the area.

7.4 Scheduling of Rehabilitation

Rehabilitation activities undertaken during active mining is referred to as progressive rehabilitation.

During mining activities, works on sections of disturbed land may be completed to a point where there is no further potential operational use for that section of disturbed land. The domain is then considered available to be rehabilitated. The most common example is sections of a waste rock dump face which have received their final dumping sequence and therefore have no further operational use. Rehabilitation can then be undertaken on that face in isolation, without having to rehabilitate the entire dump at the time.

By undertaking progressive rehabilitation, the actual amount of rehabilitation required at the completion of mining is minimised. Progressive rehabilitation is scheduled considering the following factors:

- Progressive rehabilitation is to be undertaken in line with the relevant PRCPs for each QNH mine as they are approved;
- The potential for future operational use of the area;
- The progressive rehabilitation is not to conflict with mining/production priorities;
- Required plant must not be currently needed for mining/production operations.
- Opportunities to minimise double handling of topsoil, such as applying topsoil stripped directly to areas of rehabilitation is preferred. This also prevents degradation of the natural seedbank during stockpiling.

Additionally, there is an economic benefit to completing progressive rehabilitation as soon as practicable. This includes a reduction in Estimated Rehabilitation Cost (ERC) held, and reduced area requiring erosion control and dust suppression during operations. As such, while there are currently no requirements to achieve a target rate of rehabilitation (such as timeframes, areas, or outcomes) in the absence of established PRCPs, QNH will undertake progressive rehabilitation when areas and schedules become available to do so.

8 Monitoring, Maintenance and Reporting

8.1 Monitoring

8.1.1 Timing

General rehabilitation monitoring is to be undertaken annually following the wet season, or at a suitable frequency based on recommendations from the SQP undertaking the monitoring.

Soil assessments at both monitoring and reference sites (to allow comparison) are to be undertaken five (5) yearly; however, an SQP may recommend an increase or decrease in the frequency of these assessments.

Monitoring of progressive rehabilitation areas will only commence after at least one wet season has passed following completion of rehabilitation works. This will allow monitoring to better assess the performance of the seedbank, rates of growth, areas of erosion, and other issues.

8.1.2 Survey Intensity

A 1:15,000 monitoring scale (or approximately one (1) observation per nine (9) hectares) is to be used initially, as this allows for a detailed assessment of the land (McKenzie *et al.* 2008). This may be scaled up or down upon review, depending on the level of detail required as per the recommendations of an SQP.

Rehabilitation areas are to be broken into discrete management units to facilitate data management and planning for rehabilitation monitoring. Management units should be delineated based on the age of the rehabilitation, waste type, and rehabilitation methodology.

8.1.3 Reference Sites

Reference sites are used as a non-mine affected point of comparison to assess performance of the rehabilitated areas with regard to groundcover, carrying capacity (productivity), weed proportion, and species mix and composition.

Monitoring reference sites are to be chosen to be appropriate analogues to the areas being monitored and on-the-ground assessments are required to select the most appropriate locations. The land use of the reference site should align with the intended post-mining land use of the rehabilitation area(s) being monitored. The location of reference sites are to be determined during monitoring works and can be altered based on the dynamic nature of ephemeral landscapes that are, and have historically been, used for cattle grazing. The location of reference sites may also change based on landholder access restrictions.

Current reference sites used for monitoring of progressive rehabilitation on the QNH are presented in **Table 16**. The location or number locations may change based on the recommendations of an SQP undertaking the monitoring.

Table 16 – QNH Rehabilitation Reference Sites

Reference Site	Start		End	
	Latitude	Longitude	Latitude	Longitude
V19	-20.6168	147.8346	-20.6164	147.8346
V20	-20.6187	147.8352	-20.6182	147.8351
V21	-20.6143	147.8323	-20.6139	147.8324
V33	-20.6157	147.8336	-20.6153	147.8335

8.1.4 Parameters

Soils

Where soil monitoring is undertaken, profiles will be excavated to a depth of at least 1 m below the soil surface, with samples collected at intervals of 10 cm, except where an SQP recommends that sampling be undertaken to a different depth or at different intervals. The following parameters are to be assessed:

- Plant Available Water Capacity (PAWC)
- Exchangeable Sodium Percentage (ESP)
- Soil Salinity (1:5)
- Soil pH (1:5)
- Water erosion, calculated as a function of slope % and ESP
- Rockiness

Analysis is to be undertaken by a laboratory that is NATA-accredited for the given parameter.

The following information should also be gathered in accordance with the methods and categories in the *Australian Soil and Land Survey Field Handbook* (NCST, 2009):

- Slope
- Surface condition
- Depth of topsoil and other horizons
- Soil colour per horizon (as per the Munsell Soil Colour Charts)
- Soil structure per horizon
- Coarse fragment content at the soil surface and in each horizon
- Root depth
- Presence of waterlogging features
- Presence of free carbonate and other segregations.

Land Suitability and Vegetation

Vegetation assessments are to be conducted using 50 m transects to confirm land suitability has been achieved. Sites will be chosen through a random selection process by the SQP undertaking the work and is landform dependent. Any photographs taken during vegetation assessment are to follow the methodology found in the *Pasture photo standards* (DPIF, 2003). The following parameters are to be measured:

- Species list for each transect to determine species composition and proportion of preferred species
- Groundcover to be measured within 1 m square quadrats and the average will be used to assess compliance with the groundcover completion criteria (see **Section 5.5**). This measurement is also to include characterisation of the groundcover (e.g. vegetation, woody debris, rock, etc.).
- Stock carrying capacity as head/ha based on grass load.
- Vegetation structure.
- Species showing evidence of fruiting or flowering are to be noted.
- Prescribed weed species are to be noted.

Carrying capacity is to be calculated as per advice from Bob Shepard, Principal Extension Officer, Queensland Department of Agriculture Fisheries and Forestry (NRA, 2015), as follows:

- One adult equivalent (450 kg beast) requires 2.2% of live body weight of dry biomass per day (3,650 kg per annum).
- A utilisation rate of 25% to 30% should be applied to prevent degradation.
- Therefore, one beast requires between 12,167 and 14,600 kg of dry biomass per annum.

The number of hectares required per beast is to be calculated by dividing the dry biomass required per annum by the measured mean pasture biomass (in kg/ha) of each management unit. To determine the carrying capacity, the number of hectares per beast is then converted to head/ha.

Other

Other data to be collected during monitoring is as follows:

- Evidence of any slope failure or rock falls
- Evidence of any rill or gully erosion
- Evidence of pest animals
- Note any leachate observed originating from rehabilitated co-disposal facilities.

8.1.5 Creek Diversions

Diversions are present on the SCM and require specific administering authority approval based on RPEQ designs. Those designs include requirements for rehabilitation of the landform as part of construction activities.

In addition, the designs require annual monitoring and reporting (by an RPEQ) of diversion stretches as per **Condition J7** of the SCM EA. The monitoring and reporting program includes annual assessment of the progress of the rehabilitation of the diversion. As such, diversion rehabilitation monitoring is separate from other rehabilitation monitoring works and is subject to the approved diversion design.

8.2 Reporting

Following annual monitoring (or any other frequency as proposed by an SQP), a report is to be prepared providing a summary of data collected and an update on the progress towards meeting completion criteria. These reports do not need to be submitted to the administering authority; however, they should be retained and reviewed internally to determine the readiness of the rehabilitated domains for certification. Monitoring reports are also to be used to identify the need to amend rehabilitation practices, or the RMP itself, prior to future works.

A separate report related to creek diversions is also to be generated by an RPEQ annually and must be submitted to the administering authority.

8.3 Rehabilitation Maintenance and Potential Issues

Ongoing monitoring of progressive rehabilitation will inform any required maintenance and identify any issues requiring corrective action. Potential issues, which could occur following rehabilitation, have been identified and include, but are not limited to, those presented in **Table 17**.

Table 17 – Potential Issues and Remedial Action

Issue	Remedial Action
Seedbank fails to germinate or groundcover dies following early establishment when using the seedbank present in topsoil.	Investigate topsoil quality. Considering supplementary seeding of future rehabilitation using this topsoil. Reseed rehabilitated areas as required.
Rapid die-off of groundcover.	Investigate cause, and reseed rehabilitation as required.
Groundcover species are failing to thrive.	Investigate soil quality, consider the suitability of applying fertilisers
Water stress – wilting foliage, heavy insect damage, die back.	Apply water to the rehabilitation area until signs of stress have been alleviated.
Water logging – stem rot, fungal infection	Ensure that drainage features are installed correctly. Where additional drainage is required, instate drainage features. Cease, or cut back, any watering regime being undertaken. Reassess the use of fertiliser (if it had been applied)
Extensive exotic weed cover	Assess the viability of undertaking additional weed management actions in order to ensure that the groundcover seedbank can undertake secondary succession.
No germination or die-off of direct seeding	Assess the seed being used and consider reseeding with a different stock. Assess soil quality and consider the requirement for fertilisation.
Erosion or Slippage in rehabilitation areas	Investigate for failures in drainage features and reinstate or add additional drainage as required. Repair rill erosion by ripping and re-contouring. Repair gully erosion by filling and recontouring.

8.4 Rehabilitation Completion

Rehabilitation is considered functionally complete once the completion criteria set out in **Section 5.5** have been achieved, and the associated performance verification works have been undertaken.

Once completion criteria have been met to a satisfactory level and the performance verification has been completed, a final rehabilitation report (see **Section 6**) must be provided to the administering authority. The final rehabilitation report outlines compliance with conditions of the EA and completion criteria, the extent and success of the rehabilitation, any ongoing environmental management and monitoring requirements, and any residual risk. A compliance statement drafted by a third party must also be provided with the final rehabilitation report, detailing compliance of the report against the requirements of the EA, as well as the accuracy of the report itself.

Additionally, any land that has previously been on the environmental management register (such as contaminated land) must be removed or have an appropriate Site Management Plan approved and in place (see **Section 6**).

Upon receipt of the final rehabilitation report, the administering authority can certify the rehabilitation and subsequent allow for the surrender of the site EAs.

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Appendix A Residual Voids on the QCoal Northern Hub Mining Complex



Residual Voids on the QCoal Northern Hub Mining Complex

Sonoma, Cows, Drake and Jax Coal Mines



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Submitter information	
Report type	Investigation to inform Rehabilitation Management Plan
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Project	Sonoma Coal Mine Cows Coal Mine Drake Coal Mine Jax Coal Mine
Date of report	27 April 2020

Revision summary		
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1 Introduction

QCoal Pty Ltd (QCoal) manages four (4) adjacent open cut coal mines located between six (6) and fifteen (15) km south of the town of Collinsville in Central Queensland. The four mines are Sonoma Coal Mine (SCM), Cows Coal Mine (CCM), Drake Coal Mine (DCM) and Jax Coal Mine (JCM). Mining pits, waste rock dumps, roads and water management infrastructure span mining lease (ML) boundaries. As such the four (4) mines are collectively managed and operated as a single multi-pit operation referred to as the QCoal Northern Hub (QNH). Each mine has its own environmental authority (EA), however, operational and environmental management and resources are integrated across the four mines.

1.1 Ownership

The QNH sites have ownership makeups as follows:

- SCM is owned by the Sonoma Coal Joint Venture (SCJV) in which QCoal Sonoma Pty Ltd is the majority interest holder;
- DCM is owned by Northern Hub (Drake) Pty Ltd and Drake Coal Pty Ltd;
- CCM is owned by Bowen River Coal Pty Ltd; and
- JCM is owned by Jax Coal Pty Ltd.

QCoal Sonoma Pty Ltd, Northern Hub (Drake) Pty Ltd, Drake Coal Pty Ltd, Bowen River Coal Pty Ltd and Jax Coal Pty Ltd, are wholly or majority owned subsidiaries of QCoal Pty Ltd. The owner and Managing Director of QCoal Pty Ltd is Mr Christopher Wallin.

1.2 Environmental authorities

EA numbers and primary holders for the QNH mines are provided in **Table 1**.

Table 1 – QNH EAs

Mine	MLs	EA Number	Grant	Primary EA Holder	Current version
SCM	ML10325, ML10326, ML10327	EPML00707713	13/9/2007	QCoal Sonoma Pty Ltd	6/3/2020
CCM	ML10345	EPML00334613	16/8/2012	Bowen River Coal Pty Ltd	9/3/2020
DCM	ML10349, ML10350, ML10351	EPML00393013	2/11/2014	Northern Hub (Drake) Pty Ltd	6/3/2020
JCM	ML10346	EPML00337613	20/12/2013	Jax Coal Pty Ltd	14/4/2020

1.3 Objectives

The SCM, DCM and JCM include final voids as part of their rehabilitated final landforms, while the CCM does not have approved voids (pits having previously been backfilled). The voids are approved by the Department of Environment and Science (DES) within the respective EAs. Specifically, the EAs provide the required rehabilitated landform design criteria for each void, being size (area), location and wall angles (high-wall and low-wall). The other consideration for final void rehabilitation is the approved void outcome (whether or not a final void can sustain a post mining land use and if so what type).

The JCM EA stipulates a post-mining land use (PMLU) of “residual void unable to sustain a post mining land use”, while the DCM and SCM EAs do not provide a PMLU for residual voids. Void outcomes are discussed in detail within the relevant sections of this document.

A key objective of this investigation is to determine appropriate void outcomes for the voids on the SCM and the DCM for inclusion in the respective EAs. This objective allows for the DCM and SCM EAs to align and be consistent with the JCM EA, which:

- allows for constancy in regulation of voids across the QNH;
- allows for catchment-wide cumulative consideration of all final voids collectively on the QNH rather than on a site by site basis; and
- informs the “*QCoal Northern Hub Rehabilitation Management Plan*” – April 2020 (QNH RMP) which is a single plan addressing rehabilitation of all four (4) QNH mines (including voids) cumulatively rather than in isolation.

1.4 Methodology

To achieve the above objective, this investigation addresses the following:

- Location and size of all voids on the QNH;
- Surrounding land uses (pre and post mining);
- Geology of the QNH;
- Hydrogeological and hydrological modelling of voids to determine interaction with surrounding groundwater, potential for overtopping and void water quality;
- Based on the above modelling, determine whether any DCM or SCM voids can sustain a PMLU and, if so, what that PMLU should be, and confirm the appropriateness of the approved PMLU for the JCM residual voids as “residual voids unable to sustain a post mining land use”; and
- Demonstrate that for each void, regardless of void outcome, the final landform will be safe, structurally stable, and will not cause environmental harm, including assessment of relevant surrounding values (human and environmental) and the suitability of the approved final landform wall angles for each void.

1.5 Previously submitted void studies

This investigation relies upon previously completed waste rock, rehabilitation, geochemical, geotechnical, hydrological and hydrogeological assessments undertaken across the QNH, which are referenced in the relevant sections. Two previous void studies have been completed on the QNH and submitted to DES, the conclusions of which are referenced in the relevant sections:

- “*Investigation into Residual Void Sonoma Coal Mine – QCoal January 2016*” (submitted to DES 29 January 2016), which included the technical study “*Sonoma Coal Mine Final Void Hydrology Study Main Pit – Engeny Water Management 2015*” (Engeny 2015a); and
- “*Investigation into Residual Void Jax Coal Mine – QCoal October 2018*” (submitted to DES 12 October 2018), which included the technical study “*Jax Coal Mine Final Void Hydrology Study Main Pit – Engeny Water Management 2018*” (Engeny 2018) and “*Long Term Water Quality of Jax Coal Mine Residual Voids - 2 April 2019*” ((Engeny (2018) Supplementary Memo).

1.6 Technical studies for this assessment

QCoal engaged technical consultants to undertake specific studies for this assessment as follows:

- Engeny had previously undertaken a specific final void study for the Jax Main Pit and Jax East Pit final voids “*JCM Final Void Hydrology Study Main Pit – Engeny Water Management 2018*” (Engeny 2018) which was appended to “*Investigation into Residual Void Jax Coal Mine – QCoal October 2018*” (submitted to DES 12 October 2018). Engeny (2018) is relied upon for the Jax Main Pit and Jax East Pit final voids and is appended to this assessment as **Appendix A**.
 - o A supplementary memo was prepared by Engeny “*Long Term Water Quality of Jax Coal Mine Residual Voids - 2 April 2019*”, to present an extended prediction length for water quality beyond what was presented in Engeny (2018) The results of this memo were provided to DES in person (Emerald Coal Hub) on 4 April 2019. The memo is referred to as “Engeny (2018) Supplementary Memo” and has been included in Appendix A of this assessment for completeness.
- Engeny Water Management Pty Ltd (Engeny) was engaged to undertake water balance modelling of the remaining QNH final voids, which is reported in “*Residual Void Hydrology Study QCoal Northern Hub Mines April 2020*”, Engeny (2020). Engeny (2020) is appended as **Appendix B** to this assessment.
- The key objectives of both Engeny (2018) and Engeny (2020) void modelling included:
 - o model the equilibrated (steady state) water level in QNH final voids, allowing an assessment of interaction with surrounding groundwater and the potential for overtopping into surface waterways; and
 - o determine the rate of change and make predictions on the water quality within final voids.
- Australasian Groundwater and Environmental Consultants Pty LTD (AGE) was engaged to undertake hydrogeological modelling of the QNH final voids. A specific report title was not available for reference at the time of submission of this assessment; however, the results of the AGE study are referred to in this assessment as AGE (2020) and outputs have been inserted into this assessment in the relevant sections.

2 Description of QNH

2.1 Location

The QNH is between six (6) and fifteen (15) km south of the town of Collinsville in Central Queensland. Access to all four QNH sites is by the state-controlled Bowen Development Road. The location of the QNH (SCM, CCM, DCM and JCM) is presented in **Figure 1**, which also presents the four (4) individual QNH mines.

The mines that make up the QNH are directly adjacent to one another on the western side of Bowen Development Road and the parallel Newlands rail line, apart from JCM, which is on the eastern side.

2.2 Mining tenures

The ML tenures for the QNH mines are provided in **Table 2**, for each respective mine.

Table 2 – QNH MLs

Details	Sonoma			Cows	Jax	Drake		
Lease	ML10325	ML10326	ML10327	ML10345	ML10346	ML10349	ML10350	ML10351
Status	Granted	Granted	Granted	Granted	Granted	Granted	Granted	Granted
Lodgment	21/11/2005	21/11/2005	21/11/2005	11/04/2009	11/12/2009	21/04/2010	21/04/2010	21/04/2010
Grant	12/4/2007	13/09/2007	13/09/2007	16/08/2012	20/12/2013	2/11/2014	2/11/2014	2/11/2014
Expiry	30/04/2037	30/09/2037	30/09/2037	31/08/2027	31/12/2034	29/02/2044	29/02/2044	29/02/2044
Holder	QCoal Sonoma Pty Ltd	QCoal Sonoma Pty Ltd	QCoal Sonoma Pty Ltd	Bowen River Coal Pty Ltd	Jax Coal Pty Ltd	Northern Hub (Drake) Pty Ltd	Northern Hub (Drake) Pty Ltd	Northern Hub (Drake) Pty Ltd
Area (ha)	716.7	1,063	360.4	210.5	1,943	3,982	4,805	427.9
Permit ID	108618	108619	108620	108636	108637	108640	108641	108642
Native Title	Exclusive Land	Exclusive Land	Exclusive Land	Exclusive Land	Right to Negotiate Agreement	Right to Negotiate Agreement	Right to Negotiate Agreement	Right to Negotiate Agreement

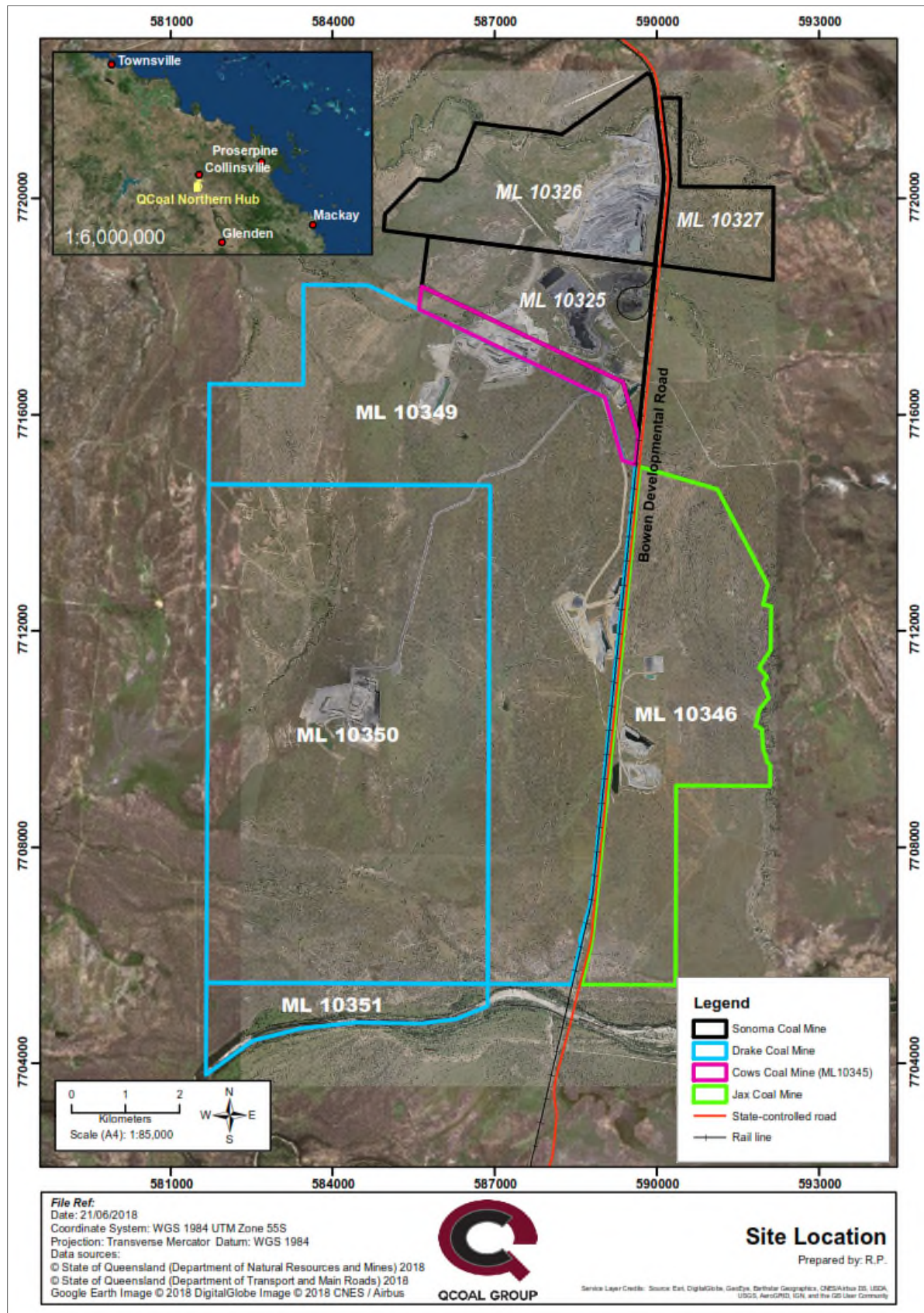


Figure 1 – QNH location and MLs

2.3 Underlying landholders

The QNH spans eight (8) MLs (see **Table 2**) located on land with several landholders, as summarised below and presented in **Figure 2**:

- **SCM:**
 - o ML10325: The land underlying ML10325 is owned by Mr Christopher Wallin.
 - o ML 10326: The land underlying ML10326 is “Sonoma” station, which is privately owned by a third party, with the exception of the land underlying the SCM rail spur and loop, which is owned by Mr Christopher Wallin.
 - o ML10327: The land underlying ML10327 is “Sonoma” station, which is privately owned by a third party.
- **CCM:**
 - o ML10345: the land underlying ML10345 is a historic stock route which is no longer declared for that purpose. The land is held under a permit to occupy by Mr Christopher Wallin.
- **DCM:**
 - o ML10349, ML10350, and ML10351: The land underlying these MLS is “Birralee” station, owned by Mr Christopher Wallin.
- **JCM:**
 - o ML10346: The land underlying ML10346 is “Birralee” station, owned by Mr Christopher Wallin.

2.4 Mining methods

Mining operations on the QNH involve extraction of Run of Mine (ROM) coal with conventional advancing highwall (mining face) open cut mining methods, utilising drill and blast, and, excavator and truck. As the high wall of an active pit progresses forwards (following the coal seam) to allow continued mining, dumping of waste rock occurs at the low wall (rear of the pit) behind the mining areas, progressively backfilling the pit.

ROM coal is hauled from active pits on the QNH (i.e. all the four QNH mines) to the SCM for processing and shipping. Processing is undertaken at the SCM Coal Handling and Processing Plant (CHPP) after which the product coal is loaded onto trains at the SCM train load-out facility located for transport to Abbot Point Coal Terminal. Coal rejects materials generated during processing at the CHPP are placed into a co-disposal facility located on the SCM.

Topsoil stripped ahead of mine-related activities is either stockpiled for later use in rehabilitation or placed directly on areas already shaped and prepared for rehabilitation works. Waste rock materials are placed in either out-of-pit dumps or in-pit dumps.

The QNH mines share water management infrastructure, haul roads, equipment, resources, and other infrastructure.

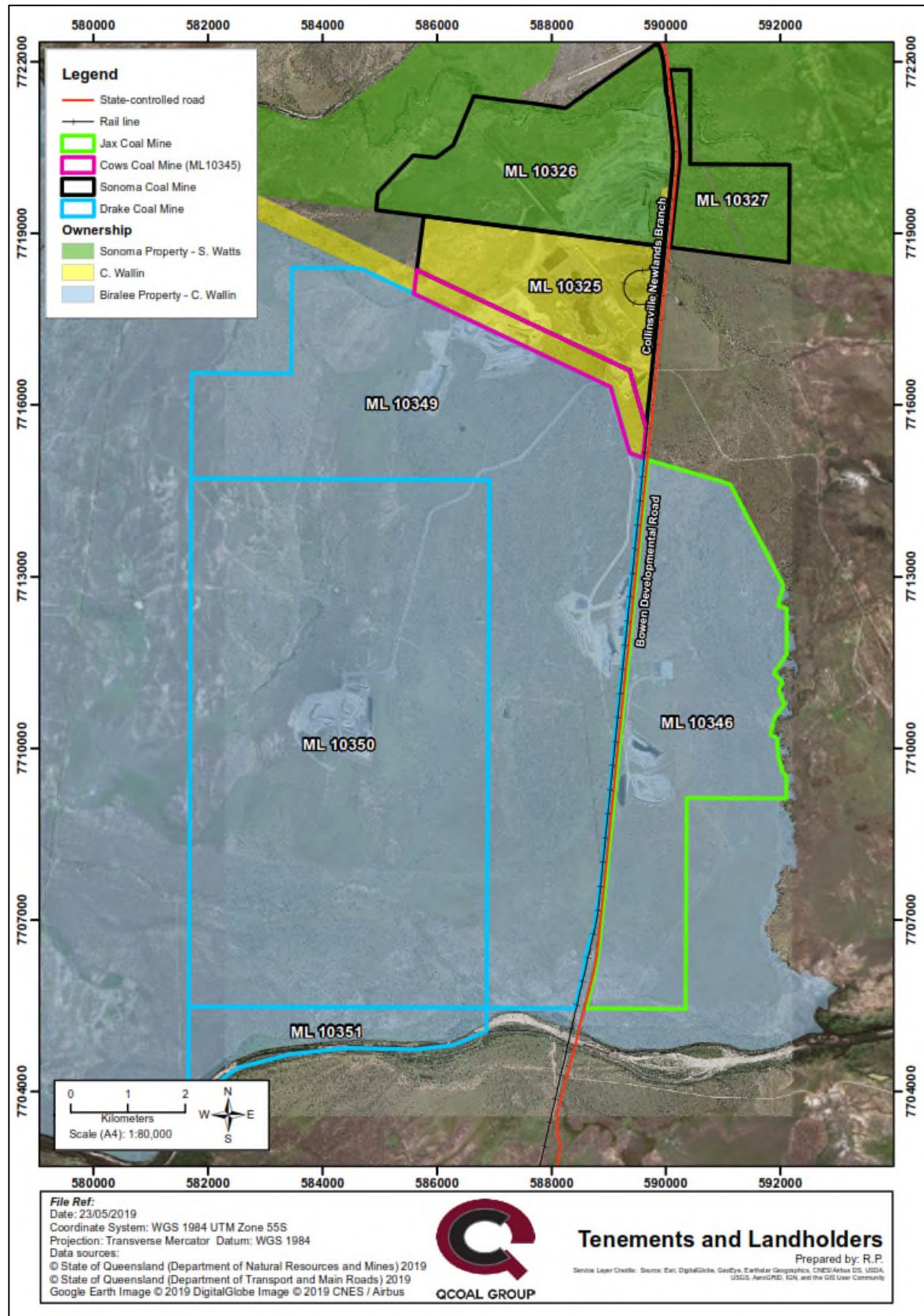


Figure 2 – QNH underlying landholders

3 Regional and Local Geology

A geological understanding of the QNH is required for both the groundwater model (**Section 6**) and water balance model (**Section 7**).

The QNH is located in the northern Bowen Basin, where active subsidence and deposition during the Permo-Triassic was centred within an extensional terrain known as the Taroom Trough. This deposition centre was situated marginal to the Collinsville Shelf in the west, which typically behaved as a stable platform throughout. The deformed Taroom Trough of the north Bowen Basin is defined by the Nebo Synclinorium, where contained sediments and volcanics of the western two-thirds dip gently toward the major synclinal axis in the east. Post-depositional compression has resulted in a fold-and-thrust style of deformation, particularly on the eastern side of the basin where sediments along this margin tend to dip steeply westward.

The QNH is underlain by the late Permian Blackwater Group consisting of lithic sandstone, siltstone, shale, conglomerate, dolomite and tuff and minor coal. This is surrounded and underlain by the low to upper Permian Blenheim Subgroup described as a succession of siltstone, sandstone, conquite and limestone (i.e. the Blackwater Group is an outlier surrounded by the Blenheim Subgroups). The Collinsville Coal Measures underlie the Blenheim Group.

Regionally, the stratigraphic sequence is summarised as follows: the Permo-Triassic sediments of the Bowen Basin are overlain by a veneer of unconsolidated Quaternary alluvium and colluvium, poorly consolidated Tertiary sediments and, in places, remnants of Tertiary basalt flows. The stratigraphy comprises basal Lizzie Creek Volcanics and overlying marine Back Creek Group, non-marine Blackwater Group, and Tertiary sediments of the Sutor Formation.

QNH geology is presented in **Figure 3**, in which the coal measures targeted by the QNH (the Fort Cooper and the Moranbah Coal Measures) are highlighted.

Geological detail in the QNH area is intermittently obscured by alluvium and gravel, especially adjacent to creeks and watercourses. This recent (Cainozoic) cover comprises unconsolidated fine to very coarse-grained sand, along with occasional irregularly interbedded silt, clay and gravel lenses. The most persistent gravel bed occurs at the base of the unit and generally comprises markedly rounded pebble to cobble-sized clasts of predominantly andesitic to basaltic composition set in a silt to clay-rich matrix. Generally the alluvial unit is a thin veneer but becomes thicker along rivers and watercourses in the region.

An example of typical QNH surficial strata is presented in **Figure 4**, which is a photo of the south-eastern wall of the current Jax Main Pit showing the surficial geological strata, in particular a thin veneer of alluvial material.

The QNH is well understood to comprise a consistent, contiguous geology and hydrogeology across the four mines. As such, geological, geochemical, and geotechnical findings are applicable across the QNH. Specific operational examples of geological continuity include (see **Figure 5**):

- the Drake 3 Pit complex and the Jax Main Pit complex target the same coal seams, with consistent overburden characteristics; and
- the SCM, CCM and DCM Q-Pit and B-Pit complexes target the same coal seams, with consistent overburden characteristics.

CENOZOIC	REWAN GROUP	QUATERNARY SEDIMENTS BASALT AND VOLCANICS SUTTOR FORMATION
		ARCADIA FORMATION SAGITTARIUS SANDSTONE
TRIASSIC		
LATE PERMIAN	BLACKWATER GROUP	RANGAL COAL MEASURES
		FORT COOPER COAL MEASURES
		MORANBAH COAL MEASURES
EARLY PERMIAN	BACK CREEK GROUP	EXMOOR FORMATION
		BLENHEIM FORMATION
		COLLINSVILLE COAL MEASURES
		GEBBIE FORMATION
LATE CARBONIFEROUS		TIVERTON FORMATION
		LIZZIE CREEK VOLCANICS BULGONUNNA VOLCANICS

Figure 3 – Geological conceptualisation



Figure 4 – Example of surficial strata Jax Main Pit

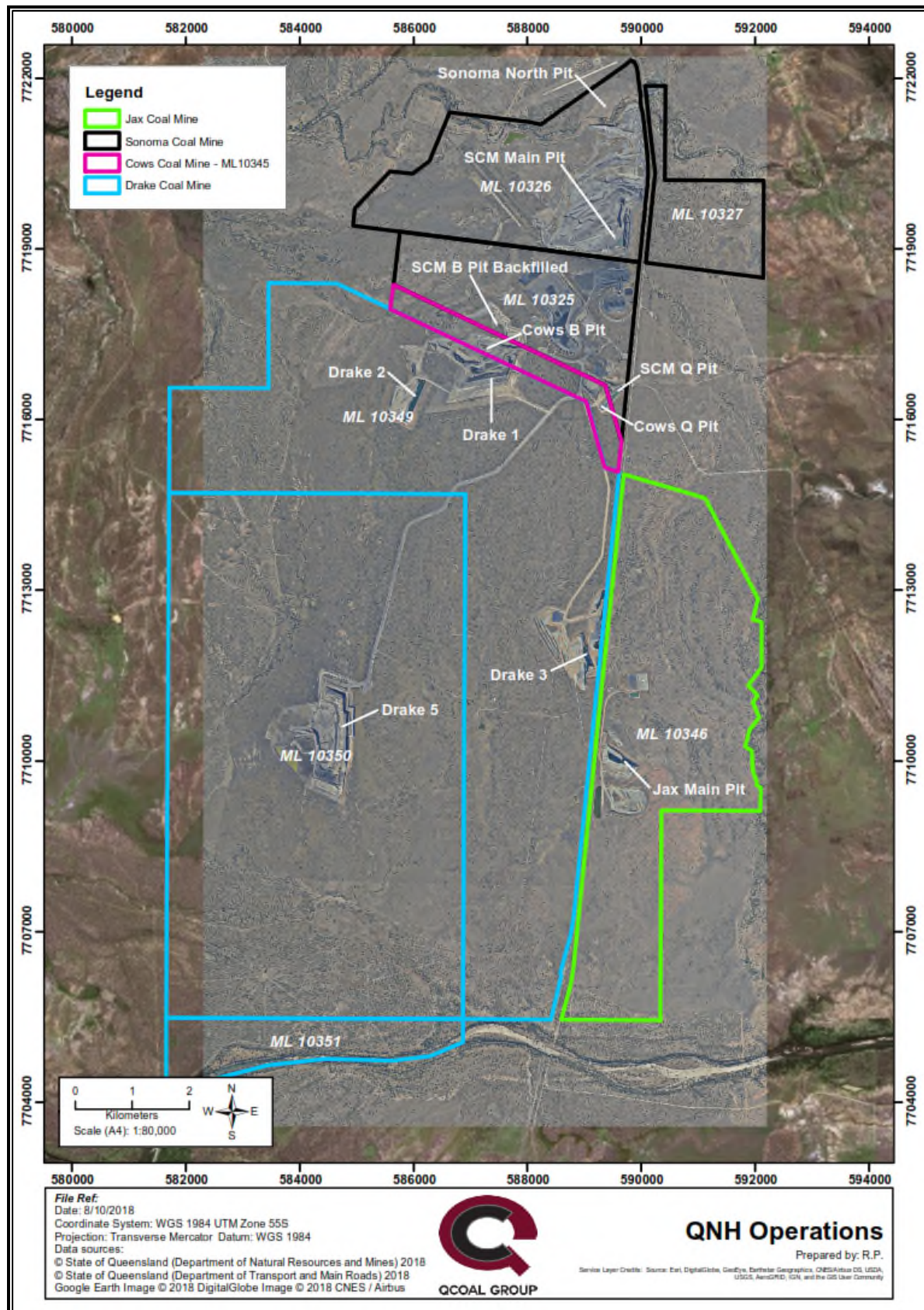


Figure 5 – QNH Operations

4 Regional and Local Groundwater

4.1 Groundwater studies

The hydrogeology across the QNH is well understood with numerous hydrological and hydrogeological studies previously completed for individual mines within the QNH (including specific void modelling for the JCM and SCM) and the QNH cumulatively. The relevant studies are listed below chronologically, and all documents have previously been submitted to DES:

- “Sonoma Coal Environmental Impact Statement – November 2005” (SCM EIS)
- “Drake Coal Project Environmental Impact Statement – March 2012” (DCM EIS)
- “Groundwater Monitoring and Management Plan – Drake Coal Project” (QCoal (2014))
- “Drake Coal Project Groundwater Model – Australasian Groundwater and Environmental Consultants Pty Ltd 2015” (AGE (2015))
- “Sonoma Coal Mine Final Void Hydrology Study Main Pit – Engeny Water Management 2015” (Engeny (2015a))
- “Stygofauna Survey for the Drake Coal Mine Project (July 2016) – Freshwater Ecology Pty Ltd 2016” (Freshwater Ecology (2016))
- “QCoal Northern Hub Water Management Plan – Engeny Water Management 2017” (Engeny (2017))
- “QCoal Northern Hub Water Management Plan – Engeny Water Management 2018” (Engeny (2018))
- “Northern Hub Groundwater Assessment – Australasian Groundwater and Environmental Consultants Pty Ltd 2018” (AGE (2018))
- “JCM Final Void Hydrology Study Main Pit – Engeny Water Management 2018” (Engeny (2018a))
- “QCoal Northern Hub Water Management Plan – Engeny Water Management 2019” (Engeny (2019))

4.2 Groundwater values (resources)

The actual groundwater values (the ways in which groundwater is relied upon by natural hydrological or ecological processes, or by humans) across the QNH area form the basis for any assessment of potential groundwater impact. A detailed review of the potential groundwater values surrounding the QNH was undertaken as part of QCoal (2014), which identified four main potential values that groundwater may have in that area:

- 1) connection to surface water as a source of baseflow for surface waterways, including the consideration of inter-aquifer hydraulic connectivity;
- 2) source water for springs, wetlands or groundwater dependent ecosystems (GDEs);
- 3) stygofauna habitat requirement; and/or
- 4) human groundwater users (irrigation, livestock, domestic, or industrial water supply).

4.2.1 Groundwater - surface water (baseflow) and inter-aquifer connectivity

As part of the DCM EIS and SCM EIS baseline studies, interaction between groundwater and surface water was considered, as well as any potential interaction between various identified groundwater-bearing units. Of particular note were the assessments of the potential for connection to exist between:

- between the groundwater underlying the QNH and the Bowen River (the only surface water body with permanent flow in the vicinity of the QNH);
- between the groundwater underlying the QNH and Twelve Mile Gully drainage channel in the central QNH area; and
- between the groundwater underlying the QNH and the Two Mile Creek/Coral Creek/Pelican Creek drainage channels in the northern QNH areas.

QCoal (2014) summarised the findings of the above in consideration of the geology of the area (further detailed in AGE (2015)), operational pit groundwater inflow data, and, importantly, ongoing groundwater monitoring of bores across the QNH since 2007.

DCM EIS, SCM EIS and QCoal (2014) concluded that there is limited connectivity between alluvium (where present) and the underlying Permian coal measures across the QNH. This observation is considered consistent with the expected low permeability of the majority of the coal measure's strata. In addition, the major ion chemistry results indicate a difference between groundwater sampled from the coal measures and surface water samples, further suggesting limited interaction between groundwater and surface water.

The groundwater level hydrographs, groundwater quality data, and expected permeabilities of the Permian coal measure aquitards suggest limited interaction between the alluvium and the underlying coal measures. Given that the Bowen River flows through strata of alluvial material, the DCM EIS concludes that there is limited connection between the coal measures and the Bowen River. Due to the observed and recorded highly ephemeral nature of Twelve Mile Gully, Two Mile Creek, Coral Creek and Pelican Creek (the channels for all of which run east west across the QNH), any alluvial deposits associated with these watercourses are well understood to be dry except as a result of rainfall, and therefore not fed by groundwater baseflow. No significant interaction between groundwater and surface water is therefore anticipated along these minor watercourses.

With specific regard to the Bowen River, AGE (2015) reports on numerical modelling of the Bowen River which was undertaken specifically for DCM approval purposes (as reported in QCoal (2014)). AGE (2015) concludes in the presentation of numerical modelling results, that drawdown extents would reach the Bowen River; however, as a result of the lack of direct hydraulic connection between groundwater and the Bowen River, the DCM voids would not have any direct interaction with baseflow in the Bowen River.

AGE (2018) builds on the modelling undertaken in AGE (2015), with updates to the QNH layout and final void locations, in addition to updated modelling software. The updates to the numerical modelling in AGE (2018) result in the cumulative QNH drawdown having a smaller southern extent than was previously modelled, mainly due to a change in the layout of the DCM. Results from AGE (2018) confirmed a lack notable surface water – groundwater connectivity in the QNH area and therefore a limited potential for changes in QNH groundwater to impact on surface water. The maximum extent of final void driven drawdown in AGE (2018) was >3 kilometres from the Bowen River, in both the coal measures and the alluvial modelling layers.

AGE (2020) was completed as a cumulative groundwater modelling study for final voids in the QNH for the specific purpose of informing this final void assessment. AGE (2020) included updated numerical modelling of steady state drawdown extents associated with the final voids on the QNH. Results and drawdown extents of AGE (2020) are presented in **Section 6**.

Conceptually, the above studies conclude that surface water channels across the QNH are losing-disconnected streams (see **Figure 6**) with no notable interconnection between the watercourses and the groundwater system.

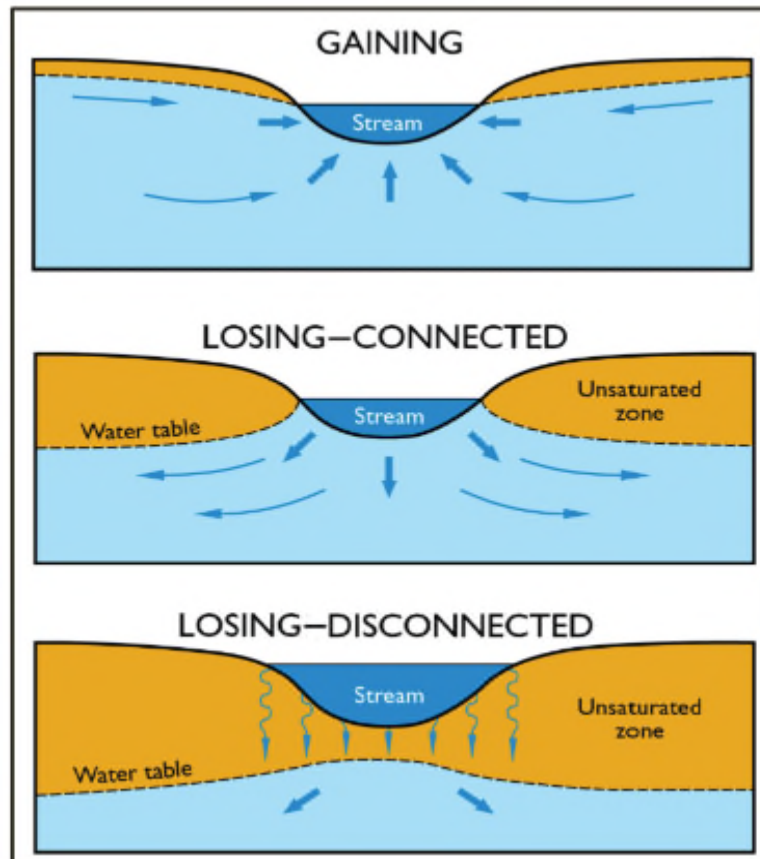


Figure 6 – Groundwater to surface water connectivity (NSW Government 2010)

As such, surface water in the vicinity of the QNH is not reliant on groundwater for baseflow; however, AGE (2018) does states there is potential for some surficial alluvial groundwater interaction with the Bowen River directly along the incised banks of the river channel. Such interaction is stated as being associated with periods of flooding in the river saturating the banks, which would then seep back into the channel after flood waters recede as opposed to any hydraulic connection to groundwater.

As such, surface water baseflow as a value for QNH groundwater is not considered further in this investigation other than in presentation of groundwater and water balance modelling results in **Section 6** and **Section 7** respectively.

4.2.2 Springs, wetlands and GDE

As part of the DCM EIS and SCM EIS baseline studies, a review of potential springs, swamps, wetlands and GDEs in the surrounding area was undertaken. Numerous environmental surveys, investigations and studies have been undertaken during ongoing QNH operations, including numerous receiving environment monitoring programs (REMPs) which specifically focus on aquatic ecology, groundwater reviews such as QCoal (2014) and stygofauna assessments such as Freshwater Ecology (2016). As a result of those EIS's, operational site observations and environmental studies, it is concluded that

- there are no notable groundwater springs or seeps in the QNH area;
- there are no notable wetlands in the QNH area; and
- GDEs are unlikely to exist in the vicinity of the QNH.

As such, springs, wetlands and GDEs are not considered groundwater values for the QNH and are therefore not considered further for impact assessment or associated mitigation.

4.2.3 Stygofauna

As part of the DCM EIS baseline survey assessments, a stygofauna pilot survey was undertaken in May 2011 (GHD (2011)) in accordance with *Guideline No. 54a: Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia* (the stygofauna guideline). The DCM EIS stygofauna pilot survey sampling was undertaken in ten (10) bores at varying depths across QNH area (predominantly across the DCM and JCM). Stygofauna were not recorded in any of the samples obtained during the pilot survey; however, it is noted that low abundances of terrestrial invertebrates including Diptera adults and Coleoptera larvae were recovered from some samples (these are typical of ingress from surface environments and are not obligate subterranean forms, i.e. are not stygofauna). As such, the DCM EIS determined that the absence of stygofauna from the sampled bores indicates a low likelihood of stygofauna occurrence in the groundwater across the area, and, as such, stygofauna was not identified as a QNH groundwater value in the DCM EIS.

Subsequently, a second stygofauna study was undertaken in July 2016 (Freshwater Ecology (2016)) at three DCM bores located along the Bowen River to focus on alluvial sequences in the QNH, which were identified by the Queensland Government Department of Natural Resources Mines and Energy (DNRME) as potential stygofauna habitat. The alluvial groundwater bores along the Bowen River were recorded as dry and as such the alluvial material along the Bowen River in the vicinity of the QNH is not a notable stygofauna habitat.

As per **Section 3**, the QNH spans a consistent contiguous geology and hydrogeology with consistent overburden characteristics. As such, stygofauna results from the DCM EIS and the Bowen River alluvium study are representative of the entire QNH. Accordingly, stygofauna is not a groundwater value on the QNH in the Permian groundwater or the Bowen River alluvium, and, as such, stygofauna is not considered further for impact assessment or associated mitigations.

4.2.4 Human groundwater use

Groundwater resource management in Queensland involves the identification of Groundwater Management Units (GMU) within heavily utilised areas and Unincorporated Areas (UA) where use and/or monitoring data is limited. GMUs are defined by the extent of aquifer systems while UAs are established by dividing the remaining area in Queensland based on geological region boundaries (ANRA (2007)). The QNH is located within the Bowen UA, which covers an area of 153,800 km². Average groundwater resource usage in the Bowen UA is estimated to be 14,900 ML/yr compared to an estimated sustainable yield of 260,000 ML/yr (National Land and Water Resources Audit, 2001).

The current low levels of groundwater use within the Bowen UA, may conservatively be considered to include pastoral, irrigation, mining, stock and domestic, and town water. The quality of the groundwater is generally described as marginal, with poorer quality groundwater typically encountered within coal bearing strata. According to the National Land and Water Resources Audit 2001, there are no priority issues for groundwater management within the Bowen UA and the current level of extraction within the Bowen UA is considered sustainable, given the relatively low level of groundwater utilisation.

As part of the previous hydrogeological investigations across the QNH (including the *“Investigation into Residual Void Sonoma Coal Mine – QCoal January 2016”* and *“Investigation into Residual Void Jax Coal Mine – QCoal October 2018”*), the Queensland Government Groundwater Database (GWDB) has been accessed and searched numerous times. The GWDB is a publicly available database of registered groundwater bores, administered by the Queensland Government Department of Natural Resources Mines and Energy (DNRME) via an online geospatial interface “The Queensland Globe”. An updated search was undertaken in April 2020, the results of which are presented in **Figure 7**, which shows the raw GWDB data (as at 20 April 2020), for a search radius of approximately 10km from the external QNH ML boundaries.

For comparison, presented in **Figure 8** is the figure from the 2016 Sonoma Final Void assessment, in which the raw DNMRE GWDB data was reviewed and identified as either supply or other use. Between 2016 and the preparation of this investigation, no new registered supply bores have been installed within the respective search radius.

Of the over 50 registered bores within the area on **Figure 8**, only four (4) are identified as a potential water supply bores:

- RN25008 – located ~2.5 km north-east from the SCM East Pits 1 and 2 and Main Pit residual final voids;
- RN125696 – located ~8.5 km east-north-east from the JCM Main Pit residual voids and ~9 km from the SCM East Pit 1 and 2 residual voids;
- RN125698 – located ~6 km south-east from the SCM East Pits 1 and 2 final voids, ~7.5 km east of the DCM Drake 1 Pit final void and ~8 km north-east of the JCM Main Pit final void; and
- RN140020 – located ~6 km south-east from the SCM East Pit final voids and ~6.5 km north-east from the JCM Main Pit void.

This indicates that landholder groundwater use (including irrigation, livestock watering and domestic use) is not considered a groundwater value across or in the immediate vicinity of the QNH site. As such, groundwater use is not considered further for impact assessment or associated mitigation.



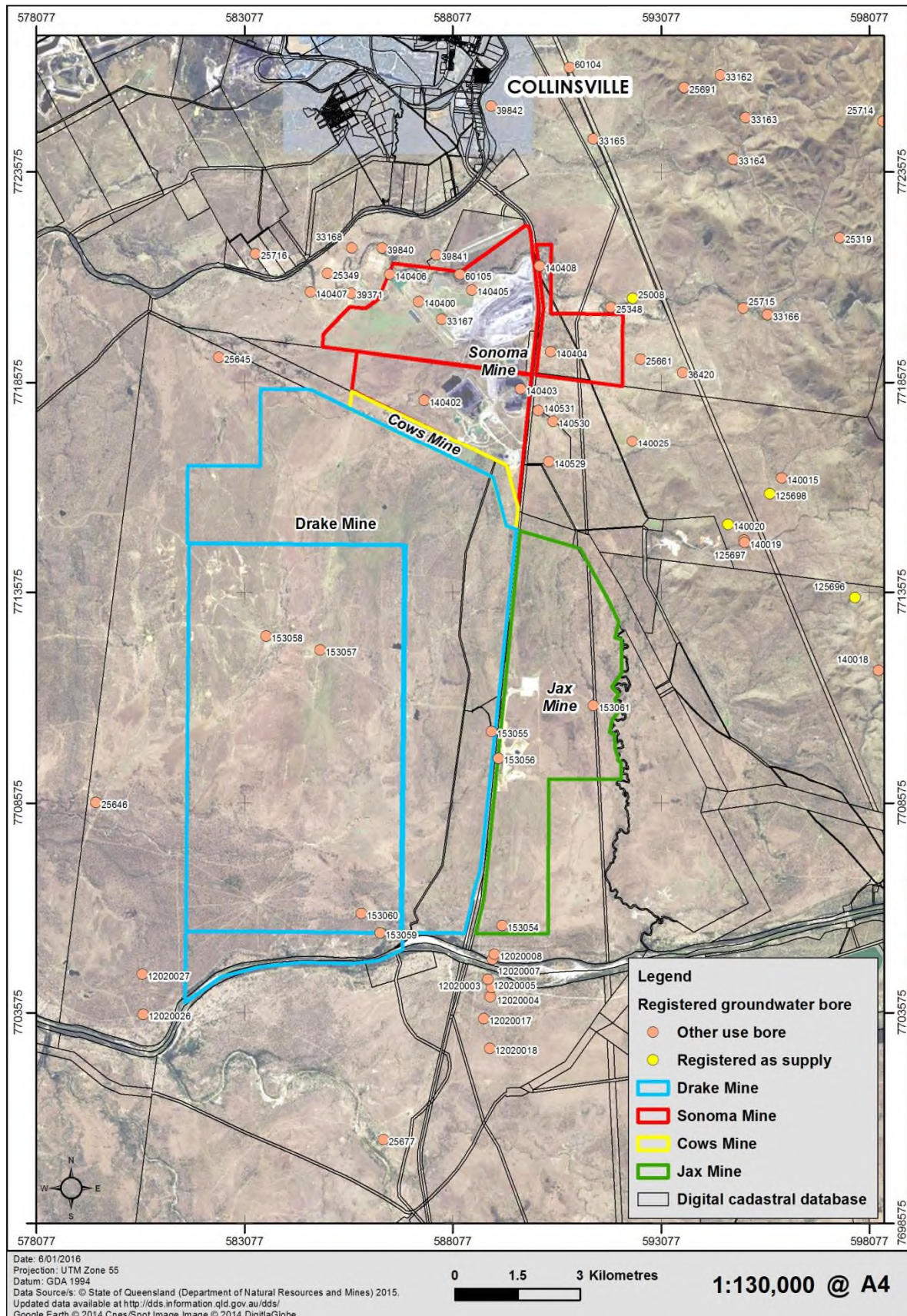


Figure 8 – DNRME GWDB figure from 2016 Sonoma Final Void Investigation

4.2.5 Summary

The four potential groundwater values of the northern QNH are listed in **Section 4.2** and discussed respectively in **Section 4.2.1** to **Section 4.2.4**. A summary of those findings is as follows:

- surface water in the vicinity of the QNH is not reliant on groundwater for baseflow and, as such, is not considered a groundwater value;
- springs, wetlands and GDEs are not considered a groundwater value for the QNH;
- stygofauna is not considered a groundwater value for the QNH; and
- groundwater use (conservatively including pastoral, irrigation, stock and domestic supply) is not considered a groundwater value across the QNH (CCM and SCM).

It has been concluded through a range of previously completed studies listed in **Section 4.1**, as well as operational environmental monitoring data (specifically groundwater monitoring), that groundwater in the QNH area has minimal value. Therefore, any changes in groundwater associated with drawdown resulting from the presence of the QNH final voids will not have notable impacts.

However, as a conservative measure, this investigation includes a modelling assessment of the potential level changes which may occur to the surrounding groundwater (e.g. modelled drawdown curve), and an associated void lake water balance (level and quality). The modelling assessments quantify the potential changes to groundwater resulting from QNH final voids.

5 QNH Final Voids

5.1 Definitions

With the advancing highwall – progressive backfilling method of open cut mining adopted at the QNH, a pit remains when mining of the highwall ceases and the waste rock recovered as part of active mining is no longer available to continue advancing the low wall (progressive backfilling). Such pits are then available to support ongoing mining related activities such as bulk water storage, in-pit rejects disposal or as a designated location for waste rock to be dumped from adjacent mining pits.

Assuming the residual pit was not backfilled by in-pit rejects disposal or waste rock from adjacent mining, the void that remains is then considered the final void, which requires rehabilitation to the final landform (shape, size, slopes etc) as discussed in **Section 9**.

5.2 Authorised final voids, locations and catchments

On the QNH, there are 14 approved final voids, which are located on the SCM, DCM and JCM, with pits on the CCM having been backfilled with waste rock from adjacent mining operations on the DCM.

The SCM, DCM and JCM EAs contain conditions relating to the size, location, slopes and post-mining land use of authorised final voids (Table H1 in each EA). It is noted that the approved size of selected final voids in the DCM EA is a cumulative total area across multiple final voids in close proximity (a “complex” of pits).

Presented in **Table 3** are the approved final voids, the operational complexes to which they belong, the approved size, void outcome and wall slopes. Also shown in **Table 3** is the status of the pit for each approved residual void, with seven of the 14 approved voids having commenced mining and the remainder yet to be developed as pits.

For the final void and the associated rehabilitated waste rock dump details required by the modelling (such as layouts, geometry, storage curves, depths, heights and precise locations), the current “life-of-mine planning” (LOMP) was used in combination with actual operational progression and observations for those pits and dumps which have commenced. For pits and dumps which have yet to commence the final void details were informed by the LOMP and by operations in adjacent pits. It is noted that the LOMP is updated and changes frequently during the life of a mine and, as such, for pits or dumps planned for commencement years into the future, the specific planning is likely to change.

Additionally, it is noted that:

- the DCM final voids “Central 3” and “Central 4”, as named in the DCM EA, are referred to in this assessment as “Drake Pit 4 North” and Drake Pit 4 South” respectively due to changes in naming conventions; and
- specific assessment of East Pit 1 (Drake) has been excluded from this assessment at this time due to its proximity to Drake 1 Pit (its hydrological processes would be dominated by Drake Pit 1 and East Pit 1 may potentially be amalgamated into Drake Pit 1 at a later date).

The locations of the final voids modelled as part of this assessment are presented in **Figure 9** along with the assumed areas of rehabilitated waste rock dumps from which runoff reports to the respective voids (the catchments). Catchment definition is required to quantify rainfall runoff inflow into a void as part of water balance modelling.

Table 3 – QNH approved final voids (as per SCM, DCM and JCM EAs)

Site	QNH Operational Complex	Approved Void Name	Approved Void Area	Approved Void Outcome	Pit status	Approved High Wall Slope	Approved Low Wall Slope
Jax	Jax	Jax Main Pit	70 ha	Residual void unable to sustain a post mining land use	Commenced	High wall – 60°	Low wall – 32°
		Jax East Pit	27 ha	Residual void unable to sustain a post mining land use	Planned		
Sonoma	Sonoma	Sonoma Main Pit	120 ha	<i>Not specified in EA</i>	Commenced	High wall – Maximum slope of 70° with the top 10m having a maximum of 45° including a 1m bund	Low wall – 17°-37°
		Sonoma East Pit 1	14 ha	<i>Not specified in EA</i>	Planned		
		Sonoma East Pit 2	15 ha	<i>Not specified in EA</i>	Planned		
Drake	Drake 5	Drake Pit 5	59 ha	<i>Not specified in EA</i>	Commenced	High wall – 65°	Low wall – 45°
	Drake 1-2	Drake Pit 1	258 ha	<i>Not specified in EA</i>	Commenced		
		Drake Pit 2		<i>Not specified in EA</i>	Commenced		
		Drake Pit 2 Expansion		<i>Not specified in EA</i>	Planned		
		East Pit 1	14 ha	<i>Not specified in EA</i>	Planned		
	Drake 3-4	Central Pit 3 (Drake Pit 4 North)	50 ha	<i>Not specified in EA</i>	Planned		
		Central Pit 4 (Drake Pit 4 South)	16 ha	<i>Not specified in EA</i>	Planned		
		Drake Pit 3-Q	61 ha	<i>Not specified in EA</i>	Commenced		
		Drake Pit 3-R		<i>Not specified in EA</i>	Commenced		

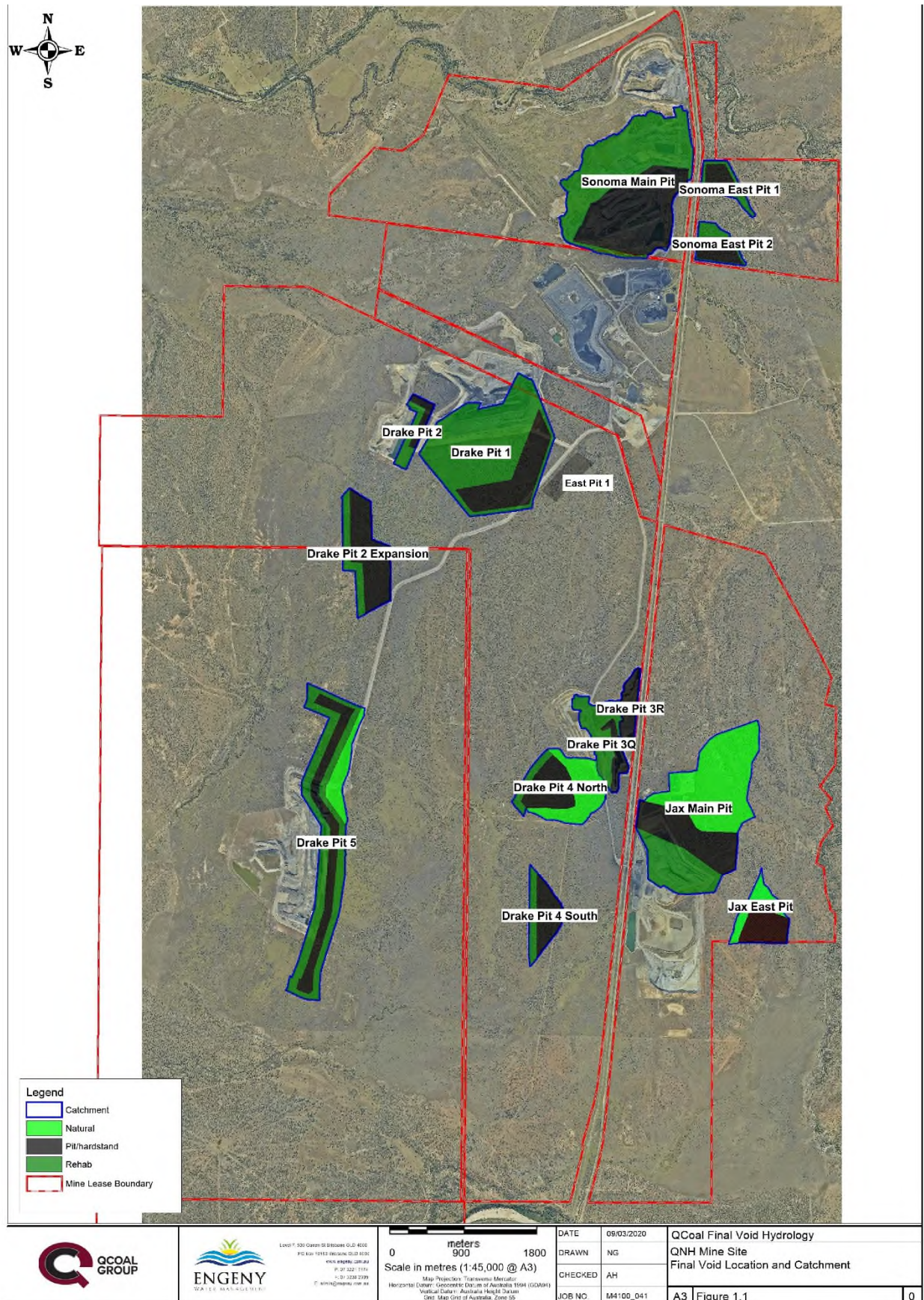


Figure 9 – QNH final void locations and catchments (adapted from Engeny (2020))

5.3 Final void storage curves

The storage curves of the final voids (i.e. the relationship between level, area and volume within a void) are a key input for the water balance and numerical groundwater modelling, and are derived from the geometry of the final voids.

Storage curves for the Jax Main Pit and Jax East Pit final voids are described and plotted in detail in Engeny (2108), provided as **Appendix A** to this assessment. Storage curves for all other QNH voids are described and plotted in detail in Engeny (2020), provided as **Appendix B** to this assessment.

The final void volumes extracted from the storage curves for all QNH voids are presented in **Table 4**.

Table 4 – Void capacity to crest (ML)

Void	Capacity to crest (ML)
Jax Main Pit	32,000 Engeny (2018)
Jax East Pit	11,000 Engeny (2018)
Sonoma Main Pit	45,151 Engeny (2020)
Sonoma East Pit 1	1,788 Engeny (2020)
Sonoma East Pit 2	2,009 Engeny (2020)
Drake Pit 5	13,996 Engeny (2020)
Drake Pit 1	18,323 Engeny (2020)
Drake Pit 2	1,711 Engeny (2020)
Drake Pit 2 Expansion	15,824 Engeny (2020)
East Pit 1	refer Section 5.2 .
Central Pit 3 (Drake Pit 4 North)	6,160 Engeny (2020)
Central Pit 4 (Drake Pit 4 South)	3,708 Engeny (2020)
Drake Pit 3-Q	2,326 Engeny (2020)
Drake Pit 3-R	1,254 Engeny (2020)

6 Groundwater Model (hydrogeology)

6.1 Model Development

AGE (2020) is a numerical groundwater modelling scope, the results of which have been inserted into this assessment.

A 3D numerical groundwater model was developed that covers the QNH mining leases. The model represents the weathered regolith and underlying Permian strata. Each key coal seam is represented as an individual model layer, as well as the interburden units that separate the coal seams. Most coal seams simulated are within the Moranbah Coal Measures, but also include the lower seam of the Fort Cooper Coal Measures. The base model layer represents the Exmoor Formation.

The modelling uses the unstructured version of the industry standard MODFLOW model (MODFLOW-USG). MODFLOW-USG uses a control volume finite difference scheme to represent the groundwater flow equation. The model is transient and simulates pre mining water levels through a steady state timestep, followed by transient annual timesteps representing both historical and future mining. The model has been calibrated against historical groundwater monitoring data. The model also simulates recovery of the groundwater system post mining, where hydraulic properties are changed within the pits to represent spoil emplacement and final voids.

The open cut mining at QNH is represented in the model using the Drain package. The drains are applied to each model layer within the mined out areas and groundwater is removed to create the desaturated conditions within the open cut pits. This drawdown then propagates away from the pits as water from the surrounding groundwater system flows through the ground towards the pits due to the gradients created by the desaturated conditions. The coal seam (and model layer) that the pit floor is in varies across the site due to the basin shape and accessibility of seams in different areas.

The mining is conservatively represented in the model by maintaining the dewatering (leaving the drain boundary on) once mining has started. This is done also to simplify the model setup, with all pits changed to spoil / void properties at the same time. This means that for pits such as Drake 3Q and 3R, which have completed mining and recovered, they continue to be dewatered in the model until all other pits have completed mining.

6.2 Groundwater level predictions

Presented in **Figure 10**, is the predicted water level in layer 1 for the end of mining with all pits dewatered. This prediction is representative of the water table, with some areas across the model domain layer 1 being fully unsaturated, in which case the predicted level resides in lower model layers. Predicted water levels in lower layers reflect these contours, though any sharp changes in level in higher levels tend to be gradually muted with depth. Due to the low permeability of the geology, predicted (and observed) impacts to the surrounding groundwater system remain local to the pits. The water levels in this figure become the starting point for the recovery simulation.

The recovery process is simulated by assuming recharge to the spoil and voids, factoring in evaporative losses to the void lakes. The level of recovery is controlled by the balance of water coming in from rainfall derived recharge and groundwater inflow as inputs and the loss due to evaporation from the void lake.

Recharge rates into the void and into the in-pit spoil are much higher than the undisturbed recharge rate calibrated for the model, which is conceptually expected as backfilled spoil has higher porosity and permeability than undisturbed material.

Presented in **Figure 11** is the predicted groundwater in layer 1 at year 10 after end of mining, and presented in **Figure 12** is the predicted groundwater in layer 1 at equilibrium, which show the following:

- the extent of groundwater change is largest at equilibrium due to the continued dewatering offered by evaporation from void lakes that equilibrate below the pre mining water levels;
- some of the pits have been predicted to have a hydraulic gradient back into the surrounding geology (a net outflow) particularly where they have been completely backfilled or where the void footprint is small. Those pits are Drake 3Q, Drake 3R and Sonoma East 2:
 - o A potential issue with such modelling outputs is the assumption that it indicates a migrating of water away from void. This assumption is not correct in the case of the QNH voids due to the proximity and influence of adjacent final voids. With this in mind, the predicted equilibrium water levels have been forensically interrogated to identify that all these potential sources are predicted to be intercepted by the larger and deeper voids (such as Drake 1, Drake 5, Sonoma East 1, and Jax 1), and will not migrate away from the site.
 - o More broadly the model identifies some minor movement of water between some of the smaller voids towards adjacent voids, while all other voids remain as groundwater sinks. In summary, the QNH voids when assessed as complexes are all groundwater sinks and the QNH when assessed cumulatively is a groundwater sink with no migration away from the QNH. To illustrate this outcome groundwater flow directions have been added to **Figure 12**.

Presented in **Figure 13** is the predicted groundwater in layer 1 at equilibrium with the bores registered as supply bores (**Section 4.2.4**). All bores are located outside of the extent of the cone of depression.

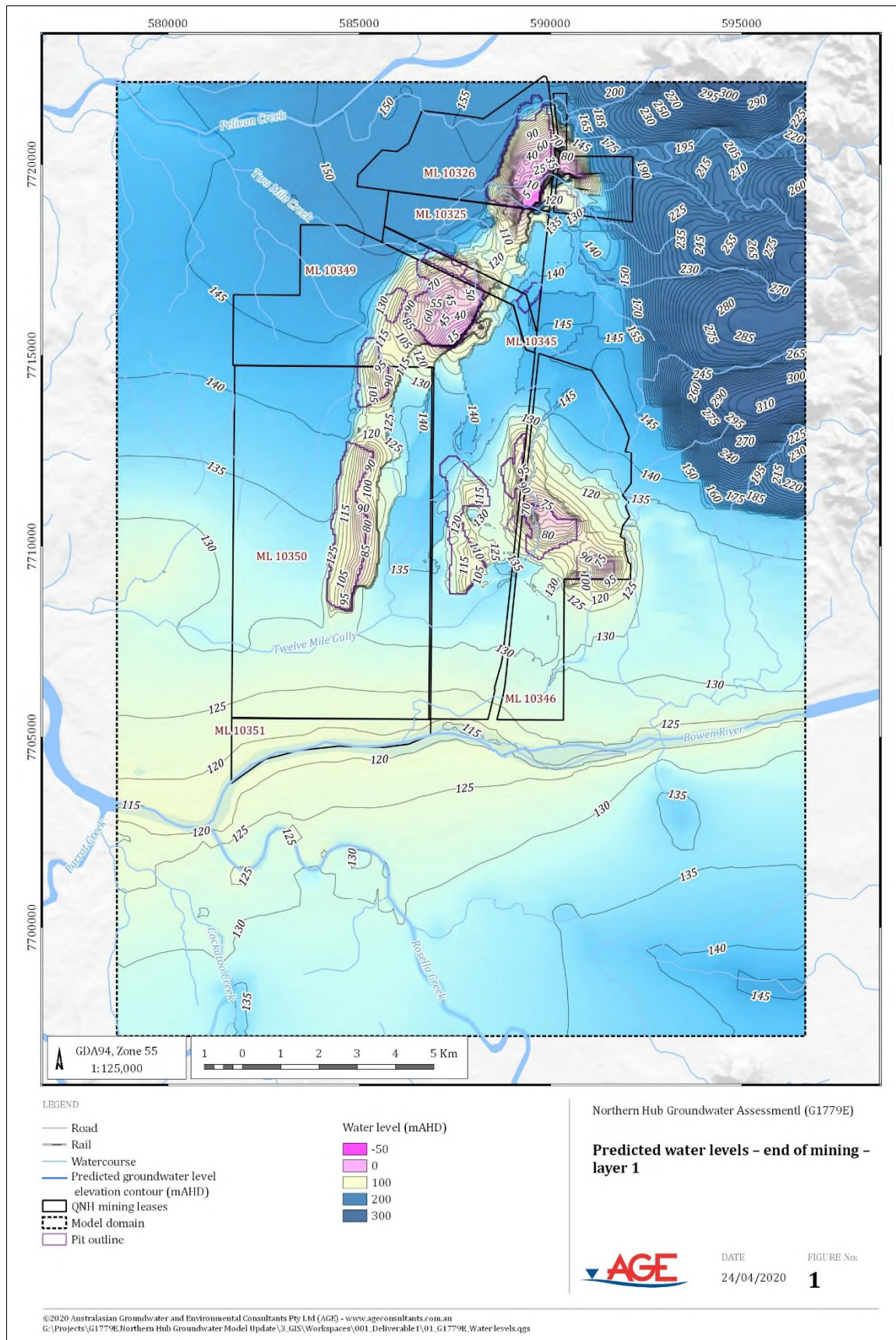


Figure 10 – Predicted groundwater levels end of mining – model layer 1

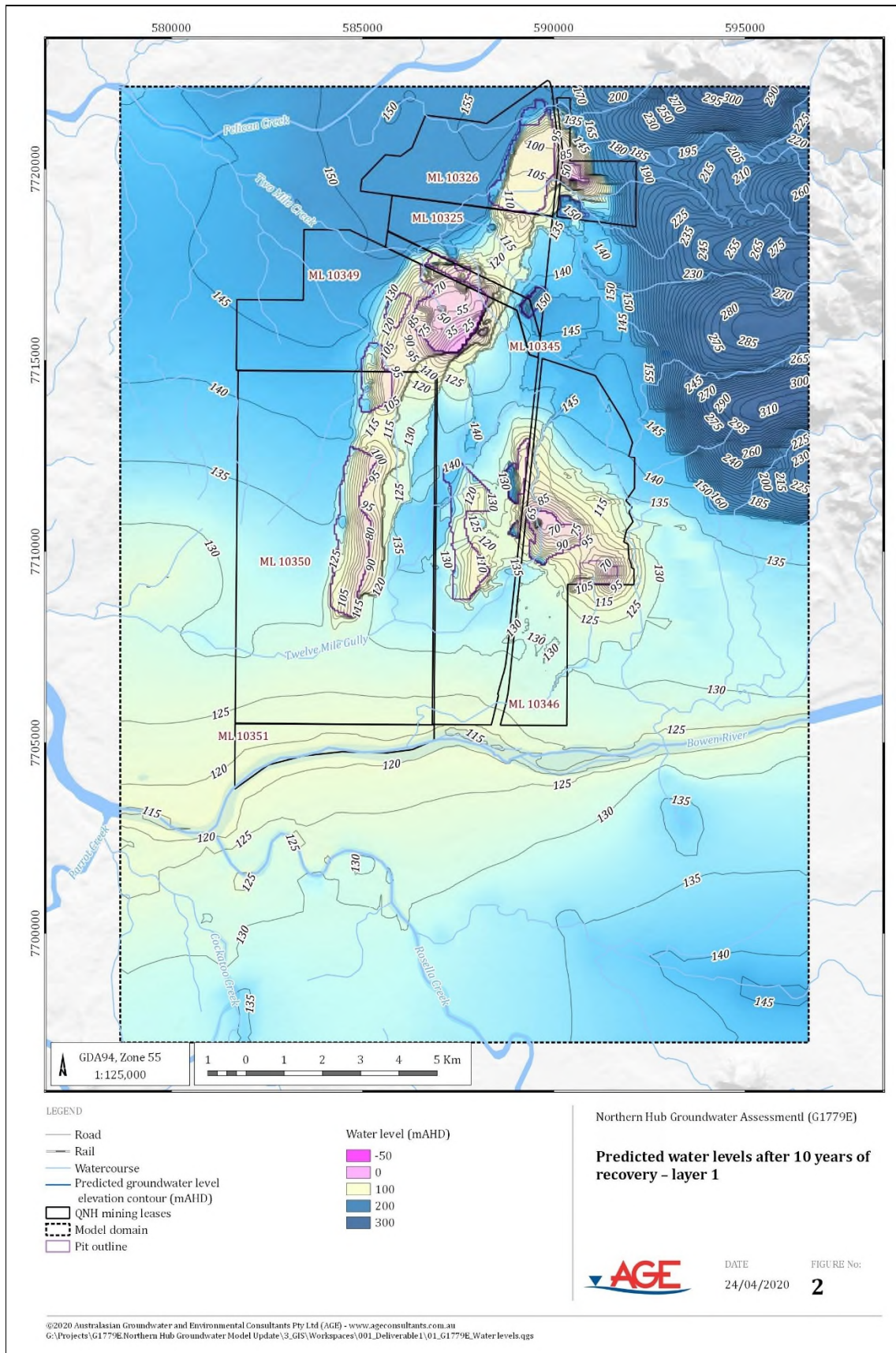


Figure 11 – Predicted groundwater levels year 10 after mining – model layer 1

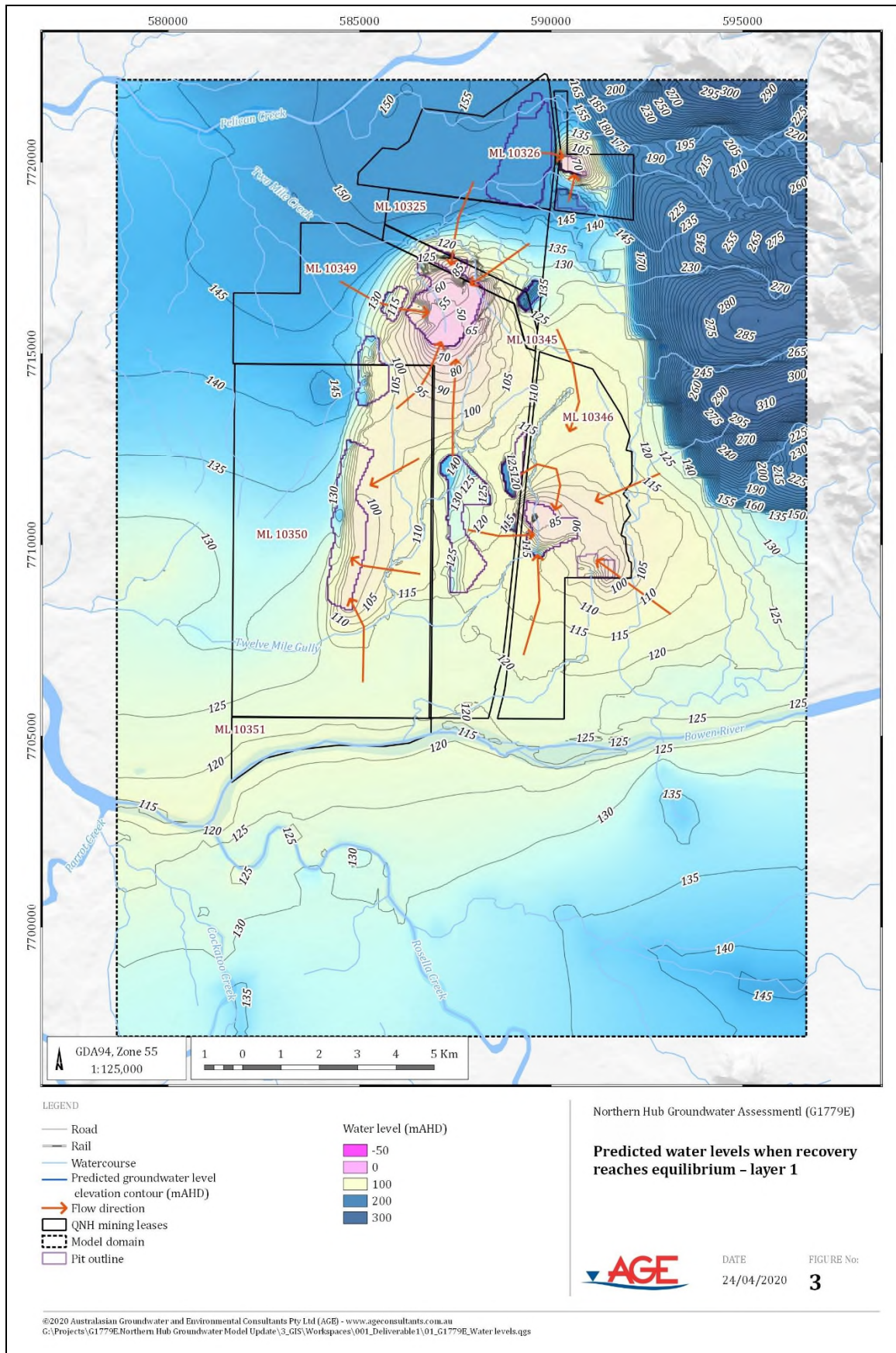


Figure 12 – Predicted groundwater levels equilibrium – model layer 1

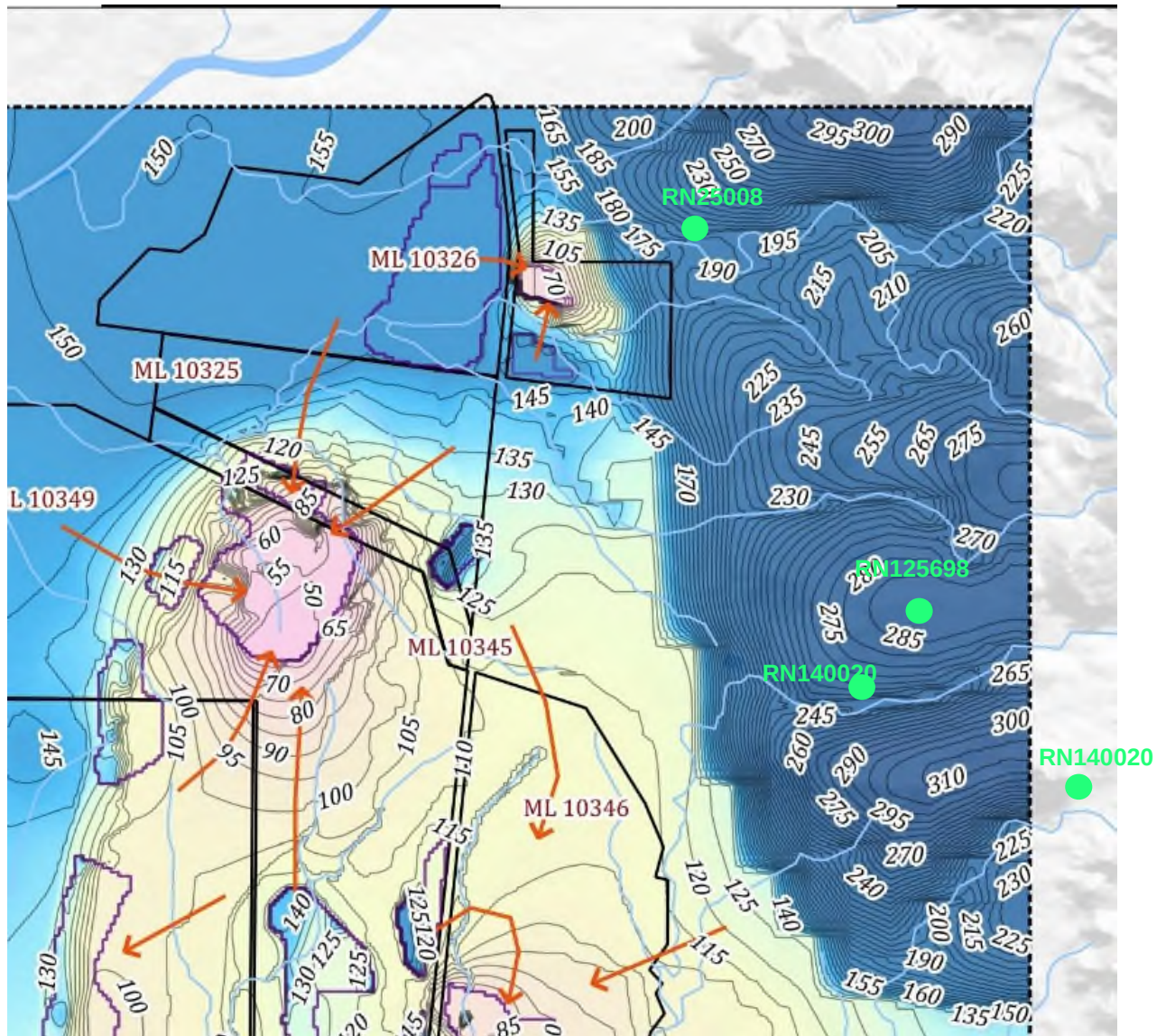


Figure 13 – Predicted groundwater levels equilibrium layer 1 and registered supply bores

7 Water Balance Model Inputs

7.1 Conceptual void hydrology

The water balance of the QNH final voids will be governed by the following water inflows and outflows:

- Inflows:
 - Surface runoff inflows from rehabilitated spoil areas that drain to the void.
 - Surface runoff inflows from the walls and ramps of the void.
 - Inflows from incident rainfall on the void lake.
 - Groundwater inflows to the void (nominally where void lake level is lower than regional groundwater).
- Continuous outflows:
 - Outflows due to evaporation losses from the surface area of the void lake.
- Hypothetical outflows (conditional on void lake level):
 - Seepage outflows from the void lake – potential to flow into an adjacent groundwater sink void or into the unsaturated low-wall waste rock dump or into the local groundwater system if not contained by the cumulative cone-of-depression surrounding the QNH voids.
 - Discharges to surface water (conditional on maximum void lake levels relative to crest height).

7.2 Groundwater recovery curves

Numerical groundwater modelling of the design residual voids was undertaken by AGE (2018) for Jax Main Pit and Jax East Pit, and by AGE (2020) for all other QNH voids, to predict groundwater recovery after the cessation of mining. From those modelling studies a rating curve of groundwater inflow versus pit water level for each residual void was developed which is required for the water balance modelling of the final voids.

Groundwater recovery curves for the Jax Main Pit and Jax East Pit final voids are described and plotted in detail in Engeny (2108), provided as **Appendix A** to this assessment. Groundwater recovery curves for all other QNH voids are described and plotted in detail in Engeny (2020), provided as **Appendix B** to this assessment.

It is noted that the range of the groundwater recovery curves is limited by the water levels simulated in the groundwater model. Where required, the final value of the groundwater recovery curves have been conservatively extrapolated for the remainder of the adopted void storage curve values.

Negative flows shown in the groundwater recovery curve figures indicate the elevation of water level within the lake is generating a hydraulic gradient out of the void lake, at which point a net outflow from the void lake can potentially occur. **Any modelled outflows from a void lake resulting from these portions of the groundwater recovery curves need to be interpreted with care and may not necessarily indicate flows to the surrounding regional groundwater system.** It is understood that the adopted groundwater recovery curves are impacted by the following processes:

- Interaction between residual void lakes located in close proximity, such as hydraulic gradients between void lakes resulting in flow from one void lake to another, which **is not considered flow into the surrounding regional groundwater** (e.g. as has been identified between Sonoma East 1 and Sonoma East 2 and between Drake 3Q and Drake 3R). It is noted that the modelled flow rates in these situations are generally of very small magnitude.
- Outflows from the void lakes into the surrounding spoil material. **The groundwater recovery curves make no distinction between outflows from the void lake into the low-wall backfill material, outflows into an adjacent void or outflows into the regional groundwater system.** As such, a modelled outflow as determined by the model may be associated with the saturation period of the low-wall waste rock until such time as steady state equilibrium is reached. This primarily occurs during the initial recovery period when the spoil material is first becoming saturated.

The interaction between the residual void lake and surrounding regional groundwater (be it net inflow or outflow) considers a range of indicators including:

- Base of Weathering – the threshold between highly weathered material and less permeable hard rock. The base of weathering provides an indication of areas where seepage from a void lake into the surrounding geology might occur if lake levels are forecast to exceed this threshold. Again, such seepage is not immediately representative of a groundwater source into regional groundwater.
- Regional Groundwater Level – when the regional groundwater level exceeds the forecast void lake level then there is a hydraulic gradient into the void and the void is considered to act as a groundwater sink. Alternatively, a void lake level that is forecast to be above the regional groundwater level may result in a hydraulic gradient out of the void into the surrounding geology (a net outflow), but, again, a net outflow is not immediately representative of a groundwater source into regional groundwater.
- Net Zero Flow Level – This level is extracted from the groundwater recovery curves and provides an indication of the direction of water fluxes to the void lake. **As previously stated, outflows resulting from these recovery curves need to be interpreted with care as they may represent movement from one void (a net outflow) to an adjacent void which is a groundwater sink (a net inflow), thus containing void water from both voids (considered as movement within a groundwater sink system), or movement of water into unsaturated low wall spoil material, as opposed to an actual flow into the regional groundwater system.**

A summary of indicator levels for each QNH final void is summarised in **Table 5**.

Table 5 – Base of weathering and regional groundwater levels

Mine Site	Residual Void	Base of Weathering (mAHD)	Pre- mining Regional Groundwater Level (mAHD)	Net Zero Flow Level (mAHD)
Jax	Jax Main Pit	149.78	140	
	Jax East Pit	146.72	140	
Sonoma	Sonoma Main Pit	153.02	155.67	8.23
	Sonoma East Pit 1	155.80	156.30	Inflows at all levels
	Sonoma East Pit 2	156.92	155.53	Outflows at all levels
Drake	Drake Pit 5	144.39	137.42	Inflows at all levels
	Drake Pit 1	169.07	146.57	Inflows at all levels
	Drake Pit 2	153.4	147.23	100.11
	Drake Pit 2 Expansion	163.99	144.24	Inflows at all levels
	East Pit 1	refer Section 5.2.		
	Central 3 (Drake Pit 4 North)	126.96	139.50	Inflows at all levels
	Central 4 (Drake Pit 4 South)	146.72	136.71	Inflows at all levels
	Drake Pit 3Q	161.28	142.55	Inflows at all levels
	Drake Pit 3R	156.72	141.78	83.15

7.3 Rainfall and evaporation data

Engeny (2020) provides detail on the climate data used for the water balance model. Long-term daily rainfall data at the QNH was obtained from the SILO climate database facility hosted by DES. SILO includes both Patched Point Data and Data Drill. The Data Drill utilises grids of data interpolated from point observations by the Bureau of Meteorology to provide climate statistics for a specified location. Patched Point Data is only available at selected rainfall stations and utilises grids of data to 'patch' any data gaps in the climate record at that site. A SILO Patched Point Data climate series was obtained for the nearby Collinsville Post Office (33013) covering the period January 1889 to September 2019. A composite data set was obtained by merging the SILO data with SCM site rainfall to obtain a continuous record from January 1889 to September 2019 (130 years of data).

The largest single day rainfall event measured as 348.7 mm (08/04/1940) and the largest seven day total measured as 454 mm (02/02/1991 – 08/02/1991),

Corrections to the lake evaporation rates were applied in the residual void water balance model to reflect the reduction to the freshwater evaporation rate that occurs for a saline water body. Morton's method for adjusting evaporation rates has been adopted as presented in Hydrological Recipes: Estimation Technique in Australian Hydrology (1996). The method predicts a relatively small evaporation correction for salinity of approximately 1% reduction per 10,000 mg/L total dissolved solids (TDS) for TDS values up to 50,000 mg/L (i.e. 5% reduction for 50,000 mg/L TDS).

7.4 Runoff rates and quality

Engeny (2020) provides detail on the assumed rates and quality of runoff used for the water balance model. Catchment runoff has been simulated using the Australian Water Balance Model (AWBM). The model represents the catchment using three conceptual surface stores to simulate partial areas of runoff. The water balance of each surface store is calculated independently of the others. The model calculates the water balance of each partial area at daily time steps. At each time step, rainfall is added to each of the three surface stores and evapotranspiration is subtracted from each store. If the value of water in the store exceeds the capacity of the store, the excess water becomes runoff. Part of this runoff becomes recharge of the baseflow store if there is a baseflow component to the stream flow. AWBM parameters were adopted from the existing QNH operational water balance model (as for “*Water Management Plan QNH Mines*” (Engeny, 2019)). These parameters are as summarised in **Table 6**.

Table 6 – Adopted AWDM Runoff Parameters

Parameter	Natural	Hardstand & Pits	Rehabilitated Spoil
C1 (mm)	23.0	5.0	10.0
C2 (mm)	125.0	20.0	120.0
C3 (mm)	180.0	40.0	180.0
A1	0.134	0.134	0.134
A2	0.433	0.433	0.433
3	0.433	0.433	0.433
BFI	0.05	0.00	0.35
Kb	0.87	0.60	0.60

For the assessment of final voids, a single indicator parameter is adopted by the water balance modelling to predict dilution and concentration cycles in the void lake. Salinity is the industry standard indicator parameter. Salinity of runoff generated in the water balance is determined based on land use type. Surface water runoff total dissolved solids (TDS) characteristics have previously been calibrated for certain land use types as documented in “*Water Management Plan QNH Mines*” (Engeny, 2019). These runoff TDS characteristics have been adopted for the modelling of the QNH voids and are summarised in **Table 7**.

Table 7 – Adopted runoff quality

Source	Salinity (mg/L)
Pit wall runoff	1300 (1,931 μ S/cm EC)
Rehabilitated Spoil runoff	700 (1,040 μ S/cm EC)
Natural catchment runoff	700 (1,040 μ S/cm EC)
Direct rainfall	5 mg/L, based on latitude and distance from the coast (DNR, 1997)

7.5 Assumed groundwater quality

Monitoring of groundwater quality across a number of monitoring bores at QNH is undertaken on a quarterly basis. For the assessment of final voids, a single indicator parameter is adopted by the water balance modelling to predict dilution and concentration cycles in the void lake. Salinity is the industry standard indicator parameter.

The groundwater quality data has previously been assessed as part of the “*Sonoma Coal Mine Final Void Hydrology Study Main Pit 2015*” (Engeny, 2015) and “*Cows Coal Mine Final Void Hydrology Study Q Pit and B Pit 2017*” (Engeny 2017). Both studies determined a representative groundwater inflow quality of 2,000 $\mu\text{S}/\text{cm}$.

A consistent quality was adopted for the Jax Main Pit and Jax East Pit final voids as described in Engeny (2108), provided as **Appendix A**, and for all other QNH voids as described in Engeny (2020), provided as **Appendix B**.

8 Water Balance Model Results

8.1 Final void lake levels

The final void lake volume and level modelling (including sensitivity analysis) for the Jax Main Pit and Jax East Pit final voids, is described and plotted in detail in Engeny (2108), which has been provided as **Appendix A**. The final void lake volume and level modelling for all other QNH final voids is described and plotted in detail in Engeny (2020), provided as **Appendix B**.

Results have been extracted from the above, and are presented in **Figure 14 - Figure 26**, with the following key information presented:

- the simulation period:
 - o 500 years for Jax Main Pit and Jax East Pit (presented for the first 100 years and the full 500 year simulation separately for both final voids)
 - o 200 years for all other QNH final voids
- minimum, median and max levels and volumes are presented for each day of the simulation period for all final voids;
- the observable oscillations are the drying/filling cycles associated with normal seasonal and climactic variations;
- the median has been used to define the equilibrium levels in this assessment;
- the crest/spill level, regional groundwater level and base of weathering assumed in the model is also presented on each figure for each final void:
 - o the additional information for Jax Main Pit and Jax East Pit is presented as an un-scaled schematic
 - o all other QNH final voids have this information presented as plotted data
- all results reported in this assessment are from modelling of the “base case” which is the catchment extent provided by the LOMP, except for Central 3 (Drake Pit 4 North), where an opportunity to refine the catchment boundary was identified during the modelling (referred to as the mitigated case). For ease of interpretation only the Central Pit 3 (Drake Pit 4 North) mitigated case is included within the body of this assessment; however, Engeny (2020) includes both the base and mitigated cases.

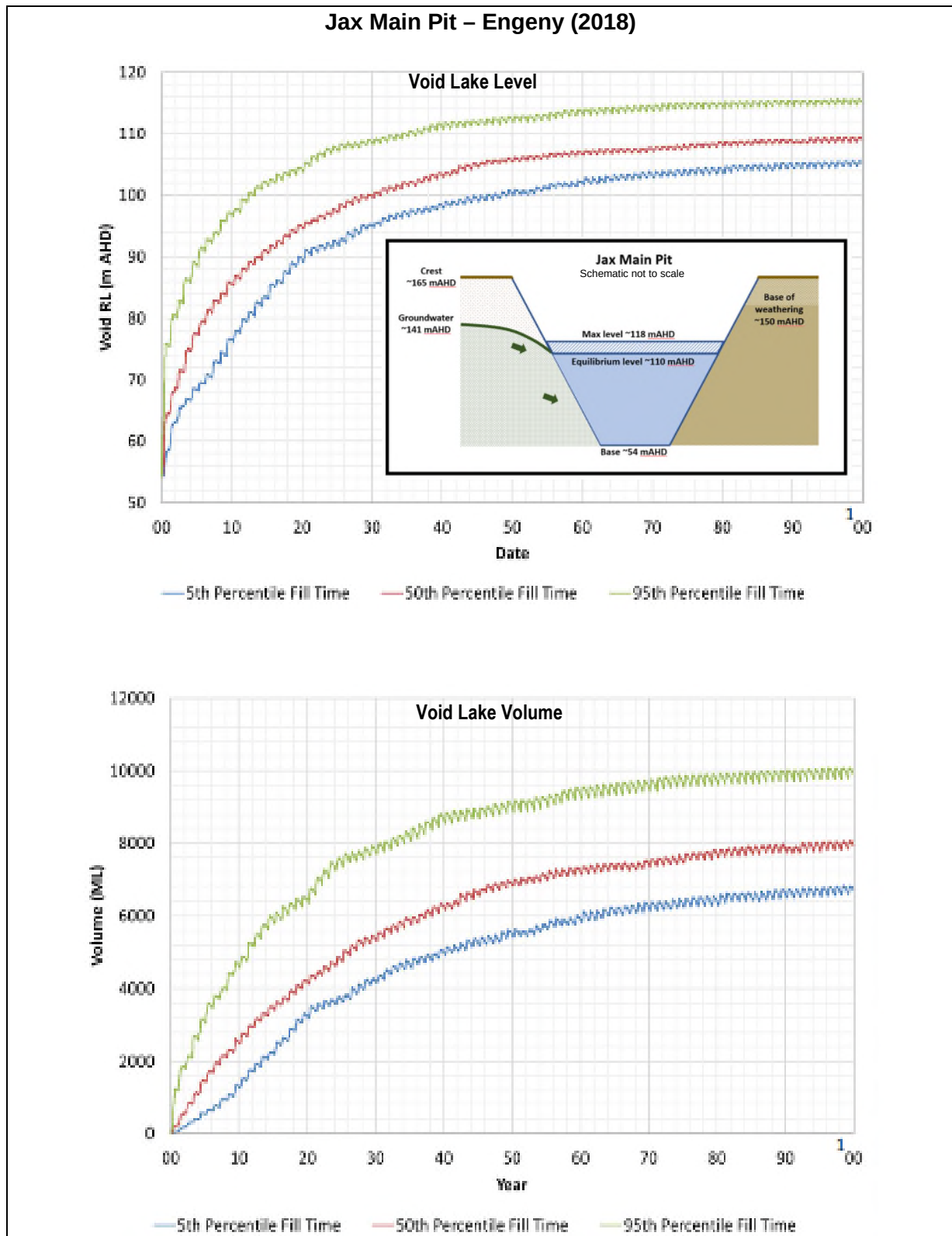


Figure 14 – Jax Main Pit final void water volume and level (base case)

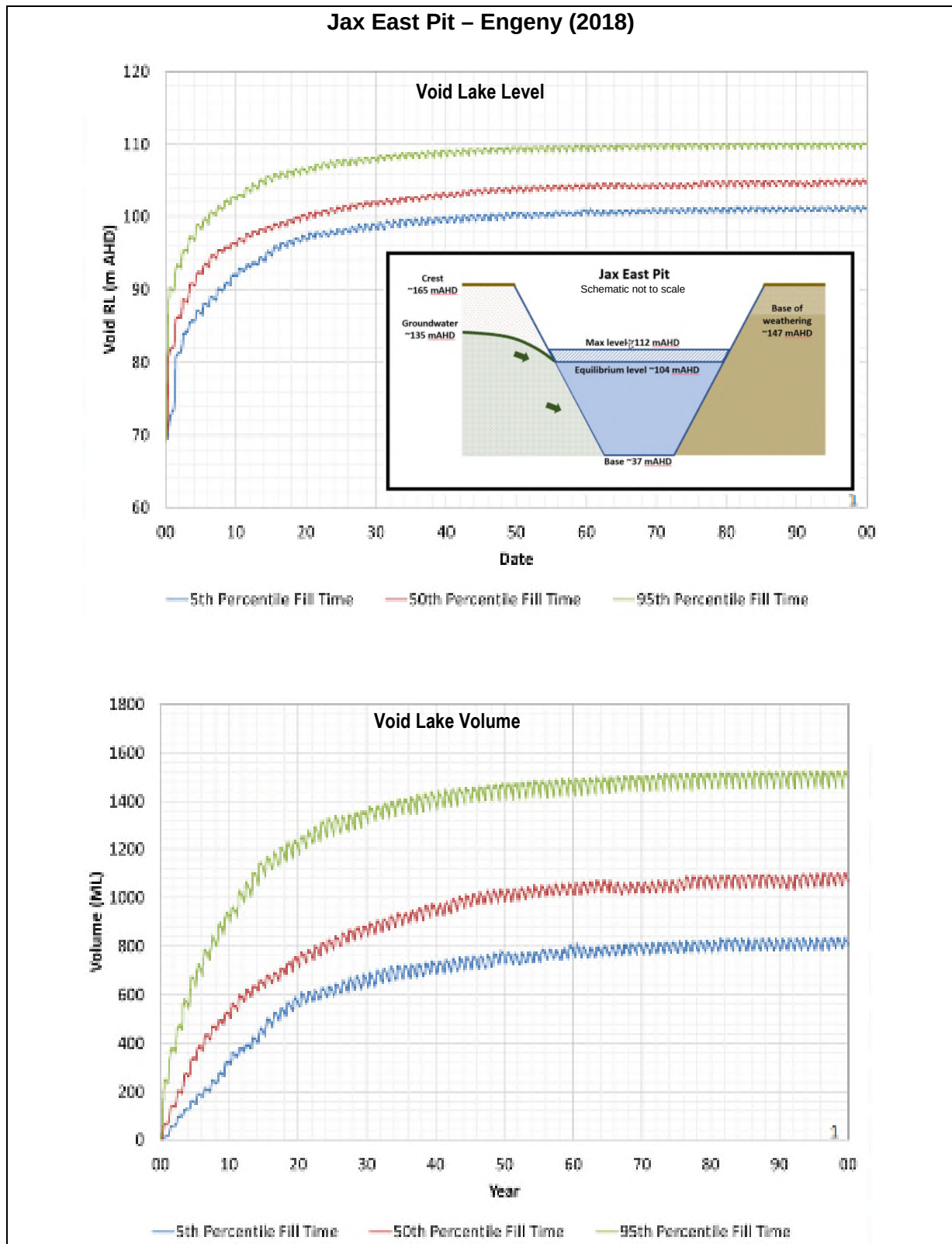


Figure 15 – Jax East Pit final void water volume and level (base case)

Sonoma Main Pit – Engeny (2020)

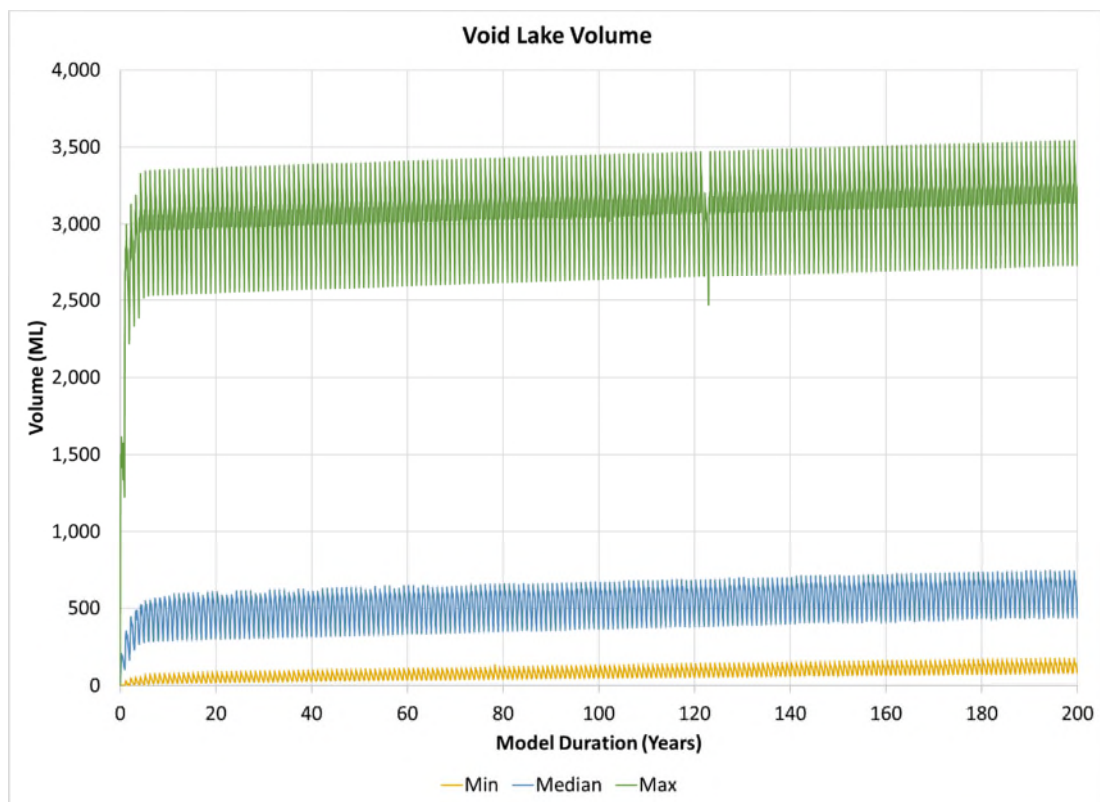
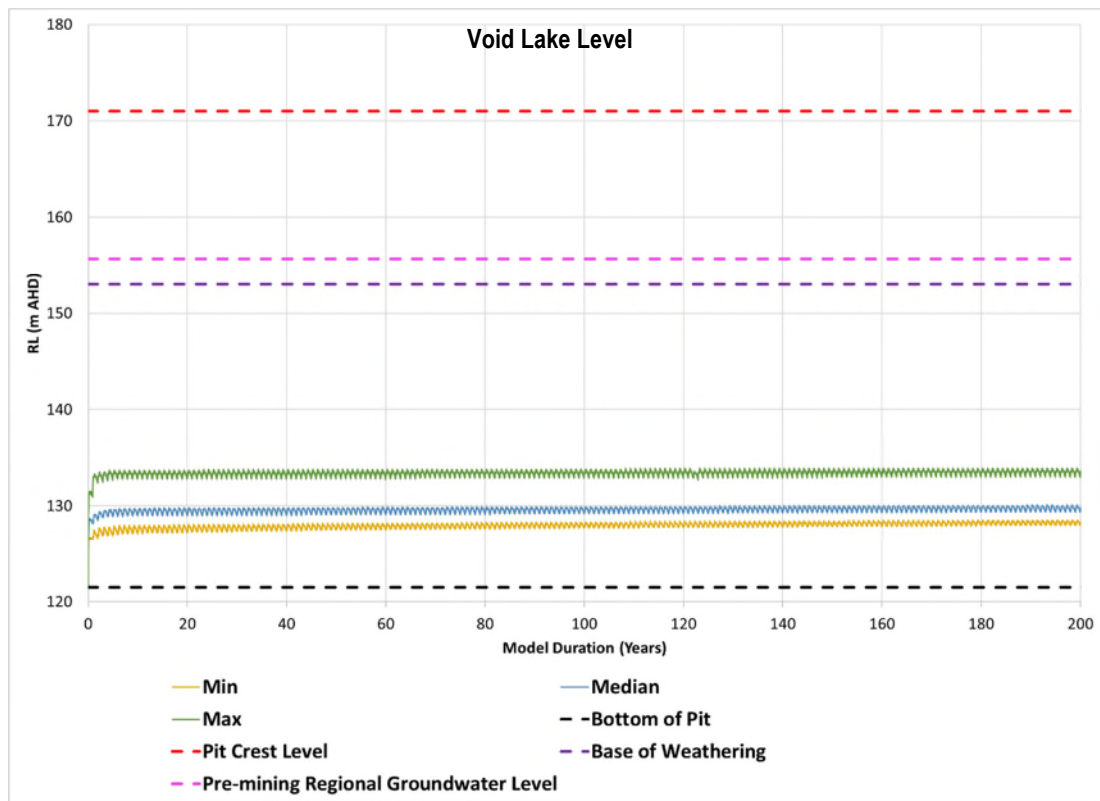


Figure 16 – Sonoma Main Pit final void water volume and level (base case)

Sonoma East Pit 1 – Engeny (2020)

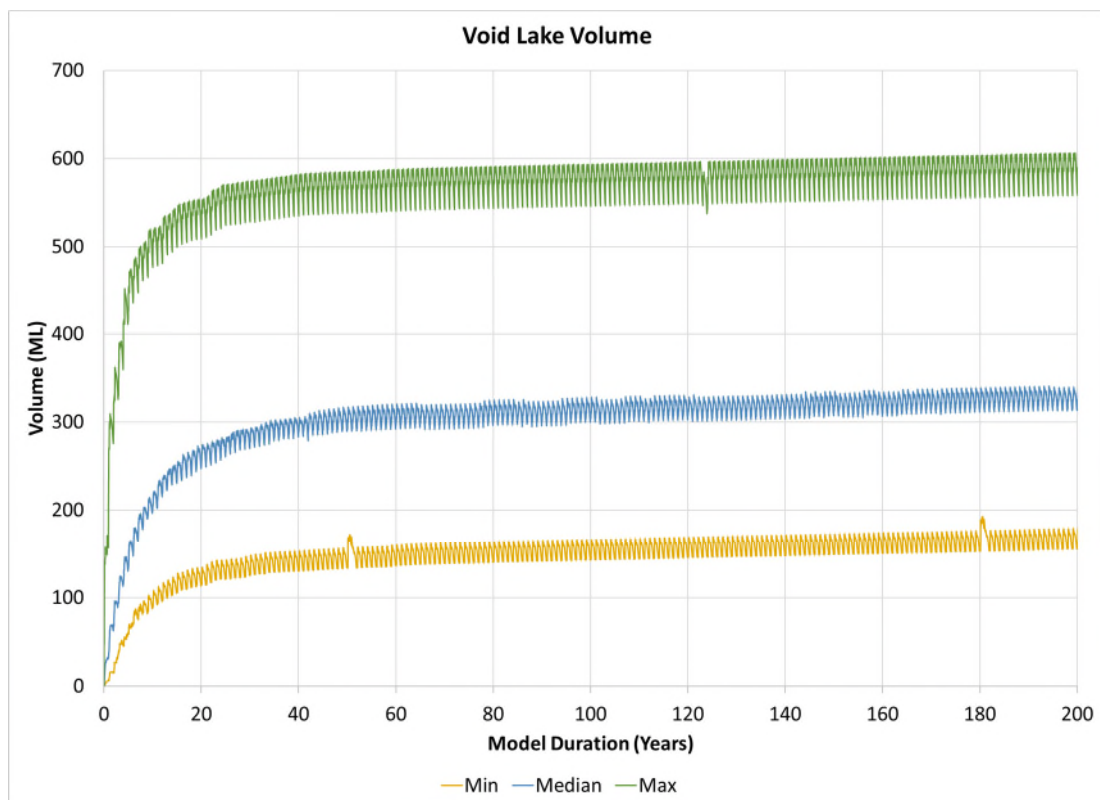
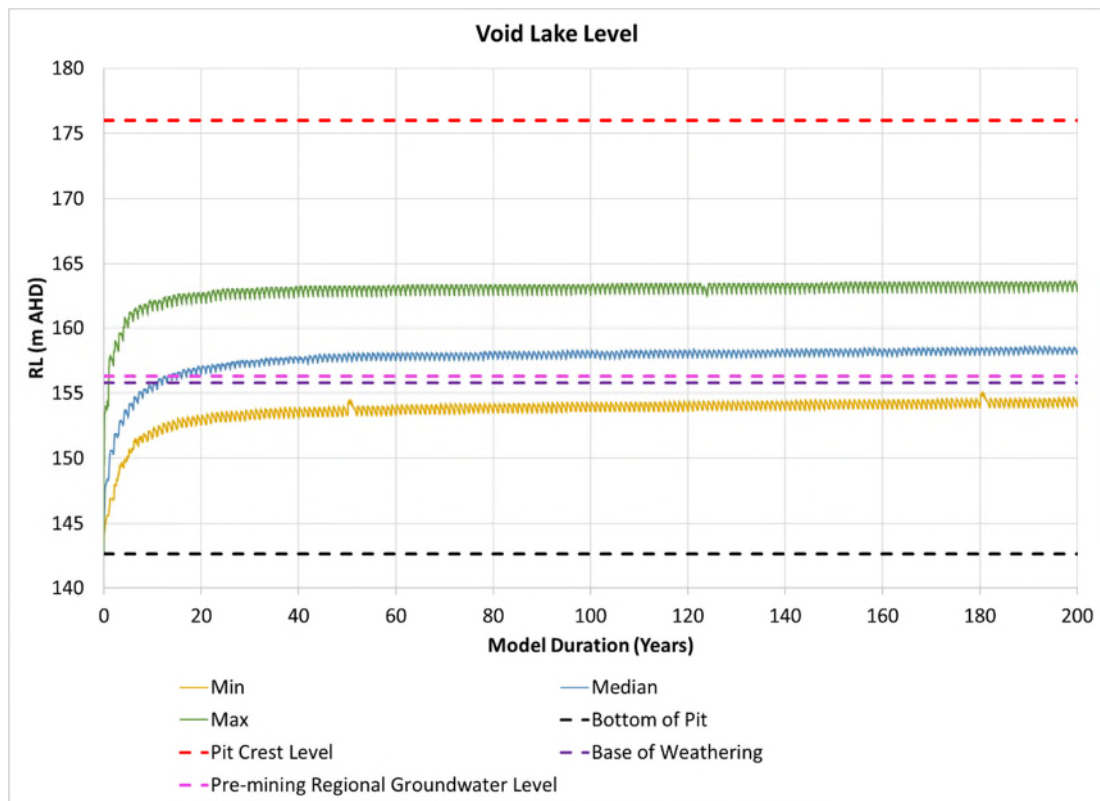


Figure 17 – Sonoma East Pit 1 final void water volume and level (base case)

Sonoma East Pit 2 – Engeny (2020)

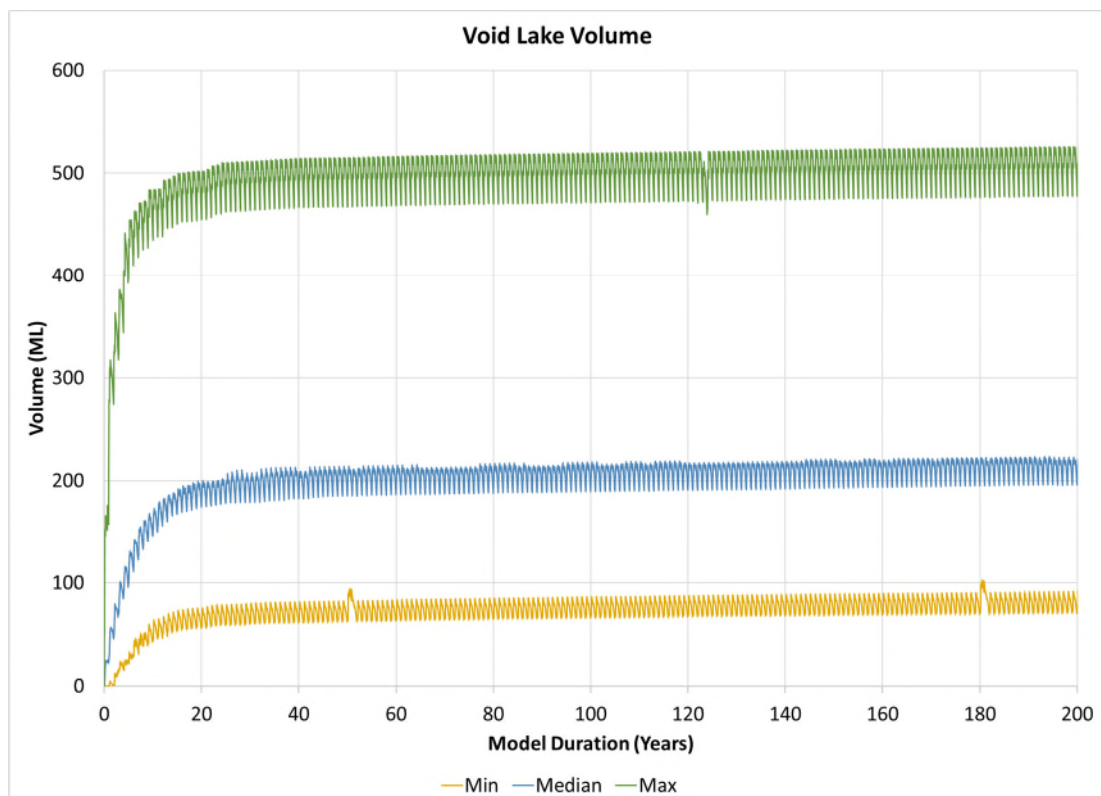
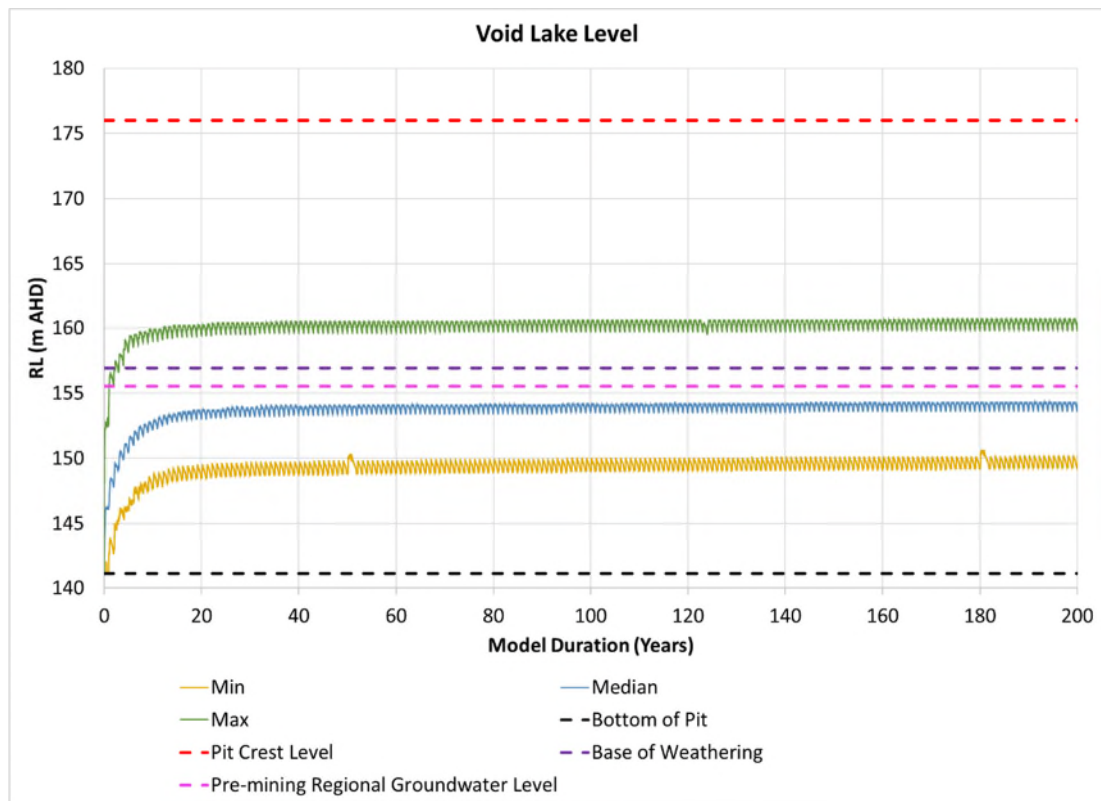


Figure 18 – Sonoma East Pit 2 final void water volume and level (base case)

Drake 5 Pit – Engeny (2020)

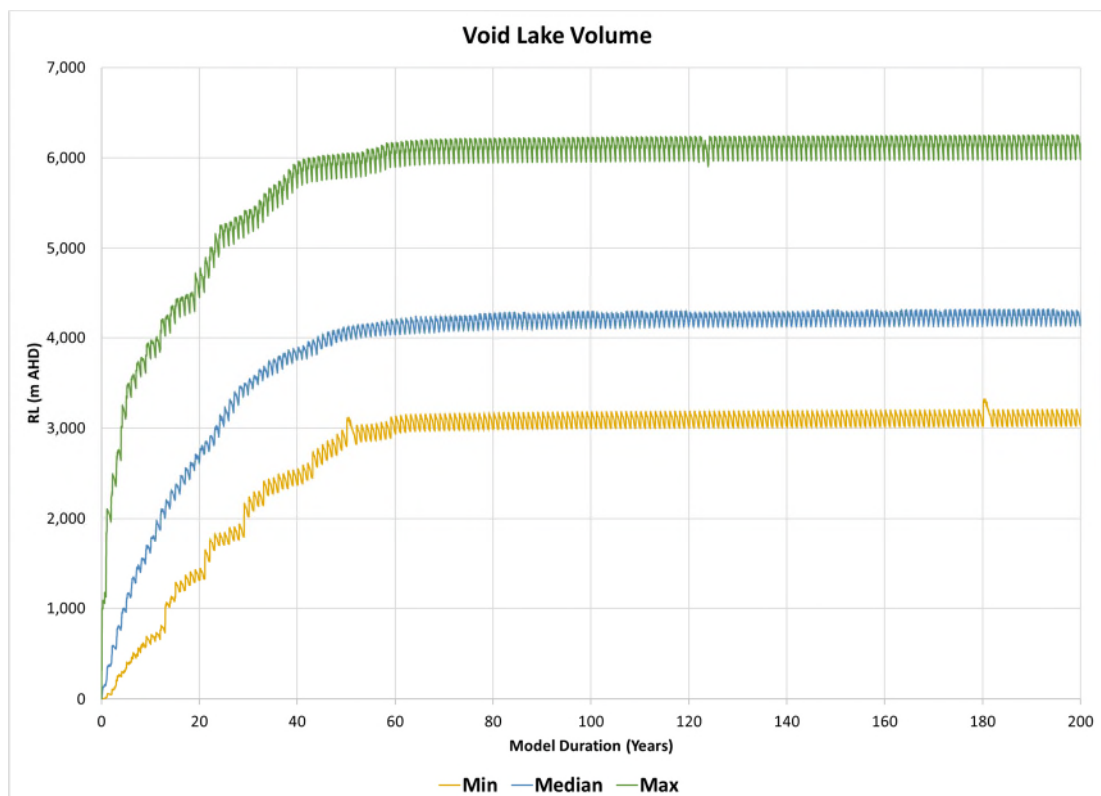
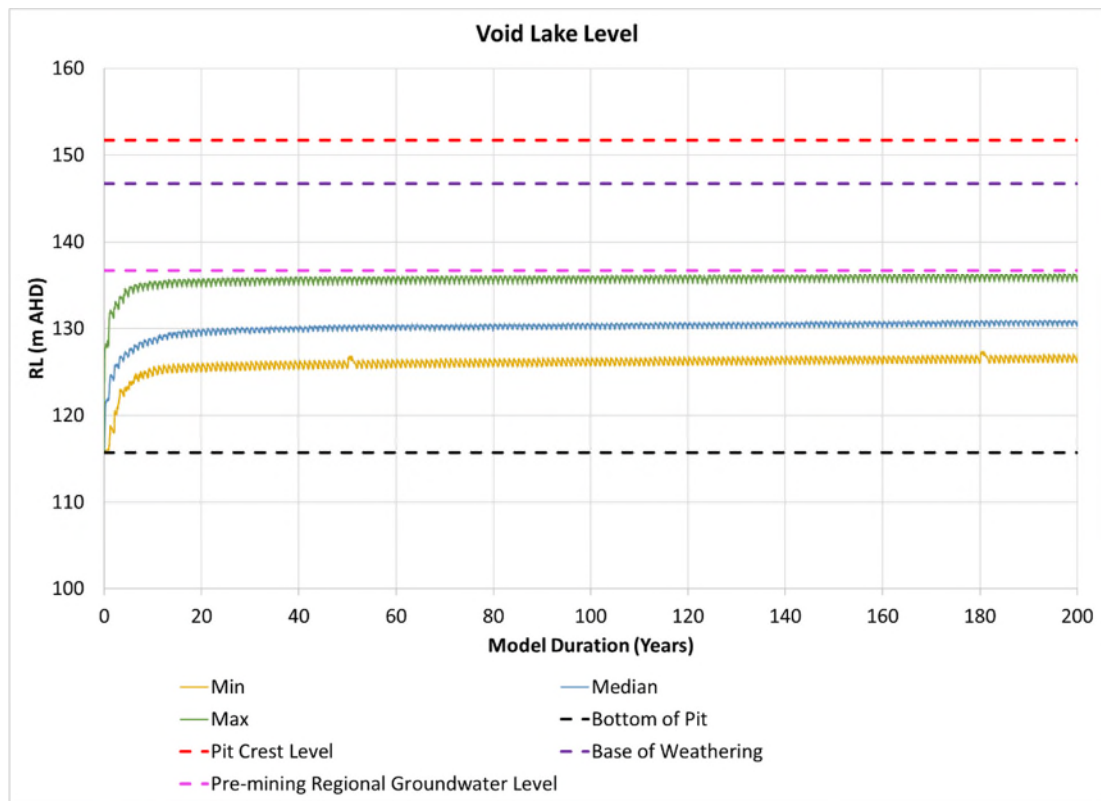


Figure 19 – Drake Pit 5 final void water volume and level (base case)

Drake 1 Pit – Engeny (2020)

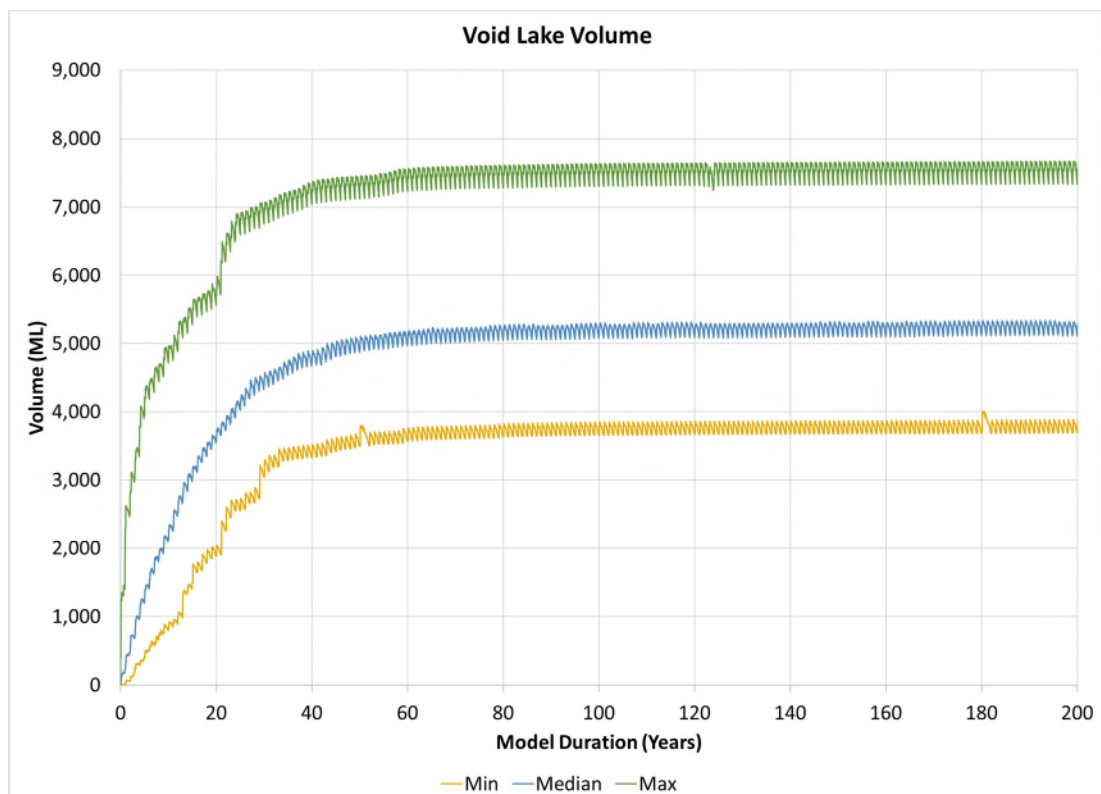
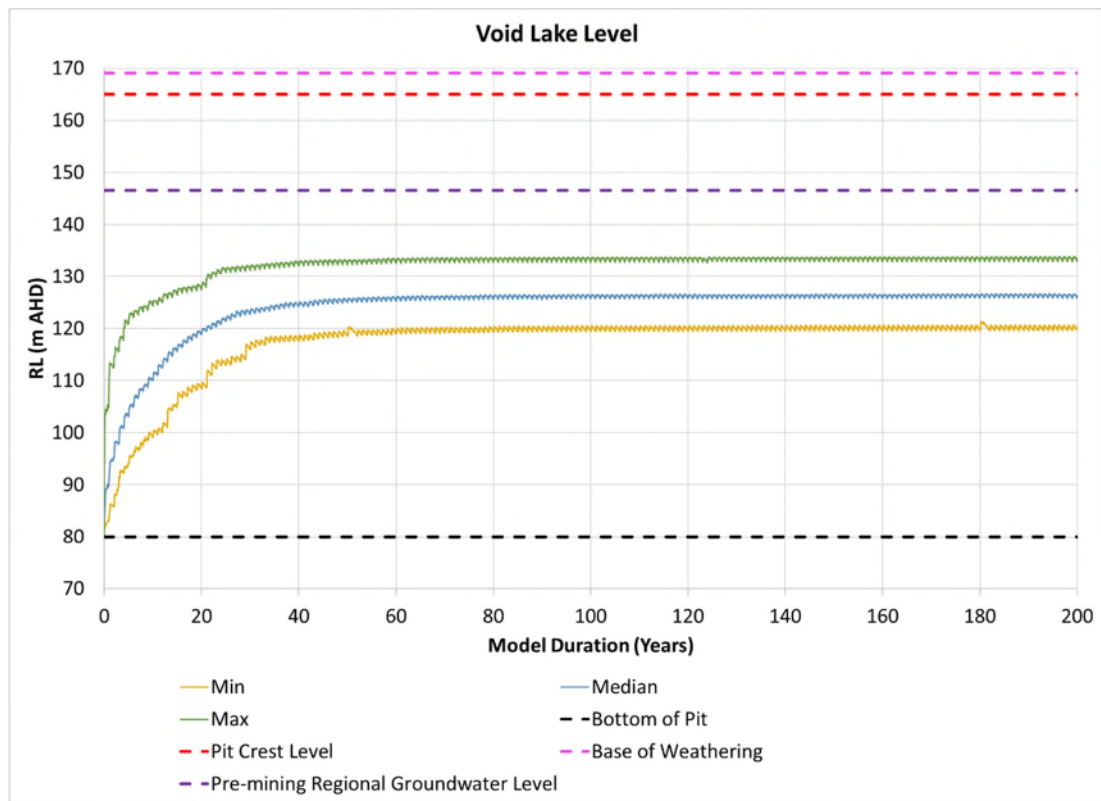


Figure 20 – Drake Pit 1 final void water volume and level (base case)

Drake Pit 2 – Engeny (2020)

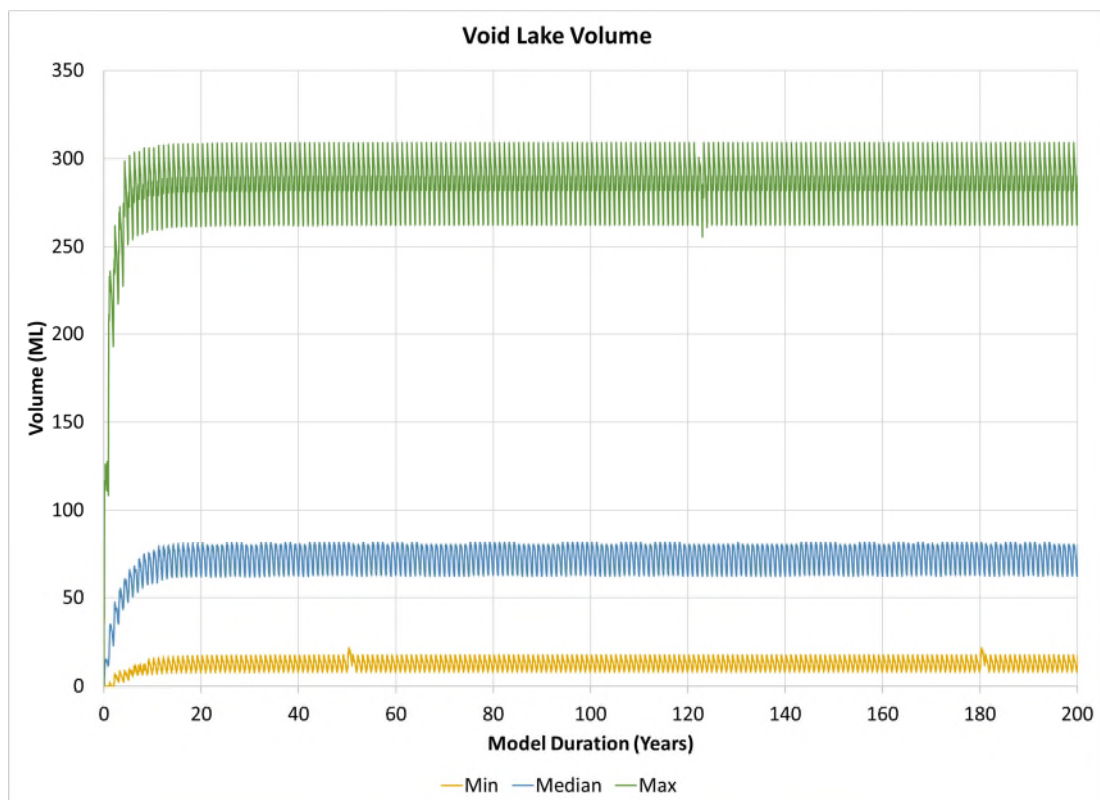
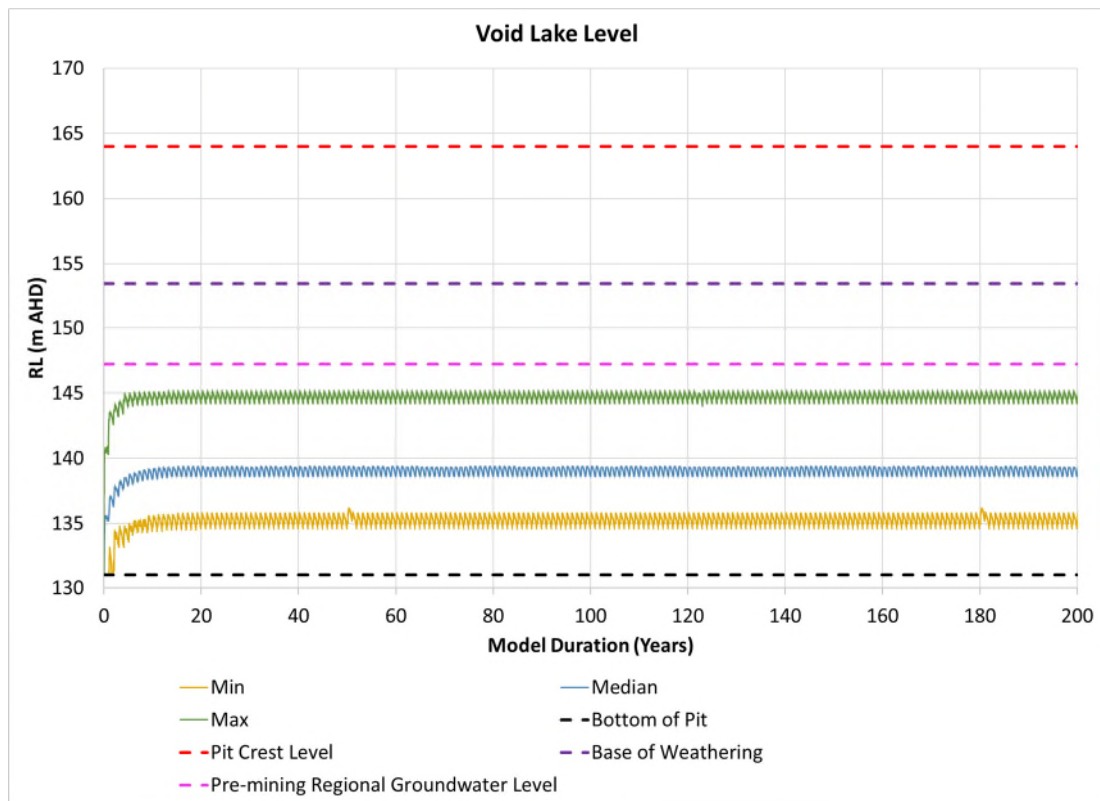


Figure 21 – Drake Pit 2 final void water volume and level (base case)

Drake Pit 2 Expansion – Engeny (2020)

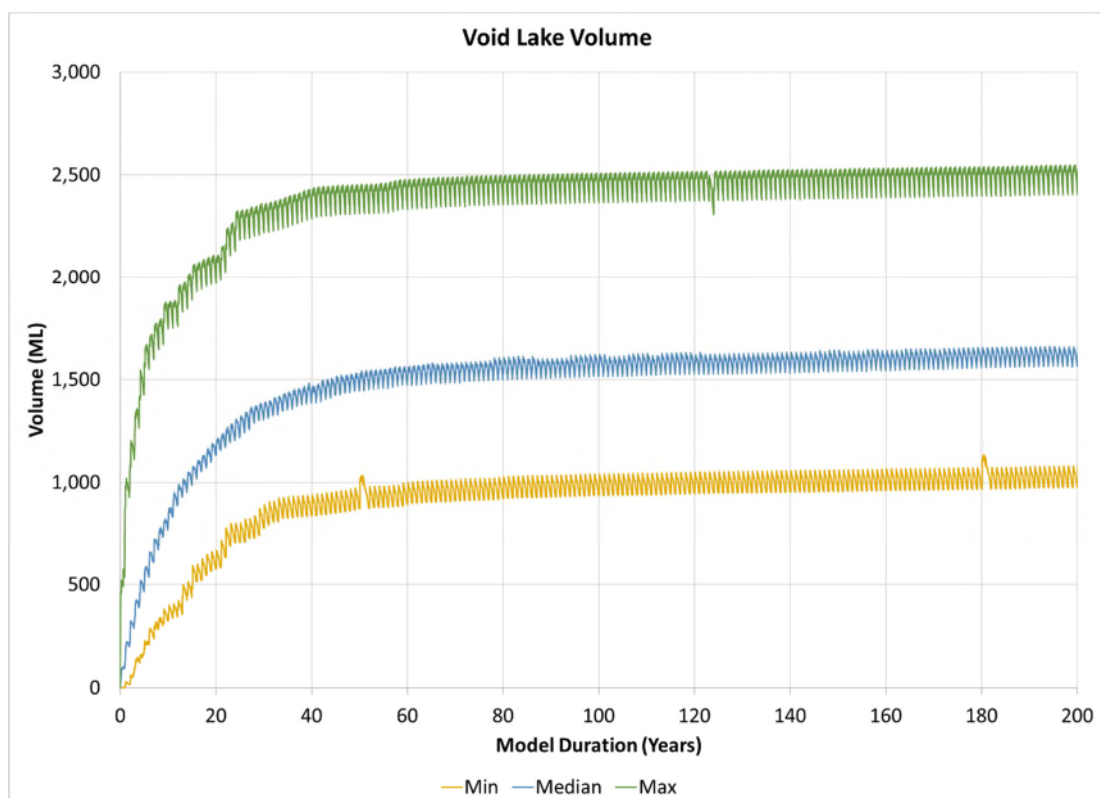
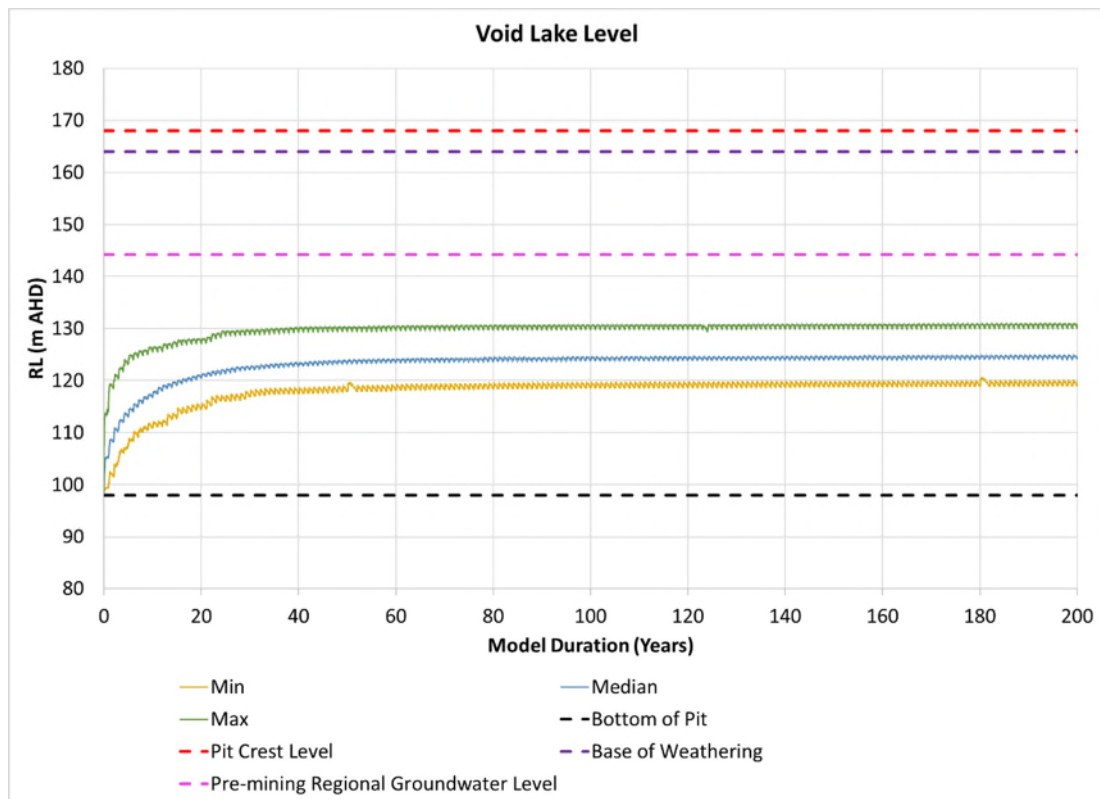


Figure 22 – Drake Pit 2 Expansion final void water volume and level (base case)

Central 3 (Drake Pit 4 North) Mitigated Case – Engeny (2020)

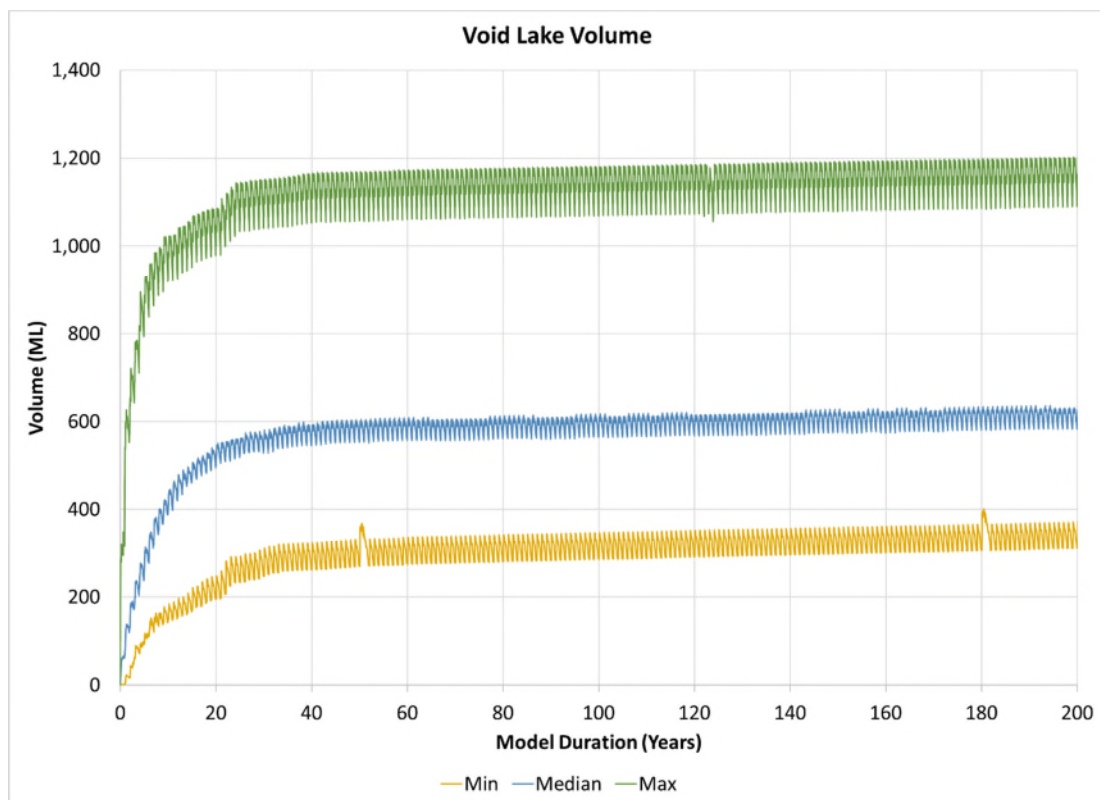
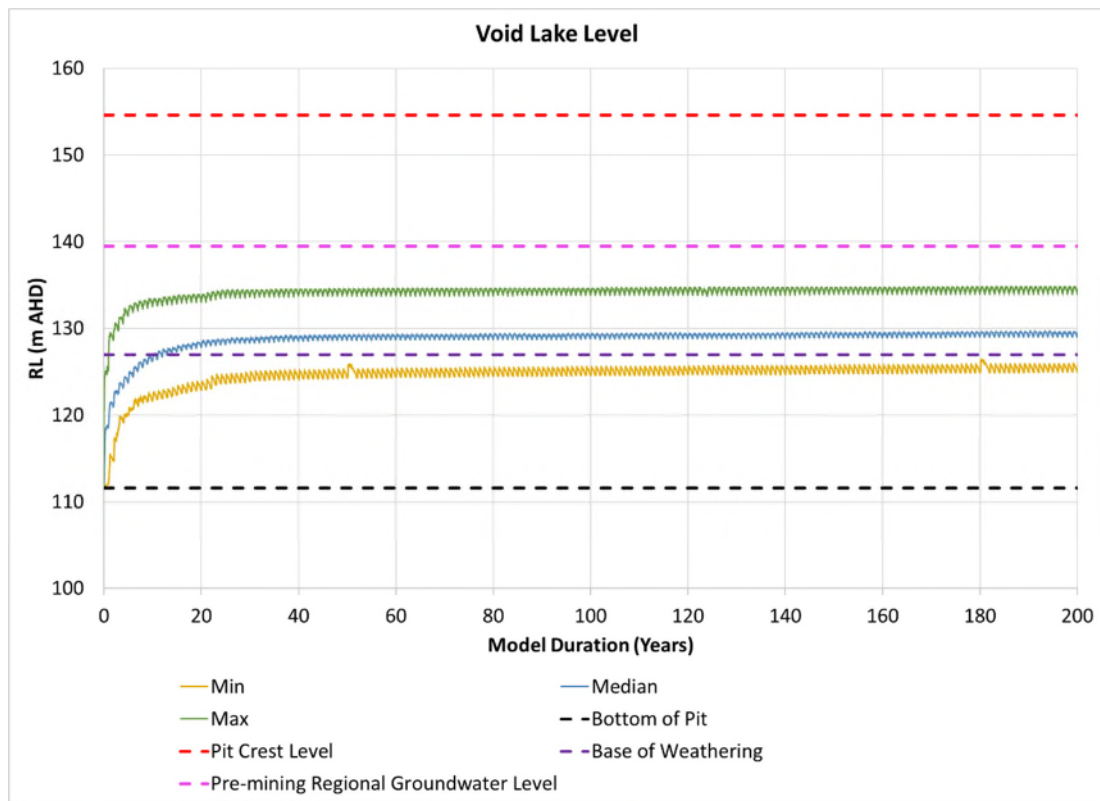


Figure 23 – Central 3 (Drake Pit 4 North) final void water volume and level (mitigated case)

Central 4 (Drake Pit 4 South) – Engeny (2020)

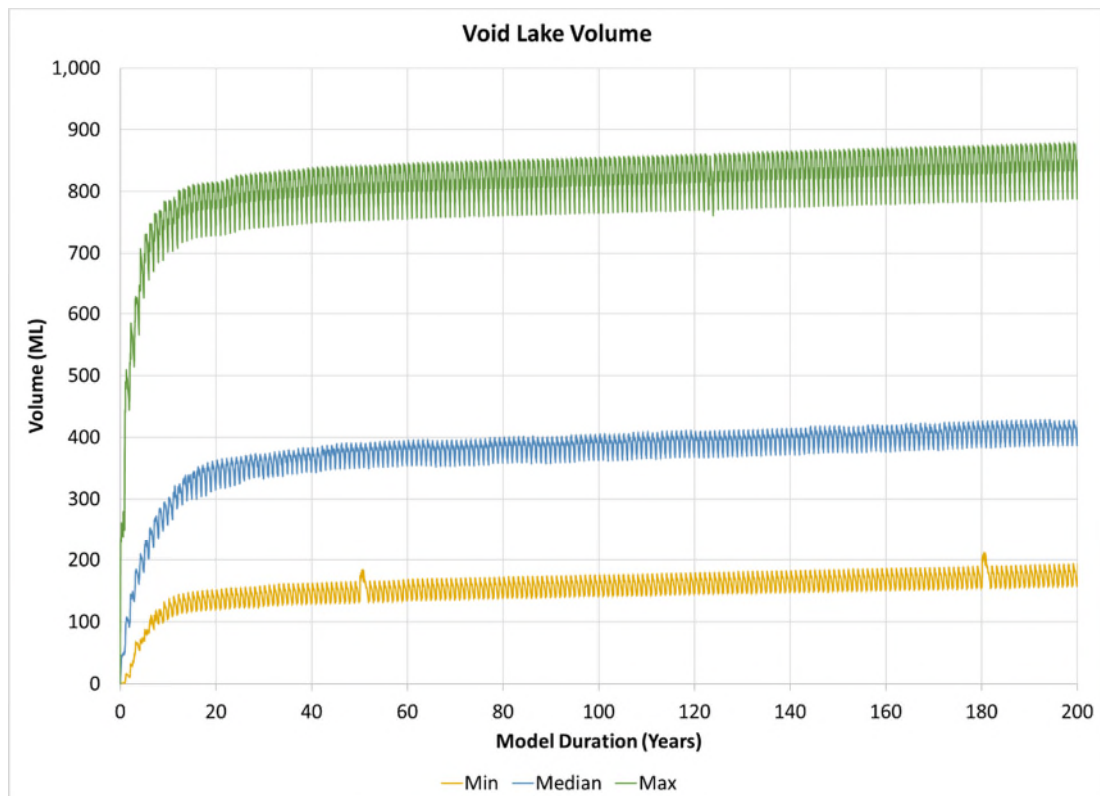
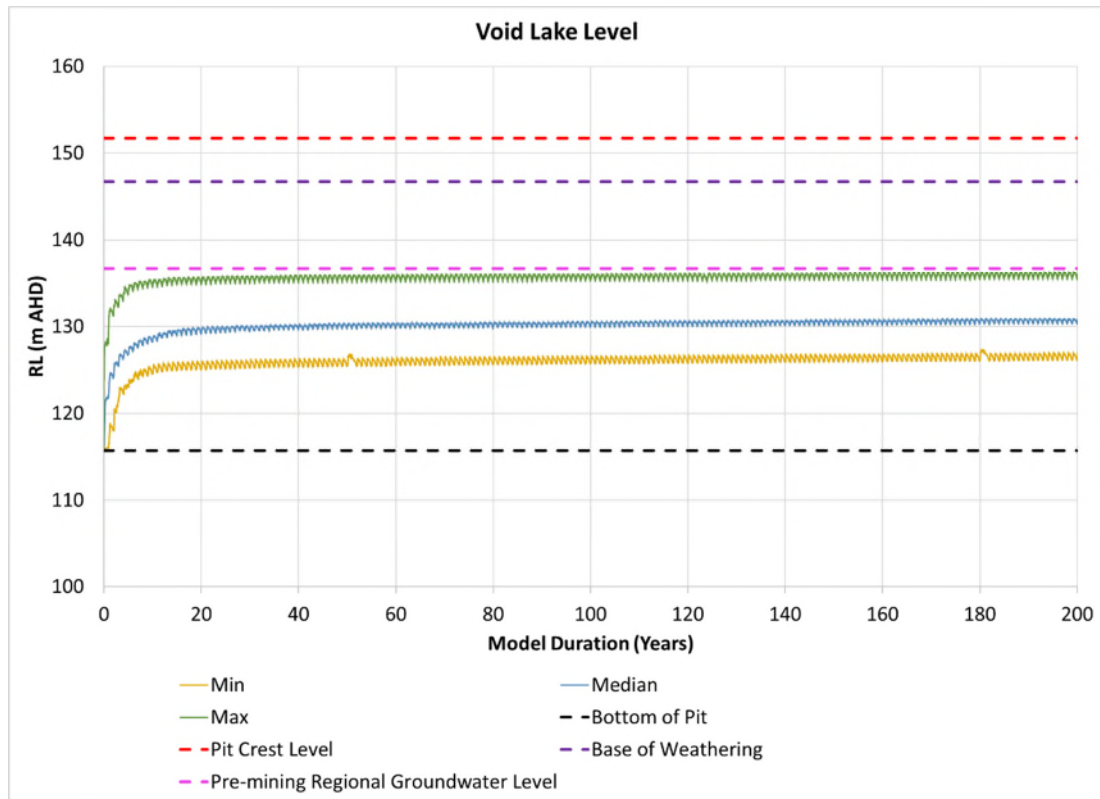


Figure 24 – Central 4 (Drake Pit 4 South) final void water volume and level (base case)

Drake 3Q Pit – Engeny (2020)

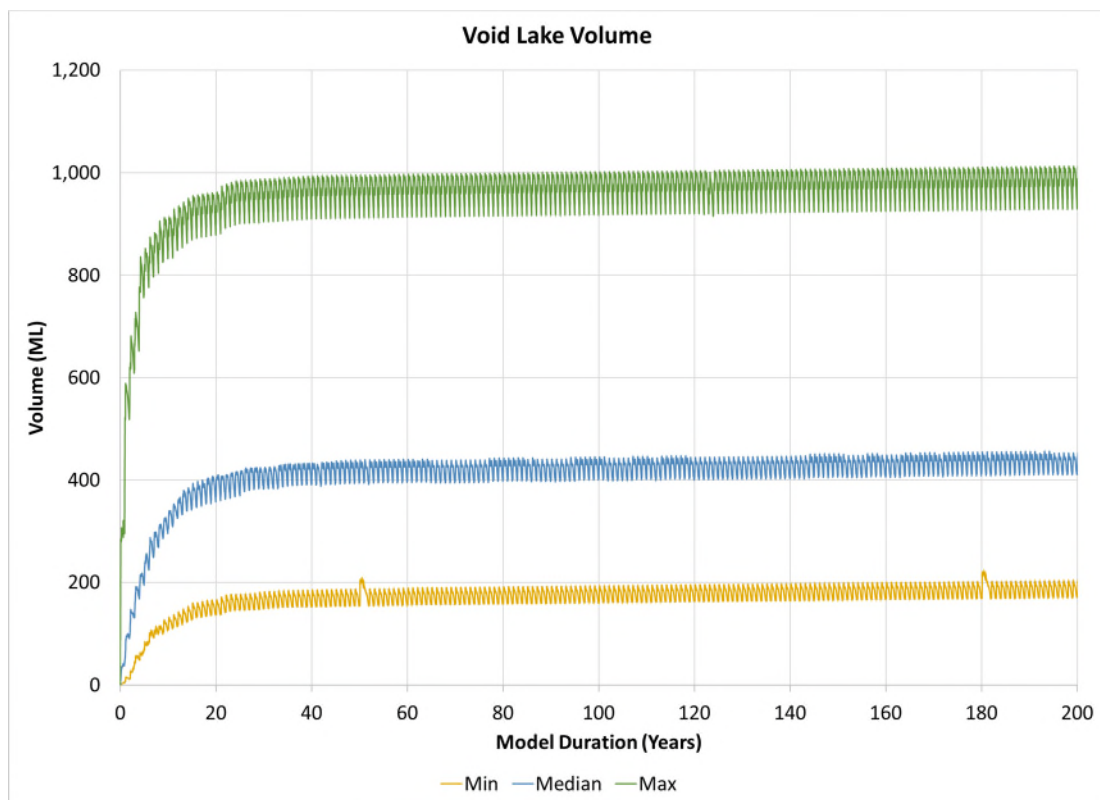
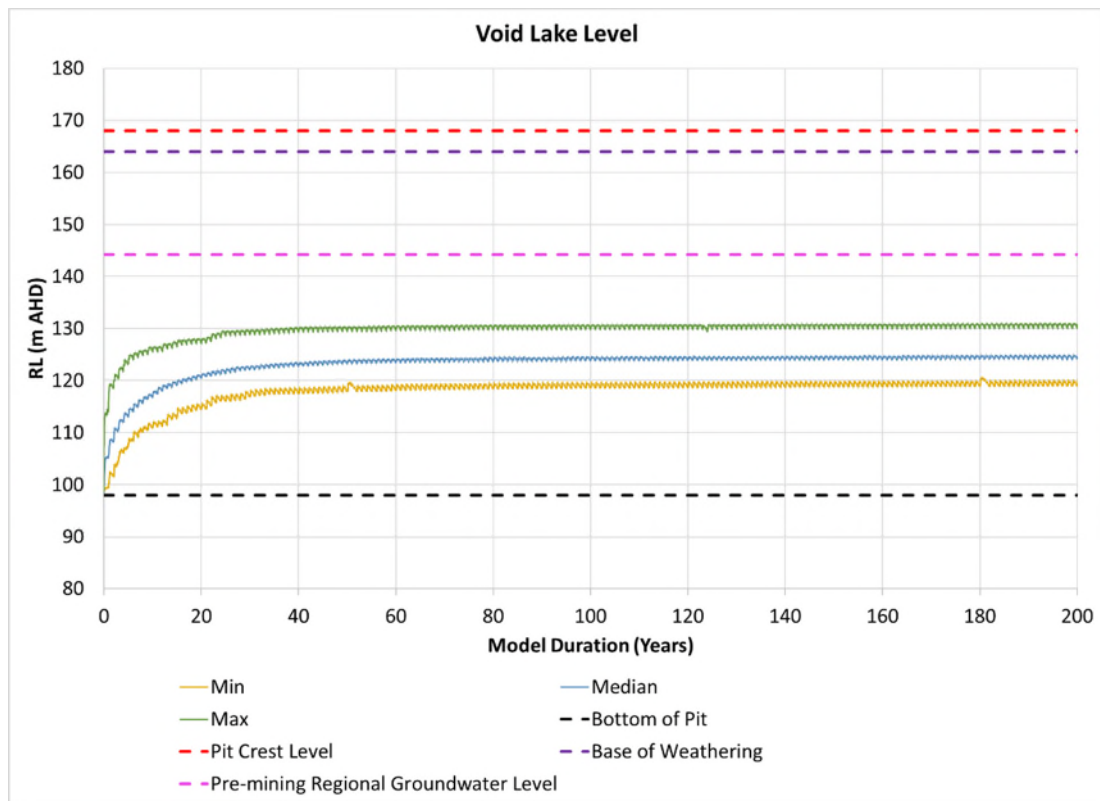


Figure 25 – Drake 3Q Pit final void water volume and level (base case)

Drake 3R Pit – Engeny (2020)

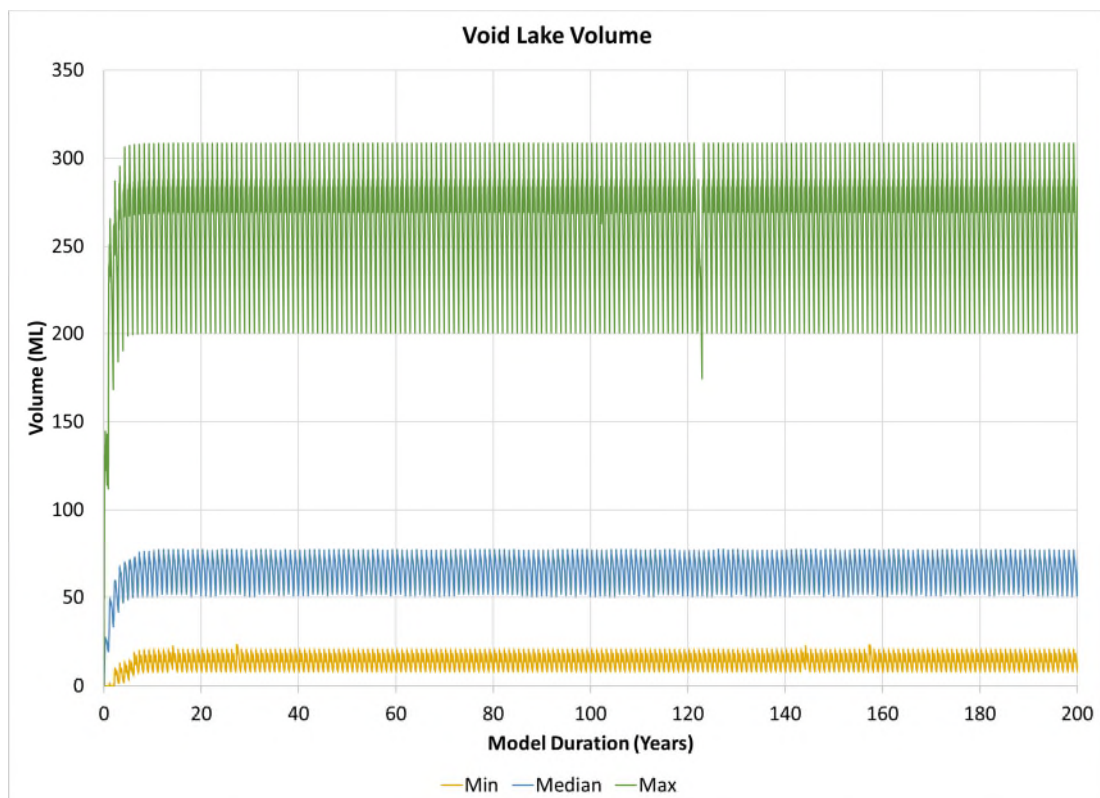
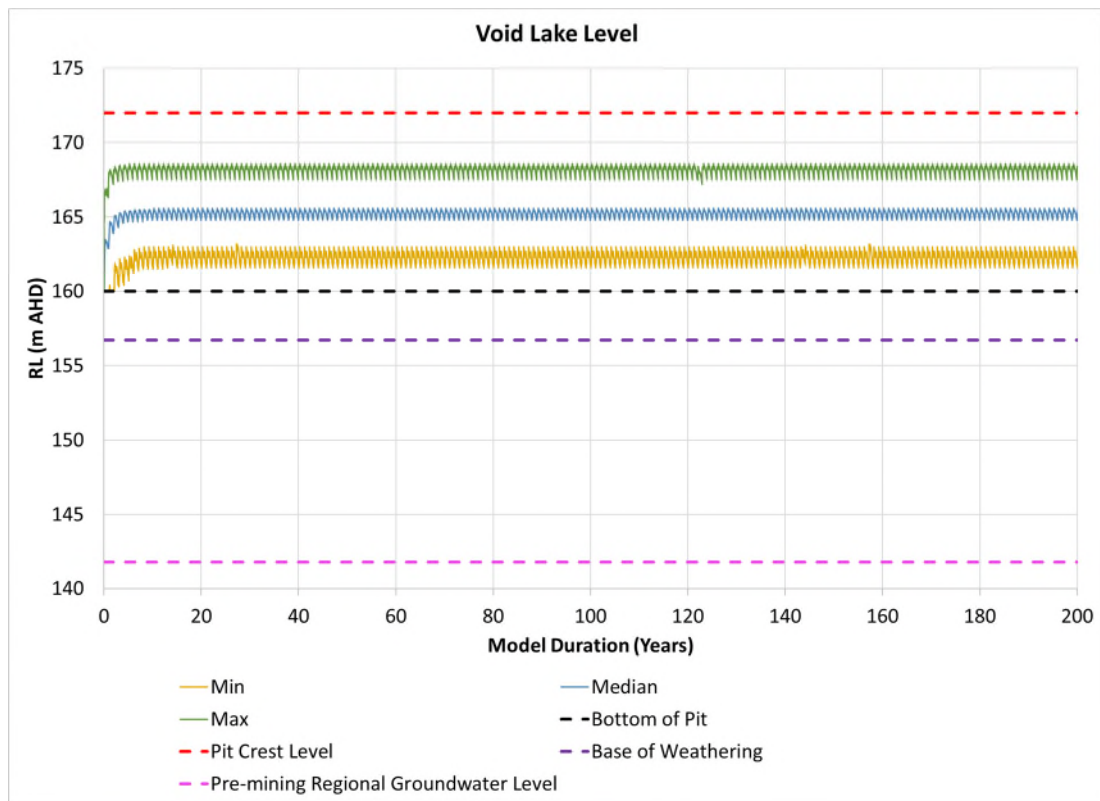


Figure 26 – Drake 3R Pit final void water volume and level (base case)

The time for the void lakes to reach their equilibrium levels varies based on the ratio of catchment area to void volume. The shortest filling time is seen to be Sonoma Main Pit (5 years) while the longest is Jax Main Pit (80 years). A summary of the results for level is provided for each final void (adapted from Engeny (2020)):

- Jax Main Pit – Using the catchment layout for the LOMP (the base case) the void lake equilibrium level (110 m AHD) and maximum void lake level (118 m AHD) are 30.8-30 m and 22.8-22 m below the pre-mining regional groundwater level (140.8-140 m AHD) respectively. Therefore, the residual void is forecast to act as a sink as per Engeny (2018).
 - o For comparison, a potential mitigated scenario was also modelled for a reduced catchment. The mitigated void lake equilibrium level (98 m AHD) and maximum void lake level (105 m AHD) are 42.8-42 m below and 35.8-35 m below the pre-mining regional groundwater level (140.8-140 m AHD) respectively.
- Jax East Pit – The void lake equilibrium level (104 m AHD) and maximum void lake level (112 m AHD) are 31.2-23.2 m and 36-28 m below the pre-mining regional groundwater level (135.2-140 m AHD) respectively. Therefore, the residual void is forecast to act as a sink. Therefore, the residual void is forecast to act as a sink as per Engeny (2018).
 - o For comparison, a potential mitigated scenario was also modelled for a reduced catchment. The mitigated void lake equilibrium level (103 m AHD) and maximum void lake level (110 m AHD) are 32.2-25.2 m below and 37-30 m below the pre-mining regional groundwater level (135.2-140 m AHD) respectively.
- Sonoma Main Pit - The void lake equilibrium level (130 m AHD) and maximum void lake level (134 m AHD) are 25.7 m and 21.7 m below the pre-mining regional groundwater level (155.67 m AHD) respectively. These outcomes are based on the design landform surface at year 20. It is expected the final co-disposal surface will be as much as 20m higher than this level. The conservative addition of a further 20 vertical metres of rejects material can be expected to result in an equilibrium level of 150 m AHD and a maximum level of 154 m AHD which remain below the regional groundwater level.
 - o As such, the Sonoma Main Pit is expected to act as a groundwater sink; however, as it will be subject to in-pit co-disposal of rejects, it will behave differently to the other voids modelled and further consideration is recommended in the detailed mine planning for this void based on the in-pit co-disposal plan.
 - o In addition, due the placement of rejects material within the void, the Sonoma Main Pit residual void geometry included a large predominantly flat surface. The void is forecast to behave as an evaporation pan and therefore periodically dries out to very minimal volumes.
- Sonoma East Pit 1 - The void lake equilibrium level (158 m AHD) and maximum void lake level (164 m AHD) are 1.7 m and 7.7 m above the pre-mining regional groundwater level (156.30 m AHD) respectively. The residual void is forecast to have ongoing net outflows to the local geology.
 - o The Sonoma East Pit 1 void lake level is forecast to result in a hydraulic gradient out of the void into the surrounding geology (a net outflow). However, as concluded during the numerical groundwater modelling (**Section 6.2**) any outflow from this void will be intercepted by the larger and

deeper voids. In the case of Sonoma Main Pit, Sonoma East Pit 1 and Sonoma East Pit, the numerical groundwater modelling concludes that groundwater in this complex of pits is fully contained with some amount of inter void movement, predicted to be minor considering the small differential in height of 1.7m.

- Sonoma East Pit 2 - The void lake equilibrium level (154 m AHD) and maximum void lake level (161 m AHD) are 1.5 m below and 5.5 m above the pre-mining regional groundwater level (155.53m AHD) respectively. The residual void is forecast to have ongoing net outflows to the local geology or regional groundwater.
 - o The Sonoma East Pit 2 void lake level is forecast to result in a hydraulic gradient out of the void into the surrounding geology (a net outflow). However, as concluded during the numerical groundwater modelling (**Section 6.2**) any outflow from this void will be intercepted by the larger and deeper voids. In the case of Sonoma Main Pit, Sonoma East Pit 1 and Sonoma East Pit, the numerical groundwater modelling concludes that groundwater in this complex of pits is fully contained with some amount of inter void movement, predicted to be minor considering the small differential in height of 1.5m.
- Drake Pit 5 - The void lake equilibrium level (111 m AHD) and maximum void lake level (119 m AHD) are 26.4 m and 18.4 m below the pre-mining regional groundwater level (137.42 m AHD) respectively. Therefore, the residual void is forecast to act as a sink.
- Drake Pit 1 - The void lake equilibrium level (126 m AHD) and maximum void lake level (134 m AHD) are 20.6 m and 12.6 m below the pre-mining regional groundwater level (146.57 m AHD) respectively. Therefore, the residual void is forecast to act as a sink.
- Drake Pit 2 - The void lake equilibrium level (139 m AHD) and maximum void lake level (145 m AHD) are 8.2 m and 2 m below the pre-mining regional groundwater level (147.23 m AHD) respectively. Therefore, the residual void is forecast to act as a sink.
- Drake Pit 2 Expansion - The void lake equilibrium level (124 m AHD) and maximum void lake level (131 m AHD) are 20.2 m and 13.2 m below the pre-mining regional groundwater level (144.24 m AHD) respectively. Therefore, the residual void is forecast to act as a sink.
- Central 3 (Drake Pit 4 North) – The LOMP is not optimised to consider catchment reduction or completed to a level of detail sufficient to consider specific drainage solutions. As such, a review of catchment reduction options was undertaken which resulted in reduced catchment reporting to the Central 3 (Drake 4 North) final void, which is referred to as the mitigated case and has been assumed as the preferred catchment layout for this void. The mitigated void lake equilibrium level (125 m AHD) and maximum void lake level (130 m AHD) are 14.5 m below and 9.5 m below the pre-mining regional groundwater level (139.50 m AHD) respectively. Therefore, based on the primary indicator of void lake and groundwater interaction, the mitigated residual void is forecast to act as a sink.
- Central 4 (Drake Pit 4 South) - The void lake equilibrium level (131 m AHD) and maximum void lake level (136 m AHD) are 5.7 m and 0.7 m below the pre-mining regional groundwater level (136.71 m AHD) respectively. Therefore, the residual void is forecast to act as a sink.

- Drake Pit 3Q - The void lake equilibrium level (150 m AHD) and maximum void lake level (157 m AHD) are 7.5 m and 14.5 m above the pre-mining regional groundwater level (142.55 m AHD) respectively. Therefore, the residual void is forecast to have ongoing net outflows to the local geology or regional groundwater.
 - o The Drake Pit 3Q void lake level is forecast to result in a hydraulic gradient out of the void into the surrounding geology (a net outflow). However, as concluded during the numerical groundwater modelling (**Section 6.2**) any outflow from this void will be intercepted by the larger and deeper voids (in the case of Drake 3Q primarily to Jax Main Pit which is a groundwater sink) and will not migrate away from the site.
- Drake Pit 3R - The void lake equilibrium level (165 m AHD) and maximum void lake level (169 m AHD) are 23.2 m and 27.2 m above the pre-mining regional groundwater level (141.78 m AHD) respectively. Therefore, the residual void is forecast to have ongoing net outflows to the local geology or regional groundwater
 - o The Drake Pit 3R void lake level is forecast to result in a hydraulic gradient out of the void into the surrounding geology (a net outflow). However, as concluded during the numerical groundwater modelling (**Section 6.2**) any outflow from this void will be intercepted by the larger and deeper voids (in the case of Drake 3R primarily to Jax Main Pit which is a groundwater sink) and will not migrate away from the site.

8.2 Final void lake quality

The final void lake water quality modelling (including sensitivity analysis) for the Jax Main Pit and Jax East Pit final voids, is described and plotted in detail in Engeny (2108) and the Engeny (2018) Supplementary Memo, provided as **Appendix A**.

The final void lake water quality modelling for all other QNH final voids is described and plotted in detail in Engeny (2020), provided as **Appendix B**.

Results extracted from the above are presented in **Figure 28-**

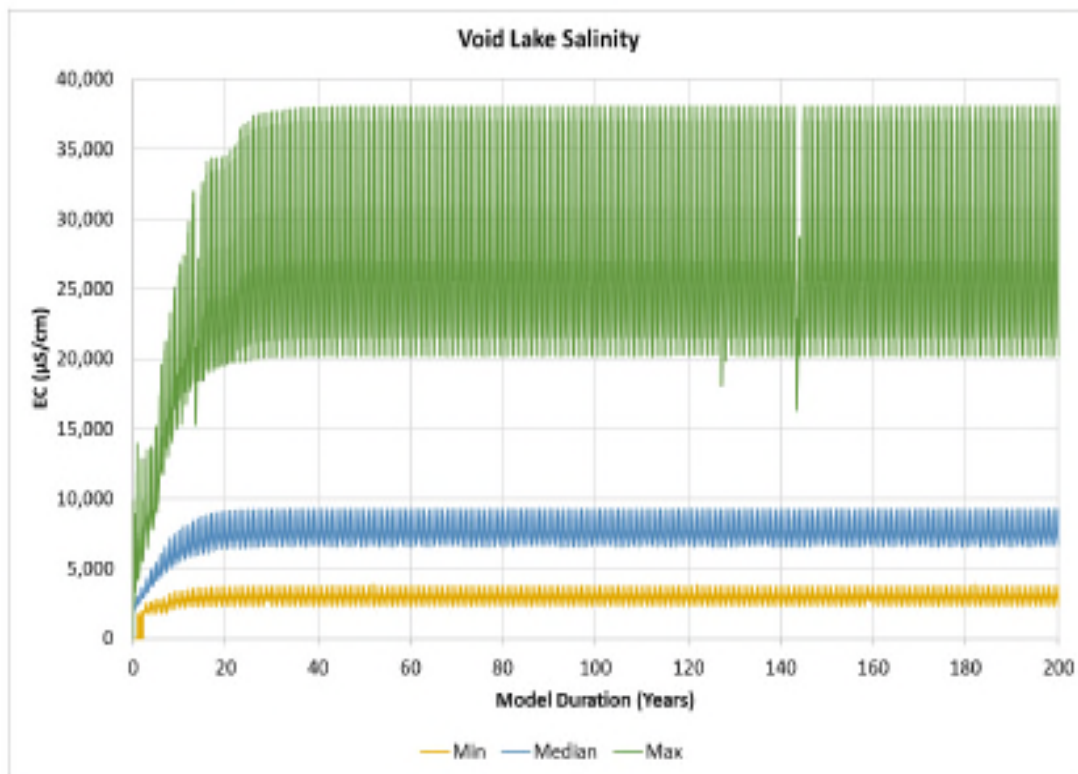


Figure 42, with the following key information presented:

- the simulation period:
 - o 500 years for Jax Main Pit and Jax East Pit (presented for the first 100 years and the full 500 year simulation separately for both final voids)
 - o 200 years for all other QNH final voids
- minimum, median and max levels and volumes are presented for each day of the simulation period for all final voids;
- the observable oscillations are the normal concentration and dilution cycles associated with normal seasonal and climactic variations;
- the median has been used to define the equilibrium levels in this assessment;
- all results reported in this assessment are from modelling of the “base case” which is the catchment extent provided by the LOMP, except for Central 3 (Drake Pit 4 North), where an opportunity to refine the catchment boundary was identified during the modelling (referred to as the mitigated case). For ease of interpretation only the Central Pit 3 (Drake Pit 4 North) mitigated case is included within the body of this assessment; however Engeny (2020) includes both the base and mitigated cases.

Engeny (2020) concludes that the salinity of all residual voids modelled as part of this assessment is forecast to continue to increase over time due to the ongoing concentration resulting from evaporation with no significant outflow of salts from either net outflow, seepage or overflow. **It should be noted that pits with net outflow (Section 8.1) were still shown to accumulate salts throughout the model duration.** The reason for this occurrence is that predicted net outflow rates into the surrounding geology at all levels of

rating curves for all pits (**Section 7.2**) were significantly smaller in magnitude than flows associated with rainfall, runoff, and evaporation.

The results indicate significant variation in the EC of the voids as a result of differing pit storage curves and catchment sizes. However, all void lakes are forecast to exceed 10,000 $\mu\text{S}/\text{cm}$ after 200 years (with the exception of Jax Main Pit which is closer to 220 years), with some pits reaching 10,000 $\mu\text{S}/\text{cm}$ after 40 years. The overall water quality outcome is consistent for all void lakes (i.e. high levels of salinity that continue to increase over time). Ultimately, salts will continue to concentrate with the maximum concentration only limited by the solubility of the constituent salts within the lake. This is conceptually the case for any comparable water body receiving inflow, which experiences evaporation as either the only outflow, or at a rate exceeding all other outflows. As such, the water quality in all QNH voids is predicted to ultimately be unsuitable for any use.

As a comparison, typical guidelines for livestock water quality are presented in **Figure 27**, (note the values are in mg/L for TDS).

Livestock	Total dissolved solids (mg/L)		
	No adverse effects on animals expected	Animals may have initial reluctance to drink or there may be some scouring, but stock should adapt without loss of production	Loss of production and a decline in animal condition and health would be expected. Stock may tolerate these levels for short periods if introduced gradually
Beef cattle	0–4000	4000–5000	5000–10 000
Dairy cattle	0–2500	2500–4000	4000–7000
Sheep	0–5000	5000–10 000	10 000–13 000 ^a
Horses	0–4000	4000–6000	6000–7000
Pigs	0–4000	4000–6000	6000–8000
Poultry	0–2000	2000–3000	3000–4000

a From ANZECC (1992), adapted to incorporate more recent information
b Sheep on lush green feed may tolerate up to 13 000 mg/L TDS without loss of condition or production

Figure 27 – Livestock water quality guidelines

Additionally, “*Draft Environmental Values and Water Quality Guidelines for Burdekin Basin and fresh estuarine waters*” (Department of Science, Information Technology and Innovation March 2017) identified a guideline EC for aquatic ecosystems in the Pelican Creek sub-catchment of 1,800 $\mu\text{S}/\text{cm}$.

The water quality forecast for the Sonoma Main Pit residual void exhibits characteristics not evident in other residual voids modelled at QNH in that modelled salinity at 200 years is an order of magnitude higher than any other modelled void. The proposed residual void for Sonoma Main Pit has a large, relatively flat surface produced by the co-disposal of tailings and rejects within the pit. Therefore, any ponding within Sonoma Main Pit is subject to very large evaporation surface areas. The modelled void behaviour is conceptually similar to an evaporation pan, or, as is naturally present in the QNH areas, an ephemeral creek with senescing pools that dry out in the dry season. In those situations, the void lake volume decreases during drying periods, and the remaining water becomes highly saline as the void does not have any mechanisms (net outflow to groundwater or spills) for salt mass reduction.

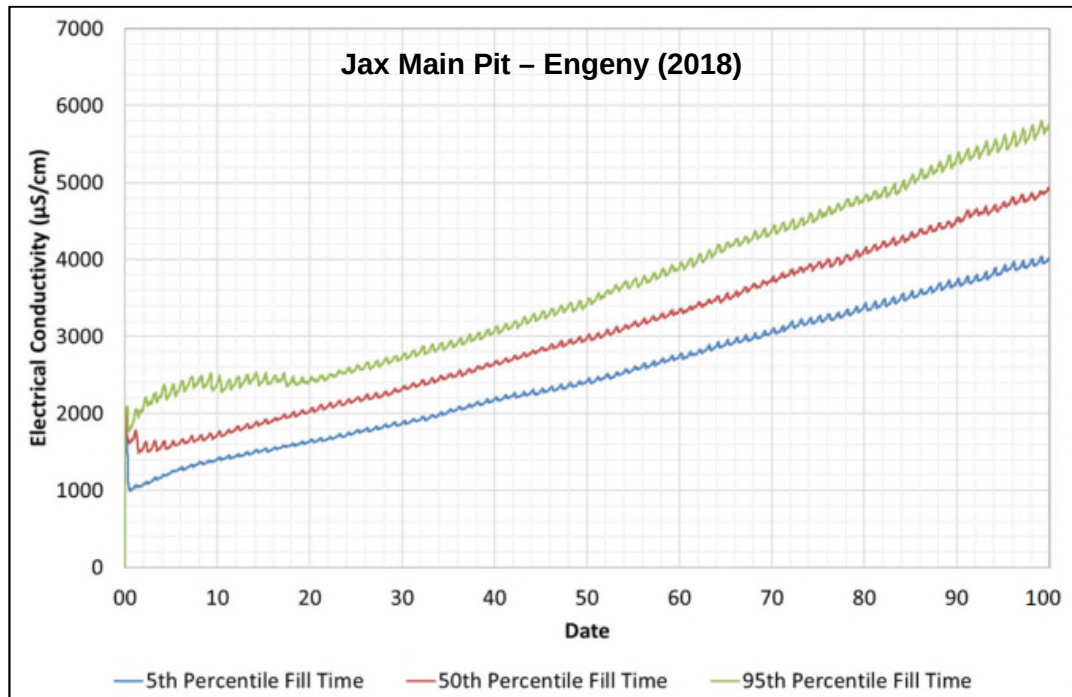


Figure 28 – Jax Main Pit final void lake EC modelling (base case)- 100 years

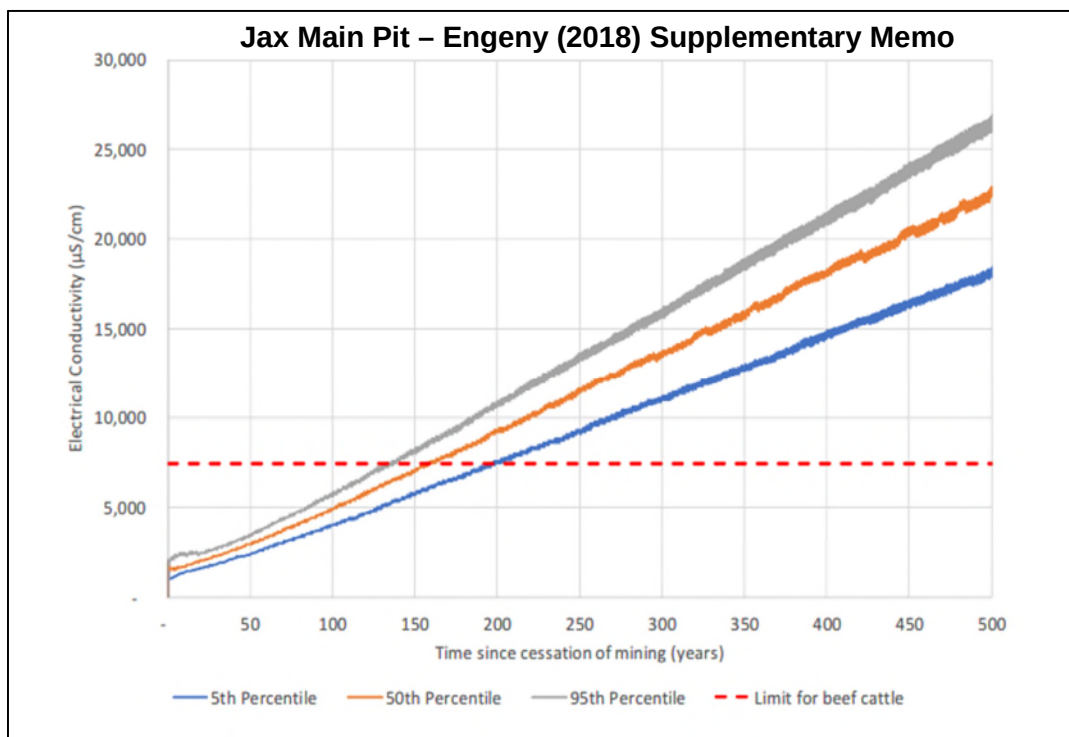


Figure 29 – Jax Main Pit final void lake EC modelling (base case) -500 years

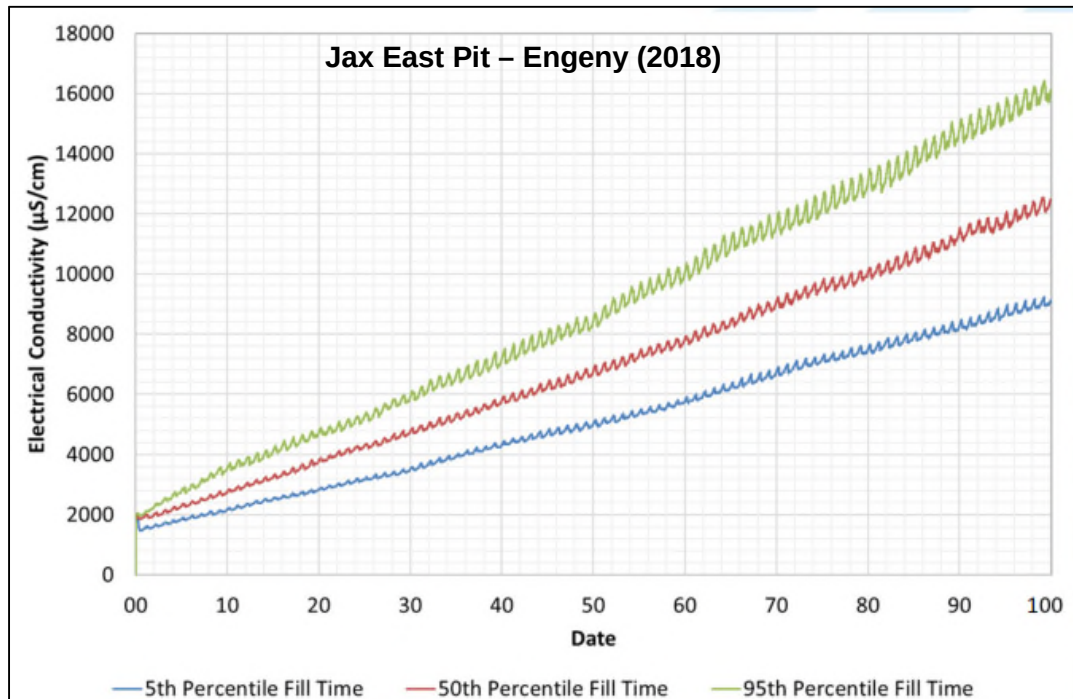


Figure 30 – Jax East Pit final void lake EC modelling (base case) – 100 years

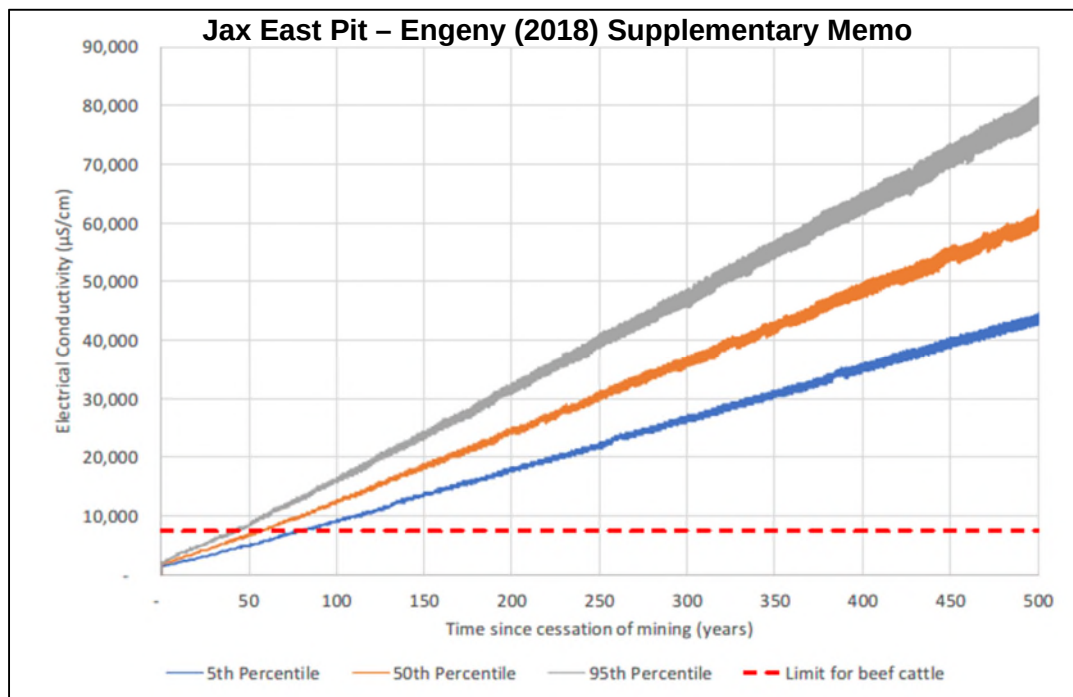


Figure 31 – Jax East Pit final void lake EC modelling (base case) – 500 years

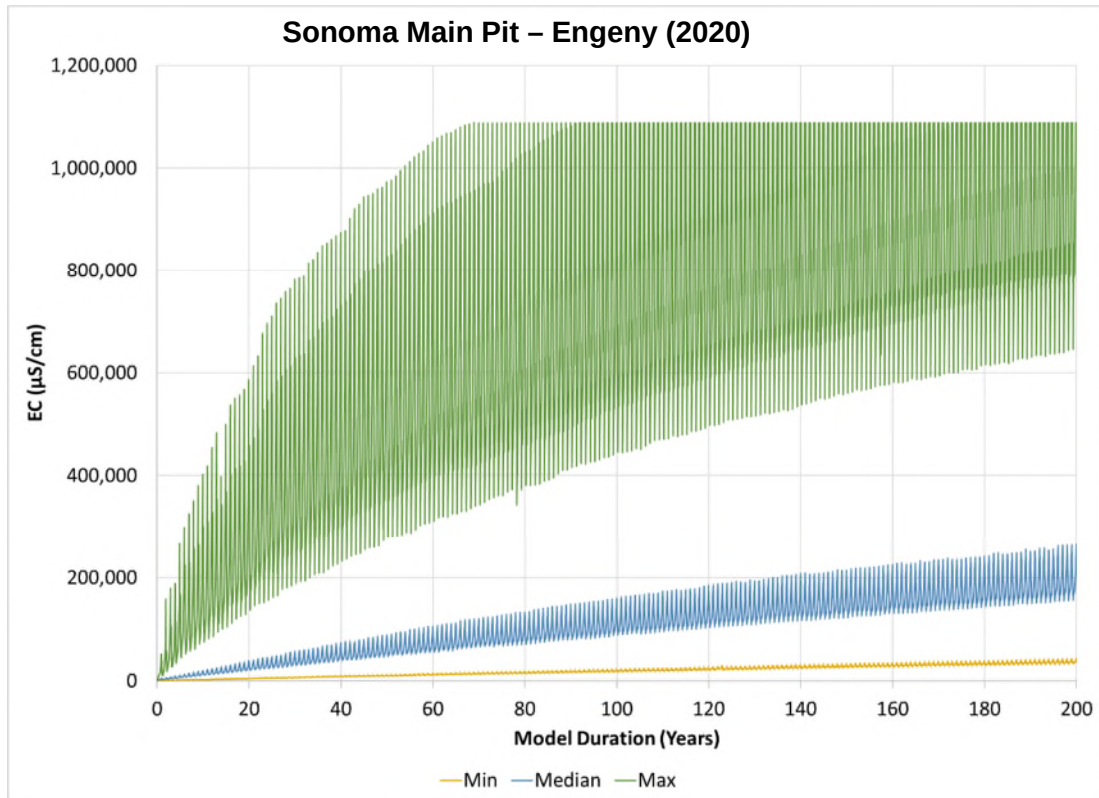


Figure 32 – Sonoma Main Pit final void lake EC modelling (base case)

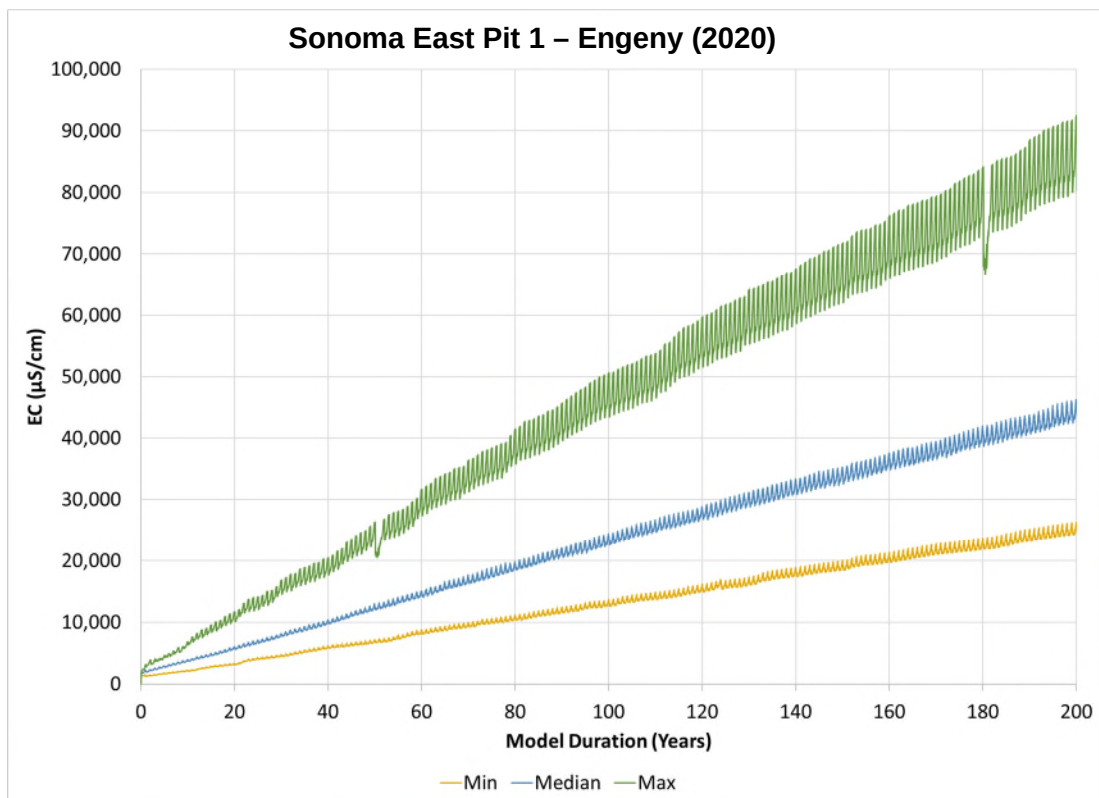


Figure 33 – Sonoma East Pit 1 Pit final void lake EC modelling (base case)

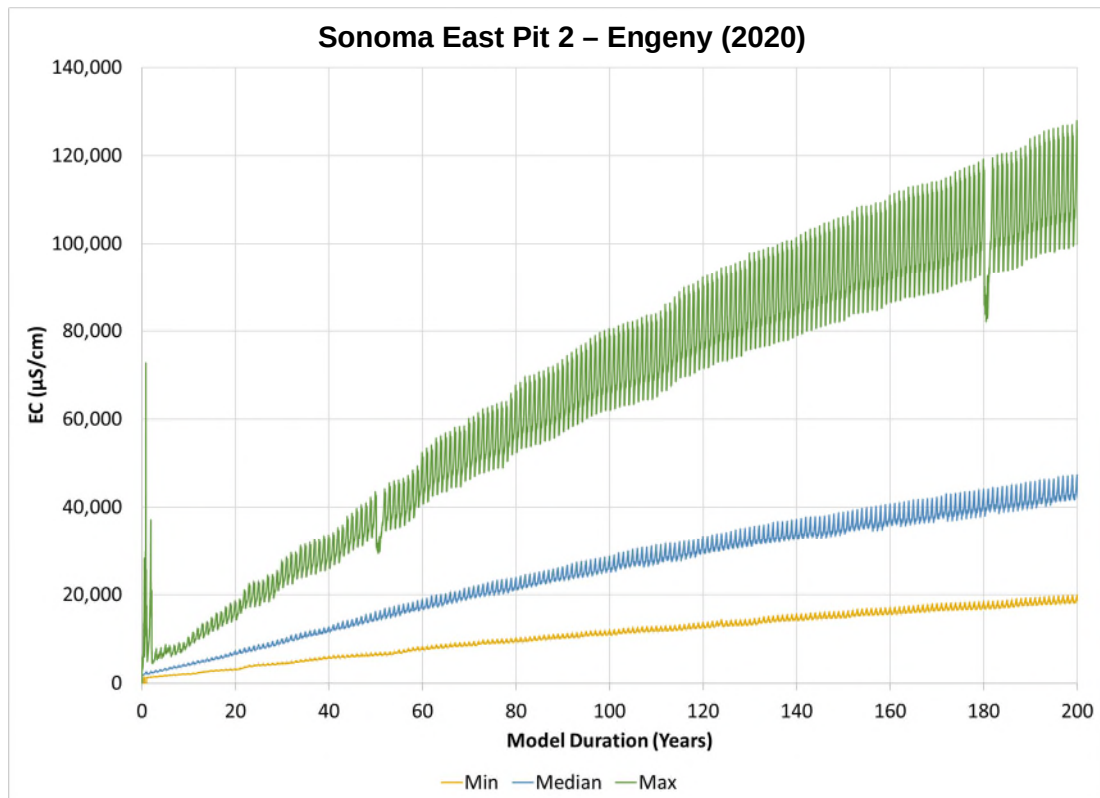


Figure 34 – Sonoma East Pit 2 final void lake EC modelling (base case)

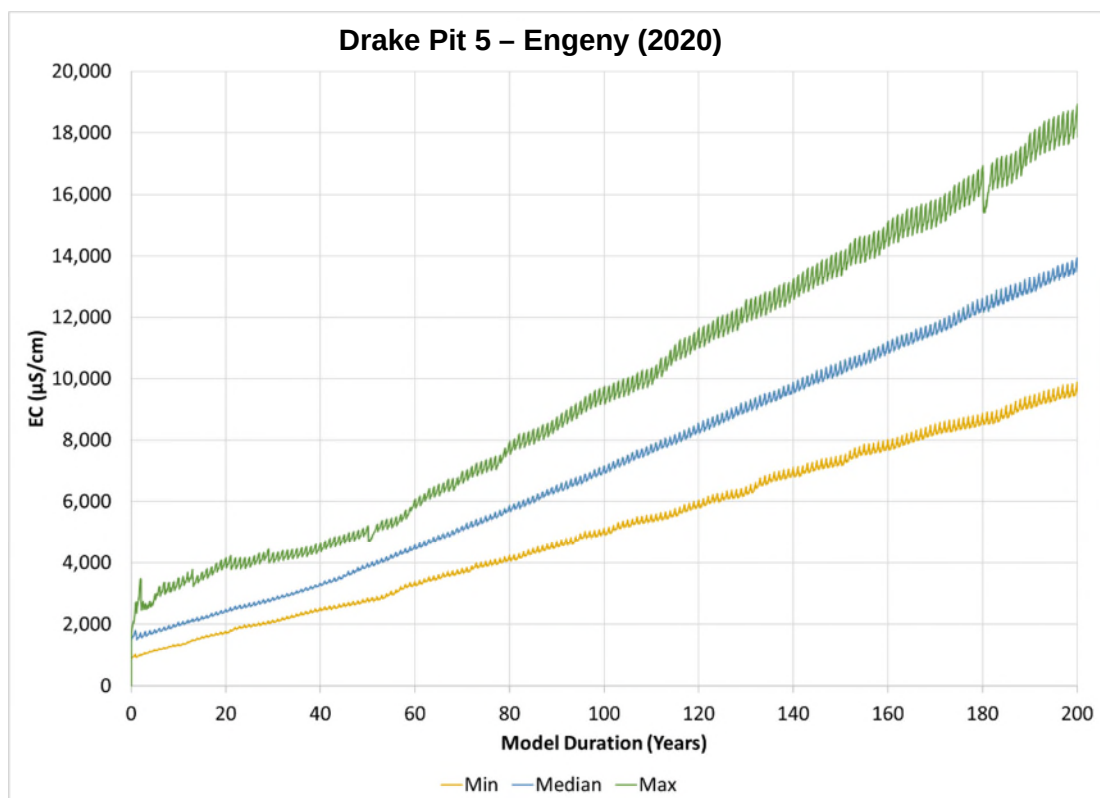


Figure 35 – Drake Pit 5 Pit final void lake EC modelling (base case)

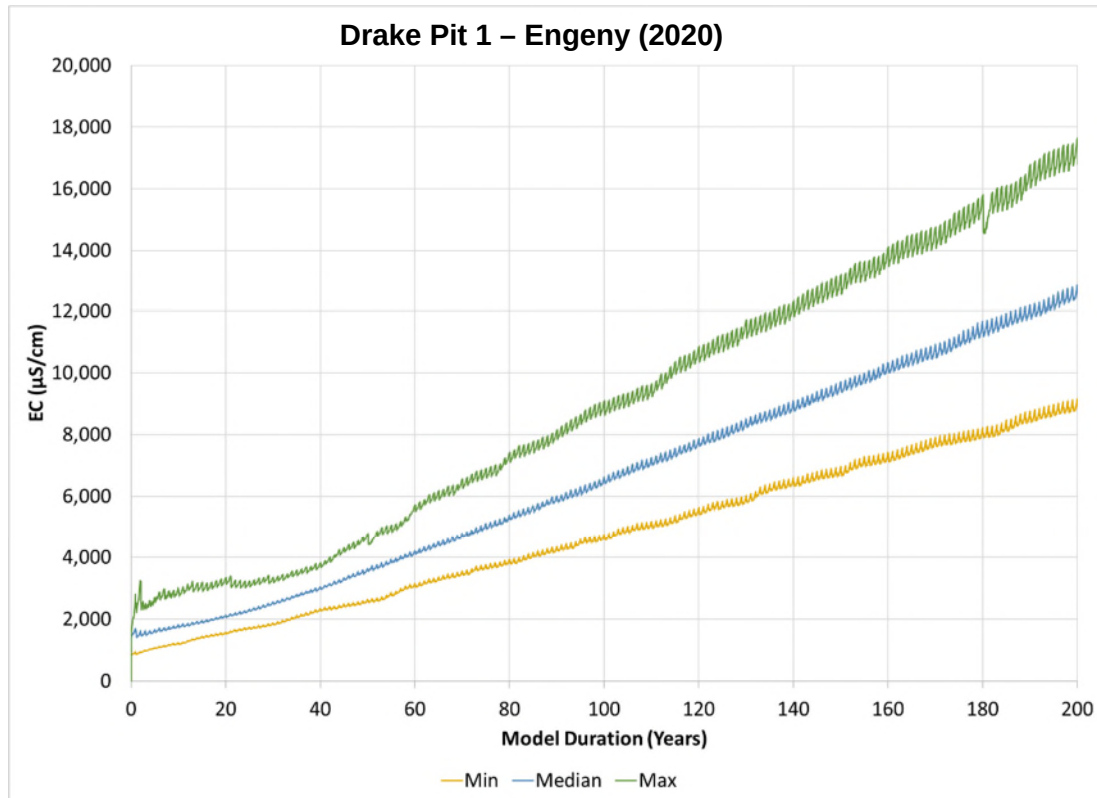


Figure 36 – Drake Pit 1 final void lake EC modelling (base case)

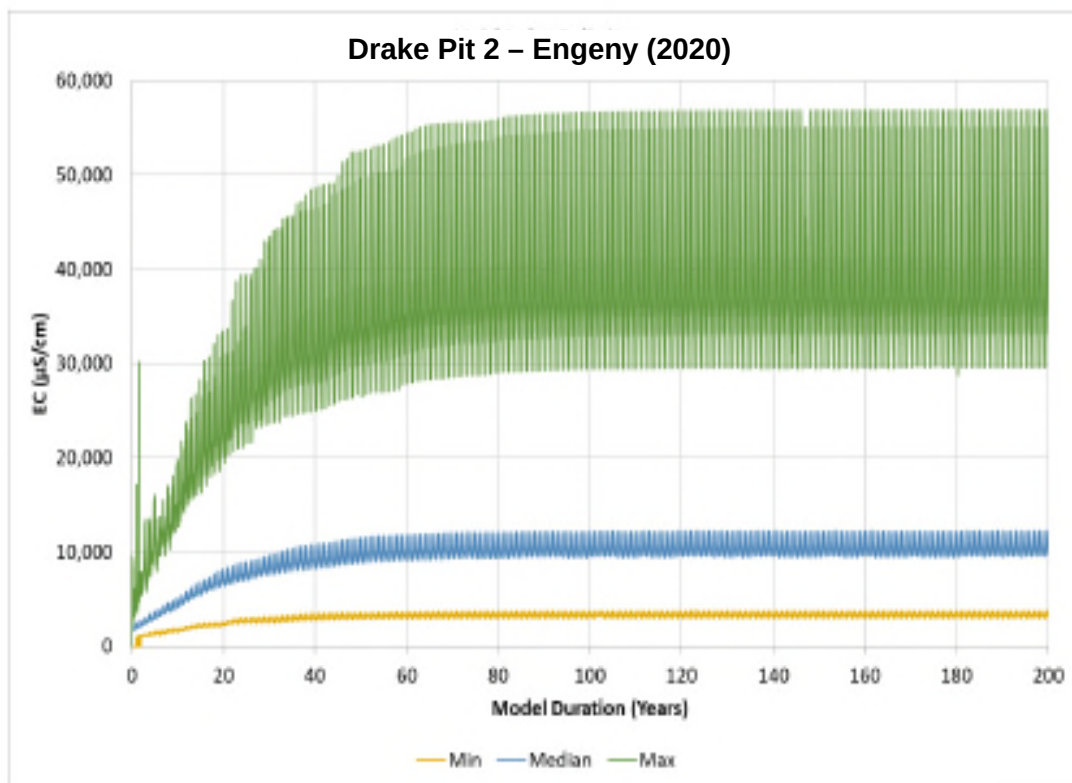


Figure 37 – Drake Pit 2 final void lake EC modelling (base case)

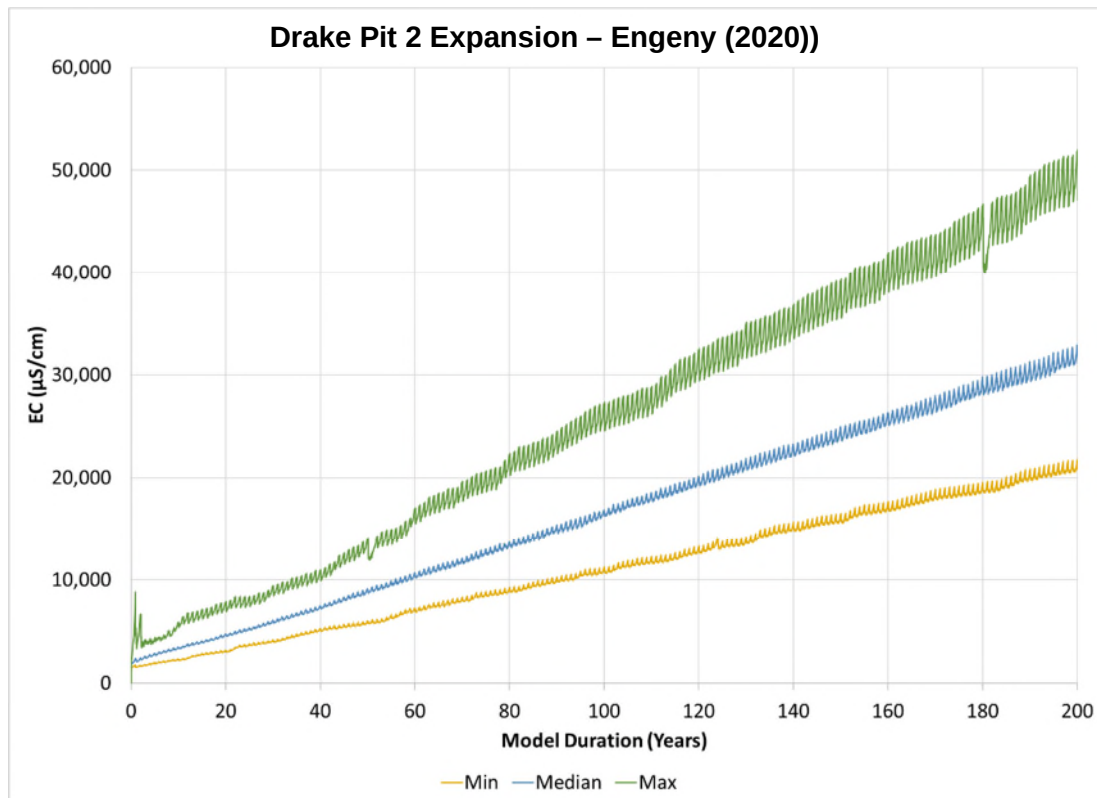


Figure 38 – Drake Pit 2 Expansion final void lake EC modelling (base case)

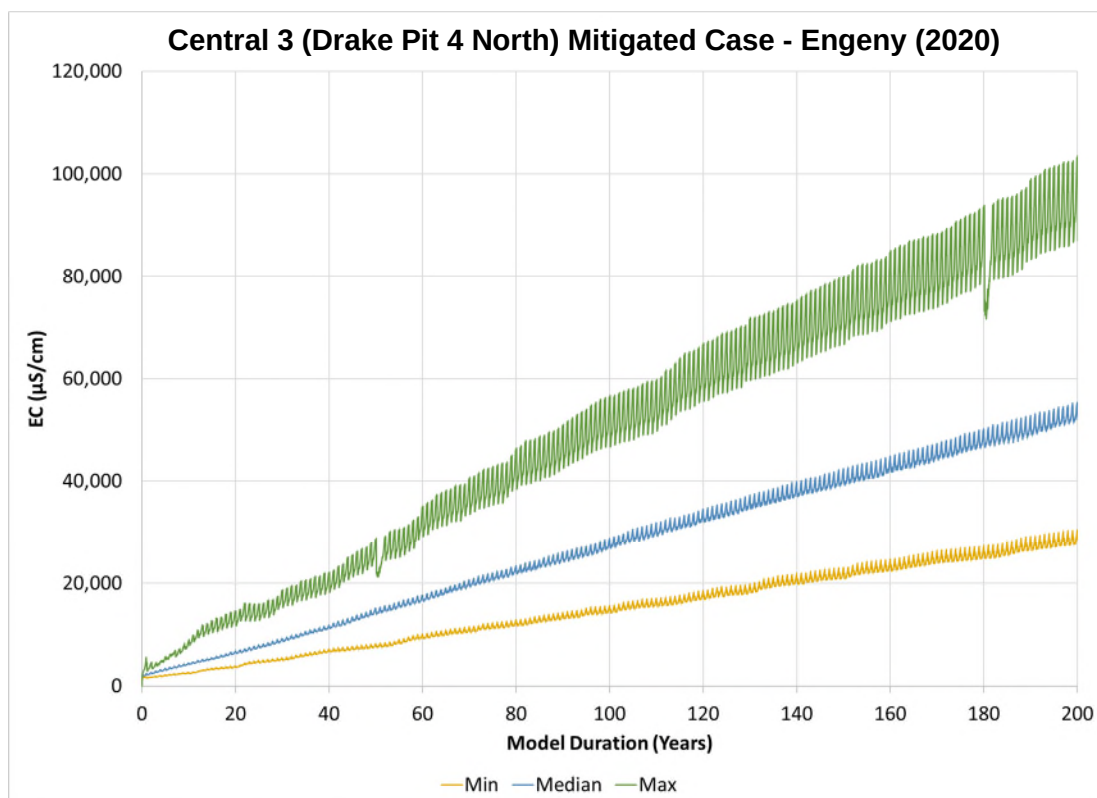


Figure 39 – Central 3 (Drake Pit 4 North) final void lake EC modelling (mitigated case)

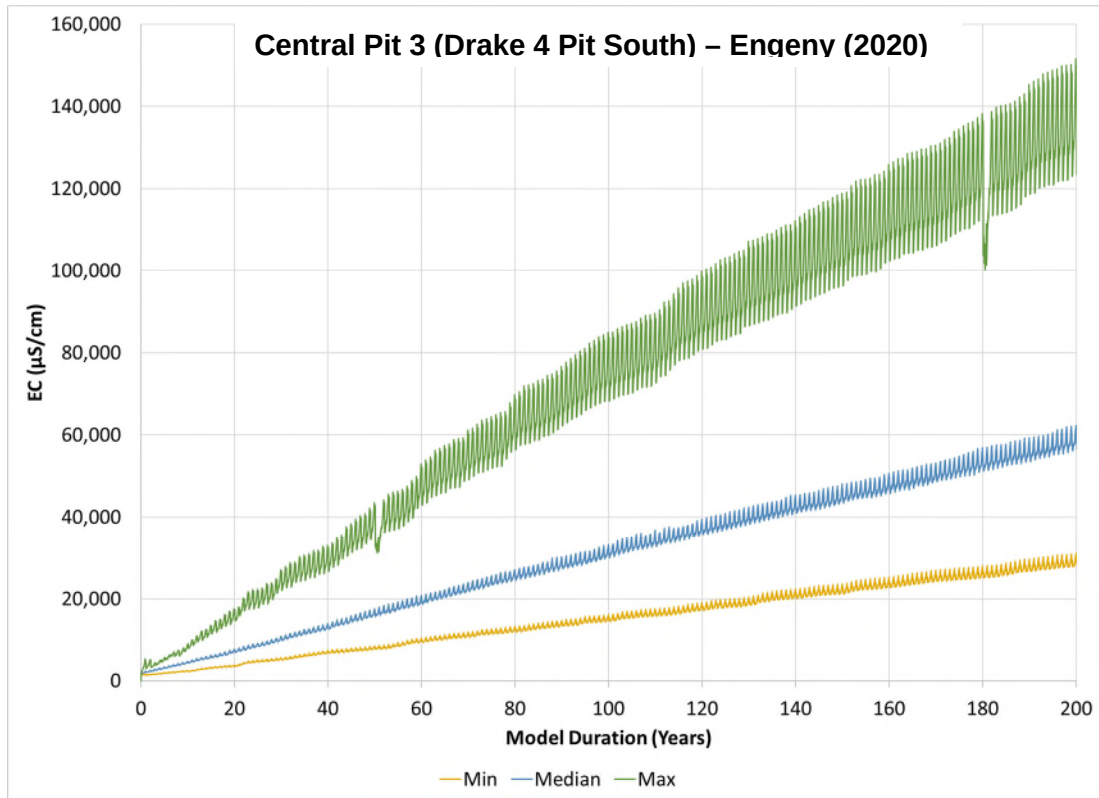


Figure 40 – Central 3 (Drake 4 Pit South) final void lake EC modelling (base case)

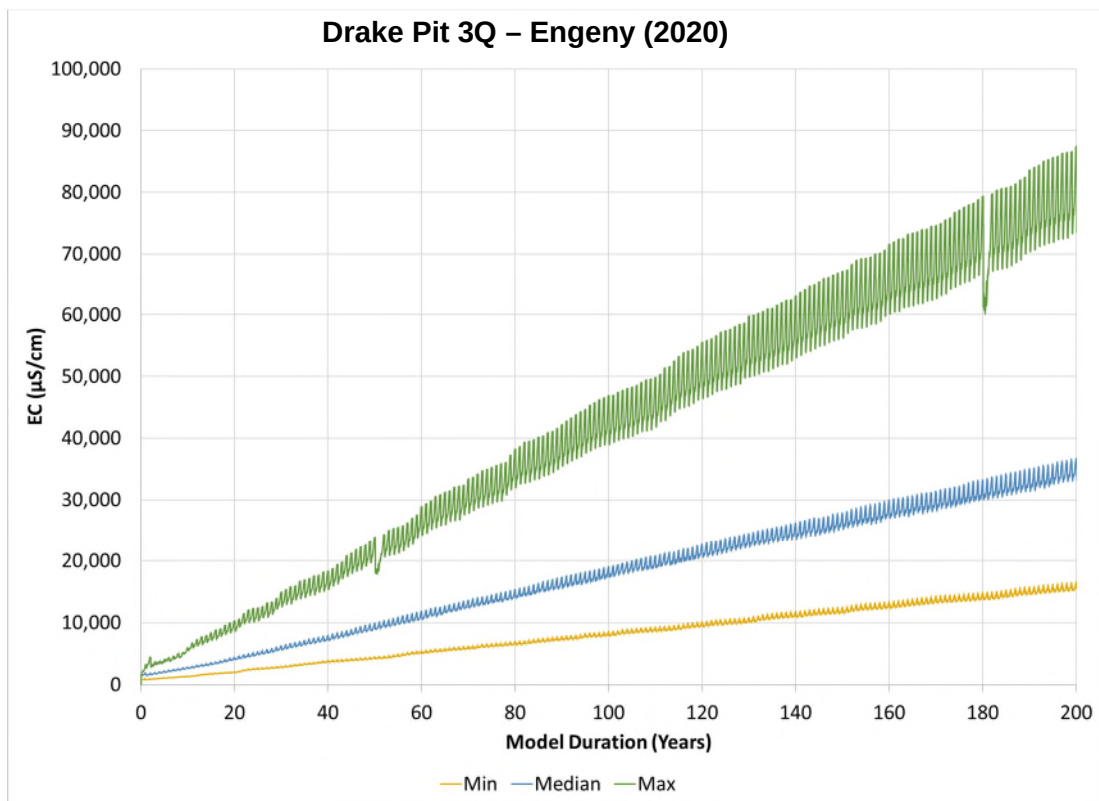


Figure 41 – Drake Pit 3Q final void lake EC modelling (base case)

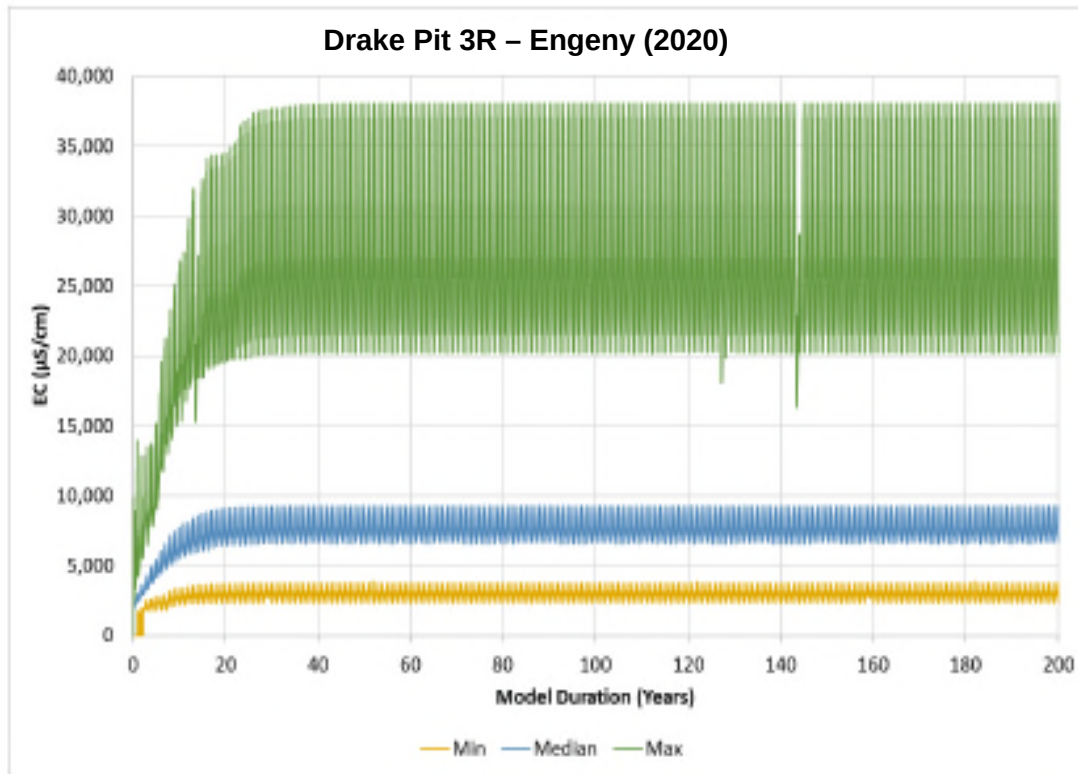


Figure 42 – Drake Pit 3R final void lake EC modelling (base case)

9 Rehabilitation

Since the commencement of operations in the QNH several rehabilitation plans have been implemented and subsequently superseded as the QNH has expanded and rehabilitation conditions within the various QNH EAs have been amended. This section should be read in conjunction with the QNH RMP. Land disturbed by mining and ancillary activities on the QNH is grouped into rehabilitation domains based on areas which require similar rehabilitation requirements and/or levels of environmental risks. Residual voids are referred to as Domain 1 in the QNH RMP. This investigation only considers the rehabilitation of final voids and therefore does not address any other rehabilitation domain.

9.1 Rehabilitation goals

Broad rehabilitation goals for the QNH are defined in **Condition H1** of the QNH EAs., which generally align with the rehabilitation goals summarised in the *Rehabilitation Requirements for Mining Projects* (EHP, 2014). The **Condition H1** rehabilitation goals in all QNH EAs are:

- Safe to humans and wildlife;
- Stable (referring specifically and only to geotechnical stability);
- Non-polluting; and
- Self-sustaining for the post-mining land use of grazing pasture, with the exception of residual voids.

This definition of “stable” for rehabilitated landforms is distinct from the from the definition of “stable condition” in the Environmental Protection Act 1994 (EP Act) Section 111A (applicable to mines under EAs). Section 111A of the EP Act defines a final landform as being in “stable condition” only if it meets all the following conditions:

- safe and structurally stable (i.e. geotechnical wall stability); and
- there is no environmental harm being caused by anything on or in the land; and
- the land can sustain a post-mining land use (i.e. self-sustain a specified use for the landform after rehabilitation).

As such, where a landform does not meet all three of the requirements under Section 111A of the EP Act, it is not considered to be in “stable condition” as per the EP Act definition.

Rehabilitation of final landforms, including voids on the QNH, is therefore undertaken to achieve one of two scenarios:

- rehabilitated to a “stable condition” as per Section 111A of EP Act; or
- rehabilitated to a condition which does not satisfy all the requirements to be considered in “stable condition” as per Section 111A of the EP Act (i.e. the final landform is unable to meet all of the criteria to be considered in “stable condition”):
 - o Section 112 of the EP Act defines such landforms as “non-use management areas” (NUMAs) – specifically defining a NUMA as an area of land the subject of a Progressive Rehabilitation and Closure plan (PRC Plan) that cannot be rehabilitated to a “stable condition” after all relevant activities for the PRCP carried out on the land have ended.
 - o until such time as the SCM, DCM and JCM transition into the PRC Plan framework, any final landforms which are determined not to be in “stable

condition” under Section 111A will be managed as NUMAs whilst not definitionally be referred to as NUMAs – once transitioned into the PRC Plan framework any such landforms will then also be definitionally referred to as NUMAs.

- o **it is noted that as per Condition H1 of the QNH EAs, all rehabilitated landforms (including those managed as NUMAs) must be safe, structurally stable and not cause any environmental harm – otherwise it is a non-compliance with the EA.** As such, where a final landform (including a void) is not considered to be in “stable condition” and is therefore managed as a NUMA, it is due only to the inability of the landform to sustain a post-mining land-use.

9.2 Void outcomes

As stated in **Section 8.2**, the water quality modelling results for final void lake water in all QNH final voids modelled as part of this assessment indicated that the water quality will continue to degrade over time, with solubility being the ultimate limiting factor. The reason for the degradation, as detailed in **Section 8.2**, is that:

- for the voids determined to be groundwater sinks in **Section 8.1**, (namely Jax Main Pit, Jax East Pit, Sonoma Main Pit, Drake Pit 5, Drake Pit 1, Drake Pit 2, Drake Pit 2 Expansion, Central Pit 3 (Drake Pit 4 North), Central Pit 4 (Drake Pit 4 South)), evaporation is the only water loss, and, as such, evaporative concentration of salts from the various inflows occurs over time; and
- for the voids determined to have a mathematical net outflow (**Section 8.1**) into an adjacent final void (**Section 6.2**) in (namely Sonoma East Pit 1, Sonoma East Pit 2, Drake Pit 3-Q and Drake Pit 3-R), the rate of net outflow into the QNH cone of depression was notably less than the evaporation rate and as such evaporative concentration of salts from the various inflows occurs over time.

As further stated in **Section 8.2**, due the degradation of quality over time, resulting from the net evaporative climate of the region, the water quality in all QNH voids will become unsuitable for any human use, agricultural or livestock use, as drinking water or designated habitat for native fauna. The time it takes for quality to reach the levels where it is unsuitable (which differ depending on the acceptable limits for each use) varies between pits; however, in all pits the quality is modelled to continue to degrade beyond acceptable limits for all potential uses identified.

In consideration of those results, it is concluded that none of the QNH final voids can self-sustain a designated post-mining land use, as all potential uses are contingent on having an acceptable level of quality for that use, none of which can be met over time.

As discussed in **Section 9.1**, where a final void is demonstrably unable to sustain a post-mining land use, it does not satisfy the requirement to be considered in “stable condition” under the definition of Section 111A of the EP Act. Accordingly, the QNH final voids modelled in this assessment are recommended to have a void outcome of “residual void unable to sustain a post mining land use”.

The Jax Main Pit and Jax East Pit voids already have this void outcome conditioned in the JCM EA, which is consistent with the findings of this assessment and the findings of “*Investigation into Residual Void Jax Coal Mine – QCoal October 2018*” (submitted to DES 12 October 2018), which included the technical study “*Jax Coal Mine Final Void Hydrology Study Main Pit – Engeny Water Management 2018*” (Engeny 2018).

It is also noted that these findings are consistent with the void outcomes previously identified for Sonoma Main Pit in *“Investigation into Residual Void Sonoma Coal Mine – QCoal January 2016”* (submitted to DES 29 January 2016), which included the technical study *“Sonoma Coal Mine Final Void Hydrology Study Main Pit – Engeny Water Management 2015”* (Engeny 2015a).

As also stated in **Section 8.1**, final voids with an outcome of “unable to self-sustain a post mining land use”, are required to be rehabilitated to be safe and geotechnically stable condition, and to not cause environmental harm as per conditions of the QNH EAs.

9.3 Safe and structurally stable

9.3.1 Slope designs

As stated in **Section 3**, the QNH comprises a consistent contiguous geology, soils profile and hydrogeology across the four mines. Geotechnical understanding of the QNH pit high-walls and low-walls is based on geotechnical studies undertaken for the SCM (being the first of the QNH mines). The SCM slope designs were derived from the geotechnical study *“QCoal Sonoma Project Initial Geotechnical Assessment”* undertaken by Sherwood Geotechnical and Research Services (Simmons 2006). Simmons (2006) provided the following summary (detailed therein) for the slope design:

- Alluvium: 37° overall
- Weathered coal measures rock: 45° overall
- Fresh coal measures rock: 70° overall separated by benches to suit drilling and high wall ramp/road requirements
- Benching: a minimum 10m bench at the base of alluvium or weathered coal measures (i.e. top of "hard" digging)
- Excavated faces in-pit spoil: 37° overall, 45° to max height of 15m above floor
- Dumped spoil (alluvium and coal measures): rill angle 37°, max. height of rill slope 30m normally, separated by benches to suit operational requirements
- Ex-pit dump toe setback to pit crest: not less than 20m under any conditions until in-pit spoil dump has been developed.

The above slope design targets were further investigated by consultant GHD in *“Sonoma Mine Management Residual Void Outcome of Sonoma Mine July 2010”* (GHD 2010), which provided acceptance criteria for slope rehabilitation to meet the recommended design.

The slope requirements for final voids are conditioned in the QNH EAs, as discussed in **Section 5.2**, and are presented again in **Table 8**.

The QNH EAs conditions for slopes on the low and high-walls in voids are informed by the aforementioned geotechnical assessments.

Table 8 – QNH EA void slope criteria

Site	QNH Operational Complex	Void Name	Approved High Wall Slope	Approved Low Wall Slope
Jax	Jax	Jax Main Pit	High wall – 60°	Low wall – 32°
		Jax East Pit		
Sonoma	Sonoma	Sonoma Main Pit	High wall – Maximum slope of 70° with the top 10m having a maximum of 45° including a 1m bund	Low wall – 17°-37°
		Sonoma East Pit 1		
		Sonoma East Pit 2		
Drake	Drake 5	Drake Pit 5	High wall – 65°	Low wall – 45°
	Drake 1-2	Drake Pit 1		
		Drake Pit 2		
		Drake Pit 2 Expansion		
		East Pit 1		
	Drake 3-4	Central Pit 3 (Drake Pit 4 North)		
		Central Pit 4 (Drake Pit 4 South)		
		Drake Pit 3-Q		
		Drake Pit 3-R		

Further to the above, quarterly geotechnical inspections across the QNH operational pits have been undertaken by GeoTek Solutions (GeoTek) under the supervision of an RPEQ, with reports submitted after each inspection. The objective of those inspections and reports is to monitor, assess and provide ongoing operational recommendations on the geotechnical stability of the major landforms across the QNH, including slopes, drainage, loose materials etc. Inspections provide actual geotechnical observations of active pits in the same material which will comprise final void walls and which are therefore directly applicable to likely final void conditions. A list of the RPEQ geotechnical quarterly inspection reports for the last five years are listed as follows:

- Geotechnical Inspection of QCNH, 21-22 Apr 2015 (GeoTek Solutions 26/4/15);
- Geotechnical Inspection of QCNH, 23-24 Aug 2015 (GeoTek Solutions 29/4/15);
- Geotechnical Inspection of QCNH, 10-13 Nov 2015 (GeoTek Solutions 21/11/15);
- Geotechnical Inspection of QCNH, 15-17 Feb 2016 (GeoTek Solutions 28/2/16);
- Geotechnical Inspection of QCNH, 8-10 Nov 2016 (GeoTek Solutions 3/12/16);
- Geotechnical Inspection of QCNH, 13-15 Feb 2017 (GeoTek Solutions 16/2/17);
- Geotechnical Inspection of QCNH, 22-24 May 2017 (GeoTek Solutions 26/6/17);
- Geotechnical Inspection of QCNH, 14-16 Aug 2017 (GeoTek Solutions 20/8/17);
- Geotechnical Inspection of QCNH, 13-14 Nov 2017 (GeoTek Solutions 4/12/17);
- Geotechnical Inspection of QCNH, 2-3 Mar 2018 (GeoTek Solutions 9/3/18); and
- Geotechnical Inspection of QCNH, 8-9 Aug 2018 (GeoTek Solutions 27/8/18).
- Geotechnical Inspection of QCNH, 30 Nov-1 Dec 2018 (GeoTek Solutions 22/12/18);
- Geotechnical Inspection of QCNH, 5-6 Apr 2019 (GeoTek Solutions 11/6/19);
- Geotechnical Inspection of QCNH, 3-4 Oct 2019 (GeoTek Solutions 28/11/19); and
- Geotechnical Inspection of QCNH, 10-11 Jan 2020 (GeoTek Solutions 23/3/2020).

These inspections directly inform the geotechnical condition of walls in all pits, refer to original design slopes recommended in Simmons (2006), and inform ongoing and regular assessment of the suitability of final void approved design slopes.

As such, and in addition to regular geotechnical inspections, GeoTek Solutions has periodically undertaken assessment of, and made specific recommendations relating to, the wall design slopes across the QNH. These periodic assessments are undertaken as pits develop and walls become exposed and available for actual geotechnical observation. For example, the report “Compilation of Current Pit Slope Design Recommendations Ver 5 30/08/16” (GeoTeck Solutions 30/8/16). was undertaken on pit slope designs for all QNH pits and determined that no notable changes were required to the existing approved design slopes.

Subsequent and future inspections may make recommendations based on updated and new observations. If such recommendations make suggestions that a revision to the approved EA final void design slopes for a specific EA is required (i.e. the maximum slope is recommended to be reduced), then EA amendments would be made accordingly.

QNH final void detailed designs will be subject to RPEQ review.

9.3.2 Erosion and weathering

This section addresses the potential erosion and weathering of the void walls. Specific geochemical studies completed for the SCM are directly applicable to the broader QNH (as per **Section 3**), and it is noted that the JCM ML was approved by the Queensland Government, relying on SCM waste rock investigations being directly applicable to the JCM. Key geochemical studies are listed below:

- “*Sonoma Coal Project – Overburden assessment report May 2006*”, (Parsons Brinkerhoff 2006).
- “*Geochemical Assessment of Mining Waste and Coal Reject Materials Sonoma Coal Mine – Dec 2012*” (Terrenus 2012)
- “*Mining waste and coal reject management plan Ver 1: Jan 2013*” (Terrenus 2013)

Parsons Brinkerhoff (2006) described the tertiary/quaternary material in the SCM and CCM areas, making a determination that the materials were consistent from the SCM into the CCM, indicating continuity of the soils and geology from north to south (as per **Section 3**). Parsons Brinkerhoff (2006) made the following comments on tertiary/quaternary material:

- slightly alkaline (pH 7.8 – 8.6);
- low to moderate salinity/EC (EC 200 – 700 ms/cm);
- ESP <15% (<5% is non-dispersive);
- Emerson class results of 4-6 (5-6 is considered non-dispersive);
- dispersivity index 2-6% (<30% is non-dispersive); and
- suitable for capping.

Terrenus (2012) and (2013) provide geochemical comment for the SCM factoring in operational pit data and pit wall observations. Of note are the findings relating to dispersion of the wall material (reported as overburden and interburden). Soil dispersion is the loss of cohesion and the breaking down of soil structures into soil particles, making spoils susceptible to erosion or loss of geotechnical competence.

The following relevant conclusions have been extracted from Terrenus (2012) and (2013) regarding the potential for erosion of the overburden and interburden of the SCM as applicable to the QNH:

- Terrenus (2013) stated that Permian spoil is generally moderately sodic, however it is not expected to be significantly dispersive or prone to significant soil erosion. Alluvial spoil was noted as generally having lower sodicity.
- Terrenus (2012) stated that weathered and un-weathered Permian overburden and interburden is expected to be moderately sodic, but is not expected to be dispersive or prone to significant soil erosion, based on:
 - in-pit and drill core spoil samples of weathered and unweathered Permian overburden and interburden;
 - exchangeable sodium percentage (ESP) tests which are an indirect measure of the potential for dispersion - ESP results indicated moderate sodicity with no notable difference between weathered and unweathered overburden; and
 - Emerson Class tests which are a direct measure of soil dispersion - Emerson Class results (class No. 8 on a scale of 1-8 for all samples tested) indicated that the overburden and interburden soils are non-slaking, non-swelling and non-dispersive.

Therefore, pit walls on the QNH, which comprise an upper layer of surficial tertiary/quaternary material underlain by weathered and unweathered Permian material, are considered to be potentially sodic but unlikely to be dispersive. The risk of erosion on the QNH final void walls is considered to be more likely associated with normal weathering of material, or hydraulic or gully erosion, which requires mitigation in drainage designs.

9.3.3 Significant hydrological events

As detailed in **Section 7.3**, the water balance model used climate data from 1889 to September 2019 (a 130 year period) measured in the QNH area (Collinsville). The largest single day rainfall event measured as 348.7 mm (08/04/1940) and the largest seven day total measured as 454 mm (02/02/1991 – 08/02/1991), as such the adoption of this climate data factors in actual measured significant hydrological events. Specific consideration of these events as they relate to geotechnical stability of the JCM and SCM final voids was considered in the previous void assessment and modelling reports:

- *“Investigation into Residual Void Jax Coal Mine – QCoal October 2018”* (submitted to DES 12 October 2018), which included the technical study *“Jax Coal Mine Final Void Hydrology Study Main Pit – Engeny Water Management 2018”* (Engeny 2018); and
- *“Investigation into Residual Void Sonoma Coal Mine – QCoal January 2016”* (submitted to DES 29 January 2016), which included the technical study *“Sonoma Coal Mine Final Void Hydrology Study Main Pit – Engeny Water Management 2015”* (Engeny 2015a).

The other aspect of significant rainfall events potentially affecting pit wall stability is associated with infiltration of rain water into the walls from the surface down, saturating the material behind the wall surface, reducing the geotechnical competency of the wall material. The geotechnical inspections listed in **Section 9.3.1**, include assessment of drainage and saturation of wall materials. As such the final detailed landform designs associated with the QNH final void closures (which will include drainage requirements above the highwall to prevent pooling and saturation) will be well informed by geotechnical highwall observations made on the QNH operational pits.

9.3.4 Revegetation

Revegetation considerations for the QNH final voids are only applicable to the sections of the low-walls between the void lake level and the upper sections of the low-wall where the rehabilitation domain transitions from final void to waste rock dump. This is because there is no practical revegetation activities which could be undertaken on the high-wall or the void lake itself (as it is a water body).

As stated in **Section 9.2**, the recommended void outcome for all QNH final voids is “Residual void unable to sustain a post-mining-land-use”, with the Jax Main Pit and Jax East Pit voids already having that outcome as a rehabilitation condition in Table H1 of the JCM EA. Revegetation of the applicable sections of the low walls on the QNH final voids is not intended to be utilised habitat or grazing, but is for the purpose of slope stabilisation and erosion protection. As such, a primary metric of successful rehabilitation will be the capability of the void to support establishment, survival and propagation of suitable vegetation species to stabilise slopes and reduce erosion.

QCoal (2018) provides guidance on establishing vegetation in rehabilitated areas, including a list of preferred native and pasture species for revegetation, and should be referred to accordingly. Additional detailed information is provided in the QNH RMP

Indirect/incidental establishment of grasses is anticipated to occur on the final void low-walls based on observed and monitored progressive rehabilitation of areas of rehabilitated waste rock dump on the QNH mines

It is important to note that grass and shrub cover has been well established on rehabilitated areas of the QNH for several years, which is a clear demonstration of the suitability of the QNH waste rock and re-spread topsoil to support vegetation. In addition, it is noted that this revegetated area was not actively seeded as part of rehabilitation works, but was revegetated by seedbank within the material and the indirect/incidental processes described above.

9.4 Potential for environmental harm

This section considers the potential for the final voids on the QNH to directly or indirectly cause environmental harm once they have been rehabilitated to achieve the approved final landform design criteria (**Section 9.5**) and void outcomes (**Section 9.2**).

The potential for environmental harm to occur exists where there is an environmental or human value which could experience long-term negative impact beyond the normal range of natural variations.

9.4.1 Groundwater levels

As presented in **Section 4.2**, the following are not considered values of groundwater in the QNH:

- inter-aquifer connectivity;
- springs wetlands of GDEs;
- stygofauna; or
- human groundwater use.

In specific consideration of potential impacts to surface water baseflow, conceptually for there to be any impact to baseflow associated with a QNH final void, two conditions would need to be satisfied simultaneously:

- a surface water body needs to have demonstrated baseflow which is (at least partly) fed by a hydraulic connection to the underlying groundwater; and
- the extent of a cone of depression would need to intercept that same underlying groundwater causing a reduction in level.

As stated in **Section 4.2**, Pelican Creek, Coral Creek, Two Mile Creek and Twelve Mile Creek are ephemeral, and are considered to be losing-disconnected systems with no notable hydraulic connection to groundwater. As such, despite the prediction of a cone-of-depression in the vicinity of Coral Creek, Two Mile Creek and Twelve Mile Creek, no potential impact is considered likely.

As also stated in **Section 4.2**, the Bowen River does experience a baseflow; however, previous studies have determined that no hydraulic connection exists with the underlying groundwater. The modelling results from groundwater modelling presented in **Section 6.2** (and previously in AGE (2015)), indicate that cones-of-depression do not extend to the Bowen River. As such, the Bowen River is not expected to experience any impact to baseflow as a result of the QNH final voids.

9.4.2 Non-polluting

The mechanisms by which pollution (that is the release of a contaminant to the environment **outside of the natural range of concentrations**) could occur as the result of the presence of the QNH voids, are:

- void lake water of a degraded quality (as discussed in **Section 8.2**) migrating into the **regional** groundwater system; or
- void lake water of a degraded quality (as discussed in **Section 8.2**) spilling over the pit crest and into surrounding drainage channels flowing into the Bowen River.

The potential for void lake water to migrate to the regional groundwater is addressed in **Section 6.2 and Section 8.1**, which collectively describe that:

- Modelling predictions indicate that all final voids on the QNH are predicted to be groundwater sinks with a net inflow, except for Drake Pit 3Q, Drake Pit 3R, Sonoma East 2 and Sonoma East 1 (in the water balance model), where the modelling returned a mathematical net outflow;
- **Section 6.2** determines that in all such cases any such net outflow is intercepted by an adjacent groundwater sink final void on the QNH, that QNH voids when assessed as complexes are all groundwater sinks and that QNH when assessed cumulatively is a groundwater sink with no migration away from the QNH
- As such, the modelling results indicate that no water from the QNH final void lakes is predicted to migrate outside of the cumulative cone of depression, with nine of the 14 final voids predicted to not experience any outflow at all. The mechanisms by which pollution of the regional groundwater might occur are not predicted by the modelling.

The potential for void lake water to spill over void crests is addressed for every QNH final void in **Section 8.1**, where water balance modelling results indicated that no QNH final void maximum water level height was above the final landform crest elevation. This modelling was in consideration of all possible inflows including natural catchment and disturbed catchment runoff, direct rainfall and pit inflows (no flood ingress was identified as potentially occurring on any QNH final void as a result of location and landform design)

9.5 Rehabilitation completion criteria

The void outcome for all QNH voids has been recommended as “residual void unable to sustain a post-mining-land use” (with the Jax Main Pit and Jax East Pit voids already having this outcome as a condition in the JCM EA). As such, rehabilitation of the QNH final voids is required to achieve the following goals:

- Safe to humans and wildlife;
- Structurally and geotechnically stable; and
- Non-polluting with no environmental harm being caused by anything on or in the land.

In order to demonstrate that a rehabilitated final void has achieved the rehabilitation goals, objectives for each goal have been identified along with completion criteria to be applied to each objective. Completion criteria are the specific quantifiable metrics by which the status, progress and ultimately completion of a rehabilitation objective can be demonstrated. The completion criteria comprise an indicator and a target value for the indicator. Once the rehabilitation criteria are achieved, the final void can be said to have been rehabilitated to the required condition.

Table 9 provides a summary of the rehabilitation goals, objectives and completion criteria recommended for the QNH final voids.

Table 9 – QNH voids rehabilitation goals, indicators and completion criteria

Goal	Rehabilitation objective	Completion Criteria	
		Indicator	Target to be achieved
Safe to humans and wildlife	Safety risk to people, fauna and livestock is managed	- Access to high walls minimised	Bunds present, stable and self-sustaining. Fencing around high walls present.
Structurally and geotechnically stable	Void walls are geotechnically stable	- Slope of high wall and low wall; - No evidence of cracking/collapse; - No evidence of significant erosion	- high wall slope: $\leq 173\%$ (60°) - low wall slope: $\leq 86\%$ (32°) - RPEQ monitoring of void walls - Drainage design and completion to prevent scouring or gully erosion - RPEQ sign-off of drainage design - RPEQ inspection of completed slopes
Non-polluting with no environmental harm being caused by anything on or in the land.	Void water does not present a risk of impacting on the surface water environmental values (overtopping)	Results from water balance model determining overtopping risk.	Model results predict low risk of overtopping including consideration of significant hydrological events.
	Void water does not present a risk of impacting on the groundwater environmental values of the local aquifer/s (seepage into groundwater)	Results from water balance model and numerical groundwater model	Model results predict a low risk of void lake water migrating into the regional groundwater system Specific model findings may be that voids are individually groundwater sinks or (if there is a mathematical outflow) are located within a cone of depression associated with an adjacent pit such that there is a net groundwater inflow into the QNH.
	Void drawdown does not present a risk of impacting on the groundwater values of the local aquifer/s	Surrounding groundwater level	Model results provide a maximum drawdown extent inside of which there are either no groundwater values which can be impacted, or if groundwater values are identified the drawdown extent, the risk of impact is determined to be low.

10 Conclusions

There are 14 approved QNH final voids, three on the SCM, two on the JCM and nine on the DCM. At cessation of active operation, dewatering will cease and the natural hydrological/hydrogeological process will commence the formation of void lakes.

The groundwater in the QNH area has no notable value as baseflow in surrounding surface water features, as stygofauna habitat, or as source water for springs, wetlands or GDEs. In addition, there is limited human use of groundwater in the vicinity of the QNH.

A numerical hydrogeological model and a numerical water balance model were developed for the QNH final voids to predict an equilibrium state after completion of rehabilitation. The results indicated an equilibrated state where:

- Groundwater drawdown cones-of-depression will occur surrounding the void complexes, as expected, with the extent of drawdown not shown to intercept the Bowen River or any surrounding potential supply bores.
- Void water is fully contained within the QNH final void complexes:
 - o void water from Drake 3Q Pit and Drake 3R flows into the Jax Main Pit.
 - o void water in the Sonoma Main Pit, Sonoma East Pit 1 and Sonoma East Pit 2 voids may experience localised flow between voids dependent on the final level of in-pit rejects disposal within Sonoma Main Pit.
 - o all other individual QNH final voids are groundwater sinks predicted not to experience any net outflow.
 - o the QNH voids when assessed as complexes are all groundwater sinks, and the QNH when assessed cumulatively is a groundwater sink. As such, there is no scenario which results in migration of QNH void water out of the cumulative cones of depression.
- No scenario was predicted where any void lake water level will reach spill/crest elevation.

The salinity of all residual voids modelled is forecast to continue to increase over time due to the ongoing concentration resulting from evaporation in conjunction with no significant outflow of salts from either net outflows seepage or overflows. **It should be noted that pits with net outflow were still shown to accumulate salts throughout the model duration.** The reason for this occurrence is that predicted net outflow rates into the surrounding geology, at all levels of rating curves, for all pits, were significantly smaller in magnitude than flows associated with rainfall, runoff, and evaporation. The results indicate significant variation in the EC of the different voids; however, all void lakes are forecast to exceed 10,000 $\mu\text{S}/\text{cm}$ after 200 years (with the exception of Jax Main Pit which is closer to 220 years), with some pits reaching 10,000 $\mu\text{S}/\text{cm}$ after 40 years. Ultimately, salts will continue to concentrate with the maximum concentration only limited by solubility of the constituent salts within the lake. This is conceptually the case for any comparable water body receiving inflow, which experiences evaporation as either the only outflow, or at a rate exceeding all other outflows. As such, the water in the QNH voids is predicted to be unsuitable for any use and be contained within the QNH voids for all modelled scenarios. In consideration of those results, it is concluded that none of the QNH final voids can self-sustain a designated post-mining land use, as all potential uses are contingent on having an acceptable level of quality for that use, none of which can be met over time.

The specific slope design criteria for the QNH final void walls is conditioned in the respective EAs. The origin of those slopes was the initial geotechnical assessment for the SCM followed by specific subsequent geotechnical studies which informed the slopes designs adopted in the EAs. Since commencement of operation, QNH pit walls have been subject to RPEQ geotechnical inspections, including specific reviews of the design slopes for pit walls. None of the findings in the RPEQ geotechnical assessments indicate that the final void slopes proposed in the QH EAs are unsuitable, provided contributing factors are addressed (such as drainage), and a final RPEQ design of final voids is undertaken to consider the specific materials exposed in the final high walls. As such, provided an RPEQ final design is undertaken which includes full drainage design, there is no impediment to achieving a geotechnically stable final landform.

There have been several studies previously completed into the geochemistry of the QNH including which included comment on sodicity and dispersion. The materials comprising QNH final void walls are not considered especially dispersive, and, as such, erosion and weathering risk is considered more likely to be associated with hydraulic erosion (gully, erosion, tunnel erosion and scouring), which is to be addressed in drainage designs. In additional saturation of walls (leading to a risk of failure) is also to be addressed in final drainage designs.

Revegetation of the applicable sections of the low walls on the QNH final voids is not intended to be utilised for habitat or grazing but is for the purpose of slope stabilisation and erosion protection. QCoal (2018) provides guidance on establishing vegetation in rehabilitated areas, including a list of preferred native and pasture species for revegetation, and should be referred to accordingly. Additional detailed information is provided in the QNH RMP. Indirect/incidental establishment of grasses is anticipated to occur on the final void low-walls based on observed and monitored progressive rehabilitation of areas of waste rock dump on the QNH mines. It is important to note that grass and shrub cover has been well established on rehabilitated areas of the QNH for several years, which is a clear demonstration of the suitability of the QNH waste rock and re-spread topsoil to support vegetation.

Accordingly, all QNH final voids modelled in this assessment are determined not to be in “stable condition” as defined in Section 111A of the EP Act, and are recommended to have a void outcome of “residual void unable to sustain a post mining land use”. Until such time as the SCM, DCM and JCM transition into the PRC Plan framework, any final landforms which are determined not to be in “stable condition” under Section 111A will be managed as NUMAs whilst not definitionally be referred to as NUMAs. Once transitioned into the PRC Plan framework any such landforms will then also be definitionally referred to as NUMAs.

The Jax Main Pit and Jax East Pit voids already have this void outcome conditioned in the JCM EA, which is consistent with the findings of this assessment and *“Investigation into Residual Void Jax Coal Mine – QCoal October 2018”* (submitted to DES 12 October 2018).

These findings are also consistent with the void outcomes previously identified for Sonoma Main Pit in *“Investigation into Residual Void Sonoma Coal Mine – QCoal January 2016”* (submitted to DES 29 January 2016).

Final voids with an outcome of “unable to self-sustain a post mining land use”, are required to be rehabilitated to be safe and geotechnically stable condition, and to not cause environmental harm as per conditions of the QNH EAs.

10.1 Recommendations

The following recommendations are made based on this investigation:

- 1) The goals for all QNH residual voids are that they should be safe, geotechnically stable and not cause any environmental harm or carry any additional level of risk, beyond what is inherent to the existence of the void itself. The nominated completion criteria reflect this objective.
- 2) All QNH residual voids have been found to be unable to sustain a PMLU as a result of degrading water quality. This is reflected in the JCM EA for the JCM voids. The SCM and DCM EAs should be amended to also reflect this finding.
- 3) From the cessation of pit dewatering until the completion of rehabilitation activities:
 - a) undertake a monthly survey or measurement of water level in the main pit final voids;
 - b) undertake quarterly water quality monitoring of final void water;
 - c) undertake a monthly inspection of the pit walls by a geotechnical engineer/mining engineer/pit geologist for any visual signs of weakening, slipping, failure or gully/tunnel erosion
 - o if required, the inspection may make recommendations for remedial actions
 - o if required, the inspection may make recommendations for further pit wall stability studies.
- 4) Prior to final rehabilitation, engage a third party RPEQ engineer to undertake a final assessment and design of the high wall and low wall, in consideration of the completion criteria in the EA. Such a design should be informed by the prior quarterly RPEQ operational inspections and data.
 - a) Any recommendations made by the RPEQ should be factored into rehabilitation works.

11References

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Sonoma Mine Management Residual Void Outcome Sonoma Mine July 2010 (GHD 2010).

Stygofauna Survey for the Drake Coal Mine Project (July 2016) – Freshwater Ecology Pty Ltd 2016 (Freshwater Ecology 2016)

APPENDIX A

**Jax Coal Mine Final Void Hydrology Study Main Pit – Engeny Water
Management 2018 (Engeny 2018)**

and

**Long Term Water Quality of Jax Coal Mine Residual Voids - 2 April 2019
(Engeny (2018) Supplementary Memo)**



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JCM Final Void Hydrology Study

Jax Main Pit and Jax East Pit



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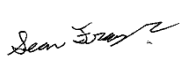
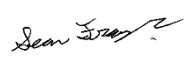
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1. INTRODUCTION

The Jax Coal Mine (JCM) is located approximately 8 km south of Collinsville within the Bowen Basin. Sonoma Coal Mine (SCM), Drake Coal Mine (DCM) and Cow Coal Mine (CCM) are located to the north and west of JCM. These four mines are owned and operated by subsidiaries of QCoal Pty Ltd (QCoal) and are collectively referred to as the QCoal Northern Hub (QNH).

There is currently one open cut mining pit within the JCM mining lease (ML10346), JCM Main Pit. JCM East Pit is a planned open cut mining pit, which has not yet commenced. The site layout is illustrated in Figure 1.1.

The JCM is authorised to operate under Environmental Authority (EA) EPML00337613 dated 5th September 2017. The EA specifies the following requirements for final voids:

- **Condition F9 Residual Void Outcome**

Residual voids must comply with the following outcomes:

- a) *Residual voids must not cause any serious environmental harm to land, surface waters or any recognised groundwater aquifer, other than the environmental harm constituted by the existence of the residual void itself and subject to any other condition within this environmental authority.*
- b) *residual voids must comply with Table F1: Residual void design.*
- c) *with the exception of the residual void (Jax Pit 1) referred to in Table F1, all voids must be backfilled.*

- **Condition F10**

Complete an investigation into residual voids and submit a report to the administering authority for review and approval. The report must propose acceptance criteria to meet the landform design criteria stipulated in the Rehabilitation Management Plan and Table F1: Residual void design by 31 July 2018.

QCoal has commissioned Engeny Water Management (Engeny) to undertake a void hydrology study of the proposed JCM voids, to inform the assessment report required under **Condition F10**. This void hydrology study has been prepared under the direct supervision of Sean Frazer (RPEQ No. 21211).

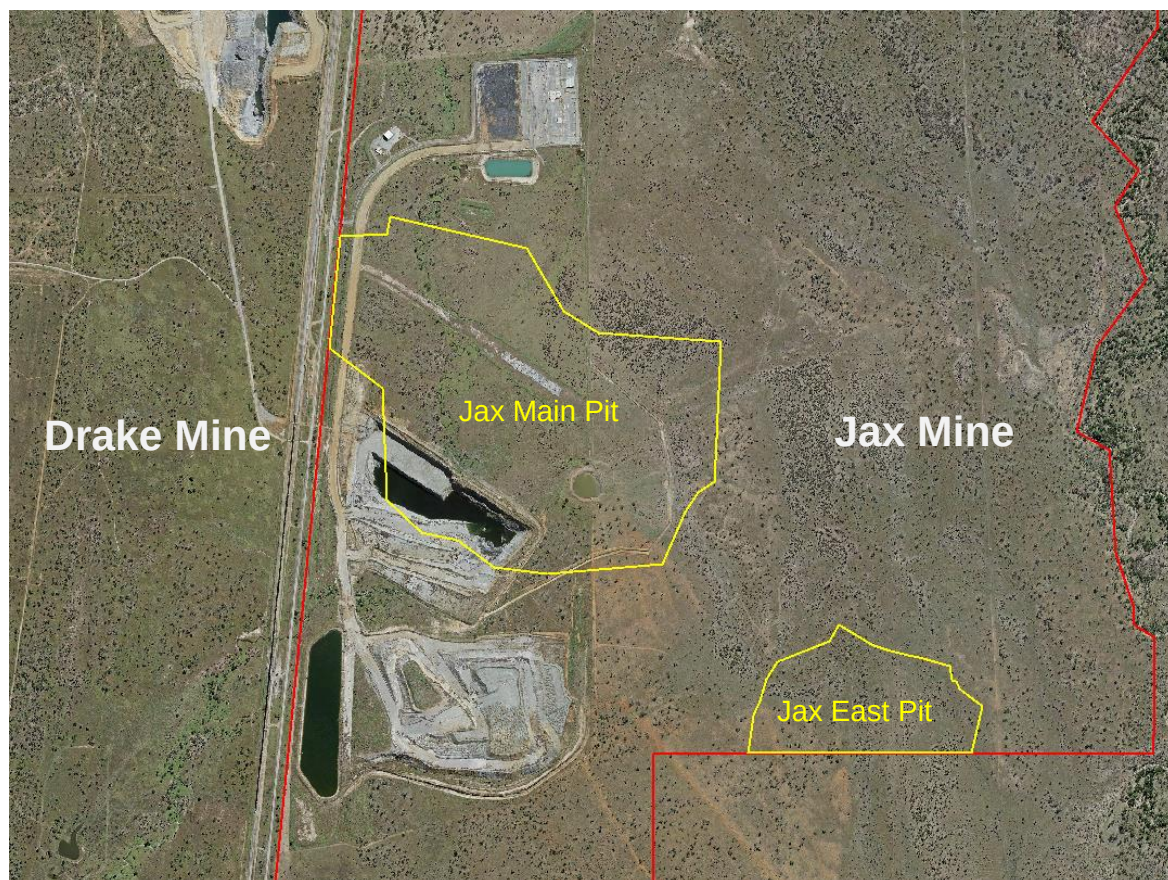


Figure 1.1 JCM Site Layout

2. DATA REVIEW

2.1 Previous Studies

A number of previous studies have been referred to for this assessment including:

- *Water Management Plan 2017 QCNH Mines* (Engeny, December 2017).
- *SCM Final Void Hydrology Study Main Pit* (Engeny, November 2015).
- *CCM Final Void Hydrology Study Q Pit and B Pit* (Engeny, April 2017).
- *Drake Coal Project Groundwater Model* (AGE, January 2015).

2.1.1 Water Balance Model

Engeny has previously developed a water balance model of the QNH mines (including JCM) in the GoldSim software. The development of the model, input parameters and calibration are detailed in *Water Management Plan Northern Hub Mines* (Engeny, Dec 2017). The existing model has been adopted as a basis for this final void hydrology study.

2.2 Final Void Landform

The purpose of this study is to conservatively inform the overall report required as per Condition F10; therefore, a final void scenario has been assumed which has both Jax pits retained as final voids. As such the final landforms for the JCM voids (including storage curves) have been determined based upon the latest mine planning designs supplied by QCoal. Catchment areas for the base case have been estimated from the mine plans and existing survey while a sensitivity analysis has been undertaken with potential catchment variations. The actual final landforms on the JCM are not considered likely to differ from the final landforms modelled in this report to a degree which would negate the findings of this study.

2.2.1 Storage Curve

The assumed final landform storage curves are presented in Figure 2.1 and Figure 2.2. The Jax Main Pit and Jax East Pit voids are estimated to have a storage capacity of 32 GL and 11 GL respectively. The storage curves have been adopted as a reasonable estimate of the final pit void storage characteristics.

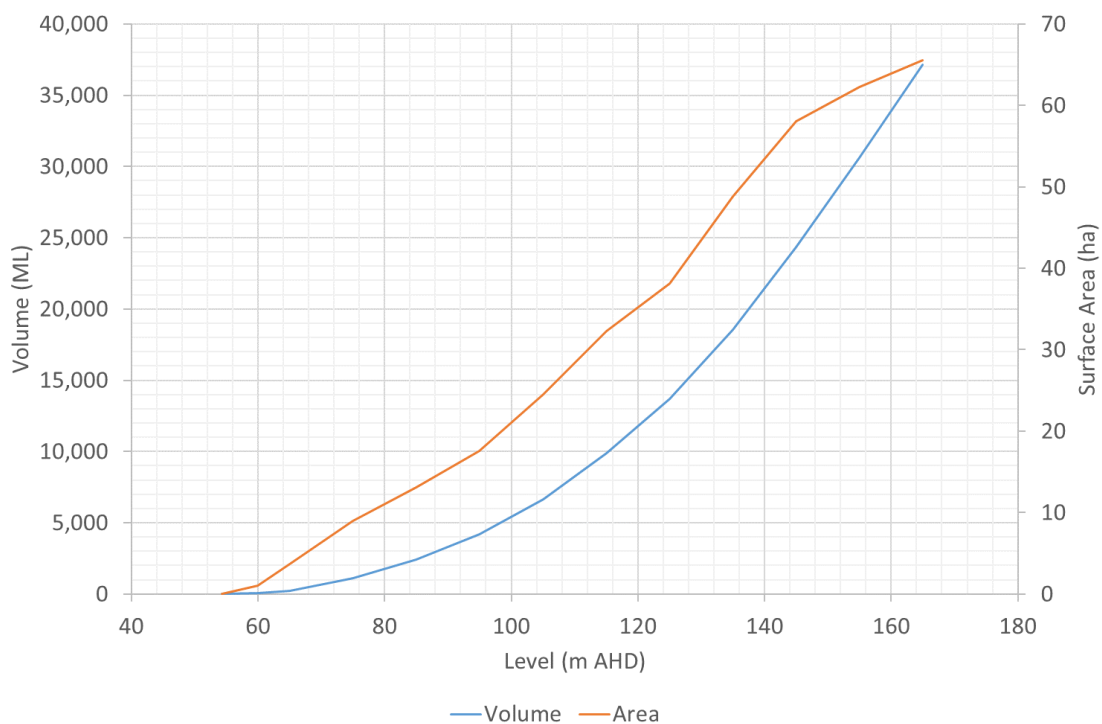


Figure 2.1 Jax Main Pit Storage Curve

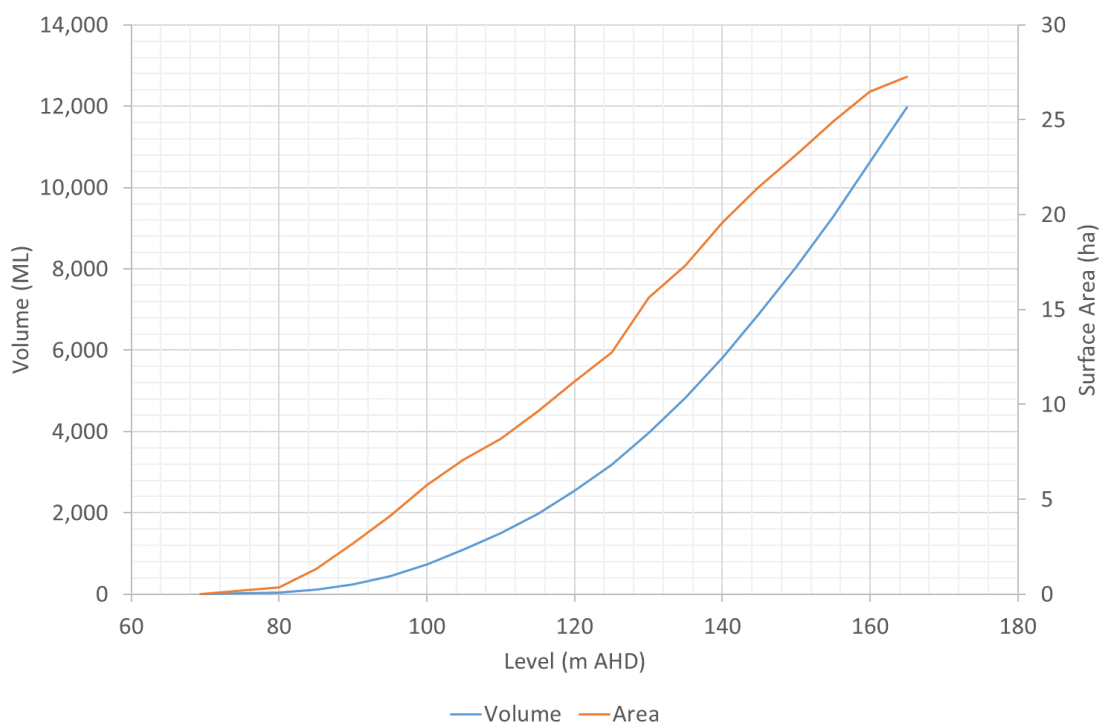


Figure 2.2 Jax East Pit Storage Curve

2.2.2 Contributing Catchment

In addition to the LiDAR data, aerial photography from July 2018 and mine plans have been used to model the final landform catchments. It has been assumed that all out-of-pit spoil areas will be rehabilitated following the cessation of mining.

The adopted final void catchments for JCM pits are presented in Figure 2.3 and Figure 2.4 for the Base Case Scenario. These catchments have been determined from current topography and final void designs. Review of the topography indicates that the natural catchment to the east of Jax Main Pit can be readily diverted away from the void and it was therefore considered reasonable to exclude this area from the Base Case catchment (refer to pink shaded region in Figure 2.3).

Both final voids have additional upslope natural catchments that would require more substantial drainage infrastructure to divert. The impact of diverting this additional catchment has been assessed by undertaking a sensitivity assessment presented in the Reduced Catchment Scenario. The contributing catchments for this scenario are presented in Figure 2.5 and Figure 2.6 and represent the minimum contributing catchment, which will minimise the void lake level.

A summary of the contributing catchment areas for the two scenarios is provided in Table 2.1.

Table 2.1 Contributing Catchment and Landuse

Pit	Scenario	Area (ha)			
		Pit	Rehab	Natural	Total
Jax Main Pit	Base case	69.4	59.8	134.3	263.5
Jax Main Pit	Reduced catchment	69.4	59.8	14.1	143.3
Jax East Pit	Base case	28.3	-	20.3	48.6
Jax East Pit	Reduced catchment	28.3	-	12.9	41.2

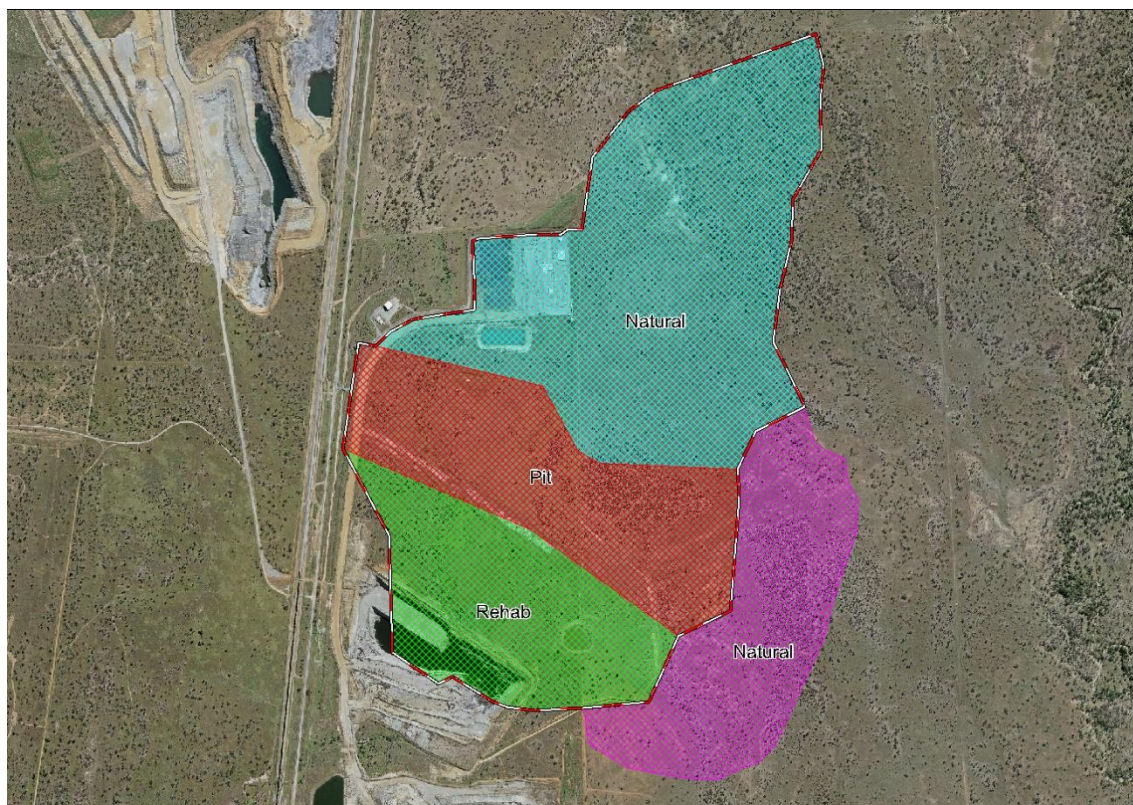


Figure 2.3 Jax Main Pit Catchment (Base Case)

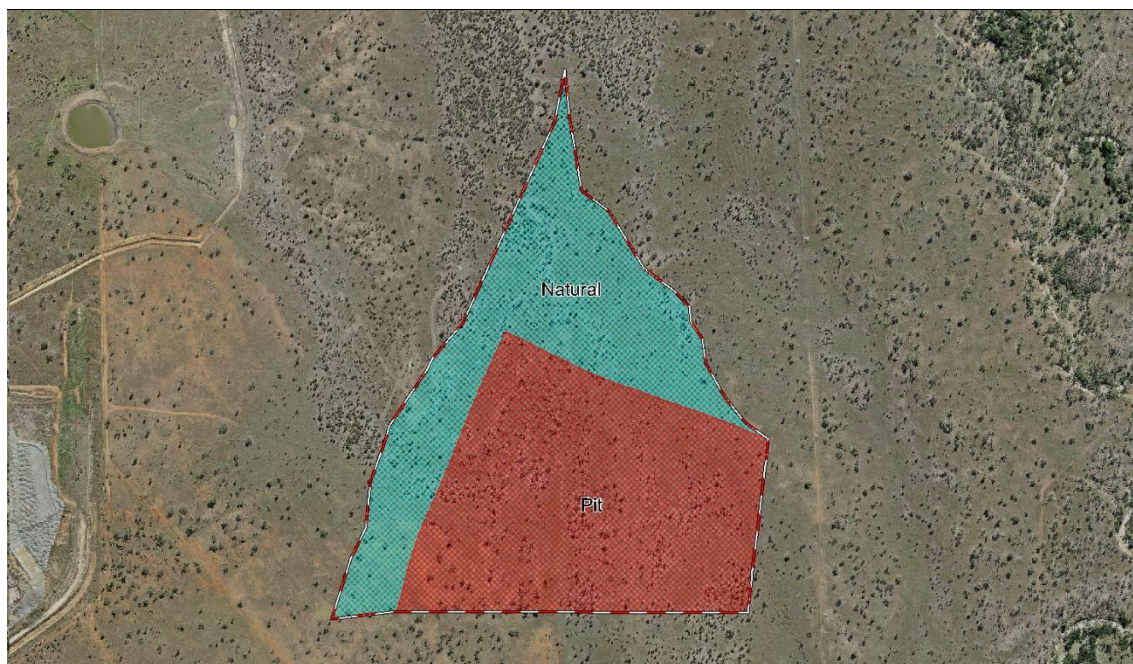


Figure 2.4 Jax East Pit Catchment (Base Case)

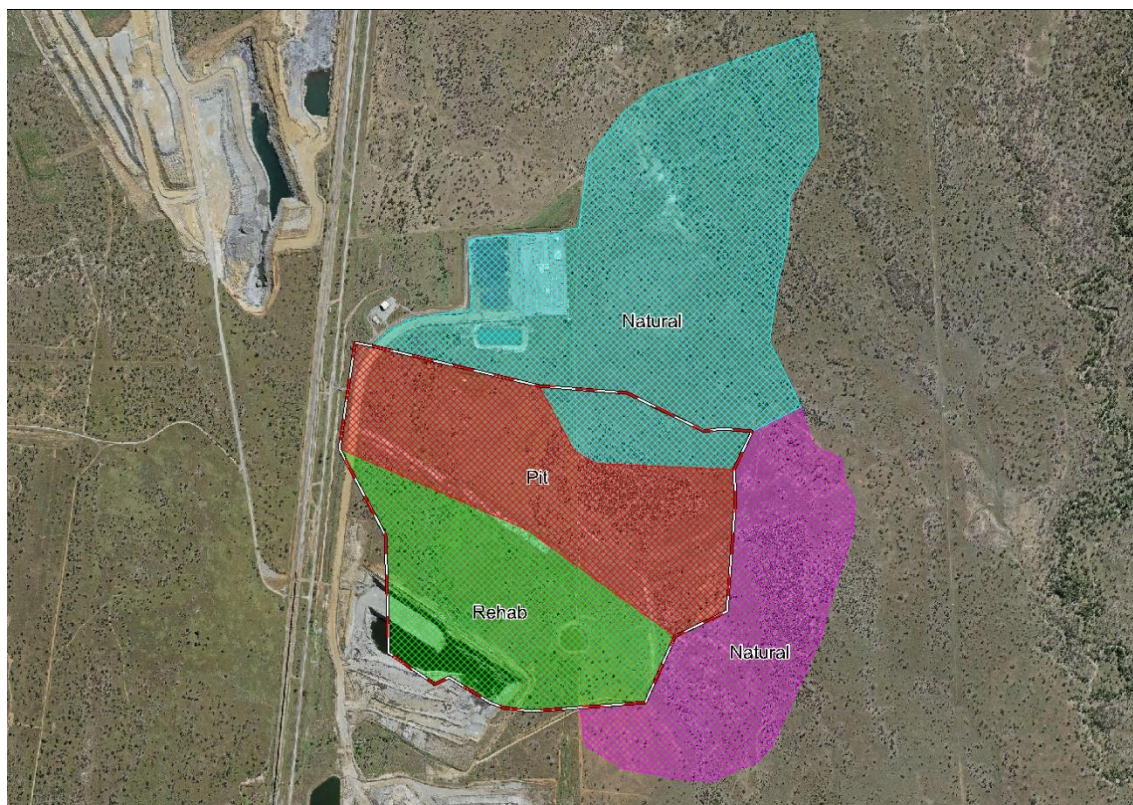


Figure 2.5 Jax Main Pit Catchment (Reduced Catchment Scenario)

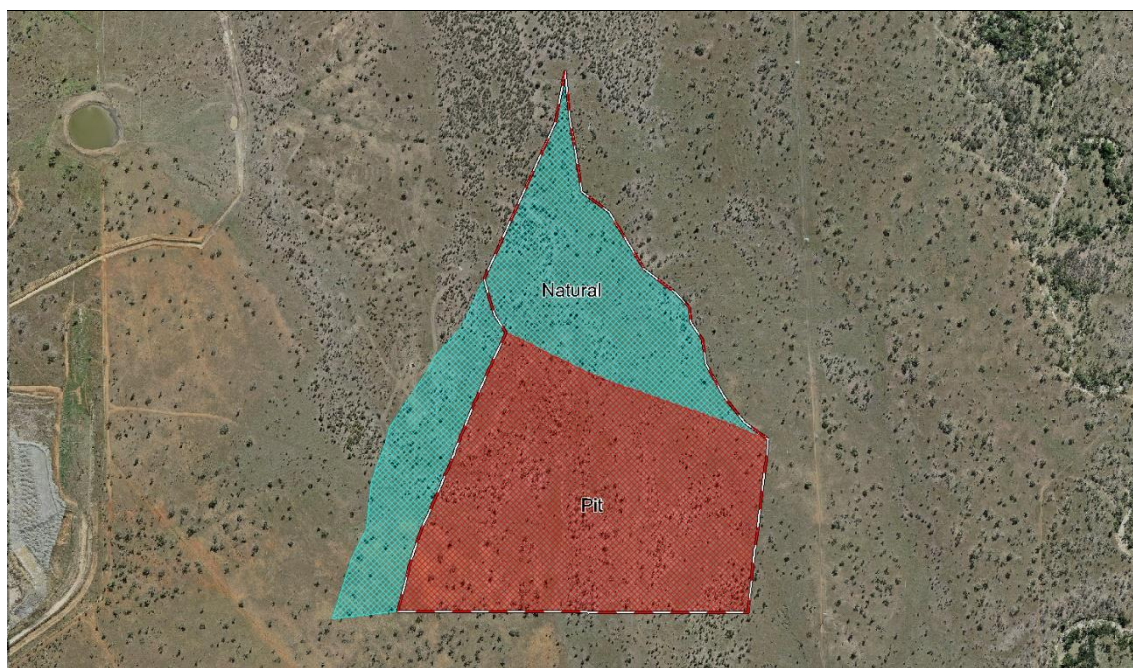


Figure 2.6 Jax East Pit Catchment (Reduced Catchment Scenario)

2.3 Connections to Groundwater

The regional groundwater system in the vicinity of the JCM has been described in a number of previous studies, the most recent of which is the Drake Coal Project Groundwater Model (AGE, 2015) which informed a broader groundwater assessment inclusive of the JCM, in the Drake Coal Mine Groundwater Monitoring and Management Plan (QCoal, 2014).

Numerical groundwater modelling of the design final voids was undertaken by AGE in September 2018 to predict groundwater inflow in the Jax Pit voids. From the model, a rating curve of groundwater inflow vs pit water level for the two Jax Voids was developed. The modelling included both a combined assessment (assuming the water level in each void is the same) as well as Jax Main Pit and East Pit in isolation. The groundwater inflow relationship for the base case scenario is based on the combined pits model. A sensitivity analysis was undertaken using the rating curves derived for each pit in isolation.

The AGE assessment (Sep 2018) identified the following key findings:

- The pre-mining regional groundwater levels in the vicinity of Jax Pits is approximately 140 m AHD. As shown in Figure 2.7, the zero flow level (i.e. the level at which there is no net inflow or outflow from the pit lake to groundwater) is 143 m AHD for Main Pit and 131 m AHD for East Pit.
- The base of weathering around Jax Main Pit varies from approximately 140 m AHD in the south west of the pit to around 160 m AHD in the north east of the pit.
- The base of weathering at Jax East Pit ranges from 143 m AHD to 154 m AHD across the pit footprint.
- The numerical model indicate that the pre-mining regional water table is coincident with the base of weathering.

The base case relationship between water level and groundwater inflows for both Jax Main Pit and Jax East Pit are presented in Figure 2.7. Negative flows shown in the figure indicate a net outflow from the pit into the surrounding groundwater system. In theory, this would occur in the situation where the water level in the pit is higher than the groundwater level surrounding the pit. It is noted that these hypothetical net outflow rates are likely to be artificially high due to the application of an “infinite sink” as a boundary condition on the groundwater model.

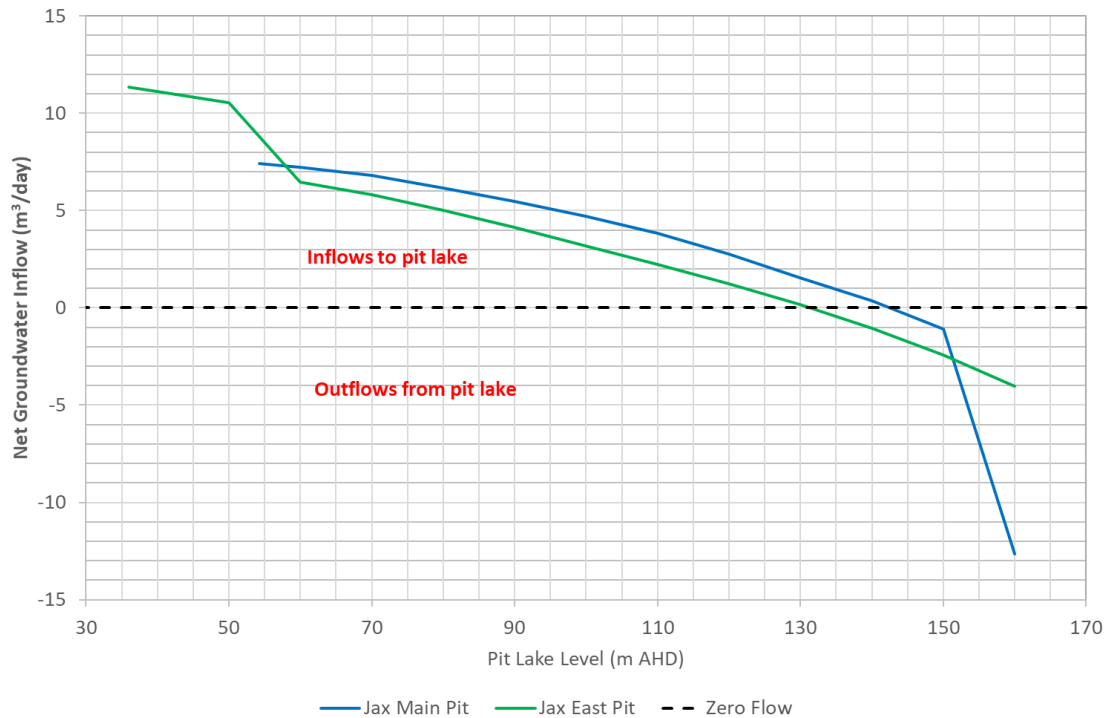


Figure 2.7 Pit Lake Level vs Groundwater Inflow Relationship for JCM Pits

2.4 Water Quality

Electrical conductivity (EC) and Total Dissolved Solids (TDS) are key indicators of water quality and can be simulated within the existing water balance model. The model directly simulates TDS using a salt mass balance and converts to EC via a constant conversion factor ($1 \text{ mg/L TDS} = 1.49 \text{ } \mu\text{S/cm EC}$). Water quality inputs to the water balance model have been reviewed and are summarised in the following sections.

2.4.1 Groundwater

Monitoring of groundwater quality across a number of monitoring bores at QNH is undertaken on a quarterly basis. The groundwater quality data has previously been assessed as part of the *SCM Final Void Hydrology Study Main Pit* (Engeny, 2015) and *CCM Final Void Hydrology Study Q Pit and B Pit* (Engeny 2017). Both studies determined a representative groundwater inflow quality of $2,000 \text{ } \mu\text{S/cm}$. A consistent quality has been adopted for the JCM Void Assessment, which is considered suitable to model the rate of change resulting from hydrological processes within the pit voids. The impact of a higher groundwater inflow EC has been assessed via a sensitivity analysis (as presented in Section 3.4).

2.4.2 Surface Water

Surface water runoff TDS characteristics have previously been calibrated for a number of land use types as documented in *Water Management Plan Northern Hub Mines* (Engeny, Dec 2017). These runoff TDS characteristics have been adopted for the modelling of both JCM voids in this void hydrology study and are summarised in Table 2.2.

Table 2.2 Runoff TDS

Landuse Type	TDS (mg/L)
Pit	1,300
Rehabilitated Spoil	Varies with runoff depth: $547 \times (\text{Rainfall Excess})^{-0.19}$ max 700 mg/L

2.4.3 Potential for Stratification

Due to the depths of the final void lakes and the likely thermal gradients, the lakes are considered to have a potential for stratification. This is likely to occur on a seasonal cycle with stratification in the warmer summer months followed by mixing in the cooler winter months or under climatic conditions that would promote the turnover of the void lake stratification (e.g. strong winds).

3. WATER BALANCE MODEL ASSESSMENT

3.1 Final Void Inflows and Outflows

The water balance of the final void will be governed by the following water inflows and outflows:

- Inflows:
 - Surface runoff inflows from rehabilitated spoil areas that drain to the void.
 - Surface runoff inflows from the walls and ramps of the void.
 - Inflows from incident rainfall on the void lake.
 - Groundwater inflows to the void (if the void lake level is lower than the regional groundwater level).
- Continuous Outflows:
 - Outflows due to evaporation losses from the surface area of the void lake.
- Potential Outflows (conditional on void lake level):
 - Seepage outflows from the void lake to groundwater (if the void lake level is higher than the regional groundwater level).
 - Discharges to surface water (only if the void fills to its' spill level).

3.2 Modelled Scenarios

A number of scenarios have been simulated using the water balance model in order to assess the hydrological behaviour of the final voids. The scenarios assessed are presented in Table 3.1. Scenario 1 (i.e. the Base Case) has adopted the best available estimates of model inputs, while Scenarios 2 to 8 provide a sensitivity analysis of uncertainties in key adopted input parameters.

The model has been simulated for a period of 100 years. The historical climate record (as detailed in the Water Management Plan (Engeny, 2017)) has been utilised to assess 124 potential realisations of the void behaviour under different climate sequences.

Table 3.1 Water Balance Model Scenarios

ID	Scenario	Description
1	Base	Jax Main Pit: Pit shell = 69.4 ha; Rehab spoil = 59.8 ha, Natural = 134.3 ha Jax East Pit: Pit shell = 28.3 ha; Natural = 20.3 ha

ID	Scenario	Description
2	Reduced catchment sensitivity	Jax Main Pit: Pit shell = 69.4 ha; Rehab spoil = 59.8 ha, Natural = 14.1 ha Jax East Pit: Pit shell = 28.3 ha; Natural = 12.9 ha
3	Groundwater inflow sensitivity	Base with 50% increase in groundwater rates (both inflow and outflows)
4	Regional groundwater level sensitivity	Groundwater inflow relationship shifted up by 5m (i.e. higher inflows at the same void lake level)
5	Groundwater TDS sensitivity	Base with EC of groundwater inflows increased to 15,000 $\mu\text{S}/\text{cm}$
6	Reduced evaporation sensitivity	Base with 30% reduced lake evaporation due to reduced wind, increased shading and increased salinity
7	Isolated Groundwater Inflow	Base model with groundwater rates associated with each pit in isolation
8 ¹	Increased catchment sensitivity	Base with natural catchment at the east of Jax Main Pit Jax Main Pit: Pit shell = 69.4 ha; Rehab spoil = 59.8 ha, Natural = 194.6 ha

Note 1: Assessed increased catchment sensitivity for Jax Main Pit only

3.3 Base Case Results

3.3.1 Void Lake Volume

The predicted future void lake volume over time in Jax Main Pit and Jax East Pit are presented in Figure 3.1 and Figure 3.2 respectively. The range of forecast void lake behaviour is illustrated, including:

- A high void lake level (95th Percentile).
- A median void lake level (50th Percentile).
- A low void lake level (5th Percentile).

The results indicate that the void lake levels will rise steadily over the first decades following the cessation of mining. Although the void lake levels are forecast to fluctuate over time as a result of the prevailing climate conditions, an equilibrium volume of approximately 8 GL and 1 GL is forecast for Jax Main Pit and East Pit respectively.

The time required for the void lakes to reach their equilibrium volume is presented in Table 3.2 and ranges from approximately 70 to 90 years for Jax Main Pit to 40 to 50 years for Jax East Pit.

The equilibrium volumes correspond to void lake levels of approximately 110 m AHD (Jax Main Pit) and 104 m AHD (Jax East Pit). These levels are 47 m to 58 m below the level at which the void lakes would spill to the receiving waterways. No overtopping of the void lakes to the receiving environment is forecast to occur.

The modelled Jax Main Pit equilibrium level (110 m AHD) is 30 m below the pre-mining regional groundwater level (140 m AHD) and 33 m below the zero flow level (143 m AHD). The Jax Main Pit final void is therefore forecast to operate as a sink, with a groundwater inflow of 3.9 m³/day (i.e. 1.4 ML/year) and no flow from the void to groundwater expected to occur.

The modelled Jax East Pit equilibrium level (104 m AHD) is 36 m below the pre-mining regional groundwater level (140 m AHD) and 27 m below the zero flow level (131 m AHD). The Jax East Pit final void is therefore forecast to operate as a sink, with a groundwater inflow of 2.7 m³/day (i.e. 1.0 ML/year) and no flow from the void to groundwater expected to occur.

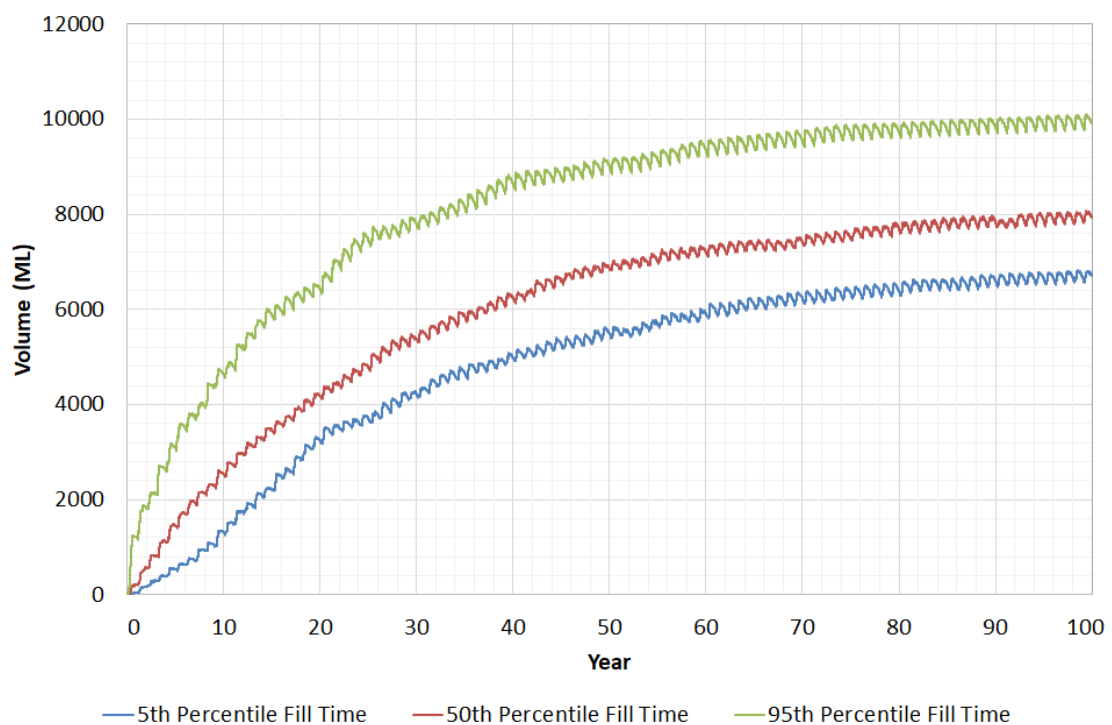


Figure 3.1 Forecast Jax Main Pit Void Lake Volume (Base Case)

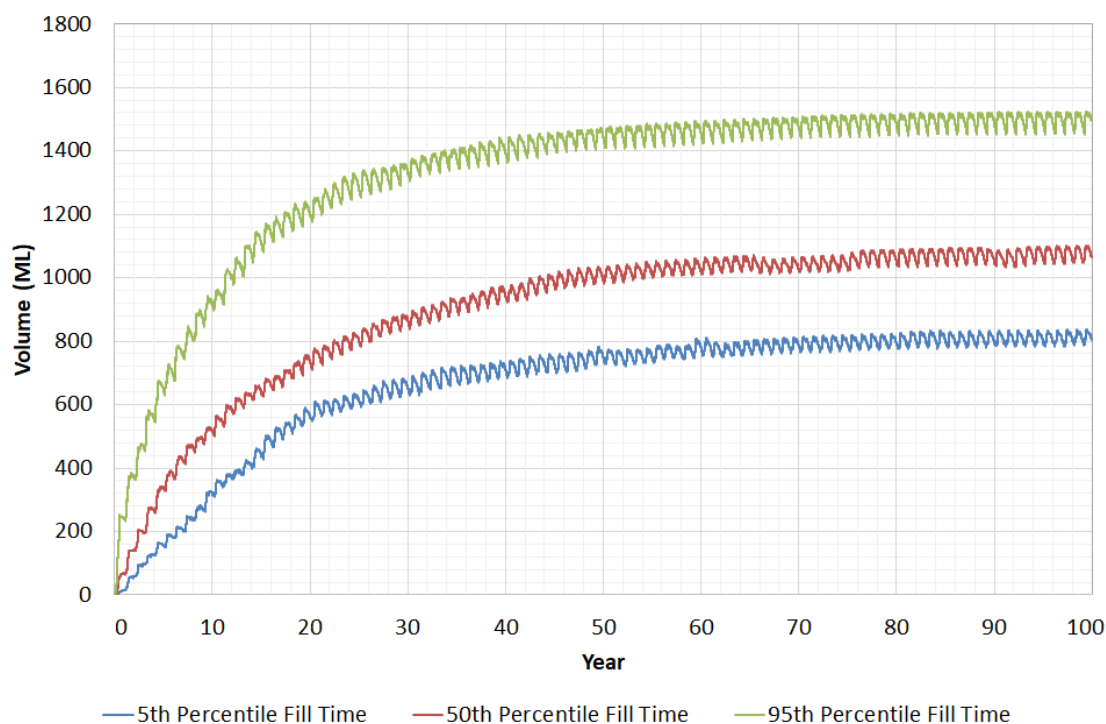


Figure 3.2 Forecast Jax East Pit Void Lake Volume (Base Case)

Table 3.2 Forecast Time for Void Lake to Fill to Equilibrium Level

Percentile	Filling Time (Years)	
	Jax Main Pit	Jax East Pit
95	90	50
50	80	45
5	70	40

The average annual inflows and outflows to the final voids following the initial filling to the equilibrium void level are presented in Table 3.3. The results indicate that:

- Groundwater inflows are a negligible component of the void lake water balance.
- Direct rainfall on the lake surface is approximately 35% smaller than the catchment runoff.
- Evaporation is the only significant water loss from the lake.

Table 3.3 Average Void Water Balance at Equilibrium

Inflow / Outflow		Average Annual Volume (ML/yr)	
		Jax Main Pit	Jax East Pit
Inflow	Rainfall on Void Lake	209	52
	Surface Runoff	328	79
	Groundwater Inflow	1.4	1.0
Outflow	Evaporation	522	131
	Groundwater Outflow	0	0

3.3.2 Water Quality

The void lake EC for the base case scenario was modelled and is presented in Figure 3.3 (Jax Main Pit) and Figure 3.4 (Jax East Pit).

The salinity of the final void lakes is predicted to increase over time. This is a result of evaporation being the only significant outflow from the lakes, which results in an ongoing concentration of salts. Modelling indicates that salts will continue to concentrate with a generally linear trend at an average rate of approximately 30 – 100 $\mu\text{S}/\text{cm}$ per year. Ultimately the maximum EC will be limited by solubility, which will vary with temperature both seasonally and with depth throughout the void lake water column.

It is noted that the invert levels of drainage paths in the vicinity of Jax Final Voids are significantly higher than equilibrium lake levels. Consequently, surface water quality in the drainage paths is not expected to be impacted by the void lakes.

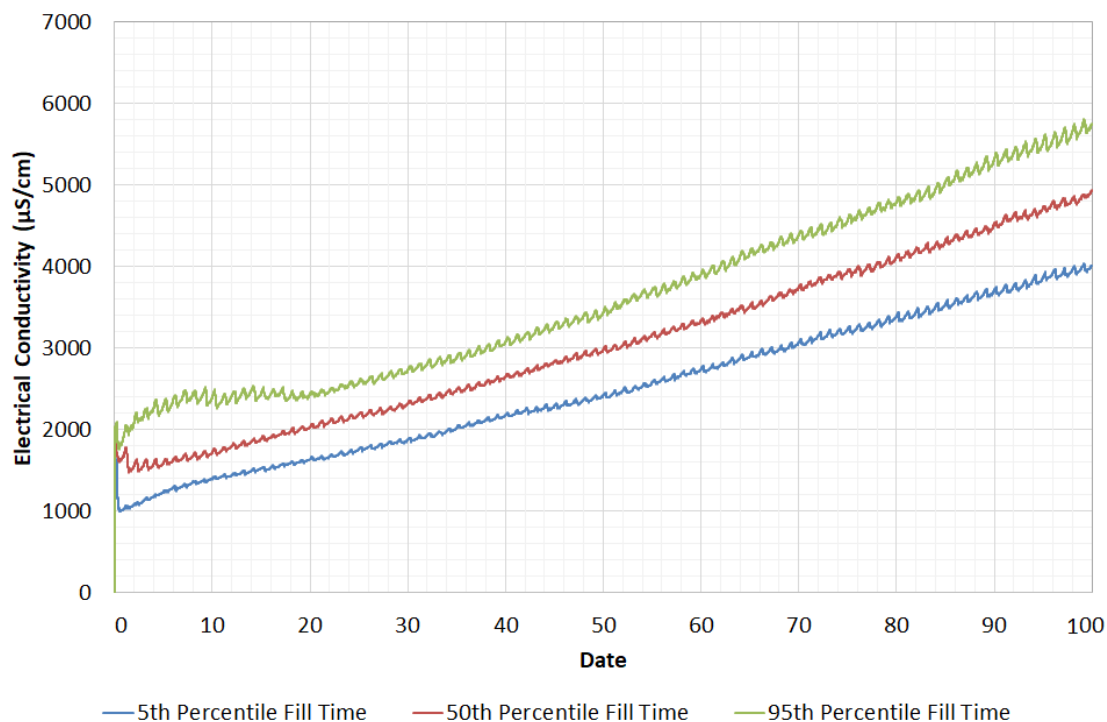


Figure 3.3 Forecast Jax Main Pit Void Lake EC (Base Case)

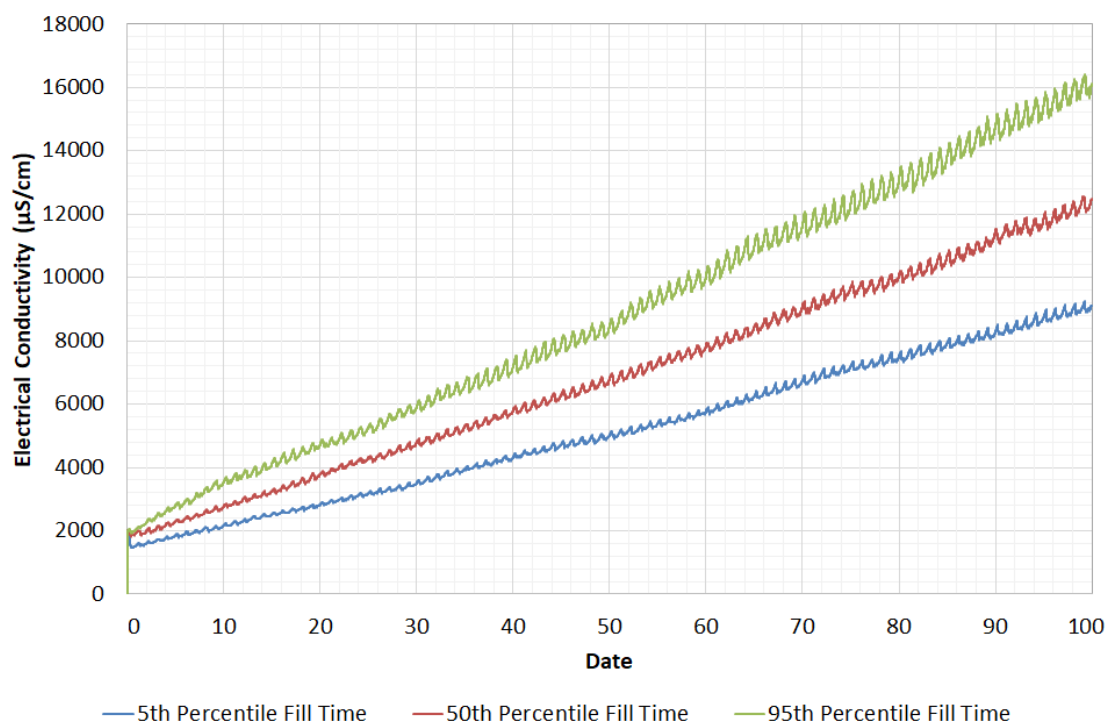


Figure 3.4 Forecast Jax East Pit Void Lake EC (Base Case)

3.4 Sensitivity Results

3.4.1 Void Lake Volume

The median forecast void lake volumes for the range of sensitivity analysis scenarios summarised in Table 3.1 are presented in Figure 3.5 and Figure 3.6 for Jax Main Pit and Jax East Pit respectively. Results indicate:

- Changes to the groundwater inflow rates and regional groundwater level (Scenario 3 and 4) are seen to have minimal impact on the void filling times and equilibrium void lake volumes.
- Scenario 7 uses the alternative groundwater inflow vs pit water level curve developed by AGE for the case of either Jax Main Pit or Jax East Pit in isolation (i.e. a one final void scenario). This scenario indicates that the void lake behaviour does not change significantly based on there being only one final void instead of two.
- Reducing the out-of-pit catchment (Scenario 2) results in lower equilibrium volumes due to the smaller catchment.
- The greatest variation is a result of reduced evaporation (Scenario 6), which results in increased filling rates and higher equilibrium levels.
 - The equilibrium level in Jax Main Pit of 133 m AHD (17 GL) is 7 m lower than to the pre-mining regional water table (140 m AHD) and 10 m lower than the zero flow level (143 m AHD). The void is forecast to remain a minor groundwater sink of 1.4 m³/day (i.e. 0.5 ML/yr).
 - The equilibrium level in Jax East Pit of 121 m AHD (17 GL) is 29 m lower than to the pre-mining regional water table (140 m AHD) and 10 m lower than the zero flow level (131 m AHD). The void is forecast to remain a minor groundwater sink of 1.2 m³/day (i.e. 0.4 ML/yr).
- Inclusion of the natural catchment in the east of Jax Main Pit (Scenario 8) results in a slightly higher equilibrium volume due to the increased catchment. This impact is less than the Scenario 6 sensitivity.

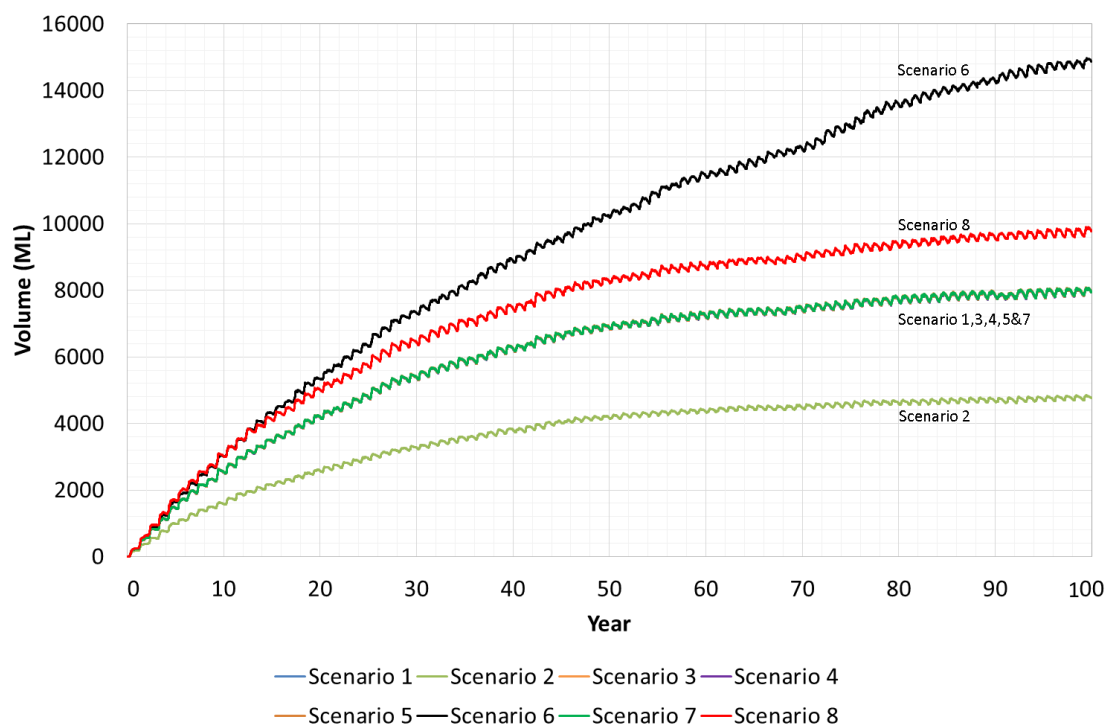


Figure 3.5 Forecast Jax Main Pit Void Lake Median Volume (Sensitivity)

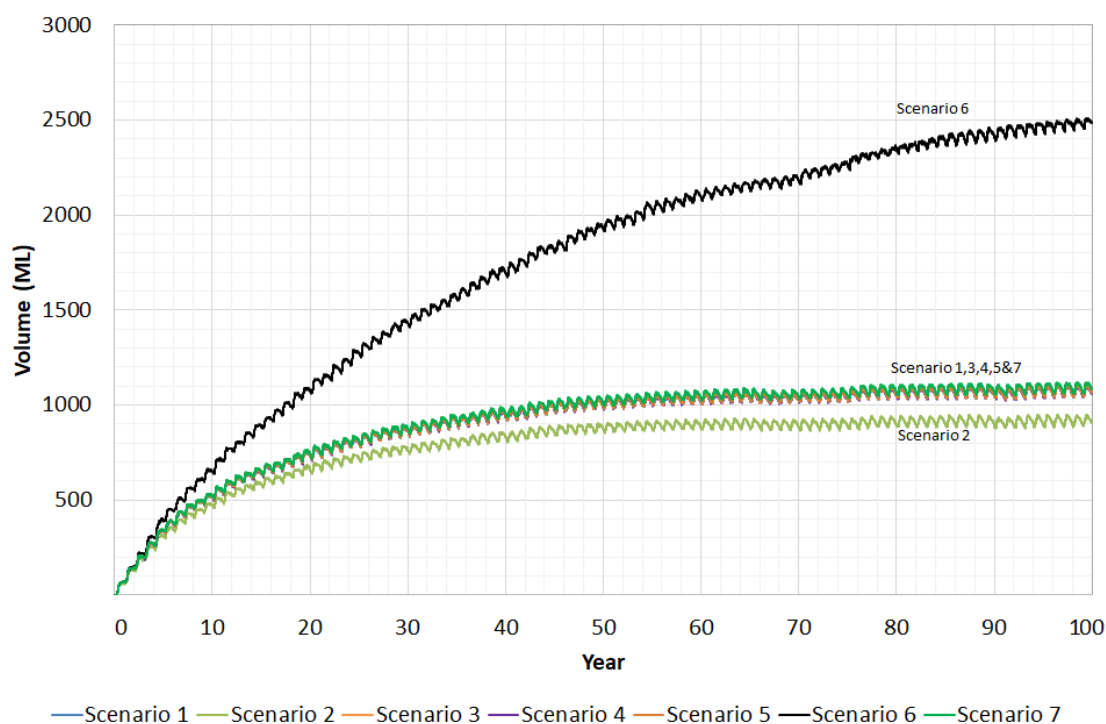


Figure 3.6 Forecast Jax East Pit Void Lake Median Volume (Sensitivity)

3.4.2 Water Quality

The median forecast void lake EC for the range of scenarios summarised in Table 3.1 are presented in Figure 3.7 and Figure 3.8 for Jax Main Pit and Jax East Pit respectively, for the period up to volumetric equilibrium for each void. Results indicate:

- Changes to the groundwater inflow rates, regional groundwater level and isolated pit groundwater inflow rate (Scenario 3, 4 and 7) are seen to have minimal impact on the long-term void lake salinity.
- Reducing the out-of-pit catchment (Scenario 2) results in the salinity of the void lakes increasing more quickly, although this difference in quality is minor. This is a result of the comparative reduction in rehabilitated catchment area, which produces 'clean' runoff to dilute void lake EC.
- By contrast, increasing the natural catchment to the east of Jax Main Pit (Scenario 8) is forecast to result in a slower increase in the concentration of salts in the void lake.
- Increasing the groundwater EC is found to result in a very minor increase in the rate of increase of overall void lake EC (Scenario 5). This is due to groundwater being a negligible component of the void lake water balance.
- Reducing evaporation (Scenario 6) is forecast to result in a slower increase in the concentration of salts in the void lake. However, as for the Base Case, maximum EC will be governed by the salt solubility limit rather than the evaporation rate.

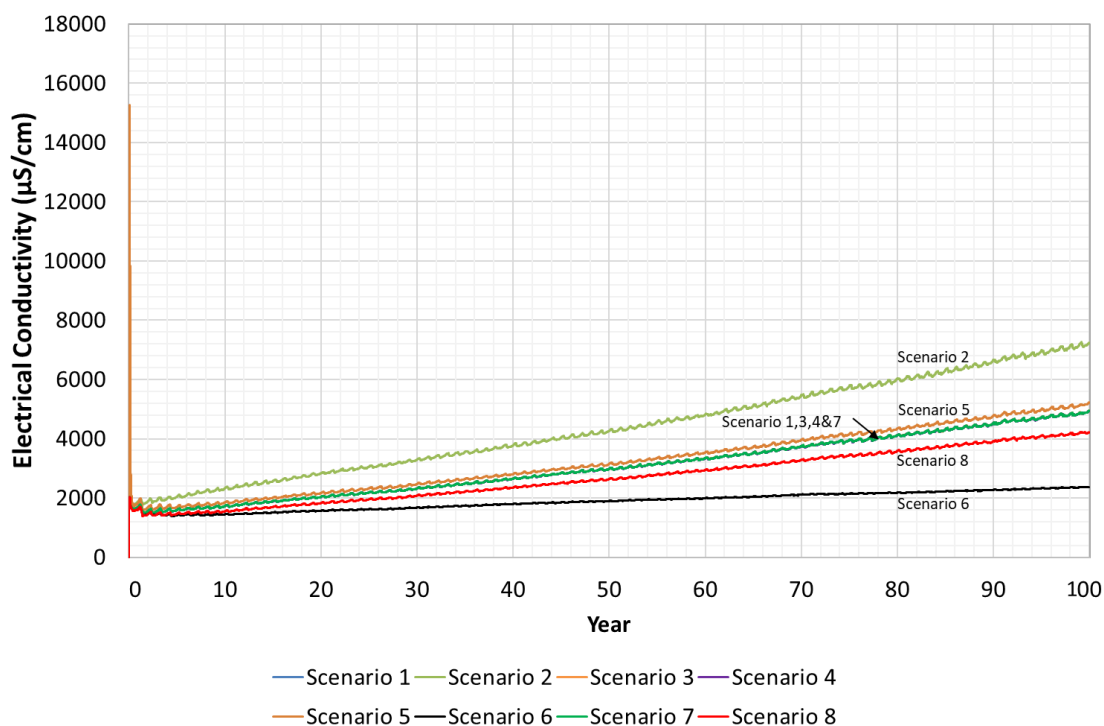


Figure 3.7 Forecast Jax Main Pit Void Lake Median EC (Sensitivity)

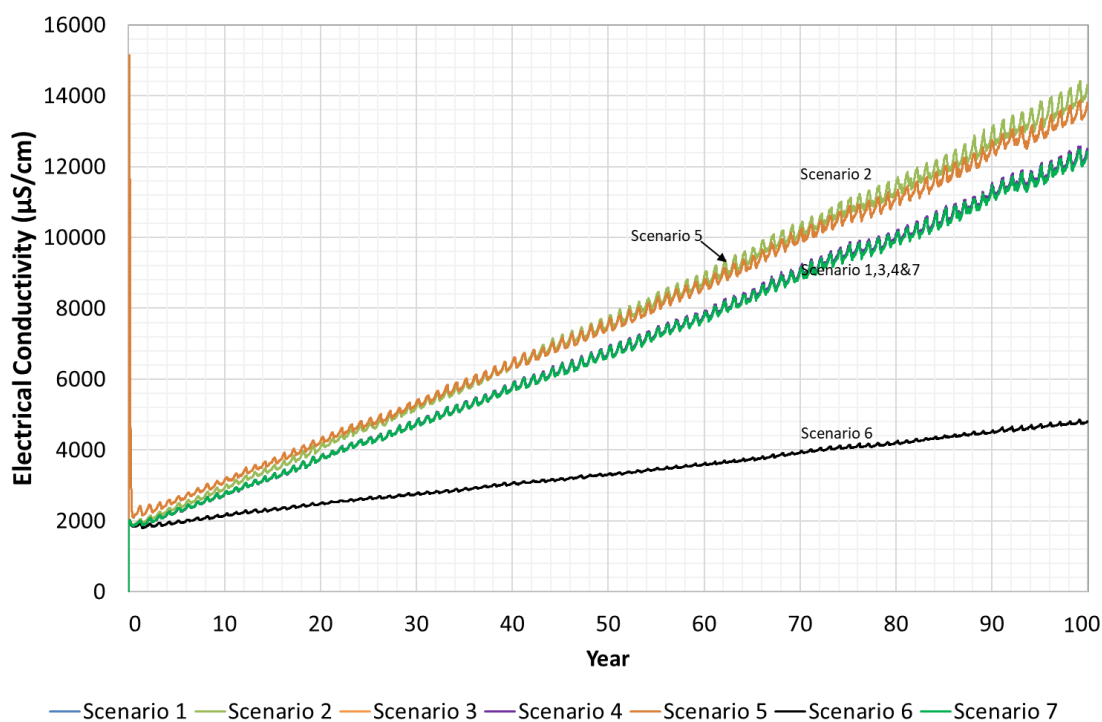


Figure 3.8 Forecast Jax East Pit Void Lake Median EC (Sensitivity)

4. CONCLUSIONS

The key findings from the study are:

- The final void lakes are forecast to fill to equilibrium levels of:
 - Approximately 110 m AHD in Jax Main Pit within a period of approximately 70 to 90 years following cessation of dewatering activities in Jax Main Pit.
 - Approximately 104 m AHD in Jax East Pit within a period of approximately 40 to 50 years following cessation of dewatering activities in Jax East Pit.
 - These levels are approximately 47 m to 58 m below the level at which the void lakes would spill to the receiving waterways. No overtopping of the void lakes to the receiving environment is forecast to occur.
- The pre-mining groundwater level in the vicinity of Jax Main Pit is substantially higher (30 m) than the forecast void lake equilibrium level. Accordingly, the Jax Main Pit final void is expected to remain a sink to groundwater flows, with no reverse flow from the void to groundwater expected to occur.
- The pre-mining groundwater level in the vicinity of Jax East Pit is substantially higher (36 m) than the forecast void lake equilibrium level. Accordingly, the Jax East Pit final void is expected to remain a sink to groundwater flows, with no reverse flow from the void to groundwater expected to occur.
- Due to the future depth of the void lakes and the likely thermal gradient, the lakes are considered to have a high potential for stratification. This is likely to occur on a seasonal cycle with stratification in the warmer summer months followed by mixing in the cooler winter months or under climatic conditions that would promote the turnover of the void lake stratification (e.g. strong winds).
- The salinity of the void lakes is forecast to increase over time as evaporation results in on-going concentration of salts.
 - The void lake EC of both Jax Main Pit and Jax East Pit is forecast to increase at an average rate of approximately 30-100 $\mu\text{S}/\text{cm}$ per year. The maximum EC will ultimately be governed by the salt solubility limit.
 - The water in the Jax void lakes is not expected to impact surface water quality in the adjacent drainage features due to the significant difference in elevation between the equilibrium lake level and the surface drainage channels.

5. QUALIFICATIONS

- a. In preparing this document, including all relevant calculation and modelling, Engeny Water Management (Engeny) has exercised the degree of skill, care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering principles.
- b. Engeny has used reasonable endeavours to inform itself of the parameters and requirements of the project and has taken reasonable steps to ensure that the works and document is as accurate and comprehensive as possible given the information upon which it has been based including information that may have been provided or obtained by any third party or external sources which has not been independently verified.
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 - (ii) Engeny considers it prudent to revise any aspect of the works in light of any information which becomes known to it after the date of submission.
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- g. This report does not provide legal advice.

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2 April 2019

QCoal Services Pty Ltd
Level 15, 40 Creek Street
Brisbane QLD 4000

Attention: Julian Dobos

Dear Julian,

RE: LONG TERM WATER QUALITY OF JAX COAL MINE RESIDUAL VOIDS

As per our conversation on Monday 25 March 2019, I understand that you require confirmation of the long term water quality in the planned residual void lakes at the Jax Coal Mine (JCM). This is to inform the post-mining land use.

Previous Study

Engeny Water Management (Engeny) previously prepared the *JCM Final Void Hydrology Study Jax Main Pit and Jax East Pit* (Engeny, Nov 2018). That study utilised a GoldSim water balance model of the planned residual voids to forecast the long term hydrology of the void lakes including equilibrium volumes and water quality trends. Water quality was represented as electrical conductivity (EC) by undertaking a salt mass balance coupled with the water balance to estimate Total Dissolved Solids (TDS) and utilising a conversion factor ($1 \mu\text{S/cm EC} = 0.67 \text{ mg/L TDS}$).

The study presented results for a 100 year simulation after cessation of mining, which was long enough to achieve an equilibrium volume in the void lakes. However, the EC was continuing to rise linearly over time. This increase is due to the lack of any significant outflows from the voids (i.e. water leaves the voids through evaporation, but there is no associated transport of salt). Consequently, the concentration of TDS and associated EC continues to increase over time, ultimately governed by the solubility limit.

Review of Livestock Drinking Water Quality

Guidance on drinking water quality limits for livestock is provided in *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC & ARMCANZ, Oct 2000). Tolerance of livestock to TDS in drinking water is summarised in Table 1. The livestock of interest in the locality of JCM is beef cattle, which experiences a loss of production and decline in animal condition for TDS values exceeding 5,000 mg/L (approximately 7,460 $\mu\text{S/cm EC}$).

Table 1 Tolerance of livestock to TDS in drinking water (ANZECC & ARMCANZ, Oct 2000)

Livestock	Total dissolved solids (mg/L)		
	No adverse effects on animals expected	Animals may have initial reluctance to drink or there may be some scouring, but stock should adapt without loss of production	Loss of production and a decline in animal condition and health would be expected. Stock may tolerate these levels for short periods if introduced gradually
Beef cattle	0–4000	4000–5000	5000–10 000
Dairy cattle	0–2500	2500–4000	4000–7000
Sheep	0–5000	5000–10 000	10 000–13 000 ^b
Horses	0–4000	4000–6000	6000–7000
Pigs	0–4000	4000–6000	6000–8000
Poultry	0–2000	2000–3000	3000–4000

a From ANZECC (1992), adapted to incorporate more recent information

b Sheep on lush green feed may tolerate up to 13 000 mg/L TDS without loss of condition or production

Long Term Water Quality

The previous water balance model has been extended to simulate a period of 500 years after cessation of mining. The forecast water quality trends in the Jax Main Pit and Jax East Pit void lakes over this horizon are presented in Figure 1 and Figure 2 respectively.

The results indicate that the previous water quality trends continue over the longer simulation period. The time to exceed the threshold for loss of production in beef cattle is summarised in Table 1 and shown to be within 80 years and 200 years for Jax East Pit and Jax Main Pit respectively. The average rate of increase in EC over the simulation is summarised in Table 3.

Table 2 Time to exceed the threshold for loss of production in beef cattle (years)

Pit Void	5 th Percentile	50 th Percentile	95 th Percentile
Jax Main Pit	196	157	133
Jax East Pit	78	55	40

Table 3 Rate of increase in EC (µS/cm/year)

Pit Void	5 th Percentile	50 th Percentile	95 th Percentile
Jax Main Pit	34	42	50
Jax East Pit	84	119	157

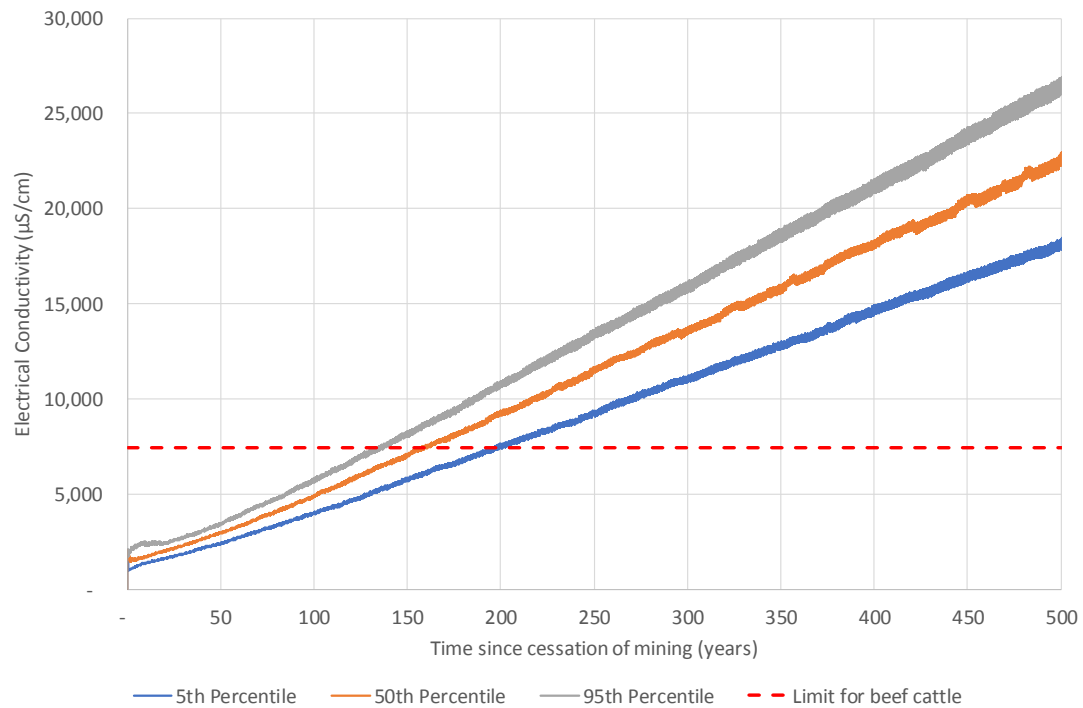


Figure 1 Jax Main Pit void lake EC forecast

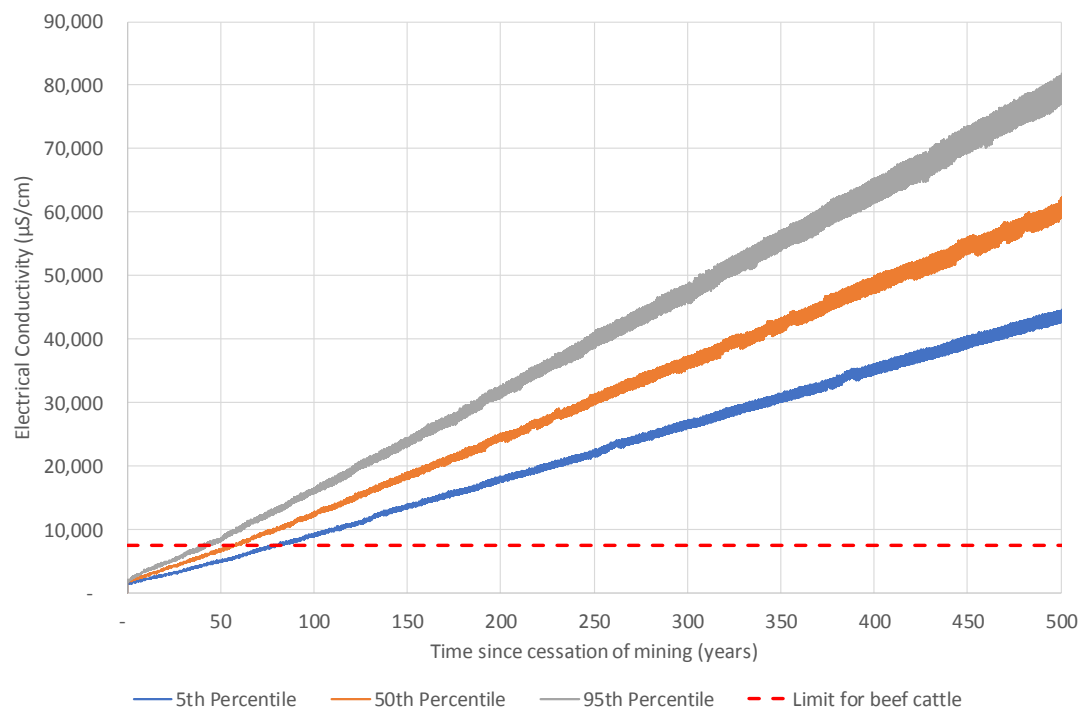
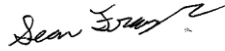


Figure 2 Jax East Pit void lake EC forecast

Please don't hesitate to contact the undersigned if you have any questions or would like to discuss further.

Yours faithfully



Sean Frazer
Principal Engineer (CPEng, RPEQ)
Associate

APPENDIX B

Residual Void Hydrology Study QCoal Northern Hub Mines April 2020 (Engeny ((2020))

QCOAL SERVICES PTY LTD

Residual Void Hydrology Study

QCoal Northern Hub Mines



April 2020

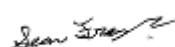
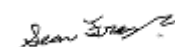
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M4100_041 RESIDUAL VOID HYDROLOGY STUDY						
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REV	DESCRIPTION	AUTHOR	REVIEWER	PROJECT MANAGER	APPROVER (PD)	DATE
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Signatures						

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1. INTRODUCTION

Sonoma Coal Mine (SCM), Cows Coal Mine (CCM), Drake Coal Mine (DCM) and Jax Coal Mine (JCM) are four independent but co-located mining operations owned and operated by subsidiaries of QCoal Pty Ltd (QCoal) and are collectively referred to as the QCoal Northern Hub (QNH). The QNH is located south of Collinsville within the Bowen Basin.

Environmental Authorities (EAs) have been issued for each independent mine by the Department of Environment and Science (DES) under the Environmental Protection Act 1994. The EAs associated with the QNH are summarised in Table 1.1. SCM, CCM, DCM and JCM are each authorised to operate under their respective EA.

Table 1.1 Summary of QNH Environmental Authorities

Site	EA Permit Number	EA Date	EA Holder	Locations
SCM	EPML00707713	03/10/2019	Watami (Qld) Pty Ltd JS Sonoma Pty Ltd CSC Sonoma Pty Ltd QCoal Sonoma Pty Ltd	ML10325 ML10326 ML10327
CCM	EPML00334613	03/10/2019	Bowen River Coal Pty Ltd	ML10345
DCM	EPML00393013	03/10/2019	Northern Hub (Drake) Pty Ltd Drake Coal Pty Ltd	ML10349 ML10350 ML10351
JCM	EPML00337613	2020	Jax Coal Pty Ltd	ML10346

QCoal has commissioned Engeny Water Management (Engeny) to undertake a void hydrology study of existing and proposed QNH residual voids. Previous void assessments have been undertaken by Engeny for the QNH as described in Section 2.1.

2. DATA REVIEW

2.1 Previous Studies

Previous studies referred to for this assessment include:

- Water Management Plan 2019/2020 QNH Mines (Engeny, February 2020).
- Drake Coal Project: Environmental Impact Statement (GHD, 2012)
- SCM Final Void Hydrology Study Main Pit (Engeny, November 2015).
- CCM Final Void Hydrology Study Q Pit and B Pit (Engeny, April 2017).
- *JCM Final Void Hydrology Study Jax Main Pit and Jax East Pit (Engeny, November 2018)* – this assessment and the conclusions therein remain applicable as there is no change to the proposed final landform.

2.2 Approved Residual Voids

The EAs for SCM, DCM, CCM and JCM stipulate the approved voids, their size and required wall slopes for each of the specific sites (i.e. Table H1 in each EA), which has been summarised in Table 2.1.

It is noted that not all of the voids may eventuate and/or some approved voids stated as discrete pits in the EA are operationally part of broader complexes comprising multiple in close proximity where the void area is cumulative (this is especially the case for the DCM), as shown in Table 2.1 and detailed further in Section 2.3.

Table 2.1 EA Table H1 for SCM, CCM, DCM and JCM

Residual Void	Void Area	Maximum Slope
Sonoma Coal Mine – EPML00707713		
Sonoma Main Pit	120 ha	High wall – maximum slope of 70° with the top 10m having a maximum slop of 45° including a 1m bund Low wall – 17° – 37°
Sonoma East Pit 1	14 ha	
Sonoma East Pit 2	15 ha	
Sonoma Q-Pit	N/A backfilled	N/A backfilled

Residual Void	Void Area	Maximum Slope
Sonoma B-Pit	N/A backfilled	N/A backfilled
Cows Coal Mine – EPML00334613		
B Seam Pit	Backfilled	N/A
Q Seam Pit	Backfilled	N/A
Drake Coal Mine – EPML00393013		
Drake Pit 5	59 ha	High wall – 65° Low wall – 45°
Drake Pit 1	258 ha	
Drake Pit 2		
Drake Pit 2 Expansion		
Central Pit 3	50 ha	
Central Pit 4	16 ha	
East Pit 1	14 ha	
Drake Pit 3-Q	61 ha	
Drake Pit 3-R		
Jax Coal Mine - EPML00337613		
Jax Main Pit ¹	70 ha	High wall – 60° Low wall – 32°
Jax East Pit ¹	27 ha	

Note 1: Post mining land use of Aquatic Ecosystems

2.3 Voids Modelled for this Assessment

There are currently seven existing open cut mining pits across QNH. There are an additional six open cut pits planned at this time (subject to operational and economically driven changes) which have not yet commenced (i.e. Sonoma East Pit 1, Sonoma East Pit 2, Jax East Pit, Drake Pit 2 Expansion, Drake Pit 4 North and Drake Pit 4 South).

It is clearly noted that as mine planning is subject to change driven by economic factors locally and internationally (notably coal price and demand), the presence of voids as well as their size or shape, is subject to change. As such within the level of design information available, Engeny has undertaken to conservatively assess the layout of final voids provided by QCoal, such that should minor changes to a void or pit complex occur over the life of QNH, this assessment can still be relied upon to inform impact assessments provided key hydrological modelling parameters (e.g. catchment and pit geometry) are maintained (see Section 5.1).

Additionally, the nomenclature for QNH pits and residual voids has changed from approvals through to operation as a result of changes to mine planning.

As such the key document sets used to define the residual void locations and extents were:

- Environmental Impact Statements (EIS) for DCM;
- Later Development Plans (LDP) for SCM, DCM and JCM;
- EAs for SCM, CCM, JCM and DCM; and
- QCoal Life of Mine Planning (LOMP) for SCM, CCM, JCM and DCM

A summary of the residual voids modelled in this assessment, including the various nomenclatures, areas and operational status is provided in Table 2.2, which shows that:

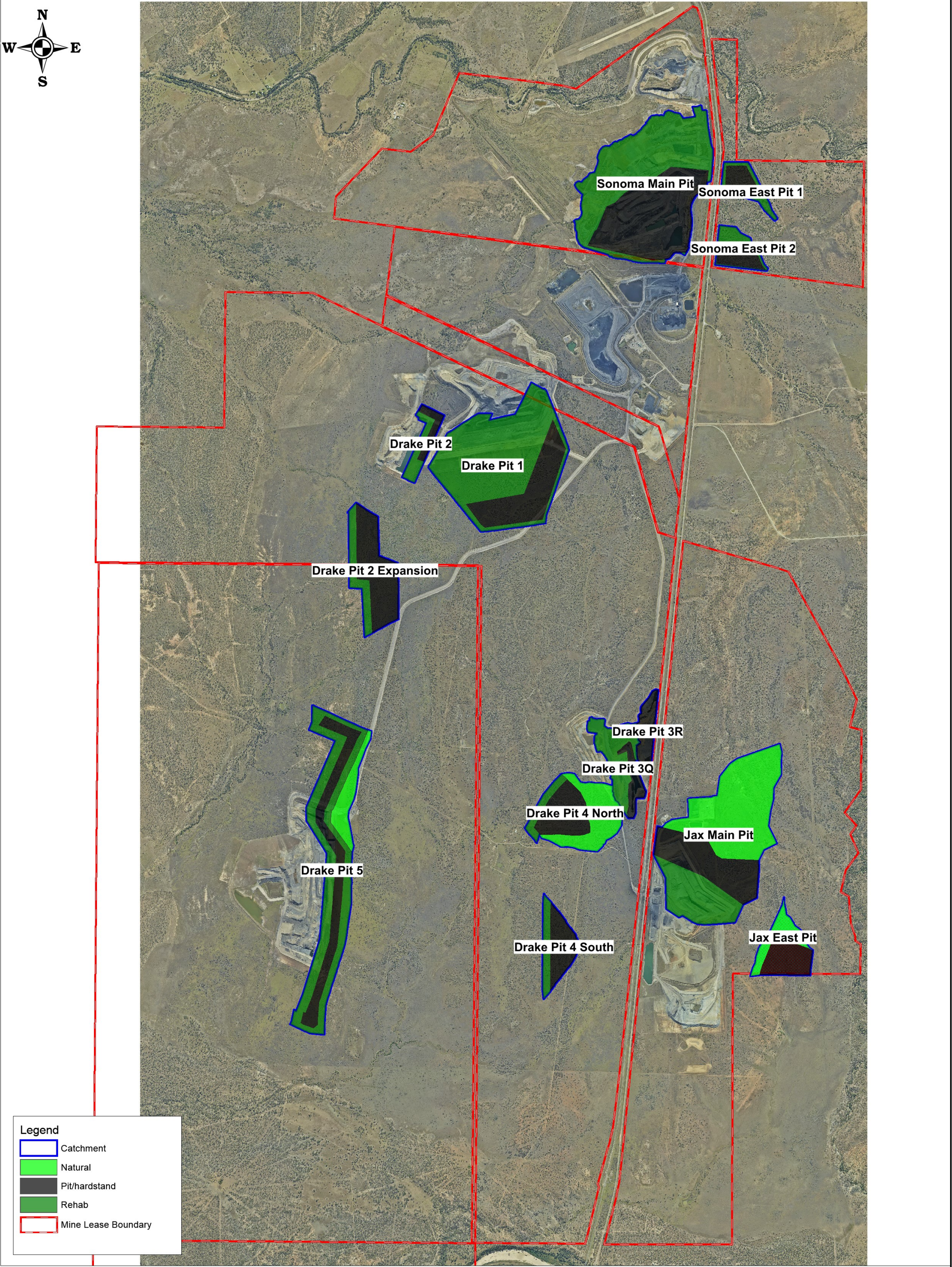
- DCM Central 3 is Drake Pit 4 North;
- DCM Central 4 is Drake Pit 4 South; and
- DCM East Pit 1 void as approved in the EA has not been modelled as a discrete void for the purposes of this assessment as it was considered that any potential development of East Pit 1 would be more likely as a small extension or satellite pit of Drake 1 Pit.

A site layout is presented in Figure 2.1 and identifies the locations of the proposed residual voids modelled in this assessment.

Table 2.2 Summary of Modelled QNH Residual Voids

Mine Site	Report ID	EIS ID	EA ID	Approved Residual Void Surface Area	Modelled Residual Void Surface Area	Current Status
SCM	Sonoma East Pit 1	Sonoma East Pit Complex	Sonoma East Pit 1	14 ha	14 ha	Planned
	Sonoma East Pit 2		Sonoma East Pit 2	15 ha	15 ha	Planned
	Sonoma Main Pit	Sonoma Main Pit	Sonoma Main Pit	120 ha	139 ha	Commenced
DCM	Drake Pit 1	West 2	Drake Pit 1	258 ha	64 ha	Commenced
	Drake Pit 2		Drake Pit 2		9 ha	Commenced
	Drake Pit 2 Expansion		Drake Pit 2 Expansion		60 ha	Planned
	Drake Pit 3Q	East 3	Drake Pit 3Q	61 ha	14 ha	Commenced
	Drake Pit 3R		Drake Pit 3R		21 ha	Commenced
	Drake Pit 4 North	Central 3	Central 3	66 ha	38 ha	Planned
	Drake Pit 4 South	Central 4	Central 4		28 ha	Planned
	Drake Pit 5	West 1	Drake Pit 5	59 ha	59 ha	Commenced
JCM	Jax Main Pit	N/A	Jax Main Pit	70 ha	69 ha	Commenced

Mine Site	Report ID	EIS ID	EA ID	Approved Residual Void Surface Area	Modelled Residual Void Surface Area	Current Status
	Jax Pit East	N/A	Jax East Pit	27 ha	28 ha	Planned



2.4 Residual Void Requirements and Outcomes

The EAs for SCM, DCM, CCM and JCM also stipulate general rehabilitation requirements and outcomes for voids (stated as Condition H13 in each EA):

- Condition H13 Residual Void Outcome (all QNH EAs)

Residual Voids must comply with the following outcomes:

- a) Residual voids must not cause any serious environmental harm to land, surface waters or any recognised groundwater aquifer, other than the environmental harm constituted by the existence of the residual void itself and subject to any other condition within this environmental authority;*
- b) residual voids must comply with Table H1: Residual void outcomes;*
- c) At the completion of decommissioning and rehabilitation, all voids must demonstrably have the appropriate level of flood protection from nearby watercourses as approved by the administering authority, such that the protection is sustainable for the foreseeable future.*

The JCM EA also includes some more specific detail regarding the outcomes for the two approved voids (stated in JCM EA Table H1), which the SCM, DCM and CCM EAs do not. The JCM EA Table H1 includes the following void outcome statement:

- Table H1 JCM EA

Void Outcomes for Jax Main Pit and Jax East Pit: Residual Void unable to sustain a Post Mining Land Use.

2.5 Mine Planning and Residual Void Concepts

The residual void locations and extents for current and proposed pits were determined based on the following documents:

- DCM EIS (2012).
- LOMP – outlines the mining operations and extent of disturbance within existing as well as proposed mining pits for the remainder of the mine life. This was used to determine the geographical location of the residual voids.
- LDP – a 5-year plan (FY20 to FY24) developed by QCoal which was used to determine the direction of mining progression within the disturbed extent.
- EAs – for each respective mine site. Approved residual void surface areas for each residual void were used as a guide to delineate void surface area at natural ground level.

An overview of the conceptual final landform for residual voids at each mine site is provided in the following sections.

2.5.1 SCM Residual Voids

- Sonoma Main Pit is located centrally within the SCM ML. Design final landforms including in-pit co-disposal have been provided by QCoal (August 2019) for two final scenarios. Option 1 involved in-pit co-disposal with a rejects embankment and Option 2 involved in-pit co-disposal without rejects embankment. Option 2 (refer Figure 2.2) has been assumed for this assessment. Both options remain under review by QCoal at the time of this assessment. Results presented in this document are for Option 2. It is noted that the landform provided to Engeny was for year 20 of in-pit co-disposal deposition and it is understood that the ultimate final landform of rejects deposition is estimated to be an additional 20m higher. Forecast void lake water levels determined in this assessment need to be translated up by a similar amount but remain representative of the final higher final landform surface.
- Sonoma North Pit is located in the north-east of the SCM ML. QCoal propose to backfill this pit and it will therefore will not remain as a residual void post-mine closure.
- Sonoma East Pit 1 and Sonoma East Pit 2 are planned for commencement within the next five years. It is not proposed to backfill either pit and therefore both are expected to remain as residual voids.

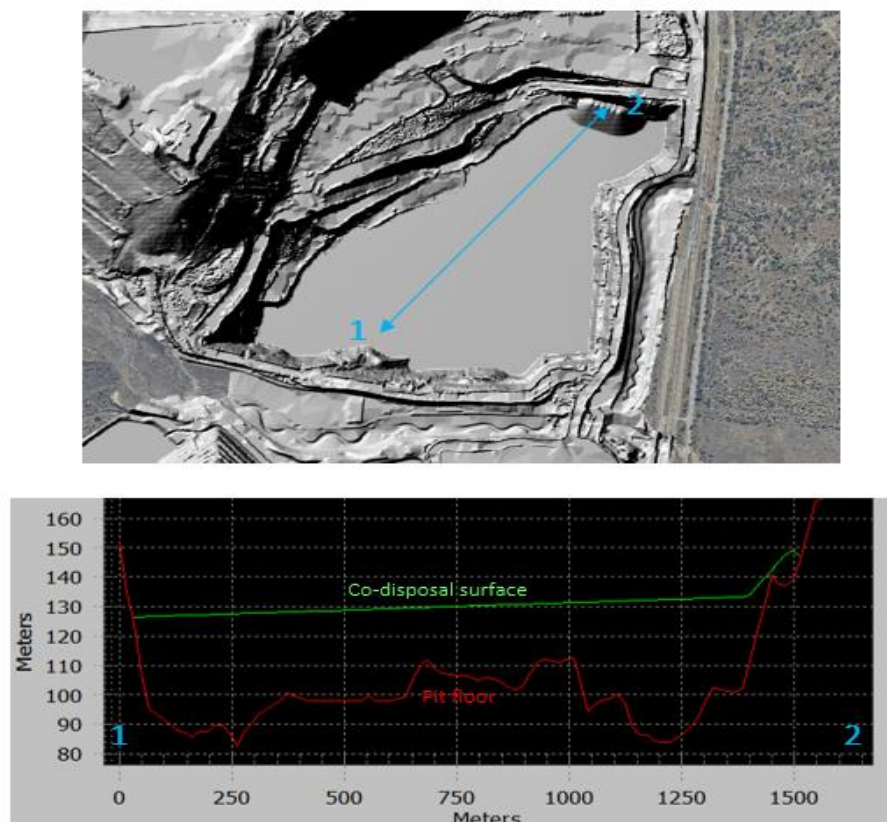


Figure 2.2 Year 20 Proposed Sonoma Main Pit Residual Void Landform (Option 2)

2.5.2 CCM Residual Voids

- Q Pit was in the south-east corner of the SCM/CCM mines and spanned the SCM and CCM MLs. Q Pit has been fully backfilled. A small sediment dam (Q Pit Sediment Dam) has since been constructed on the SCM ML portion of the backfilled void.
- B Pit operation (referred to as the Cows Pit in various other documents) spans the SCM and CCM MLs, and transitions into the Drake 1 Pit to the south on the DCM ML. B Pit void on the SCM and CCM MLs has been backfilled.

There are no residual voids proposed on the CCM mine lease.

2.5.3 DCM Residual Voids

- Drake Pit 1 void is located at the northern extent of the DCM abutting the CCM ML boundary and is the southern progression from B Pit into the north of DCM.
- Drake Pit 2 is immediately to the west of Drake 1 Pit.
- Drake Pit 2 Expansion is a proposed residual void to the south-west of Drake 1.
- Drake Pit 3R is located on the eastern boundary of the mine lease approximately 5 km south of Q Pit.
- Drake Pit 3Q is located on the eastern boundary of the mine lease immediately south of Drake 3 R Pit.
- Drake Pit 4 North and Drake Pit 4 South are two additional proposed residual voids within DCM.
- Drake Pit 5 is located in the south- western portion of DCM.
- East Pit 1 remains an approved void but as describe in Section 2.3 is likely to be amalgamated as part of the broader Drake Pit 1, Drake Pit 2 and Drake Pit 2 Expansion complex.

It is not currently planned to backfill any of the DCM pits and therefore all above mentioned DCM pits will remain as residual voids. It is noted that a new pit called Drake Pit 3Q South is included in the DCM life of mine plan, however it has not been included in the residual void hydrology assessment. As advised by QCoal, there is not sufficient planning data to inform an assessment of Drake 3Q South Pit at this time. It may be assessed at a future date when planning has further progressed.

2.5.4 JCM Residual Voids

- The JCM Main Pit void is located centrally within the JCM mine lease. QCoal is not planning to backfill the JCM Main Pit and it is planned to remain as a residual void.

- Jax East Pit has not yet commenced, and the timing of mining commencement has not yet been confirmed. It is planned to remain as a residual void.

A residual void hydrology assessment for Jax Coal Mine was previously undertaken (Engeny, November 2018). The proposed final landform has not changed since that study was undertaken. Minor changes to groundwater levels and recovery curves were reported in the updated groundwater assessment (AGE, 2020) however these changes were not material to residual void outcomes. Consequently, the previous Jax pits void assessment outcomes remain suitable and have not been updated.

2.6 Storage Characteristics

It has been assumed that existing storage curves of operational pits at their current layout is suitable to represent pit geometry of their respective residual voids. Storage curves for pits which have not yet commenced were estimated based on the geometry of existing pits of similar size. The process for adapting storage curves to new locations involved the following steps:

- Comparison of approved residual void areas to the surface area (at crest level) of existing pit voids to identify an appropriate pit to represent the future residual void storage characteristics.
- Transpose the adopted storage curve vertically such that the crest level corresponds to the natural ground level at the location of the planned residual void.

The assumed final landform storage curves of existing and proposed residual voids along with their respective storage capacities are summarised in Table 2.3. Plots of adopted storage curves are provided in Appendix A. Storage curves for any final void planning or assessment are an area of uncertainty as actual final storage curves will not be possible to determine until mining has been completed, and any low-wall/high-wall rehabilitation requirements have also been completed. The adopted curves are the best available estimate of the residual void storage characteristics based on currently available mine planning information and are considered suitable for the purposes of this assessment.

Table 2.3 Assumed Residual Void Storage Curves

Residual Void	Adopted Storage Curve	Storage Capacity (ML)
Sonoma Main Pit	In-pit co-disposal without reject wall (Design)	45,151
Sonoma East Pit 2	Jax Pit (survey 2013)	2,009
Sonoma East Pit 1	Jax Pit (survey 2013)	1,788
Drake Pit 1	Drake Pit 1 (survey 2019)	18,323

Residual Void	Adopted Storage Curve	Storage Capacity (ML)
Drake Pit 2	Drake Pit 2 (survey 2019)	1,711
Drake Pit 2 Expansion	Drake Pit 1 (survey 2019)	15,824
Drake Pit 3Q	Drake Pit 3Q (survey 2019)	2,326
Drake Pit 3R	Drake Pit 3R (survey 2019)	1,254
Drake Pit 4 North	Jax Pit (survey 2019)	6,160
Drake Pit 4 South	Jax Pit (survey 2019)	3,708
Drake Pit 5	Drake Pit 1 (survey 2019)	13,996

2.7 Catchment Delineation

The contributing catchment to each residual void has been determined using the following data:

- Drone survey dated August 2019.
- LOMP polygons (supplied by QCoal 11/10/2019).
- EA conditions determining maximum residual void footprints (refer Table 2.1).
- Site wide aerial survey dated July 2014.
- Aerial photography dated June 2019.

It has been assumed that all out-of-pit spoil areas will be rehabilitated following the cessation of mining. The adopted catchments for QNH residual voids are presented in Figure 2.1. Based on the final landform criteria defined in the site EAs (refer Table 2.1) and the anticipated maximum landform heights (LOMP), it is estimated that approximately a 100 m width of the low wall batter will drain to the residual void while all remaining rehabilitated catchment will be diverted by grading the dump away from the void.

Where diversion of upslope natural catchment can be achieved with minor drainage works (i.e. shallow drains and bunds) it has been assumed that these works would be incorporated into the final landform. Where more significant infrastructure would be required to divert upslope catchment, it has been conservatively assumed to report to the residual void in the base case scenario with an optimised catchment scenario discussed in Section 2.7.1.

A summary of the contributing catchment areas for the base scenarios is provided in Table 2.4

Table 2.4 Contributing Catchment Area for Residual Voids (Base Case)

Mine Site	Residual Void	Catchment Area (ha)
SCM	Sonoma East Pit 1	25
	Sonoma East Pit 2	27
	Sonoma Main Pit	280
DCM	Drake Pit 1	240
	Drake Pit 2	22
	Drake Pit 2 Expansion	80
	Drake Pit 3Q	55
	Drake Pit 3R	21
	Drake Pit 4 North	97
	Drake Pit 4 South	42
	Drake Pit 5	191
JCM	Jax Main Pit	264
	Jax East Pit	49

2.7.1 Optimisation of Catchment

Catchment area is one of the key driving variables for residual void hydrology outcomes. Void catchment area was investigated as a driver in the equilibrium lake level, which informs a voids potential for seepage into the regional groundwater. For example, the conceptual Drake Pit 4 North residual void was identified during this assessment as a void where sections of the upslope catchment defined in the LOMP could be diverted around the void as an alternative to directing it into the void, thereby reducing the void lake level. The diversion concept is illustrated in Figure 2.3 and involves an excavated drain along the north-eastern side of Drake Pit 4 North to divert approximately 48 ha of undisturbed catchment.

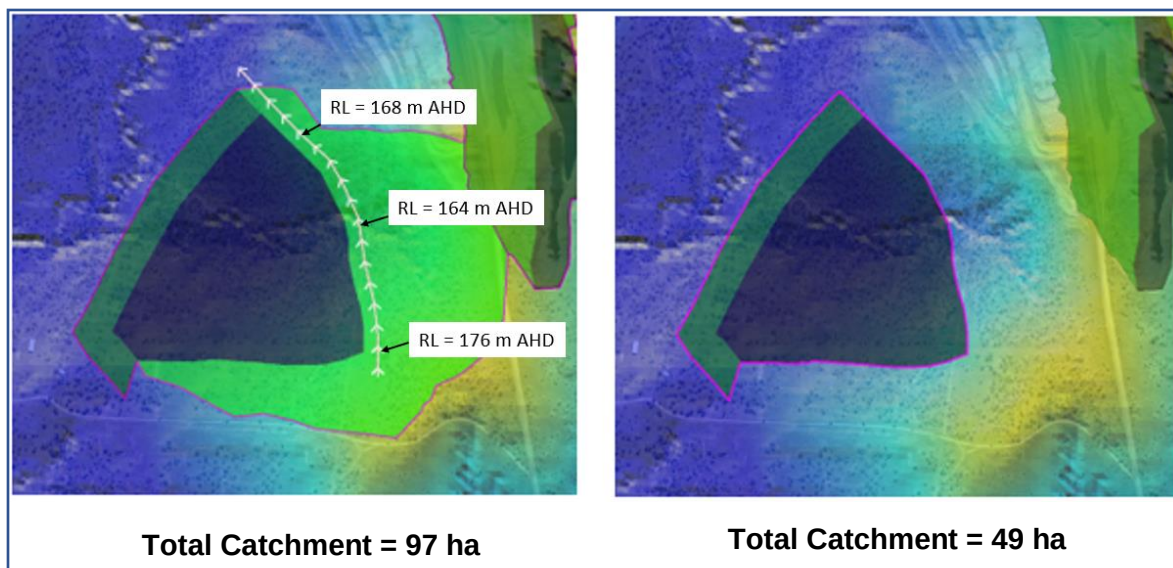


Figure 2.3 Drake Pit 4 North diversion concept (left) and mitigated catchment (right)

3. GROUNDWATER CONTRIBUTION

3.1 Groundwater Quantity and Interaction

Numerical groundwater modelling of the design residual voids was undertaken by AGE (March 2020) to predict groundwater recovery after the cessation of mining. From the model, a rating curve of groundwater inflow versus pit water level for each residual void was developed (Refer to Appendix B). It is noted that the range of the groundwater recovery curves is limited by the water levels simulated in the groundwater model. Where required, the final value of the groundwater recovery curves have been conservatively maintained for the remainder of the adopted void storage curves.

Negative flows shown in the groundwater recovery curve figures indicate the elevation of water level within the lake at which point a net outflow from the void lake can potentially occur. **Any modelled outflows from a void lake resulting from these portions of the groundwater recovery curves need to be interpreted with care and may not necessarily indicate flows to the surrounding regional groundwater system.** In particular, through discussion with AGE, it is understood that the adopted groundwater recovery curves are impacted by the following processes:

- Interaction between residual void lakes located in close proximity such as hydraulic gradients between void lakes resulting in flow from one void lake to another **which is not considered to be flow into the surrounding regional groundwater** (e.g. between Sonoma East 1 and Sonoma East 2 and between Drake 3Q and Drake 3R). It is noted that the modelled flow rates in these situations are generally of very small magnitude.
- Outflows from the void lakes into the surrounding spoil material. The numerical model makes no distinction between outflows from the void lake into the low-wall backfill waste rock material and outflows into the regional groundwater system. As such a modelled outflow as determined by the model may be associated with the saturation period of the low-wall waste rock until such time as steady state equilibrium is reached. This primarily occurs during the initial recovery period when the spoil material is first becoming saturated.

The interaction between the residual void lake and surrounding regional groundwater (be it net inflow or outflow) considers a range of indicators including:

- Base of Weathering – the threshold between highly weathered material and less permeable hard rock. The Base of Weathering provides an indication of areas where seepage from a void lake into the surrounding geology might occur if lake levels are forecast to exceed this threshold. Again such seepage is not immediately representative of a groundwater source into regional groundwater.
- Regional Groundwater Level – when the regional groundwater level exceeds the forecast void lake level then there is a hydraulic gradient into the void and the void is considered to act as a groundwater sink. Alternatively, a void lake level that is forecast

to be above the regional groundwater level may result in a hydraulic gradient out of the void into the surrounding geology (a net outflow). However, localised outflow from a source pit has the potential to be captured by a down-gradient pit acting as a global sink in which case would not be representative of a source to the regional groundwater. This process can be identified through hydrogeological modelling.

- **Net Zero Flow Level** – This level has been extracted from the groundwater recovery curves described in Section 3.1 and provides an indication of the direction of water fluxes to the void lake. As previously stated, outflows resulting from these recovery curves need to be interpreted with care as they may represent movement from one void (an net outflow) to an adjacent void which is a groundwater sink (a net inflow) thus containing void water from both voids (considered as movement within a groundwater sink system), or movement of water into unsaturated low wall spoil material, as opposed to an actual flow into the regional groundwater system.

AGE (2020) has provided a summary of these indicator levels for each of the residual voids as summarised in Table 3.1.

Table 3.1 Base of Weathering and Regional Groundwater Levels

Mine Site	Residual Void	Base of Weathering (mAHD)	Pre- mining Regional Groundwater Level (mAHD)	Net Zero Flow Level (mAHD)
SCM	Sonoma East Pit 1	155.80	156.30	Inflows at all levels
	Sonoma East Pit 2	156.92	155.53	Outflows at all levels
	Sonoma Main Pit	153.02	155.67	8.23
DCM	Drake Pit 1	169.07	146.57	Inflows at all levels
	Drake Pit 2	153.4	147.23	100.11
	Drake Pit 2 Expansion	163.99	144.24	Inflows at all levels
	Drake Pit 3Q	161.28	142.55	Inflows at all levels
	Drake Pit 3R	156.72	141.78	83.15
	Drake Pit 4 North	126.96	139.50	Inflows at all levels
	Drake Pit 4 South	146.72	136.71	Inflows at all levels
	Drake Pit 5	144.39	137.42	Inflows at all levels

3.2 Groundwater Quality

Monitoring of groundwater quality across a number of monitoring bores at QNH is undertaken on a quarterly basis. The groundwater quality data has previously been assessed as part of the *SCM Final Void Hydrology Study Main Pit* (Engeny, 2015) and *CCM Final Void Hydrology Study Q Pit and B Pit* (Engeny 2017). Both studies determined a representative groundwater inflow quality of 2,000 $\mu\text{S}/\text{cm}$. A consistent quality has been adopted for the *JCM Final Void Hydrology Study Jax Main Pit and Jax East Pit* (Engeny, November 2018) is considered suitable for the purposes of this assessment.

4. WATER BALANCE MODEL DEVELOPMENT

4.1 Overview

Engeny has previously developed a water balance model of the QNH mines using the GoldSim software. The development of the model, input parameters and calibration are detailed in *Water Management Plan QNH Mines* (Engeny, 2020). The existing model has been adopted as a basis for this assessment.

4.2 Residual Void Inflows and Outflows

The water balance of the residual voids will be governed by the following water inflows and outflows:

- Inflows:
 - Surface runoff inflows from rehabilitated spoil areas that drain to the void.
 - Surface runoff inflows from the walls and ramps of the void.
 - Inflows from incident rainfall on the void lake.
 - Groundwater inflows to the void (if the void lake level is lower than the regional groundwater level) (refer to Section 3).
- Continuous Outflows:
 - Outflows due to evaporation losses from the surface area of the void lake.
- Potential Outflows (conditional on void lake level):
 - Seepage outflows from the void lake – either to an adjacent groundwater sink void, into the unsaturated low-wall waste rock dump or into the regional groundwater (if the void lake level is higher than the regional groundwater level).
 - Discharges to surface water (only if the void fills to spill level).

4.2.1 Runoff Generation

Catchment runoff has been simulated using the Australian Water Balance Model (AWBM). The model represents the catchment using three conceptual surface stores to simulate partial areas of runoff. The water balance of each surface store is calculated independently of the others. The model calculates the water balance of each partial area at daily time steps. At each time step, rainfall is added to each of the three surface stores and evapotranspiration is subtracted from each store. If the value of water in the store exceeds the capacity of the store, the excess water becomes runoff. Part of this runoff becomes recharge of the baseflow store if there is a baseflow component to the stream flow.

AWBM parameters were adopted from the existing QNH operational water balance model (as for *Water Management Plan QNH Mines* (Engeny, 2020)). These parameters are as summarised in Table 4.1.

Table 4.1 Adopted AWBM Runoff Parameters

Parameter	Natural	Hardstand & Pits	Rehabilitated Spoil
C1 (mm)	23.0	5.0	10.0
C2 (mm)	125.0	20.0	120.0
C3 (mm)	180.0	40.0	180.0
A1	0.134	0.134	0.134
A2	0.433	0.433	0.433
A3	0.433	0.433	0.433
BFI	0.05	0.00	0.35
Kb	0.87	0.60	0.60
Ks	0.30	0.10	0.10
Average Soil Store (mm)	135	27	131
Average Annual Runoff Coefficient	14%	36%	16%

4.2.2 Climate Data

Long-term daily rainfall data at the QNH was obtained from the SILO climate database facility hosted by the Queensland Department of Environment and Science (DES). SILO includes both Patched Point Data and Data Drill. The Data Drill utilises grids of data interpolated from point observations by the Bureau of Meteorology to provide climate statistics for a specified location. Patched Point Data is only available at selected rainfall stations and utilises grids of data to 'patch' any data gaps in the climate record at that site.

A SILO Patched Point Data climate series was obtained for the nearby Collinsville Post Office (33013) covering the period January 1889 to September 2019. A composite data set was obtained by merging the SILO data with SCM site rainfall to obtain a continuous record from January 1889 to September 2019 (130 years of data).

Table 4.2 Residual void Hydrology Assessment Climate Data

Month	Mean Rainfall (mm)	Mean Morton's Lake Evaporation (mm)	Mean Evapotranspiration (mm)
January	156	198	195
February	144	170	162
March	99	171	164
April	37	139	133
May	31	110	107
June	32	89	89
July	20	100	100
August	17	127	127
September	15	158	162
October	24	196	199
November	55	205	207
December	98	214	212
Total	727	1875	1857

Corrections to the lake evaporation rates were applied in the residual void water balance model to reflect the reduction to the freshwater evaporation rate that occurs for a saline water body. Morton's method for adjusting evaporation rates has been adopted as presented in *Hydrological Recipes: Estimation Technique in Australian Hydrology (1996)* as follows:

- Evaporation reduction factor = $1 / [1 + \text{TDS (mg/L)} / 10^6]$

This equation predicts a relatively small evaporation correction for salinity of approximately 1% reduction per 10,000 mg/L total dissolved solids (TDS) for TDS values up to 50,000 mg/L (i.e. 5% reduction for 50,000 mg/L TDS).

4.3 Water Quality

4.3.1 Salinity EC Conversion

Electrical conductivity (EC) and Total Dissolved Solids (TDS) are key indicators of water quality and can be simulated within the residual voids water balance model. The model directly simulates TDS using a salt mass balance and converts to EC via a constant conversion factor (1 mg/L TDS = 1.49 μ S/cm EC) (ANZECC & ARMCANZ, 2000). Water quality inputs to the water balance model have been reviewed and are summarised in the following sections.

4.3.2 Rainfall Dependent Salt Mass Inputs

Salinity of runoff generated in the water balance is determined based on land use type. Surface water runoff TDS characteristics have previously been calibrated for certain land use types as documented in *Water Management Plan QNH Mines* (Engeny, 2020). These runoff TDS characteristics have been adopted for the modelling of all voids in this void hydrology study and are summarised in Table 4.3.

Table 4.3 Water Source TDS Concentration (mg/L)

Source	Salinity (mg/L)
Pit wall runoff	1300 (1,931 μ S/cm EC)
Rehabilitated Spoil runoff	700 (1,040 μ S/cm EC)
Natural catchment runoff	700 (1,040 μ S/cm EC)
Direct rainfall	5 mg/L, based on latitude and distance from the coast (DNR, 1997)

4.3.3 Potential for Stratification

Due to the depths of the residual void lakes and the likely thermal gradients, the lakes are considered to have a potential for stratification which is a well understood hydrological occurrence. This is likely to occur on a seasonal cycle with stratification in the warmer summer months followed by mixing in the cooler winter months or under climatic conditions that would promote the turnover of the void lake stratification (e.g. strong winds).

For the purpose of the model, runoff entering the residual voids was assumed to be fully mixed with the existing stored water. This does not account for the potential stratification of water quality within voids. Assuming complete mixing of the void lake contents will provide an average salinity in the void lake over the simulation period and is considered suitable for the purposes of this assessment.

4.4 Model Assumptions

The following key assumptions were applied in the water balance modelling:

- Water outflows associated with the saturation of the spoil in the backfilled voids (typically during first filling conditions) are indirectly captured in the groundwater recovery curves and as such not explicitly represented in the water balance model. The model results are indicative of void lake behaviour after the backfill material becomes saturated.
- All residual voids were assumed empty at the start of simulation.
- The void lakes are fully mixed (i.e. no stratification). Water quality results indicate the average salt concentration of the entire void lake.
- The salinity of runoff from rehabilitated spoil was assumed to be consistent with undisturbed natural runoff.
- Storage curves and catchment areas have been inferred from the best available mine planning information. Adopted storage curves are assumed to be representative of proposed residual voids.
- All spoil stockpiles, backfilled areas and regraded pit walls were assumed to have the runoff quantity and quality characteristics of rehabilitated spoil.

5. MODEL RESULTS

The residual void hydrology water balance model was simulated for a period of 200 years. The historical climate data set has been used to assess 130 potential realisations of the void lake behaviour under different climate sequences. The residual void hydrology assessment was completed for two scenarios as described below:

- Base Case Scenario - The base case has been adopted using catchment delineation methodology described in Section 2.7 and Table 2.4.
- Mitigated Case Scenario - The mitigated scenario has been modelled where there is an opportunity to reduce the catchment area reporting to the residual voids beyond what was provided in the LOMP designs – which are not intended to be to such a detailed level of drainage design (Refer to Section 2.7.1).

Forecast void lake performance indicators are defined in section 5.1 while an example of typical void lake behaviour is provided in section 5.2. Detailed model output plots are provided in Appendix C and Appendix D. A discussion of the key outcomes of the assessment is provided in Section 5.3.1 and Section 5.3.2.

5.1 Void Lake Performance Indicators

The key indicators of the hydrological behaviour of the void lakes for this assessment include:

- Void lake equilibrium level - The equilibrium level is defined as the forecast median level (50th percentile) after the rapid filling period. This is considered to be the level at which the void lake is most likely to sit with periodic fluctuations above and below. Equilibrium level is relatively stable in the long term following the initial rapid filling period.
- Void lake equilibrium volume – The equilibrium volume is defined as the volume corresponding to equilibrium level.
- Void lake maximum level – The maximum level is defined as the highest void lake level forecast during the simulation.
- Void lake filling time – The void filling time is defined as the initial period of filling of the void after cessation of mining until the lake reaches its equilibrium volume.
- Poned area at equilibrium – Equilibrium level is determined by the balance between lake inflows (primarily catchment runoff) and outflows (primarily evaporation). The evaporation is governed by the ponded area of the lake based on the adopted storage curve. The ponded area at equilibrium has been reported to inform the suitability of the forecast results following more detailed refinement of the mine plan (i.e. the results presented are applicable when the contributing catchment, equilibrium level and ponded area at equilibrium are maintained), allowing for potential changes to void designs as per Section 2.3.

- Void lake water quality (EC) 200 years after cessation of operations – Void lake salinity has been reported at the end of the simulation to indicate the general trend of EC over time. The concentration of salts is forecast to increase beyond simulation period as there are negligible outflows of the salts from the residual voids.
- Residual void outcome - The void equilibrium and maximum level results have been compared with the groundwater interaction indicator levels (refer Section 3.1) to determine whether the void is likely to act as a groundwater 'sink' or a 'source'.
 - Sink - A groundwater 'sink' refers to a void which has modelled equilibrium and/or maximum levels lower than the regional groundwater level. The hydraulic gradient generated by this change in levels would result in groundwater ingress to the pit. It has been identified where lake levels are in close proximity to the regional groundwater level (within 2 m) or above the base of weathering as these outcomes may be impacted by uncertainties in model inputs.
 - Source - A groundwater 'source' refers to a void which has a net outflow of water from the void lake into the surrounding geology (generally identified by a water level above the regional groundwater level) where such outflow is not into the low-wall backfill material. In these cases, the hydraulic gradient would result in water within the pit seeping into groundwater systems.

A summary of the key void lake hydrology performance indicators are provided in Table 5.1 for the base case and mitigated catchment scenarios respectively.

5.2 Typical Void Lake Forecast Behaviour

An example of the void lake hydrology assessment results is provided in Figure 5.1 for level and Figure 5.2 for quality, for a typical residual void (i.e. Drake Pit 1).

Figure 5.1 presents the following key results for void lake water level:

- Minimum value on each day of the simulation period.
- Median (i.e. 50th percentile) value on each day of the simulation period. The median is indicative of the most likely value at any point in time (i.e. half the results are higher and half the results are lower) and has been used to define the equilibrium level.
- Maximum value on each day of the simulation period.

The information provided on Figure 5.1 provides the results of Drake 1 Pit void as an example of the typical behaviour of the void lake levels. The graph also features the key levels such as pit floor and pit crest level indicating the total depth of the pit and providing context for the void lake depth. The base of weathering level and pre-mining regional groundwater level (defined in Section 3.1) are also presented to assess the potential pit behaviour. The pre-mining regional groundwater level is a key level compared against the maximum pit lake level to demonstrate if the residual void will act as a "sink" or a "source", whereas, the base

of weathering level is used a secondary indicator to determine seepage through weathered material. Such a scenario can be when maximum void lake level is below pre-mining regional groundwater level but above the base of weathering level.

Key features illustrated on Figure 5.1 include:

- Void lake level will steadily rise over initial years following the cessation of mining (approximately 40 years in this example).
- The void lake levels are forecast to fluctuate over time as a result of prevailing climate conditions. The lake level fluctuates around an equilibrium level, which has been defined as the median lake level (approximately 126 m AHD in this example). The minimum and maximum forecast levels indicate the potential range of fluctuation in lake levels over time (120 m AHD to 134 m AHD in this example).
- The depth of the forecast lake levels relative to the groundwater interaction levels. In this example, the maximum void lake level (134 m AHD) is 12.6 m below the pre-mining regional groundwater level (146.6 m AHD) and 35.1 m below the base of weathering level (169.1 m AHD). This example residual void is therefore forecast to behave as a groundwater sink.

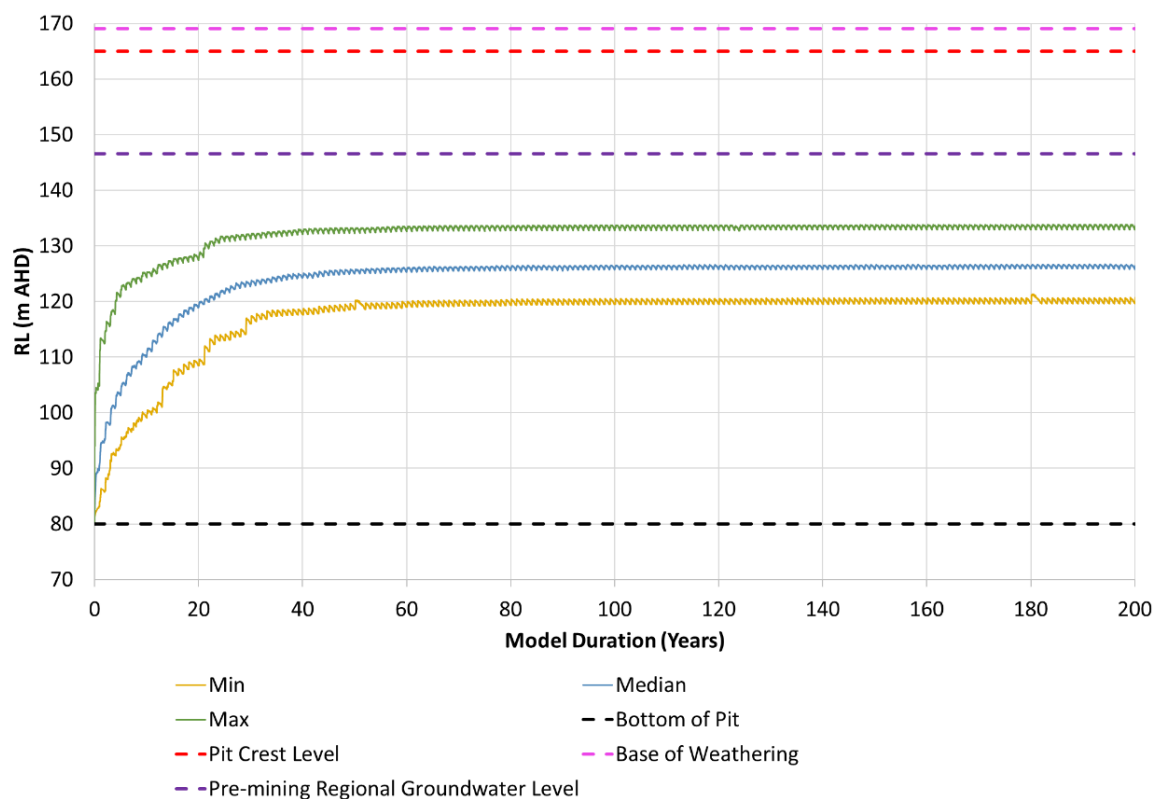


Figure 5.1 Example Void Lake Level Forecast

Figure 5.2 provides the results of water quality modelling for the Drake 1 Pit as an example of typical water quality behaviour of the void lakes. Key features illustrated include:

- The void lake salinity (EC) increases over the simulation period. This is a result of evaporation being the only significant outflow from the void lakes, which results in ongoing concentration of salts. In this example, the equilibrium void lake EC (i.e. the median value) at the end of simulation period is approximately 12,900 $\mu\text{S}/\text{cm}$.
- The forecast indicates an ongoing linearly increasing trend in void lake salinity. In this example, the equilibrium void lake EC is continuing to increase at a rate of approximately 130 $\mu\text{S}/\text{cm}$ per year. **Ultimately salts will continue to concentrate with the maximum EC limited by solubility of the constituent salts within the lake – this is conceptually the case for any comparable water body which experiences an inflow where evaporation is the only outflow and occurs at a rate exceeding the inflow.**

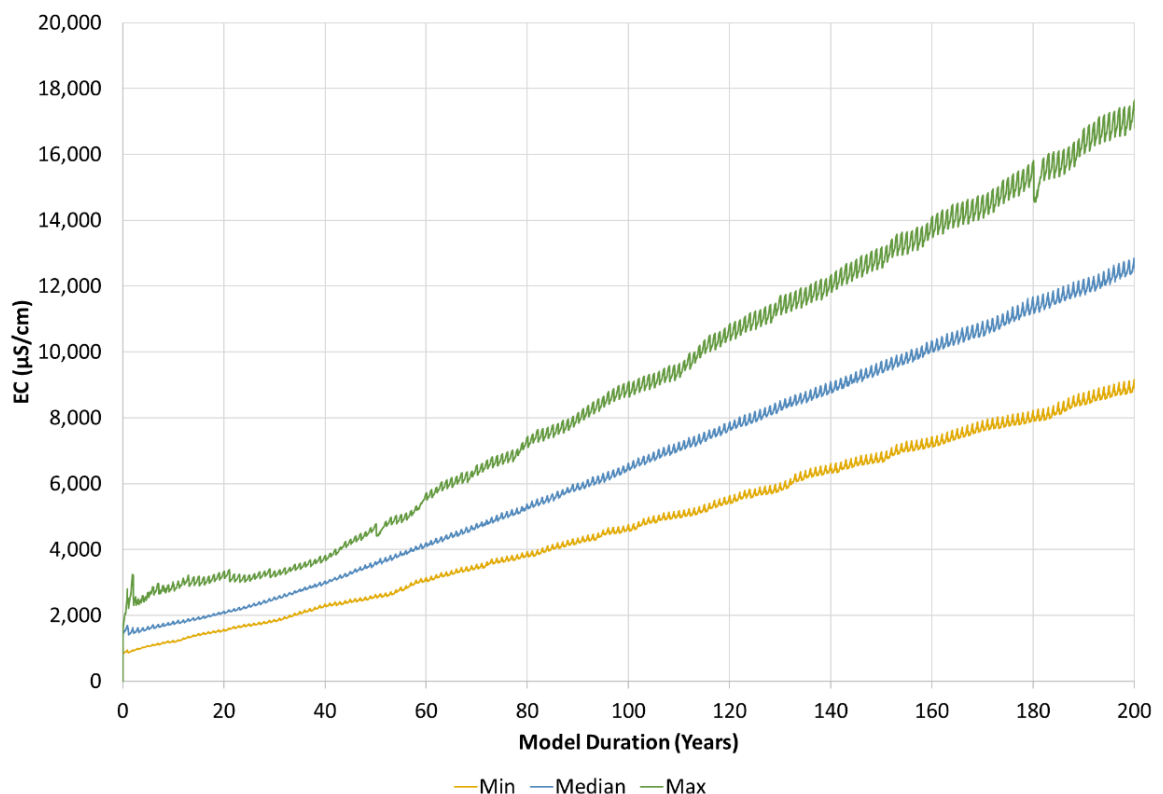


Figure 5.2 Example Void Lake Salinity (EC) Forecast

5.3 Modelling Results

The key model outputs for all QNH modelled voids are summarised in Table 5.1 for level and quality. A graphical representation of the forecast void lake level, volume and salinity for all QNH modelled voids are provided in Appendix C for base cases and Appendix D for mitigated cases.

Table 5.1 Residual Void Lake Results Summary (Base Case and Mitigated Case for Selected Voids)

Residual void	Catchment Area (ha)	Void Equilibrium Water Level (m AHD)	Maximum Water Level (m AHD)	Void Spill Elevation (m AHD)	Pre-mining Groundwater Level (m AHD)	Base of Weathering Level (m AHD)	Void Equilibrium Volume (ML)	Ponded area at Equilibrium (ha)	Void Equilibrium EC at 200 years (µS/cm)	Rate of Increase in EC (µS/cm/year)	Initial Void Filling Period (Years)
Sonoma East Pit 1 (Base Case)	25	158	164	176	156.30	155.80	322	4.6	46,352	493	20
Sonoma East Pit 2 (Base Case)	27	154	161	176	155.53	156.92	214	3.8	47,635	380	20
Sonoma Main Pit (Base Case)	280	150 ¹	154 ¹	171	155.67	153.02	587	49.2	266,030	1,787	5
Drake Pit 1 (Base Case)	240	126	134	165	146.57	169.07	5,245	27.3	12,896	130	40
Drake Pit 2 (Base Case)	22	139	145	164	147.23	153.40	74	2.3	12,282	15	10
Drake Pit 2 Expansion (Base Case)	80	124	131	168	144.24	163.99	1,601	13.0	33,008	310	30
Drake Pit 3Q (Base Case)	55	150	157	172	142.55	161.28	434	3.6	36,812	334	15
Drake Pit 3R (Base Case)	21	165	169	172	141.78	156.72	66	2.4	9,284	9	5
Drake Pit 4 North (Base Case)	97	133	140	155	139.50	127.96	961	11.7	37,665	394	20

Residual void	Catchment Area (ha)	Void Equilibrium Water Level (m AHD)	Maximum Water Level (m AHD)	Void Spill Elevation (m AHD)	Pre-mining Groundwater Level (m AHD)	Base of Weathering Level (m AHD)	Void Equilibrium Volume (ML)	Ponded area at Equilibrium (ha)	Void Equilibrium EC at 200 years (µS/cm)	Rate of Increase in EC (µS/cm/year)	Initial Void Filling Period (Years)
Drake Pit 4 North (Mitigated Case)	49	125	130				608	6.1	55,775	594	20
Drake Pit 4 South (Base Case)	42	131	136	152	136.71	146.72	401	6.6	62,509	606	20
Drake Pit 5 (Base Case)	191	111	119	138	137.42	144.39	4,237	21.6	14,007	140	60
Jax Main Pit ⁴ (Base Case)	264	110	118	165	140.8 ² /140 ³	149.78	7,999	28.4	4,940	30-100	80
Jax Main Pit ⁴ (Mitigated Case)	143	98	105				4,794	19.4	7,271	60	80
Jax East Pit ⁴ (Base Case)	47	104	112	165	135.2 ² /140 ³	146.72	1,086	6.9	12,547	30-100	80
Jax East Pit ⁴ (Mitigated Case)	41	103	110				923	6.6	14,415	130	45

Note 1: Levels have been shifted up 20m to represent additional 20m of co-disposal deposition

Note 2: Level as provided by AGE (2020)

Note 3: Level used in previous assessment (Engeny, 2018)

Note 4: JCM Final Void Hydrology Study (Engeny 2018)

Legend

	Void lake level is below the pre-mining regional groundwater level and base of weathering
	Void lake level is above pre-mining regional groundwater level

5.3.1 Levels

The key level findings for each residual void are summarised as follows:

- Sonoma East Pit 1 - The void lake equilibrium level (158 m AHD) and maximum void lake level (164 m AHD) are 1.7 m and 7.7 m above the pre-mining regional groundwater level (156.30 m AHD) respectively. The residual void is forecast to have ongoing net outflows to the local geology or regional groundwater.
 - The Sonoma East Pit 1 void lake level is forecast to be above the regional groundwater level and therefore may result in a hydraulic gradient out of the void into the surrounding geology (a net outflow). However, localised outflow from Sonoma East Pit 1 has the potential to be captured by a down-gradient pit acting as a global sink (for example, Sonoma Main Pit) and would therefore not be representative of a source to the regional groundwater. This process can be identified through hydrogeological modelling.
- Sonoma East Pit 2 - The void lake equilibrium level (154 m AHD) and maximum void lake level (161 m AHD) are 1.5 m below and 5.5 m above the pre-mining regional groundwater level (155.53m AHD) respectively. The residual void is forecast to have ongoing net outflows to the local geology or regional groundwater.
 - The Sonoma East Pit 2 void lake level is forecast to be above the regional groundwater level and therefore may result in a hydraulic gradient out of the void into the surrounding geology (a net outflow). However, localised outflow from Sonoma East Pit 2 has the potential to be captured by a down-gradient pit acting as a global sink (for example, Sonoma Main Pit) and would therefore not be representative of a source to the regional groundwater. This process can be identified through hydrogeological modelling.
- Sonoma Main Pit - The void lake equilibrium level (130 m AHD) and maximum void lake level (134 m AHD) are 25.7 m and 21.7 m below the pre-mining regional groundwater level (155.67 m AHD) respectively. These outcomes are based on the design landform surface at year 20. It is expected the final co-disposal surface will be as much as 20m higher than this level. The conservative addition of a further 20 vertical metres of rejects material can be expected to result in an equilibrium level of 150 m AHD and a maximum level of 154 m AHD which remain below the regional groundwater level.
 - As such the Sonoma Main Pit is expected to act as a groundwater sink; however as it will be subject to in-pit co-disposal of rejects it will behave differently to the other voids modelled and further consideration is recommended in the detailed mine planning for this void based on the in-pit co-disposal plan.
 - In addition, due the placement of rejects material within the void, the Sonoma Main Pit residual void geometry included a large predominantly flat surface. The void is forecast to behave as an evaporation pan and therefore periodically dries out to very minimal volumes.

- Drake Pit 1 - The void lake equilibrium level (126 m AHD) and maximum void lake level (134 m AHD) are 20.6 m and 12.6 m below the pre-mining regional groundwater level (146.57 m AHD) respectively. Therefore, the residual void is forecast to act as a sink.
- Drake Pit 2 - The void lake equilibrium level (139 m AHD) and maximum void lake level (145 m AHD) are 8.2 m and 2 m below the pre-mining regional groundwater level (147.23 m AHD) respectively. The residual void is forecast to act as a sink.
- Drake Pit 2 Expansion - The void lake equilibrium level (124 m AHD) and maximum void lake level (131 m AHD) are 20.2 m and 13.2 m below the pre-mining regional groundwater level (144.24 m AHD) respectively. Therefore, the residual void is forecast to act as a sink.
- Drake Pit 3Q - The void lake equilibrium level (150 m AHD) and maximum void lake level (157 m AHD) are 7.5 m and 14.5 m above the pre-mining regional groundwater level (142.55 m AHD) respectively. Therefore, the residual void is forecast to have ongoing net outflows to the local geology or regional groundwater.
 - The Drake Pit 3Q void lake level is forecast to be above the regional groundwater level and therefore may result in a hydraulic gradient out of the void into the surrounding geology (a net outflow). However, localised outflow from Drake Pit 3Q has the potential to be captured by a down-gradient pit acting as a global sink (for example, Jax Main Pit) and would therefore not be representative of a source to the regional groundwater. This process can be identified through hydrogeological modelling.
- Drake Pit 3R - The void lake equilibrium level (165 m AHD) and maximum void lake level (169 m AHD) are 23.2 m and 27.2 m above the pre-mining regional groundwater level (141.78 m AHD) respectively. Therefore, the residual void is forecast to have ongoing net outflows to the local geology or regional groundwater
 - The Drake Pit 3R void lake level is forecast to be above the regional groundwater level and therefore may result in a hydraulic gradient out of the void into the surrounding geology (a net outflow). However, localised outflow from Drake Pit 3R has the potential to be captured by a down-gradient pit acting as a global sink (for example, Jax Main Pit) and would therefore not be representative of a source to the regional groundwater. This process can be identified through hydrogeological modelling.
- Drake Pit 4 North – Using the catchment layout from the LOMP (the base case), the void lake equilibrium level (133 m AHD) and maximum void lake level (140 m AHD) are 6.5 m below and 0.5 m above the pre-mining regional groundwater level (139.50 m AHD) respectively. The equilibrium and maximum void lake level sit above the base of weathering (127.96 m AHD) which has been used as a secondary indicator for potential seepage out of the void lake. As such the base case modelling results indicate that this void may alternate between periods of net outflow and periods of acting as a sink, as the lake levels fluctuate over time.

- As discussed in Section 2.7.1 and Section 5, the LOMP is not optimised to consider catchment reduction or completed to a level of detail sufficient to consider specific drainage solutions. Accordingly, a review of catchment reduction options was undertaken which resulted in reduced catchment reporting the Drake 4 North Void (referred to as the mitigated option). The catchment mitigation is discussed in Section 2.7.1.
- The key outcomes for the mitigated case are summarised in Table 5.1. The mitigated void lake equilibrium level (125 m AHD) and maximum void lake level (130 m AHD) are 14.5 m below and 9.5 m below the pre-mining regional groundwater level (139.50 m AHD) respectively. Therefore, based on the primary indicator of void lake and groundwater interaction, the mitigated residual void is forecast to act as a sink.
- Drake Pit 4 South - The void lake equilibrium level (131 m AHD) and maximum void lake level (136 m AHD) are 5.7 m and 0.7 m below the pre-mining regional groundwater level (136.71 m AHD) respectively. The residual void is forecast to act as a sink.
- Drake Pit 5 - The void lake equilibrium level (111 m AHD) and maximum void lake level (119 m AHD) are 26.4 m and 18.4 m below the pre-mining regional groundwater level (137.42 m AHD) respectively. Therefore, the residual void is forecast to act as a sink.
- Jax Main Pit – Using the catchment layout for the LOMP (the base case) the void lake equilibrium level (110 m AHD) and maximum void lake level (118 m AHD) are 30.8-30 m and 22.8-22 m below the pre-mining regional groundwater level (140.8-140 m AHD) respectively. Therefore, the residual void is forecast to act as a sink.
- As a measure of comparison a potential mitigated scenario was also modelled for a reduced catchment. The key outcomes for the mitigated case are also summarised in Table 5.1.. The mitigated void lake equilibrium level (98 m AHD) and maximum void lake level (105 m AHD) are 42.8-42 m below and 35.8-35 m below the pre-mining regional groundwater level (140.8-140 m AHD) respectively.
- Conclusions as per JCM Final Void Hydrology Study Jax Main Pit and Jax East Pit (Engeny, November 2018).
- Jax East Pit – The void lake equilibrium level (104 m AHD) and maximum void lake level (112 m AHD) are 31.2-23.2 m and 36-28 m below the pre-mining regional groundwater level (135.2-140 m AHD) respectively. Therefore, the residual void is forecast to act as a sink. Conclusions as per *JCM Final Void Hydrology Study Jax Main Pit and Jax East Pit (Engeny, November 2018)*.
- As a measure of comparison a potential mitigated scenario was also modelled for a reduced catchment. The key outcomes for the mitigated case are also summarised in Table 5.1. The mitigated void lake equilibrium level (103 m AHD) and maximum void lake level (110 m AHD) are 32.2-25.2 m below and 37-30 m below the pre-mining regional groundwater level (135.2-140 m AHD) respectively.
- Conclusions as per JCM Final Void Hydrology Study Jax Main Pit and Jax East Pit (Engeny, November 2018).

5.3.2 Quality

The salinity of all residual voids modelled as part of this assessment is forecast to continue to increase over time due to the ongoing concentration resulting from evaporation with no significant outflow of salts from either net outflows seepage or overflows. It should be noted that pits with net outflow to the regional groundwater were still shown to accumulate salts throughout the model duration (refer Appendix C). The flow rates to groundwater at all levels of rating curves for all pits (refer Appendix B) were significantly smaller in magnitude than flows associated with rainfall, runoff, and evaporation. This resulted in accumulation of salt in net outflow pits despite salt losses through groundwater mechanisms.

The results presented in Table 5.1 indicate significant variation in the EC of the different voids as a result of differing rates of concentration. However, all void lakes are forecast to exceed 10,000 $\mu\text{S}/\text{cm}$ after 200 years (with the exception of Jax Main Pit). The overall water quality outcome is consistent for all void lakes (i.e. high levels of salinity that continue to increase over time).

The water quality forecast for the Sonoma Main Pit residual void exhibits characteristics not evident in other residual voids modelled at QNH in that modelled salinity at 200 years is an order of magnitude higher than any other modelled void. The proposed residual void for Sonoma Main Pit has a large, relatively flat surface produced by the co-disposal of tailings and rejects within the pit. Therefore, any ponding within Sonoma Main Pit is subject to very large evaporation surface areas. The void behaves much like an evaporation pan, with the volume of water within the void regularly reaching very low quantities. During drying periods, the remaining water in the void becomes highly saline as the void does not have any mechanisms (net outflow to groundwater or spills) for salt mass reduction.

The time for the void lakes to reach their equilibrium levels varies based on the ratio of catchment area to void volume. The shortest filling time is seen to be Sonoma Main Pit (5 years) while the longest is Jax Main Pit (80 years).

5.3.3 Ongoing Reliability of Results

It has been necessary to make a number of assumptions associated with the LOMP, which itself is expected to change as the QNH progresses (as discussed in Section 2.3). The accuracy of the results presented is inherently dependent upon the input data and assumptions. In particular, the relationship between contributing catchment area, equilibrium level relative to regional groundwater levels and ponded area at equilibrium level determines the residual void modelling results (i.e. sink or net outflow).

As noted previously in Section 2.3, Engeny has undertaken to conservatively assess the layout of final voids provided by QCoal, such that should minor changes to a void or pit complex occur over the life of QNH, this assessment can still be relied upon to inform impact assessments provided key hydrological modelling parameters are maintained (see Section 5.1).

6. UNCERTAINTY ASSESSMENT

The outcomes of numerical models are inherently dependent upon the quality of the inputs in addition to the modelling process itself. A qualitative uncertainty assessment has been completed on key input data that impacts the outcomes of the residual void lake hydrology and is presented in Table 6.1. Each data input has been assigned a quality rating based on confidence in the data, and whether the data is measured or estimated:

- High – measured data with a high level of confidence.
- Medium – measured data with a low level of confidence or estimated from data with a high level of confidence.
- Low – Estimated from data with a low level of confidence, or incomplete measured data.

Data inputs with a 'Low' quality rating and a 'High' impact rating are the greatest sources of uncertainty in the assessment. As seen in Table 6.1, the data input items with this **Low/High** combination are the pit geometry of residual voids that are yet-to-commence which is to be expected of any mining operation and the pre-mining regional groundwater level.

Table 6.1 Uncertainty Assessment – Residual Void Hydrology

Input	Primary Data Source	Data Quality Rating	Impact on Residual Void Results
130 years of climate data	SILO climate database facility hosted by Science Division of DES.	High	High
Catchment areas for storages	Based on mine plan polygons, survey dated 2014 and August 2019 provided by QCoal	High	High
Pit geometry: storage curves and maximum storage capacities for residual voids of existing pits	Based on existing pit geometry and survey dated August 2019 or design surfaces (e.g. SCM Main Pit). Residual void inferred to be similar to existing geometry.	Medium	High
Pit geometry: storage curves and maximum storage capacities for residual voids that are yet-to-commence	Based on comparison with existing pit geometry and void surface area	Low	High
Pre-mining regional groundwater level	Supplied by AGE from monitoring and numerical modelling	Low	High

Input	Primary Data Source	Data Quality Rating	Impact on Residual Void Results
Location of residual voids	Based on mine plan polygons provided by QCoal	Medium	Medium
Base of Weathering	Supplied by AGE from exploration data	Medium	Medium
Groundwater recovery curves	Supplied by AGE from numerical modelling	Low - Medium	Low

Pit geometry is critical for identifying the equilibrium level (i.e. the level at which the evaporative outflow from the ponded surface area balances the catchment inflows). The depth at which the equilibrium level and associated ponded area occur in relation to the regional groundwater level determines whether the residual void is expected to act as a sink or a source. However, it is understood that the final void geometry for an open cut coal mine pit which has yet to commence will always be an estimate, due to the changes which occur during the life of pit, in the economic which govern the pit activities (Section 2.3). As such the uncertainty level in this parameter is a normal expectation in void modelling of this kind.

The pre-mining regional groundwater level, as described in sections 3 and 5, is the primary reference level for determining whether a pit is a sink or source. The uncertainty associated with this input originates from the model and has been quantified with input from AGE.

The results of this assessment are considered suitable for determining overall final void hydrology outcomes (i.e. whether a void is a groundwater sink) for the purposes of assessing potential environmental impacts associated with the presence of the final voids.

All model outputs are improved with more accurate inputs and should further modelling of voids be required, additional refining of the inputs would assist in improving the model.

7. CONCLUSIONS

The residual void assessment has demonstrated the following key outcomes:

- None of the void lakes assessed were modelled to overtop to the receiving environment in any climate scenarios.
- The salinity of the residual void lakes is forecast to increase over time as evaporation results in on-going concentration of salts. Water quality in all voids is expected to continue to worsen beyond the 200 year modelled time frame with solubility being the limit on increasing salinity.
- Four (4) residual voids were forecast to have ongoing net outflows to surrounding geology:
 - Sonoma East Pit 1
 - Sonoma East Pit 2
 - Drake Pit 3Q
 - Drake Pit 3R
- Nine (9) residual voids were forecast to act as groundwater sinks:
 - Sonoma Main Pit
 - Drake Pit 1
 - Drake Pit 2
 - Drake Pit 2 Expansion
 - Drake Pit 4 North (mitigated scenario)
 - Drake Pit 4 South
 - Drake Pit 5
 - Jax Main Pit
 - Jax East Pit
- Key areas of uncertainty were identified to be the pit geometry for voids which have not yet commenced as well as with the reported regional groundwater levels.

The residual void forecast outcome in ascending order of depth below regional groundwater are presented in Table 7.1.

Table 7.1 Residual Void Forecast Outcome

Residual void	Modelling outcome	Maximum lake level comparison to pre-mining groundwater level
Jax Main Pit	Sink	35.8 m below pre-mining GW Level
Jax East Pit	Sink	25.2 m below pre-mining GW Level

Residual void	Modelling outcome	Maximum lake level comparison to pre-mining groundwater level
Drake Pit 5	Sink	18.4 m below pre-mining GW Level
Drake Pit 2 Expansion	Sink	13.4 m below pre-mining GW Level
Drake Pit 1	Sink	12.6 m below pre-mining GW Level
Drake Pit 4 North (mitigated)	Sink	9.5 m below pre-mining GW Level
Drake Pit 2	Sink	2 m below pre-mining GW Level
Sonoma Main Pit	Sink	1.7m below pre-mining GW Level
Drake Pit 4 South	Sink	0.7 m below pre-mining GW Level
Sonoma East Pit 2	Net outflow	5.4 m above pre-mining GW Level
Sonoma East Pit 1	Net outflow	7.7 m above pre-mining GW Level
Drake Pit 3Q	Net outflow	14.4 m above pre-mining GW Level
Drake Pit 3R	Net outflow	27.2 m above pre-mining GW Level

8. QUALIFICATIONS

- a. In preparing this document, including all relevant calculation and modelling, Engeny Water Management (Engeny) has exercised the degree of skill, care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering principles.
- b. Engeny has used reasonable endeavours to inform itself of the parameters and requirements of the project and has taken reasonable steps to ensure that the works and document is as accurate and comprehensive as possible given the information upon which it has been based including information that may have been provided or obtained by any third party or external sources which has not been independently verified.
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- g. This report does not provide legal advice.

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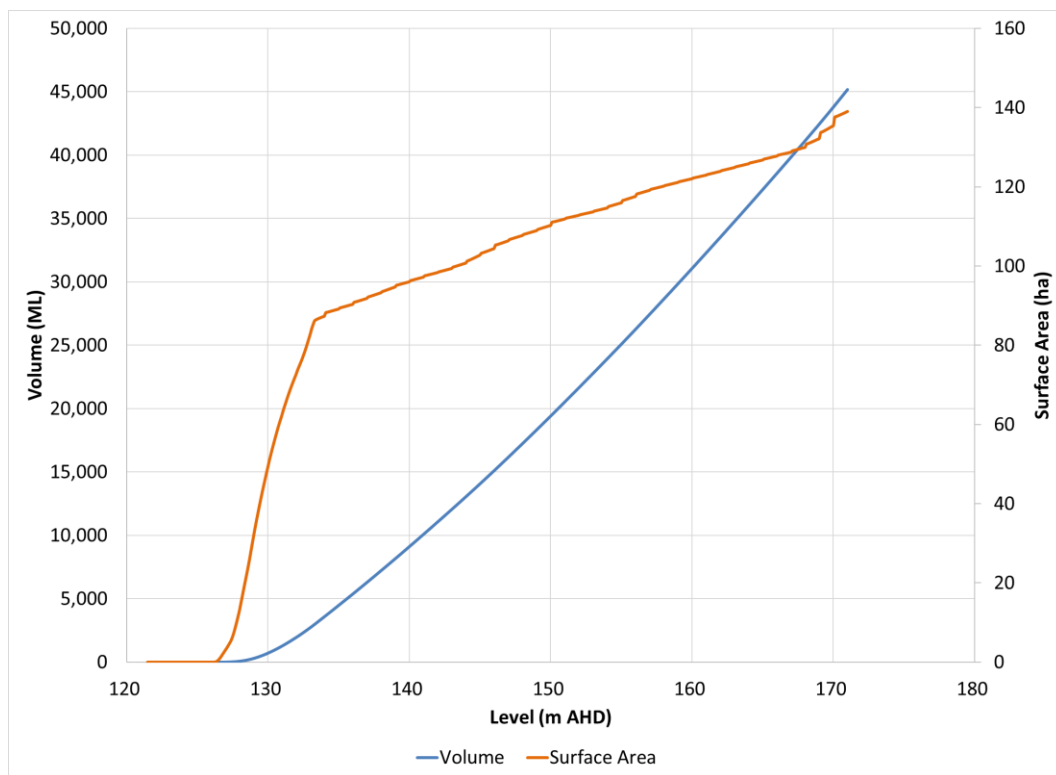
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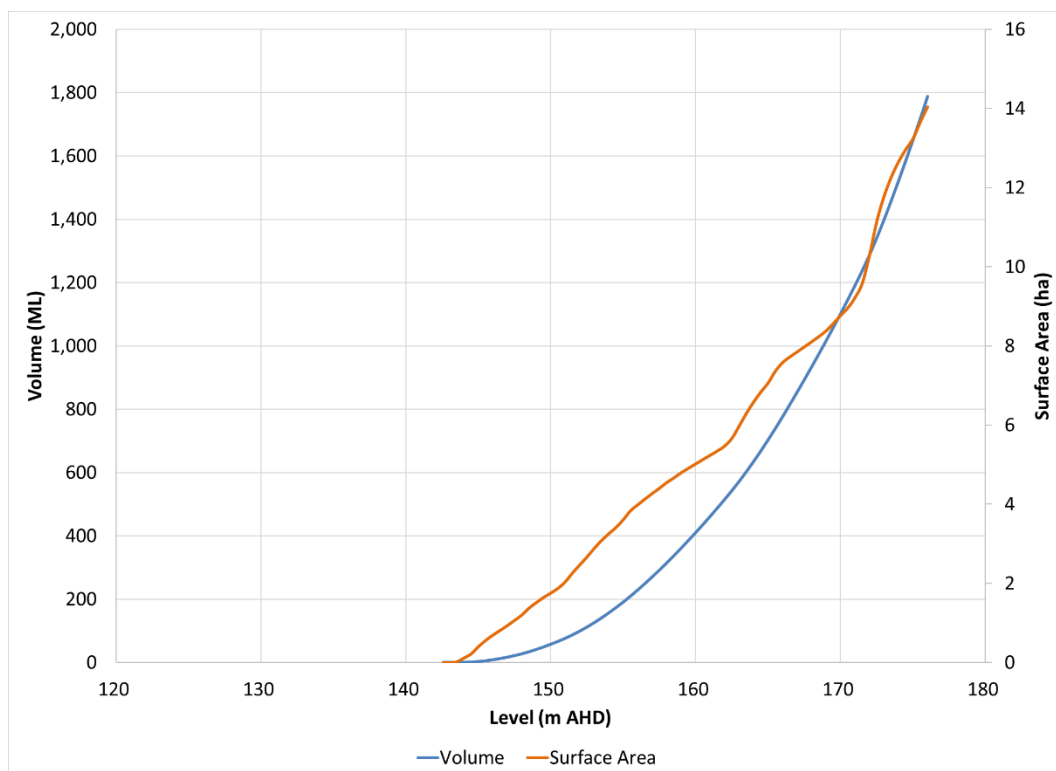
Appendix A

Residual Void Storage Curves

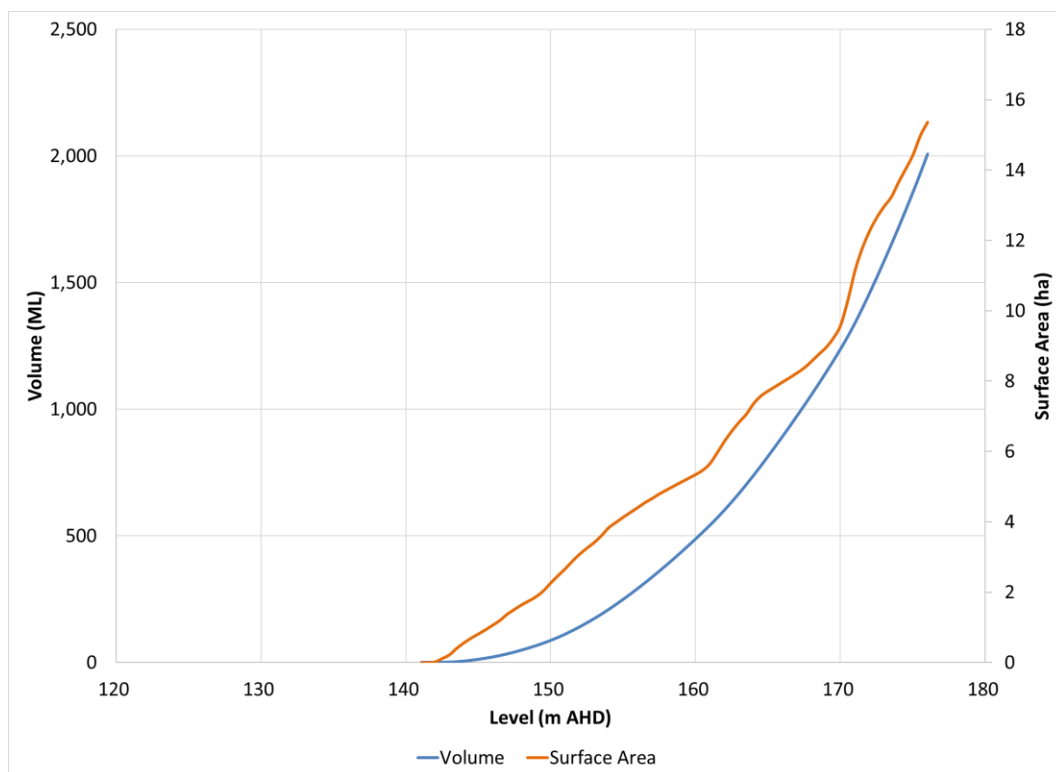
Sonoma Main Pit



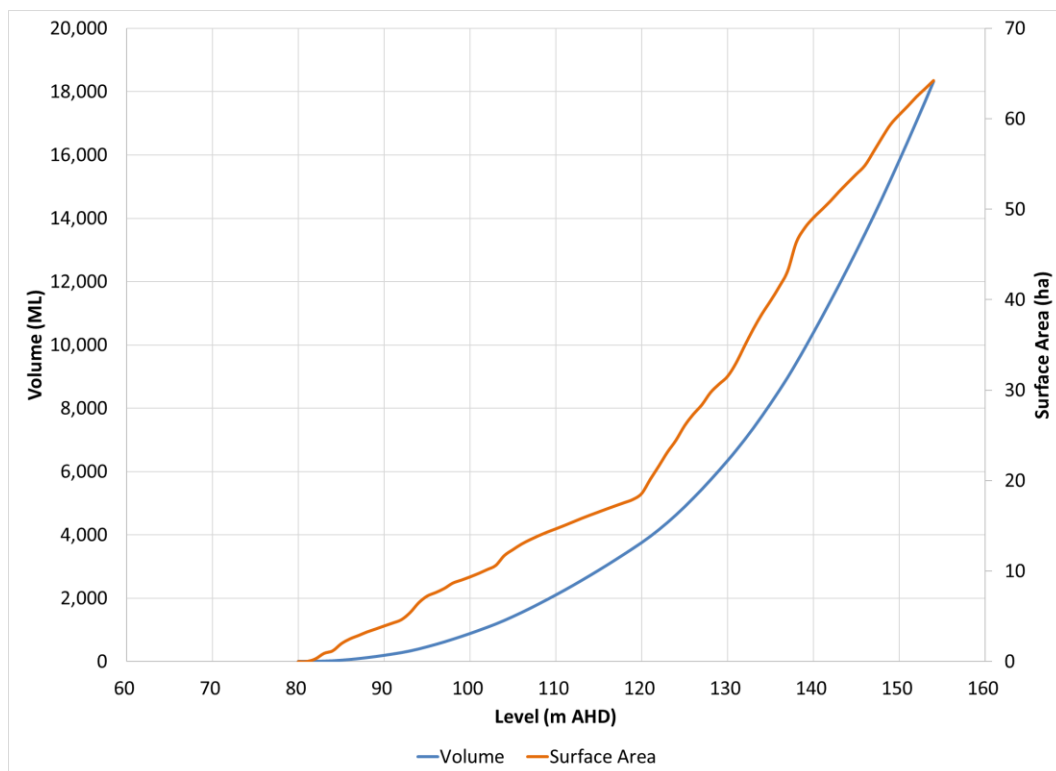
Sonoma East Pit 1



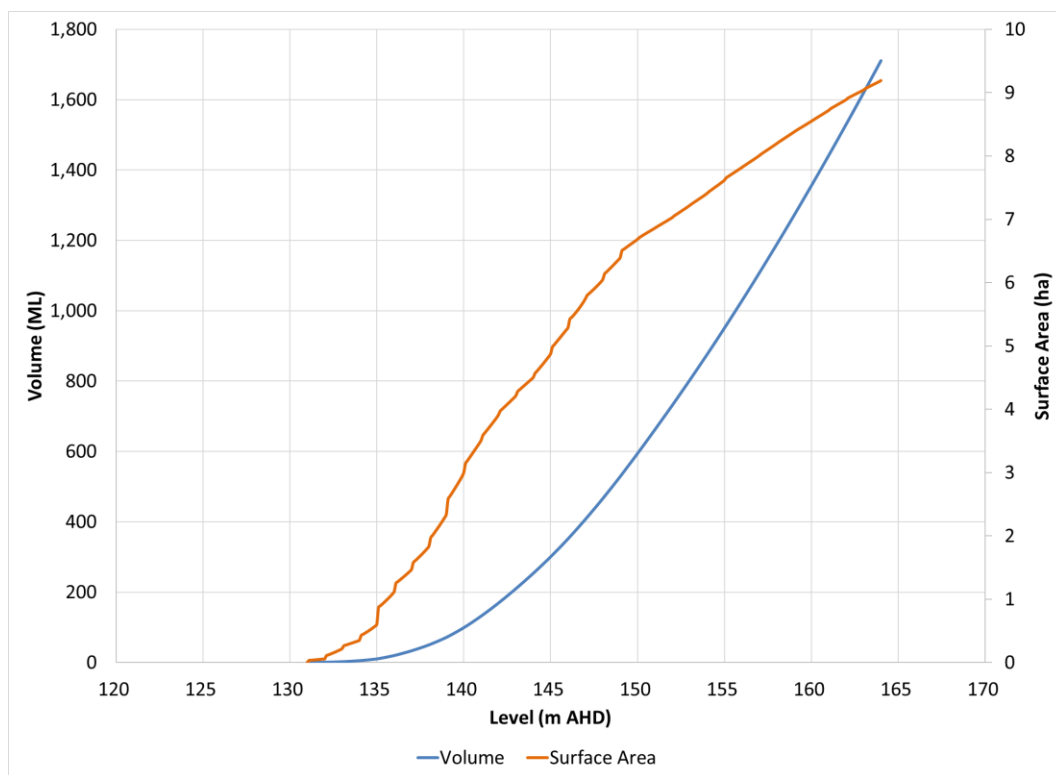
Sonoma East Pit 2



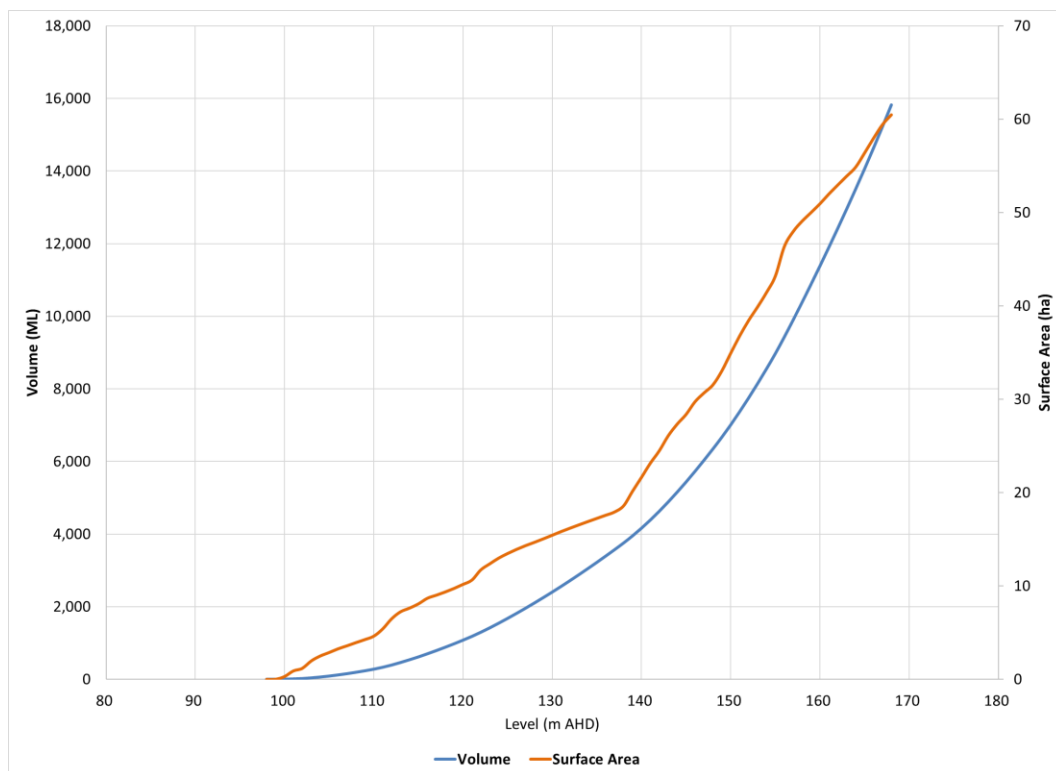
Drake Pit 1



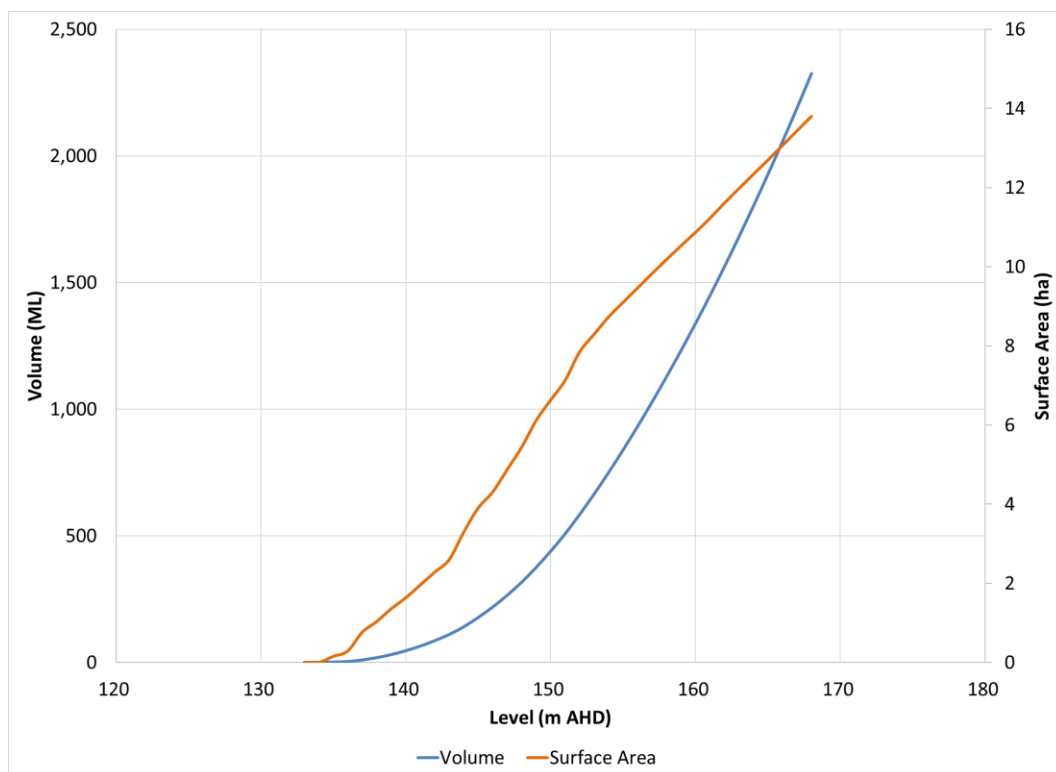
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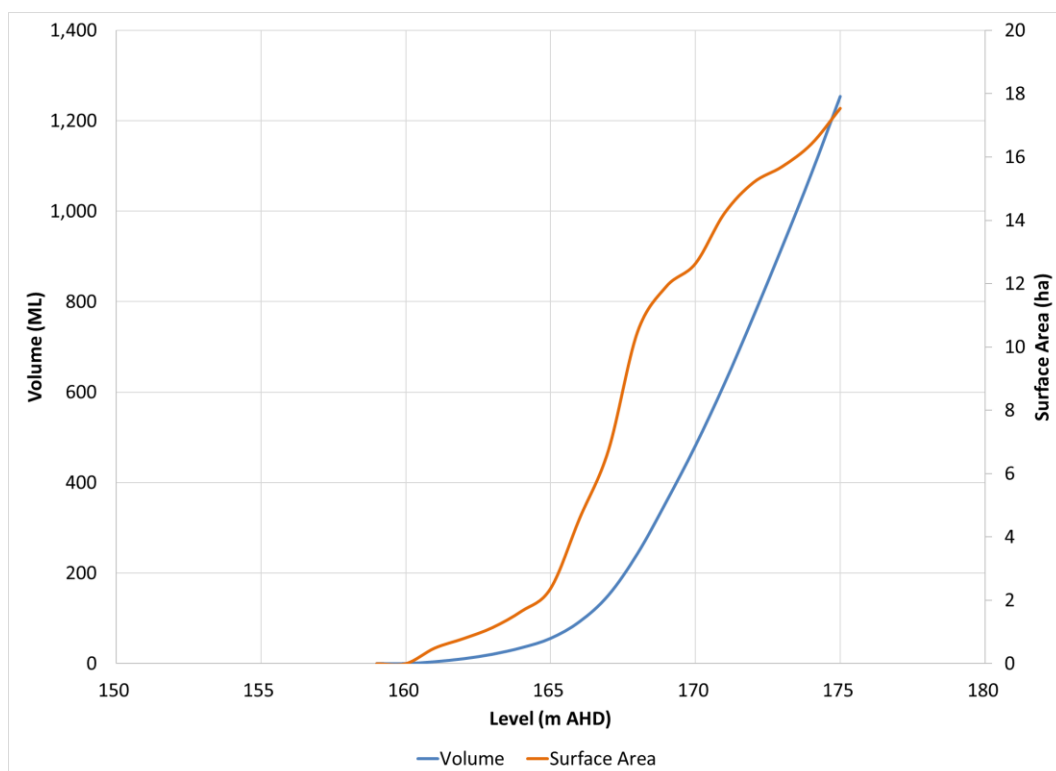
Drake Pit 2 Expansion



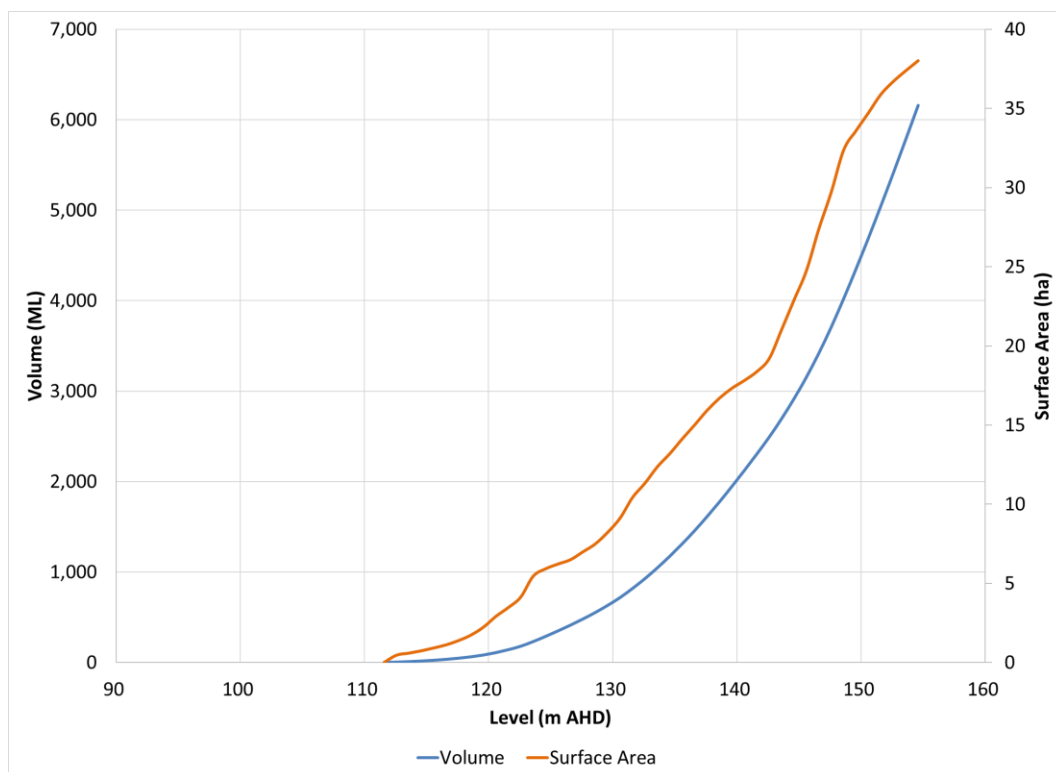
Drake Pit 3Q



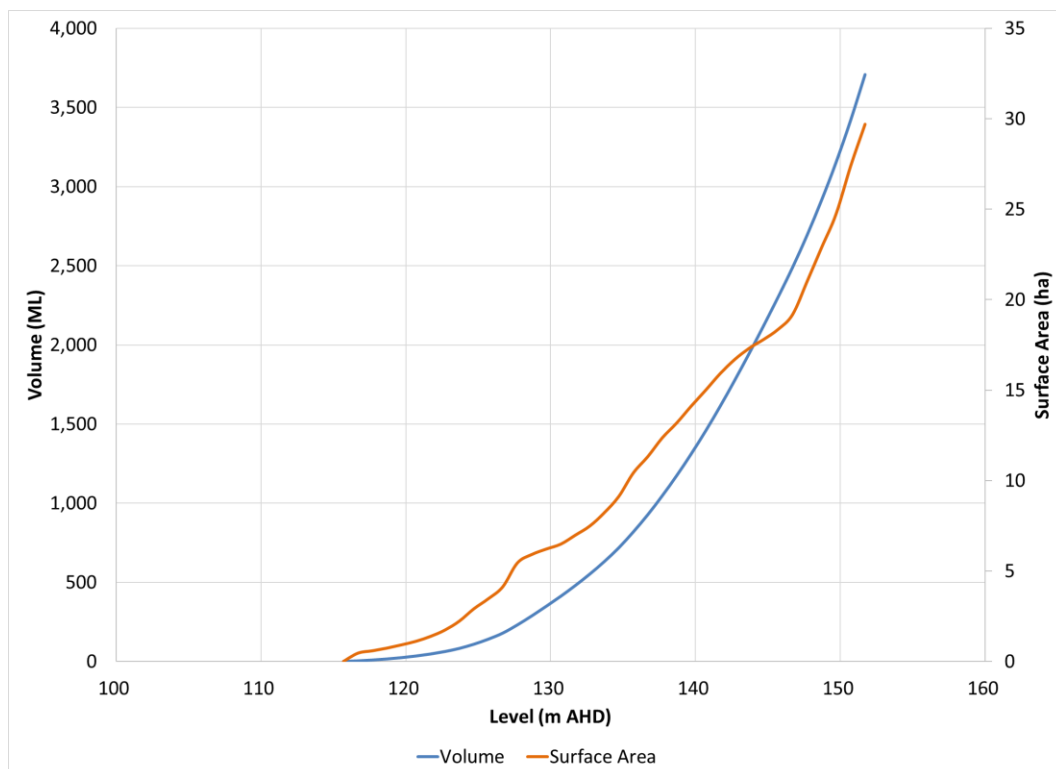
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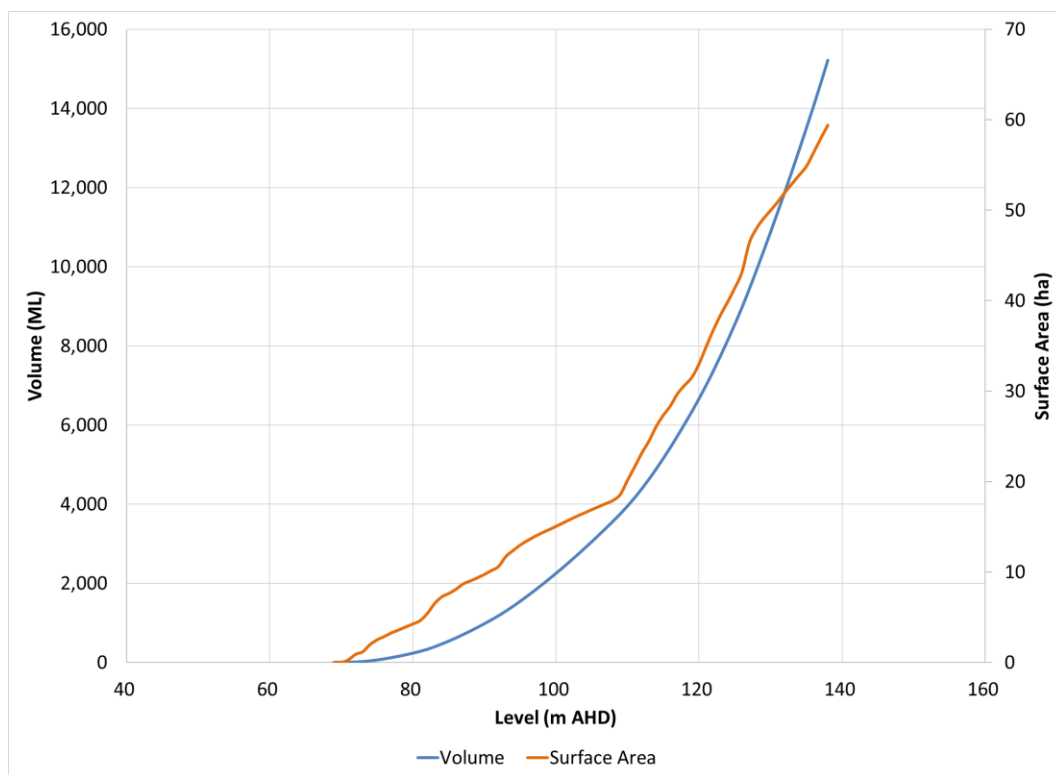
Drake Pit 4 North



Drake Pit 4 South



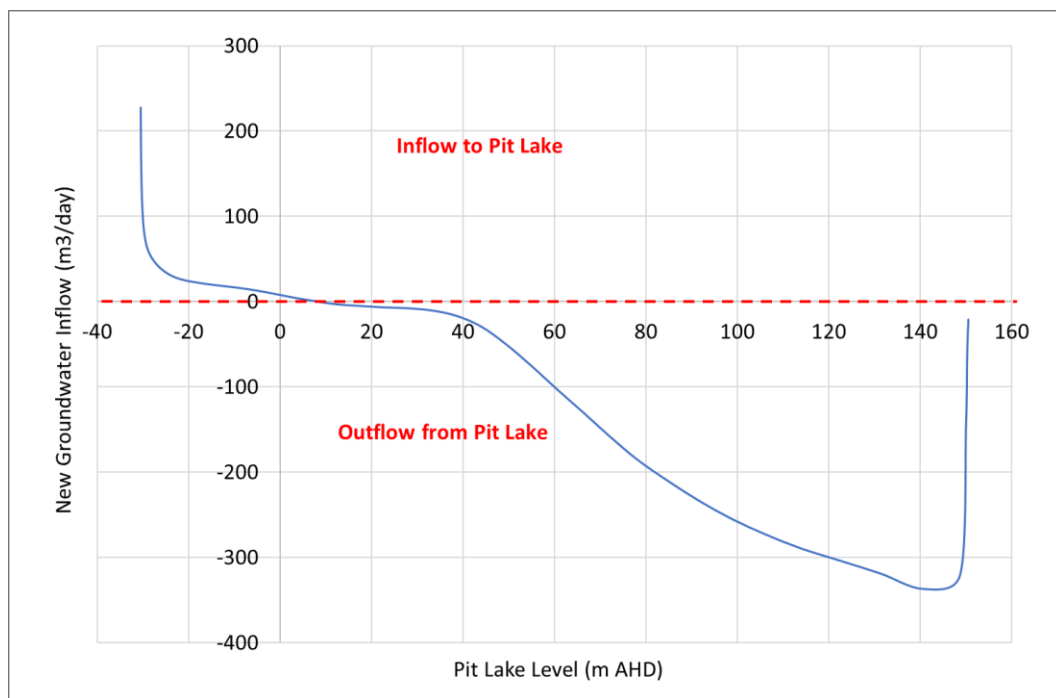
Drake Pit 5



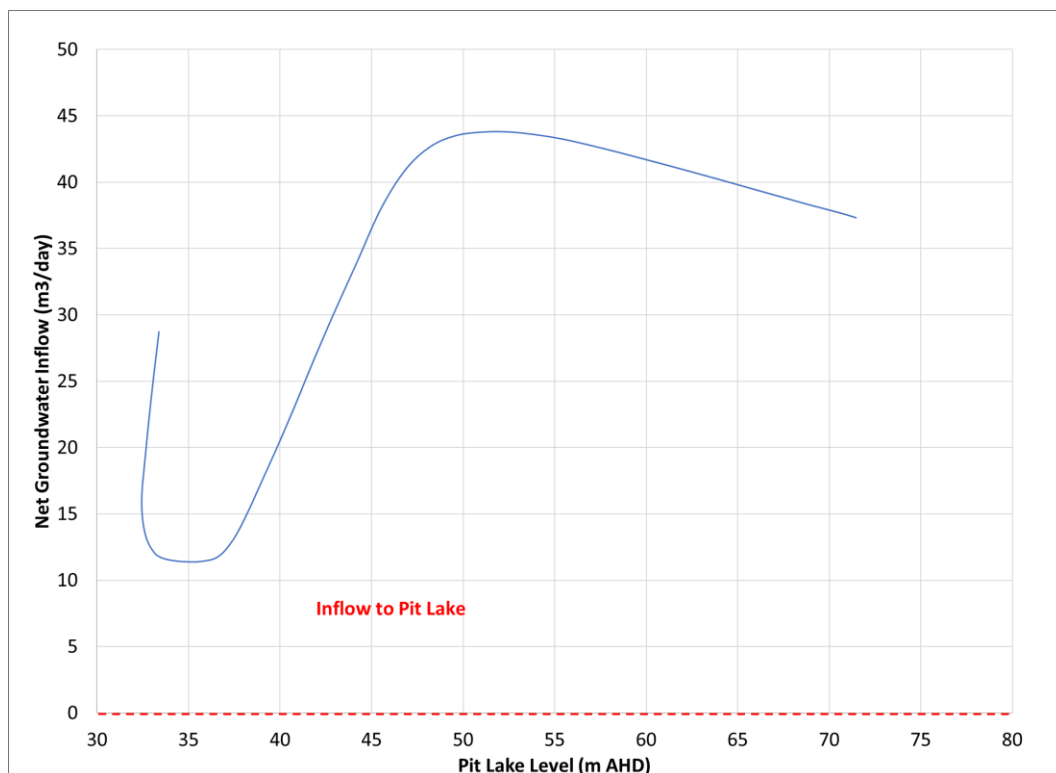
Appendix B

Groundwater Recovery Curves

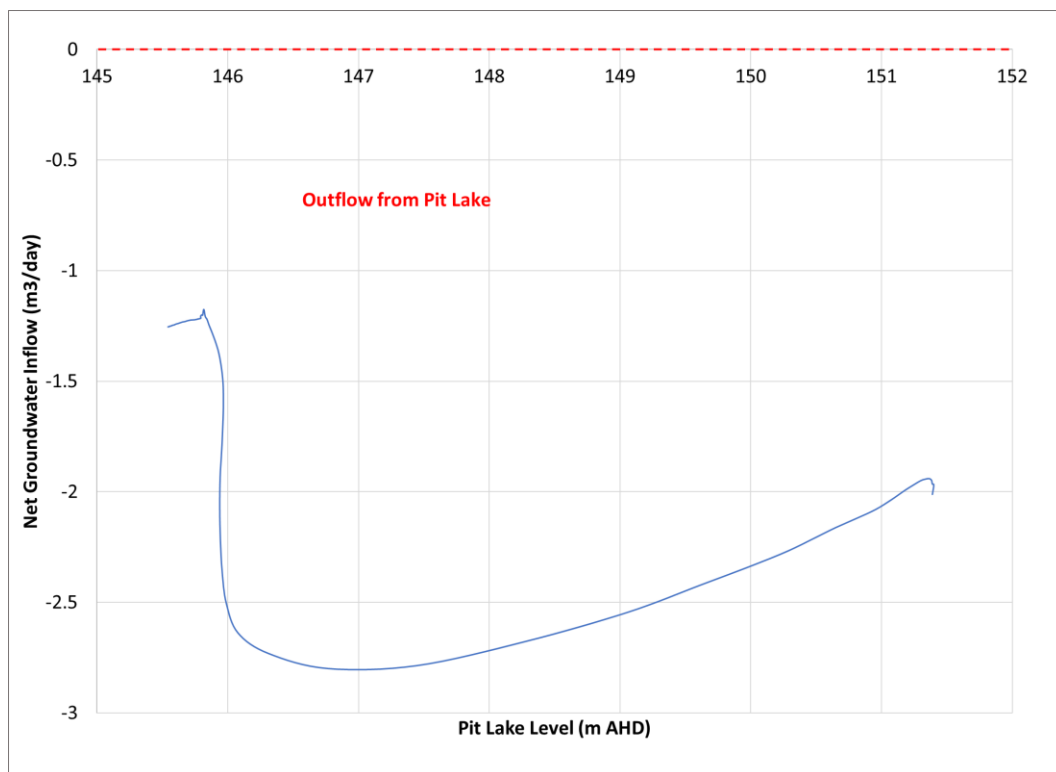
Sonoma Main Pit



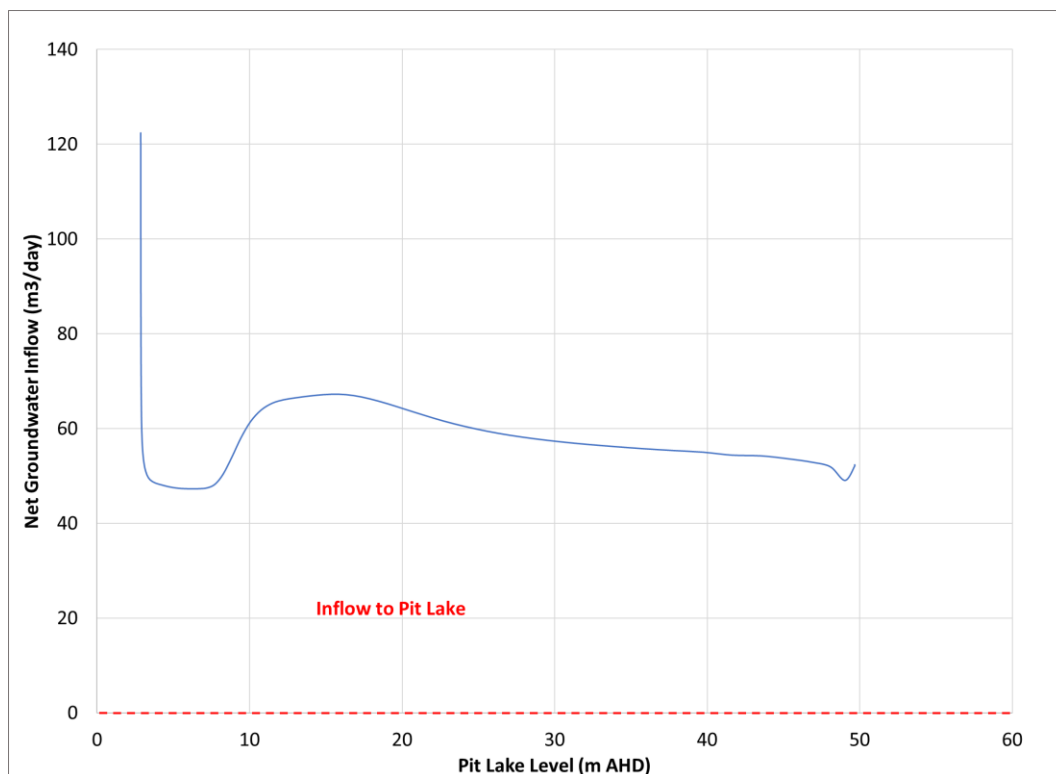
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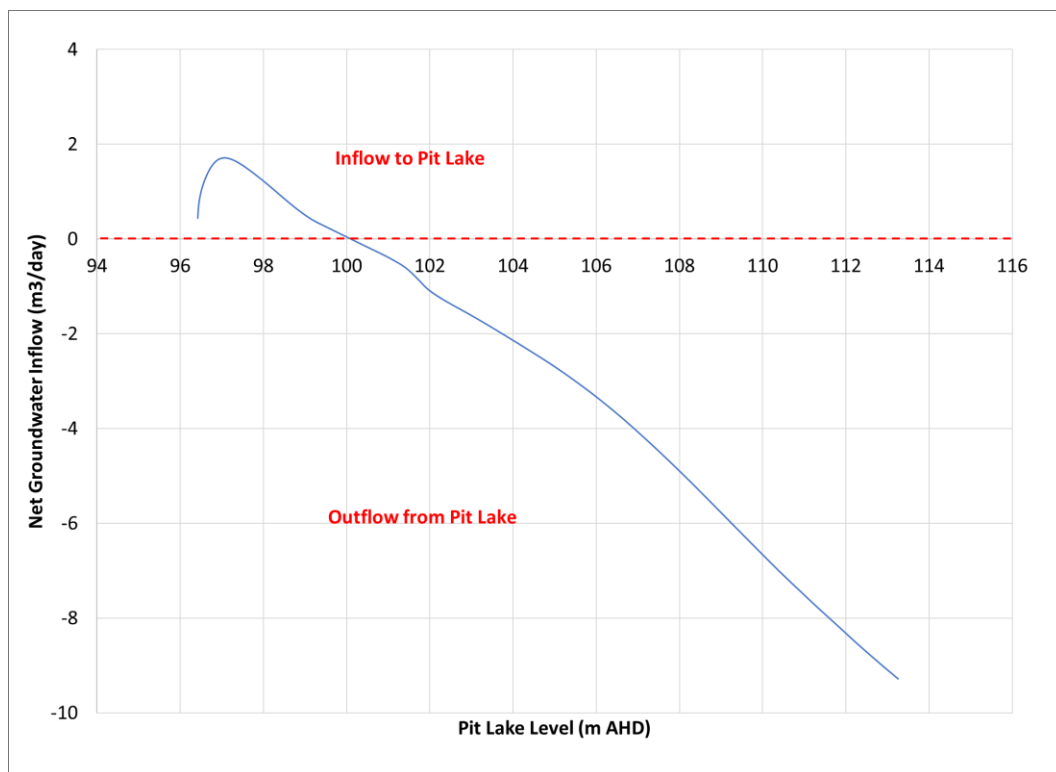
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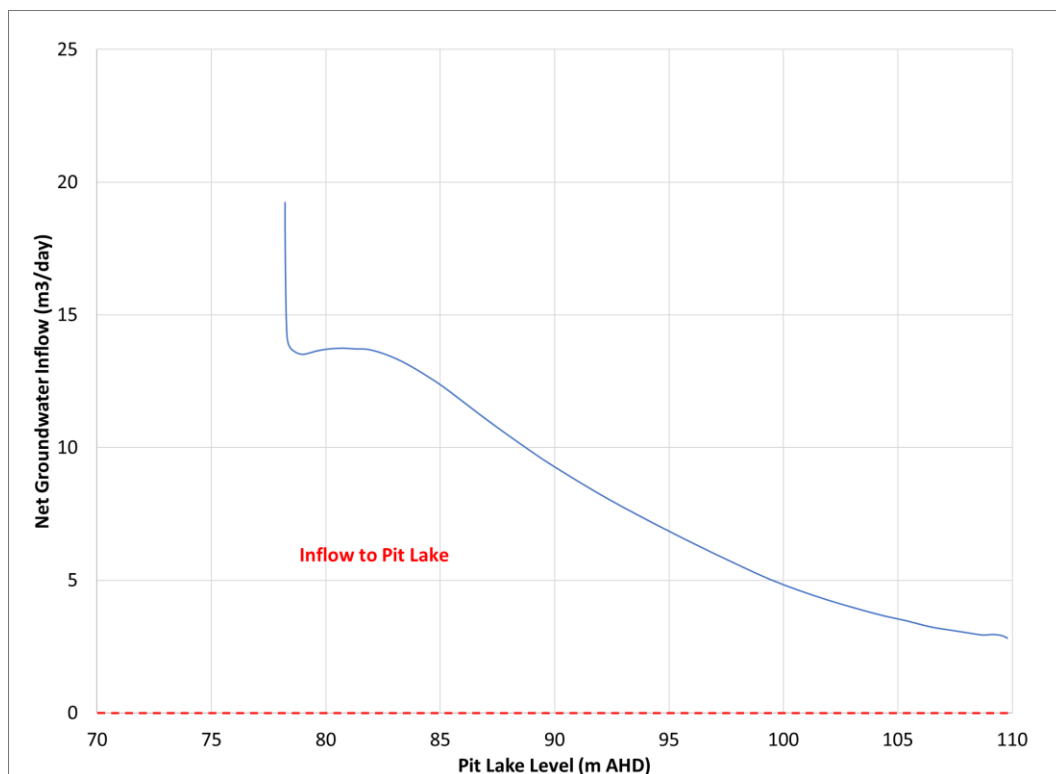
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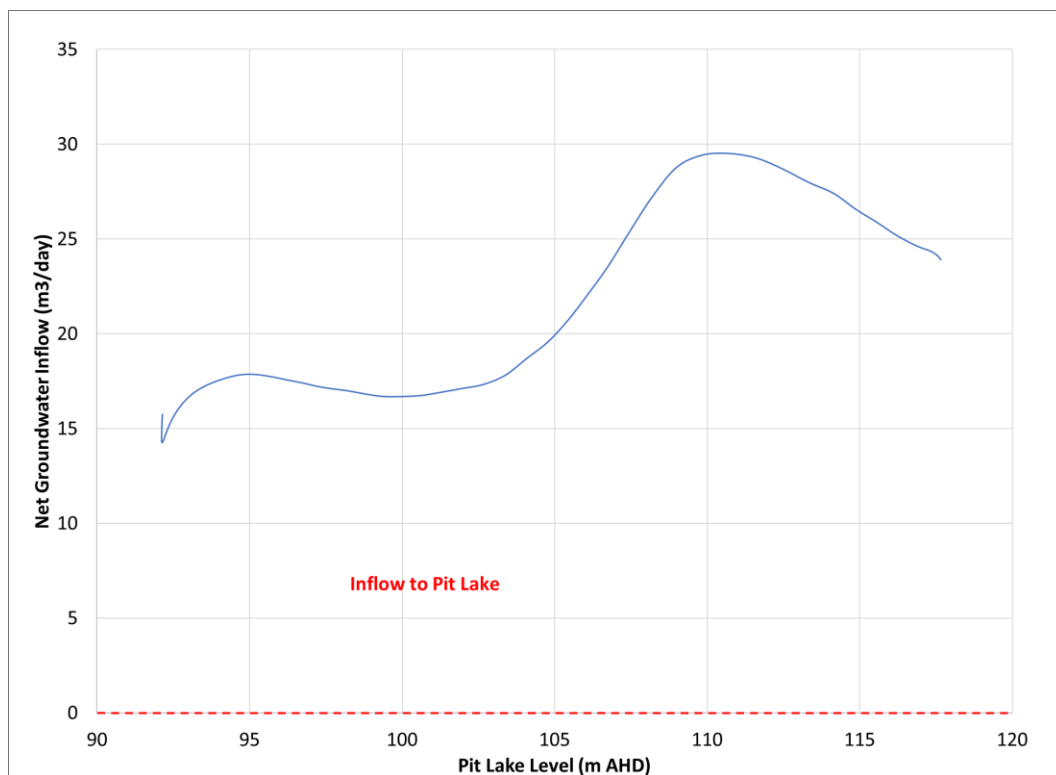
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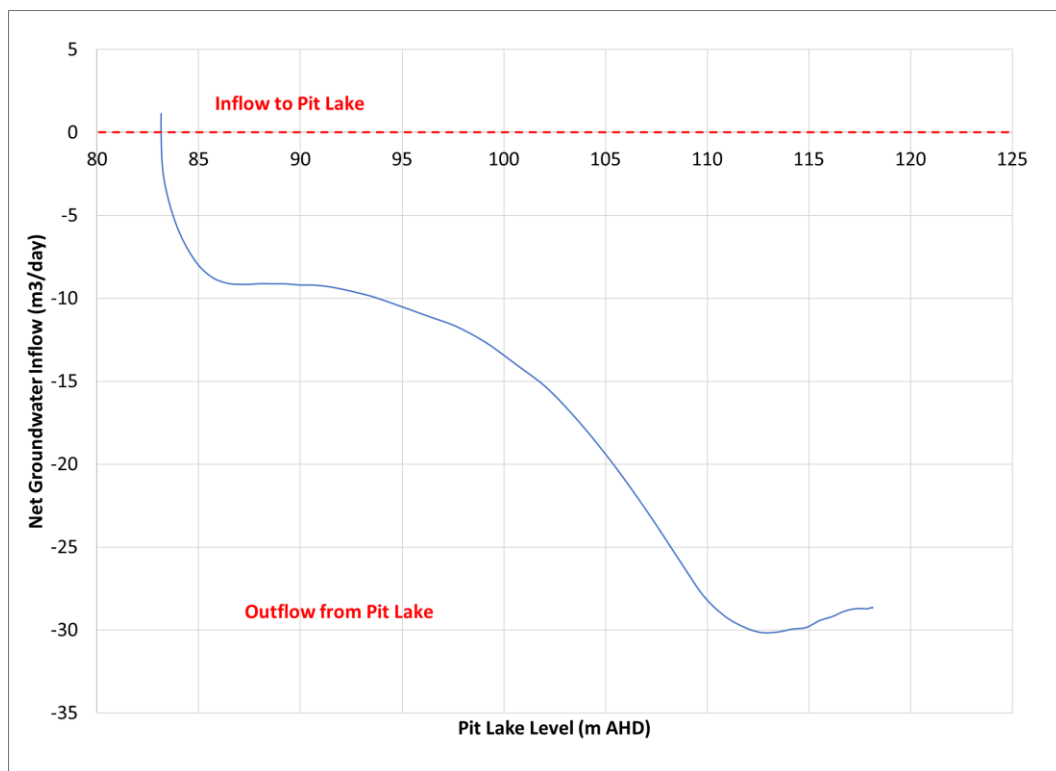
Drake Pit 2 Expansion



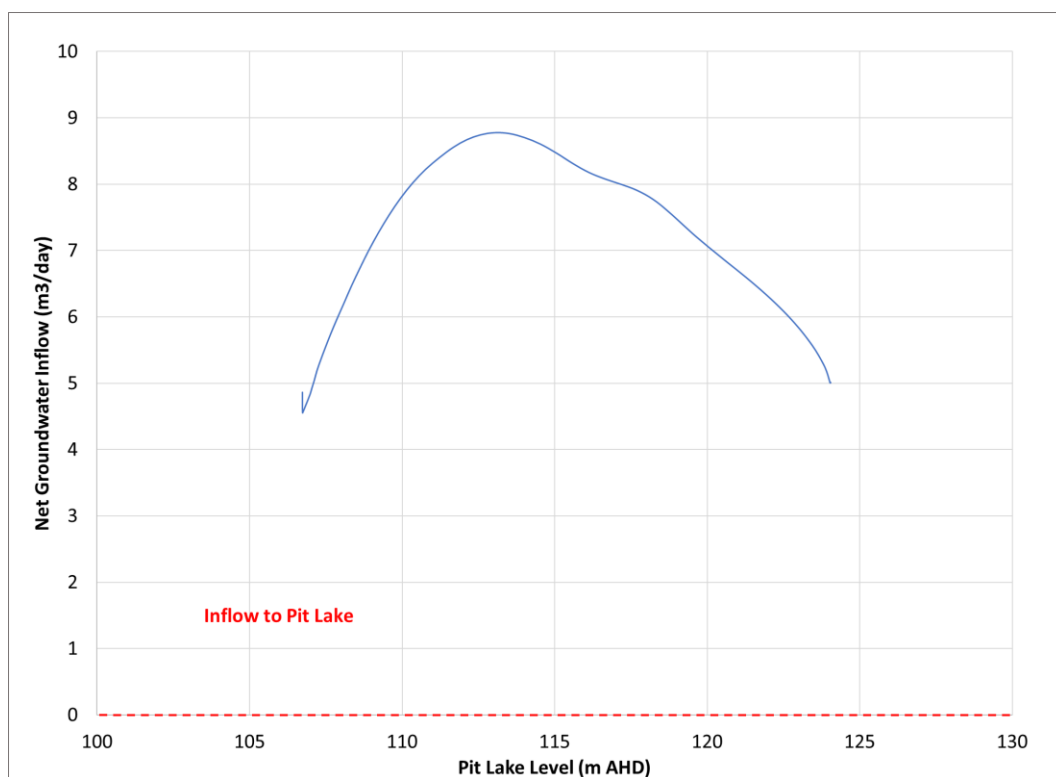
Drake Pit 3Q



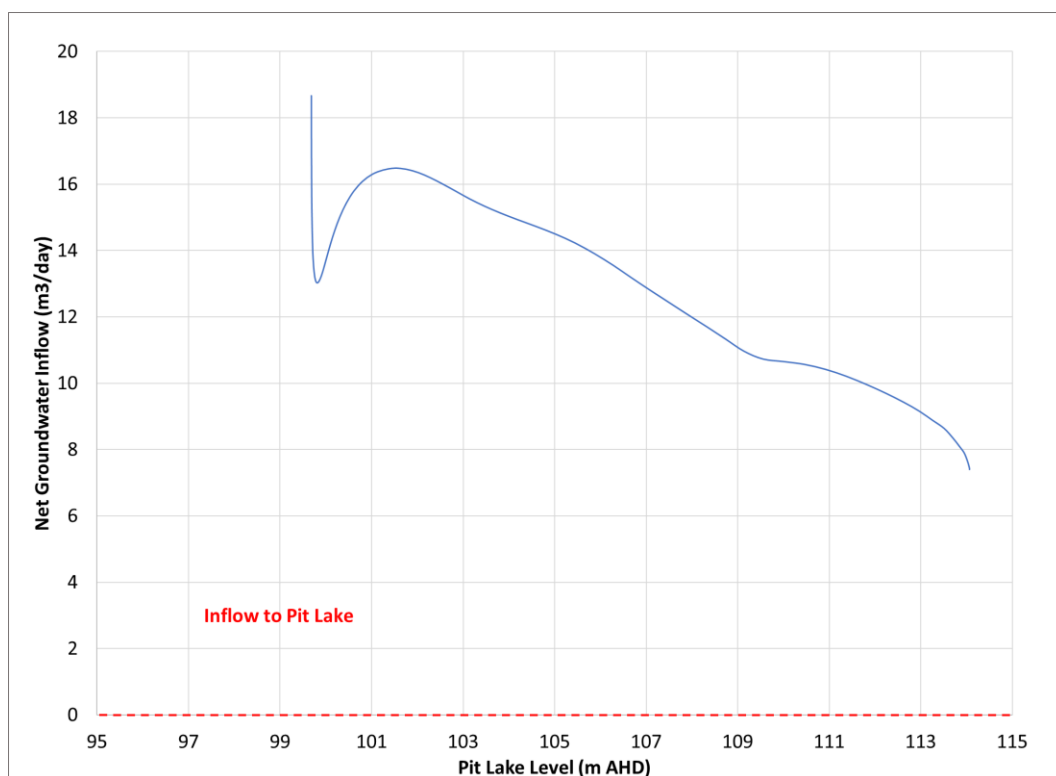
Drake Pit 3R



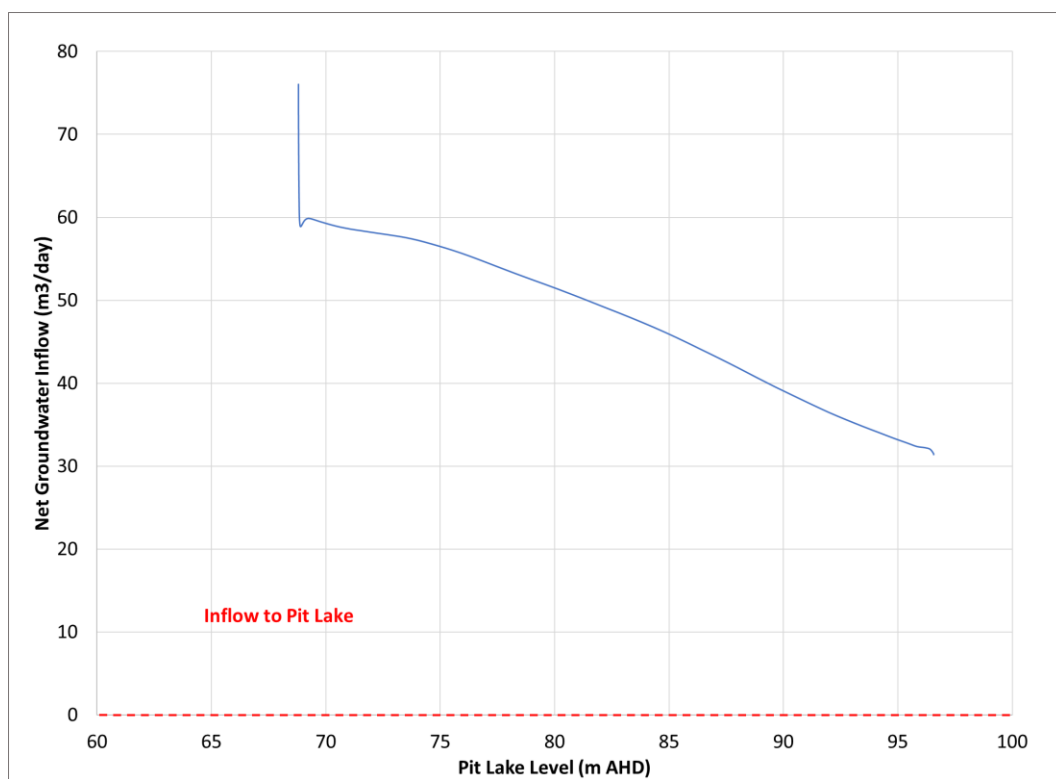
Drake Pit 4 North



Drake Pit 4 South



Drake Pit 5

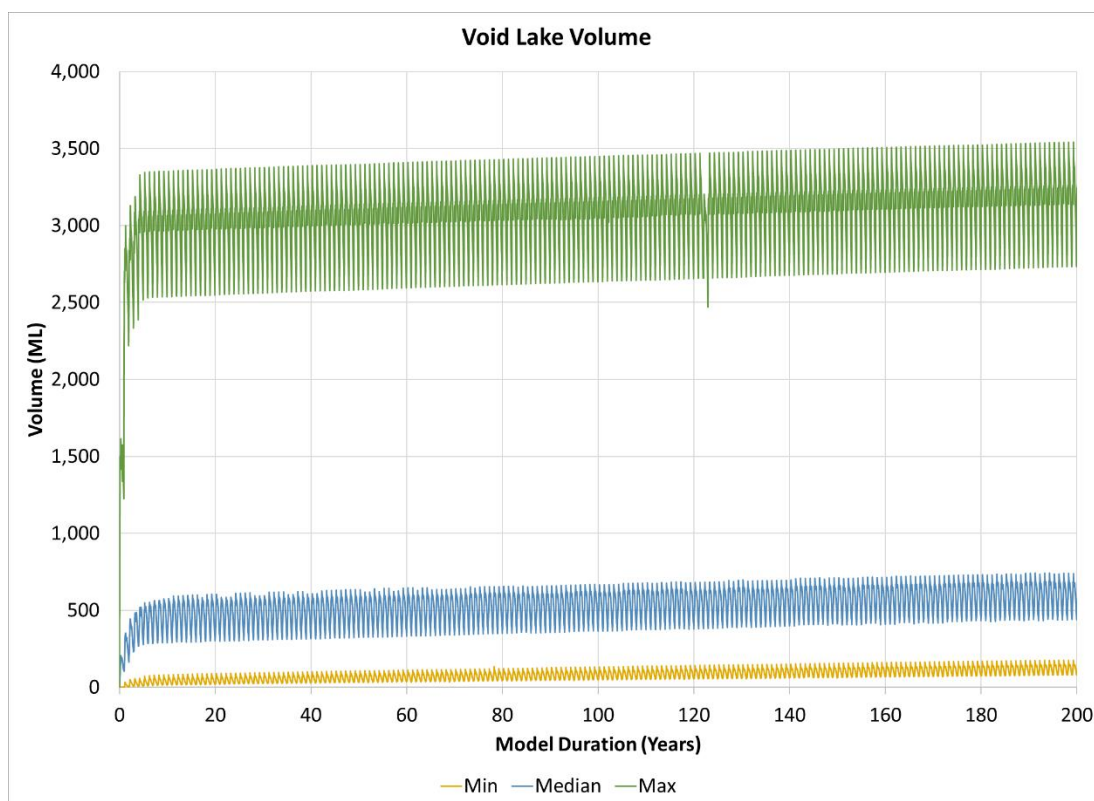
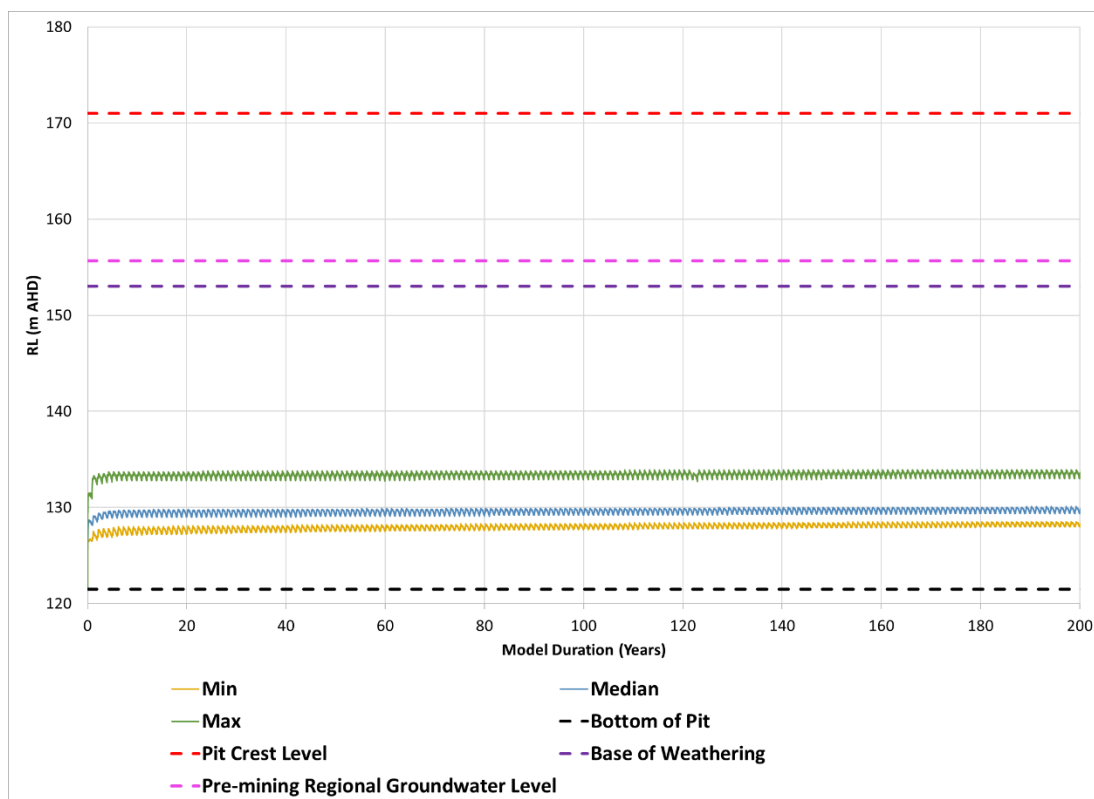


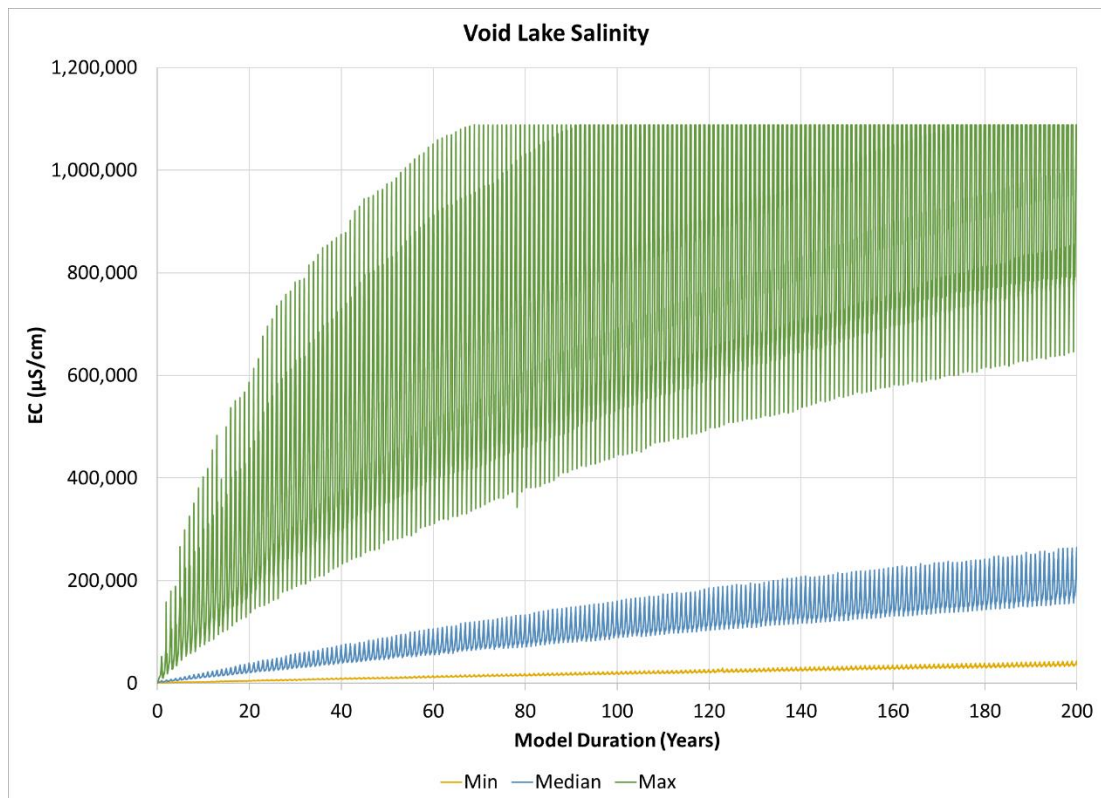
Appendix C

Void Hydrology Model Results

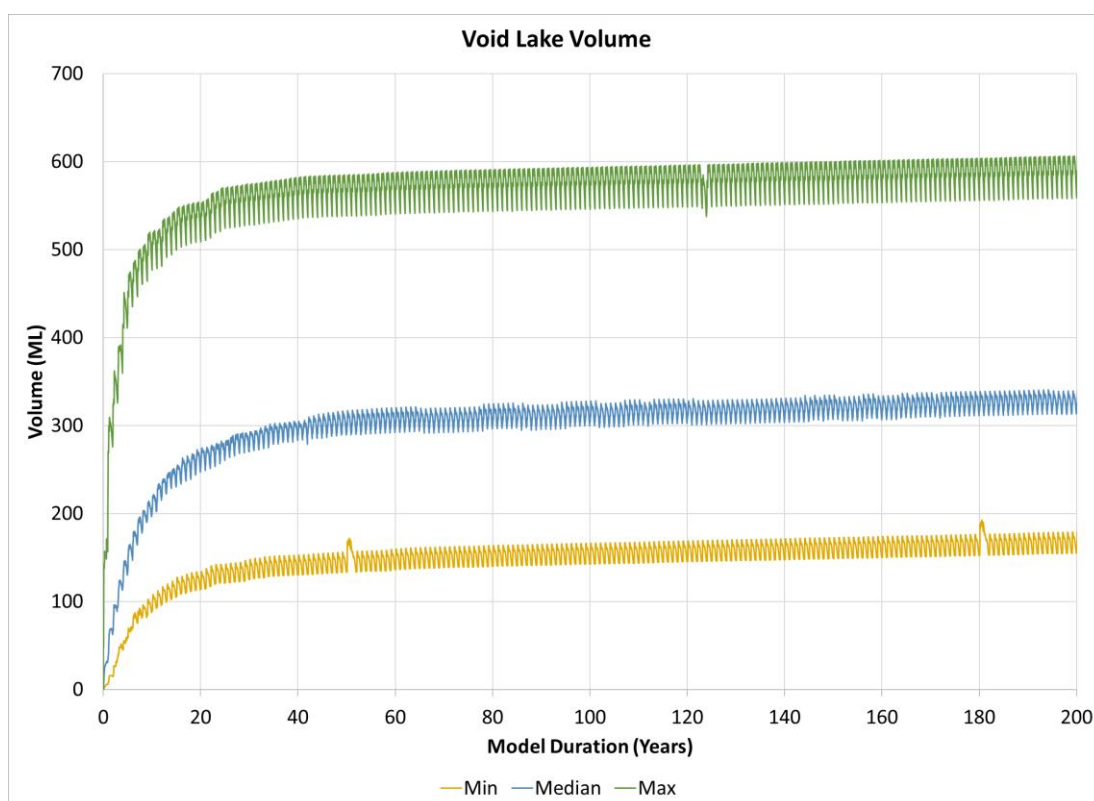
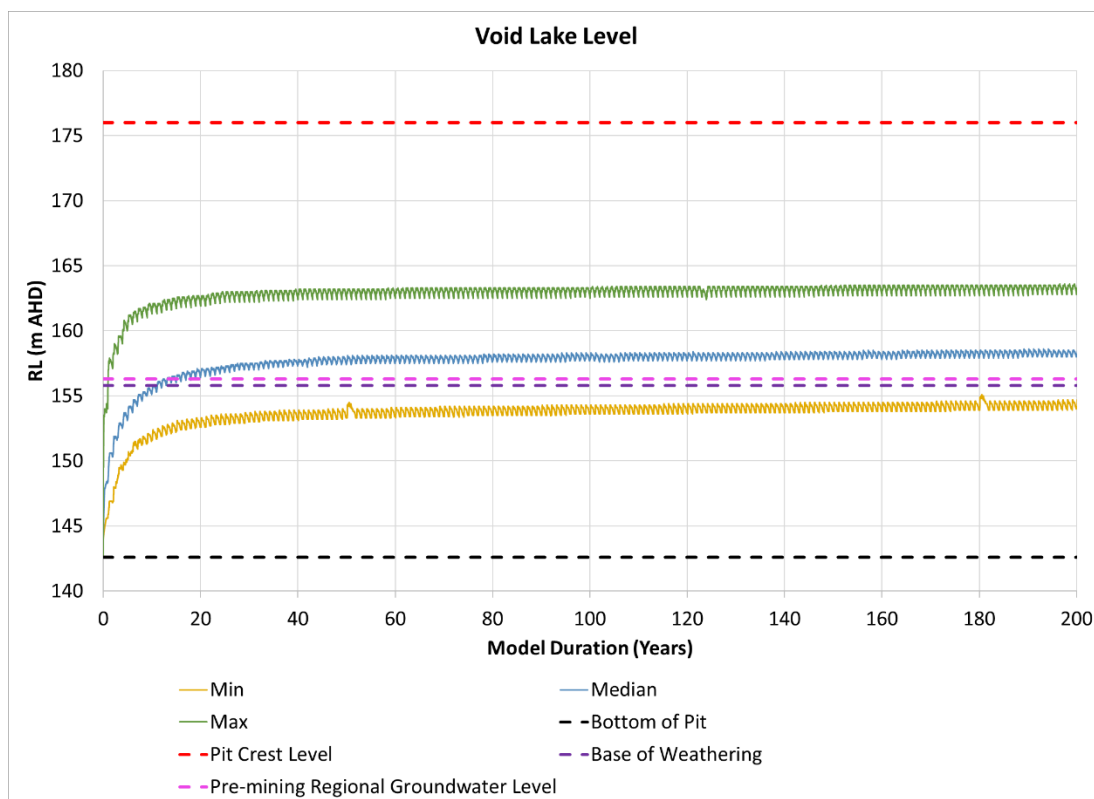
Base Case Scenario

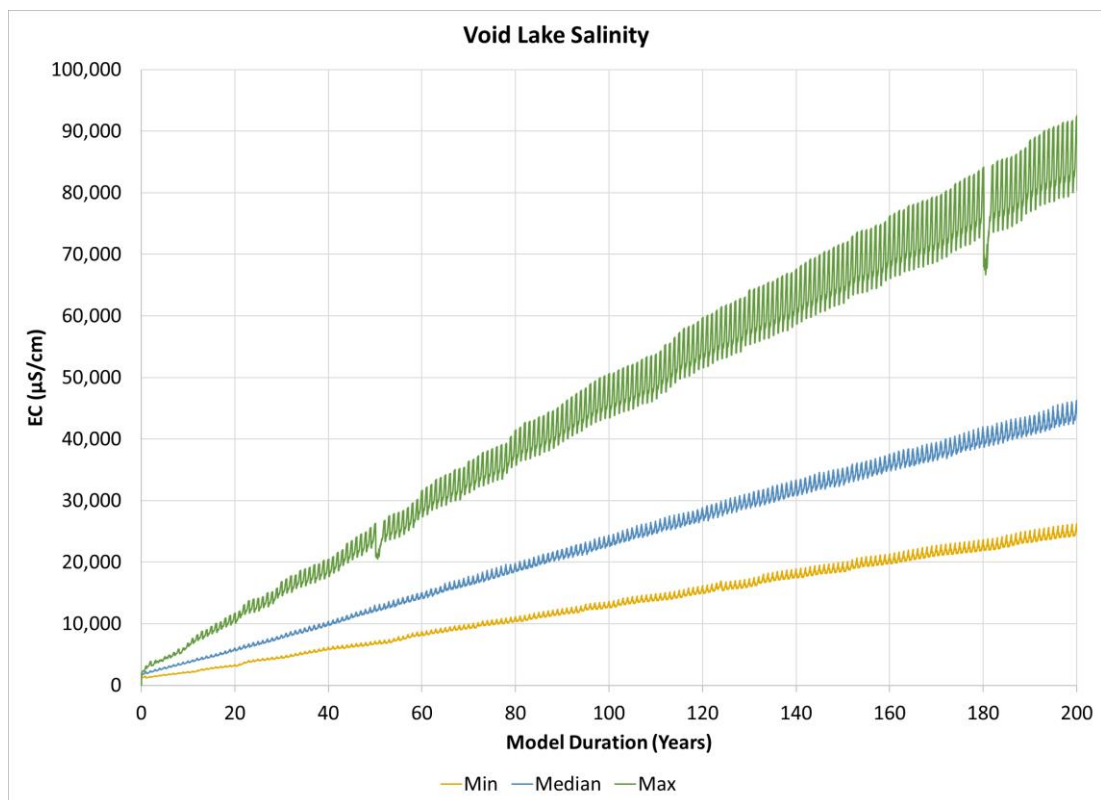
Sonoma Main Pit



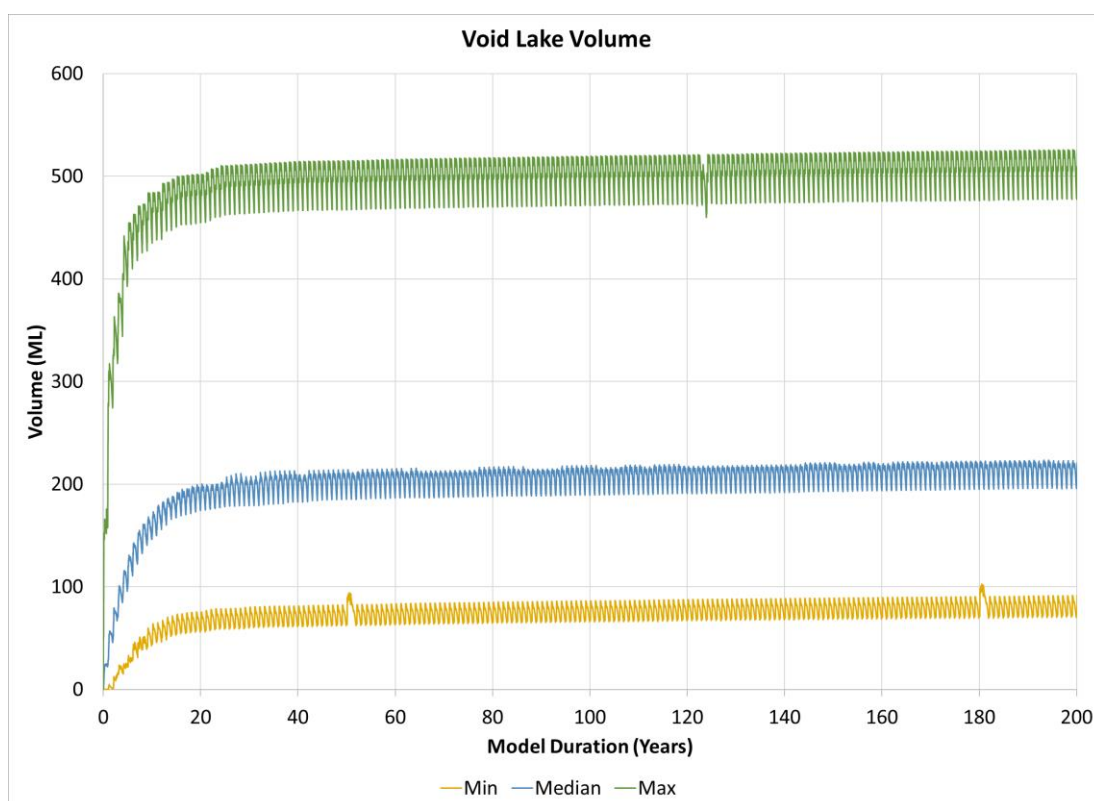
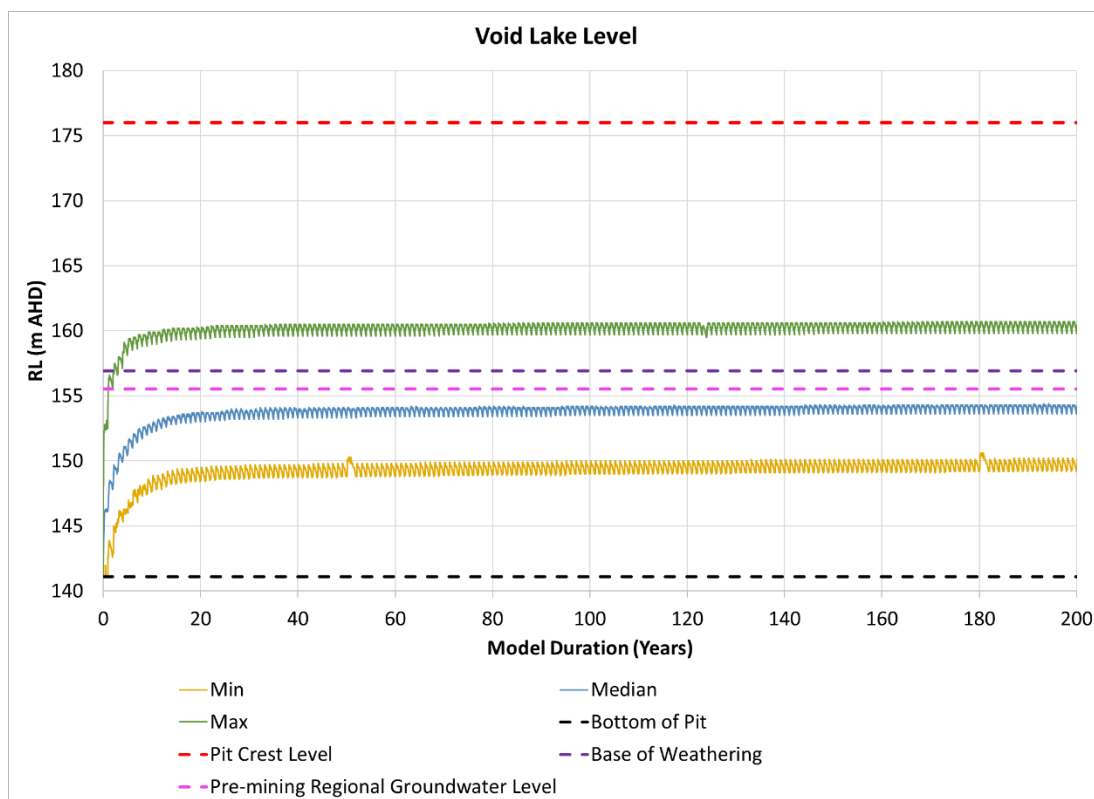


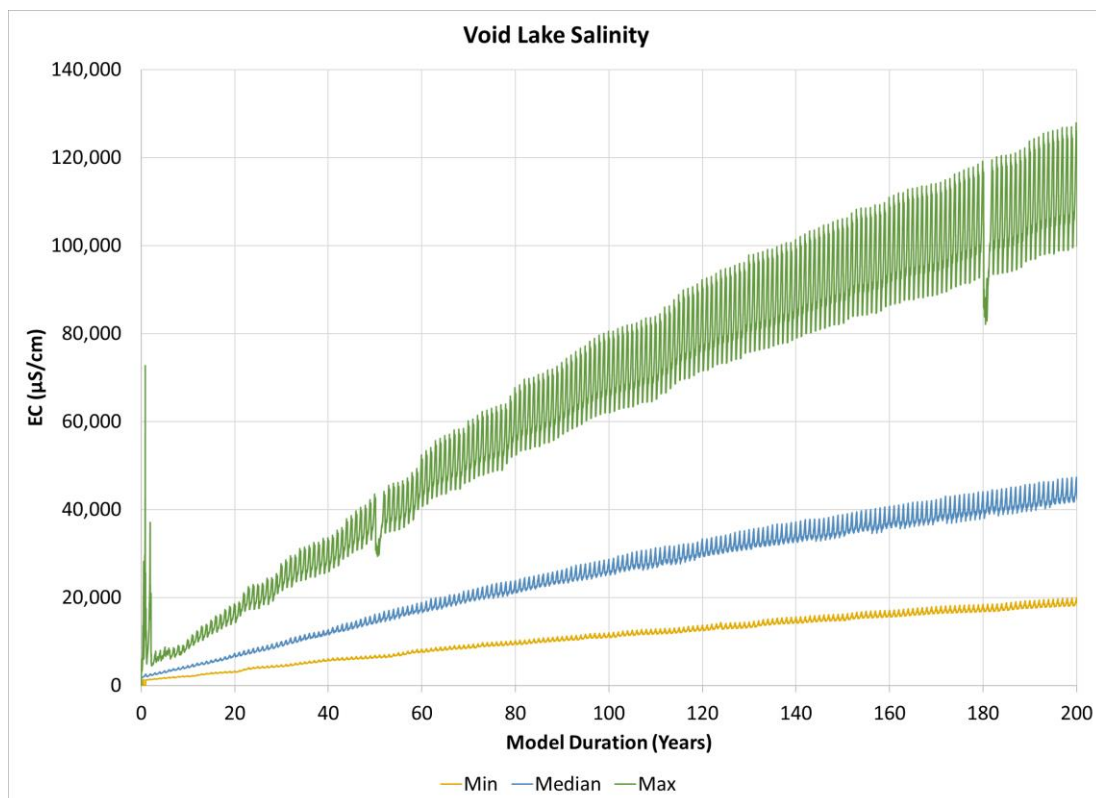
Sonoma East Pit 1



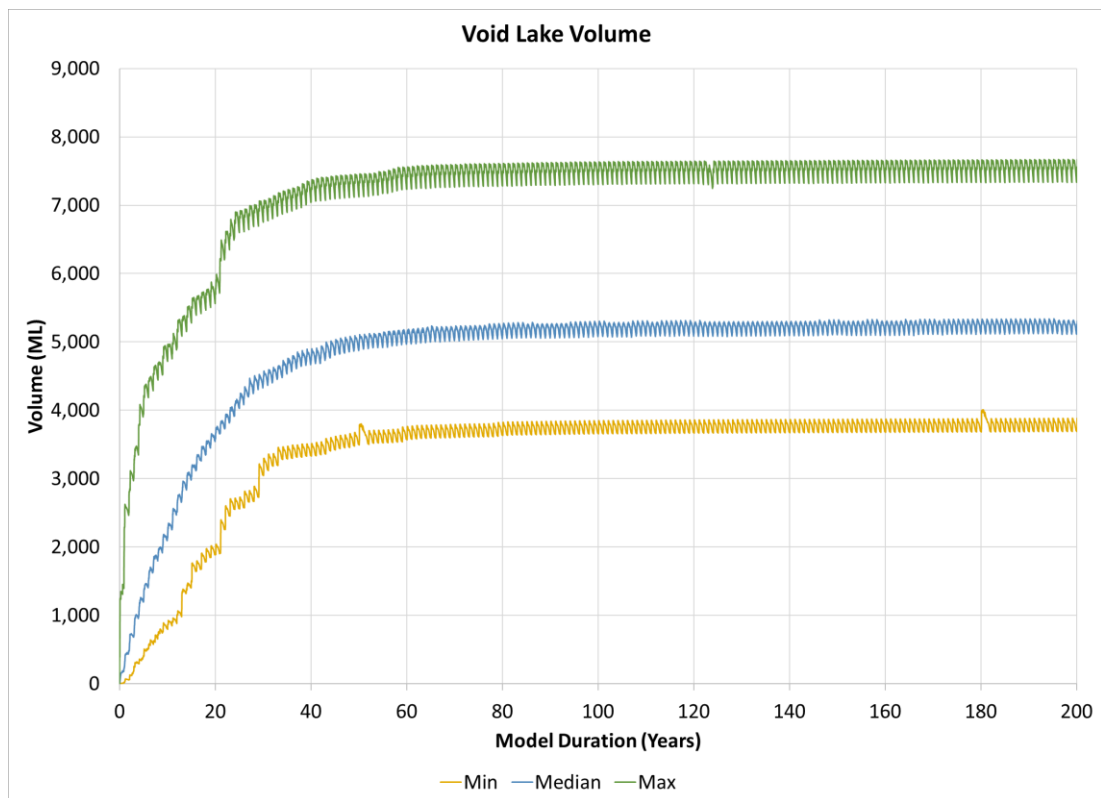
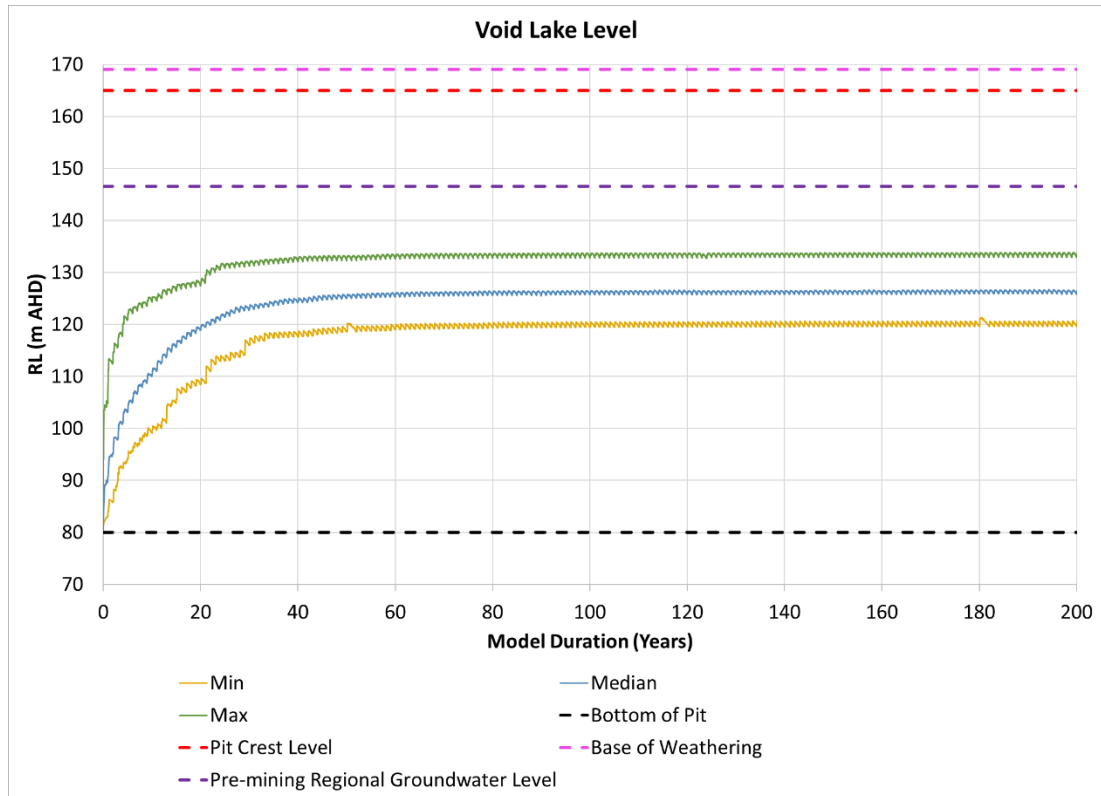


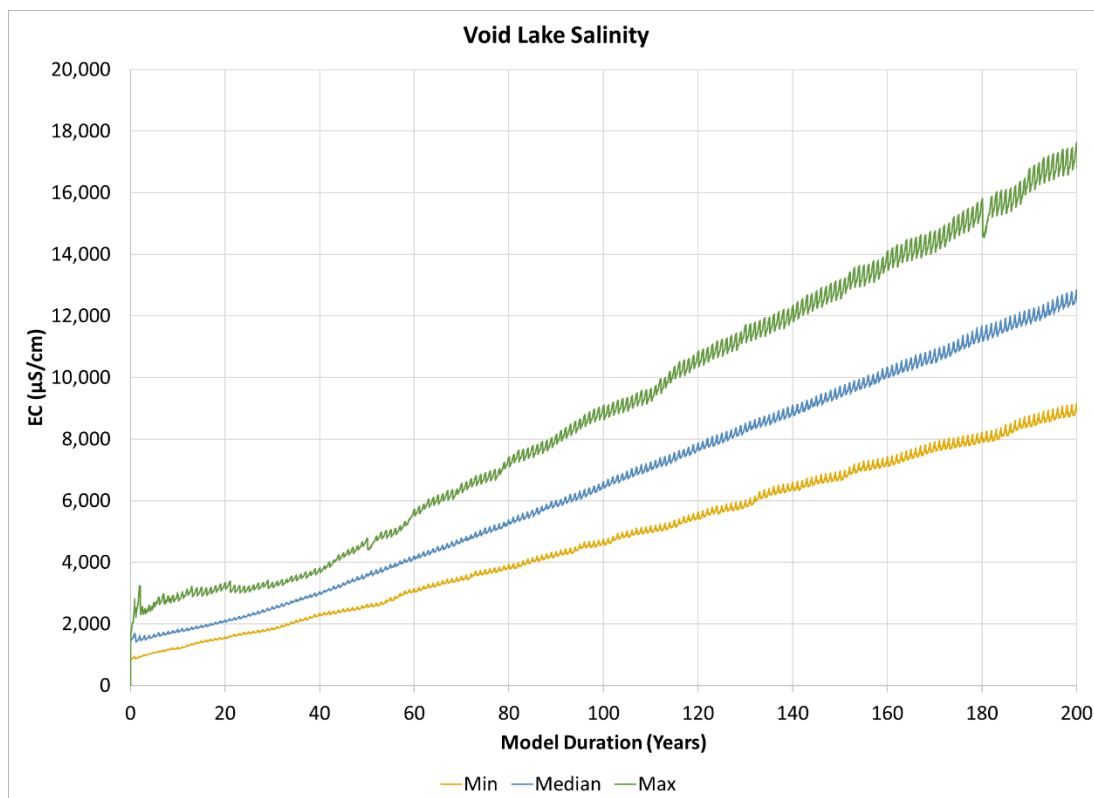
Sonoma East Pit 2



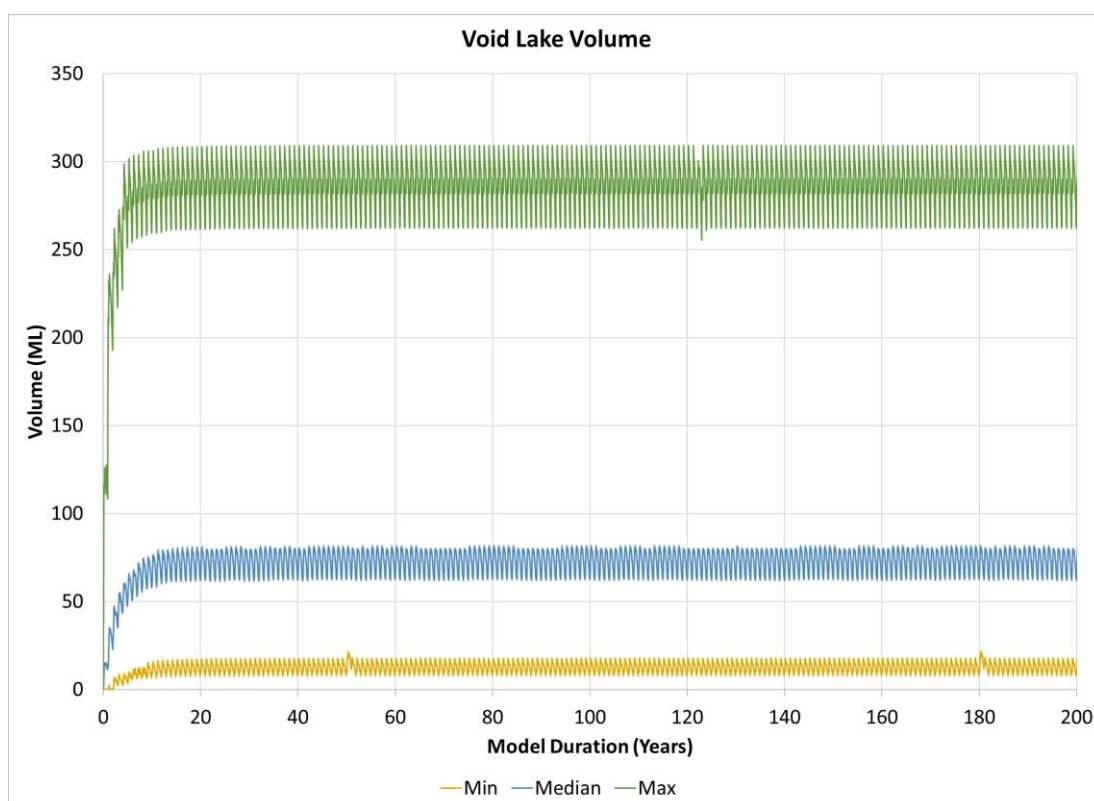
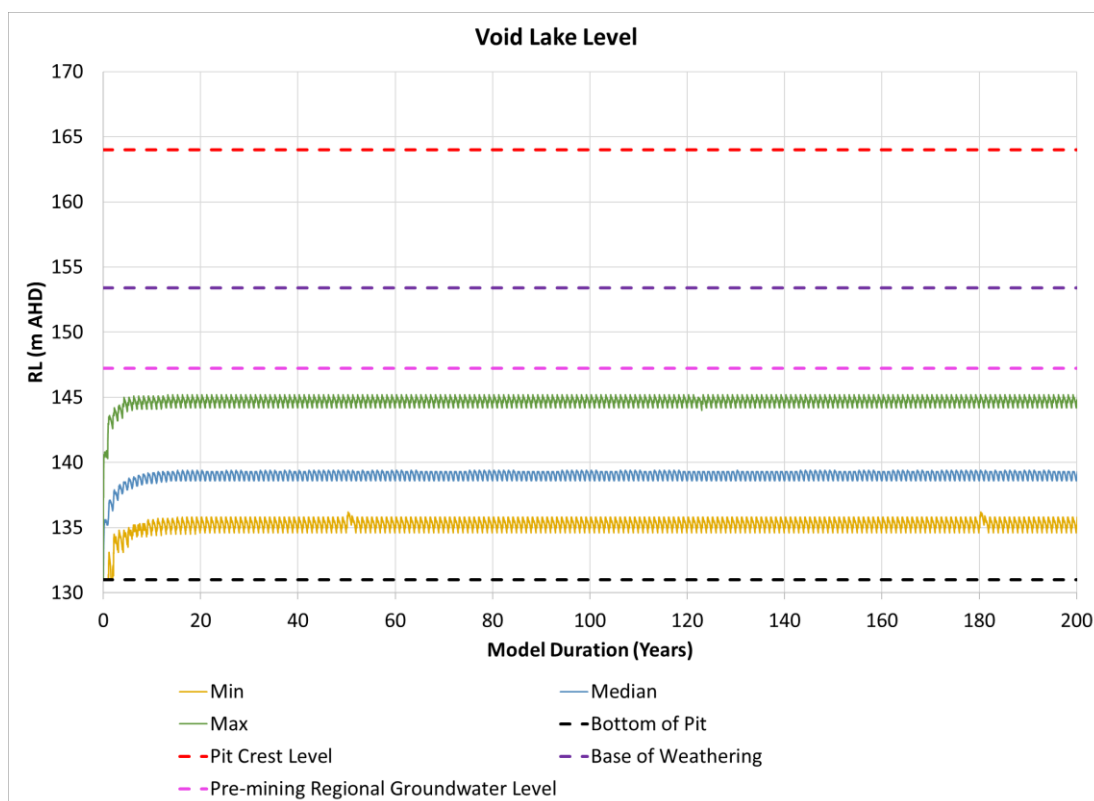


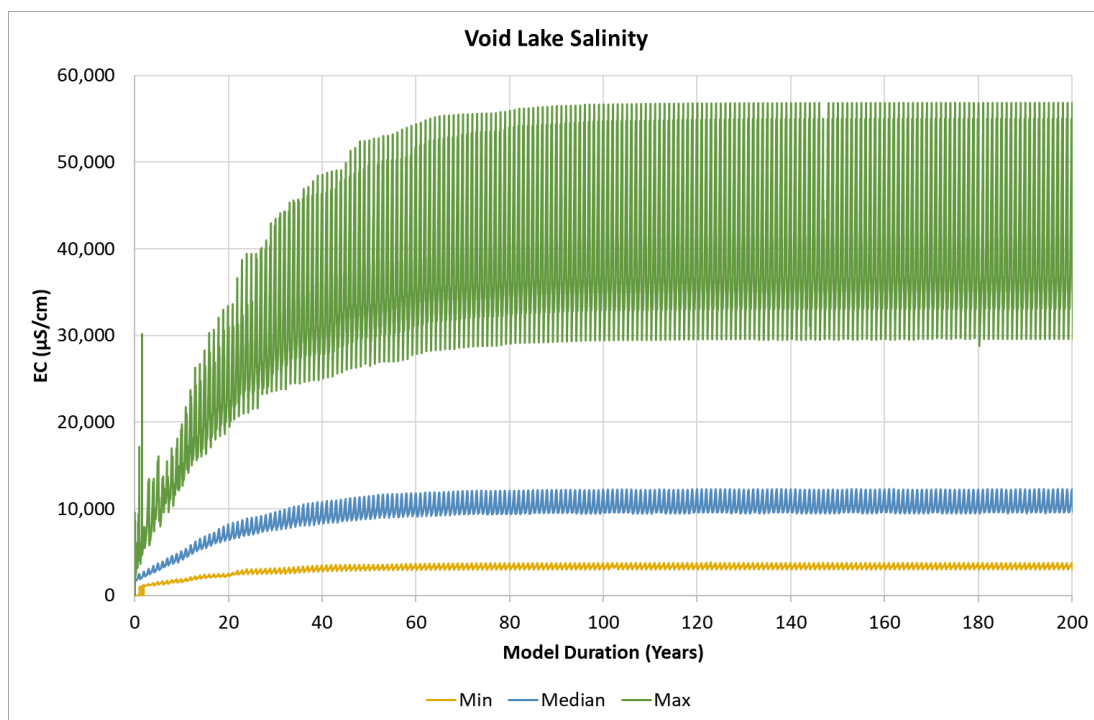
Drake Pit 1



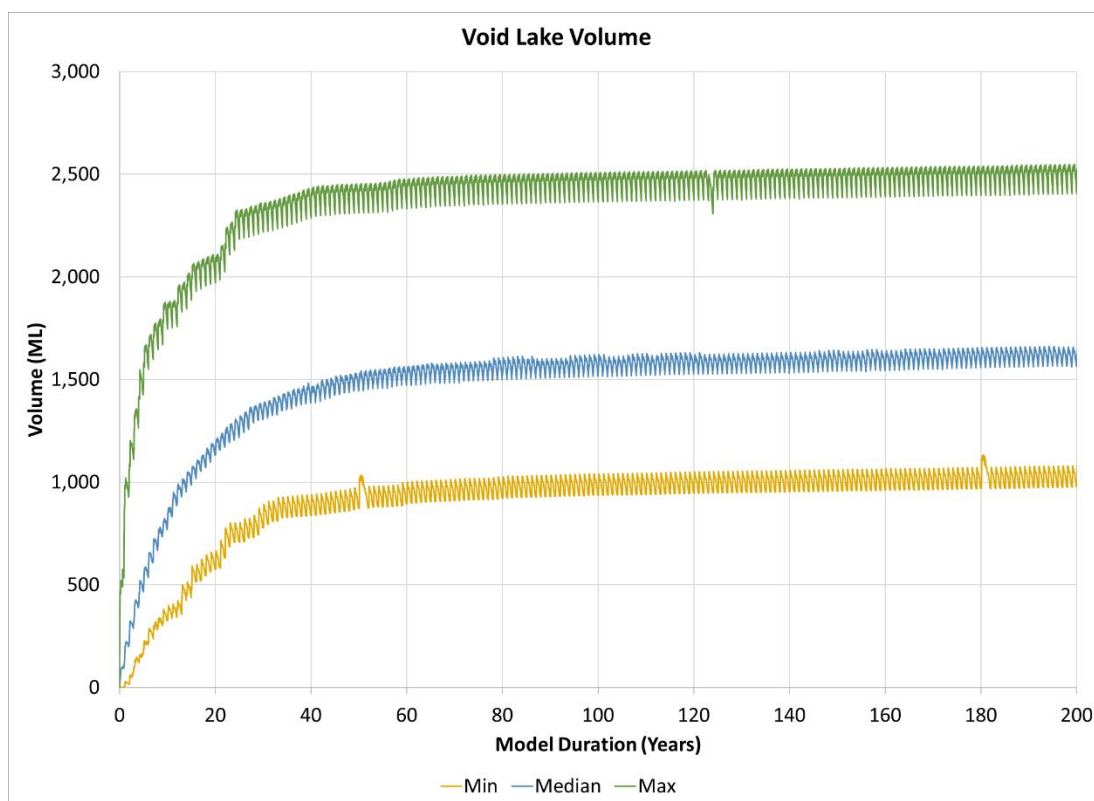
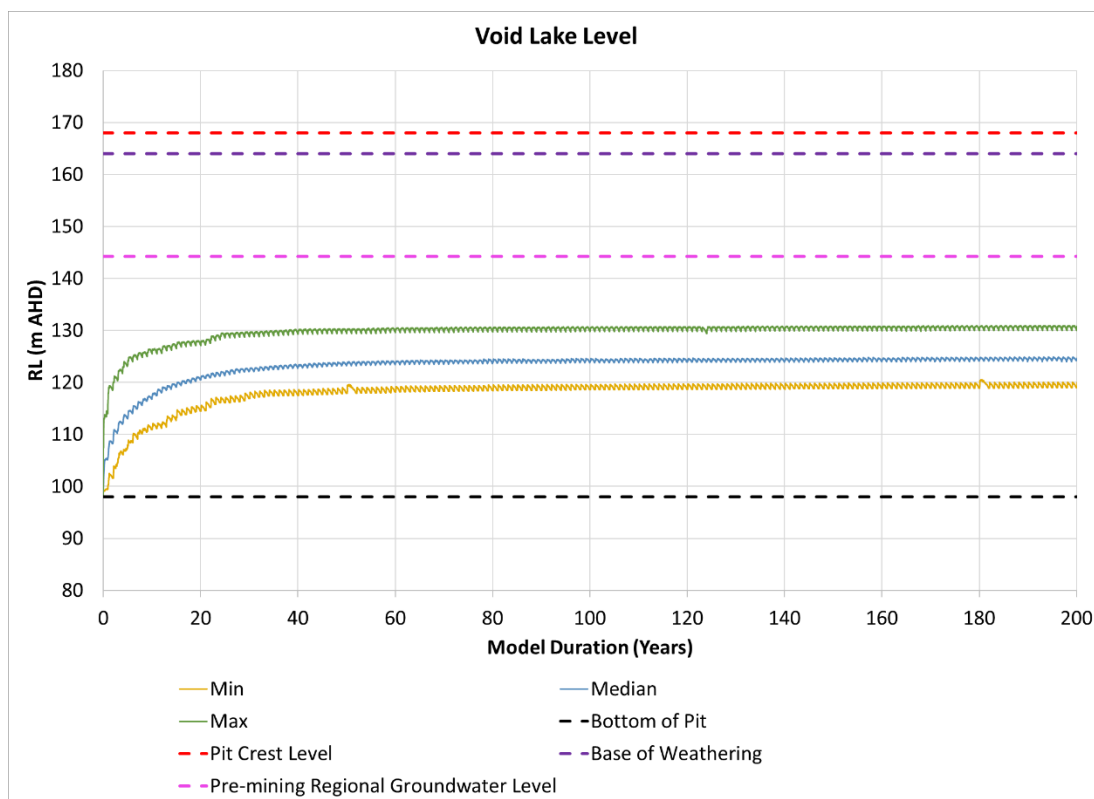


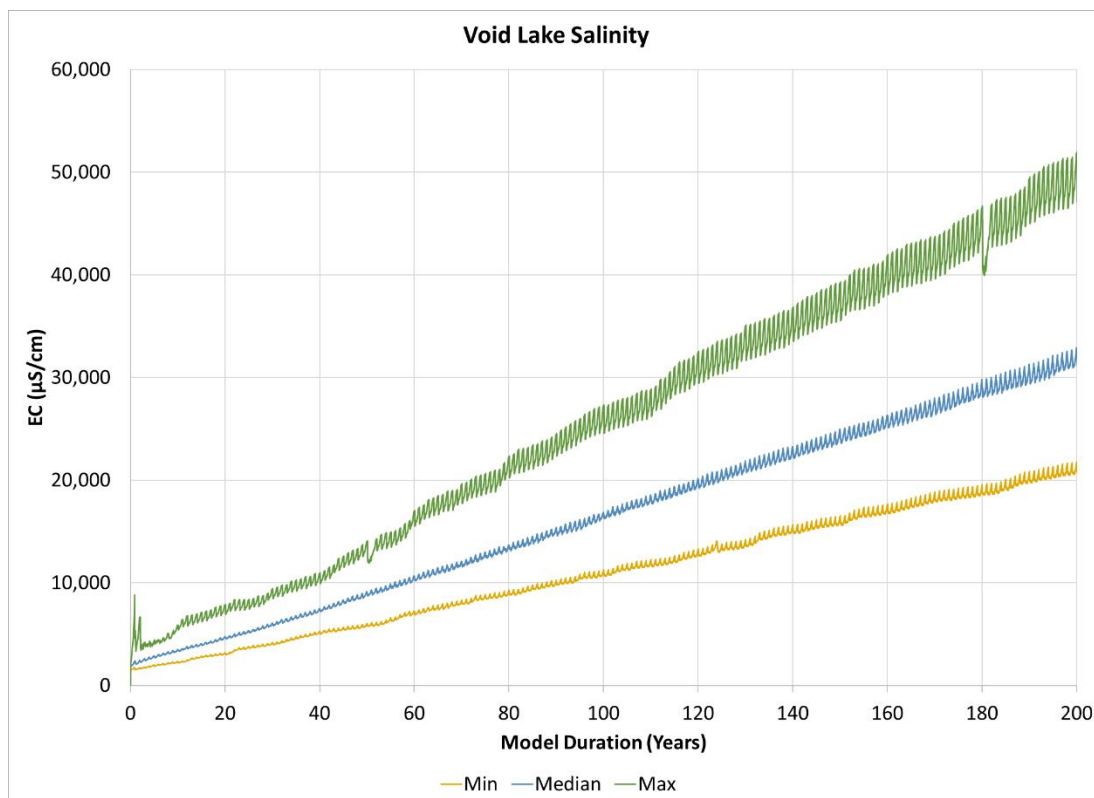
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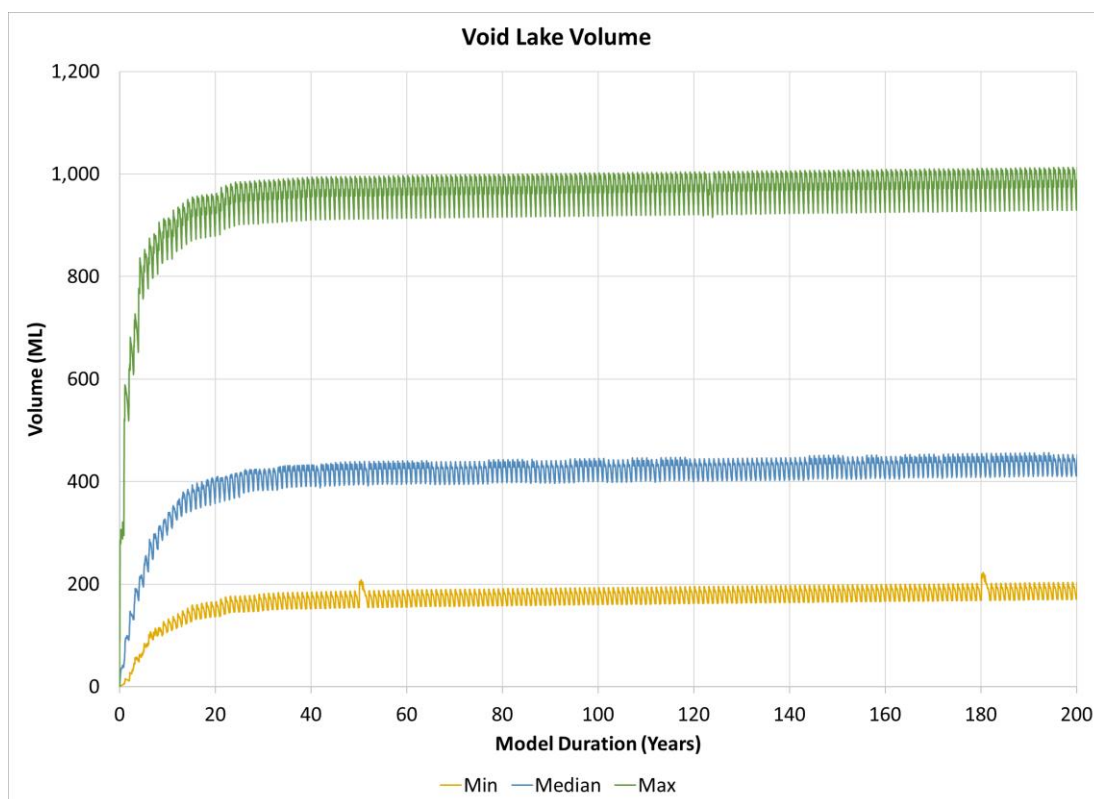
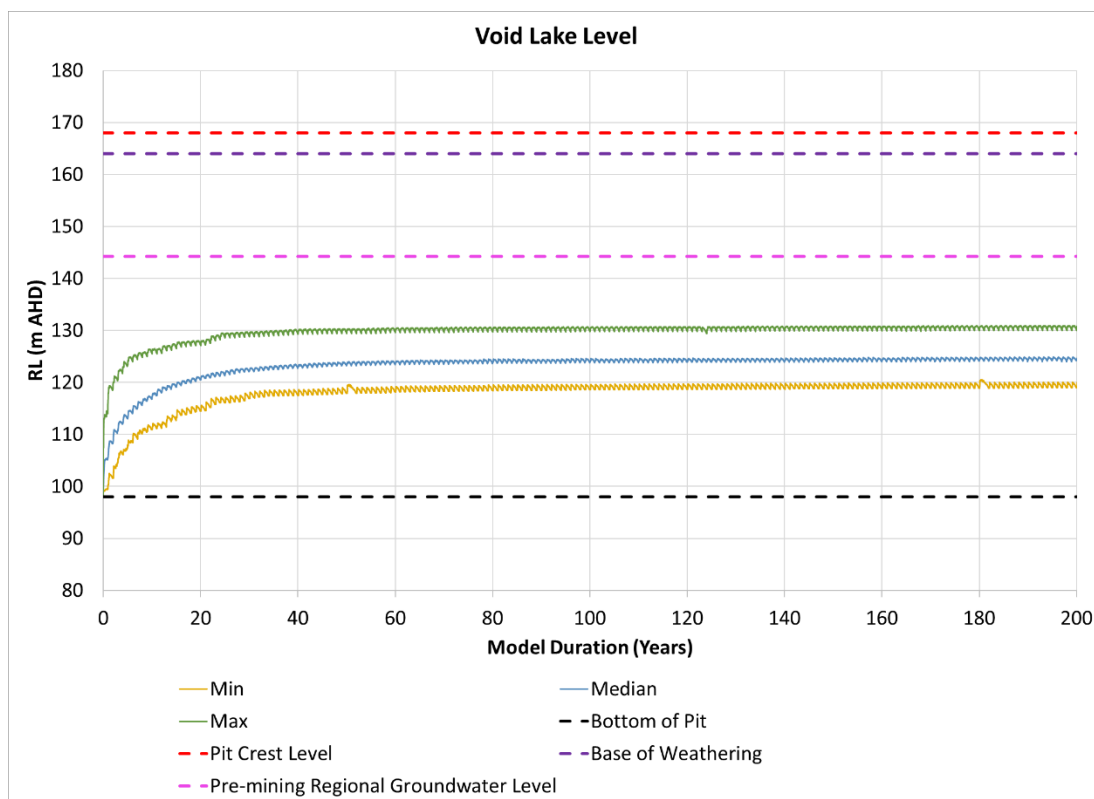


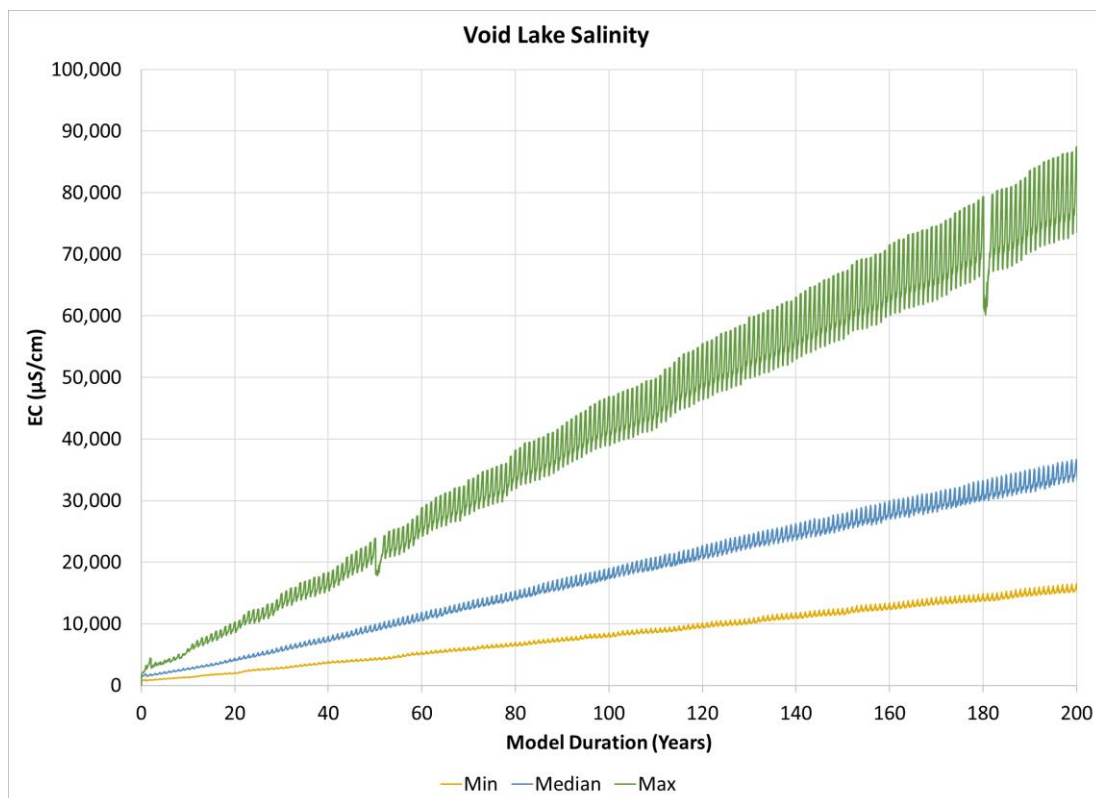
Drake Pit 2 Expansion



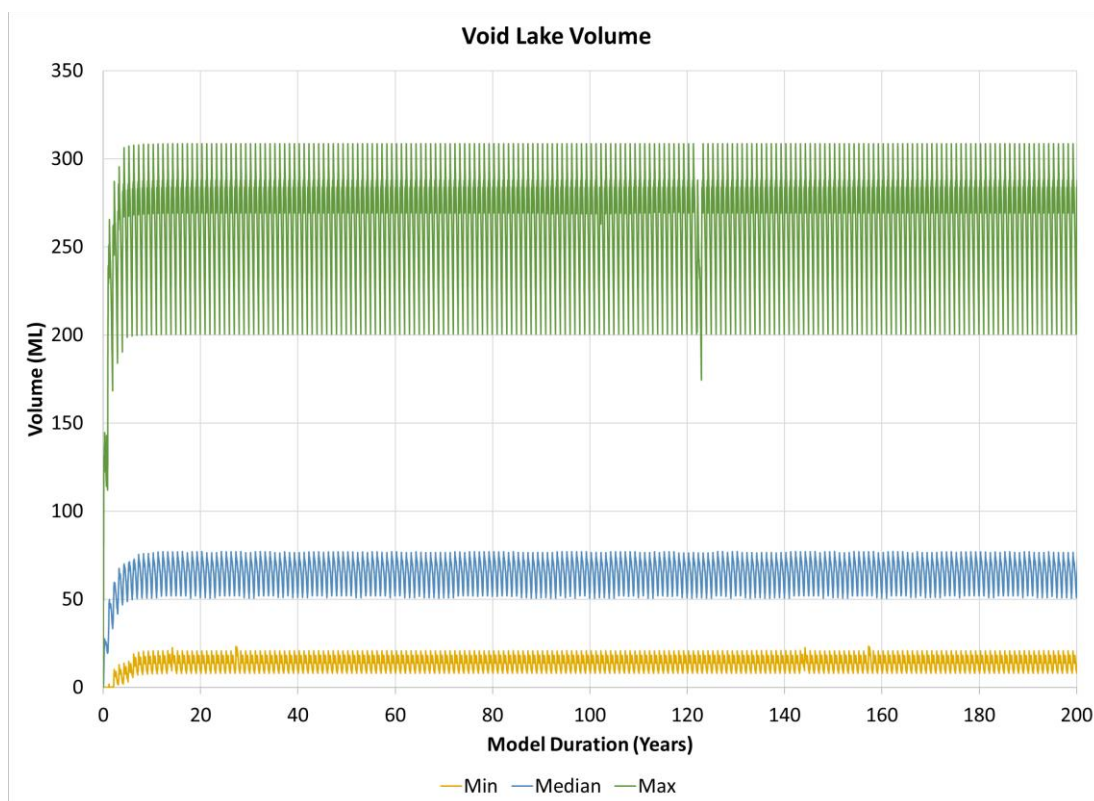
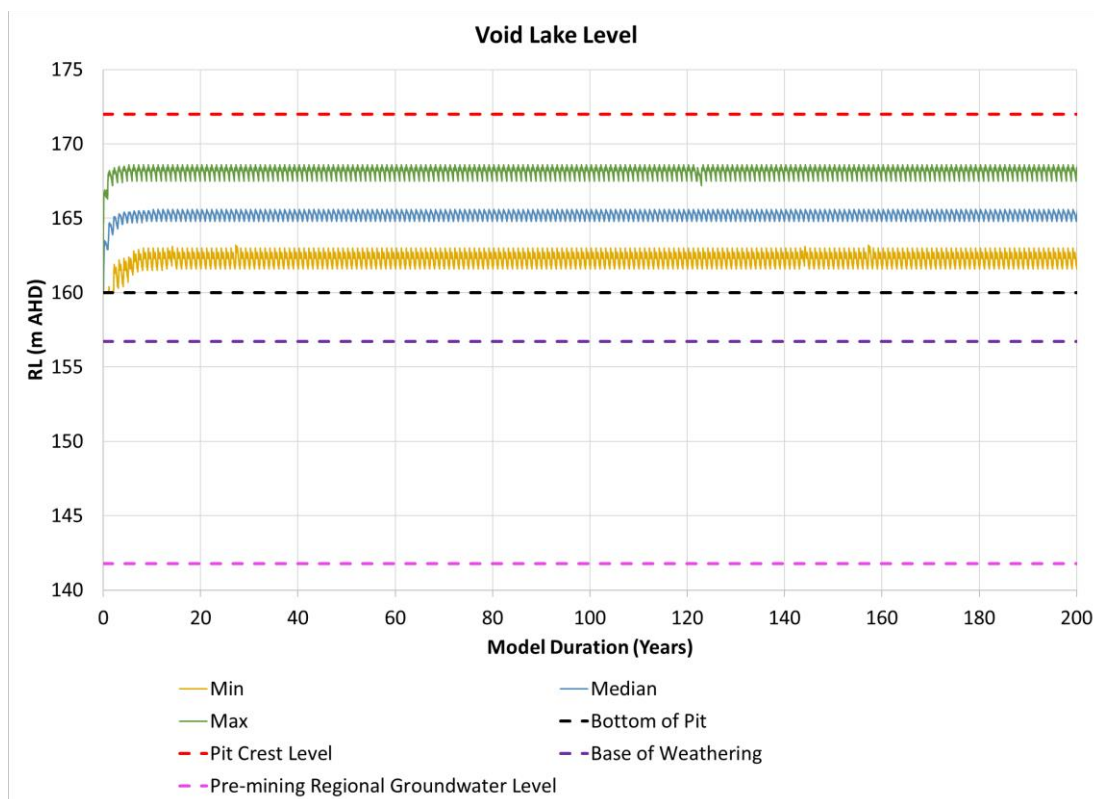


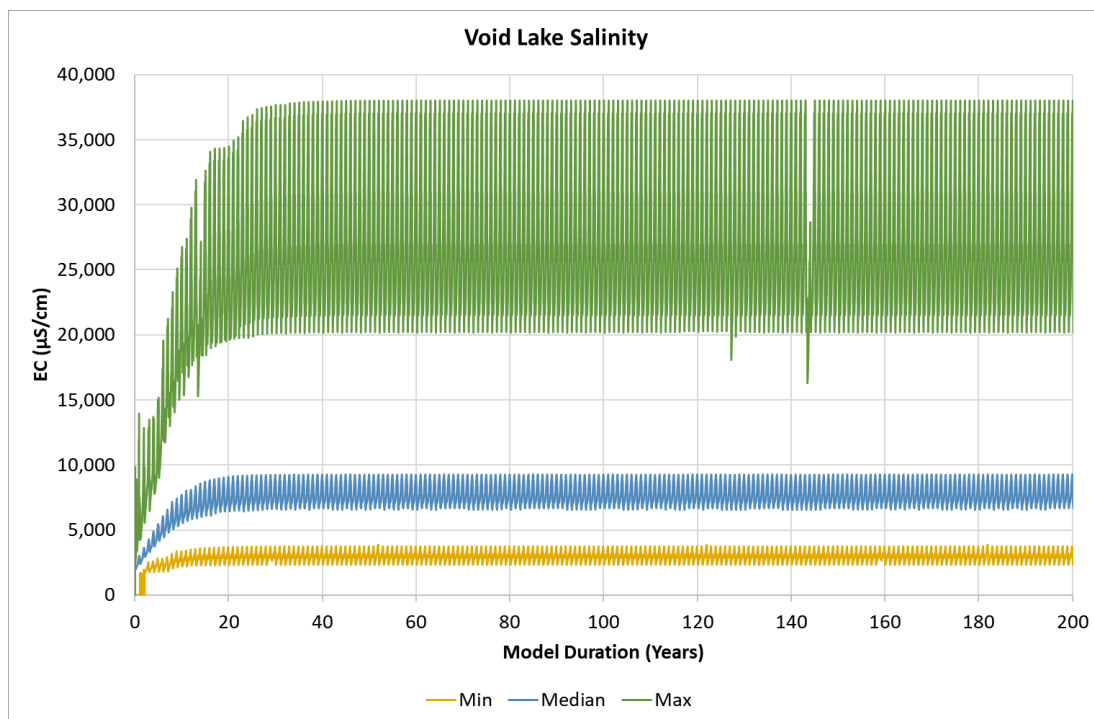
Drake Pit 3Q



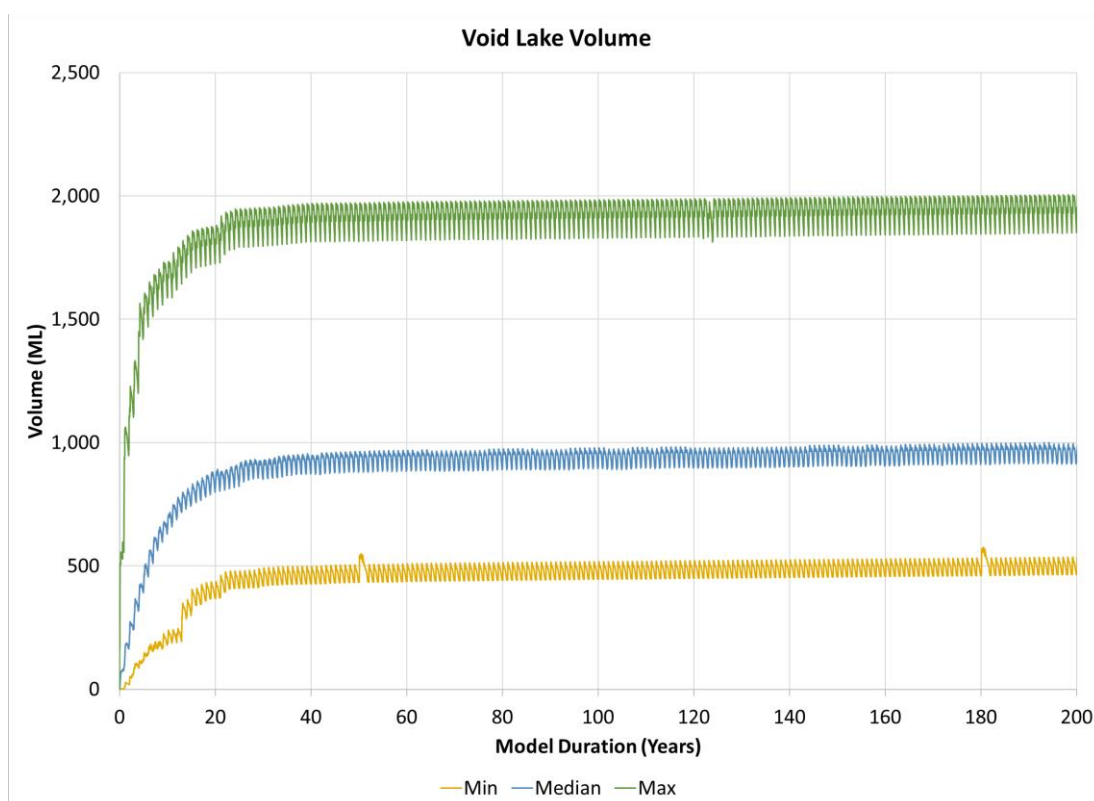
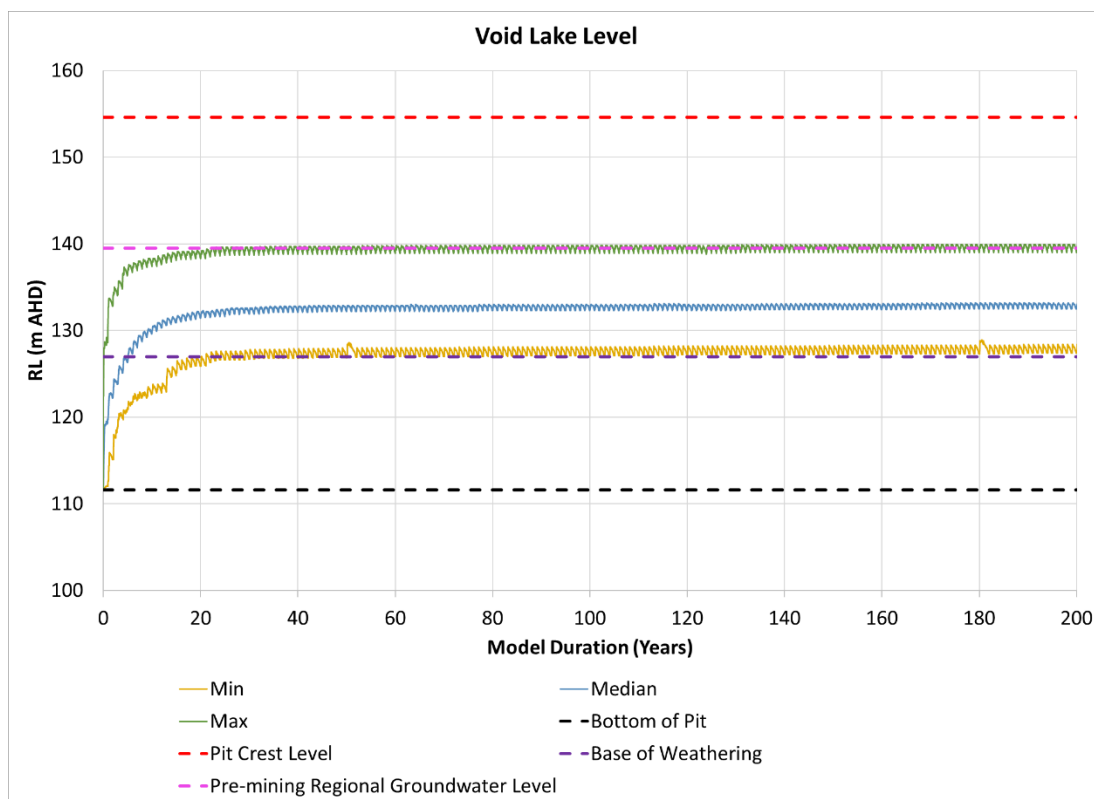


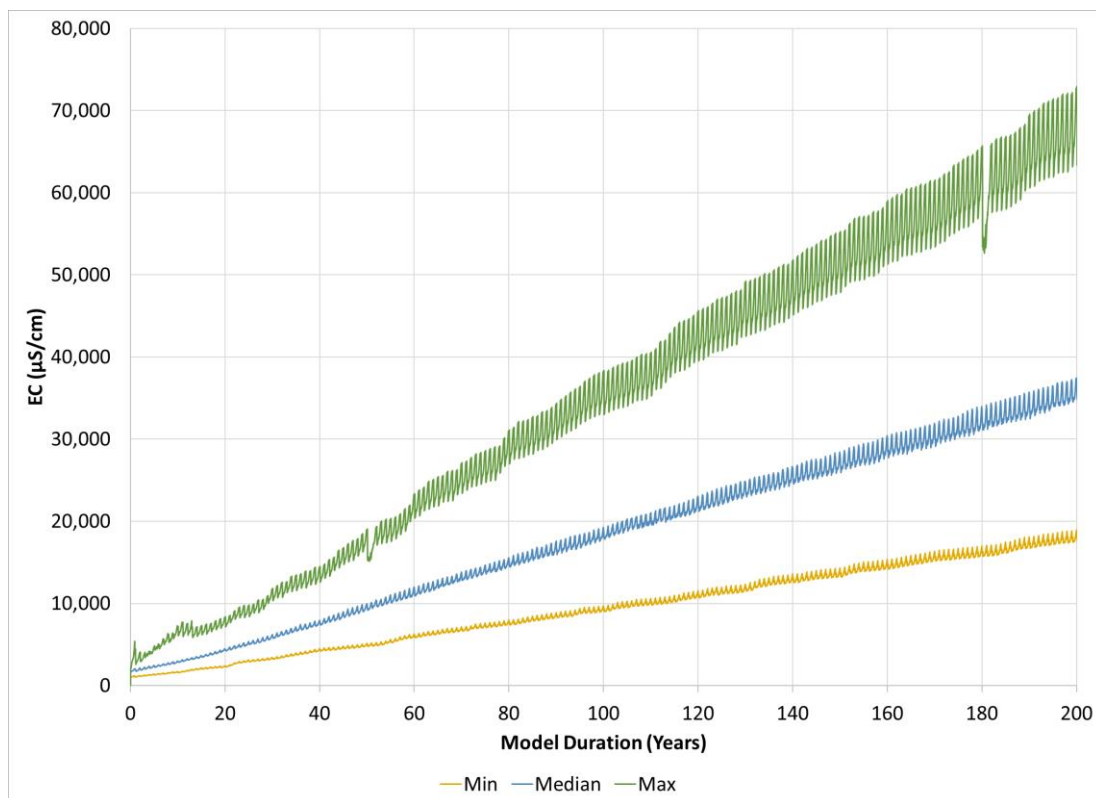
Drake Pit 3R



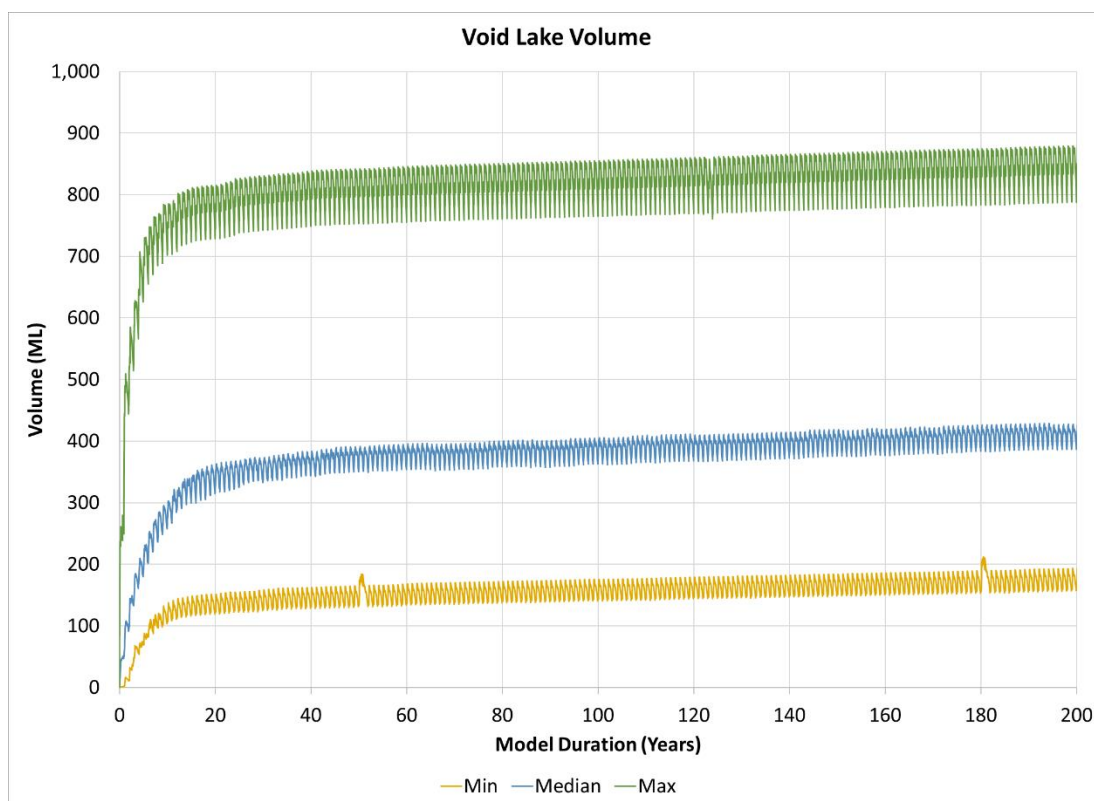
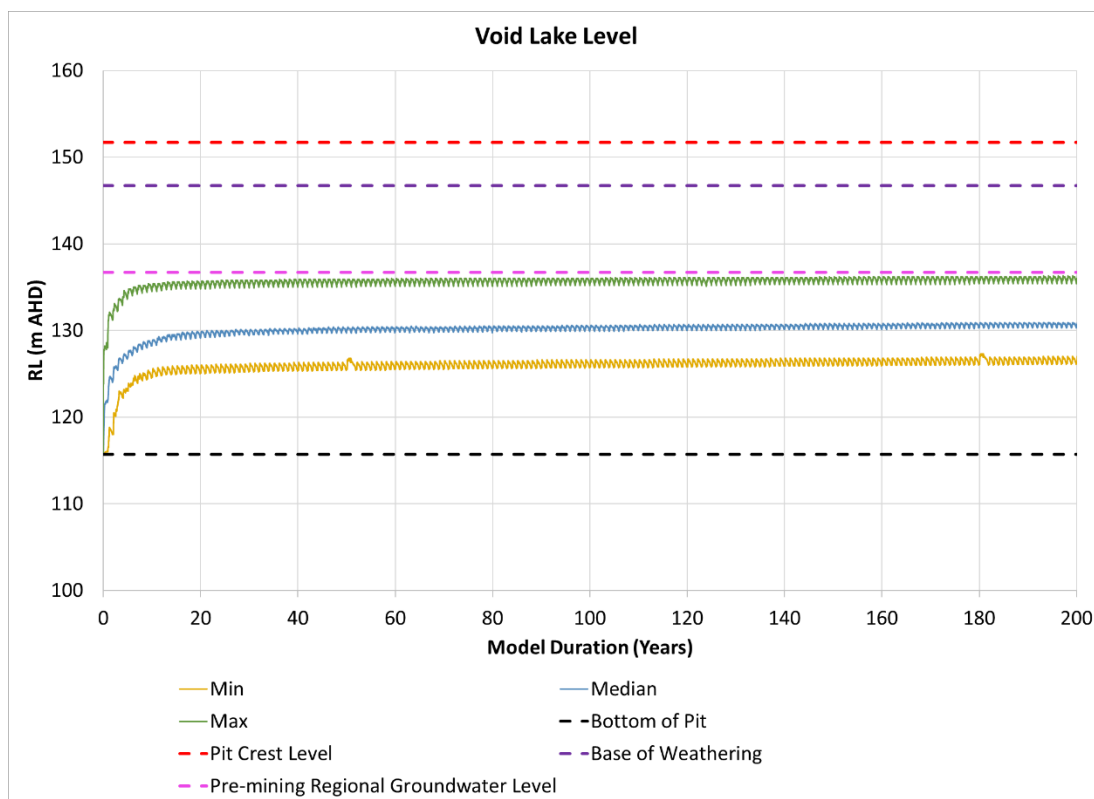


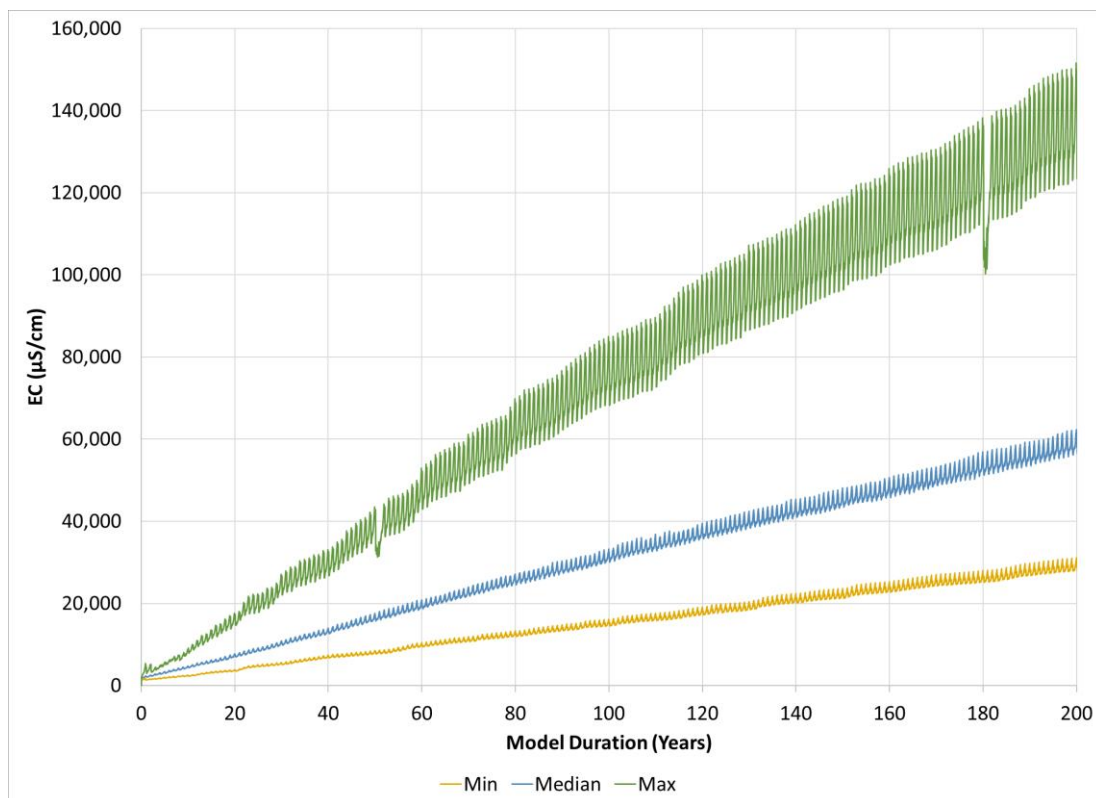
Drake Pit 4 North



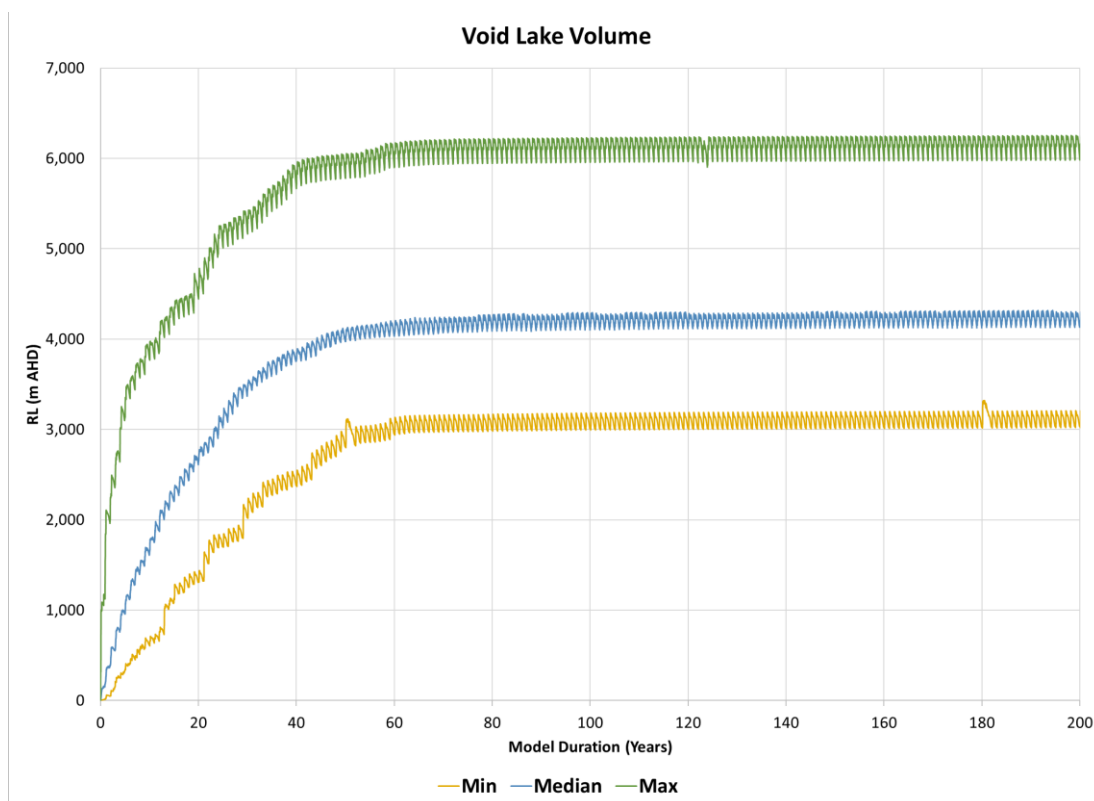
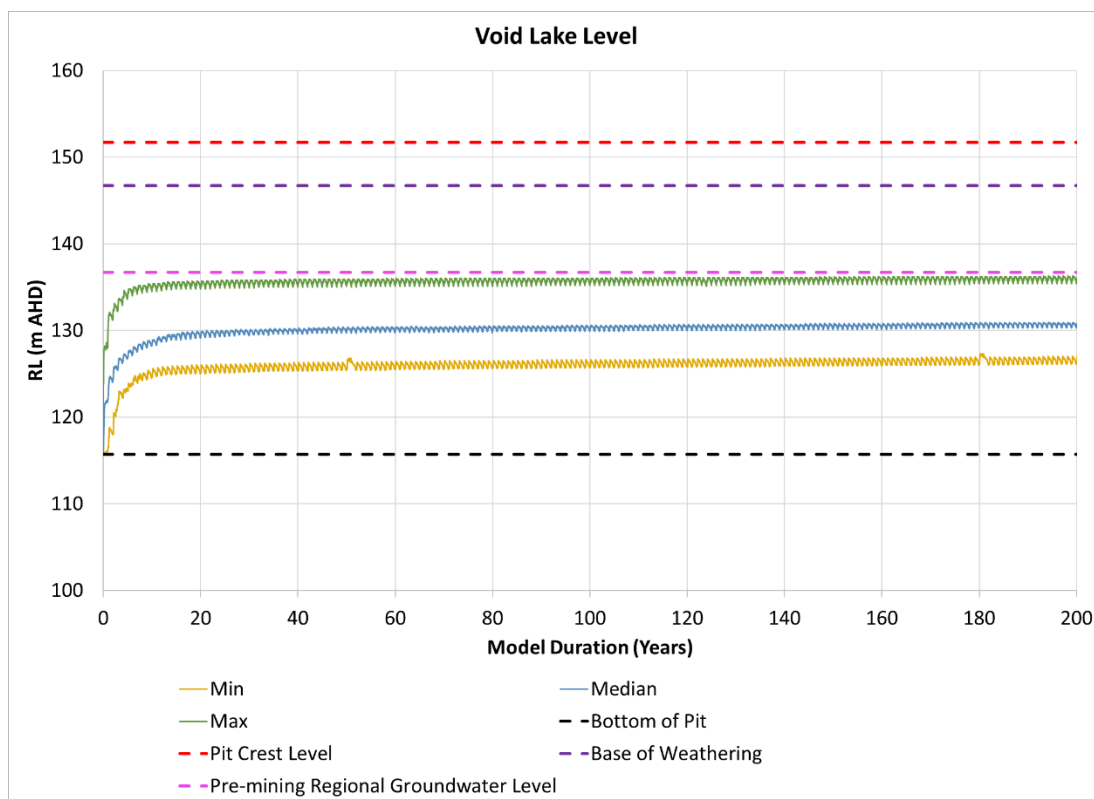


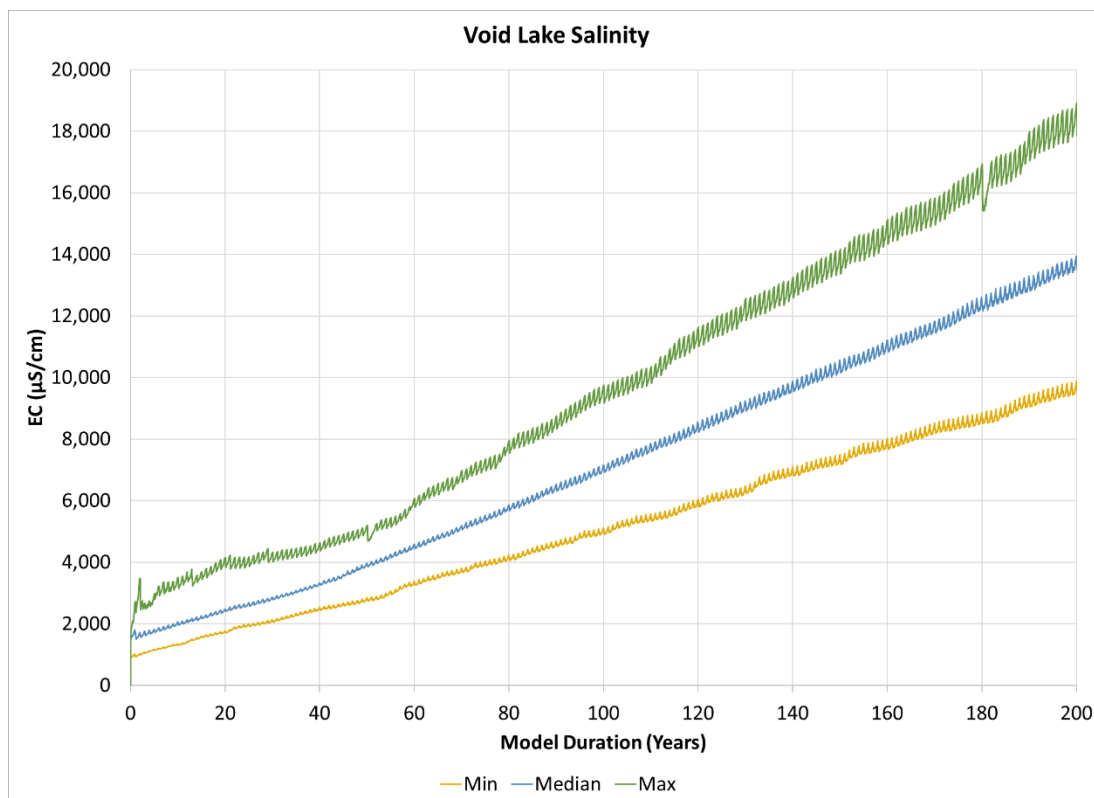
Drake Pit 4 South





Drake Pit 5





Appendix D

Void Hydrology Model Results

Mitigated Scenario

Drake Pit 4 North

