Perilya Broken Hill Limited

ABN: 46 099 761 289

Water Management Plan

Broken Hill North Mine

TITLE BLOCK

Name of Mine:	**Broken Hill North Mine**
Development Application Number	**SSD 7538**
Applicant	**Perilya Broken Hill Limited**
Development Consent Date	**22 December 2017, Last Modified 9 September 2018**
Development Consent Condition Number & Title	**Condition 33 of Schedule 3** **Water Management Plan**

VERSION CONTROL

SUMMARY OF DOCUMENT REVISIONS

Rev. No.	Date Revised	Section Revised	Revision Description	Revision Authority
A	23/10/18	ALL	Issued for INTERNAL Review	P. Ryall
B	24/10/18	Various	Issued for AGENCY consultation	G. Hender
C	19/11/18	Various	Issued for SECRETARY'S Approval	G. Hender
D	22/11/18	3, 11.4, 12.2.1	Issued for SECRETARY'S Approval (incorporating NRAR comments)	G. Hender
E	07/12/18	Various	Issued for SECRETARY'S Approval (incorporating DPE comments)	G. Hender
F	14/12/18	3, 9.2, 9.3.2 and 12.5.3	Issued for SECRETARY'S Approval (incorporating DPE 2nd comments)	G. Hender

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1 Introduction and Scope

This *Water Management Plan* management plan is one of several required by the Development Consent Conditions of SSD 7538. These plans are listed in Section 4. The overarching document in this list is the *Environmental Management Strategy* for the Broken Hill North Mine which contextualises each of the subordinate management plans and includes generic systems-based details that are common to all plans.

This document describes the management of water associated with the operational phase of the Broken Hill North Mine (the North Mine).

This document represents a staged approach to the preparation of the various management plans and covers the post-construction phase of the North Mine following formal notification of the commencement of mining operations under Condition 10(b) of Schedule 2 of SSD 7538. This document specifically addresses the requirements of Condition 33 of Schedule 3 of SSD7538.

Responsibility for preparation of the document has been as follows.

- RW Corkery & Co Pty Limited (RWC) – Mr Paul Ryall of RWC prepared the draft version of this document, including preparation of the calculations and design components required for the Plan. Mr Ryall holds a Bachelor of Science (Hydrology and Water Resources) and was approved as a suitably qualified expert by Department of Planning and Environment on 17 September 2018.

  Mr Mitchell Bland of RWC undertook a peer review of the final draft of this document, ensuring consistency between this document and the commitments made throughout the development application process and the other Management Plans prepared for the North Mine. RWC also provided administrative assistance in the finalisation of this report.

- Perilya Broken Hill Limited (PBHL) – was intimately involved in all stages of the preparation of this document, provided technical input to the calculations and design components prepared by Mt Ryall and reviewed and approved the document for release.

2 Project description

The North Mine first started operations in 1883. Perilya Broken Hill Limited (PBHL) acquired assets of Pasminco Ltd in Broken Hill, including the North and South Mines, in 2002. Operations recommenced at the North Mine in 2003, with ore from the North Mine crushed and transported to PBHL Southern Operations (“Southern Operations”) for processing. The North Mine was placed under care and maintenance in August 2008. Underground exploration and maintenance re-commenced in April 2017.

Development Consent SSD7538 for the recommencement of mining operations at the North Mine was granted under Section 89E of the *Environmental Planning and Assessment Act 1979* on the 22 December 2017 and subsequently modified on 9 September 2018. The approved activities within the North Mine include the following work (**Figures 1** and **2**).

- Remediate the existing Cosmopolitan access ramp, portal and decline to the 12 Level (the limit of the existing decline) to facilitate safe and efficient access to the underground workings
- Restore and upgrade existing electrical, ventilation, air and water services, including on surface and within the decline, No. 2 and No. 3 Shafts, No. 3 Vent Rise.
- Extend the existing decline from the 12 Level to link with the existing decline between the 32 Level and the 38 Level.
- Undertake exploration drilling from underground to further define remnant ore and identify additional ore lenses and lodes.
- Develop access drives to permit access by modern mining equipment.
- Extract remnant ore and ore below the base of previous mining operations, including within the Fitzpatrick Area.
- Transport extracted ore to the surface ROM Pad using underground haul trucks, including establishment of a haulage route utilising existing roads and a proposed haul road cutting.
- Transport extracted waste rock for placement either within completed stopes underground or within the in-pit waste rock emplacement in the Cosmopolitan Open Cut.
- Extract waste rock from the existing surface waste rock emplacement for transportation back underground as required.
- Extract tailings from a former Tailings Storage Facility for mixing with water and cement in a pastefill plant for use backfilling completed stopes.
- Re-establish surface infrastructure required to support the mining operation, including a ROM pad, office and store, workshop and fuel store, change house and car park, services (power, water, air and communications), surface magazine and ancillary infrastructure.
- Stockpile and crush ore within the existing ROM Pad using a mobile crusher.
- Load and transport the crushed ore to the Southern Operations using A-double road trains via the approved transport route, namely the Potosi Mine Haul Road, Barrier Highway, Iodide Street, Crystal Street and Gypsum Street.
- Process the transported ore within the Southern Operations Concentrator under the continuing use rights held for that operation.
- Dewater the existing workings and transfer that water to the Southern Operations or on site evaporation ponds.

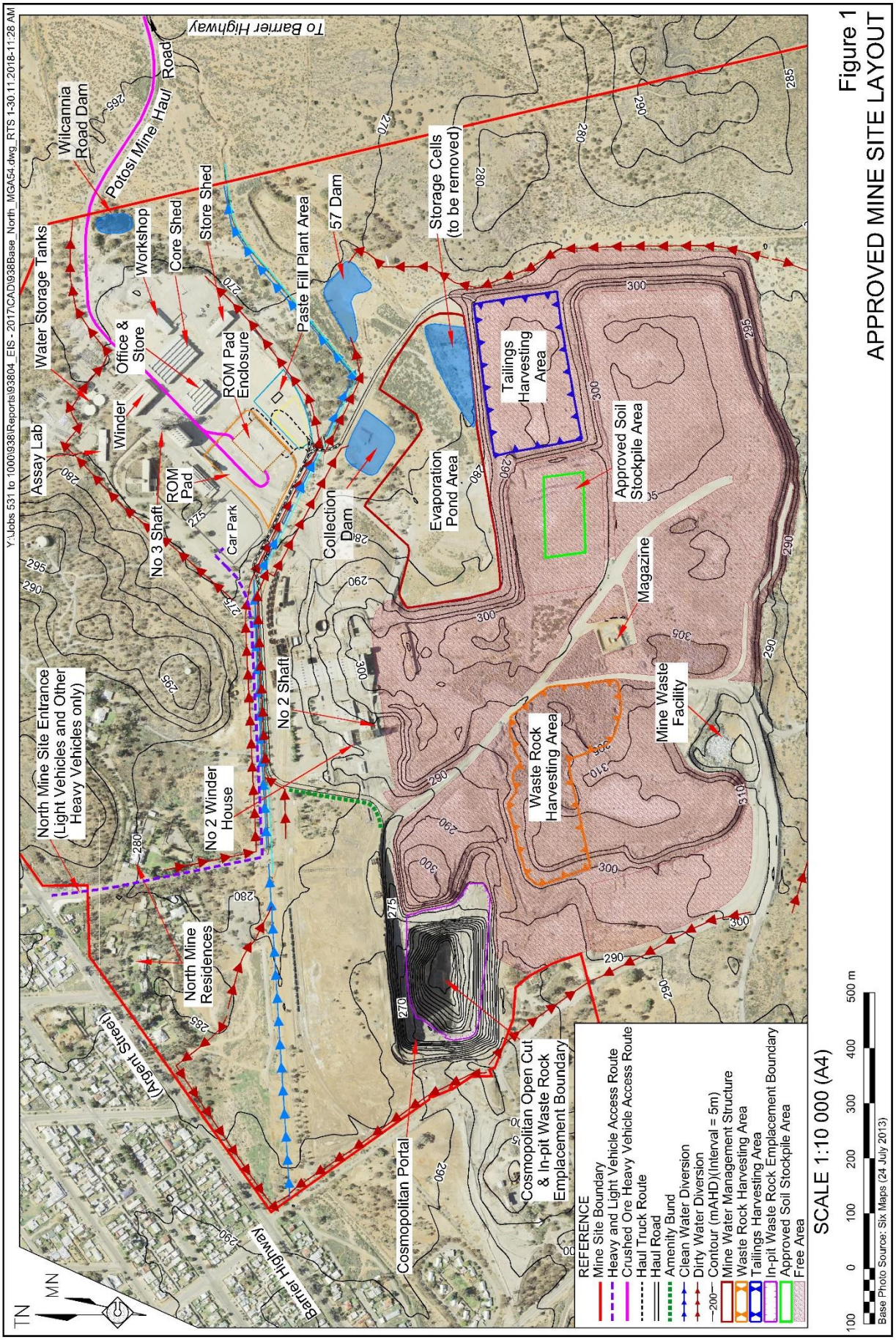

Figure 1
APPROVED MINE SITE LAYOUT

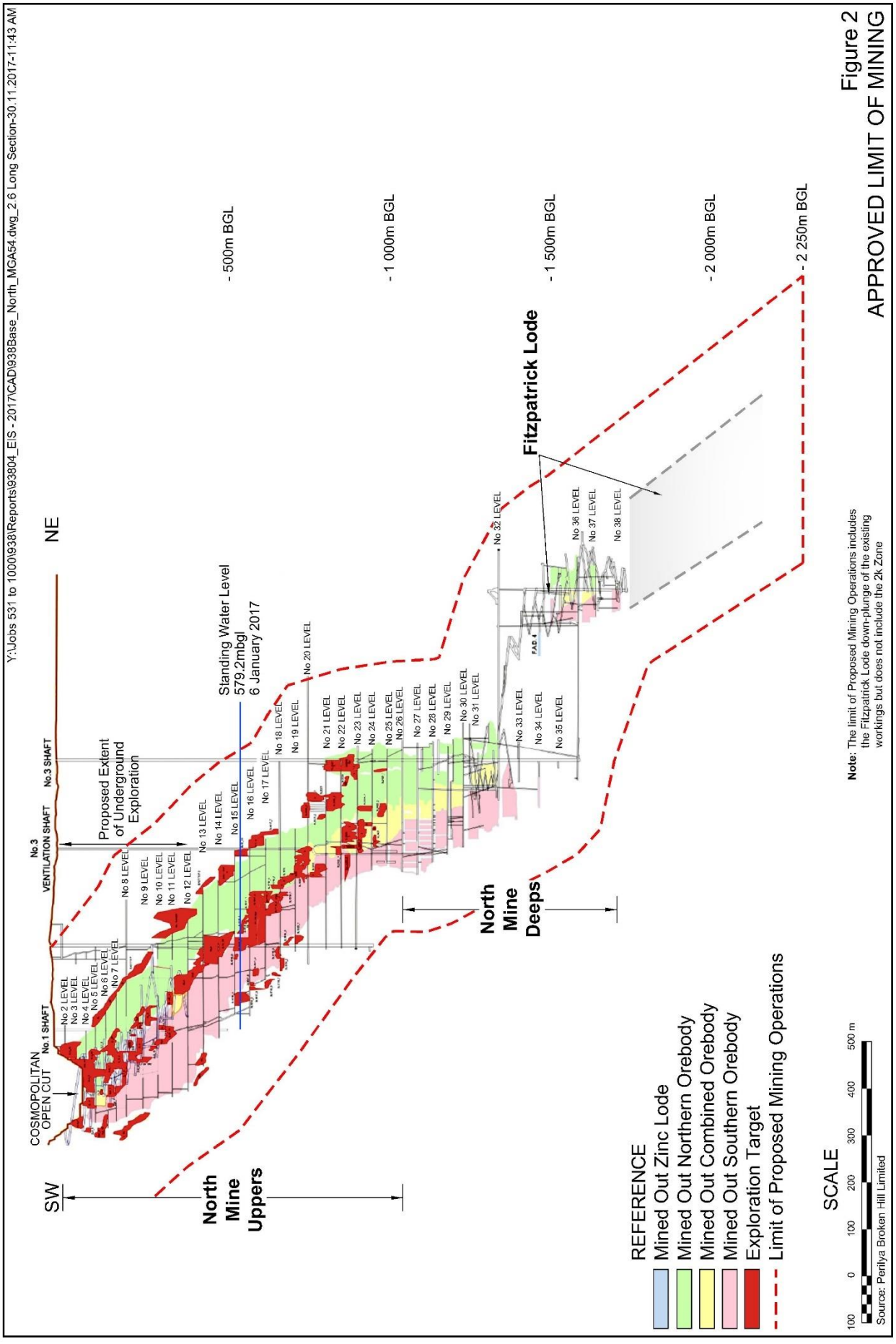

Figure 2
APPROVED LIMIT OF MINING

3 Consultation

The following consultation related to the preparation of this Management Plan was undertaken, with the following responses received.

- Environment Protection Authority.

  An email requesting requirements for this Plan was provided to the Environment Protection Authority on 23 January 2018. A response was received from the Environment Protection Authority on 1 February 2018 stating that "EPA's response to the project generally contains our main requirements for the management plans."

  A draft of the *Construction Environmental Management Plan*, incorporating the requirements of Condition 33 of Schedule 3 of SSD7538 for the construction phase of the North Mine was provided to the Environment Protection Authority on 14 March 2018. No response was received prior to approval of that Plan on 16 August 2018.

  A draft of this Plan was provided to the Environment Protection Authority on 24 October 2018, with a response received on 15 November 2018. **Table 1** presents an overview of the comments received and where/how each has been addressed.

Table 1 Environment Protection Authority Comments – 15/11/2018

Page 1 of 2

Location	*Environment Protection Authority Comment*	*How/Where Addressed*
Table 7	Risk description refers to "negative impacts" and it's not clear from what the potential negative impact arises. The plan should be more descriptive about the provenance of the risk.	Table 7 has been amended to better quantify the nature and provenance of the risks associated with the negative impacts.
Table 11	It is unclear what the operational performance criteria is and if it is directly related to the key performance outcomes (objective a). There are two operational performance criteria (same as the outcomes) but it is still not clear whether there are more criteria listed elsewhere in the plan.	Table 11 has been amended to identify the relevant section of the WMP where the operational performance criteria are stated. It is noted that the operational performance criteria directly reflect the key performance outcomes.
Table 11	What defines an incident should be detailed (objective f).	The text in Section 14.2 has been amended to identify the circumstances by which the incident management protocols would be triggered.
Section 10.3	Average rainfall runoff coefficient does not appear conservative and there is no evidence presented supporting the opinion that the soil has a low to moderate runoff potential	The text in Section 10.3 has been amended to justify the coefficient of runoff adopted for the annualised water balance.
Section 11	Insufficient detail about the capability of the mine to empty dams within 5 days of a rainfall event greater than 25mm in 24 hours. Calculations in Table 14 are done with the dams empty prior to the rainfall event, which is unlikely.	Text has been amended throughout the document to identify that, as the outlets for their respective sub-catchments, the Wilcannia Road Dam and the 57 Dam will be emptied within 5 days of a rainfall event that exceeds 25mm in 24 hours. Section 11.2 (TARP Level 2) text has been amended to identify the actions to be undertaken should discharge of sediment-laden water from the Bovril Dam and Small Dam. Automated pumping and transfer of water in the Wilcannia Road Dam and the 57 Dam will be initiated once a prescribed water level has been reached and this action is independent of antecedent conditions (i.e. volumes held in storage or rainfall).

Table 1 Environment Protection Authority Comments – 15/11/2018 (Cont'd)

Location	*Environment Protection Authority Comment*	*How/Where Addressed*
Table 13	Table considers wet years and surplus site water however there is no overt response to manage the surplus water. The plan does not appear to have considered prolonged wet weather (as opposed to single rainfall events	Table 13 presents an annualised water balance, not a strategy for managing inflows. Section 11.3 (Level 3 TARP) identifies the actions required should a rainfall event exceed the design event on which the operational performance criteria were developed, should TARP Level 3.3 actions be required, PBHL advises that underground dewatering activities are intended to maintain a 30 day advance period on mining and therefore TARP Level 3.3 actions could occur without disrupting operations.

- Crown Lands and Water/Department of Industry – Natural Resource Access Regulator.

  An email requesting requirements for this Plan was provided to Crown Lands and Water on 23 January 2018. No response was received.

  A draft of the *Construction Environmental Management Plan* was provided to Crown Lands and Water on 14 March 2018. A response was received from Mr Tim Baker on 13 April 2018:

  - supporting the mitigation measures as then drafted:
  - requesting that standing water levels and volumes of water transferred around the North Mine be monitored to enable groundwater take to be measured; and
  - requesting confirmation that the erosion and sediment control measures are consistent with *Managing Urban Stormwater – Volume 2E Mines and Quarries*.

  The *Construction Environmental Management Plan* was approved on 16 August 2018.

  A draft of this Plan was provided to Department of Industry – Natural Resource Access Regulator on 24 October 2018 with a response received on 21 November 2018. **Table 2** presents an overview of the comments received and where/how each has been addressed.

Table 2 Natural Resource Access Regulator Comments – 21/11/2018

Location	*Natural Resource Access Regulator Comment*	*How/Where Addressed*
12.2.1	Section 12.2.1 refers to the installation of piezometers to monitor potential seepage from the evaporation ponds. This is supported. However trigger levels and response protocols have not been included. This needs to be addressed.	A commitment to monitor the Evaporation Ponds monthly has been included
11.4	If seepage/water is found in the piezometers, testing for water quality needs to be included to assist in determining the relationship with water in the evaporation ponds	An additional TARP providing triggers and responses in the event that water is observed within the Evaporation Pond Piezometers

4 Environmental Management System

The Environmental Management System for the North Mine comprises the following principal documents.

- *Environmental Management Strategy* (EMS).

  The EMS defines the broader environmental management system requirements that are common to all relevant environmental aspects of the North Mine

- *Air Quality Management Plan.*
- *Noise Management Plan.*
- *Blast Management Plan.*
- *Transportation Management Plan.*
- *Water Management Plan.*
- *Historic Heritage Management Plan.*
- *Aboriginal Cultural Heritage Chance Finds Protocol* .
- *Rehabilitation Management Plan* (to be prepared at a later date).

A range of Standard Operating Procedures (SOPs) are in place to manage implementation of the above Management Strategy and Management Plans. These SOPs provide operational personnel with a detailed description of how each of the identified measures is to be implemented. These SOPs are live documents and are introduced, amended, removed and replaced as required.

5 Legal and Other Requirements

5.1 Introduction

A range of approvals, licenses and consents exist for the North Mine, each of which include conditional requirements. The following subsections present the statutory commitments relevant to this *Water Management Plan*.

5.2 Legislation

Section 120 of the *Protection of the Environment Operations Act 1997* (POEO Act) makes it an offence to pollutes water unless the relevant discharge is authorised under an Environment Protection Licence. EPL2683 does not include a licenced discharge point for surface water.

Part 3, Division 1A of the *Water Management Act 2000* make it an offence to undertake the following without an appropriate approval or licence.

- Use water without a water use approval.
- Construct or use a water supply work without approval.

PBHL hold a number of relevant water related approvals (see Section 5.5).

5.3 Conditions of Consent

Development Consent SSD7538 was granted on 22 December 2017. Conditional requirements identified in SSD7538 that are relevant to this Plan are reproduced in **Table 3** with a reference provided to the section(s) of this document where each conditional requirement is addressed.

Table 3 Conditions of consent associated with the Water Management Plan

<table>
<tr><th>Cond No.</th><th>Conditions of Consent</th><th>Document Reference</th></tr>
<tr><td>3(29)</td><td>The Applicant must ensure that it has sufficient water for all stages of the development, and if necessary, adjust the scale of mining operations to match its available water supply.

Note: Under the Water Act 1912 and/or the Water Management Act 2000, the Applicant is required to obtain necessary water licences for the development.</td><td>Sect 10</td></tr>
<tr><td>3(30)</td><td>Unless an EPL authorises otherwise, the Applicant must comply with Section 120 of the POEO Act.</td><td>Sect 8</td></tr>
<tr><td>3(31)</td><td>The Applicant must provide a compensatory water supply to anyone whose basic landholder water rights (as defined in the Water Management Act 2000) are adversely and directly impacted as a result of the development. This supply must be provided in consultation with CL&W, and to the satisfaction of the Secretary.

The compensatory water supply measures must provide an alternative long-term supply of water that is equivalent to the loss attributable to the development. Equivalent water supply must be provided (at least on an interim basis) as soon as practicable after the loss was identified, unless otherwise agreed with the relevant landholder.

If the Applicant and the landholder cannot agree on the measures to be implemented, or there is a dispute about the implementation of these measures, then either party may refer the matter to the Secretary for resolution.

If the Applicant is unable to provide an alternative long-term supply of water, then the Applicant must provide alternative compensation to the satisfaction of the Secretary.

Note: The Water Management Plan (see condition 33 of schedule 3 of this consent) is required to include trigger levels for investigating potentially adverse impacts on water supplies.</td><td>Sect 11.5</td></tr>
<tr><td>3(32)</td><td>The Applicant must comply with the performance measures in Table 6.

Table 6: Water management performance measures
<table>
<tr><th>Feature</th><th>Performance Measure</th><th></th></tr>
<tr><td>General</td><td>• Maintain separation between clean, dirty and mine water management systems
• Minimise the use of clean water on site
• Design, install, operate and maintain water management systems in a proper and efficient manner</td><td>Sect 9.3 & 10</td></tr>
<tr><td>Clean water diversion infrastructure</td><td>• Maximise the diversion of clean water around disturbed areas on site</td><td>Sect 9.3</td></tr>
<tr><td>Sediment dams</td><td>• Design, install and/or maintain sediment dams to ensure no discharges to surface waters, except in accordance with an EPL or in accordance with Section 120 of the POEO Act</td><td>Sect 9.1, 9.3 & 11</td></tr>
<tr><td>Mine water storages</td><td>• Design, install and/or maintain mine water storage infrastructure to ensure no unlicensed or uncontrolled discharge of mine water off-site</td><td>Sect 9.1, 9.3 & 11</td></tr>
<tr><td>Evaporation pond</td><td>• Design, install and maintain the facility to ensure that a minimum freeboard of 500 mm is maintained at all times, and that that any leakage is prevented
• Facility must be lined with a welded High-Density Polyethylene liner, or equivalent</td><td>Sect 11</td></tr>
<tr><td>Chemical and hydrocarbon storage</td><td>• Chemical and hydrocarbon products to be stored in bunded areas or structures in accordance with relevant Australian Standards</td><td>Sect 9.3.4</td></tr>
</table></td><td></td></tr>
<tr><td>3(33)</td><td>Prior to commencing construction, unless the Secretary agrees otherwise, the Applicant must prepare a Water Management Plan for the development by a suitably-qualified expert whose appointment has been endorsed by the Secretary in consultation with CL&W and the EPA, and to the satisfaction of the Secretary. This plan must include a:

(a) Site Water Balance, that:
• includes details of:
o sources and security of water supply, including contingency planning for future reporting periods;</td><td>Sect 1 and 3

Sect 10.1</td></tr>
</table>

Table 3 Conditions of consent associated with the Water Management Plan

Cond No.	Conditions of Consent	Document Reference
3(33) Contd	o water use and management on-site, including:	
	- prioritisation of on-site water sources over raw water supplies, where practicable; and - details of water sharing between the Applicant's other mining operations in Broken Hill;	Sect 10.1
	o any off-site water transfers and discharges;	Sect 10.6
	o a program to monitor and report on the split of water between the site and South Mine, and the associated treatment requirements to minimise raw water use at South Mine;	Sects 10.6 and 12.3
	o reporting procedures, including the preparation of a site water balance for each calendar year; and	Sects 12.3 and 13.3
	o water balance monitoring of inputs and outputs of the evaporation pond	Sect 10 and 12.3
	• describes the measures that would be implemented to minimise water use on-site;	Sect 10.1
	(b) Surface Water Management Plan, that includes:	
	• baseline data on water flows and quality in the watercourses that could be affected by the development (if available);	Sect 7.2.2
	• a detailed description of the water management system on-site, including the:	
	o clean water diversion systems, and measures to ensure these are maintained;	Sect 9.3 & 12.4
	o erosion and sediment controls; and	Sect 9.3
	o mine water management system, including detailed design and quality assurance procedures for the evaporation pond;	Sect 9, 12.2 and Appendix 2
	• objectives and performance criteria, including trigger levels for investigating any potential or actual adverse impacts associated with the development, including the:	
	o surface water flows and quality;	Sect 11
	o downstream surface water quality; and	Sect 11
	o McCulloch Stormwater Drain and Creek A;	Sect 11
	• a program to monitor and report on:	
	o the effectiveness of the mine water management system;	Sect 12
	o surface water flows and quality;	Sect 12
	o McCulloch Stormwater Drain and Creek A;	Sect 12
	o the performance measures listed in Table 6;	Sect 12
	o potential leakage from the evaporation pond; and	Sect 12.2
	• a plan to respond to any exceedances of the trigger levels and/or performance criteria, and minimise and/or offset any adverse surface water impacts of the development;	Sect 11
	(c) Groundwater Management Plan, that includes:	
	• baseline data on groundwater levels and quality in the region, and any privately-owned groundwater bores that could be affected by the development;	Sect 7.3
	• groundwater assessment criteria, including trigger levels for investigating any potentially adverse groundwater impacts associated with the development, including perching of water within voids and backfilled stopes;	N/A[1]
	• a program to monitor and report on:	
	o groundwater take (reported against water entitlement across all relevant operations);	Sect 12.4.3
	o perching of water within voids and backfilled stopes;	N/A[1]
	o the seepage/leachate from mine water storages;	Sect 12.2
	o if applicable, the impacts of the development on groundwater supply of any potentially affected landholders and aquifers; and	11.5
	• a plan to respond to any exceedances of the trigger levels and/or performance criteria, and minimise and/or offset any adverse groundwater impacts of the development; and	N/A[2]
	• shallow monitoring bores around the pond perimeter to monitor potential leakage.	Sect 12.2
3(34)	The Applicant must implement the approved Water Management Plan for the development	Noted

Table 3 Conditions of consent associated with the Water Management Plan (Cont'd)

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Cond No.	*Conditions of Consent*	*Document Reference*
4(4)	*The Applicant must ensure that the management plans required under this consent are prepared in accordance with any relevant guidelines, and include:*	
	(a) detailed baseline data;	*Sect 7*
	(b) a description of:	
	• the relevant statutory requirements (including any relevant approval, licence or lease conditions);	*Sect 5*
	• any relevant limits or performance measures/criteria;	*Sect 8*
	• the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the development or any management measures;	*Sect 8 & 11*
	(c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;	*Sects 9 to 14*
	(d) a program to monitor and report on the:	
	• impacts and environmental performance of the development;	*Sect 12*
	• effectiveness of any management measures (see c above);	*Sect 12*
	(e) a contingency plan to manage any unpredicted impacts and their consequences and to ensure that ongoing impacts reduce to levels below relevant impact assessment criteria as quickly as possible;	*Sect 11*
	(f) a program to investigate and implement ways to improve the environmental performance of the development over time;	*Sect 17*
	(g) a protocol for managing and reporting any:	
	• incidents; • complaints; • non-compliances with statutory requirements; and • exceedances of the impact assessment criteria and/or performance criteria; and	*Sect 14*
	(h) a protocol for periodic review of the plan.	*Sect 17*

Note 1: Perching of water within voids and backfilled stopes is a safety-related matter and management of this issue is addressed within the North Mine Safety Management System and is not addressed in this document.

Note 2: No groundwater performance or trigger levels are proposed or required because the standing water level prior to granting of SSD753 was 579.2m below ground level, well below any surrounding bores and PBHL holds adequate licences tor dewatering of the North Mine.

5.4 Environment Protection License

A variation to Environment Protection License (EPL) 2683 was issued 6 July 2018. The licence currently applies to both the North Mine and Potosi Mine sites. Conditional requirements identified in EPL 2683 that are relevant to this Plan are reproduced in **Table 4** with a reference provided to the section(s) of this document where each conditional requirement is addressed.

Table 4 Conditions of EPL2683 relevant to the Water Management Plan

Cond No	*Conditions of Consent*	*Document Reference*
L1.1	*Except as may be expressly provided in any other condition of this licence, the licensee must comply with section 120 of the Protection of the Environment Operations Act 1997.*	*Sect 8*

5.5 Water-related Approvals

PBHL holds Water Supply Works Approval 60WA583325 and Water Access Licence WAL40959 for the Mine Site. Conditional requirements relevant to this Plan are reproduced in **Table 5** with a reference provided to the section(s) of this document where each conditional requirement is addressed.

Table 5 Conditions of Water Licences relevant to the Water Management Plan

Cond No	*Conditions of Consent*	*Document Reference*
Water Supply Works Approval 60WA583325		
MW0714-00001	*The licence holder must produce the logbook to the Minister for inspection, when requested*	*Sect 12.4.3*
MVV0715-00001	*The licence holder must retain the information required to be recorded in the logbook for 5 years from the date to which that information relates.*	*Sect 12.4.3*
MW0777·00001	*The approval holder must keep a logbook, except where the water supply work is metered with a data logger. A "logbook" means a written record, kept in hard copy or electronic form, which accurately records all information required to be kept for this approval.*	*Sect 12.4.3*
MW077-0001	The *approval holder must record the following in the logbook:*	*Sect 12.4.3*
	(i) each date and period of time on which water was taken using the water supply work;	
	(ii) the volume of water taken on that date;	*Sect 12.4.3*
	(iii) the access licence number of the access licence under which water was taken on that date, or, if water was taken under some other authority (such as basic landholder rights entitlement), the authority under which water was taken	*Sect 12.4.3*
	(iv) the purpose or purposes for which the water taken on that date was used;	*Sect 12.4.3*
	(v) details of any cropping carried out using the water taken through the water supply work including the type of crop, area cropped, and dates of planting and harvesting;	*N/A*
	(vi) where metering equipment has been installed for use in connection with the water supply work, the meter reading before water is taken;	*Sect 12.4.3*
	(vii) where metering equipment has not been installed for use in connection with the water supply work, details of all pumping Activities for the water supply work including pump running hours, pump power usage or pump fuel usage, pump start and stop times for water taken and pump capacity per unit of time;	*N/A[1]*
	(viii) any other information required to be recorded in the logbook as specified by the Minister.	*Sect 12.4.3*
Water Access Licence WAL40959		
	Share component – 1466 units (4.466 GL)	*Sect 9.2*
	Work Approval Number(S) - 85WA753477, 60WA583325, 60WA582773, 60WA582777, 60WA582779,	*Sect 9.2*
Note 1: Metering equipment has been installed. As a result, this condition is not applicable.		

5.6 Mining Leases

Consolidated Mining Leases (CMLs) 4 and 5 have been renewed until 23 June 2024 and 17 June 2021. Conditional requirements identified in CML4 and 5 that are relevant to this CMP are reproduced in **Table 6** with a reference provided to the section(s) of this document where each conditional requirement is addressed.

Table 6 Mining lease conditions associated with the Water Management Plan

Cond No	*Conditions of Consent*	*Document Reference*
2	*The proponent shall implement all practicable measures to prevent and/or minimise any harm to the environment that may result from the construction, operation or rehabilitation of the development.*	*This Plan*
18	*Operations must be carried out in a manner that does not cause or aggravate air pollution, water pollution (including sedimentation) or soil contamination or erosion, unless otherwise authorised by a relevant approval, and in accordance with an accepted Mining Operations Plan. For the purpose of this condition, water shall be taken to include any watercourse, waterbody or groundwaters. The lease holder must observe and perform any instructions given by the Director-General in this regard.*	*This Plan*

5.7 Guidelines, policies and standards

Other documents relevant to this management plan include:

- *Managing Urban Stormwater* (Volumes 1, 2C and 2E) (Landcom, 2004 and DECC 2008a and 2008b).

6 Environmental Risk

Tables 7 and **8** present the risk rating matrix and risk assessment specific to water during the operational phase of the North Mine. The risk rankings and control measures identified in **Table 8** have informed the management and mitigation measures identified in Section 9.

7 Existing Environment

7.1 Introduction

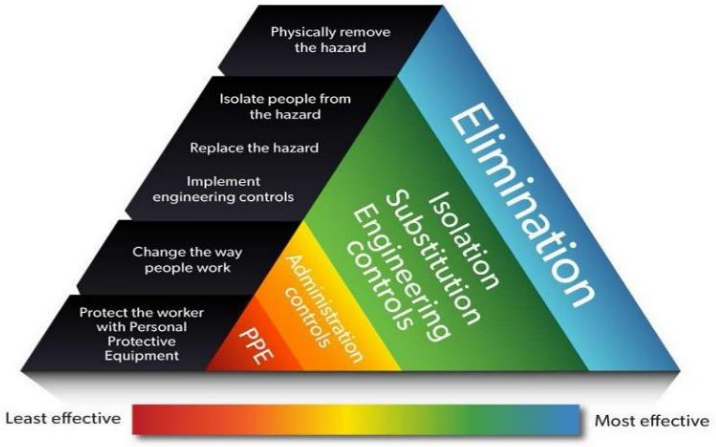
Information presented in this subsection is largely consistent with that presented in the *Environmental Impact Statement for the Recommencement of Mining Operations at the Broken Hill North Mine* (RWC, 2017).

7.1.1 Site Water Classification

Four classes of water are identified and managed on the North Mine Site (the "Mine Site") as follows:

- "Clean water" refers to runoff from catchments unaffected by mining related activities (regardless or water quality). This water is directed through the Mine Site without mixing with other classes of water.
- "Sediment-laden" refers to runoff from disturbed or active sections of the Mine Site with the potential to contain suspended sediment but are unlikely to contain elevated dissolved metals. This runoff will be captured and priority given for its use in mining-related activities on the Mine Site such as ablutions, dust suppression, including on the mobile crushing plant, within the underground mine and for manufacturing paste fill..

Table 7 Risk Rating Matrix



Consequence	Negligible	Minor	Moderate	Major	Catastrophic
People	Minor injury First aid treatment	Medical treatment injury Restricted work injury	Serious injury Lost time injury (LTI)	Multiple LTIs Permanent disabling injury	Fatality Multiple fatalities
Environment	Little or no environmental harm. Not required to inform EPA/Government.	Minor transient environmental harm. Transient release of pollutants. Required to inform EPA/Government	Measurable environmental harm with mid-term recovery. Significant release of pollutants.	Long term environmental harm. Major contamination, unapproved clearance of native vegetation, damage to heritage site.	Serious impacts, long term environmental damage. Dislocation of people, significant breach of tailings storage, contamination of potable water
Reputation	No measurable impact	Minor or moderate impact. Local media coverage, public complaints	Short term measurable but recoverable impact. (recovery <6 months) Averse capital city media coverage	Medium term impact (recovery < 12 months). National adverse mainstream media, loss of investor confidence, possible staff losses or moral issues	Serious, permanent or irrecoverable damage. Forced shutdown of major installation, extended national adverse media campaign, parliamentary enquiry
Financial & Commercial	No measurable loss, no measurable impact on customers	Loss $50-500K Minimal business interruption.	Loss $0.5-5M Business impact, service interruption, loss of market share	Loss $5-10M Business interruption, major equipment failure, major loss of market share	Loss >$10M Major business interruption, significant loss of market share, plant catastrophe.
Legal Liability	Little or no liability	Third part claims <$500K	Corporate fine <$1M, multiple third part claims $0.5-2M	Corporate fine $1-5M, personal fine, multiple third part claims $2-10M	Corporate fine >$5M, Officer goaled, multiple third part claims >$10M

		Risk Level				
Likelihood		A	B	C	D	E
Almost certain: < 1 in 100 expected to occur within 1 yr	1	16	10	8	3	1
Likely: 1 in 100 - 1000 probably occur within 3 yrs	2	18	14	9	5	2
Possible: 1 in 1000 - 10,000 may occur in within 10 yrs	3	20	17	11	7	4
Unlikely: in normal situations 1 in 10,000 - 1M, >10 yrs	4	23	21	15	12	6
Rare: >1 in 1M theoretically possible	5	25	24	22	19	13

Table 8 Risk Assessment: Water

Risk Description	*Unmitigated Risk Level*	*Current Controls*	*Additional Controls Required*	*Residual Risk Level*	*Accept Y/N*
Negative impacts on downstream watercourses through excess sedimentation as a result of the discharge of sediment-laden water.	Minor (17)	• Maintain infrastructure to meet operational performance criteria. • Regularly service all water transfer equipment • Maintain program of regular inspections and maintenance.	• Undertake real-time water level monitoring and adjust on-site activities in the event that nominated trigger levels are exceeded.	Low (21)	Yes
Negative impacts on downstream surface water quality through discharge of high salinity produced water.	Moderate (11)	• Construct and maintain infrastructure in accordance with design. • Maintain minimum 0.5m operational freeboard in the Evaporation Ponds (A, B and C) at all times. • Regularly service all water transfer equipment. • Maintain program of regular inspections and maintenance.	• Undertake real-time water level monitoring and adjust on-site activities in the event that nominated trigger levels are exceeded.	Low (21)	Yes
Negative impacts on groundwater quality (through outflow of groundwater from underground workings)	Low (25)	• Active mine dewatering results in the mine being a groundwater inflow zone, resulting in negligible potential for groundwater outflow from the underground workings and the subsequent transmission of contaminated groundwater to local and regional aquifer systems..	• Nil.	Low (25)	Yes
Negative impacts on groundwater availability via reduced access for existing groundwater users.	Low (25)	• Undertake dewatering activities in accordance with relevant licences and approvals.	• Nil.	Low (25)	Yes
Groundwater contamination from hydrocarbon or chemical spill.	Moderate (11)	• Store all hydrocarbons and chemicals in accordance with AS1940 – The storage and handling of flammable and combustible liquids. • Regularly service all on-site equipment • Conduct all refuelling in nominated areas with designated equipment.	• Nil.	Low (22)	Yes
Poorly managed site water balance results in higher demand for raw water from Essential Water.	Low (22)	• Maximise effective reuse and recycling of water by implementing measures to prioritise use of site generated water to meet site water demand.	• Nil.	Low (22)	Yes

- "Produced water" refers to water pumped from the underground workings with the potential to contain elevated concentrations of dissolved solids. This water will, in the first instance, be transferred off site for use in processing at the Southern Operations or would be managed through the onsite evaporation pond.
- "Raw water" refers water transported to site via an existing pipeline under a commercial arrangement with Essential Water. If required, this water would be used for ablutions, dust suppression, including on the mobile crushing plant, within the underground mine and for manufacturing paste fill. As raw water would be commercially supplied via pressurised mains that are maintained by a third-party, no further consideration of this class of water is provided in this WMP.

7.2 Surface Water

The following sub-sections describe the surface water environment of the Mine Site that has been subjected to a range of measures that will be implemented to optimise the diversion of clean water and reduce the size of sub-catchments that contribute runoff to site water storages so as to lower the risk of discharge from the Mine Site in rainfall events which exceed the design rainfall event (1 in 100 year 24-hour), namely:

- Construction of the Tanks Stormwater Drain, to divert clean runoff away from the disturbed No. 3 Shaft sub-catchment.
- Bunding of the shaped, low slope No. 3 Shaft sub-catchment to separate it from the Wilcannia Road Dam sub-catchment, thus reducing the size of the disturbed sub-catchments which would contribute runoff to the Wilcannia Road Dam.
- Construction of Evaporation Pond Cells B and C.

7.2.1 Mine Site Catchments

Surface water drainage within and adjacent to the Mine Site is divided into five zones by site topography, drainage infrastructure or bunds (see **Figure 3**). **Table 9** identifies and describes each zone and any contributing sub-catchment as well as identifying the class of water (runoff) generated within each zone and nominates the method of managing catchment runoff (either diversion to natural discharge, captured for infiltration or captured for storage, re-use and recycling).

7.2.2 Surface Water Flow and Quality

Sediment-laden runoff, generated within the Mine Site, typically occurs as overland flow.

Flow within the McCulloch Stormwater Drain will typically only occur immediately following a rainfall event. No data is available to correlate discharge within the McCulloch Stormwater Drain with rainfall events, however, it is noted that much of the External Catchments comprise sealed surfaces (roads, footpaths, rooves, hardstand areas) and, as a result, a rapid response to rainfall, with an equally rapid cessation of flow would typically be expected.

No water quality data is available for flows within the McCulloch Stormwater Drain.

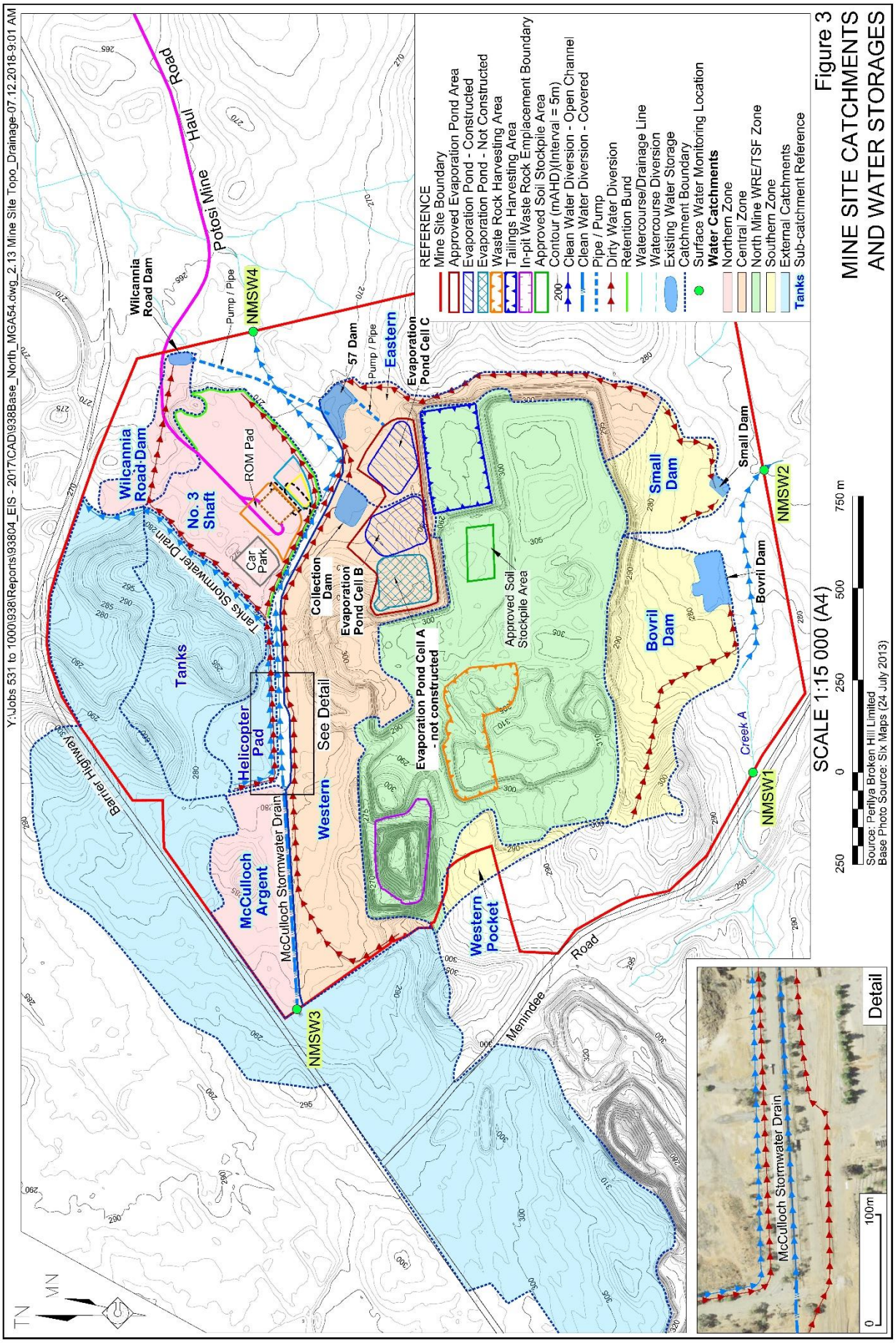


Figure 3
MINE SITE CATCHMENTS AND WATER STORAGES
SCALE 1:15 000 (A4)
250 0 250 500 750 m
Source: Perilya Broken Hill Limited
Base Photo Source: Six Maps (24 July 2013)
REFERENCE
Mine Site Boundary
Approved Evaporation Pond Area
Evaporation Pond - Constructed
Evaporation Pond - Not Constructed
Waste Rock Harvesting Area
Tailings Harvesting Area
In-pit Waste Rock Emplacement Boundary
Approved Soil Stockpile Area
Contour (mAHD)(Interval = 5m)
Clean Water Diversion - Open Channel
Clean Water Diversion - Covered
Pipe / Pump
Dirty Water Diversion
Retention Bund
Watercourse/Drainage Line
Watercourse Diversion
Existing Water Storage
Catchment Boundary
Surface Water Monitoring Location
Water Catchments
Northern Zone
Central Zone
North Mine WRE/TSF Zone
Southern Zone
External Catchments
Tanks
Sub-catchment Reference
Wilcannia Road Dam
Potosi Mine Haul Road
NMSW4
Pump / Pipe
57 Dam
Eastern Evaporation Pond Cell C
Wilcannia Road Dam
No. 3 Shaft
ROM Pad
Car Park
Tanks Stormwater Drain
Tanks
Collection Dam
Evaporation Pond Cell B
Approved Soil Stockpile Area
Small Dam
Small Dam
NMSW2
Bovril Dam
Bovril Dam
Creek A
NMSW1
Helicopter Pad
See Detail
Western
Evaporation Pond Cell A - not constructed
McCulloch Argent
McCulloch Stormwater Drain
Western Pocket
Barrier Highway
Menindee Road
NMSW3
Detail
McCulloch Stormwater Drain
0 100m
Y:\Jobs 531 to 1000\938\Reports\93804_EIS - 2017\CAD\938Base_North_MGA54.dwg_2.13 Mine Site Topo_Drainage-07.12.2018-9:01 AM

Table 9 Mine Site Catchments

Zone	*Area (ha)*	*Sub-catchment*	*Runoff Class*	*Catchment Description*	*Management*
External Catchments	Not Applicable	Multiple off-site	Clean	This zone includes all land not controlled by PBHL where surface water flow onto the Mine Site, primarily via the McCulloch Stormwater Drain.	Diverted: McCulloch Stormwater Drain/Bypass
	Not Applicable	Helicopter Pad	Clean	Vegetated catchment formerly considered part of the Northern Zone.	Diverted: McCulloch Stormwater Drain/Bypass
	Not Applicable	Tanks	Clean	Vegetated catchment formerly considered part of the Northern Zone.	Diverted: Tanks Stormwater Drain
Northern	10.0	McCulloch / Argent	Sediment-laden	Comprising a non-vegetated area to the west of the Site Access Road and north of the McCulloch Stormwater Drain.	Captured: Infiltration
	5.3	Wilcannia Road Dam	Sediment-laden	Comprising an area to the northeast of the No. 3 Shaft sub-catchment.	Captured: Wilcannia Road Dam
	20.2	No. 3 Shaft	Sediment-laden	Comprising an area to the northeast of the McCulloch Stormwater Drain dirty water diversion bund.	Captured: Infiltration
Central	34.6	Western	Sediment-laden	Comprising the area to the south of the McCulloch Stormwater Drain and north of the WRE/TSF Zone.	Captured: Collection Dam, 57 Dam
	14.5	Eastern	Sediment-laden	Comprising the area to the southeast and east of the WRE/TSF Zone.	Captured: 57 Dam
North Mine WRE/TSF	69.9	None	Sediment-laden	*Comprises the existing waste rock emplacements, tailings storage facilities and the Cosmopolitan Open Cut. This catchment is internally draining.*	Captured: Infiltration Cosmopolitan Open Cut
Southern	3.5	Western pocket	Sediment-laden	Comprises an area to the west of the North Mine WRE/TSF Zone.	Captured: Infiltration
	19.0	Bovril Dam	Sediment-laden	Comprises an area to the south (west) of the North Mine WRE/TSF Zone.	Captured: Bovril Dam
	7.0	Small Dam	Sediment-laden	Comprises an area to the south (east) of the North Mine WRE/TSF Zone.	Captured: Small Dam

7.3 Groundwater

7.3.1 Local Hydrogeological Setting

The Mine Site lies within the area identified as the Adelaide Fold Belt North Western Groundwater Source managed under the *Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources 2011*.

Groundwater recharge occurs via recharge by direct rainfall in subcrop areas or via leakage from the overlying regolith or alluvial deposits associated with ephemeral water courses.

7.3.2 Standing Water Level

In the vicinity of the Mine Site, the aquifer has been the subject of extensive dewatering since the commencement of mining operations in 1883. Dewatering operations ceased in February 1998 and subsequently the standing water level within the underground workings of the Mine Site steadily rose approximately
1 135m in the approximately 19 year period to 2017, or 16cm per day. However, since the installation of an automated logger in the No. 3 Shaft in July 2014, water levels have risen 59.2m, at a constant rate of 6.4cm per day. PBHL notes that this apparent reduction in the rate of standing water level rise is likely to be a function of the fact that the workings in the deeper sections of the underground workings of the Mine Site are substantially less extensive than the workings in the higher sections of the underground workings into which groundwater inflows are currently occurring. More recently, PBHL installed a submersible pump in the No. 3 Shaft on 2 March 2018 to recommence dewatering operations.

Table 10 presents the standing water level within the No. 3 Shaft since February 1998.

Table 10 Standing Water Levels within the No. 3 Shaft

Date	*Standing Water Level (m BGL)*	*Volume Pumped (ML)*
10 August 2018	584.5	144.7
2 March 2018	544.0	Nil
6 January 2017	579.2	Nil
10 October 2016	585.8	Nil
15 January 2016	610.0	Nil
20 July 2014	638.4	Nil
August 2011	724.0	Nil
February 1998	1 714.0	Nil
Note: m BGL = metres below ground level		

In summary, it is noted that as all underground workings within the Mine Site are interconnected (refer **Figure 2**), the standing water level within the underground workings is considered by PBHL to be representative of the water level throughout the remainder of the workings

7.3.3 Registered Groundwater Bores and Groundwater Dependent Ecosystems

Table 11 and **Figure 4** present the registered bores surrounding the Mine Site. In summary, there are 41 registered bores in the vicinity of the Mine Site. These bores are typically between 6m and 20m deep, with only 13 bores deeper than 20m and one deeper than 40m. Many of these bores are clustered around existing operations, including the PBHL's Southern Operations and Potosi Mine and Broken Hill Airport. As a result and given the shallow depth of many of the bores, generally low yields and poor water quality, it is presumed that most of the registered bores are monitoring bores.

The closest bore to the Mine Site is GW804682 which has a recorded depth of 38m and a yield of between 0.1L/s and 0.75L/s.

There are no known groundwater dependant ecosystems in the vicinity of the Mine Site.

Table 11 Surrounding Registered Bores

Bore	*Date drilled*	*Maximum depth (m)*	*Yield (L/s)*	*Aquifer*
GW500071	1995	7.5	Not stated	Silt
GW600001	2000	44.3	Not stated	Not stated
GW600132	2006	15.0	0.01	Conglomerate
GW600160	2009	30.0	Not stated	Basalt
GW600162	2009	14.0	Not stated	Basalt
GW600163	2009	30.0	0.10	Basalt
GW600171	2009	30.0	1.25	Quartzite
GW600301	2011	20.4	Not stated	Amphibolite
GW600302	2011	20.54	Not stated	Amphibolite
GW600303	2011	12.0	Not stated	Not stated
GW600304	2011	16.0	Not stated	Not stated
GW600305	2011	16.0	Not stated	Not stated
GW600306	2011	23.2	Not stated	Not stated
GW600307	2011	18.9	Not stated	Not stated
GW600308	2011	12.8	Not stated	Not stated
GW600360	2008	19.0	Not stated	Not stated
GW600361	2008	26.0	Not stated	Not stated
GW600362	2008	17.0	Not stated	Not stated
GW600363	2008	19.0	Not stated	Not stated
GW600364	2008	22.0	Not stated	Not stated
GW600365	2010	25.0	Not stated	Not stated
GW600366	2010	16.0	Not stated	Not stated
GW600367	2010	20.0	Not stated	Not stated
GW600368	2010	20.0	Not stated	Not stated
GW600381	2012	6.0	Not stated	Not stated
GW600382	2012	6.0	Not stated	Not stated
GW600383	2012	6.0	Not stated	Not stated
GW600384	2012	6.0	Not stated	Not stated
GW600385	2012	6.0	Not stated	Not stated
GW600386	2012	6.0	Not stated	Not stated
GW600433	2012	17.0	Not stated	Not stated
GW600434	2012	17.7	Not stated	Not stated
GW600435	2012	20.0	Not stated	Not stated
GW600468	2013	2.0	Not stated	Not stated
GW600469	2013	6.0	0.10	Feldspar porphyry
GW600470	2013	40.0	1.0	Quartz porphyry
GW600471	2013	5.2	1.2	Feldspar porphyry
GW600472	2013	15.0	0.25	Feldspar porphyry
GW600473	2013	40.0	1.5	Feldspar porphyry
GW600474	2013	4.4	0.10	Feldspar porphyry
GW804682	2010	38.0	0.10 to 0.75	Basalt

Source: NSW Water Info 2017

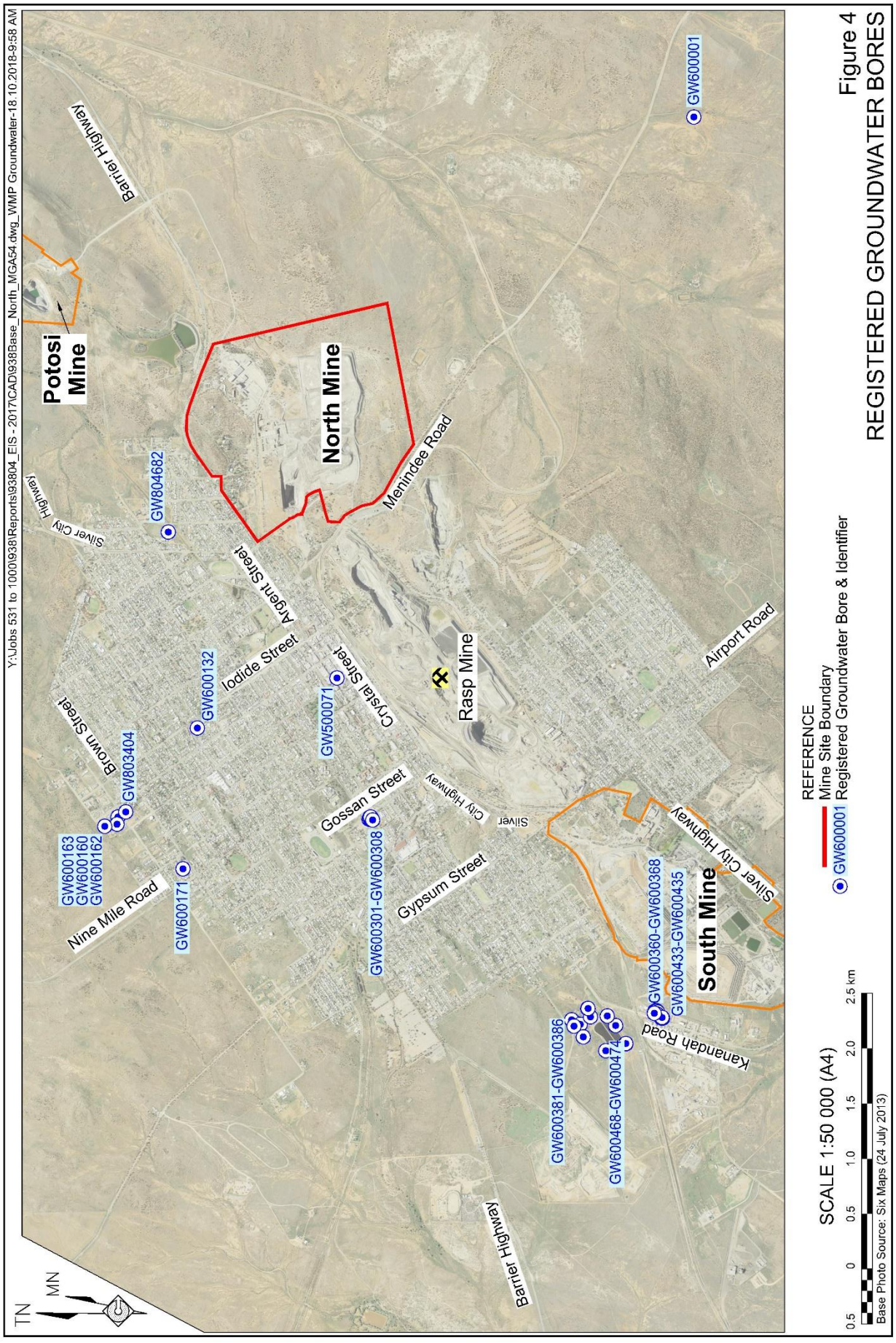


Figure 4
REGISTERED GROUNDWATER BORES

7.3.4 Groundwater Volume in the Underground Workings of the Mine Site

As the standing water level within the underground workings of the Mine Site has risen, each of the remaining voids and backfilled stopes has been filled with water. Given the uncertainty in relation to the extent of some older workings, as well as the nature of the fill used to back fill some stopes, it is not possible to accurately estimate the volume of water contained with the existing workings. As a result, based on available survey and production records, the PBHL anticipates that the workings contained between 1GL and 2GL of water prior to the commencement of dewatering operations.

7.3.5 Estimated Groundwater Inflows to the Underground Workings of the Mine Site

The Mine Site occurs within a fractured rock aquifer associated with the Willyama Supergroup. Groundwater occurrence within the aquifer is limited to fractures and faults within the host rock formation with groundwater flow typically constrained by the frequency, size, orientation and connectivity of the fractured. As such, yields in fractured rock aquifers systems may be low. As noted in Section 10.3.1.3, approximately 1GL to 2GL of water has entered the workings. Assuming that that groundwater inflow has occurred at a constant rate, the rate of inflow is expected to be between 55ML/year and 110ML/year. However, it is likely that groundwater inflows to the underground workings of the Mine Site would have been higher initially when the groundwater gradient within the surrounding aquifer was steeper. As a result, a conservative estimate of groundwater flow into the workings following the cessation of mining operations may be double the average inflow suggesting that the rate of groundwater inflow may have been as high as 110ML/year to 220ML/year.

The estimated rates of groundwater inflow may also be compared with the estimated rates of inflow at the following operations.

- Southern Operations ..... 470ML/year.
- Rasp Mine ..... 725ML/year.

7.3.6 Groundwater Quality

Groundwater quality within the underground workings of the Mine Site is presented in Table 2.13 of the EIS (RWC, 2017) and may be summarised as follows.

- pH – between 6.5 and 7.0.
- Electrical conductivity – between 12 000µS/cm and 13 000µS/cm.
- Metals – elevated concentrations of arsenic, cadmium, copper, iron, lead, manganese, nickel and zinc.

As a result, groundwater within the underground workings of the Mine Site does not meet the criteria for discharge to natural drainage and is subsequently classed and managed as “produced water”.

8 Performance and Compliance Criteria

Table 12 presents the water-related compliance criteria that have been adopted for the North Mine.

Table 12 North Mine-related Compliance Criteria –Water

Aspect	Criteria
Discharge of Water	
Discharge from Wilcannia Road or 57 Dams	Nil up to the 1 in 100 year 24-hour rainfall event of 137mm.
Discharge from Evaporation Pond(s)	Nil discharge
Surface Water Quality	
Discharge of water (generally)	Not to result in pollution of waters/contrary to Section 120 of the *Protection of the Environment Operations Act 1997*
McCulloch Stormwater Drain	Water quality at NMSW4 within 20% of the concurrent water quality result at NMSW4
Net Volume of Groundwater Produced	
Volume extracted (in combination with Potosi Mine, Southern Operations and While Leeds)	<1.466GL

9 Management and Mitigation Measures

9.1 Surface Water Management System

With reference to the water management method identified in **Table 9**:

- "Diverted" refers to runoff that is directed through the Mine Site, regardless of water quality and prevented from mixing with other classes of water;
- "Captured Infiltration" refers to areas where rainfall ponds and enters the ground surface due to the permeability (perviousness) of the material and the low slope gradient of the landform which prevents the concentration of runoff; and
- "Captured Dam" refers to a storage receiving runoff from active or disturbed catchments of the Mine Site (regardless of water quality).

As shown in **Table 9**, runoff generated in the external catchments is considered clean whilst the four Mine Site zones and associated sub-catchments are considered to contain sediment-laden runoff. An overview of the drainage for each zone and sub-catchment is provided below (**Figure 3**).

External Catchments Zone

Runoff generated in the External Catchments Zone enters the Mine Site from various off-site surrounding catchments, including residential areas, Willyama Common Lands or from undisturbed sections of the Mine Site (**Figure 3**). This water is directed either around or through the Mine Site via clean water diversion drainage infrastructure (open drain or pipe) without mixing with other classes of water.

Northern Zone

The runoff generated in the Northern Zone is generally managed via internally draining overland flow and infiltration, with earthen bunds, approximately 1m high, being constructed in sections of the sub-catchment perimeters of the McCulloch Argent sub-catchment (eastern section) and No. 3 Shaft sub-catchment (southern and eastern sections). These drainage diversion bunds prevent runoff entering the adjacent clean water diversion (McCulloch Stormwater Drain). Runoff from the McCulloch Argent sub-catchment is prevented from entering the adjacent the McCulloch Stormwater Drain due to the

installation of large diameter reinforced concrete pipe in place of an open drain in this location. Backfilling of this covered, piped section of the McCulloch Stormwater Drain has been conducted so as to leave a slightly raised profile which prevents runoff from the Central Zone entering the McCulloch Argent sub-catchment.

Concentrated runoff from the No.3 Shaft sub-catchment is prevented from forming due to the low slope profile created by the shaped landform created to facilitate mining operations and the construction of infrastructure. Any runoff that may be generated within this sub-catchment is subsequently prevented from entering either the McCulloch Stormwater Drain or the adjacent Wilcannia Road Dam catchment by perimeter bunding approximately 0.5m high and allowed to infiltrate.

Runoff from the Wilcannia Road Dam sub-catchment flows to the Wilcannia Road Dam from where it is prevented from discharging to downstream watercourses via the automated pumped transfer of captured runoff through a pipeline to the 57 Dam so as to maintain the operational performance criteria (refer Section 9.3.2 and Section 11.1).

Central Zone

Runoff generated in the western sub-catchment of the Central Zone is directed via gravity, overland flow, internal roads, drainage diversion bund and drainage infrastructure to the Collection Dam for capture and management. In the event of discharge from the Collection Dam, that water flows via an via open drain and culvert.

Runoff generated in the eastern sub-catchment of the Central Zone is directed to the 57 Dam for capture and management via an open drain which collects runoff from the toe of the WRE/TSF.

Management of all runoff from the Central Zone occurs via the integration of three hydraulically connected storages, as follows:

- Collection Dam, hydraulically connected to the 57 Dam via open drain and culvert;
- 57 Dam, hydraulically connected via automated pumped transfer through pipeline to the Evaporation Pond; and
- Evaporation Pond (or underground workings) (receives automated pumped transfer).

Due to the integrated arrangements of the Central Zone site water storages, runoff from the Central Zone sub-catchments is prevented from discharging to downstream watercourses via the automated pumped transfer of captured runoff stored in 57 Dam through a pipeline to the Evaporation Pond so as to maintain the operational performance criteria (refer Section 9.3.2 and Section 11.1).

North Mine WRE/TSF Zone

Runoff generated in the North Mine WRE/TSF Zone, is managed via internally draining overland flow and infiltration. Should a rainfall event be of sufficient intensity and duration to generate runoff, gravity drainage will direct runoff to the haul road from the Cosmopolitan Open Cut.

Southern Zone

The runoff generated in the Southern Zone is managed using various methods dependent upon the sub-catchment. Runoff in the western pocket sub-catchment is internally drained and allowed to infiltrate or evaporate whilst runoff generated in either the Bovril Dam or Small Dam catchments is directed via

gravity drainage to their respective dams. An open drain clean water diversion prevents runoff from upstream "clean" water catchments from entering the Bovril Dam catchment. This clean water diversion discharges into an ephemeral watercourse, known as "Creek A".

Further information on the design, capacities and management of these dams is provided in Section 9.3.2.

9.2 Groundwater Management System

PBHL holds a water supply works approval (60WA583325) for the underground workings of the North Mine as well as a water access licence (WAL40959) that allows for the extraction of up 1.466 gigalitres of groundwater per annum from the North Mine workings, as well as:

- Southern Operations (WA60582773, WA60582777 and WA60582779); and
- Potosi Mine (85WA753477).

PBHL installed a submersible pump in the No. 3 Shaft on 2 March 2018 to recommence dewatering operations.

Groundwater pumped from the underground workings of the Mine Site is classified as "produced water". All produced water is directed to the Southern Operations as a priority. PBHL has completed a due diligence assessment of the permissibility of this activity and has determined that:

- water extracted under the above may be used for mining-related purposes; and
- relevant approvals are held for the pipeline used to transfer that water.

In the event that produced water is surplus to the needs of the Southern Operations, the water would be transferred to the Evaporation Pond.

Subsequently, as the Evaporation Pond do not have contributing catchments, inflows can be controlled by variations to the rate at which produced water may be transferred into it.

9.3 Site Water Management Infrastructure

9.3.1 Clean Runoff

Runoff that enters the Mine Site from surrounding catchments, including residential areas, Willyama Common Lands or run off from undisturbed sections of the Mine Site (**Figure 3**). This water is directed through the Mine Site without mixing with other classes of water. Three clean water diversion drainage structures exist within the Mine Site as follows.

- McCulloch Stormwater Drain/Bypass – this structure collects water from the urban area to the west and north of the Mine Site and conveys it through the Mine Site via a buried storm water pipe (refer Section 9.1) and a lined open drain (refer Section 9.1). Diverted clean water is subsequently discharged to an ephemeral watercourse to the east of the Mine Site.

- Tanks Stormwater Drain – this structure conveys runoff generated on the sections of the Tanks sub-catchment upslope of the No. 3 Shaft sub-catchment and diverts it to the north where it discharges via overland flow adjacent to the Mine Site boundary in the vicinity of longitudinal drainage for the Barrier Highway.
- Creek A – As noted in Section 9.1, an unnamed watercourse, referred to hereafter as Creek A, drains an area to the west of Menindee Road and conveys that water to the east and southeast, entering the Mine Site on the southwestern boundary and exiting at the southern boundary. A short section of the Creek A watercourse has been diverted to prevent runoff entering the Bovril Dam catchment and mixing with sediment-laden runoff.

9.3.2 Sediment-laden Runoff

As detailed in Section 9.1, surface water runoff generated within certain Mine Site catchments is directed into one of six water storages or dams via gravity drainage, drainage diversion bund, open drain or pump and pipe. Subsequently, sediment laden water is managed in a manner so as to ensure that two operational performance criteria are achieved:

1. No discharge of sediment-laden runoff during rainfall events that are less than the 1 in 100 year 24-hour design rainfall event: and

2. The Wilcannia Road Dam and 57 Dam will be maintained such that each storage will be empty within 5 days of a rainfall event greater than 25mm in a 24 hour period.

Details of the six water surface storages within the Mine Site which are used for the capture, storage and management of runoff and the method by which each storage achieves operational performance criterion 1 (design rainfall event) are presented in **Table 13** below.

Table 13 Site Water Storages

Storage	*Estimated Volume (ML)[1]*	*Purpose*	*Management Method (design rainfall event)*	*Water Use*
Wilcannia Road Dam	2.7	Collection and storage of runoff from Northern Zone, Wilcannia Road Dam	Capture and storage of runoff. Pumping as required to 57 Dam to maintain operational performance criteria in design rainfall event (see Section 11.1.2).	Source of water for dust suppression and crushing.
Collection Dam	5.0	Collection and storage of runoff from Central Zone, Western sub-catchment	Capture and storage of runoff. Gravity discharge to 57 Dam via open drain and culvert.	Source of water for dust suppression and crushing.
57 Dam	11.0	Collection and storage of runoff from Central Zone, Eastern sub-catchment	Capture and storage of runoff. Pumping as required to Evaporation Pond (or underground workings) to maintain operational performance criteria in design rainfall event (see Section 11.1.2).	Source of water for dust suppression and crushing.
Bovril Dam	15.1	Collection and storage of runoff from Southern Zone, Bovril Dam sub-catchment	Capture and storage of runoff.	Source of water for dust suppression and crushing.
Small Dam	6.5	Collection and storage of runoff from Southern Zone, Small Dam sub-catchment	Capture and storage of runoff.	Source of water for dust suppression and crushing.
Evaporation Pond (Cell C)	34.7	Receives pumped discharge from the underground workings of the Mine Site and the 57 Dam	Natural and enhanced (mechanical) evaporation.	Source of water for dust suppression and crushing.
Estimated volumes based on LIDAR data captured between 25 November 2016 and 10 December 2016 and additional works undertaken in November and December 2018.				

The operational performance criteria will be achieved through either natural or enhanced mechanical evaporation, seepage or through pumping to the Evaporation Ponds. See also Trigger Action Response Plans (TARP) in Section 11 and the summary of management and mitigation measures in Section 9.4.

Finally, Section 12.5.3 identifies inspections of sediment and erosion control structures to be undertaken. In the event that evidence of erosion or sedimentation is observed, the following management and mitigation measures will be implemented. Each of the following will be installed in accordance with the requirements embodied in the standard drawings included in *Managing Urban Stormwater – Volume 1* (Landcom, 2004).

- Sediment Fencing.

  Sediment (silt) fencing consisting of geotextile filter fabric supported by wire and posts will be utilised in areas where the:

  - the area draining to the fence is 0.6 ha or less;
  - the maximum slope gradient behind the fence is 1:2 (V:H); and
  - the maximum slope length behind the fence is 60m.

- Straw Bale Filters and Check Dams.

  In the event that additional erosion control is required at the outlet of a drain or across a swale or drain of a diversion bund, a temporary barrier of straw bales laid end to end across the direction of flow may be utilised to reduce the water velocity and capture sediments.

  Check dams may also be utilised consisting of rock material. Check dams will primarily be utilised to reduce the velocity of water to prevent erosion rather than as a sediment retention structure.

- Rock Armouring and Jute Mesh.

  In the event additional erosion controls are required, other options that will be considered include the use of rock armouring, whereby a drain or outlet is effectively lined with appropriately sized aggregate material to provide a physical barrier to erosion. Similar to rock armouring, jute mesh, a biodegradable erosion control blanket, may be installed, particularly where vegetation growth is preferable.

- Energy Dissipaters and Outlet Protection.

  In the event that additional erosion controls are required to reduce water velocity and mitigate erosion at the outlet of pipe drains, the outlet and a section of the receiving drain or watercourse is lined with appropriately sized, angular and durable material to provide a physical barrier to erosion and lower water velocity by obstructing the flow path and absorbing energy (rip rap apron). The rip rap apron will be underlain with geotextile and the rip rap apron level matched to the invert level of the receiving watercourse. The dimensions of the rip rap apron and material will be determined by the flow conditions (water level and peak discharge) and pipe diameter.

9.3.3 Produced Water

Produced water is water pumped from the underground workings with the potential to contain elevated concentrations of dissolved solids is directed.

In the first instance and as a priority, produced water is directed to the Southern Operations for reuse and recycling so as to reduce demand on the raw water supply from Essential Water. Should produced

water not be required to facilitate the Southern Operations, it will be transferred and stored in the Evaporation Pond and allowed to evaporate via natural or mechanical means.

Subsequently, the Evaporation Ponds provide for additional contingency storage should this be required to meet the operational performance criteria for the 1 in 100 year 24-hour design rainfall event described in Section 11.1.

9.3.4 Chemicals and Hydrocarbons

All hydrocarbon and chemical products will be stored within a bunded area in accordance with the guidance contained in the Australian Standard: *AS1940 – The storage and handling of flammable and combustible liquids.*

9.4 Summary of Management and Mitigation Measures

Table 14 presents a summary of the management and mitigation measures required to ameliorate potential North Mine-related water impacts. Reference is made to the Section this document where the management and mitigation measure is described in more detail.

Table 14 Summary Management and Mitigation Measures – Water

Page 1 of 2

Mitigation Measure	*Timing*	*Source/Section of this Plan*	*Responsibility*	*Evidence for compliance*
Ensure that all surface water within the External Catchment Zone is permitted to discharge from the Mine Site without mixing with other classes of water	Throughout the life of the North Mine	Sect 9.1	North Mine Manager or their delegate	Surface water quality monitoring Physical inspection of diversion structures
Ensure that all potentially sediment laden water within the No 3 Shaft Catchment is retained within the catchment or directed to the Wilcannia Road Dam	Throughout the life of the North Mine	Sect 9.1	North Mine Manager or their delegate	Physical inspection of diversion structures
Ensure that all potentially sediment laden water within the Central Zone is retained within the catchment or directed to the Collector and 57 Dams	Throughout the life of the North Mine	Sect 9.1	North Mine Manager or their delegate	Physical inspection of diversion structures
Ensure that all potentially sediment laden water within the North Mine WRE/TSF Zone is retained within the catchment	Throughout the life of the North Mine	Sect 9.1	North Mine Manager or their delegate	Physical inspection of diversion structures
Ensure that all potentially sediment laden water within the Southern Zone is retained within the catchment or directed to the Bovril or Small Dams	Throughout the life of the North Mine	Sect 9.1	North Mine Manager or their delegate	Physical inspection of diversion structures
Ensure that all produced water from the North Mine is pumped to either the Evaporation pond or transferred off site	Throughout the life of the North Mine	Sect 9.2	North Mine Manager or their delegate	Pumping/meter records
Ensure that the Wilcannia Road and 57 Dams are empty within 5 days of a rainfall event of 25mm in 24-hours	5 days of a rainfall event of 25mm in 24-hours	Sect 9.3.3 and 11.1.2	North Mine Manager or their delegate	Pumping/meter records Meteorological station records Photographs
Store all hydrocarbons and chemicals within a bunded area in accordance with AS1940	Throughout the life of the North Mine	Sect 9.4	North Mine Manager or their delegate	Photographs
Use produced or sediment-laden water in preference to raw water where possible	Throughout the life of the North Mine	Sect 10.1 and 10.4	North Mine Manager or their delegate	Pumping/meter records
Ensure that water is pumped from the Wilcannia Road Dam to the 57 Dam at a maximum rate of 20L/s	When water present	Sect 11.2.1	North Mine Manager or their delegate	Pumping/meter records Water level records

Table 14 Summary Management and Mitigation Measures – Water (Cont'd)

Mitigation Measure	*Timing*	*Source/Section of this Plan*	*Responsibility*	*Evidence for compliance*
Ensure that water is pumped from the Wilcannia Road Dam to the 57 Dam at a minimum rate of 20L/s	When the water level within the Wilcannia Road Dam reaches 265.76m AHD	Sect 11.1	North Mine Manager or their delegate	Pumping/meter records Water level records
Ensure that water is pumped from the 57 Dam to the Evaporation Pond at a minimum rate of 25L/s	When water present	Section 11.1	North Mine Manager or their delegate	Pumping/meter records Water level records
Ensure that water is pumped from the 57 Dam to the Evaporation Pond or underground workings at a minimum rate of 300L/s	When the water level within the 57 Dam reaches 268.8m AHD	Sect 11.1	North Mine Manager or their delegate	Pumping/meter records Water level records
Ensure that water is pumped from the Collection Dam for use on site or exported from the Mine Site at between 9L/s and 12L/s	When water present	Sect 11.2.1	North Mine Manager or their delegate	Pumping/meter records Water level records
Measure surface water quality at NMSW1 and NMSW2	Following 137mm of rain in 24 hours	Sect 11.2.2	Environmental Superintendent	Meteorological station records Monitoring records
Commence mechanical evaporation at the Evaporation Pond and maximise offsite transfer of contained water	Once <2.4m of freeboard is available	Sect 11.3.1	North Mine Manager or their delegate	Diary notes Water level records
Continue mechanical evaporation at the Evaporation Pond and maximise offsite transfer of contained water AND cease underground dewatering	Once <1.25m of freeboard is available	Sect 11.3.1	North Mine Manager or their delegate	Diary notes Pumping/meter records Water level records
Continue mechanical evaporation at the Evaporation Pond and maximise offsite transfer of contained water, cease underground dewatering AND transfer water underground at a minimum rate of 20L/s	Once <0.65m of freeboard is available	Sect 11.3.1	North Mine Manager or their delegate	Diary notes Pumping/meter records Water level records
Monitor Evaporation Pond Piezometers for the presence of water and sample if required	Monthly	Sect 11.4 and 12.2.1	Environmental Superintendent	Monitoring records
Ensure compensatory water supply is provided for any surrounding landholder who's basic landholder water rights are adversely impacted by the North Mine	Throughout the life of the North Mine	Sect 11.5	North Mine Manager or their delegate	Correspondence
Ensure that water levels are monitored automatically in the Evaporation Pond and Wilcannia Road and 57 Dams.	Throughout the life of the North Mine	Sect 12.1.1	Environmental Superintendent	Monitoring records
Measure surface water quality at NMSW3 and NMSW4	Following 25mm of rain in 24-hours	Sect 12.1.2	Environmental Superintendent	Monitoring records
Monitor the water level within the No 3 Shaft	Throughout the life of the North Mine	Sect 12.2.1	North Mine Manager or their delegate	Monitoring records
Monitor the volumes of water pumped and transferred within the Mine Site, including volumes or ore and waste rock transported to surface (at 2.3% moisture) and ventilation rate to allow water balance estimation to be completed	Throughout the life of the North Mine	Sect 12.3	Environmental Superintendent	Monitoring records
Inspect all surface water management structures	Monthly and following 25mm of rain in 24-hours	12.5.1	Environmental Superintendent	Monitoring records
Maintain and test all pumps and associated infrastructure	Monthly	12.5.2	North Mine Manager or their delegate	Maintenance records

10 Site Water Balance

10.1 Water Sources

There are three principal sources of water on the Mine Site which are suitable for use in mining-related activities, namely (in order of priority):

1. Rainfall which generates surface runoff that accumulates within the onsite water storages.
2. Produced water, where suitable, namely for use underground or in areas where it is not possible for it to be discharged from the Mine Site, produced water may be sourced from the underground workings or the Evaporation Pond.
3. Water purchased from off-site sources (Essential Water Supply). Priority for meeting the site water demand will therefore be given to that water which is collected in the site water storages. **Figure 5** presents a schematic of the water balance, priority of usage and site water infrastructure.

Due to quality constraints, produced water is unsuitable for some uses within the Mine Site. However produced water may be suitable for use underground and is suitable for use without further treatment at the Southern Operations. The cost differential between using produced water and the use of raw water purchased from Essential Water ensures that the use of purchased water is minimised.

10.2 Site Water Demand

Principal uses for water within the Mine Site with include the following.

- Dust suppression on the mobile crusher.
- Dust suppression around the Mine Site.
- Underground operations;
- Mixing with tailings and binder in the Paste Fill Plant.
- Ablutions

The volumetric water requirements for the above Mine Site demand equates to approximately **36ML/year.**

Water will also be lost through evaporation from the surface of the relevant site water storage. To estimate annual losses, Monthly evaporation data (Morton's lake evaporation) was processed using information sourced from the Scientific Information for Land Owners (SILO) database, managed by the Queensland Department of Environment and Science (DES). The program uses historic Bureau of Meteorology datasets and interpolation techniques to generate continuous daily time step synthetic climate data for any given location in Australia. The SILO dataset for the period 1 January 1889 to 22 September 2018 was generated for the Mine Site (Latitude -31.95, Longitude 141.50) on 23 September 2018.

Based on a combined minimum dam surface area for the Collection Dam, 57 Dam, Small Dam and Bovril Dam (typical site water storages for runoff) 2.23ha of dam surface area, and an average evaporation of 1548.1mm/year (varying between 41.7mm in June and 220.1mm in January) for the local setting, evaporation of **34.5ML/year** is expected.

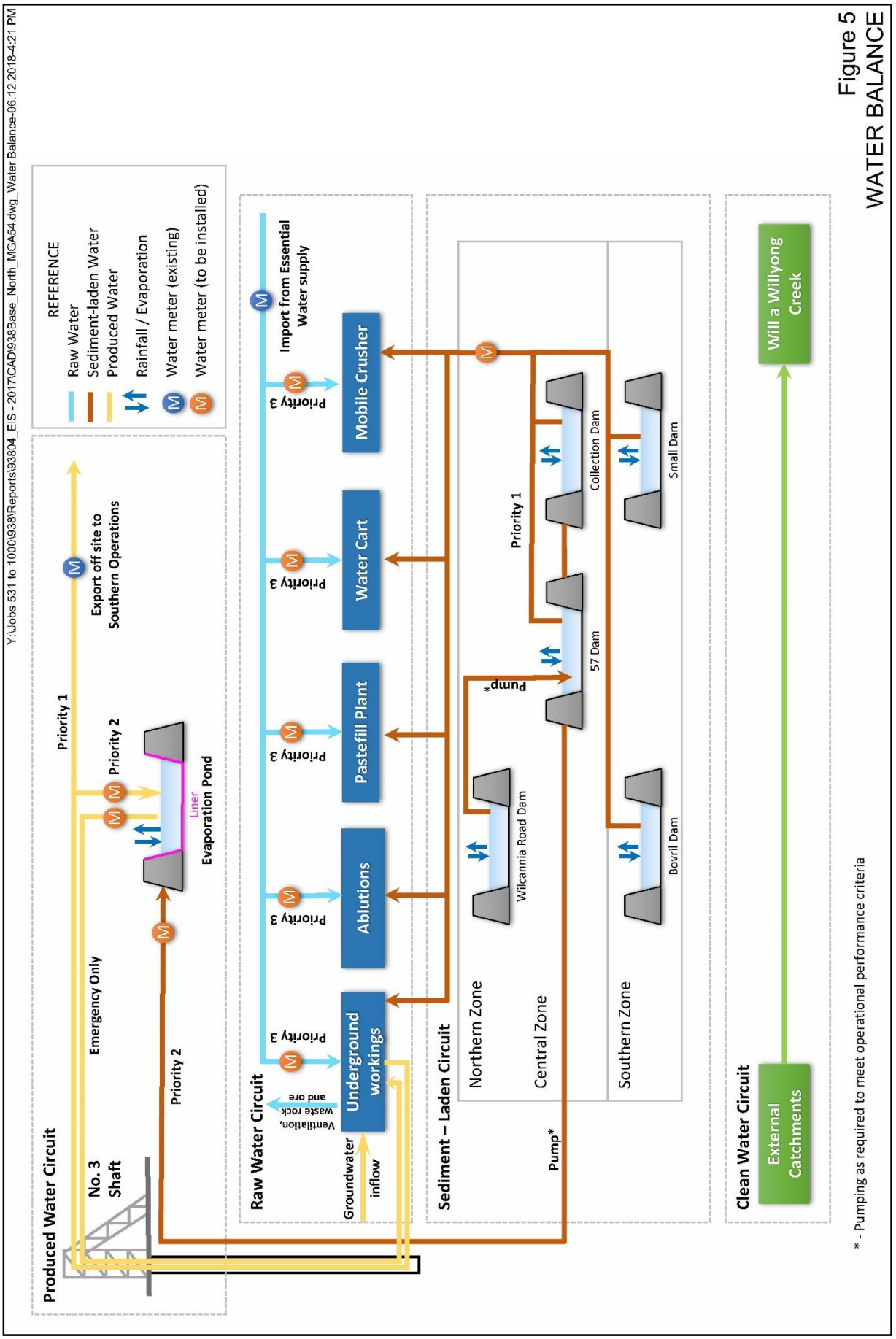


Figure 5
WATER BALANCE

10.3 Water Storage Inputs

As detailed in Section 10.1, inputs to the site water balance are derived from rainfall and the capture of runoff, produced water where suitable and, where required, shortfalls are met via importation of raw water from Essential Water Supply. **Table 15** below details the runoff yield volumes calculated based on statistical analysis (Log Pearson Type III) of the rainfall data derived from the Scientific Information for Land Owners (SILO) database, managed by the Queensland Department of Science, Information Technology and Innovation (DSITI). The program uses historic Bureau of Meteorology datasets and interpolation techniques to generate continuous daily time step synthetic rainfall and other climate data for any given location in Australia. The SILO dataset for the period 1 January 1889 to 22 September 2018 was generated for the Mine Site (Latitude -31.95, Longitude 141.50) on 23 September 2018. Note that **Table 15** only includes those site water storages which are generally anticipated to receive runoff over the course of a typical rainfall event and therefore the site water storages which are managed to provide storage capacity in order to meet the operational performance criteria for the design rainfall event, such as the Evaporation Pond, which have limited contributing catchments, have been excluded from this water balance for conservatism.

Table 15 Calculated Runoff Volumes

Storage	***Runoff Volume (ML/year)***				
	Annual Exceedance Probability				
	95%	**90%**	**50%**	**10%**	**5%**
Wilcannia Road Dam	1.8	2.2	4.1	6.9	7.9
Collection Dam	12.0	14.5	26.8	45.2	51.5
57 Dam	5.0	6.0	11.2	18.8	21.4
Bovril Dam	6.1	7.4	13.7	23.1	26.4
Small Dam	2.5	3.0	5.6	9.4	10.7
Total	**27.5**	**33.1**	**61.4**	**103.4**	**117.9**

Assessment of the 100 year 24 hour rainfall event (137mm) using the initial (10mm) and continuing (2mm/hr) loss values obtained by Miedecke and Partners (1993) indicates that a rainfall excess of 83mm would occur and this value equates to a Cv of 0.59, similar to those presented for 'soil' with low to moderate runoff potential (Cv 0.58, refer to *Table F2* of the *Managing Urban Stormwater – Volume 1* (Landcom, 2004)). Subsequently, for the annualised water balance, a runoff coefficient (C_v) of 0.34 has been applied to all sub-catchments. This accounts for variation in runoff between rainfall events of 10mm or less, when runoff will be very low (C_v <0.10), and more substantive rainfall (>10mm) when runoff from the disturbed surfaces and moderately steep topography will be high (C_v ~0.58), (refer to *Table F2* of the *Managing Urban Stormwater – Volume 1* (Landcom, 2004)).

10.4 Water Storage Reuse and Evaporation (Site Water Demand)

Water used for processing activities, dust suppression and evaporation are effectively withdrawals from the three water circuits on the Mine Site (refer **Figure 5**) with the use of the water within these circuits prioritised to maximise effective use of water resources as follows (refer **Figure 5**):

Priority 1:

- Produced water circuit - transferred directly to Southern Operations.
- Sediment-laden circuit – onsite water demand

Priority 2:

- Produced water circuit - transferred to Evaporation Pond.
- Sediment-laden circuit – transferred to Evaporation Pond.

Priority 3:

- Raw water circuit – imported to meet onsite water demand

The anticipated annual volumes (ML) required to meet the demand from each of these parameters is as follows:

- **Site water demand**.....36ML/year.
- **Evaporation**.....34.5ML/year.

10.5 Water Balance

Table 16 presents the expected water surplus or deficit for a range of Annual Exceedance Probability rainfall that has been calculated using Log Pearson Type III analysis of rainfall data provided by SILO. Additional linear interpolation of the results of the analysis indicates that annual rainfall greater than that experienced in approximately 60% of years will be sufficient to meet site water demand and evaporative loss (i.e. above average rainfall is required to meet site water demand).

Furthermore, the balance of **Table 16** is indicative as site water demand and evaporative losses will vary on an annual basis. Importantly:

- the balance illustrates that sufficient water will be available to account for losses (70.5ML) is likely in greater than 60% of years;
- PBHL will increase the export of water or reduce the rate of dewatering or importation of raw water when the site water balance is positive; and
- PBHL will decrease the export of water or increase the rate of dewatering or importation of raw water when the site water balance is negative.

As a result, North Mine water balance will be in balance, with no net gain or loss of water resulting in storage or operational constraints.

Table 16 Calculated Water Balance for Selected AEP Rainfall Years

AEP	*Runoff (ML)*	*Site Water Demand / Loss (ML)*	*Surplus/Deficit*
95%	27.5	70.5	-43.0
90%	33.1		-37.4
80%	41.5		-29.0
50%	61.4		-9.1
60%*	77.7		7.2
20%	87.2		16.7
10%	103.4		32.9
5%	117.9		47.4
Note: * value interpolated from results of Log Pearson Type III analysis			

10.6 Off-site Water Transfers

The only discharge of water anticipated to occur from the Mine Site will be under the following circumstances.

1. Transfer of produced water to the Southern Operations. No treatment of water transferred from the Mine Site is required to use that water at Southern Operations.
2. Discharge from site water storages in the Southern Zone during rainfall events exceeding the rainfall depths presented in Section 11.2.

11 Trigger Action Response Plans

As noted in Section 8, the water management infrastructure and water management strategy has been developed to achieve two operational performance criteria which are as follows:

1. No discharge of sediment-laden runoff during rainfall events that are less than the 1 in 100 year 24-hour design rainfall event: and
2. The Wilcannia Road Dam and 57 Dam will be maintained such that each of these storages will be empty within 5 days of a rainfall event greater than 25mm in a 24 hour period.

In order to achieve these operational performance criteria, three levels of Trigger Action Response Plans (TARPs) have been developed. The TARPs are based on levels of action that are predicated upon the following.

1. Rainfall event less than or equal to the 1 in 100 year 24-hour design rainfall event.
2. Maintaining the Wilcannia Road Dam and the 57 Dam to ensure that each of these storages is emptied within 5 days of a rainfall event greater than 25mm in a 24 hour period.
3. Management of rainfall events in excess of the design rainfall events in terms of both duration and volume.

11.1 Trigger Action Response Plan: Level 1

11.1.1 Introduction

As noted in **Table 13**, a number of management methods have been identified to ensure that site water management infrastructure achieves the operational performance criteria whereby there is no discharge of sediment-laden runoff during rainfall events that are less than the 1 in 100 year 24-hour design rainfall event.

The parameters pertaining to the design rainfall event are as follows:

- Rainfall depth (Australian Rainfall & Runoff, 2016)..... 137mm
- Initial rainfall loss (adopted from John Miedecke and Partners, 1993)..... 10mm
- Continuing rainfall loss (adopted from John Miedecke and Partners, 1993) 2mm/hr
- Rainfall excess..... 83mm

Review of the storage capacities of site water storages indicates that some storages do not have the requisite volume necessary to capture and retain the volume of runoff calculated for the design rainfall event**. Table 16** presents the calculated volumes of runoff from the respective Mine Site sub-catchments and the storage capacity of the receiving storage.

11.1.2 Pump Triggers

Stage storage calculations have been developed to identify the pump triggers necessary to manage the storage deficits identified in **Table 17**. As it is difficult to predict whether an actual rainfall event is the same as the design rainfall event or the volumes held in storage at the commencement of a rainfall event, the identified pump triggers are based on water levels in the nominated storage not rainfall depth. Subsequently, the nominated water levels and pump triggers are based on the commencement of pumping once the volume of water held in the storage is equal to the storage deficit with the pump rate designed to transfer the calculated storage deficit over a 24 hour duration of the design rainfall event, thus preventing the discharge of sediment-laden water. Each of the nominated storages will be equipped with an automated water level monitor linked to the Honeywell system, with alerts provided to the North Mine Manager or their delegate in the event that the water level trigger is met. In addition, all site water storages will have water level posts installed, with trigger levels prominently marked to provide for a manual observation method of water level inspection.

Table 17 Design Rainfall Event Storage Requirements and Storage Capacities

Storage	*Estimated Volume (ML)*	*Runoff Volume From Design Rainfall Event (ML)*	*Surplus / Deficit (ML)*	*Management of storage deficit*
Wilcannia Road Dam	2.7	4.4	-1.7	Excess runoff automatically transferred via pump to 57 Dam once water level trigger is reached (refer Section 11.1)
Collection Dam	5.0	28.7	-23.7	Excess runoff transferred via open drain and culvert (gravity) to 57 Dam
57 Dam	11.0	12.0	Actual -1.0 With transferred (pumped) volumes -26.4	Excess runoff, pumped inflow from Wilcannia Road Dam and surplus discharge from Collection Dam transferred via pump to Evaporation Pond or underground workings once water level trigger is reached
Bovril Dam	15.1	14.7	0.4	No deficit, capture and storage of design event runoff.
Small Dam	6.5	6.1	0.6	No deficit, capture and storage of design event runoff.
Evaporation Pond (Cell C)	34.7 (maximum) 28.5 (operational	2.1*	Actual 32.6 With transferred (pumped) volumes 6.2	No deficit, sufficient capacity to receive pumped transfer from 57 Dam
Note: * Assumes full rainfall depth (137mm) across entire surface area of storage				

Subsequently, the water level triggers and pump rates will apply at the storages nominated below.

- Wilcannia Road Dam:
  - Water level trigger: ..... 265.76m AHD.
  - Water volume trigger: 1.7ML
  - Pump rate: 20L/sec
  - Pump to: ..... 57 Dam

- 57 Dam:
    - Water level trigger: ..... 268.8m AHD.
    - Water volume trigger: 1.1ML
    - Pump rate: 300L/sec
    - Pump to: .....Evaporation Pond or underground workings.

11.2 Trigger Action Response Plan: Level 2

11.2.1 Northern and Central Zones

In order to achieve the operational performance criteria, whereby the Wilcannia Road Dam and the 57 Dam are managed so as to ensure that each of these storages is emptied within 5 days of a rainfall event greater than 25mm in a 24 hour period, the following actions are required.

1. Review rainfall data for previous 24 hour period and identify if 25mm rainfall threshold has been met.
2. Initiate inspection protocols identified in Section 12.4.
3. If water present, initiate transfer of water from:
    a) Wilcannia Road Dam to 57 Dam at:
        i. Minimum rate: 1L/second
        ii. Maximum rate:.....20L/second
    b) 57 Dam to Evaporation Pond at:
        iii. Minimum rate of: 1L/second
        iv. Maximum rate of: 20L/second

2. Prioritise that site water demand for dust suppression and mobile crushing is met via water held in the Collection Dam until such time as this storage is emptied met via extraction, this should occur at rates as follows (assuming 24 hours per day operations):
    c) Collection Dam:
        i. Minimum pump rate: 9L/second
        ii. Maximum pump rate: 12L/second

11.2.2 Southern Zone

Should a rainfall event exceed the design rainfall event by which the site water management strategy, based on the operational performance criteria have been developed, there is a likelihood that discharge from site storage will occur.

In the first instance, due to the lack of integration with other site storages, the Bovril Dam and Small Dam will be managed under this level TARP once 137mm of rain in 24-hour occurs.

Under the rainfall conditions identified above, the storage volumes for the Bovril Dam and Small Dam will be exceeded and discharge likely to occur. Therefore the following measures will be enacted once the nominated event triggers, identified above, occur:

1. Initiate immediate inspection of both storages (if safe to do so) and observe the integrity of the crest and spillway function.
2. Conduct in-field measurements (refer **Appendix 1**) of water held in each storage for the following parameters (if safe to do so):
   a) Turbidity;
   b) pH; and
   c) Electrical conductivity.
3. If possible (and if safe to do so), observe and record the time at which discharge commences from either storage.
4. Notify the relevant agencies in accordance with the incident management protocols identified in Section 13.
5. Collect water samples of water held in each storage (refer **Appendix 1**) for the submission to a NATA accredited laboratory for analysis (if safe to do so).
6. Conduct water sampling of Creek A at NMSW1 and NMSW2 (refer **Figure A1**) daily during discharge from Bovril Dam, Small Dam or both storages.
7. If possible, observe and record the time at which discharge ceases from either storage.

11.3 Trigger Action Response Plan: Level 3

11.3.1 Northern and Central Zones

Due to the integration of the Northern and Central Zone site storages, should a rainfall event exceed the design rainfall event by which the site water management strategy, based on the operational performance criteria have been developed, there is limited likelihood that discharge from site storage will occur for the following reasons.

- The bulk of the storage volume deficit for the integrated Northern and Central Zone sub-catchments (26.4ML) are accounted for by the pumped transfer from 57 Dam to the available storage in the Evaporation Pond.
- Operational storage for surplus runoff volumes up to 28.5ML is provided up to the minimum freeboard level (275.0m AHD), 0.5m below the crest elevation of Evaporation Pond Cell C. This TARP has been developed to maintain this minimum freeboard.
- Maximum contingency storage for surplus runoff volumes up to 34.7ML is provided by the Evaporation Pond Cell C. This contingency storage is equivalent to 66% of the entire runoff volume (47ML) for the design rainfall event in these zones.

This notwithstanding, the following actions will take place to limit the potential for discharge from site storages in the Northern and Central Zones once the following triggers are met in the Evaporation Pond:

TARP Level 3.1:

- Water level trigger: ... 273.10m AHD or 1.9m below the 275.0m AHD minimum freeboard level.
- Water volume trigger:.....1.5ML
- Action:..... Initiate mechanical evaporation
  ..... Maximise offsite transfer

TARP Level 3.2:

- Water level trigger: . 273.45m AHD or 1.55m below the 275.0m AHD minimum freeboard level.
- Water volume trigger:.....6.2ML
- Actions: ..... Continue mechanical evaporation
  .....Cease underground dewatering (if being directed to Evaporation Pond)
  ..... Maximise offsite transfer

TARP Level 3.3:

- Water level trigger: 274.05m AHD or 0.95m below the 275.0m AHD minimum freeboard level.
- Water volume trigger:.....14.5ML
- Actions: ..... Continue mechanical evaporation
  .....Cease underground dewatering (if being directed to Evaporation Pond)
  ..... Cease transfer from 57 Dam (and direct to underground workings)
  .....Return water to underground workings at the minimum rate of 20L/second until such time as the rainfall event ceases.
  ..... Maximise offsite transfer

11.4 Trigger Action Response Plan: Evaporation Pond

Three piezometers will be established within 10m of the toe of the Evaporation Pond. **Table 18** presents the procedures to be implemented should water be intersected within the piezometers.

11.5 Trigger Action Response Plan – Compensatory Water Supply

The EIS prepared to support the application for SSD7538 (RWC, 2017) determined that the North Mine will not exceed the minimum impact threshold criteria under the NSW *Aquifer Interference Policy*. That conclusion was supported in part because of the 58 registered bores in the vicinity of the Mine Site:

- only 17 were deeper than 20m and only 4 were deeper than 40m;
- the majority of those bores were for monitoring purposes; and
- the recorded yields (where recorded) were less than 1.3L/s.

In addition, the water level within the North Mine workings prior to submission of the application was approximately 579.2m below surface and water quality was typically unsuitable for non-industrial beneficial uses, with the electrical conductivity of groundwater between 12 000μS/cm and 13 000μS/cm.

Table 18 Trigger Action Response Plan: Evaporation Pond

TARP No	*Issue*	*Trigger Level*	*Alert Level*	*Action*	*Response*
1	Water observed in one or more Evaporation Pond piezometers	No water observed	Green	Nil. Monitor again in 1 month	Nil
		Limited water observed (inadequate volume to be sampled)	Yellow	Increase monitoring frequency to fortnightly until water no longer observed or adequate water has accumulated to permit sampling Inspect Piezometer to ensure surface water is not entering piezometer and rectify if so	Nil
		Water observed (sufficient volume to be sampled)	Amber	Collect sample (refer **Appendix 2**) from piezometer(s) and evaporation pond and analyse for major anions, cations, pH and TDS/EC	Compare provenance of evaporation pond and piezometer sample(s)
		Water observed and provenance of water in piezometer(s) and Evaporation Ponds matches	Red	Cease pumping to and empty Evaporation Pond (except in the case of a rainfall emergency as described in Sections 11.2 and 11.3) Inspect liner of Evaporation Pond and repair as required	Refill Evaporation Pond and continue to monitor piezometers fortnightly for 6 months.

Furthermore, given the arid nature of the climate, all water courses are ephemeral and only flow immediately following rainfall.

Notwithstanding the above, Condition 31 of Schedule 3 of SSD7538 requires that PBHL provide a compensatory water supply to anyone whose basic landholder water rights (as defined in the Water Management Act 2000) are adversely and directly impacted as a result of the development. Basic landholder water rights include rights to harvest limited volumes of surface water or groundwater for stock and domestic purposes without a licence.

In the event that a surrounding landholder advises PBHL that their basic landholder water rights have been adversely impacted by the North Mine, PBHL will:

- immediately ensure that adequate water is supplied, either from the Essential Water raw water supply or from water sourced from dewatering operations;
- implement a suitable investigation to determine if the North Mine has in fact adversely impacted the landholder's basic water rights and, if so, the extent of that impact; and

if the above investigation determines that basic landholder water rights have been adversely impacted, ensure that a suitable long-term compensatory supply is provided or that adequate compensation is made available.

12 Monitoring

12.1 Surface Water Monitoring

12.1.1 Water Level Monitoring

Water levels in the following dams form a critical component in management of surface water within the Mine Site and ensuring that the site does not discharge water under rainfall events less than the 1 in 100 year 24-hour event. As a result, each of these dams will be equipped with an automated water level monitor, with data transferred to the Honeywell system. Alerts will be provided to the North Mine Manager or their delegate in the event that the water level triggers identified in Section 11 are achieved.

- Evaporation Pond.
- Wilcannia Road Dam.
- 57 Dam.

In addition, all dams will have water level posts/boards installed, with trigger levels prominently marked to provide a manual backup to the automated system. Observation and recording of water levels in all dams will form part of the regular inspections and maintenance strategy for the Mine Site.

12.1.2 Water Quality Monitoring

PBHL will conduct in-field measurements of water quality of water entering and discharging from the Mine Site at NMSW3 and NMSW4 (**Figure 3**) following 25mm of rain in 24-hours in accordance with the procedures identified in **Appendix 1**.

12.1.3 Monitoring of the Volume of Transferred Water

In addition to the regular inspections and maintenance strategy, PBHL will measure and record monthly all volumes of water transferred from the following water storages:

- Evaporation Pond:
- Wilcannia Road Dam; and
- 57 Dam;

In addition, PBHL will record the volumes of water transferred within the Mine Site using in line meters at the locations shown on **Figure 5**.

12.2 Groundwater Monitoring

12.2.1 Groundwater Monitoring Frequency and Parameters

Given the shallow depth of many of the registered bores compared to the standing water level within the North Mine working prior to the recommencement of mining operations (579.2m below ground level), generally low yields and poor water quality, no monitoring of standing water levels or groundwater quality will be undertaken at registered bores in the vicinity of the Mine Site.

Notwithstanding this, measurement and recording of standing water levels will be undertaken in the No. 3 Shaft using a continuous data logger.

Groundwater levels will also be monitored at 3 shallow piezometers that will be installed approximately 10m northeast of the toe of the Evaporation Pond Cell C downstream batter. These piezometers will be installed to a depth of approximately 3.0m below the ground surface for the purpose of detecting seepage from the Evaporation Pond Cell C. These piezometers will be monitored monthly using a manual dip meter. If water is encountered, the procedures identified in Section 11.4 will be implemented.

In addition and in accordance with the conditions of WAL40959, PBHL will measure and record the volume of all groundwater pumped from No. 3 Shaft. Records will also be maintained of the mass of ore and waste rock material transferred to the surface (allowing a moisture content of 2.3% by weight) and an estimate of moisture losses via the ventilation system.

Finally, the volume of water transferred into the underground workings from the sediment-laden circuit, the produced water circuit and / or the raw water circuit (Essential Water's external supply system) will also be monitored and recorded.

12.2.2 Groundwater Monitoring Parameters

As noted above, the monitoring criteria for groundwater in the vicinity of the underground workings relates solely to the measurement and recording of standing water levels in No. 3 Shaft via a continuous data logger and the volumes of water transferred from underground.

Monitoring of the piezometers adjacent to Evaporation Pond Cell C will also be conducted to identify any seepage from this site water storage.

All results for standing water levels will be reported as metres AHD (m AHD) and metres below ground level (mbgl) whilst all volumes will be reported as megalitres (ML).

12.2.3 Groundwater Monitoring Procedures

12.2.3.1 Monitoring Equipment

The following equipment is used for the collection of groundwater level data.

- A portable dip meter (with spare batteries) to measure groundwater levels (ensure suitability and methods in accordance with data logger manufacturer's instructions prior to use).

12.2.3.2 Field Measurement and Observations

Procedure

1. Lower the dip meter into the casing until it reaches the bottom of the hole as this happens the tape will become slack. Note that the meter does not need to be turned on for this measurement
2. Lift and drop the tape several times to 'feel' the bottom of the bore.
3. Remember to add the length of the weight / probe onto the tape measurement (if this has not been accounted for).
4. Subtract the height of the casing (mark) above the ground level from the measurement.
5. Record the result as total depth (in metres) of the bore on the Bore Information Sheet.
6. Rewind the tape onto the reel taking care to prevent the tape rubbing on the edge of the casing as this will damage the wiring.

Once the groundwater level has been measured the measurement should be recorded on a field sheet, along with the following information:

1. Monitoring location;
2. Date and time of measurement;
3. Water level in Evaporation Pond Cell C at time of measurement;
    a) General site observations;
    b) Appearance of the water, including water clarity and colour (if possible);
    c) Water odour; and
    d) Anything else that may be significantly contributing to the groundwater conditions at the location.

12.3 Water Balance Monitoring

PBHL will monitor the following water movements annually within the Mine Site (see **Figure 5**).

- Pumped and piped water movements using in-line water meters as shown on **Figure 5**.
- Anticipated evaporative losses from surface storages calculated based on evaporation data derived from the SILO database (see Section 10.3) and the surface area of each that is filled with water.
- Actual material movements to surface (2.3% of all material movements is water).

- Actual ventilation rate and calculated water losses through ventilation.
- Calculated groundwater inflows.

12.4 Review and Recording of Monitoring Data

12.4.1 Surface Water Pumping and Storage Volumes

The volumes held in storage and the transferred volumes will be reviewed by the Environmental Superintendent or delegate. The results will also be entered into the site water balance database to allow for further refinement of the operational water balance to reflect actual conditions and inform management decisions regarding surface water management.

The site water balance database will be reviewed annually to identify any trends in the inputs and outputs of the balance and to identify opportunities to refine site water management.

12.4.2 Groundwater Levels

Groundwater data obtained from the data logger and manual measurements at the Evaporation Pond Cell C piezometers will be stored within the Honeywell System. That data will be available to establish the long-term trends in standing water levels at all monitoring locations.

12.4.3 Groundwater Pumping

In accordance with the conditions of WAL40959, PBHL will measure and record the volume of all groundwater pumped from No. 3 Shaft. Records of the meter, time, date, duration of pumping, volumes and use of groundwater pumped from the underground workings as well as any other relevant information will be retained by PBHL for a minimum period of five years and made available upon request from an authorised representative of the relevant water management authority.

12.5 Inspections and Maintenance

12.5.1 Water Storages and Diversions

Regular inspections will be undertaken of all surface water management structures, including surface water diversions and bunds. Inspections will be undertaken on a monthly basis and following a rainfall event of >25mm/24hr, where safe to do so. The inspections of water management structures will record the following details.

- Integrity of all structures, including physical inspection of all surface water diversions, bunds and storages.
- Water levels in each dam based on the water level posts installed in each.
- Evidence of overflow and, if overflow has occurred, the condition of downstream catchment.
- Water colour of all dams, especially (e.g. highly turbid, brown, clear).
- Presence of any oily film.
- The general condition of the water management structures. This will include recording of any areas of active erosion and the level of any sedimentation.

In any areas where active erosion has / is occurring, consideration will be given to installation of additional erosion and sediment controls as described in Section 12.4.3.

12.5.2 Pumping Infrastructure

Monthly inspections will be undertaken to ensure the serviceability of the pumping infrastructure identified in Section 11. These inspections will include, but not be limited to the following:

- Review of pump operations log and maintenance requirements, as set out in the manufacturers advice, to ensure all servicing requirements are met.
- Automated water level sensors are operational and meet the triggers identified in Section 11.1.2.
- All telemetry and auto-start settings are functional to enable automatic pumping when the water level trigger is achieved.
- Pump power supply (or fuel supply) is serviceable, ready for operation and sufficient to maintain operations for sufficient time until re-supply can be arranged.
- All pump fittings, connections and transfer lines are serviceable and fit for purpose.

12.5.3 Erosion and Sediment Control

Should regular inspection of surface water management infrastructure identify evidence of erosion, erosion and sediment control measures will be installed as required to reduce the velocity of flows and capture sediment. Additional sediment protection will include the use of one or more of the following.

13 Data Management and Reporting

13.1 Sample Collection, Data Receipt, Analysis and Storage

The following data will be retained in relation to all samples collected in accordance with the requirements of the Environment Protection Licence.

- the date(s) on which the sample was taken;
- the time(s) at which the sample was collected;
- the location at which the sample was taken; and
- the name of the person who collected the sample.

Analyses will be performed by NATA certified laboratories for the specific tests required.

All laboratory monitoring data will be reviewed as soon as reasonably practicable after receipt.

The data collected as part of the monitoring and reporting of all water transfers, dam volumes and rainfall on the Mine Site will be entered into the site water balance for the purpose of an annual review and to refine the assumptions upon which the water balance is maintained (e.g. runoff coefficients etc).

13.2 Data Validation

The monitoring program will generate three classes of data, namely:

- automatically generated data from water level monitors, water meters and the meteorological station; and
- laboratory data from water samples; and
- observational data generated during inspections and from incident reports.

Each class of data will be validated separately as follows.

- Automatically generated data.

  Data loggers on the instruments or within the Mine Control Centre will provide an alert if data is no longer being recorded or if telemetry is lost. The Environmental Officer or their delegate will interrogate the data monthly during preparation of the monthly report described in Section 13.3 and compare the data with related data as a sense check, i.e. do the manual observations and automatically collected water level data match and do water volumes pumped reflect pump hours or water levels within storages.

- Laboratory-generated data

  The Environmental Officer or their delegate will receive the data from the laboratory and compare it with expected results. In the event that the data is within expected ranges, it will be loaded into the relevant database.

- Observational data

  The Environmental Superintendent or their delegate will receive the inspection checklists from the various monitoring and inspection programs. Where required, remedial action will be implemented, including maintenance or calibration of equipment. Inspection checklists will then be filed. All monitoring data is backed up in accordance with Perilya's information technology procedures. Records will be maintained for a minimum of four years.

13.3 Reporting and Publishing of Reports

The results of the above monitoring will be provided as a monthly summary report containing the following information for publication on the PBHL website.

- Name and address of reporting organisation or individual.
- Date of issue of the report.
- Period of monitoring.
- Water levels within each of the water storages.
- The adequacy of the water management structures, including the status of any remedial action required.
- Whether the triggers identified in Section 11 were achieved and the outcomes of the actions that resulted, including the volumes of water pumped from the Wilcannia Road and 57 Dam or the Evaporation Pond Cell C.

In addition, the Annual Review will include a summary of the above information ,as well as a detailed review of the water balance during the reporting period. This document, once approved by DPE and the relevant government agencies, will be published on PBHL's website.

14 Incident and Non-compliance Management

14.1 Incident and Non-compliance Identification

An incident is defined by SSD7538 as

"*A set of circumstances that:*

- *causes or threatens to cause material harm to the environment; and/or*
- *breaches or exceeds the limits or performance measures/criteria in this consent"*

Section 147 of the POEO Act, harm to the environment is deemed to be material if:

i. it involves actual or potential harm to the health or safety of human beings or to ecosystems that is not trivial; or

ii. it results in actual or potential loss or property damage of an amount, or amounts in aggregate, exceeding $10,000 (or such other amount as is prescribed by the regulations).

For the purpose of this Plan, an incident is defined as follows.

- Any discharge of North Mine-affected water, including dirty or produced water or mine affected water in the Evaporation Pond piezometers, but not including clean water.
- Any failure of a water management structure that has the potential, if not controlled, to result in either of the above.

A non-compliance is defined as any exceedance of the criteria identified in Section 8.

14.2 Incident and Non-compliance Management and Notification

Sections 8.1 and 8.2 of the *Environmental Management Strategy* describe the procedures to be implemented in the event of an incident or non-compliance. In summary, PBHL will:

- Implement measures to control and/or manage the incident or non-compliance;
- Immediately report the incident or non-compliance to the Environment Protection Authority, Resources Regulator and Department of Planning and Environment; and
- Prepare a written report within 7 days and provide a copy of that report to the above agencies.

14.3 Emergency Management Process

The PBHL *Emergency Response and Crisis Management Procedure* is the prevailing document that governs emergency response actions. That document incorporates the *Pollution Incident Response Management Plan* required under EPL2683. In summary, in an emergency situation, one or more crisis management teams are convened and those teams coordinate emergency response, including interactions with external agencies, including emergency services.

14.4 Complaints Management Process

Section 7.1 of the *Environmental Management Strategy* describes the procedures to be implemented in the event of a complaint. In summary, complaints may be received directly via telephone, email or web form from PBHL's website, or indirectly via relevant government agencies. Upon receipt, the name and contact details of the complainant and the nature of the complaint are recorded. PBHL will then investigate the complaint and implement system improvements if required. The results of the investigation are communicated back to the complainant.

15 Roles and responsibilities

Table 19 outlines the roles and responsibilities of for implementation of this Plan.

Table 19 Roles and Responsibilities of Personnel with Respect to Management of Water

Role	*Responsibilities*
General Manager	Ensure adequate resources are available to implement the Water Management Plan.
North Mine Manager	Ensure compliance with the Water Management Plan. Relocate or postpone relevant activities in the event of adverse weather conditions, where practical. Initiate investigations of complaints as received from the public or government agency. Ensure employees are competent through training and awareness programs.
Environmental Superintendent	Accountable for the implementation of this Plan, including all management and mitigation measures, monitoring and reporting. Ensure monitoring results are regularly reviewed/evaluated and entered into the environmental database and site water balance database. Provide primary contact for complaints and supply follow-up information to any complainant.
Environmental Advisor	Accountable for the day-to-day implementation of this Plan, including ensuring standard operating procedures re complied with and all monitoring data is collected and stored appropriately.
All other employees and contractors	Responsible for following directions and instructions from site management and supervisors. Operate in manner that minimises risks of incidents to themselves, fellow workers or the surrounding environment. Report any incidents to the North Mine Manager.

16 Competence training and awareness

All personnel and contractors working at the Mine Site will undergo an induction. This induction includes information on the management of water while working on site.

After completing the induction, workers will sign a statement of attendance and records of this are kept in the administration office.

Regular toolbox meetings are held to discuss whole-of-site production, management, safety and environmental issues. Matters relating to water and water quality are raised during these meetings, when necessary.

17 Review and Revision Process

In accordance with the requirements of Condition 6 of Schedule 4, this Plan will be reviewed within 3 months of:

a) the submission of an annual review
b) the submission of an incident report
c) the submission of an audit
d) any modification to the conditions of this consent, (unless the conditions require otherwise);

PBHL will review and, if necessary revise, the strategies, plans, and programs required under the consent.

Where this review leads to revisions in any such document, then within 4 weeks of the review the revised document will be submitted to the Secretary for approval, unless otherwise agreed with the Secretary.

18 References

Australian and New Zealand Environment Conservation Council (ANZECC) (2000). *Australian and New Zealand guidelines for fresh and marine water quality*.

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors) (2016). *Australian Rainfall and Runoff: A Guide to Flood Estimation*

DECC (2008a). *Managing Urban Stormwater – Soils and Construction: Volume 2C Unsealed Roads.*

DECC (2008b). *Managing Urban Stormwater – Soils and Construction: Volume 2C Mines and Quarries.*

John Miedecke and Partners (1993). Stormwater Management Plan prepared in association with Water Studies Pty Ltd for Poseidon Mining Investment

Landcom (2004). *Managing Urban Stormwater – Soils and Construction: Volume 1.*

R.W. Corkery & Co. Pty Limited (2017). *Environmental Impact Statement for the Recommencement of Mining Operations at the Broken Hill North Mine***.**

APPENDIX 1 WATER MONITORING PROCEDURES UNDER TARP LEVEL 3

1 In-Field Analyses

A hand-held meter will be used to collect measurements of turbidity, pH and electrical conductivity. Prior to use, the meter will be calibrated in accordance with the manufacturers specifications.

1.1 Sample Collection and Analyses

The procedures water sampling and analysis generally follow those presented in the *Approved Methods for the Sampling and Analysis of Water Pollutants in New South Wales* (DEC, 2004).

Monitoring Equipment

The following equipment is used for the collection of surface water samples.

- Chain of custody form (laboratory supplied).
- Labelled sample containers. As supplied by laboratory.
- Marker pen and ink pen.
- Esky (with ice or chilled briquettes).
- Camera.
- Spares kit, including;
  - spare sampling bottles; and
  - marker pen/ink pen.

Due to the types of analyses required, it is anticipated that two separate sampling containers will be required for the purposes of collecting samples:

1. Electrical conductivity, TSS, turbidity and pH.
2. Oil and Grease.

A minimum of 8 sets of sampling bottles (i.e. sufficient for two rounds of sampling) will be retained on site. Additional bottles are available through the laboratory services provider.

Sampling Procedure

The following procedures apply to surface water sampling under TARP Level 3.

1. Clearly label each sample bottle **before sampling**, as follows.

   Site: .....North Mine.

   Sampling Location:..... e.g. NMSW3.

   Date: ..... 15/10/2019.

   Time: ..... 7:00am.

   Sampled by: .....John Smith.

2. Remove lid of TSS, EC, turbidity and pH sampling container and rinse with at least 500mL of water from the sample area. Ensure rinsed water is tipped away from the sampling area.
3. Fill the sampling container and use it to carefully fill the other sampling container ensuring not to spill the preservative contained within the other sampling container, or mix the lids between bottles. Tighten the sampling container lid and place the sample in the chilled esky immediately.
4. Refill the other sampling container to capacity. Tighten the sample bottle lid and place the sample in the chilled esky immediately.
5. Prior to leaving each monitoring site, photograph the site and record observations on stream flow, water colour or any other relevant matter.

Collected water samples will be delivered to laboratory for analysis as soon as possible and submitted with a chain of custody form.

1.1.1 Surface Water Flow Monitoring

The methods for determining flow when sampling for water quality are modified from the Velocity-area method of Part 3 of Australian Standard (AS) 3778-2009: Measurement of water flow in open drains (SA, 2009).

The flow will be recorded as either:

- high: rapid movement of water flowing at, or over the defined drain;
- medium: moderate movement of water covering >50% of the defined drain;
- low: slow movement of water covering >50% of the defined drain; or
- none: no movement of water.

A photo will be taken on each occasion for comparison to previous flows.

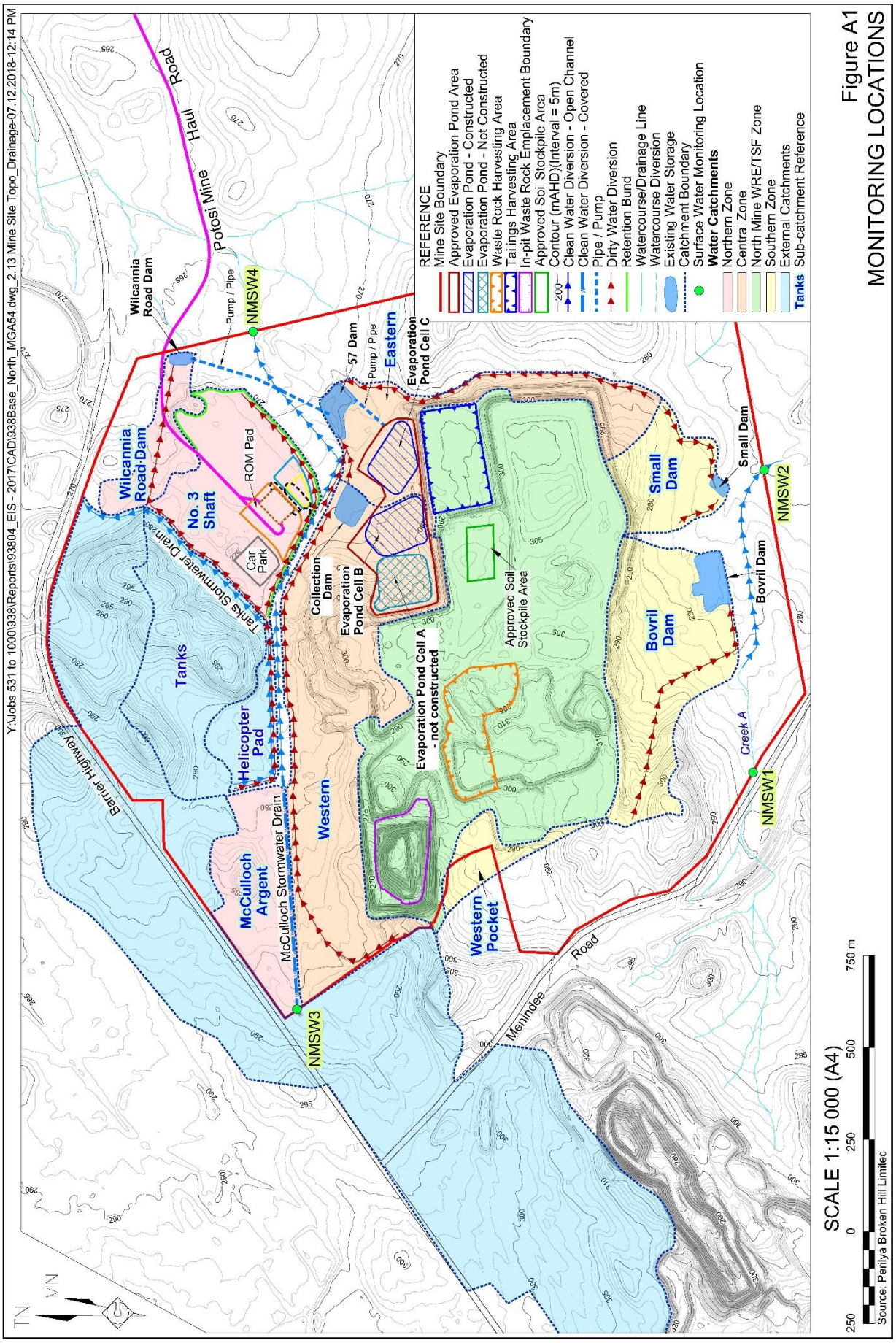


Figure A1
MONITORING LOCATIONS
REFERENCE
Mine Site Boundary
Approved Evaporation Pond Area
Evaporation Pond - Constructed
Evaporation Pond - Not Constructed
Waste Rock Harvesting Area
Tailings Harvesting Area
In-pit Waste Rock Emplacement Boundary
Approved Soil Stockpile Area
Contour (mAHD)(Interval = 5m)
Clean Water Diversion - Open Channel
Clean Water Diversion - Covered
Pipe / Pump
Dirty Water Diversion
Retention Bund
Watercourse/Drainage Line
Watercourse Diversion
Existing Water Storage
Catchment Boundary
Surface Water Monitoring Location
Water Catchments
Northern Zone
Central Zone
North Mine WRE/TSF Zone
Southern Zone
External Catchments
Sub-catchment Reference
Tanks
Haul Road
Potosi Mine
Wilcannia Road Dam
Pump / Pipe
NMSW4
57 Dam
Eastern Evaporation Pond Cell C
Wilcannia Road Dam
No. 3 Shaft
ROM Pad
Car Park
Tanks Stormwater Drain
Tanks
Collection Dam
Evaporation Pond Cell B
Approved Soil Stockpile Area
Small Dam
Small Dam
NMSW2
Bovril Dam
Bovril Dam
Creek A
NMSW1
Helicopter Pad
McCulloch Argent
McCulloch Stormwater Drain
Western
Evaporation Pond Cell A - not constructed
Western Pocket
Barrier Highway
Menindee Road
NMSW3
SCALE 1:15 000 (A4)
0 250 500 750 m
250
Source: Perilya Broken Hill Limited
Y:\Jobs 531 to 1000\938\Reports\93804_EIS - 2017\CAD\938Base_North_MGA54.dwg_2.13 Mine Site Topo_Drainage-07.12.2018-12:14 PM

APPENDIX 2 WATER MONITORING PROCEDURES UNDER TARP: EVAPORATION POND

1 Groundwater Sampling Protocols

1.1 Monitoring Equipment

The following equipment is used for the collection of groundwater samples.

- Chain of custody form (laboratory supplied).
- A portable water quality logger for the measurement of the following parameters;
  - pH;
  - electrical conductivity (EC) in mS/cm or µS/cm;
  - total dissolved solids, and
  - temperature in °C.
- Labelled sample containers. As supplied by laboratory.
- Disposable syringe. As supplied by laboratory.
- Disposable filter (0.5 Micron (µm)). As supplied by laboratory.
- Re-usable sample collection container (e.g. plastic bucket) of known volume.
- Disposable, powder free nitrile gloves.
- Disposable bailer.
- Length of cable or string with marks / knots at every metre.
- Marker pen and ink pen.
- Demineralised water.
- Decon 90.
- Esky (with ice or chilled briquettes).
- Camera
- Spares kit, including;
  - spare sampling bottles; and
  - marker pen/ink pen.

Due to the types of analyses required, it is anticipated that one sample container, as required by the laboratory for the sampling and analysis of physico-chemical parameters and the major and minor ions will be required for the purposes of collecting samples:

A minimum of 6 sets of sampling bottles and sampling consumables (i.e. sufficient for two rounds of groundwater sampling) should be retained on site. Additional bottles and sampling consumables are available through the laboratory services provider.

1.2 Timing

Groundwater samples should be collected in as short a period as possible in order to avoid variation in external influences such as temperature and rainfall. It is therefore preferable to arrange sampling of all piezometers over the period of one day. Subsequently the following sequence should occur:

1. Water level dipping at all monitoring bores to establish standing water levels and identify if monitoring bores require sampling.
2. Purging and sampling of all monitoring bores.
3. Sampling of all remaining monitoring bores.

Samples should not be collected on a Friday or immediately before a public holiday unless prior arrangements have been made with the laboratory to ensure samples can be analysed within the necessary timeframe.

1.3 Groundwater Sampling Procedures

Upon attending a piezometer location, the standing water level and depth to the bottom of the piezometer should be recorded. Additional observations regarding the condition of the piezometer and any odours emanating from the piezometer should be made and recorded at this time.

Note: All standing water levels at piezometer are to be measured from a mark at the top of either the piezometer casing or the bore casing. This mark is to be established during the initial sampling round and will have the height of the mark above ground level measured and recorded so that subsequent measurements can use this reference point to account for the elevation above ground level.

1.3.1 Measuring total depth

Over time, the bottom of the piezometer may collect silt. Comparing the original depth of the piezometer with the measured depth over time will be useful in determining the piezometer condition and any remediation measures required.

1.3.1.1 Procedure

1. Lower the dip meter into the casing until it reaches the bottom of the hole as this happens the tape will become slack. Note that the meter does not need to be turned on for this measurement.
2. Lift and drop the tape several times to ‘feel’ the bottom of the piezometer.
3. Remember to add the length of the weight / probe onto the tape measurement (if this has not been accounted for).
4. Subtract the height of the casing (mark) above the ground level from the measurement.
5. Record the result as total depth (in metres) of the piezometer.
6. Rewind the tape onto the reel taking care to prevent the tape rubbing on the edge of the casing as this will damage the wiring.
7. Clean the tape before using it again.

1.3.2 Measuring standing water level

The standing water level (depth to water) should be measured and recorded prior to every sampling event. The water level dip meter uses a probe attached to a permanently marked polyethylene tape, fitted on a reel. The probe detects the presence of a conductive liquid between its two electrodes and is powered by a standard 9 volt battery. When contact is made with water, the circuit is closed, sending a signal back to the reel. This activates a buzzer and a light. The water level is then determined by taking a reading directly from the tape, at the top of the casing of the piezometer.

1.3.2.1 Procedure

1. Lower the dip meter into the casing until it reaches the water surface, as this happens the dip meter will commence beeping. Note that the meter will need to be turned on for this measurement.
2. Gently lift and drop the dip meter several times to accurately read the water level within 1cm.
3. Remember to add the length of the probe onto the tape measurement (if this has not been already been accounted for).
4. Subtract the height of the casing (mark) above the ground level from the measurement.
5. Record the result as depth (in metres) of the piezometer.
6. Rewind the tape onto the reel taking care to prevent the tape rubbing on the edge of the casing as this will damage the wiring.
7. Clean the tape before using it again.

1.4 Purging

The purpose of groundwater sampling is to retrieve a water sample form the piezometer that represents the characteristics of water within the aquifer, not water that may have been exposed to air within the piezometer. Therefore, to obtain a representative sample it is necessary to remove the stagnant water from the piezometer casing before a sample is taken and this must occur at each piezometer prior to each sampling event. It is recommended that at least three casing volumes of water should be removed before sampling. The piezometer are to be purged using a bailer. A bailer is a simple device that can be used to withdraw water from the piezometer. It consists of tubing with a one-way check valve at the bottom. When the bailer is lowered into the bore casing below the water level, it fills with water. The check valve closes once the bailer containing the water sample is lifted to the surface.

1.4.1 Calculation of volume

Using the information collected from the preceding steps (total depth and standing water level measurements), calculate the depth of the water column in the piezometer using the following method:

Standing water level (m) – total depth (m) = water column (m)

The length of the water column is then used to calculate the total volume of water required to purge three casing volumes of water by using the following volumes (L) for each unit of measurement (m) **(assumes 50mm monitoring bore diameter).**

- 6Lper 1 metre of water column.

- 0.6Ls per 10 centimetres (0.1m) of water column.
- 0.06 per centimetre (0.01m) of water column.

It is noted that a standard disposable bailer has a volume of 1.1Lwhen full.

1.4.2 Procedure

1. Lower the bailer to the level of the slotted part of the casing (screened interval).
2. Lower and withdraw the bailer slowly, taking care not to allow the bailer to touch or disturb sediment at the bottom of the piezometer.
3. Empty the bailer into the bucket of known volume
4. Repeat the process, trying not to disturb the water column by splashing until the required volume of water has been removed or the standing water level has been lowered to within 25cm of the total depth of the piezometer.
5. Using the bucket of known volume, record the volume of water that has been removed.

1.5 Sample Collection

Prior to sampling the logger and any other associated equipment (e.g. the container or bucket) should be washed with a solution of Decon90 and water to remove soil material, followed by a rinse in demineralised water.

Once the purge volume has been removed from the piezometer, a bucket of known volume should be filled with water extracted from the piezometer at a depth approximately 25cm above the measured bottom of the hole. Where practicable, a minimum of 1L of water should be collected in the bucket.

1.5.1 Field measurements

A portable water quality logger should be used in the field to measure the following parameters at each piezometer to be sampled.

- pH.
- Electrical conductivity (EC) in mS/cm or µS/cm.
- Total dissolved solids.
- Temperature in °C.

The water quality logger should be calibrated prior to each sampling round, and a record of the calibration should be provided with any related report.

The probes should then be dipped into the water and suspended within the water column above the bottom of the container, ensuring that all the probes are submerged in the water. Powder-free nitrile gloves should be worn by the sampler during sampling to prevent contamination by products such as sunscreen. The water quality probes should be remain suspended in the water until the readings have stabilised within 10% for electrical conductivity and 0.1 for pH.

To avoid contamination during relocation between sites, equipment should be washed immediately prior to sampling at each site, rather than immediately after sampling.

Care should be taken to ensure:

- the conductivity probe is adequately submerged
- in-situ conditions (as shown on the multi-probe display screen) have stabilized before a measurement is recorded (note that temperature and pH are likely to stabilize first).

Once the parameter readings have stabilised they should be recorded along with the following information:

- piezometer identifier;
- date and time of sampling;
- weather at the time of sampling;
- depth at which the standing water level and bottom of hole was recorded;
- appearance of the water, including water clarity and colour;
- water odour; and
- substrate material (if any) in the water (e.g. silt or sand).

1.5.2 Sampling for Laboratory Analysis

Once the purging has been completed, the sampled water should then be poured from the collection container directly into the sample containers, which should then be placed in eskies filled with ice without delay, and later transported to a National Association of Testing Authorities (NATA) accredited laboratory. Sample containers should be clearly marked with the site name, project reference number, sampler's name or initials and date and time of collection. To assist the laboratory it is also prudent to clearly mark the lid of the sample container with the correct site name or number.

Disposable, powder free nitrile gloves should be worn by the sampler and replaced between each sample site. Sampling equipment can be kept clean between uses by being housed in a plastic bag that is then placed in a clean, plastic, sealable container. The rinsing process described above should be undertaken prior to sampling.

Care should be taken to ensure the following

- One duplicate is collected for every 10 samples collected (if sufficient water has not been collected in the bucket to fill the duplicate and standard sample container for a particular analyte, then both containers should be half-filled with water from the bucket, and this process should be repeated until the container is full).
- Samples are placed on ice as soon as practicable after collection.
- Samples should not be collected on a Friday or immediately before a public holiday unless prior arrangements have been made to ensure analytes with short holding times can be analysed within the necessary timeframe.

1.5.3 Procedure

1. Clearly label each sample container **before sampling**, as follows.
   i. Site: North Mine.
   ii. Sampling Location: e.g. Piezometer 126.
   iii. Date: dd/mm/yyyy.
   iv. Time (24h): hh:mm hours.
   v. Sampled by: John Smith.
2. Prior to sampling, the water quality probes and re-usable sample collection equipment should be washed with a solution of Decon90 and water to remove soil and vegetative material, then rinsed in demineralised water.
3. Powder-free nitrile gloves should be worn by the sampler during sampling to prevent contamination by products such as sunscreen.
4. The re-usable collection container should be filled sufficiently to yield a sample after the purge volume has been removed from the monitoring bore.
5. Remove lid of Major and Minor Ions sampling container and rinse with at least 500mL of water from the sample collection container. Ensure rinsed water is tipped away from the sampling area.
6. Sampled water should then be poured from the collection container directly into the Major and Minor Ions sampling container.
7. Once full, tighten the sampling container lid and place the sample in the chilled esky immediately.
8. Prior to leaving each monitoring site ensure that the Bore Monitoring Sheet has been completed with field measurements, purge volumes, observations or any other relevant matter are recorded.

Once collected, all samples should be placed within an ice-cooled esky and transported to the NATA accredited laboratory for analysis as soon as practicable and within 24 hours of collection. Samples should be stored, transported and handled at a temperature of less than 4 degrees Celsius.

The date and time of collection should be noted on the chain of custody (CoC) form that is to be submitted to the lab so that it can be confirmed that the sample has reached the lab within the appropriate holding times.

1.6 Evaporation Pond Sampling Procedure

Similar to the protocols identified for TARP Level 3, the following procedures apply to surface water sampling under TARP: Evaporation Pond.

1. Clearly label each sample bottle **before sampling**, as follows.
   Site: .....North Mine.
   Sampling Location:.....Evaporation Pond.
   Date: ..... 15/10/2019.
   Time: ..... 7:00am.
   Sampled by: .....John Smith.

2. Remove lid of Major and Minor Ions sampling container sampling container and rinse with at least 500mL of water from the sample area. Ensure rinsed water is tipped away from the sampling area.
3. Fill the sampling container and use it to carefully fill the other sampling container ensuring not to spill the preservative contained within the other sampling container, or mix the lids between bottles. Tighten the sampling container lid and place the sample in the chilled esky immediately.
4. Refill the other sampling container to capacity. Tighten the sample bottle lid and place the sample in the chilled esky immediately.
5. Prior to leaving each monitoring site, photograph the site and record observations on stream flow, water colour or any other relevant matter.

Collected water samples will be delivered to laboratory for analysis as soon as possible and submitted with a chain of custody form.