INVINCIBLE COLLIERY WATER MANAGEMENT PLAN

Shoalhaven Coal Pty Limited (Castlereagh Coal)

INVINCIBLE COLLIERY

(Southern Extension)

Water Management Plan

Document Status Register

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1.0 Introduction

1.1 Background

Shoalhaven Coal Pty Limited (Shoalhaven Coal), trading as Castlereagh Coal Pty Ltd (Castlereagh Coal), owns the Invincible Colliery (Invincible), a coal mine located approximately 25 kilometres (km) north- west of Lithgow in New South Wales (NSW) (refer to **Figure 1-1**). The town of Cullen Bullen is located approximately 3 km north-west of Invincible.

Shoalhaven Coal is part of the Manildra Group (Manildra), a family owned Australian group of companies providing integrated diverse agribusiness operations. In 2015, Shoalhaven Coal purchased Invincible, and the nearby Cullen Valley Mine, to secure a continued supply of specialty coal product, known as 'nut' coal, for Manildra's Shoalhaven Starches Plant located at Bomaderry on the NSW South Coast (refer to **Figure 1-1**)

Invincible has a long history of mining, with operations commencing in 1901. Open cut mining has been carried out at Invincible at various times ranging from the 1940s through to 2013, when the mine was placed into care and maintenance.

Shoalhaven Coal sought to modify the Invincible Project Approval 07_0127 (Project Approval Mod 5) to extend open cut mining operations to the south of the existing approved mining area (Southern Extension). The Southern Extension is located within the Ben Bullen State Forest to the east of the Castlereagh Highway (refer to **Figure 1-2**). The modification was approved by the Planning Assessment Commission (PAC) on 2 February 2018.

The Project Approval permits mining operations to be carried out until 31 December 2025. The Southern Extension includes:

- extending the open cut mining area to mine down to, and including, the Lithgow Seam to the south of the existing mine (referred to as the Southern Extension Area);
- maximum mining and production rates of up to 1.2 Mtpa product coal;
- product coal transport arrangements (with coal to be transported from the site by road truck to either the Shoalhaven Starches Plant or Mount Piper Power Station);
- use of existing open cut voids and former underground workings for temporary water storage;
- continued use of existing Invincible infrastructure (including maintenance work, and minor upgrades and operation of the existing Invincible Coal Preparation Plant (Invincible CPP); and
- rehabilitation of the Southern Extension Area and all existing disturbance areas at Invincible by reshaping mining areas to remove voids and revegetating the reshaped landform with locally endemic woodland and forest communities.

The approved disturbance area for Invincible is 215 hectares (ha) (former mining areas plus the Southern Extension).

1.2 Purpose and Scope

The purpose of this Water Management Plan (WMP) is to describe the soil and water quality management strategies, procedures, controls and monitoring programs to be implemented at Invincible for the management of potential impacts.

This WMP applies to the Invincible Colliery Water Management System as shown on **Figure 1-2**.

Figure 1-1 Locality Plan

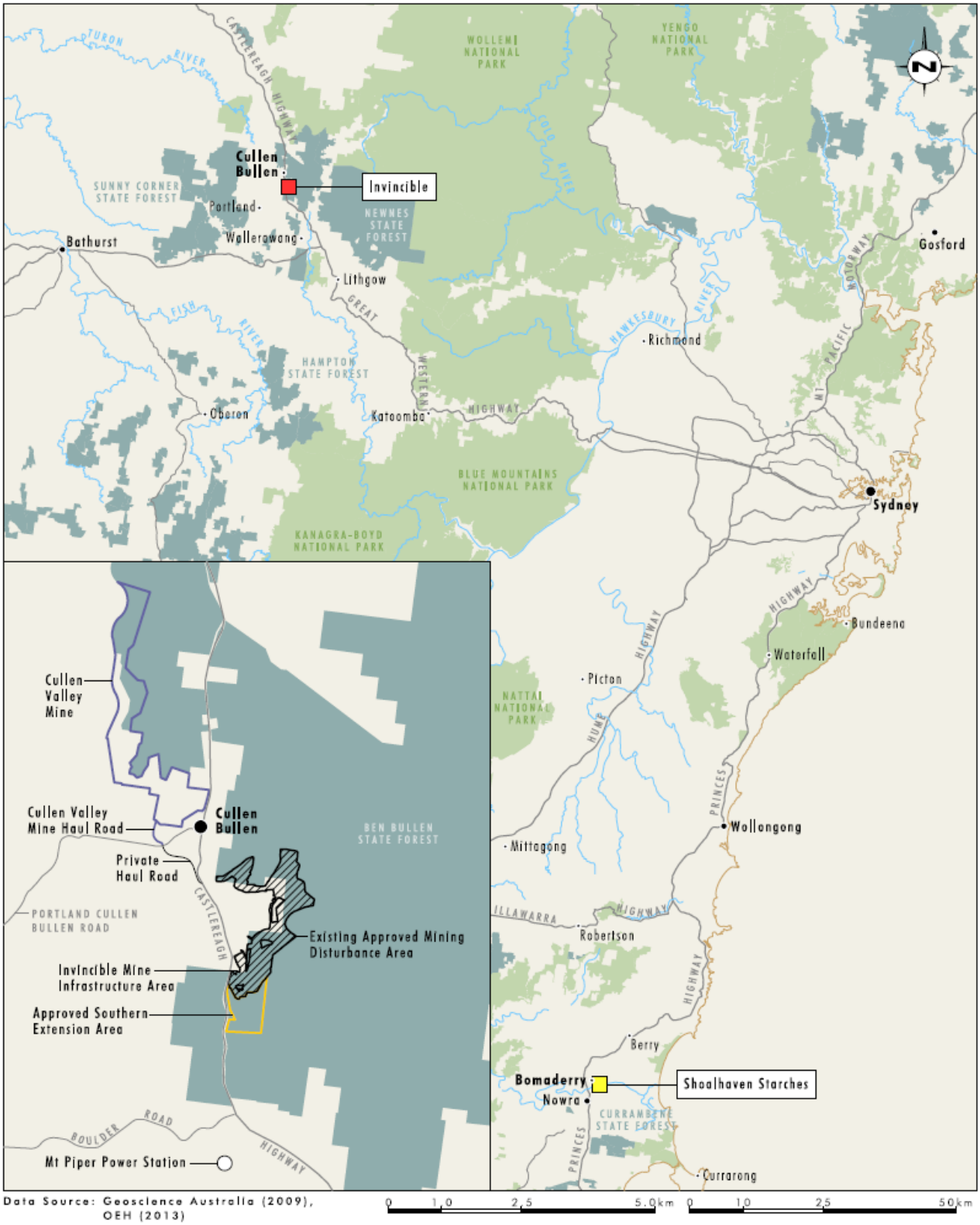
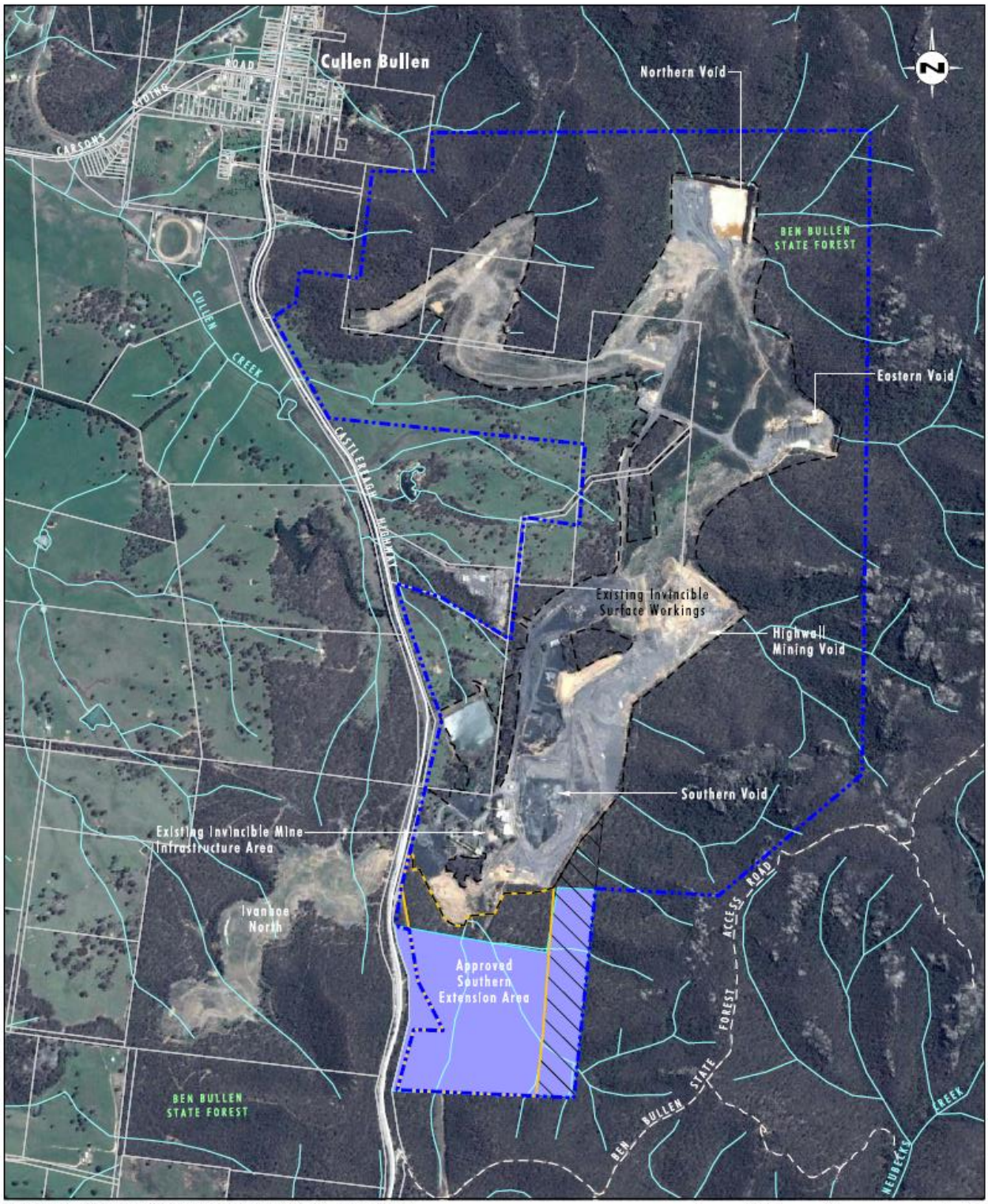


FIGURE 1.1

Locality Plan

Figure 1-2 Invincible Southern Extension Project and Existing Operations



This WMP addresses the relevant requirements of the Project Approval and Environment Protection Licence (EPL) 1095. The Project Approval conditions and related Environmental Assessment (EA) management commitments relevant to this plan are provided in **Section 1.4**. EPL conditions relevant to this plan are also provided in **Section 1.4**.

This plan also outlines the control and contingency measures to be implemented as part of the continued operations at the mine to minimise the potential impacts on local soil and water quality.

1.3 Plan Implementation

1.3.1 Responsibilities

Environmental management at the mine is the responsibility of all employees with the Mine Manager having overall responsibility for environmental management of the operations. Roles and responsibilities for implementation of this WMP for key personnel at Invincible are outlined in **Table 1**.

Table 1 Roles and Responsibilities

Role	Responsibilities
Shoalhaven Coal Owners Representative	Provide sufficient resources for the implementation of this plan.
Mine Manager	• Oversee the implementation of this plan. • Have working knowledge of this plan. • Coordinate the implementation of water management measures and strategies in accordance with this plan. • Ensure that the mine has sufficient water for all stages of the development, and if necessary, adjust the operations to match available water supply. • Ensure the mine is managed within the capacity of the mine water management system. • Be aware of the environmental legislative requirements associated with the mine and take measures to ensure compliance. • Ensure employees are provided with the necessary training and awareness programs.
Environmental Officer	• Coordinate the review of this plan in accordance with the requirements of the Project Approval. • Coordinate the water monitoring program described in this plan. • Evaluate and report monitoring results as required by the Project Approval and Environment Protection Licence (EPL). • Coordinate water related incident investigations and reporting as required by legislation and approvals. • Initiate investigations of complaints as received from the public or government agency. • Provide primary contact for complaints and supply follow-up information to any complainant. • Prepare a report to government agencies or neighbours following incidents/ non-compliances.

Role	Responsibilities
All employees and contractors	• Comply with all requirements in this plan. • Report all potential environmental incidents to the Mine Manager immediately. • Operate in a manner that minimises risks of incidents to themselves, fellow workers or the surrounding environment. • Follow any instructions provided by the Mine Manager.

1.3.2 Further Studies

Shoalhaven Coal has a requirement as detailed within the Project Approval to investigate all reasonable and feasible measures to minimise capture of clean water on site. This is discussed further in **Section 3.2.2**.

1.3.3 Hold Points

Shoalhaven Coal has two hold point requirements as detailed in the Project Approval:

- Prior to recommencing mining operations, unless the Secretary agrees otherwise, the Proponent must prepare a Clean Water Diversion Strategy for the project to the satisfaction of the Secretary; and

- Prior to recommencing mining operations, unless the Secretary agrees otherwise, the Proponent must prepare a Water Management Plan for the project to the satisfaction of the Secretary.

These hold points and where they are addressed within this WMP is included in **Table 2**.

1.4 Compliance Requirements

1.4.1 Project Approval Conditions

Table 2 presents the Project Approval conditions relevant to water management at Invincible.

Table 2 Project Approval Conditions relevant to water management at Invincible Colliery

Condition	Requirement	Section/s Addressed
Schedule 3 – Specific Environmental Conditions		
22.	**Water Supply** The Proponent must ensure that is has sufficient water for all stages of the project, and if necessary, adjust the scale of the operations on site to match its available water supply. *Note: Under the Water Act 1912 and/or the Water Management Act 2000, the Proponent is required to obtain all necessary water licences for the project.*	**Section 4.0**
23.	**Compensatory Water Supply** The Proponent must provide a compensatory water supply to any landowner of privately owned land whose water supply is adversely and directly impacted (other than an impact that is negligible) as a result of the project, in consultation with DPI Water, 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 attributed to the project. Equivalent water supply should be provided (at least on an interim basis)	**Section 1.4.5**

<table>
<tr><th>Condition</th><th colspan="2">Requirement</th><th>Section/s Addressed</th></tr>
<tr><td></td><td colspan="2">within 24 hours of the loss being identified.
If the Proponent and the landowner 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 Proponent is unable to provide an alternative long-term supply of water, then the Proponent must provide alternative compensation to the satisfaction of the Secretary.</td><td></td></tr>
<tr><td>24.</td><td colspan="2">Discharge limits
Any water discharged from the site must comply with Section 120 of the POEO Act and, unless expressly provided by an EPL, must not exceed:
(a) the default ANZECC electrical conductivity trigger value for lowland rivers; and
(b) all other default ANZECC trigger values for 95% species protection and relevant potential contaminants.</td><td>Section 2.1.12</td></tr>
<tr><td>25.</td><td colspan="2">Clean Water Diversion Strategy
Prior to recommencing mining operations, unless the Secretary agrees otherwise, the Proponent must prepare a Clean Water Diversion Strategy for the project to the satisfaction of the Secretary. This strategy must:
(a) be prepared in consultation with DPI Water;
(b) investigate all reasonable and feasible measures to minimise the capture of clean water on site; and
(c) include a detailed description of the measures to be implemented and a plan for the implementation of these measures.</td><td>Section 3.2.2</td></tr>
<tr><td rowspan="6">26.</td><td colspan="2">Water Management Performance Measures
The Proponent must comply with the performance measures in Table 7 to the satisfaction of the Secretary.
Table 7 Water Management Performance Measures</td><td rowspan="6">Section 3.2</td></tr>
<tr><td>Feature</td><td>Performance Measure</td></tr>
<tr><td>General</td><td>Maintain separation between clean, dirty and mine water management systems.
• minimise the use of clean water on site.
• No direct discharge of water dewatered from the Ivanhoe No. 2 workings.
• Design, install, operate and maintain water management systems in a proper and efficient manner.</td></tr>
<tr><td>Clean water diversion & storage
Infrastructure
Sediment dams</td><td>Maximise, as far as reasonable and feasible, the diversion of clean water around the disturbed areas on site.
Design, install and maintain the dams generally in accordance with the series Managing Urban Stormwater: Soils and Construction - Volume 1 and Volume 2E Mines and Quarries.</td><td>Section 3.2.2 and 3.4</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>Section 3.2</td></tr>
<tr><td>Overburden, CHPP reject materials</td><td>Design, install and maintain emplacements to prevent or minimise the migration of pollutants due to seepage.</td><td>Section 3.2</td></tr>
<tr><td>Chemical and</td><td>Chemical and hydrocarbon products to be stored in bunded</td><td>Section 3.2.4</td></tr>
</table>

Condition	Requirement		Section/s Addressed
	hydrocarbon storage	areas in accordance with the relevant Australian Standards.	
27.	**Water Management Plan** Prior to recommencing mining operations, unless the Secretary agrees otherwise, the Proponent must prepare a Water Management Plan for the project to the satisfaction of the Secretary. This plan must: a) be prepared in consultation with DPI Water and the EPA, by suitably qualified and experienced persons whose appointment has been approved by the Secretary;		**Section 1.4.6**
	b) include detailed performance criteria and describe measures to ensure that the Proponent complies with the water management performance measures;		**Sections 2.1.11 and 6.0**
	c) in addition to the standard requirements for management plans (see Condition 3 of schedule 5), this plan must include a: (i) <u>Site Water Balance</u> that: • includes details of: ○ sources and security of water supply, including contingency planning for future reporting periods; ○ water use and management on site, including details of water sharing between neighbouring mining operation; ○ any off-site water transfers and discharges; ○ reporting procedures, including the preparation of a site water balance for each calendar year; and • investigates and implements all reasonable and feasible measures to minimise water use on site;		**Section 4.0**

Condition	Requirement	Section/s Addressed
	(ii) Surface Water Management Plan that includes: • detailed baseline data on surface water flows and quality in creeks and other waterbodies that could be affected by the project; • a program to augment the baseline data over the life of the project; • a detailed description of the relevant discharge limits as required by condition 24 of schedule 3; • a detailed description of the water management system on site, including the, o clean water diversions, as informed by condition 25 of this schedule; o sediment dams and associated infrastructure; o mine water management system; o measures to be implemented to ensure that water from Ivanhoe No.2 workings is not directly discharged off-site; and o reinstatement of drainage lines on the rehabilitated areas of the site; • detailed objectives and performance criteria, including trigger levels for investigating any potential or actual adverse impacts associated with the project for: - dewatering the Ivanhoe No 2 workings; - downstream surface water quality; - stream and riparian vegetation health; - channel stability; - design and management for the emplacement of coal reject materials; - reinstatement of draining lines on the rehabilitation areas of the site; and - control of any potential water pollution from the rehabilitated areas of the site; • a program to monitor and report on: - the effectiveness of the water management system; and - surface water flows and quality in the watercourses that could be affected by the project; - the performance measures listed in Table 7; - impacts on water users; • reporting procedures for the results of the monitoring program; and • a plan to respond to any exceedances of the trigger levels/and or performance criteria, and mitigate and/or offset any adverse surface water impacts of the project;	**Sections 2.1, 3.2, 5.1 and 6.1**
	(iii) Groundwater Management Plan that includes: • detailed baseline data on groundwater levels, yield and quality in the region that could be affected by the development, including privately owned groundwater	**Sections 2.2, 5.2 and 6.2**

Condition	Requirement	Section/s Addressed
	bores and groundwater dependent ecosystems: groundwater assessment criteria, including trigger levels for investigating any potentially adverse groundwater impacts; • a program to monitor and report on: - groundwater supply of potentially affected landowners; - groundwater inflows to the open cut mining operations; - the seepages/leachate from water storages, emplacements and backfilled voids; - the background changes in groundwater yield/quality against mine-induced changes; - impacts of the project on: o regional and local (including alluvial) aquifers; o groundwater supply of potentially affected landowners; and o groundwater dependent ecosystems and riparian vegetation; - a program to validate the groundwater model for the project, and compare the monitoring results with modelled predictions; and • a plan to respond to any exceedances of the trigger levels and /or performance criteria, and mitigate and/or offset any adverse groundwater impacts of the development;	
	(iv) a protocol that has been prepared in consultation with the owner of the Baal Bone mine to ensure all groundwater take, including increased inflows to the Baal Bone underground workings, is appropriately licensed.	**Section 5.2.2**
28.	The Water Management Plan approved by the Secretary must be implemented.	**Section 1.3**
Schedule 5 – Environmental Management, Reporting and Auditing		
3.	The proponent must ensure that the management plans under this approval are prepared in accordance with any relevant guidelines, and include: (a) detailed baseline data;	**Sections 2.1.9 and 2.2.2**
	(b) a description of: • the relevant statutory requirements (including and relevant approval, licence or lease conditions); • any relevant limits or performance measures/criteria; • the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures;	**Sections 1.4, 2.1.11 and 6.0**
	(c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;	**Section 3.0**
	(d) a program to monitor and report on the: • impacts of environmental performance of the project; • effectiveness of any management measures (see c above);	**Sections 5.1 and 5.2**

Condition	Requirement	Section/s Addressed
	(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;	**Section 6.0**
	(f) a program to investigate and implement ways to improve the environmental performance of the project over time;	**Section 7.0**
	(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	**Section 5.1.4.1**
	(h) a protocol for periodic review of the plan.	**Section 7.0**
5.	Within 3 months of: • the submission of an annual review under condition 4 above; • the submission of an incident report under condition 7 below; • the submission of an audit report under condition 9 below; or • any modification to the conditions of this approval, (unless the conditions require otherwise), the Proponent must review, and if necessary revise, the strategies, plans, and programs required under this approval to the satisfaction of the Secretary. Where this review leads to revisions in any such document, then within 4 weeks of the review, unless the Secretary agrees otherwise, the revised document must be submitted to the Secretary for approval. *Note: This is to ensure the strategies, plans and programs are updated on a regular basis, and incorporate any recommended measures to improve the environmental performance of the project.*	**Section 7.0**
6.	To ensure the strategies, plans and programs are updated on a regular basis, and incorporate any recommended measures to improve the environmental performance of the project, the Proponent may submit revised strategies, plans or programs required under this approval at any time. With the agreement of the Secretary, the Proponent may also submit any strategy, plan or program required by this consent on a staged basis.	**Section 7.0**
7.	The Secretary may approve a revised strategy, plan or program required under this consent, or the staged submission of any of these documents, at any time. With the agreement of the Secretary, the Proponent may prepare the revised or staged strategy, plan or program without undertaking consultation with all parties nominated under the applicable condition in this consent.	**Section 7.0**
9.	The Proponent must immediately notify the Secretary and any other relevant agencies of any incident. Within 7 days of the date of the incident, the Proponent must provide the Secretary and any relevant agencies with a detailed report on the incident, and such further reports as may be requested.	**Section 5.1.4**
10.	The Proponent must provide regular reporting on the environmental performance of the project on its website, in accordance with the reporting arrangements in any plans or programs approved under the conditions of this approval.	**Section 5.1.5**

1.4.2 Environmental Management Commitments

Table 3 summaries the management commitments relating to soil and water quality that have been identified in the EA (Umwelt 2016) report.

Note: references to Castlereagh Coal below are as per the EA. Castlereagh Coal is the trading name for Shoalhaven Coal. The Project Approval and EPL are in the name of Shoalhaven Coal.

Table 3 Relevant EA Soil and Water Quality Management Commitments

Source	Description	Section/s Addressed
EA Section 7.2	Castlereagh Coal will monitor the water level in the former Ivanhoe No. 2 Underground workings and estimate the volume of water that will need to be removed to safely mine the Lithgow Seam in the Southern Extension Area prior to any dewatering of these workings.	**Section 2.2.4**
	Castlereagh Coal will ensure any water discharged from discharge point (LDP002) meets the relevant requirements of EPL 1095.	**Sections 3.2, and 5.1**
	Castlereagh Coal will obtain appropriate water licences for all take from surface and groundwater systems as required for the Southern Extension Project. The Water Management Plan will outline a licensing strategy developed in consultation with DPI-Water to ensure that water access licences are obtained to account for take through the life of the Southern Extension Project.	**Sections 5.1.1 and 5.2.1**
	Castlereagh Coal will inspect the settlement ponds and sediment basins on a regular basis, or following rainfall of >25mm/24 hours, and clean out the sediment basins of consolidated sediment once capacity reduced by 20 per cent.	**Sections 3.4.2 and 3.4.9**
	Castlereagh Coal will excavate temporary sumps within the open cut area to capture rainfall and runoff within the open cut.	**Section 3.2**
	Castlereagh Coal will monitor water quality and volume of water released from licensed discharge point LDP002 within 24 hours of commencement of discharge and / or as specified on EPL 1095.	**Section 5.1.3.1**
	Castlereagh Coal will monitor water quality within the Main Water Storage Dam at least monthly.	**Section 5.1.3.1**
	Castlereagh Coal will monitor the quality of any water in the former Ivanhoe No. 2 Underground workings that may need to be dewatered to enable mining in the Southern Extension Area prior to dewatering.	**Section 5.2.3**
	Castlereagh Coal will install standpipe monitoring bores into the former Invincible Underground workings for the purposes of monitoring water levels and water quality in the former workings.	**Section 5.2.3**

1.4.3 Environment Protection Licence

The Invincible Colliery operates under EPL 1095, issued under the NSW Protection of the Environment Operations Act 1997 (POEO Act) (refer to Section **5.1.3**).

1.4.4 Water Licences

There are no existing Water Access Licences (WALs) for surface water associated with the Invincible Colliery. Castlereagh Coal currently holds one WAL (WAL 35978) for the Invincible Colliery for water sourced from the NSW Murray-Darling Porous Rock Groundwater Sources Water Sharing Plan with an allocation of 26 unit shares (equivalent to 26 ML per year

assuming full allocation) in the groundwater source. The requirement for water licensing is discussed further in Sections **5.1.2** and **5.2.1**.

1.4.5 Compensatory Water Supply

In the unlikely event that the Southern Extension Project directly and adversely impacts (other than a negligible impact) the water supply to any landowner of privately owned land, Shoalhaven Coal will provide a compensatory water supply to the landowner in consultation with DPI Water, and to the satisfaction of the Secretary.

If required, all reasonable attempts will be made by Shoalhaven Coal to provide an equivalent water supply to the landowner within 24 hours of the loss being identified prior to the establishment of long term measures (if required). The compensatory supply will have equivalent or better water quality and be of an equivalent volume. If Castlereagh Coal and the landowner are unable to reach agreement on the measures for the compensatory water supply then either party may refer to the matter to the Secretary for resolution.

If Shoalhaven Coal is unable to provide an alternate long term compensatory water supply, alternate compensation will be provided to the satisfaction of the Secretary.

1.4.6 Stakeholder Consultation

As required by Schedule 3, Condition 27 of Project Approval 07_0127, the WMP has been prepared in consultation with DPE-Water and EPA. The latest update to the WMP (to reflect the approval of MOD5) was provided to these agencies for comment. **Table 4** summarises the matters raised by these agencies and indicates where these matters have been addressed in the document. The responses from DPE-Water and EPA are provided in full in **Appendix A**.

Table 4 Stakeholder Consultation

Stakeholder	Matter Raised	Where Addressed in this Plan
EPA	Volume on water required to be dewatered from the Ivanhoe #2 workings	**Section 2.2.4**
	Conditions of EPL 1095	**Section 5.1.2**
DPE-Water	Groundwater monitoring to measure impacts of the Southern Extension Project	**Section 5.2.3**
	Redefined groundwater trigger values	**Section 5.2.4**
	Update to erosion and sediment control plans	**Section 3.4.4**
	Channel stability and riparian health	**Section 5.1.3.3**
	Conceptual hydrogeological model	**Section 2.2.5**
	Site water balance	**Section 4.0**
	Consultation with owner of Baal Bone Mine	**Section 5.2.2**
	Water licensing	**Section 5.1.1** and **5.2.1**

1.5 Guidelines and Policies

Receiving water quality standards and trigger values have been developed in general accordance with The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG) (Australian and New Zealand Governments and Australian state and territory governments, 2018).

The following guidelines are relevant to the management of sediment and erosion control on site:

- Managing Urban Stormwater – Soils and Construction, Volume 1 (the Blue Book) (Landcom, 2004);

- Managing Urban Stormwater – Soils and Construction, Volume 2E: Mines and Quarries (DECC, 2008); and
- AS1940 – 2017 The storage and handling of flammable and combustible liquids.

2.0 Context

2.1 Surface Water

Invincible and the surrounding areas have been subject to open cut and underground mining operations for over 100 years. Recent and existing mining at Invincible includes the Invincible open cut and underground operations and Ivanhoe No.2 underground operations. Other mining operations in the local region include Cullen Valley, Baal Bone, Angus Place, Pine Dale, Ivanhoe and Springvale. With the exception of Springvale Colliery, all other operations are currently in 'care and maintenance' or in the process of being closed.

The Southern Extension Project involves an extension of mining activities to the south of the existing approved Invincible mining area. Due to the history of mining activity at Invincible, there are existing water management systems and structures in place. The following sections describe the nature of the catchment areas and associated watercourses, existing water quality and licensing provisions.

2.1.1 Catchment and Hydrology

Invincible is located within the catchment of Cullen Creek, a tributary in the upper reaches of the Turon River. The Cullen Creek catchment is approximately 1,725 ha in area and is within the area regulated by the Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Sources 2012 (Macquarie Bogan WSP) which is regulated under the associated Water Sharing Plan (WSP) (refer to **Section 5.1.1**). The existing Invincible Water Management System (WMS) encompasses an area of approximately 37% of the pre mining catchment area of Cullen Creek. The Southern Extension Area is located entirely within the existing Invincible WMS catchment area (refer to **Figure 2-1**).

The Turon River and its catchments are managed under the Macquarie Bogan WSP, a Water Sharing Plan which is administered by the Department of Primary Industry (DPI) Water.

The Invincible open cut workings, existing mine infrastructure area and Southern Extension Area are located on the western fall of the Great Dividing Range within the Murray Darling Basin. The topography of the land surrounding the Southern Extension Area mainly consists of high Blue Mountains plateau terrain, with the western boundary running roughly parallel to, and west of, the outcrop of the Lithgow seam. The Southern Extension Area is located just within the outcrop of the seam and is characterised by flat undulating land adjacent to the outcrop rising to steeper land in the east.

On a regional scale, Invincible open cut and Southern Extension Area are located within the headwaters of the Turon River catchment within the broader Burrendong Catchment Area. The main channel of the Turon River is located to the north-west of Invincible. This catchment drains to the west and is not in Sydney's drinking water catchment. Burrendong Dam is located near Wellington, approximately 100 km north-west of Invincible. Regional drainage flows in a northerly direction along the Turon River, then westerly into the Macquarie River (and Burrendong Dam).

On a local scale, both the existing Invincible open cut and the Southern Extension Area lie entirely within the upper catchment of Cullen Creek. Cullen Creek, and its tributaries are ephemeral watercourses (refer to **Figure 2-1**). Cullen Creek is a fourth order watercourse (based on the Strahler stream ordering system). Cullen Creek flows in a north-westerly direction before joining Dulhuntys Creek approximately 4 km downstream of Invincible. Dulhuntys Creek flows in a north-westerly direction and joins Williwa Creek which then flows into Jews Creek before joining the Turon River. The confluence of Jews Creek and the Turon River is approximately 25 km downstream of Invincible. The nearest downstream flow gauging station is DPE-Water's site number 421026 that records flow data for the Turon River at Sofala.

Under the existing Invincible EPL, the site is authorised for wet weather discharges into an unnamed tributary of Cullen Creek from the Main Water Storage Dam. This discharge point is referred to as LD002.

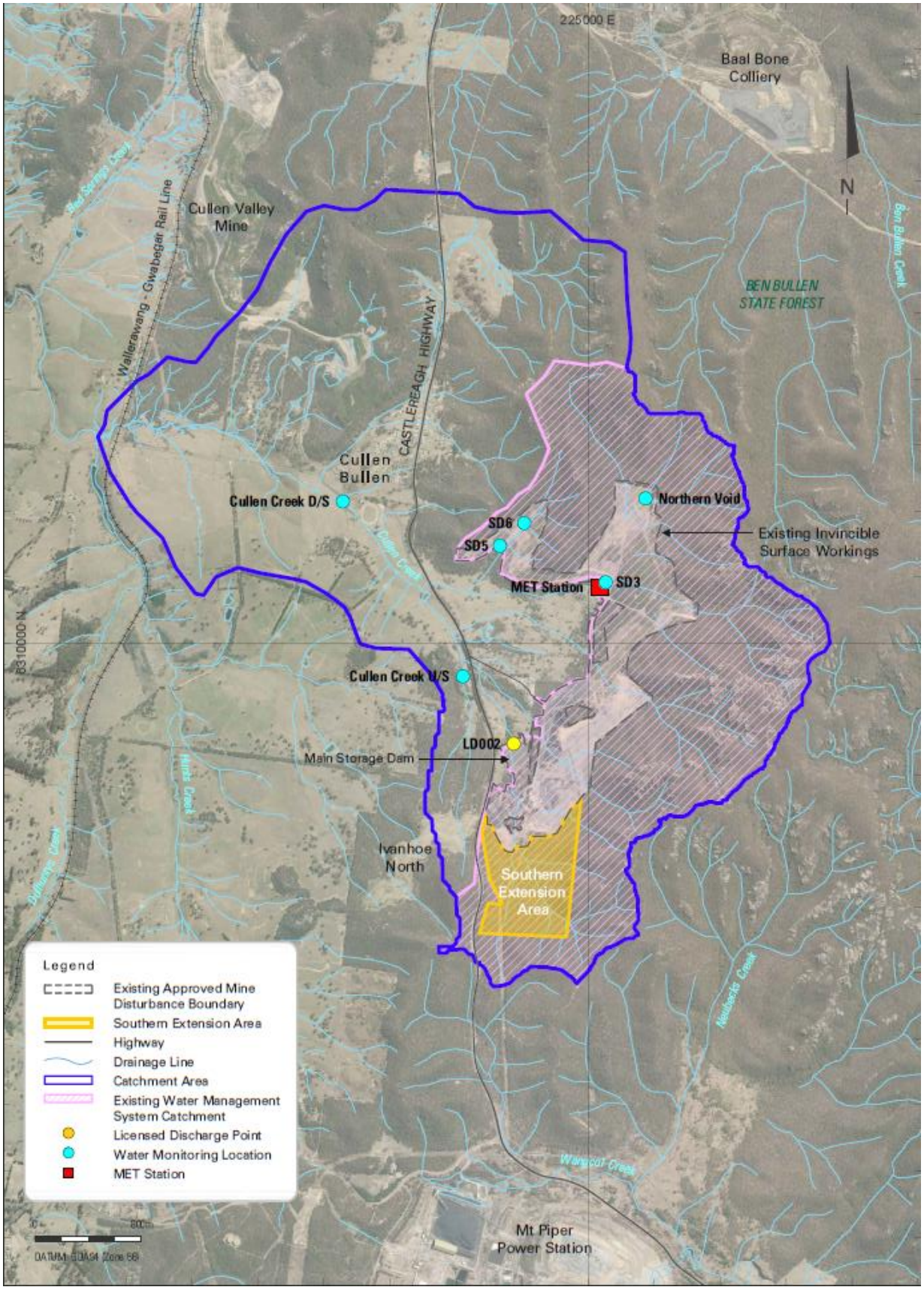
The former Invincible underground workings in the Lithgow Seam extend to the east of the open cut voids below land that is located in the upper reaches of the Coxs River catchment, part of the Sydney drinking water catchment. There is

no discharge from these underground workings into the Coxs River catchment. Licensed discharges into Coxs River ceased in 2008 and this discharge point (LD001) was removed from the Invincible EPL in 2012.

The existing Invincible open cut mining areas intersect a number of 1st, 2nd and 3rd order tributaries of Cullen Creek with runoff from the catchment areas of these tributaries captured within the Invincible Water Management System (WMS). In addition, significant portions of the Southern Extension Area are affected by pre-existing surface cracking from underground bord and pillar mining in the abandoned Ivanhoe No.2 underground workings. Much of the surface water runoff from the Southern Extension Area does not report to downstream surface water management structures, instead entering a large sinkhole and fractures in the drainage lines and reporting directly to the abandoned Ivanhoe underground workings. None of the completed open cut or underground mining has intercepted the main channel of Cullen Creek.

Figure 2-1 shows the catchment context of the Southern Extension Project.

Figure 2-1 Catchment Context and Surface Water Monitoring Locations



2.1.2 Geomorphological and Hydrological Values

Upstream of the crossing with the Castlereagh Highway, Cullen Creek has a generally poorly defined channel and a sparsely vegetated riparian zone. The lower reaches of Cullen Creek prior to joining Dulhuntys Creek are better defined but remain sparsely vegetated.

The main channel of Cullen Creek has not been disturbed by previous open cut or underground mining operations. Disturbance has been limited to 1st, 2nd and 3rd order tributaries of Cullen Creek. As such, the geomorphology of Cullen Creek has not significantly been impacted.

The Southern Extension Area intercepts 1st, 2nd and 3rd order tributaries of Cullen Creek. Experience at the site indicates that these catchments do not contribute substantial flows to Cullen Creek, as most runoff seeps into the historic underground workings. Accordingly, the Southern Extension Project is not expected to significantly affect the hydrology or geomorphology of Cullen Creek.

2.1.3 Soils

Three soil units have been mapped within the Southern Extension area, deep orange clay loam, shallow brown sandy loam and skeletal sandy loam (Ecobiological, 2011). The location of these soil units in the Southern Extension Area is mapped on **Figure 2-2**. The following sections describe the soil units in the Southern Extension Area.

2.1.4 Deep orange clay loam

This soil type occurs in a residual soil landscape and primarily on lower gradual slopes. The topsoil associated with the soil is approximately 20 centimetres in depth, and is non-saline, slightly dispersive and slightly acidic (pH 5.0 to 5.5). The subsoil extends to a depth of up to 240 centimetres (cm) and is non- saline, moderately dispersive and acidic (pH 4.9 to 6.1).

The deep orange clay loam covers approximately 42 ha (85%) of the Southern Extension Area (refer to **Figure 2-2**).

2.1.5 Shallow brown sandy loam

This soil type occurs in residual soil landscapes located primarily on the upper gradual slopes.

The topsoil associated with the soil is approximately 15 cm in depth and is non-saline, slightly dispersive and slightly acidic (pH 4.6 to 6.1). The subsoil extends to a depth of up to 114 cm and is non-saline, moderately dispersive and acidic (pH 4.6 to 6.2).

The salinity levels and acidity of the soil material is not suitable for supporting vegetation growth (Ecobiological, 2011).

The shallow brown sandy loam is found on mid slope areas in the east of the Southern Extension area and covers approximately 5 ha (10%) of the Southern Extension Area (refer to **Figure 2-2**).

2.1.6 Skeletal sandy loam

This soil type occurs in a residual soil landscapes located primarily on crests and upper steep slopes. The occurrence of this soil landscape in the Southern Extension Area is limited to the upper crests of the in the east of the Southern Extension Area (refer to **Figure 2-2**)

The topsoil associated with the soil is approximately 2 cm in depth and is non-saline, slightly dispersive and slightly acidic (pH 5.1). The subsoil is limited to a depth of only 2 cm and is non-saline, moderately dispersive and generally slightly acidic (pH 5.1).

The skeletal sandy loam covers approximately 3 ha (6%) of the Southern Extension Area.

Figure 2-2 Soil Types within Southern Extension Area

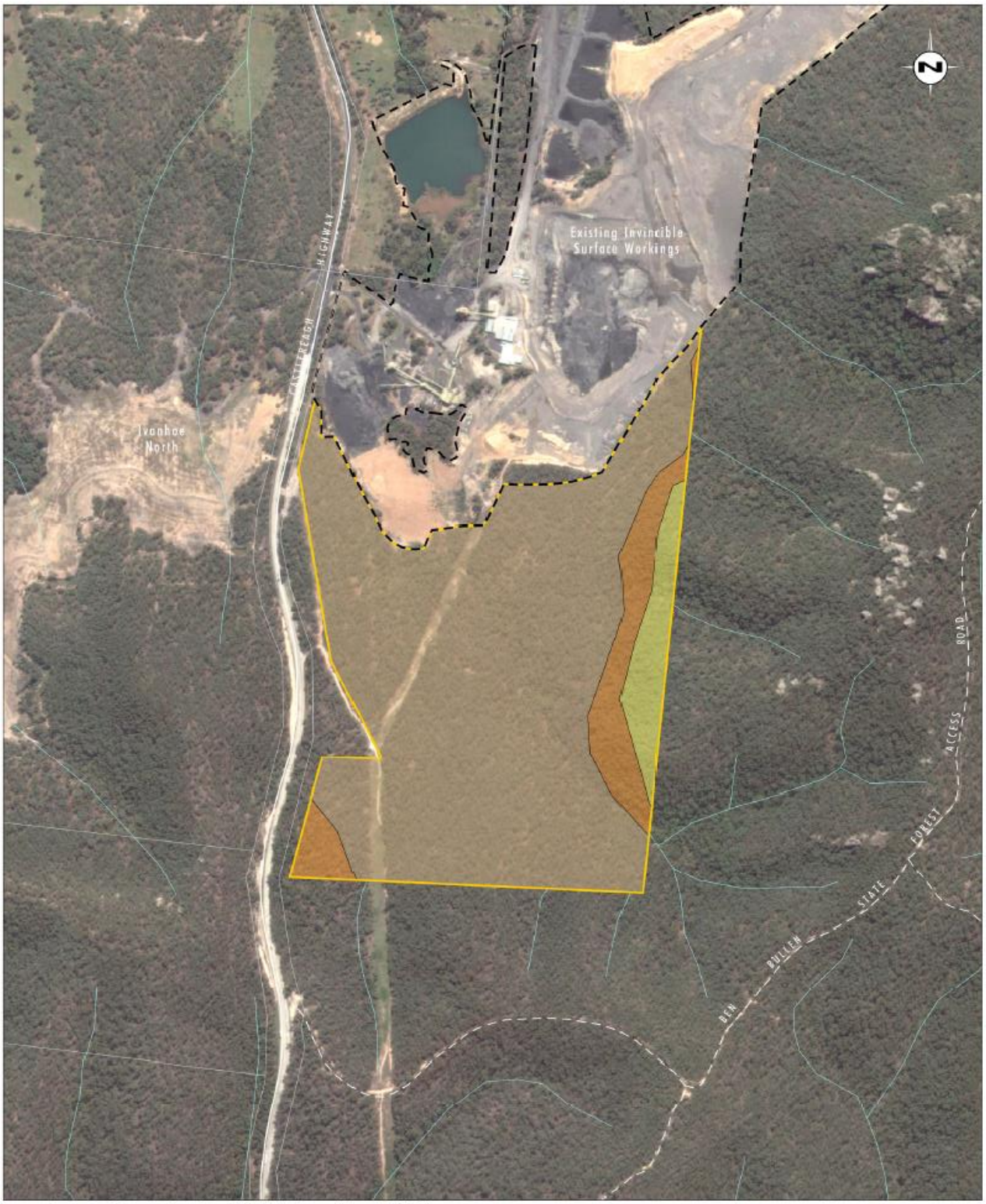


FIGURE 2.2

Soil Types within Southern Extension Area

2.1.7 Geology and Geochemistry

Invincible is located within the Western Coalfield of NSW on the western edge of the Sydney Basin. The Sydney Basin consists of a series of gently dipping sedimentary beds of shale and sandstone of Permo- Carboniferous age capped by massive sandstones of Triassic Age (Yoo et al 2001). Directly beneath the Triassic sandstone these beds contain coal seams and form the Upper Coal Measures. The measures extend from the western boundary of the Western Coalfield in an easterly direction, dipping generally at an angle of 1 degree to 3 degrees to the north-east, towards the coast, and extending out to sea (Yoo et al 2001).

The Western Coalfield is characterised by the prominent cliffs and eroding plateaus of the Triassic age sandstone and shale Narrabeen Group which overlies the shale, sandstone, conglomerate and coal of the Permian aged Illawarra Coal Measures. These form the slopes which fall away from the sandstone and shale cliffs (Yoo et al 2001).

A geochemical assessment was undertaken for the Coalpac Consolidation Project (RGS Environmental 2011) and considered the geochemical properties and constraints associated with overburden and coal reject material at Invincible. The key findings of the report are summarised below:

Overburden

- Overburden materials are likely to be non-acid forming (NAF) and have a high factor of safety with respect to potential acid generation. Most overburden samples tested had negligible total sulphur content and a low-moderate acid neutralising capacity (ANC);

- The concentration of total metals in overburden solids is well below applied guideline criteria for soils and is unlikely to present any environmental issues associated with revegetation and rehabilitation;

- Most overburden material will generate pH neutral, low salinity run-off and seepage following surface exposure. The major ion chemistry of initial surface run-off and seepage from overburden materials is likely to be dominated by sodium and sulphate with lesser amounts of bicarbonate and chloride;

- The concentration of dissolved trace metals in initial and ongoing run-off and seepage from overburden materials is unlikely to present any significant environmental issues associated with surface and ground water quality; and

- Overburden materials below 10 m depth are likely to be non-sodic and may be suitable for revegetation and rehabilitation activities (in final surfaces or as a growth medium).

2.1.8 Climate

Invincible lies within a cool-temperate climatic zone and is characterised by mild summers and cold winters. The local climate is largely influenced by factors such as topography, altitude, aspect and exposure.

Three Bureau of Meteorology (BoM) rainfall stations lie within close proximity to Invincible: Station 63132 Lidsale (9 km south-east); Station 63071 Portland (6 km south); and Station 63226 Lithgow (21 km south- east). Of these three BoM rainfall stations, Lidsdale is considered most representative of rainfall conditions at Invincible due to its topographical location and also the completeness of the data set. The BoM station nearest to Invincible recording evaporation is the Bathurst Agricultural Station (Station 63005).

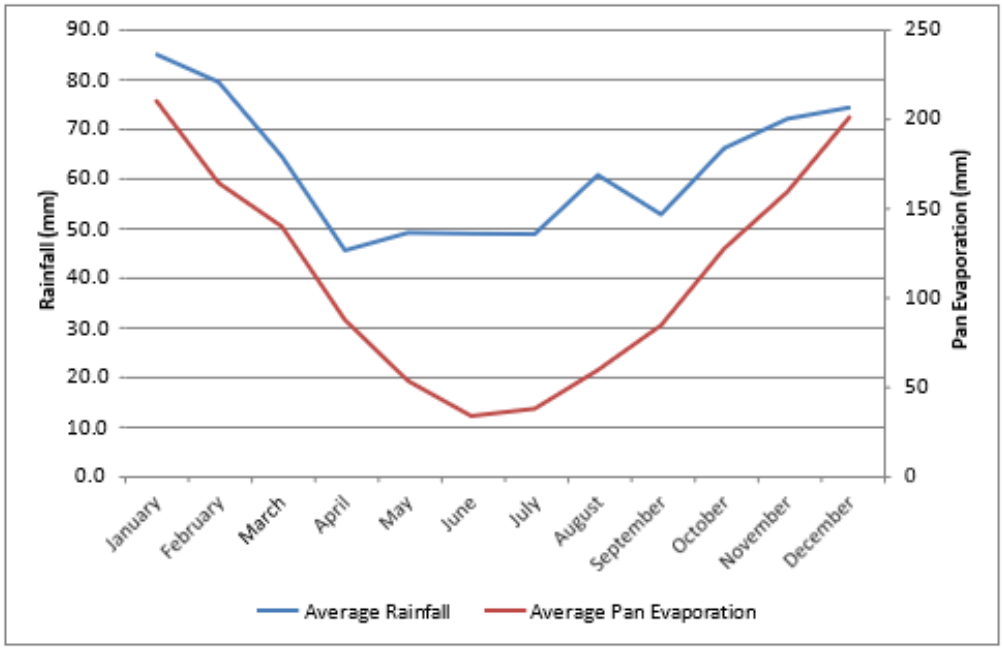
Daily rainfall has been recorded at Lidsdale (Station 63132) since 1960. Rainfall is generally spread evenly across the year, with slightly higher falls in late spring and summer and lower falls in autumn. **Table 5** presents the rainfall statistics recorded at the Lidsdale BoM station. **Chart 1** presents a plot of average monthly rainfall data recorded at the Lidsdale BoM station and the average monthly evaporation recorded at the Bathurst Agricultural Station.

Table 5 Lidsdale Rainfall Statistics 1960 - 2017

Statistic	Rainfall (mm)
Minimum	329.8
10 %ile	510.3
50 %ile	761.8
90 %ile	920.4
Maximum	1171.0

Source: Bureau of Meteorology, 2018

Chart 1 Average Monthly Rainfall Data at the Lidsdale Siding



Source: Umwelt, 2018

Castlereagh Coal operates a meteorological monitoring station at Invincible (refer to Chart 2.1). In 2014, the site received 695 millimetres (mm) of rainfall over 141 rainfall days, which is consistent with a slightly below median rainfall year for the Lidsdale station.

Evaporation of about 1,355 mm/year exceeds rainfall throughout most of the year except for the late autumn and winter months of May, June, July, and August.

2.1.9 Baseline Surface Water Quality

2.1.10 Receiving Waters

Surface water quality monitoring is undertaken at two locations on Cullen Creek. Cullen Creek U/S (formerly known as BSW01) is located immediately upstream of the Invincible LDP (LD002), as shown in **Figure 2-1**). The surface water quality monitoring program commenced in October 2011 with testing for pH, Total Suspended Solids (TSS), Oil and Grease and Electrical Conductivity (EC).

Monthly monitoring for a wider range of analytes including dissolved metals and metalloids has been conducted since September 2016.

Table 6 presents the background water quality data collected at Cullen Creek U/S as well as relevant ANZG default trigger values where available.

Monitoring of the downstream water quality was previously undertaken at site BSW02 located on Dulhuntys Creek near its confluence with Cullen Creek. A review of the water monitoring program in 2022 found that monitoring of receiving water quality should be conducted on Cullen Creek rather than Dulhuntys Creek. Accordingly, BSW02 was replaced with monitoring site Cullen Creek D/S (location shown in **Figure 2-1**).

Further details regarding the ongoing surface water monitoring program are provided in **Section 5.1.3.1**.

Table 6 Upstream Receiving Water Quality – Cullen Creek U/S

Parameter	Minimum[1,2,3]	20th Percentile[1,2,3]	50th Percentile[1,2,3]	80th Percentile[1,2,3]	Maximum[1,2,3]	ANZG Guideline Value[4,5,6]
pH	5.6	6.2	6.7	7.1	7.8	6.5 – 7.5
Total Suspended Solids	5	12	23	48	354	-
Oil and Grease	2	5	5	5	9.2	-
Electrical Conductivity (µS/cm)	78	119	162	473	1010	125 – 2,200
Sulphate	1	12	25	110	280	-
Aluminium	0.01	0.02	0.10	0.25	1.13	0.055
Antimony	0.001	0.001	0.001	0.001	0.002	ID
Arsenic	0.001	0.001	0.001	0.001	0.006	0.013
Beryllium	0.001	0.001	0.001	0.001	0.001	ID
Barium	0.010	0.018	0.026	0.044	0.124	-
Cadmium	0.0001	0.0001	0.0001	0.0001	0.0004	0.0002
Chromium	0.001	0.001	0.001	0.001	0.002	0.001
Cobalt	0.001	0.001	0.002	0.007	0.056	ID
Copper	0.001	0.001	0.001	0.002	0.026	0.0014
Lead	0.001	0.001	0.001	0.001	0.003	0.0034
Lithium	0.001	0.001	0.002	0.005	0.014	-
Manganese	0.004	0.141	0.275	0.894	3.200	1.900
Molybdenum	0.001	0.001	0.001	0.001	0.001	ID
Nickel	0.002	0.005	0.008	0.015	0.056	0.011
Selenium	0.01	0.01	0.01	0.01	0.01	ID
Silver[7]	0.001	0.001	0.001	0.001	0.010	0.00005
Thorium	0.001	0.001	0.001	0.001	0.001	-
Tin	0.001	0.001	0.001	0.001	0.001	ID
Titanium	0.01	0.01	0.01	0.01	0.05	-
Uranium	0.001	0.001	0.001	0.001	0.001	ID

Parameter	Minimum[1,2,3]	20th Percentile[1,2,3]	50th Percentile[1,2,3]	80th Percentile[1,2,3]	Maximum[1,2,3]	ANZG Guideline Value[4,5,6]
Vanadium	0.01	0.01	0.01	0.01	0.01	ID
Zinc	0.005	0.006	0.016	0.064	0.499	0.008
Boron	0.05	0.05	0.05	0.05	0.07	0.37
Iron	0.13	0.50	1.07	2.37	17.60	ID

Notes

1. *Dissolved concentrations presented for metal/metalloid results;*
2. *Result units are mg/L unless otherwise specified;*
3. *Where water quality results were recorded below the limit of detection, the limit of detection was taken to be the result;*
4. *ANZG guideline values presented for EC are for lowland rivers;*
5. *ANZG guideline values presented for metals/metalloids are for the 95% species protection level for aquatic ecosystems;*
6. *ID – Insufficient Data to set default guideline value; and*
7. *Analysis undertaken with an LOR above the ANZG default guideline value. All future analysis for silver to be done to an LOR of 0.00001 mg/L.*

Available monitoring data for Cullen Creek U/S demonstrates that Cullen Creek has concentrations of dissolved metals that occasionally exceed the ANZG guideline values for the 95% species protection level. Further monitoring will need to be conducted at the newly instituted Cullen Creek D/S before trends concerning downstream water quality can be identified.

2.1.11 Site Specific Receiving Water Quality Trigger Values

Due to Cullen Creek D/S being a newly introduced monitoring location, there is insufficient data to establish site specific triggers for receiving water quality. In lieu of long-term local data, the default ANZG guideline values have been adopted as the trigger values for Cullen Creek D/S. Where the ANZG does not recommend a guideline value for a particular analyte, the 80th percentile value for Cullen Creek U/S has been adopted as the trigger value.

Historical water quality data for the Cullen Creek U/S and former BSW02 monitoring sites have indicated that concentrations of certain metals and metalloids are generally below the limit of reporting. Trigger values have not been defined for analytes that are generally below the limit of reporting. The adopted trigger values for receiving water quality are presented in **Table 7**.

The ongoing water quality monitoring program is detailed in **Section 5.1.3.2**.

Table 7 Site Specific Receiving Water Quality Trigger Values – Cullen Creek D/S

Parameter	Units	Trigger Value/Range [1]
pH	-	6.5 – 7.5
TSS	mg/L	21 [2]
Oil and Grease	mg/L	5 [2]
Electrical Conductivity	µS/cm	125-2,200
Sulphate	mg/L	252 [2]
Aluminium	mg/L	0.055
Arsenic	mg/L	0.013
Barium	mg/L	0.058 [2]

Parameter	Units	Trigger Value/Range [1]
Cadmium	mg/L	0.0002
Chromium	mg/L	0.001
Cobalt	mg/L	0.006 [2]
Copper	mg/L	0.0014
Lead	mg/L	0.0034
Lithium	mg/L	0.005 [2]
Manganese	mg/L	1.9
Nickel	mg/L	0.0011
Silver	mg/L	0.001 [3]
Zinc	mg/L	0.030 [2]
Boron	mg/L	0.37
Iron	mg/L	2.74

Notes

1. *Unless stated otherwise, triggers are based on ANZG guideline values;*
2. *Based on the 80th percentile value recorded at BSW01; and*
3. *The ANZG guideline value for silver is lower than the limit of reporting. As such, the limit of reporting has been adopted as the trigger value.*

2.1.12 Discharge Criteria

Condition 24 of Schedule 3 of the Project Approval (Mod 5) requires that any water discharged from site must comply with Section 120 of the POEO Act and, unless expressly provided by an EPL, must not exceed:

- The default ANZG electrical conductivity guideline value for lowland rivers; and
- All other default ANZG guideline values for 95% species protection and relevant potential contaminants.

As demonstrated in **Section 2.1.10**, the concentrations of dissolved metals at Cullen Creek U/S (upstream of Invincible) has been recorded at concentrations above the ANZG guideline values for the 95% species protection level. As such, the site EPL will be varied to incorporate discharge water quality criteria based on the ANZG guideline values for the 95% species protection and baseline water quality monitoring data collected at Cullen Creek U/S which is immediately upstream of the confluence of Cullen Creek and the drainage line into which discharges from LD002 occur. Relevant 20th and 80th percentile values have been applied where baseline water quality data has been used to set discharge limit conditions. Limit conditions have only been applied for metal/metalloid for species that were found to have detectable concentrations in site water or where an ANZG default guideline value was available.

Table 8 LD002 Water Quality Discharge Limit Conditions

Parameter	Limit(s)	Units	Source of Discharge Limit[1]
pH	6.50 – 8.50	-	Existing EPL
TSS	30.0	mg/L	Existing EPL
Oil and Grease	10	mg/L	Existing EPL
Electrical Conductivity	125 – 2,200	µS/cm	ANZG default guideline value for lowland rivers (as per Project Approval Condition 24 of Schedule 3)
Sulphate	500.8	mg/L	BSW02
Aluminium	0.102	mg/L	BSW01
Arsenic	0.013	mg/L	ANZG

Parameter	Limit(s)	Units	Source of Discharge Limit[1]
Barium	0.053	mg/L	BSW01
Cadmium	0.0002	mg/L	ANZG
Chromium	0.001	mg/L	ANZG
Cobalt	0.028	mg/L	BSW01
Copper	0.002	mg/L	BSW01
Lead	0.0034	mg/L	ANZG
Lithium	0.0082	mg/L	BSW01
Manganese	1.918	mg/L	BSW01
Nickel	0.034	mg/L	BSW01
Silver	0.00005	mg/L	ANZG
Zinc	0.115	mg/L	BSW01
Boron	0.37	mg/L	ANZG
Iron	3.38	mg/L	BSW01

Notes:

1. ANZG guideline values presented for metals/metalloids are for the 95% species protection level for aquatic ecosystems.

2.1.13 Site Surface Water

Table 9 presents the water quality statistics for the Main Storage Dam (MSD) for the period September 2016 to August 2018. EPL licensed site surface water discharges occur from the MSD in accordance with the EPL. Water quality statistics for the Northern Void, which is hydraulically connected to the Invincible Underground workings, are presented in **Table 10**.

The 20th and 80th percentile values for the Northern Void water quality parameters listed in **Table 10** have been adopted as trigger values that may indicate a deviation in water quality from the normal range.

A Trigger Action Response Plan (TARP) to respond to deviations in water quality in the Northern Void is presented in **Section 6.2**.

Water stored in the Northern Void exhibits higher TDS, sulphate, Barium, Cobalt, Lithium, Manganese, Nickel, Zinc and Iron concentrations compared to the Main Storage Dam. This difference in water quality for the two surface water storages can be attributed to the connectivity of the Northern Void with the water stored Invincible Underground workings (refer to **Section 2.2.1**).

Table 11 presents the water quality statistics for site sediment dams SD2, SD3, SD5 and SD6. Due diligence water quality monitoring of sediment dams commenced in August 2018 and the statistics presented are based on aggregated results for all dams.

The ongoing site water quality monitoring program is detailed in **Section 5.1.3.2**.

Water quality results for the MSD indicate that water stored within the MSD will be within the EPL limit conditions as proposed in **Table 8.** It should be noted that the limit of reading (LOR) for the MSD monitoring results for dissolved silver was 0.001 mg/L which is above the ANZG guideline value for 95% species protection. It is therefore unknown whether MSD dissolved silver concentrations are within the proposed EPL limits. All future monitoring for silver will be undertaken with an LOR of 0.00001 mg/L. Sediment dam water quality results also indicate that water captured in sediment dams will also be within the proposed EPL limits with the exception of TSS.

Table 9 Site Water Quality – Main Storage Dam

Parameter	Minimum[1,2,3]	20th Percentile[1,2,3]	50th Percentile[1,2,3]	80th Percentile[1,2,3]	Maximum[1,2,3]
pH	6.5	7.1	7.4	7.7	7.9
TSS	2	5	5	6	26
Oil and Grease	2	5	5	5	5
Electrical Conductivity (µS/cm)	491	551	589	616	667
TDS	293	378	400	422	464
Sulphate	167	196	220	232	246
Aluminium	0.01	0.01	0.01	0.01	0.04
Antimony	0.001	0.001	0.001	0.001	0.001
Arsenic	0.001	0.001	0.001	0.001	0.001
Beryllium	0.001	0.001	0.001	0.001	0.001
Barium	0.020	0.024	0.025	0.026	0.031
Cadmium	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	0.001	0.001	0.001	0.001	0.001
Cobalt	0.001	0.001	0.001	0.001	0.001
Copper	0.001	0.001	0.001	0.001	0.002
Lead	0.001	0.001	0.001	0.001	0.001
Lithium	0.003	0.004	0.004	0.005	0.006
Manganese	0.001	0.003	0.010	0.113	0.241
Molybdenum	0.001	0.001	0.001	0.001	0.001
Nickel	0.001	0.001	0.001	0.002	0.004
Selenium	0.01	0.01	0.01	0.01	0.01
Silver[4]	0.001	0.001	0.001	0.001	0.001
Thorium	0.001	0.001	0.001	0.001	0.001
Tin	0.001	0.001	0.001	0.001	0.001
Titanium	0.01	0.01	0.01	0.01	0.01
Uranium	0.001	0.001	0.001	0.001	0.001
Vanadium	0.01	0.01	0.01	0.01	0.01
Zinc	0.005	0.005	0.005	0.007	0.014
Boron	0.05	0.05	0.05	0.05	0.05
Iron	0.05	0.05	0.05	0.05	0.05

Notes:

1. Dissolved concentrations presented for metal/metalloid results;

2. *Result units are mg/L unless otherwise specified;*
3. *Where water quality results were recorded below the limit of detection, the limit of detection was taken to be the result; and*
4. *Analysis undertaken with an LOR above the ANZG default guideline value. All future analysis for silver to be done to an LOR of 0.00001 mg/L.*

Table 10 Site Water Quality and Trigger Values – Northern Void

Parameter	Minimum[1,2,3]	20th Percentile[1,2,3]	50th Percentile[1,2,3]	80th Percentile[1,2,3]	Maximum[1,2,3]
pH	6.2	6.7	7.0	7.2	7.4
TSS	5	5	5	9	9
Oil and Grease	5	5	5	5	5
Electrical Conductivity (µS/cm)	1052	1328	1423	1542	1680
TDS	1121	1185	1227	1288	1331
Sulphate	586	672	737	796	829
Aluminium	0.01	0.01	0.01	0.01	0.01
Antimony	0.001	0.001	0.001	0.001	0.001
Arsenic	0.001	0.001	0.001	0.001	0.001
Beryllium	0.001	0.001	0.001	0.001	0.001
Barium	0.012	0.014	0.018	0.020	0.025
Cadmium	0.0001	0.0001	0.0001	0.0001	0.0002
Chromium	0.001	0.001	0.001	0.001	0.001
Cobalt	0.001	0.024	0.030	0.042	0.054
Copper	0.001	0.001	0.001	0.001	0.010
Lead	0.001	0.001	0.001	0.001	0.001
Lithium	0.004	0.055	0.057	0.061	0.069
Manganese	0.887	1.028	1.130	1.512	1.880
Molybdenum	0.001	0.001	0.001	0.001	0.001
Nickel	0.002	0.108	0.125	0.147	0.207
Selenium	0.01	0.01	0.01	0.01	0.01
Silver[4]	0.001	0.001	0.001	0.001	0.001
Thorium	0.001	0.001	0.001	0.001	0.001
Tin	0.001	0.001	0.001	0.001	0.001
Titanium	0.01	0.01	0.01	0.01	0.01
Uranium	0.001	0.001	0.001	0.001	0.001
Vanadium	0.01	0.01	0.01	0.01	0.01
Zinc	0.013	0.114	0.146	0.199	0.399
Boron	0.05	0.05	0.05	0.05	0.05
Iron	0.05	0.05	0.14	0.53	4.61

Notes

1. *Dissolved concentrations presented for metal/metalloid results;*
2. *Result units are mg/L unless otherwise specified;*
3. *Where water quality results were recorded below the limit of detection, the limit of detection was taken to be the result; and*
4. *Analysis undertaken with an LOR above the ANZG default guideline value. All future analysis for silver to be done to an LOR of 0.00001 mg/L.*

Table 11 Site Water Quality – Sediment Dams

Parameter	Minimum[1,2,3]	20th Percentile[1,2,3]	50th Percentile[1,2,3]	80th Percentile[1,2,3]	Maximum[1,2,3]
pH	6.9	7.0	7.0	7.0	7.1
TSS	29	37	50	165	241
Oil and Grease	0	-	-	-	0
Electrical Conductivity (µS/cm)	72	80	91	111	125
TDS	68	87	115	119	121
Sulphate	7	8	10	15	18
Aluminium	0.04	0.04	0.04	0.05	0.05
Antimony	0.001	0.001	0.001	0.001	0.001
Arsenic	0.001	0.001	0.001	0.001	0.001
Beryllium	0.001	0.001	0.001	0.001	0.001
Barium	0.006	0.008	0.012	0.013	0.014
Cadmium	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	0.001	0.001	0.001	0.001	0.001
Cobalt	0.001	0.001	0.001	0.001	0.001
Copper	0.001	0.001	0.001	0.001	0.001
Lead	0.001	0.001	0.001	0.001	0.001
Lithium	0.001	0.001	0.001	0.001	0.001
Manganese	0.022	0.068	0.137	0.188	0.222
Molybdenum	0.001	0.001	0.001	0.001	0.001
Nickel	0.001	0.001	0.002	0.003	0.003
Selenium	0.01	0.01	0.01	0.01	0.01
Silver[4]	0.001	0.001	0.001	0.001	0.001
Thorium	0.001	0.001	0.001	0.001	0.001
Tin	0.001	0.001	0.001	0.001	0.001
Titanium	0.01	0.01	0.01	0.01	0.01
Uranium	0.001	0.001	0.001	0.001	0.001
Vanadium	0.01	0.01	0.01	0.01	0.01
Zinc	0.005	0.005	0.005	0.005	0.005

Parameter	Minimum[1,2,3]	20th Percentile[1,2,3]	50th Percentile[1,2,3]	80th Percentile[1,2,3]	Maximum[1,2,3]
Boron	0.05	0.05	0.05	0.05	0.05
Iron	0.05	0.06	0.07	0.07	0.07

Notes

1. *Dissolved concentrations presented for metal/metalloid results;*
2. *Result units are mg/L unless otherwise specified;*
3. *Where water quality results were recorded below the limit of detection, the limit of detection was taken to be the result;*
4. *Analysis undertaken with an LOR above the ANZG default guideline value. All future analysis for silver to be done to an LOR of 0.00001 mg/L; and*
5. *From Table 8 of this WMP.*

2.2 Groundwater

2.2.1 Groundwater Sources

Invincible is located within the WSP area for the NSW Murray-Darling Basin Porous Rock Groundwater Sources (Sydney Basin). The NSW Murray Darling Basin Porous Rock Groundwater Sources WSP is divided into four groundwater sources. Of these, the Southern Extension Project is located in the Sydney Basin Murray Darling Basin (MDB) Groundwater Source. The Sydney Basin MDB Groundwater Source includes all water contained in:

- All rocks of Permian, Triassic, Jurassic, Cretaceous, and Tertiary age within the outcropped and buried areas; and
- All alluvial sediments within the outcropped areas.

The Sydney Basin MDB is further subdivided into two management zones of which, Invincible is located in the Sydney Basin MDB (Other) Management Zone.

Invincible is also located within the catchments of the NSW Murray-Darling Basin Fractured Rock Groundwater Sources and the Macquarie Bogan Unregulated and Alluvial Water Sources. However, the Permian sequences to be mined do not extend into the underlying fractured rock groundwater source (the Marrangaroo Formation) and there are no alluvial water sources in vicinity of Invincible that will be impacted by the Southern Extension Project.

2.2.2 Groundwater Baseline Conditions

The Invincible Colliery is situated on and adjacent to land that has been impacted by extensive underground mining activity with the Invincible Underground below and to the east, the Old Tyldesley Colliery to the north west, Baal Bone Colliery to the north east, Ivanhoe #2 Colliery to the south and Wallerawang No.3 Colliery to the south west (refer to **Figure 2-3**). All these mines targeted the Lithgow coal seam due to its continuity and thickness. These historical mining operations have resulted in connective cracking to the surface, which has facilitated rainfall infiltration into the abandoned workings via points of high permeability.

As a result of historical mining operations, the Lithgow Seam has been completely depressurised in the vicinity of Invincible, including the Southern Extension Area. The abandoned underground workings have re-saturated to an extent, primarily through surface water infiltration rather than groundwater processes.

Recent groundwater investigations have concluded that water levels in the former Invincible and Ivanhoe workings have equilibrated (AGE, 2022). As a result, the Invincible workings adjacent to the Southern Extension Area are currently saturated. There is an area in the north-western portion of the Invincible workings that is dry (based on

December 2021 data). Dry areas of the Invincible workings may be used for water storage, including volumes dewatered from the Southern Extension Area.

The Southern Extension Project will target an area of the Lithgow Seam that has previously been subject to underground mining by the former Ivanhoe No.2 Colliery. Recent monitoring data indicates that the Ivanhoe workings in the Southern Extension Area are partially saturated (AGE, 2022).

The nearest registered bore (a monitoring bore at the Pine Dale Coal Mine) to the Southern Extension Project area is located approximately 1.2 km to the south. The nearest bore potentially used for productive (i.e. non mine related) purposes is located approximately 3.5 km to the west of the Southern Extension Project area. Dewatering of the Southern Extension Project area is not anticipated to impact the water levels in this bore (AGE, 2016).

2.2.3 Groundwater Water Quality

Water quality monitoring has been undertaken (including metals analysis) of the underground water quality including:

- Invincible Underground has been undertaken at LD001 since August 2016; and
- Ivanhoe #2 Underground at BHTH12 since December 2016.

The ongoing groundwater water quality monitoring program is detailed in **Section 5.2.4**.

The quality of stored water in the Ivanhoe #2 Underground is more comparable to Northern Void water quality with higher ECs, sulphate concentrations and dissolved metals concentrations than the water sampled from the Invincible Underground workings at LD001. This is likely to be the result of proximity and exposure to weathered rock and spoil (AGE, 2017).

While some dissolved metals concentrations recorded for both the Invincible Underground workings and the Ivanhoe #2 Underground workings are above the Default ANZG guideline values for the 95% protection level, no water from either the Invincible or Ivanhoe #2 underground workings will be directly transferred to the MSD (refer to **Section 3.0**) to prevent water from these sources being discharged off-site via LD002.

Table 12 and **Table 13** present the water quality statistics for the Invincible Underground (LD001) and the Ivanhoe #2 Underground (BHTH12) respectively. The 20th and 80th percentile values for LD001 water quality parameters listed in **Table 12** have been adopted as trigger values that may indicate a deviation in water quality from the normal range. A Trigger Action Response Plan (TARP) to respond to deviations in water quality in the LD001 is presented in **Section 6.2**.

Figure 2-3 Groundwater Context and Monitoring Locations

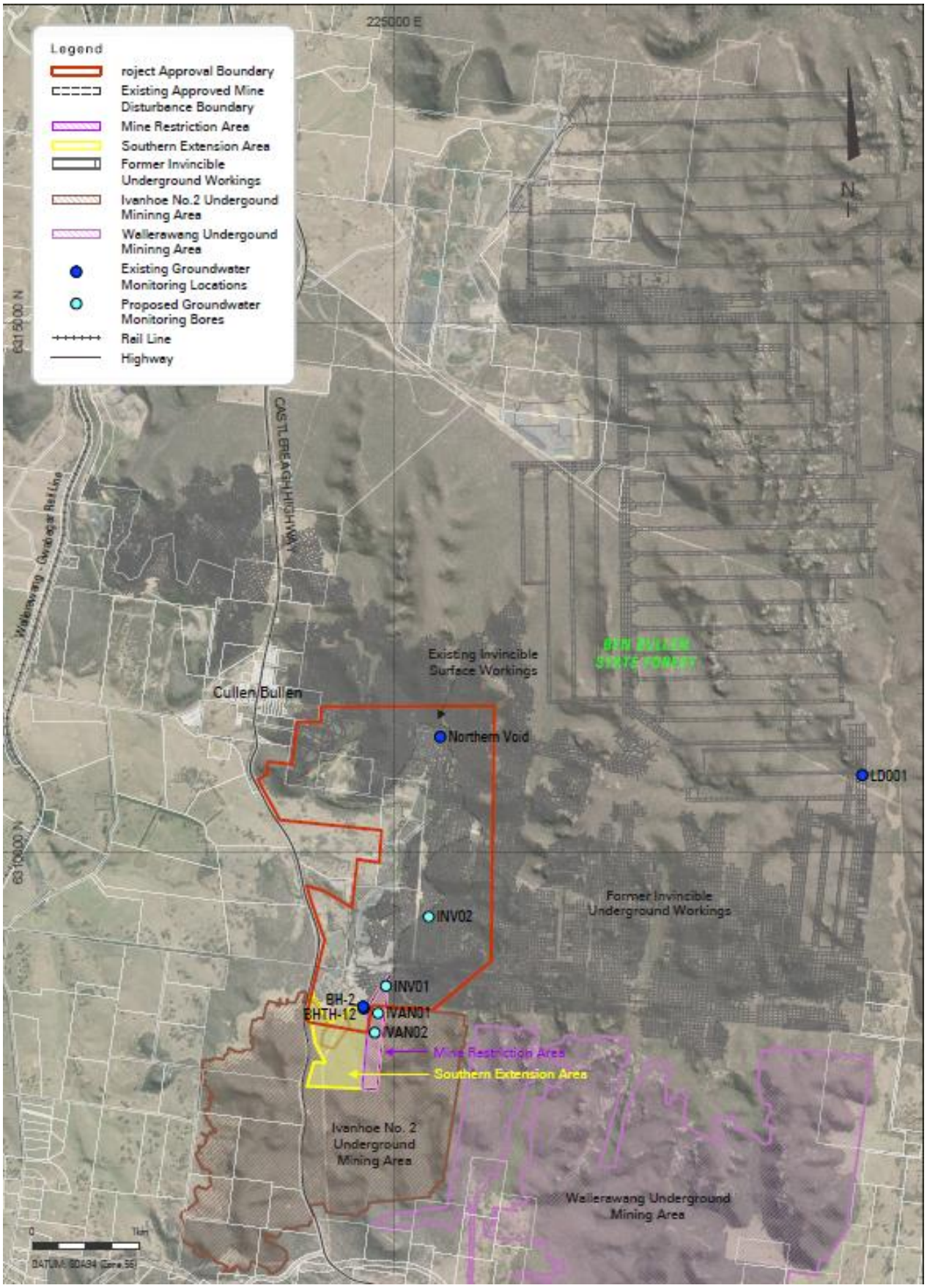


Table 12 Groundwater Water Quality and Trigger Values – Invincible Underground (LD001)

Parameter	Minimum[1,2,3]	20th Percentile[1,2,3]	50th Percentile[1,2,3]	80th Percentile[1,2,3]	Maximum[1,2,3]
pH	4.9	5.9	6.5	6.9	7.7
TSS	5	5.0	6.5	10.0	18
Oil and Grease	5	5.0	5.0	5.0	5
Electrical Conductivity (µS/cm)	120	130	142	171	330
TDS	50	77.8	101.0	119.2	147
Sulphate	10	12	13	15	25
Aluminium	0.01	0.01	0.01	0.01	0.026
Antimony	0.001	0.00	0.001	0.00	0.001
Arsenic	0.001	0.001	0.001	0.001	0.001
Beryllium	0.001	0.00	0.001	0.00	0.001
Barium	0.145	0.16	0.169	0.18	0.737
Cadmium	0.0001	0.0001	0.0001	0.0001	0.001
Chromium	0.001	0.001	0.001	0.001	0.001
Cobalt	0.001	0.00	0.001	0.00	0.002
Copper	0.001	0.002	0.006	0.022	0.038
Lead	0.001	0.001	0.001	0.001	0.001
Lithium	0.019	0.02	0.020	0.02	0.038
Manganese	0.001	0.002	0.004	0.208	0.510
Molybdenum	0.001	0.001	0.001	0.001	0.001
Nickel	0.004	0.007	0.010	0.011	0.027
Selenium	0.01	0.01	0.01	0.01	0.01
Silver[4]	0.001	0.00	0.001	0.00	0.001
Thorium	0.001	0.00	0.001	0.00	0.001
Tin	0.001	0.00	0.001	0.00	0.001
Titanium	0.01	0.01	0.01	0.01	0.01
Uranium	0.001	0.00	0.001	0.00	0.001
Vanadium	0.01	0.01	0.01	0.01	0.01
Zinc	0.024	0.065	0.079	0.140	0.150
Boron	0.05	0.05	0.05	0.05	0.05
Iron	0.01	0.01	0.05	0.05	5.37

Notes

1. *Dissolved concentrations presented for metal/metalloid results*
2. *Result units are mg/L unless otherwise specified*
3. *Where water quality results were recorded below the limit of detection, the limit of detection was taken to be the result.*
4. *Analysis undertaken with an LOR above the ANZG default guideline value. All future analysis for silver to be done to an LOR of 0.00001 mg/L.*

Table 13 Groundwater Water Quality – Ivanhoe #2 Underground (BHTH12)

Parameter	Minimum[1,2,3]	20th Percentile[1,2,3]	50th Percentile[1,2,3]	80th Percentile[1,2,3]	Maximum[1,2,3]
pH	5.1	5.4	5.6	6.0	6.5
TSS	4967	4967	4967	4967	4967
Oil and Grease	45	45	45	45	45
Electrical Conductivity (µS/cm)	738	814	880	919	1688
TDS	177	530	631	680	1414
Sulphate	278	333	373	391	750
Aluminium	0.01	0.01	0.02	0.04	0.46
Antimony	0.001	0.001	0.001	0.001	0.001
Arsenic	0.001	0.001	0.001	0.001	0.001
Beryllium	0.001	0.001	0.001	0.001	0.004
Barium	0.006	0.018	0.02	0.024	0.029
Cadmium	0.0001	0.0002	0.0003	0.00046	0.001
Chromium	0.001	0.001	0.001	0.001	0.001
Cobalt	0.034	0.0618	0.067	0.0694	0.088
Copper	0.001	0.001	0.001	0.001	0.007
Lead	0.001	0.001	0.001	0.001	0.004
Lithium	0.041	0.071	0.075	0.0782	0.12
Manganese	1.18	2.09	2.30	2.49	2.91
Molybdenum	0.001	0.001	0.001	0.001	0.008
Nickel	0.165	0.297	0.316	0.383	0.478
Selenium	0.01	0.01	0.01	0.01	0.01
Silver[4]	0.00001	0.001	0.001	0.001	0.01
Thorium	0.001	0.001	0.001	0.001	0.001
Tin	0.001	0.001	0.001	0.001	0.001
Titanium	0.01	0.01	0.01	0.01	0.01
Uranium	0.001	0.001	0.001	0.001	0.027
Vanadium	0.01	0.01	0.01	0.01	0.01
Zinc	0.03	0.3264	0.413	0.561	1.58
Boron	0.05	0.05	0.05	0.05	0.13
Iron	0.05	0.152	0.79	5.656	10.2

Notes

1. *Dissolved concentrations presented for metal/metalloid results;*
2. *Result units are mg/L unless otherwise specified;*
3. *Where water quality results were recorded below the limit of detection, the limit of detection was taken to be the result; and*

4. Analysis undertaken with an LOR above the ANZG default guideline value. All future analysis for silver to be done to an LOR of 0.00001 mg/L.

2.2.4 Groundwater Levels

The standing water level within the flooded workings of the Invincible Underground has been recorded within LD001 since 2010. The standing water levels in Ivanhoe #2 workings and coal barrier (BHTH12 and BH2 respectively) have been monitored since December 2016. Historical standing water levels in bores LD001, BHTH12 and BH2 for the period August 2016 to August 2018 are presented in **Chart 2**.

The westernmost parts of Invincible Underground and those immediately adjacent to the Southern Extension Project area are dry (AGE, 2016). As the Invincible underground workings dip to the north east they become saturated and seep towards the Baal Bone Mine.

The Northern Void (refer to **Figure 2-3**) in the existing Invincible open cut workings is known to be hydraulically connected (confirmed by pumping test undertaken August 2018) to the underground workings and the surface water level in the Northern Void is understood to represent the hydraulic head of water in the adjacent Invincible underground workings. The discrepancy between the water level in the Northern Void and LD001 of approximately 3.3 mAHD suggests that while hydraulically connected, there is some degree of restriction in the Invincible Underground between the Northern Void and LD001.

Australasian Groundwater and Environmental Consultants (AGE) estimated the available storage capacity remaining in the Invincible Underground workings. The flooded extent of the workings was estimated based on observations of the tidemark. The workings outside of the flooded extent are therefore assumed to be dry. AGE (2016) estimated that the remaining dry workings could provide 1,219 ML of additional storage. Due to the hydraulic connectivity between the open cut voids and underground workings, water stored in the workings will seep into the spoil emplacements within the voids. These spoil emplacements were estimated to provide an additional 366 ML of storage (AGE, 2016).

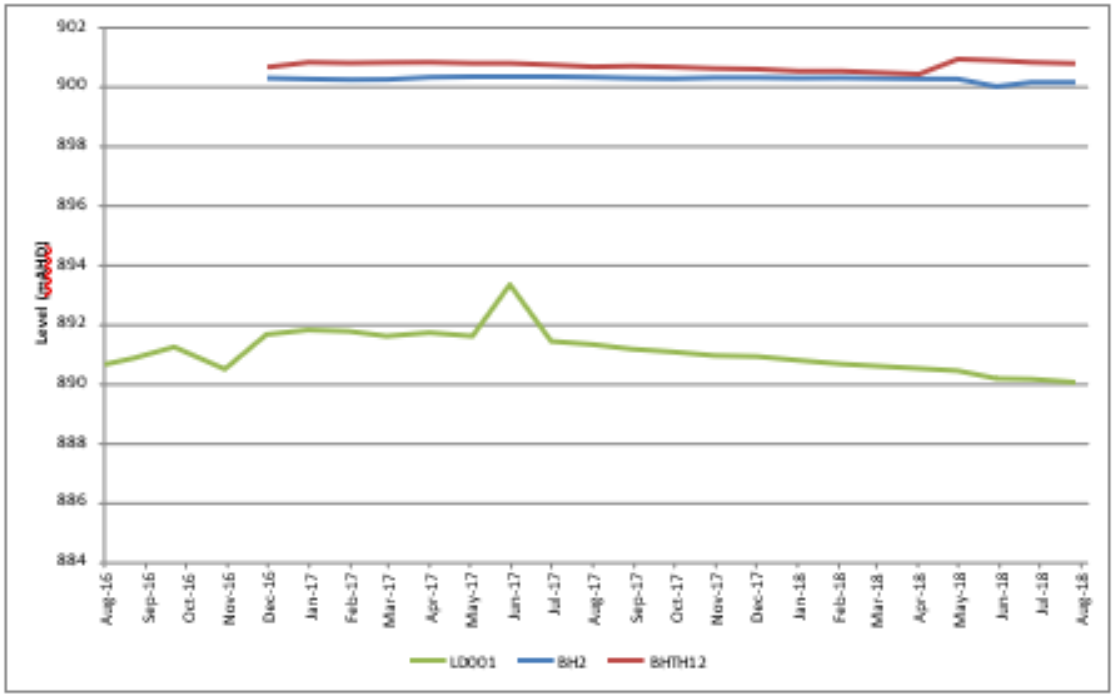
Shoalhaven Coal recognises that the underground storage volume would have changed since the AGE (2016) assessment due to recent climatic conditions and the cessation of mine dewatering at Baal Bone Colliery. Access to the underground workings is no longer available due to the mine portals being sealed. As such, it is no longer possible to confirm the flooded extent via observation of the tidemark. In lieu of personnel access to the underground workings, additional monitoring bores are proposed to confirm the current remaining storage capacity in the workings (refer to **Section 5.2.3**). To date, there has been no evidence of groundwater 'daylighting' that would suggest the underground workings are at maximum capacity.

In December 2016, monitoring bores BHTH12 was installed in the Ivanhoe #2 workings and bore BH2 was installed in the coal barrier between Ivanhoe #2 Colliery and the Invincible Underground. Measured levels suggest that there is a hydraulic gradient from Ivanhoe #2 Colliery towards the Invincible Colliery underground.

The volume of water accumulated in the Ivanhoe #2 Colliery is estimated to be in the order of 466 ML (AGE, 2022). This estimate was based on the most recent water level in the Northern Void and groundwater levels in BHTH12 and BH2.

Shoalhaven Coal has developed a revised water management strategy for the water stored in the Ivanhoe #2 and the site in general. The strategy includes a detailed TARP which includes specific Northern Void water level limits and monitoring requirements to be adhered to during the dewatering of the Ivanhoe #2 underground workings (refer to **Section 6.2**).

Chart 2 Groundwater Bore Standing Water Levels, August 2016 to August 2018



2.2.5 Conceptual Hydrogeological Model

The target coal seams for the Southern Extension Project are located within the Illawarra Coal Measures. The overburden and interburden strata (including sandstones, siltstones and mudstone) exhibit very low hydraulic conductivity and act as aquitards. As such, coal seams are typically the main water bearing strata within the Illawarra Coal Measures. However, in the vicinity of Invincible, historical mining activities have resulted in complete depressurisation of the coal seams.

The abandoned underground workings have re-saturated (to an extent) since the cessation of underground mining. Rainfall recharge is occurring primarily via subsidence induced cracking rather than natural recharge processes (AGE, 2016). The low EC recorded at bores LD001 and BHTH12 supports the conclusion that the accumulated water is predominantly derived from rainfall rather than Permian groundwater. Due to past depressurisation and reliance on subsidence induced cracking for rainfall recharge, the flooded underground workings are characterised as water storages rather than an aquifer.

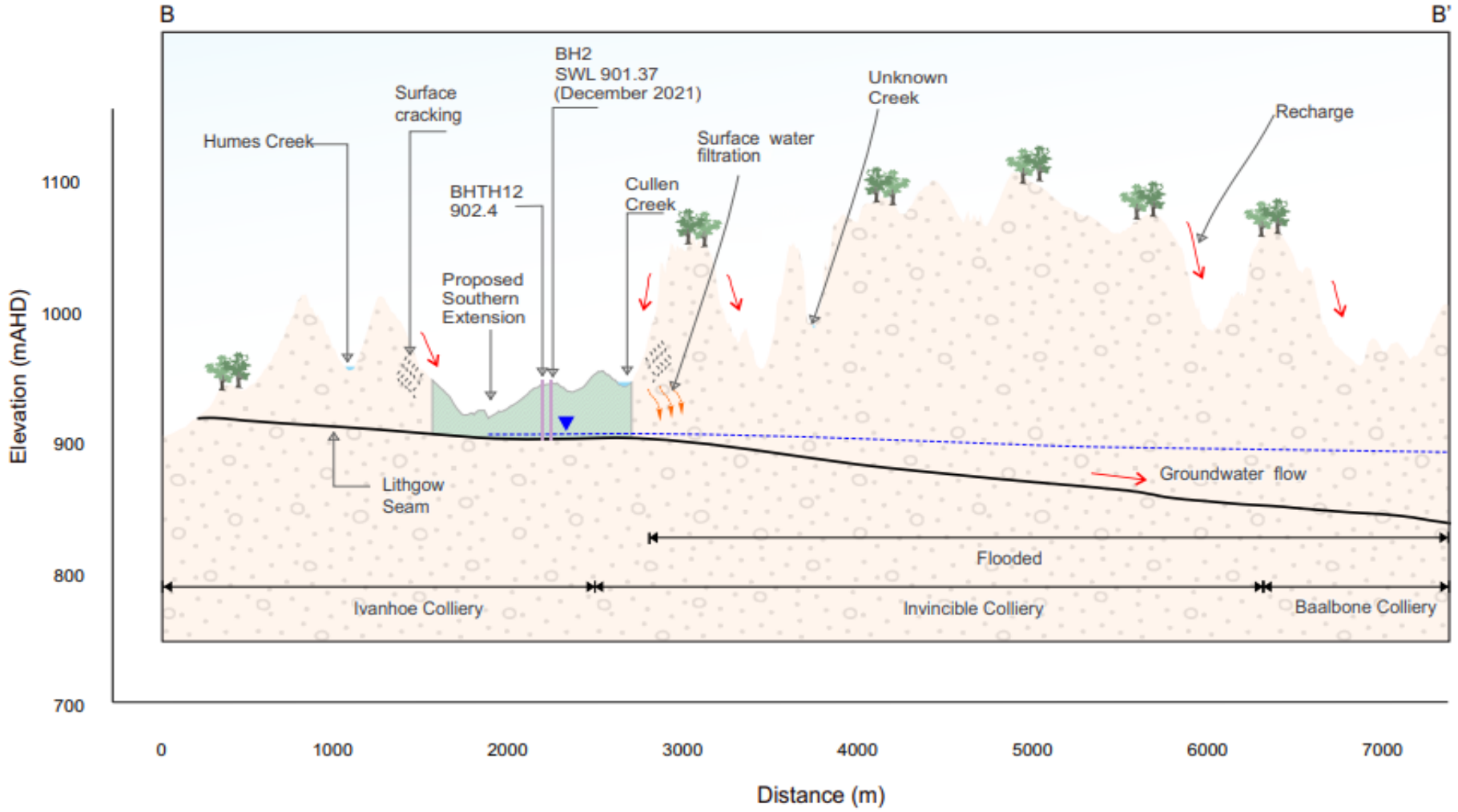
The Marrangaroo Formation underlies the Lithgow Seam and may support aquifers in areas of higher permeability. Mining in the Southern Extension Area is unlikely to significantly depressurise the Marrangaroo Formation due to the limited hydraulic conductivity of the interburden strata.

Given that the Lithgow Seam dips towards the north-east, is it expected that accumulated subsurface water will seep from Ivanhoe #2 to Invincible Underground. Invincible Underground and Ivanhoe #2 are separated by an intact coal barrier of 20-40 m thickness. Seepage from Ivanhoe #2 to Invincible Underground is therefore limited by the conductivity of the coal seam. Recent water levels recorded at BH2 and BHTH12 indicate that water levels in the Invincible and Ivanhoe workings have equilibrated (AGE, 2022).

Accumulated water in the Invincible Underground workings will seep down-dip towards Baal Bone Colliery and further to the north-east. Baal Bone Colliery is in the process of closure and no longer dewaters its workings. As water levels rise in the Baal Bone workings, the hydraulic gradient from Invincible to Baal Bone Colliery would gradually decrease. As a result, seepage to Baal Bone Colliery is likely to be less than the volumes previously experienced.

The conceptual hydrogeological model for the area surrounding Invincible is presented in **Figure 2-4**.

Figure 2-4 Conceptual Hydrogeological Model – Schematic



Source: AGE (2022)

3.0 Water Management System

3.1 Existing Water Management

Figure 3-1 and **Figure 3-2** present a plan and schematic of the existing WMS respectively. The existing surface water management strategy is to segregate clean, dirty and mine water wherever possible.

However, given the steep and complex terrain upslope of site, the opportunity to direct clean runoff around disturbed areas and areas where rehabilitation is incomplete is limited.

Runoff from disturbed catchments and catchments under rehabilitation that do not yet have adequate vegetative cover for off-site release are managed in general accordance with the Blue Book and Volume 2E Mines and Quarries (DECC, 2008). **Table 14** presents the catchment areas, relevant design standard, capacity based on the design standard and the approximate as constructed storage capacity of the five existing sediment dams (SD2, SD3, SD4, SD5 and SD6) within the WMS. All of the current sediment dams were constructed prior to Shoalhaven Coal acquiring the Invincible Colliery. Shoalhaven Coal has identified that SD2 and SD3 are undersized relative to the design standards of the Blue Book. Prior to the commencement of mining, Shoalhaven Coal will increase the capacity of SD3 to meet the Blue Book design standards. Once clean and rehabilitated catchments are directed off site (refer to **Section 3.2**), the catchment for SD2 will be significantly reduced to an area such that the capacity of SD2 will meet the Blue Book requirements (refer to **Table 16**).

SD5 and SD6 are located on an unnamed tributary of Cullen Creek. SD6 is located upstream of SD5 and overflows to SD5 via gravity. SD5 overflows to Cullen Creek via the tributary on which it is located. The catchments of SD5 and SD6 have largely been rehabilitated, other than a minor access track. Accordingly, SD5 and SD6 are currently functioning as clean water dams.

SD3 and SD4 are located east of SD5 and SD6, and on other unnamed tributaries of Cullen Creek. SD4 overflows to SD3, although a portion of these flows will seep to the Invincible underground workings via existing fracture networks. SD3 overflows to Cullen Creek via its unnamed tributary.

SD2 is located south of SD3 and is not located on a mapped watercourse. Although SD2 currently does not meet the sizing recommendations of the Blue Book, this dam can be dewatered to SD4 (if necessary). Following recommencement of operations, the catchment area of SD2 will be reduced via clean water diversions such that its settling capacity is sufficient.

Significant portions of the catchments draining to the Invincible site are affected by pre-existing subsidence from underground bord and pillar mining in the abandoned underground workings. Large sinkholes are evident along drainage lines in these portions of the catchment and it is expected that a substantial portion of surface water runoff which drains through these subsidence affected areas does not report to downstream surface water management structures, but instead enters the sinkholes and reports directly to the abandoned underground workings.

Runoff from undisturbed and disturbed catchments upslope of the Northern Void, Eastern Void, Renown Pit and Pit 209 flows into the open voids and voids that have been partially backfilled (refer to **Figure 3-1**). Due to the permeable nature of the underlying geology and proximity to abandoned underground workings, the majority of surface water runoff collected in these voids rapidly seeps into the abandoned underground workings shortly after a runoff event occurs.

The Main Storage Dam (MSD) receives runoff from the Mine Infrastructure Area (MIA) and the undisturbed catchment upslope of MIA as well as pumped transfers from the Environmental Dam. The Environmental Dam receives runoff from the disused tailings storage facility (TSF) via TSF seepage as well as runoff from a small section of haul road. Some of the runoff from the undisturbed catchment upslope of the MIA is directed under the disused Coal Handling and Preparation Plant (CHPP) to the MSD via stormwater pipe.

The Southern Extension Area is located within the catchment of the MSD. As such, the Southern Extension Area will capture runoff that would otherwise report to the MSD. This water will be managed in pit, where practicable, but can be pumped to the MSD if there is sufficient receiving capacity (refer to **Section 3.2**). Seepage from the Tailings Storage

to the Environmental Dam will also be reduced to a negligible quantity as the Tailings Storage area is backfilled and rehabilitated.

Table 14 Existing Water Storage Capacities and Catchment Areas

Storage ID	Catchment Area (ha)	Classification	Design Standard	Design Capacity[1] (Settling Zone) (ML)	Capacity (Settling Zone) (ML)
Environmental Dam	1.5	Mine Water	100 year 24 hour	2.0 (1.6)	0.5 (0.4)
SD2	26.9	Dirty Water	5 day 95th percentile	14.6 (11.2)	4.8 (3.7)
SD3	8.3	Dirty Water	5 day 95th percentile	4.5 (3.4)	<0.5 (<0.4)[2]
SD4	22.0	Dirty Water	5 day 95th percentile	11.9 (9.2)	47.8 (36.8)
SD5	5.4	Dirty Water	5 day 95th percentile	2.9 (2.2)	2.3 (1.8)
SD6	37.2	Dirty Water	5 day 95th percentile	20.2 (15.5)	1.9 (1.5)
Main Storage Dam	139.4	Mine Water	100 year 24 hour	188.1 (144.7)	117.0

Notes:

1. Based on sediment zone sized to 30% of settling zone

2. Design are works presently underway to increase SD3 capacity to meet Design Standard

Figure 3-1 Existing Water Management System – Plan

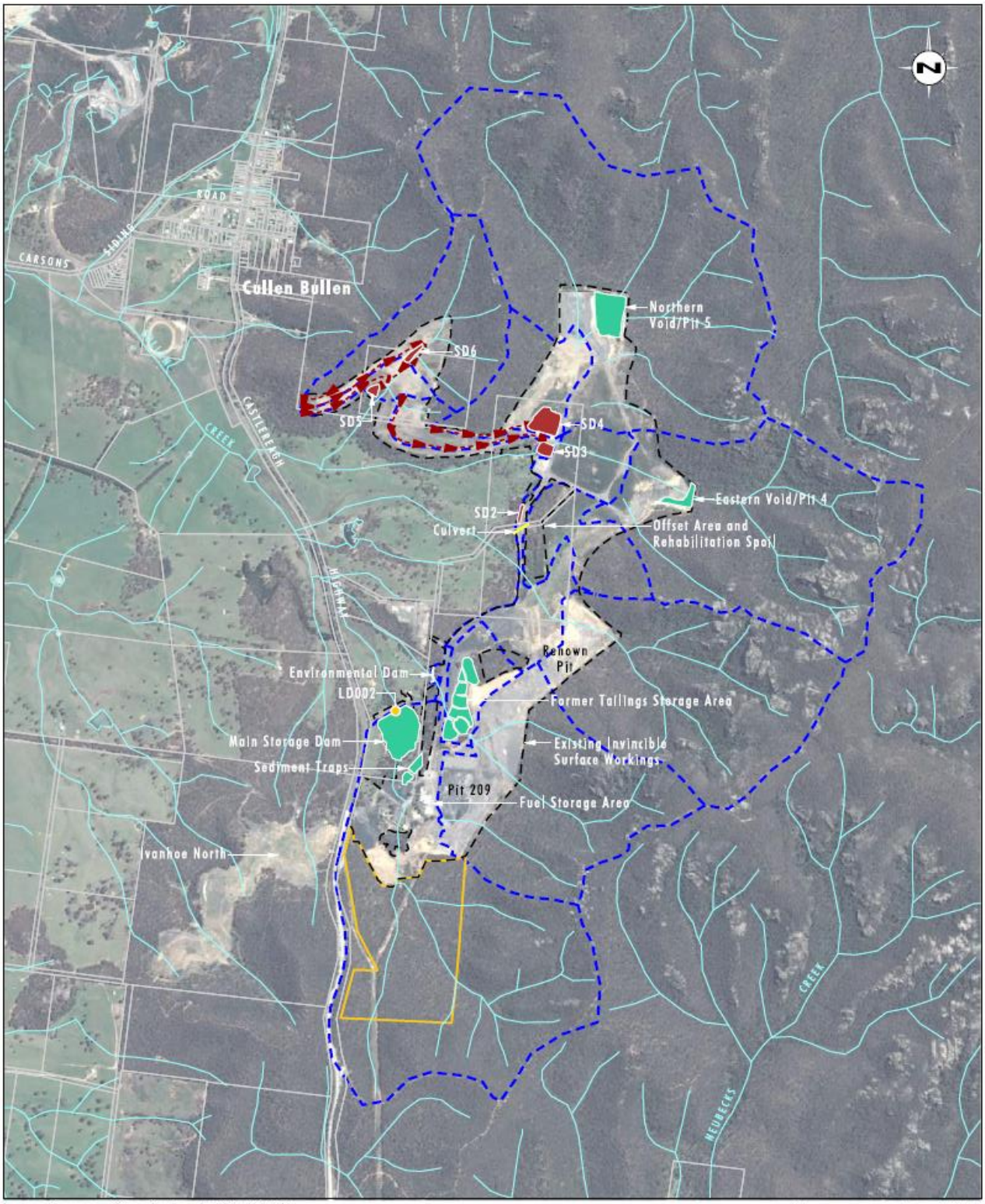
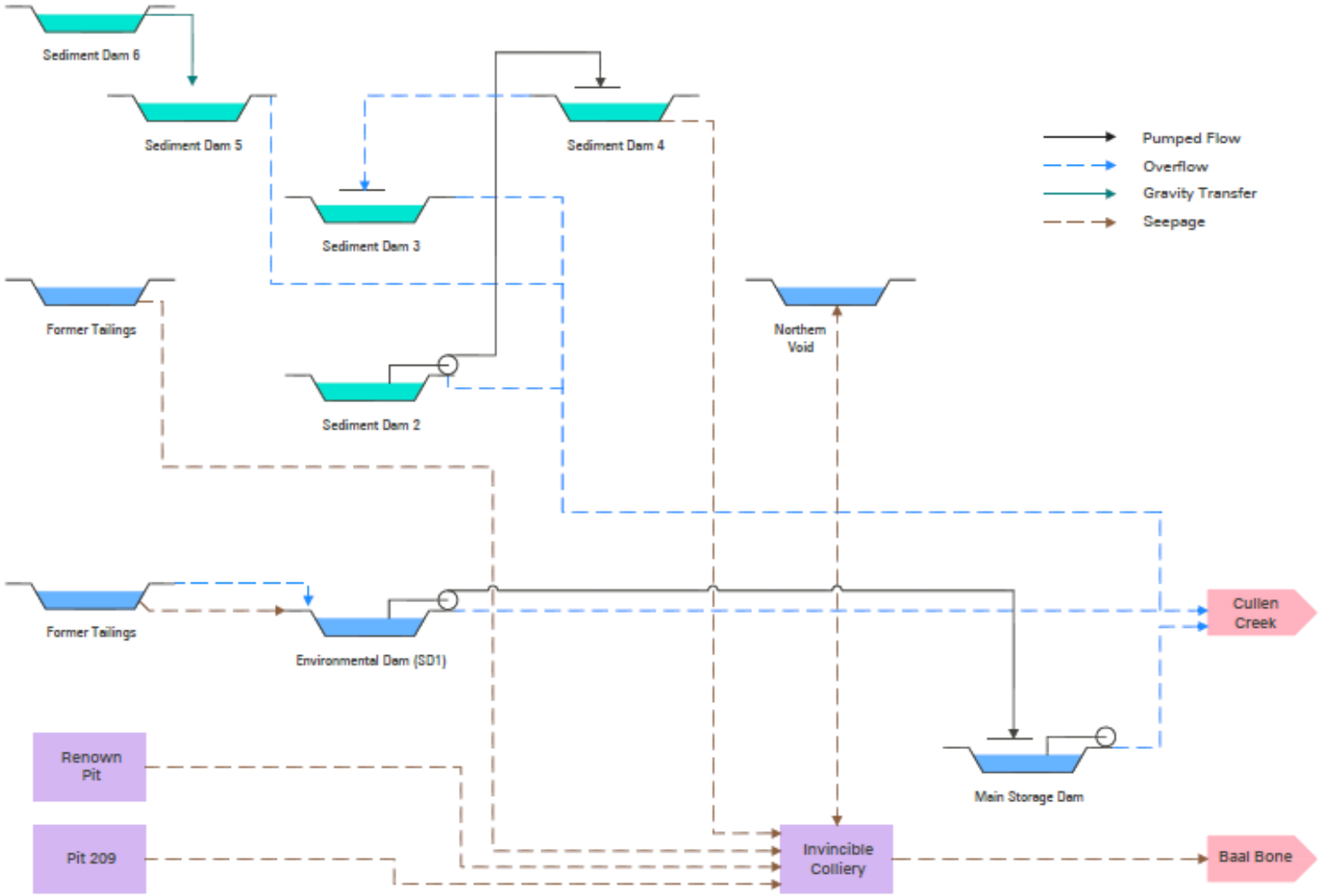


Figure 3-2 Existing Water Management System – Schematic



3.2 Operational Water Management

Figure 3-3 and **Figure 3-4** present a plan and schematic of the conceptual Year 3 WMS respectively. The overall water management strategy will remain broadly unchanged as the Invincible Colliery transitions from care and maintenance to operational. Dirty water from sediment dams will continue to be dewatered to the Invincible underground (refer to **Section 3.2**) or utilised for irrigation of areas under rehabilitation.

Catchments presently under rehabilitation will be diverted off-site progressively as adequate levels of groundcover are achieved.

3.2.1 Ivanhoe #2 Dewatering

Water that is presently stored in the Ivanhoe #2 underground workings (refer to **Section 2.2.4**) will need to be dewatered to facilitate open cut mining in the Southern Extension Area. Dewatering of the Ivanhoe #2 workings will be undertaken by either:

- breaking through coal barrier up-dip of measured water levels, digging a sump to store water and pumping around the coal barrier in a controlled manners; or
- installing a new bore in the Ivanhoe #2 open workings near the Southern Extension Project.

Water that is taken from the Ivanhoe #2 workings may be managed through the following strategies (in order of preference):

- Transferred to the Invincible Underground workings (most likely using boreholes);
- Development of sumps within shallower strata in the Southern Extension mining area (given that overburden strata are dry) and/or
- Discharged in accordance with EPL 1095.

If water is to be transferred from Ivanhoe #2 to Invincible, the key management responsibility is to ensure that the Invincible Underground workings are not filled beyond capacity. The monitoring program is detailed in **Section 5.0** and will involve monitoring of water levels in the Northern Void as well as visual monitoring of the area of potential "daylighting" of groundwater (refer to **Section 2.2.4**) to the west of SD3.

The performance measures under Schedule 3, Condition 26 of MP 07_0127 state that there is to be no direct discharge of water dewatered from the Ivanhoe workings. Water pumped from the Southern Extension Area will be transferred to either surface storages (dams or open cut voids) or the Invincible workings to facilitate mixing with other water. The resultant mixture will only be discharged if it complies with the water concentration limits in EPL 1095.

Although it was previously proposed to install additional bores to monitor the water level in the underground workings and in the spoils near the area of potential "daylighting", it is now planned to delay backfilling of the Northern Void. This enables the Northern Void to be used as a suitable water level monitoring location for the Invincible underground workings due to hydraulic connectivity between the storages. Water level in the Northern Void will be monitored monthly, consistent with the monitoring frequency for groundwater monitoring bores. Shoalhaven Coal have advised that a combination of water level monitoring in the Northern Void, restricting water transfers into the Invincible underground based on Northern Void water level trigger values and regular inspections of the area of potential "daylighting" will satisfactorily mitigate the risk of environmental harm from daylighting. Trigger Action Response Plans (TARPs) associated with water level limits in the Northern Void as well as "daylighting" of groundwater are contained in **Section 6.2**. Prior to backfilling of the Northern Void, appropriate monitoring bores will be installed to ensure that monitoring of water levels in the Invincible underground workings is maintained. This WMP and the associated TARPs will be updated to reflect these changes when this occurs.

If water levels in the Northern Void approach the water level limits detailed in the TARPs (refer to **Section 6.2**), water to meet haul road dust suppression demands will be drawn from the Northern Void to increase the available capacity in the Invincible underground workings.

Should water levels in the Invincible underground workings rise to a level requiring the restriction of incoming water transfers, excess water from sediment dams will be transferred to the MSD and cease to be transferred to the underground workings. TSS concentrations in sediment dams will be checked prior to transfer to the MSD. Should sediment dam TSS concentrations be greater than 30 mg/L, the water will be treated with coagulant and/or flocculant to aid settling of suspended solids and facilitate that TSS concentrations are less than 30 mg/L prior to transfer to the MSD. Where possible, runoff to the Southern Extension Pit will be captured in sumps to prevent mixing with water stored in the Ivanhoe #2 underground workings, with the Southern Extension runoff then transferred to the MSD.

3.2.2 Clean Water Diversion Strategy

Runoff from undisturbed catchments upslope of the former open cut pits (Northern Void, Eastern Void, Renown Pit and Pit 209) cannot presently be diverted as clean water due to the difficult terrain. As mining progresses in the Southern Extension Area, the open cut voids (Northern Void, Eastern Void, Renown Pit, Pit 209) will be progressively backfilled with overburden or imported material to develop the final landform with a number of these being filled early in the mine life. The diversion of clean water around the existing operations prior to the filling of the open cut voids is not considered feasible due to the steep and undulating terrain upslope of the operation. The capture of water upslope of the existing operation is not possible due to the steep terrain and would also pose potential safety hazards associated with the storage of water above existing highwalls.

When adequate quantities of backfill have been emplaced in the open cut voids, including the Eastern Void and the Renown Pit/Tailings Storage, catch drains will be constructed in the backfill to divert clean water runoff from upslope undisturbed catchment (refer to **Figure 3-3**). The catch drains will be lined with a suitable material to prevent erosion within the drain as runoff is directed off-site. These clean water diversions, as shown on **Figure 3-3**, will be installed as a priority following the backfilling of site voids.

3.2.3 Dirty Water Management

As outlined in **Section 3.2.2**, as mining progresses in the Southern Extension Area, the open cut voids (Northern Void, Eastern Void, Renown Pit, Pit 209) will be progressively backfilled with overburden or imported material to develop the final landform. The tailings storage area will also be backfilled and rehabilitated, thereby eliminating mine water seepage to the Environmental Dam. Once this occurs, the Environmental Dam will be reclassified as a dirty water storage.

New sediment dams will be constructed to manage runoff from the recently backfilled areas of the Eastern Void (SD7) and the Renown Pit/Tailings Storage (SD8) catchments once adequate quantities of backfill are in place. Sediment dams will be constructed to accommodate runoff from a 5 day, 95th percentile rainfall event with a 30% sediment zone allowance (refer to **Table 15**). Runoff from the recently backfilled areas of the Northern Void catchment will drain to SD4.

Backfilling of Pit 209 will occur from east to west leaving void space for water storage in the western side of the pit for an extended period. Once mining is complete in the Southern Extension Area it is planned to decommission the offices and MIA components adjacent to the western highwall of Pit 209 and reshape the landform to smoothly transition from the upslope catchment through the backfilled Pit 209 toward the Castlereagh Highway. This will involve breaking through and re-grading the western highwall of Pit 209.

Catch drains will be incorporated into the backfilled areas adjacent to the undisturbed upslope catchment to direct clean runoff off site. Dirty water runoff from the Pit 209 and MIA areas with incomplete rehabilitation will be directed to the two sediment traps upslope of the MSD for primary sediment removal before overflowing to the MSD.

3.2.4 Mine Infrastructure Area Water Management

The MSD catchment area will be significantly reduced once mining in the Southern Extension area commences. Runoff from the undisturbed upslope catchment that presently drains to the MSD will be captured in the Southern Extension Pit. The MSD will be the primary source of water for dust suppression demands (haul roads and crushing only as no washing of coal at the Invincible Colliery is presently planned). Runoff captured in the Sothern Extension Pit will either infiltrate into the downslope Ivanhoe #2 underground workings or be collected in sumps and pumped around the coal barrier in a controlled manner to Pit 209 where it will be directed into the Invincible underground workings.

Water will not be transferred from either the Invincible underground workings or the Ivanhoe #2 underground workings to the MSD. Wherever practicable, the MSD will be managed with a freeboard capacity of at least 26 ML to contain the 100 year, 24 hour duration ARI design storm event. In the unlikely event that water storage in the MSD cannot meet operational water demands, water will be imported from sediment dams to the MSD or drawn directly from the Northern Void for haul road dust suppression. Further, up to 26 ML/year of groundwater is available from the site Washery Bore (refer to **Section 5.2.1**) which has historically been used for wash down.

Refuelling of all but the less mobile mining equipment (which would be refuelled within the open cut area), will be undertaken in the designated refuelling area shown on **Figure 3-3**. Hydrocarbons (fuels and oils) will be stored in accordance with AS1940 – 2017: The storage and handling of flammable and combustible liquids. Runoff from wash down areas and other areas where runoff may entrain hydrocarbons will be directed to oil/water separators for treatment and subsequent removal by suitably licensed liquid waste contractors. In the event of a major hydrocarbon spill, Shoalhaven Coal will implement a three phase remedial action plan in accordance with the site Pollution Incident Response Management Plain (PIRMP).

The three phase action plan will involve initial recovery of the hydrocarbon, source control to prevent contamination spread and further recovery if necessary.

Table 15 Year 3 Water Storage Capacities and Catchment Areas

Storage ID	Catchment Area (ha)	Classification	Design Standard	Design Capacity[1] (Settling Zone) (ML)	Capacity (Settling Zone) (ML)
Environmental Dam	1.5	Dirty Water	5 day 95th percentile	0.8 (0.6)	0.4[2]
SD2	7.2	Dirty Water	5 day 95th percentile	3.9 (3.0)	4.8 (3.7)
SD3	8.3	Dirty Water	5 day 95th percentile	-[4]	4.5 (3.4)
SD4	76.2	Dirty Water	5 day 95th percentile	41.3 (9.5)	47.8 (36.8)
SD5	5.4	Clean Water	-[3]	-[3]	2.3 (1.8)
SD6	37.2	Clean Water	-[3]	-[3]	1.9 (1.5)
SD7	6.9	Dirty Water	5 day 95th percentile	1.4 (1.1)	To be constructed
SD8	38.8	Dirty Water	5 day 95th percentile	21.0 (16.2)	To be constructed
Main Storage Dam	25.0	Mine Water	100 year 24 hour	33.7 (25.9)	117.0

Notes:

1. *Based on sediment zone sized to 30% of settling zone;*
2. *Estimated capacity;*
3. *No minimum capacity requirement for clean water dams downslope of disturbed areas; and*
4. *Dam to be resized to meet the design standards of the Blue Book.*

Figure 3-3 Conceptual Year 3 Water Management System Plan

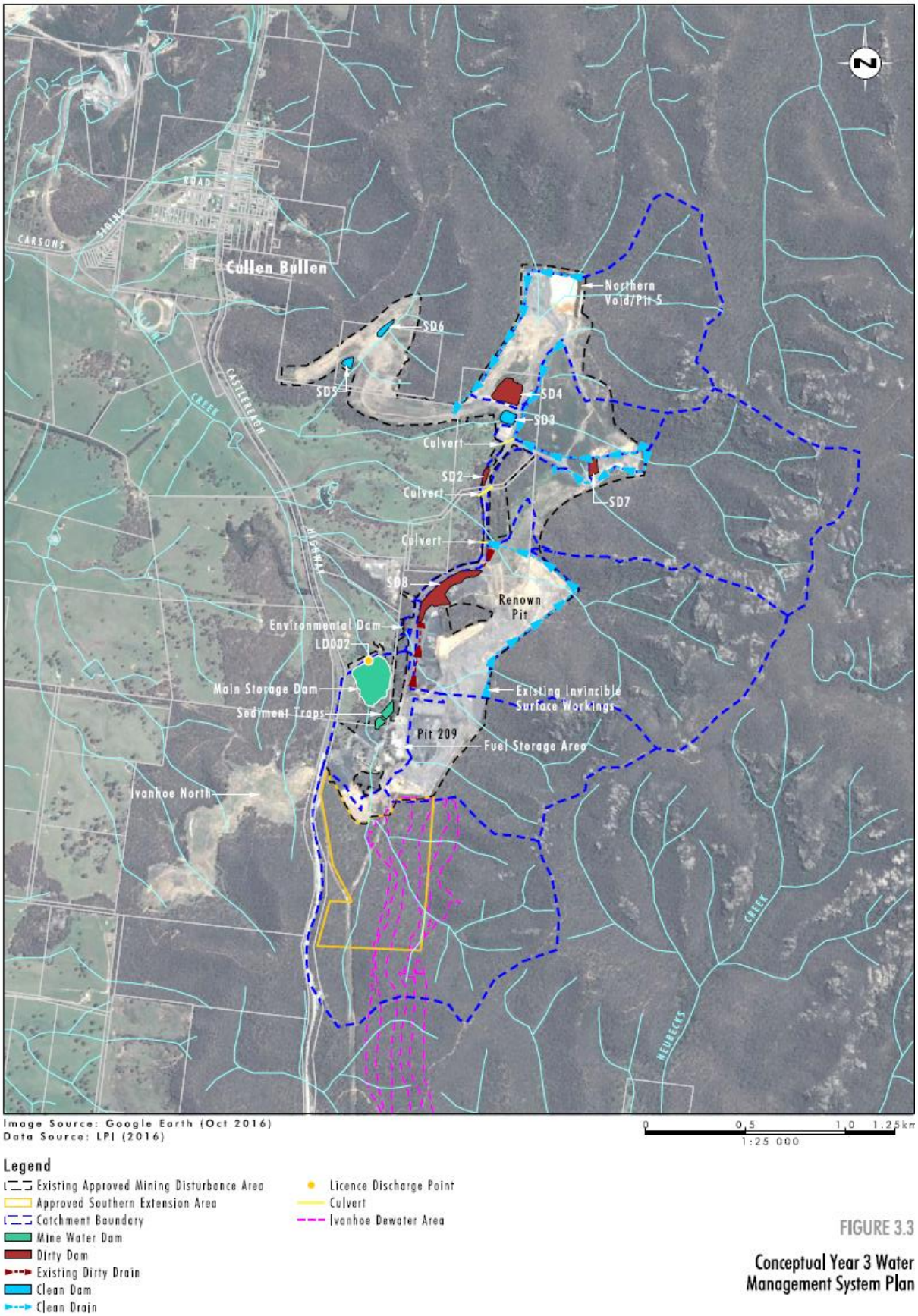
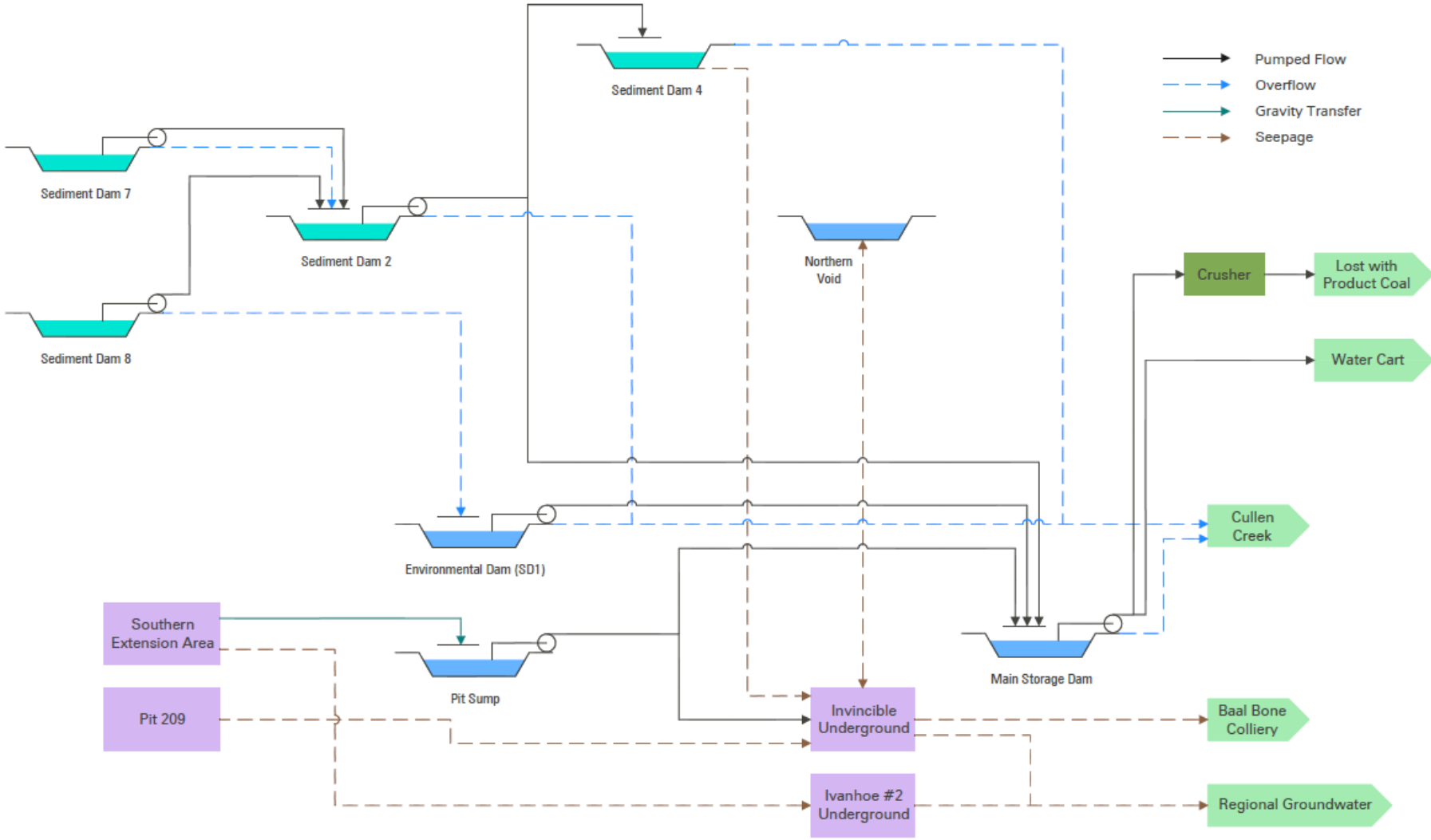


FIGURE 3.3

Conceptual Year 3 Water Management System Plan

Figure 3-4 Conceptual Year 3 Water Management System Schematic



3.3 Amenities Supply and Wastewater

Potable water supply and wastewater treatment and disposal practices for the Southern Extension Project will be the same as for the existing operations. Potable water is currently sourced from the Fish River Dam Water Supply main pipeline system. Wastewater is managed on site using a septic tank system which is periodically maintained by licensed contractors.

3.4 Erosion and Sediment Control

Activities which have the potential to cause erosion and generate sediment on site include:

- clearing and topsoil stripping ahead of mining operations;
- mining operations, noting that the majority of mining areas are internally draining;
- construction of site haul roads;
- construction of overburden emplacement areas (i.e. placement of overburden);
- rainfall/runoff on active work areas and overburden areas;
- runoff flowing across the disturbed area into drains; and
- irrigation of on-site rehabilitated areas whilst dewatering dams to achieve freeboard.

Practical erosion and sediment controls will be implemented to minimise the generation of sediment on site and transport of sediment around and off-site, as described in the following sections.

3.4.1 Soils

The soil landscapes in the Southern Extension Project area are detailed in **Section 2.1.3**.

3.4.2 Sediment Basins

All future sediment basins will be sized as Type D basins. Basins will have a settling zone capacity to capture runoff from a 5 day, 95th percentile rainfall event and a sediment zone volume equal to 30% of the settling zone capacity (refer to **Section 3.2**). Sediment will be removed from sediment basins when the basin capacity is reduced by 20%.

3.4.3 General Erosion and Sediment Control Measures

Water quality measures will be implemented for Invincible to minimise the impact on the surrounding environment. These controls are designed and constructed to a standard consistent with:

- Managing Urban Stormwater – Soils and Construction, Volume 1 (the Blue Book) (Landcom 2004); and
- Managing Urban Stormwater – Soils and Construction, Volume 2E: Mines and Quarries (DECC 2008).

The measures are designed to minimise erosion and transport of sediment around and off-site and include:

- clearly identifying and delineating areas required to be disturbed and ensuring that disturbance is limited to those areas;
- clearing as little vegetation as required and minimising machinery disturbance outside of these areas;

- installing appropriate erosion and sediment controls prior to stripping topsoil or disturbing areas;
- limiting the number of roads and tracks established;
- stabilising site entry/exit points to ensure sediment is not tracked onto sealed roadways;
- construction of drains upslope of areas to be disturbed to convey clean runoff away from most disturbed areas where possible;
- reshaping, topsoiling and re-vegetating road and cut and fill batters as soon as practical;
- construction of sediment dams where required to capture and treat runoff from disturbed catchment areas. Further details regarding construction and management of sediment dams can be found in **Section 3.4**;
- diversion of surface and road runoff away from disturbed areas where possible;
- regular maintenance of all erosion control works and rehabilitated areas; and
- revegetation of areas as soon as practical following the completion of earthworks or operations.

3.4.4 Progressive erosion and sediment control plans

Progressive erosion and sediment control plans (ESCPs) will be developed in accordance with the Blue Book (Landcom, 2004) for high risk areas detailing the specific erosion and sediment controls, rehabilitation, monitoring and maintenance requirements for these areas. These progressive ESCPs will:

- Be prepared on relevant copies of drainage drawings for:
    - o different construction stages (i.e. initial clearing, grubbing, topsoil stripping and stockpiling with revision for bulk earthworks);
    - o areas of high erosion hazard;
- Show sizing and design details for all sediment basins and erosion and sediment controls (such as diversion drains);
- Be revised when required by changing circumstances, if the site conditions change or if installed controls are not operating effectively; and
- Be site specific and will not generally repeat the information contained in this primary ESCP.

3.4.5 Erosion and sediment control measure design criteria

As the duration of the disturbance at Invincible will be greater than 3 years, sediment basins will be designed to the following standard as detailed in **Table 16** in accordance with Landcom's Managing Urban Stormwater Volume 2E Table 6.1 (DECC, 2008):

Table 16 Sediment Basin Design Criteria

Design Parameter	Design Criteria
Basin Type	"Type D"
Design Settling Zone Capacity	Runoff from a 5 day, 95th percentile rainfall event
Design Sediment Zone Capacity	30% of settling zone capacity
Primary Outlet	Rock protection on both primary and emergency outlets to ensure minimisation of scour.
Emergency Spillway	Designed to be structurally sound in the 100 year ARI storm event.

To ensure the structural stability of sediment basins and sediment basin emergency spillways and to prevent seepage, all sediment basins required to be built for the project will be constructed in accordance with Appendix B – Sediment Basin Design and Operation of Best Practice Erosion and Sediment Control (International Erosion Control Association – Australasia – Draft document revision, https://www.austieca.com.au/documents/item/697, December 2016). Particular reference will be given to Section B4 of Appendix B – Default Construction Specifications. All water management dam walls will be grassed and kept free of trees and shrubs.

Temporary drainage (erosion) (e.g. diversion banks, perimeter banks, catch drains, level spreader, check dams and batter drains and chutes) and sediment controls (e.g. sediment fences, stacked rock sediment traps etc. on small catchments where used as a 'last line of defence' (i.e. without a down slope sediment basin)) will be designed to have a non-erosive hydraulic capacity when conveying the 20 year ARI storm event.

3.4.6 Soil and stockpile management

Ensure stockpiles of erodible material that have the potential to cause environmental harm if displaced are:

- constructed in accordance with Standard Drawing SD 4-1 Stockpiles (The Blue Book) (Landcom, 2004)) (included in Appendix 4);
- appropriately protected (for example, seeded or covered) from wind, rain, concentrated surface flow and excessive up-slope stormwater surface flows;
- constructed on the contour at least 2 m (preferably 5 m from hazard areas), particularly likely areas of concentrated water flows, e.g. roads, slopes steeper than 10% etc.;
- constructed greater than 40 m away from the top of bank of drainage lines;
- protected from run-on water by installing water diversion structures upslope; and
- formed with sediment filters placed immediately downslope to protect other lands and waterways from pollution.

3.4.7 Diversion Banks and Channels

A number of existing diversion banks and channels have been previously constructed to control slope lengths and to divert water to required locations. Diversion banks and channels will be implemented and maintained in accordance with the Blue Book (Landcom 2004) and DECC 2008 (refer to Blue Book standard drawings SD 5-5 and SD 5-6 included in Appendix 4). All new diversion banks and channels will be constructed to remain stable whilst conveying peak discharges during a 20 year ARI storm event at less than erosive velocities for the channel construction materials.

3.4.8 Contour Banks and Drains

Contour banks will be installed where overland flow lengths exceed 80 m. Diversion drains will be provided at the ends of contour banking to convey stormwater to a sediment basin prior to treatment and management. Any new internal roads will grade to table drains which will convey flows to diversion drains.

All drains will be constructed to remain stable whilst conveying peak discharges during a 20 year ARI storm event at less than erosive velocities for the channel construction materials.

Drains will either be rehabilitated with grass species or rock armoured if required to manage erosivity of flow. Catch drains will be constructed with 1:3 (v:h) side slopes or less and will be grassed or rock armoured channels. Peak velocities will generally be kept below 1.5 m/s. Where peak velocities are likely to exceed 1.5 m/s, rock bars will be placed along the drain at intervals no greater than 30 m to reduce peak velocities, or flumes will be used. In addition, where drains are used in locations where the grade of the drain exceeds 5%, the drain is to be lined with a suitable material (refer to Table A3 of the Blue Book) to reduce the potential for erosion.

3.4.9 Inspections and Maintenance

Regular inspections of all disturbed areas and access tracks/roads will be undertaken to ensure drainage is working effectively and disturbed areas and tracks/roads are stable, particularly after rain. These inspections will be undertaken during construction and operation as follows.

- During construction, all temporary controls (including sediment dams, drains etc) will be inspected:
    - Daily for high risk controls such as within drainage lines;
    - Weekly for all other controls;
    - Prior to significant forecasted rainfall events (>25 mm over a 24 hour period);
    - After significant rainfall events (> 25 mm over a 24 hour period); and
- During the operational phase, monthly inspections of long-term erosion and sediment controls will be undertaken as well as inspections prior to and after significant forecasted rainfall events.

All erosion and sediment control measures, including drainage control measures, will be maintained in proper working order throughout their operational lives. All erosion and sediment control measures will be maintained in a functioning condition during construction until all construction activities are completed and full stabilisation of the site is achieved (i.e. > 70% ground cover across the whole of the disturbed area within the catchment).

All sediment fences and detention systems (sediment basins) will be kept in good working condition. In particular, attention will be given to:

- recent works to ensure that they have not resulted in diversion of sediment laden water away from them;
- degradable products (i.e. sediment fence) to ensure they are replaced as required; and
- sediment removal as required.

Visual inspections of water quality in sediment basins will be undertaken after storm events and comments on the visual water quality will be recorded on inspection records.

4.0 Water Balance

The water balance model was developed for the Southern Extension Project using the Goldsim modelling package. The model is a daily time step model. The model uses the historical meteorological records from 1960 to 2017 from the Bureau of Meteorology's Lidsdale monitoring station (Station ID 63132) with infill from the Lithgow climate monitoring station (Station ID 63226) in years with data gaps.

Inflows to the water balance occur primarily through rainfall runoff. Groundwater inflow is not significant due to the coal seams being depressurised by historical underground mining. Where possible, dirty and mine water is reused for dust suppression. The water balance also considers seepage from existing mining areas/voids to the underground workings and associated seepage out of the underground workings to the north-east into Baal Bone workings.

4.1 Water Sources

Following are the water sources to the Invincible Colliery:

- rainfall runoff to site water storages;
- stored water in the Invincible underground workings; and
- stored water in the Ivanhoe #2 underground workings.

4.2 Water Demands and Losses

Following are the water demands at the Invincible Colliery:

- dust suppression of haul roads and other disturbed areas; and
- evaporation from water storage surfaces.

4.3 Assumptions and Bases

The predictive water balance analysis was undertaken based on the WMS and catchments for Year 1 of the Southern Extension Project and the assumptions and bases in the following sections. The water balance was also run for the existing WMS to assess the potential for the Invincible underground workings to fill to the historical maximum recorded water level without inflows from the Ivanhoe #2 underground workings.

4.3.1 Operational

The Year 1 model has been prepared using the following operational assumptions and bases:

- all water captured in sediment dams will be transferred to the MSD;
- 80% of runoff to the Southern Extension Area is captured in sumps and transferred to the MSD;
- water transfer rates from sediment dams are based on a 5 day pump out of the settling zone volume;
- a maximum haul road watering demand for dust suppression of 10 mm per day; and
- water for haul road dust suppression will be sourced from the Northern Void to increase available capacity in the Invincible underground workings.

4.3.2 Rainfall and Evaporation

As discussed in the Surface Water Assessment for the Invincible Southern Extension Project, three Bureau of Meteorology (BoM) rainfall stations lie within close proximity to Invincible: Station 63132 Lidsdale (9 km south-east); Station 63071 Portland (6 km south); and Station 63226 Lithgow (21 kilometres south-east).

Of these three BoM rainfall stations, Lidsdale is considered most representative of rainfall conditions at Invincible due to its topographical location and also the completeness of the data set.

Daily rainfall has been recorded at Lidsdale (Station 63132) since 1960. Rainfall is generally spread evenly across the year, with slightly higher falls in late spring and summer and lower falls in autumn. For use in the water balance, periods of incomplete rainfall data at the Lidsdale gauge have been infilled with data sourced from Lithgow (Station 63226). **Table 17** presents the rainfall statistics for the data set used in the water balance (Lidsdale data with infilled Lithgow data).

Shoalhaven Coal operates a meteorological monitoring station at Invincible (refer to **Figure 2-3**). In 2013 and 2014, the site recorded 543 mm and 695 mm of rainfall respectively. The site measured rainfall for 2013 and 2014 compares well with the rainfall depths recorded at the Lidsdale BoM station of 630.8 mm and 735 mm respectively. Although, from 2015 to 2017 the rainfall depths recorded at the Lidsdale BoM station were found to be over 100 mm greater than that recorded by the site meteorological monitoring station. However, the use of Lidsdale BoM station rainfall data is considered to be conservative as the Project has low water demands, large inventories of water in the Invincible underground workings and a relatively short life of mine (approximately 6 years).

Table 17 Water Balance Rainfall Data

Statistic	Rainfall (mm)
Minimum	330
10th Percentile	513
50th Percentile	759
90th Percentile	928
Maximum	1171

Source: Bureau of Meteorology, 2016 (combined Lithgow and Lidsdale data set)

Two relatively wet years have occurred since the latest water balance model. The rainfall recorded for these years (875.6 mm in 2021 and 982.4 mm in 2020) is within the range of climatic conditions assessed in the water balance model. As such, no additional modelling is required to assess the performance of the water management system under the current conditions.

4.3.3 Runoff Modelling

- catchment runoff from disturbed and natural catchments has been estimated using a soil store model with natural catchment runoff calibrated to the average regional runoff of 0.8 ML/year (NSW Farm Dams Calculator(https://www.waternsw.com.au/customer-service/water-licensing/basic-water- rights/harvestable-rights-dams/maximum-harvestable-right-calculator);

- the estimated average annual runoff for catchments with surface cracking and subsidence is 2.1 ML/year based on a proportion of infiltration reporting directly to the WMS; and

- the natural catchment upslope of the Southern Extension has been conservatively modelled with increased total runoff captured to account for increased inflows to the pit as a result of surface cracking in the catchment associated with historical mine subsidence (as per the rate above).

4.3.4 Invincible underground Seepage Outflow

While seepage rates from the Invincible underground workings to Baal Bone have been estimated by AGE (2017) it is believed that the calculated outflows are underestimated. Based on a review of historical aerial imagery, the water level in the Northern Void, which represents the water level in the Invincible underground workings (refer to **Section 2.2.4**) has remained relatively stable since mining operations ceased at the Invincible Colliery in 2013. This indicates that the inflows to and outflows from Baal Bone are in equilibrium. The inflows to the Invincible underground workings are rainfall and runoff to the Northern Void, seepage from runoff draining to the open cut voids (Eastern Void, Renown Pit, Pit 209) and passive seepage from site sediment dams.

Given the apparent stability of the Northern Void water level, the maximum seepage outflow has been estimated based on the maximum modelled annual volume of direct runoff, seepage and transfers reporting to the Invincible underground workings for the period 2012 to 2017 (refer to **Section 4.4.1**).

4.4 Results

4.4.1 Invincible Underground Seepage Outflow

As outlined in **Section 4.4.1**, the outflow seepage from the Invincible underground workings used in the water balance model has been assumed to be the maximum modelled annual volume of direct runoff, seepage and transfers reporting to the Invincible underground workings for the period 2012 to 2017.

Table 18 presents the modelled inflows to the Invincible underground workings for the period 2012 to 2017 and shows that maximum modelled inflow was 665 ML in 2016.

Table 18 Inflows to Invincible Underground, 2012 – 2017

Year	Inflow (ML)
2012	619
2013	491
2014	338
2015	489
2016	**665**
2017	400

4.4.2 Year 1 Water Management System

Results for the statistical 10th percentile, 50th percentile and 90th percentile gross water balance (excluding imports and discharges) are presented in **Table 19**. Detailed results for the 50th percentile gross and net (including imports and discharges) water balance are presented in **Table 20**. The predicted annual minimum, average and maximum volume of discharges via LD002, frequency of discharges via LD002 and dewatering volumes from the Ivanhoe #2 underground workings are presented in **Table 21**, **Table 22** and **Table 23** respectively.

Table 19 Gross Water Balance

Statistic	Result (ML/year)
10th Percentile	214
50th Percentile	365
90th Percentile	513

The gross water balance results demonstrate that the operation will operate with a water surplus in the first year. Given the large volume of water stored in the Invincible underground workings to supplement dust suppression demands in dry years and the sites relatively low water demands when compared to WMS inflows (refer to **Table 20**), it is unlikely that the site will experience a shortage of water.

Table 20 Median Year Water Balance, Detailed Results

Parameter	Result (ML)
INFLOWS	
Rainfall and Runoff	909
Ivanhoe #2 Transfers	540
Total Inflows	**1,449**
OUTFLOWS	
Evaporation	100
Invincible Underground Outflow to Baal Bone	665
Haul Road Dust Suppression	298
Sediment Dam Spills	6
MSD Wet Weather Discharge (LD002)	374
Total Outflows	**1443**
Change in Storage	6
Net Water Balance	**0**

Table 21 LD002 Annual Discharge Volumes

Statistic	Result (ML/year)
Minimum	112
Average	366
Maximum	727

Table 22 LD002 Discharge Frequency

Statistic	Result (events/year)
Minimum	1
Average	6
Maximum	17

Water balance modelling predicts that on average there will be six discharges from the MSD via LD002 with an annual average discharge volume of 366 ML.

Table 23 Ivanhoe #2 Dewatering Volumes

Statistic	Result (ML/year)
Minimum	130
Average	477

Statistic	Result (ML/year)
Maximum	542

Water balance modelling predicts that on average, most of the estimated volume of water presently stored within the Ivanhoe #2 underground workings (refer to **Section 2.2.4**) will be dewatered within the first year of mining in the Southern Extension area.

4.4.3 Invincible Underground Storage

Water balance modelling predicts that during high rainfall years, the volume of water stored in the Invincible underground workings will reach the estimate capacity of the underground workings. **Table 24** presents the number of years (out of 58 modelled rainfall years) where the Invincible underground workings is predicted to reach capacity for the existing WMS and the Year 1 WMS (including water transferred from the Ivanhoe #2 workings).

Table 24 Invincible Underground at Capacity, Existing and Year 1 Scenarios

Scenario	Years
Existing	3
Year 1 (including water from Ivanhoe #2 workings)	8

The results in **Table 24** demonstrate that even without transfers from the Ivanhoe #2 underground workings, inflows from rainfall and runoff may result in the Invincible underground workings reaching storage capacity. While the water balance model predicts five additional rainfall years where the Invincible underground workings reach storage capacity, the TARPs for management of Invincible underground workings storage levels (refer to **Section 6.2**) which include a detailed program of inspections and monitoring of the Invincible Underground water storage levels will minimise the risk of groundwater "daylighting". Further, the actual rate of outflow from the Invincible underground workings to Baal Bone and the available storage capacity within the Invincible Underground workings are presently based on limited data. When mining operations commence in the Southern Extension area, Shoalhaven Coal will implement a monitoring program (refer to **Section 5.1.3.3**) that will include monitoring of all water transfer volumes to the Northern Void and continuous monitoring of the Northern Void water level to refine the estimates of the Invincible underground workings outflow seepage rate and stage storage relationship. The water level response to inflow water transfers in the Northern Void will also be used to inform the required actions and limits in the TARPs. For example, should the Northern Void water level increase at higher rate than is expected based on the present understanding of the available storage capacity, the water level limit to restrict transfers to the Invincible underground workings may be lowered.

5.0 Licensing, Monitoring and Reporting

5.1 Surface Water

5.1.1 Water Access Licensing

Operational

Water licensing for the Southern Extension Project is governed by the *Water Management Act 2000* and applicable WSPs. As discussed in **Section 2.1.1**, the Invincible open cut workings and the Southern Extension Area are wholly within the area regulated by the Water Sharing Plan for the *Macquarie Bogan Unregulated and Alluvial Water Sources 2012* (Macquarie Bogan WSP) and is located in the Turon Crudine River water source. The Macquarie Bogan WSP commenced in October 2014.

The Southern Extension Project does not result in any change to the catchment managed within the WMS compared to the existing or approved operations. That is, there is no material difference between the water captured under the existing approved operating scenario, the current care and maintenance scenario or the Southern Extension Project scenario. The existing operations at Invincible were approved in 2008 with the full extent of existing approved operations approved on 12 August 2009. The open cut footprint had reached its full extent (and the WMS catchment was at it full extent) by early 2012 and runoff from the Southern Extension area and upstream catchment (other than that intercepted via subsidence impacts) was captured and managed as part of the Invincible WMS from at least the mid-1980s.

All the mine water and sediment dams at Invincible are designed to contain dirty water on-site, such as to prevent contamination of Cullen Creek. These dams would therefore meet the definition of an 'excluded work' under Schedule 1 of the *Water Management (General) Regulation 2018* (WM Regulation), provided they are located on a minor stream.

Environmental Dam, SD4, SD5 and SD6 are located on 2nd order streams shown on the NSW government's hydroline spatial data. SD2 is not located on a mapped watercourse. Dams on 2nd order streams or unmapped watercourses are deemed to be located on 'minor streams'. Therefore, these dams meet the definition of 'excluded works' under the WM Regulation and are therefore exempt from water licensing requirements.

The Main Storage Dam and SD3 are located on 3rd order streams. The Southern Extension Area will also intercept a 3rd order tributary of Cullen Creek. Third order streams outside the definition of 'minor stream' and as such, these storages are not excluded works. Accordingly, WALs will be required for the clean water captured by these storages.

The Macquarie Bogan WSP prescribes an allocation of 316 units (for unregulated river licences) to the Turon Crudine River Water Source. Shoalhaven Coal will consult with the Natural Resources Access Regulator (NRAR) regarding the appropriate approach to obtaining the required WALs.

Final Landform

The conceptual final landform for the Southern Extension Project does not include any final voids and no dams are presently proposed as part of the final land use for the rehabilitated mine site. Notwithstanding, Shoalhaven Coal will consult with DPI Water on the licensing requirements associated with the final landform as part of the detailed mine closure process for the mine required to be undertaken as the mine progresses towards the end of the approved mining resources.

The allowable annual water take under Harvestable Rights provisions is calculated based on the average regional runoff rate (as published by DPI Water on the Farm Dams Calculator website). Shoalhaven Coal owns a land area of approximately 146 hectares. Based on the capture of 10 percent of the average regional runoff (http://www.water.nsw.gov.au/water-licensing/basic-water-rights/harvesting- runoff/calculator) this equates to a Maximum Harvestable Rights Dam Capacity (MHRDC) of 11.68 ML per year i.e. the total capacity of dams allowable without a licence under Harvestable Rights provisions. The Invincible final landform currently does not include

provision for retention of farm dams within the landform. Shoalhaven Coal may, depending on the final landuse and associated potential lots, retain specific dams within the proposed final landform. The volume of these dams will not exceed the MHRDC for each land parcel, or if this volume is exceeded, water access licences will be allocated to the land parcel to allow for water take associated with each dam.

5.1.2 Environment Protection Licence

Operations at Invincible are currently undertaken in accordance with EPL 1095 under the Protection of the Environment Operations Act 1997. Invincible propose to continue to operate under EPL 1095, which will be varied to incorporate additional water quality limit conditions for wet weather discharges (refer to **Section 2.1.12**). Due to the time that has elapsed since operations were last undertaken, Shoalhaven Coal will also consult with EPA prior to recommencement of mining to ascertain if any other variations to EPL 1095 are required.

5.1.3 Monitoring Program

5.1.3.1 Water Quality

Surface water quality monitoring will be undertaken as follows:

- Monthly sampling at Cullen Creek D/S and Cullen Creek U/S for first 12 months of operation. Review and reduce monitoring frequency to quarterly if consistent results, otherwise continue with monthly. Water samples will be analysed for the parameters listed in **Table 6** and **Table 7**. Any proposed change to the water quality frequency will be detailed in a revised water management plan prior to any changes occurring;
- Monthly sampling from the MSD. Water samples will be analysed for the parameters listed in **Table 9**;
- Sampling from sediment dams prior to transfer to MSD. Water samples will be analysed for TSS to confirm TSS concentrations are <35 mg/L prior to transfer; and
- Daily sampling commencing within 24 hours of discharge at LD002. Water samples will be analysed for the parameters listed in **Table 8**.

5.1.3.2 Water Quantity

The following water quantity parameters will be monitored:

- Visual observation of flows (flow/no flow) during water quality sampling at Cullen Creek U/S and Cullen Creek D/S;
- LD002 discharge volume;
- The daily volume of water transferred from the Ivanhoe #2 underground workings to the Invincible underground workings;
- The volume of water transferred from sediment dams (for each sediment dam dewatering event) to Invincible underground workings;
- The monthly volume of water consumed for haul road and open area dust suppression;
- The monthly volume consumed for crushing and stockpile dust suppression;
- Water storage volumes at the end of each month; and
- Daily rainfall depth.

The water quantity parameters listed above will be utilised to calibrate the numerical site water balance model by:

- Gauging catchments to allow calibration of the runoff model for the site and upslope catchments;

- Allowing the estimate of seepage outflow from the Invincible underground workings to be refined; and
- Confirming site operational water demands.

Water quantity monitoring data (including inflows, operational water demands, mine water inventory changes and pumped water transfers) will be used to develop an analytical water balance for the site. This site water balance will be updated annually and presented in the Annual Review required by Schedule 5, Condition 4 of MP 07_0127.

5.1.3.3 Channel Stability and Riparian Vegetation Health

As no monitoring of channel stability and riparian vegetation health has previously been undertaken downstream of the Invincible Colliery, a baseline assessment at selected locations between LD002 and Cullen Creek D/S will be undertaken prior to the commencement of mining. The baseline assessment will be used to develop the ongoing channel stability and riparian health monitoring program (survey points and frequency of survey) as well as detailed objective, performance criteria and trigger levels. This WMP will be updated with the proposed channel stability and riparian vegetation health monitoring program and submitted to DPE for approval within twelve months of the commencement of mining in the Southern Extension area.

The updated WMP will include TARPs to respond to deviations from baseline channel stability and riparian vegetation health conditions.

The channel stability assessment methodology based on the CSIRO Ecosystem Function Analysis – Ephemeral Stream Assessment Guidelines (CSIRO Guidelines) (CSIRO, nd). There are four main classes of indicators identified in the CSIRO Guidelines which were assessed to evaluate the degree of stream bed condition:

a) the type and condition of the vegetation present, if any;

b) the shape and profile of the drainage line and type and condition of materials on the drainage line floor;

c) the nature of the drainage line wall materials; and

d) the nature of the stream bank bordering flats and/or slopes and regulation of lateral flow into drainage line.

These four main classes of indicators are broken down into eight visual indicators and used to assess channel stability (CSIRO, nd). These eight visual indicators are described in **Table 25** to **Table 32** (CSIRO, nd).

The assessment was undertaken for Coxs River, Ben Bullen Creek, Baal Bone Creek and Jews Creek by traversing the stream beds (on-foot where practical) during a site survey conducted on 25 and 26 June 2018. The monitoring program targeted areas of active erosion which were identified in the 2014 monitoring program and surveyed areas immediately upstream, downstream and within impact areas (both underground and surface infrastructure impacts). The monitored sites included:

- Co-2, Co-3 and Co-4 on Coxs River;
- Be-1, Be-2, Be-3, Be-4, Be-5 and Be-6 on Ben Bullen Creek;
- Ba-2 and Ba-3 on Baal Bone Creek; and
- Je-1 on Jews Creek.

Where significant erosion or deposition of the creek beds was observed an assessment of the eight visual indicators as identified in the CSIRO Guidelines was undertaken to assess the erosion state of the watercourse. Estimates of the channel width and depth and photographs of upstream, downstream and at least one bank (or both left and right banks where accessible) were also taken at each assessment point.

Significant erosion or deposition was defined as erosion of the stream bed and banks and/or deposition of eroded material of greater than 30% of the original channel bed.

Table 25 A.1: Vegetation on Drainage Line (D/L) Floor (CSIRO, nd)

Rating	Description
1	Little or no vegetation growing on drainage line floor
2	Any vegetation present is annual or short-lived: partial burial of plants by recently deposited sediment evident.
3	Dense perennial plant cover, similar to vegetation on floodplain/riparian zone: characteristic wetland species composition: no observable plant burial by sediment.

Table 26 A.2: Vegetation on Drainage Line (D/L) Walls (CSIRO, nd)

Rating	Description
1	Little or no vegetation growing on drainage line walls.
2	Any vegetation present is annual or short-lived: partial burial of plants by recently deposited sediment evident.
3	Dense perennial plant cover, similar vegetation on floodplain/riparian zone: characteristic wetland species composition: no observable plant burial by sediment.

Table 27 B.1: Shape and Aspect Ratio of Drainage Line Cross-Section (CSIRO, nd)

Rating	Description
1	Very actively eroding: caving, mass wasting and/or tunnelling present: depth >> width (aspect ratio high)
2	Actively eroding: slight undercutting, near vertical walls, alluvial fans also eroding: depth = width
3	Potentially stabilising: side walls become rounded and crusted alluvial fan at foot of side walls: width > depth
4	Stabilising: wall angles less than 65°, small inactive alluvial fan at foot of side walls: width > depth
5	Stable: gently sloping walls, generally low, "S" shaped bed/bank continuum: width >> depth (aspect ratio very low)

Table 28 B.2: Longitudinal Morphology of Drainage Line (CSIRO, nd)

Rating	Description
1	Currently incising bed in pre-existing loose sediment; faceted lower wall/bed profile (benches), scour holes in bed. Morphology implies high flow rates and erosion.
2	Flat, continuous, loose sediment with signs of recent/frequent movement
3	Flat with a cohesive fine textured "soil-like" bed
4	Non-cascading pools or ponds, with non-slaking, non-dispersive clay base, implying low energy flow

Table 29 B.3: Particle Size of Materials on Drainage Line Floor - Material Available for Erosion (CSIRO, nd)

Rating	Description
1	Material on floor is similar or smaller in particle size and/or density than material in the walls (e.g. unconsolidated fine sand deposits)
2	Material on floor is slightly larger in particle size and/or denser (more consolidated) than material on walls (e.g. well sorted gravel)
3	Material on floor is much larger in particle size and/or denser than material on walls: surface armouring (e.g. cobbles, competent country rock)

Table 30 C.1: Nature of Drainage Line Wall Materials (CSIRO, nd)

Rating	Description
1	Dispersive material is exposed for greater than 1 metre of wall height
2	Materials that slake rapidly, or disperse are exposed on greater than 0.3 metres and less than 1 metre of vertical wall height (the sum of multiple layers if present)
3	Materials that slake and/or disperse are exposed on less than 0.3 metre of wall height
4	Materials than do not slake or disperse are exposed on wall surface

Table 31 D.1: Shape of Stream-bordering flats and/or slopes (CSIRO, nd)

Rating	Description
1	Very steep slope, > 30° creating high velocity flows
2	Steep bank, 10-30°, permitting moderate to high velocity flows
3	Moderately sloped bank, 5-10°
4	Gently sloped bank/floodplain, laterally extensive, < 5°
5	Woodland with dense litter: very low, diffuse inflow rate

Table 32 D.2: Nature of Lateral Flow Regulation into Drainage Line (CSIRO, nd)

Rating	Description
1	Side arm channel inflow: very high inflow rates
2	Bare bank, laterally extensive
3	Sparse grassland/woodland with bare soil bank lip: moderate flow rate, some highly focused inflow locations
4	Dense grassland: low inflow rate, mostly diffuse
5	Woodland with dense litter: very low, diffuse inflow rate

The sum of the values assigned for each of the eight indicators produces a rating (as a percentage of the total) which is used to rank each assessment point from very actively eroding through to very stable according to **Table 33** below (CSIRO, nd).

Table 33 Classification of different drainage line states (CSIRO, nd)

Activity Rating (%)	Classification	Description of Classification
80+	Very Stable	Drainage line is very stable and likely to be in original form. It is able to withstand all flow velocities that have previously occurred in this area and only minimal monitoring is required, predominantly after high flow events, to ensure condition does not deteriorate.
70-80	Stable	Drainage line is stable. It is important to assess this zone in relation to the other classifications and define whether this zone is moving from potentially stabilising to a more stable form or if it is deteriorating from a very stable form. The nature of this relationship will identify the type of monitoring required.
60-69	Potentially Stabilising	Drainage line is potentially stabilising. Ongoing monitoring is required while rehabilitation works are not needed in the immediate future.
50-59	Active	Drainage line is actively eroding and remedial actions are required. It is important to classify if erosion is caused primarily by upstream flows, lateral flows or unstable wall materials so that appropriate rehabilitation can be carried out.
< 50	Very Active	Drainage line is very actively eroding and immediate remedial actions are required. It is important to classify if erosion is caused primarily by upstream flows, lateral flows or unstable wall materials so that appropriate rehabilitation can be carried out.

5.1.4 Reporting

5.1.4.1 Incidents

Where an incident relating to surface water management has occurred Shoalhaven Coal will:

- immediately notify the Secretary and any other relevant agencies of any incident; and
- within 7 days of the date of the incident, provide the Secretary and any relevant agencies with a detailed report on the incident, and such further reports as may be requested. This report must include the time and date of the incident, details of the incident, measures implemented to prevent re- occurrence and must identify any non-compliance with this consent.

5.1.4.2 Effectiveness of Water Management System

The effectiveness of the Invincible Colliery WMS will be assessed and reported on in the Annual Review (refer to **Section 5.1.4.3**) based on the following:

- a site water balance based on water monitoring results;

- a review of receiving surface water quality results outside of trigger value range that can be attributed to mine operations (refer to **Table 6**);
- a review of discharges from LD002 outside of the limit conditions for EPL 1095 (refer to **Section 2.1.12**);
- a review of any instance of "daylighting" of groundwater from the Invincible underground workings (refer to **Section 2.2.4**); and
- the number of sediment dam spills with consideration of installed capacity and recorded rainfall events.

5.1.4.3 Annual Review

The following information relating to water management is provided in the Annual Review:

- A summary and assessment of receiving water quality monitoring results with respect to baseline water quality and potential mine impacts;
- A summary and assessment of discharge water quality monitoring results with respect to EPL discharge criteria;
- A site water balance outlining water source inflows, operational water demands, mine water inventory changes and updated Invincible underground outflow estimates;
- Details of any complaints received in relation to surface water; and
- An assessment of the overall effectiveness of the WMS with respect to surface water.

5.1.5 Publication of Monitoring Data

Section 66 of the POEO Act requires the publication of monitoring data that required to be collected under an EPL. In relation to water monitoring, EPL 1095 requires monitoring of oil and grease, pH and TSS during discharges. In accordance with Section 66 of the POEO Act, such discharge monitoring data will be published on the Shoalhaven Coal website within 14 days of the monitoring event.

5.2 Groundwater

5.2.1 Licences

As explained in **Section 2.2.5**, the coal seam in the vicinity of Invincible has ceased to be an aquifer due to depressurisation from historic mining activities. As such, there is no groundwater take associated with the Southern Extension Project.

Water that has accumulated in the historic underground workings is primarily a result of rainfall infiltration through subsidence induced cracking. The underground mining activities that induced the subsidence cracking were completed prior to commencement of the relevant WSP. In particular, the subsidence cracking within the Southern Extension Area was caused by a third party (Ivanhoe #2 Colliery). Therefore, the rainfall runoff taken by the underground workings is due to events beyond Shoalhaven Coal's control and the Southern Extension Project will not exacerbate the existing water take.

Shoalhaven Coal currently holds one WAL (WAL 35978) for water sourced from the NSW Murray-Darling Porous Rock Groundwater Sources Water Sharing Plan with an allocation of 26 unit shares (equivalent to 26 ML per year assuming full allocation) in the groundwater source.

5.2.2 Baal Bone Groundwater Extraction and Licensing

Baal Bone Colliery commenced its mine closure phase in 2019. Given that it is no longer actively dewatering its mine workings, seepage from Invincible to Baal Bone Colliery is expected to be less than the rates that occurred prior to

its closure. Notwithstanding, Shoalhaven Coal will assist the owner of the Baal Bone Colliery if any licensing enquiries arise.

5.2.3 Monitoring Program

Unlike most mining operations, the target coal seams at Invincible are already in a depressurised state. As such, monitoring of groundwater depressurisation is not a key concern of the monitoring program. Instead, the key groundwater issue for the Southern Extension Project is the management of water accumulated in the former Ivanhoe #2 workings. In particular, monitoring will be undertaken to ascertain the following:

- Volume and quality of water taken from the Ivanhoe #2 workings;
- Volume and quality of water in the Invincible underground workings; and
- Volumes of water pumped into the Invincible underground workings.

Table 34 presents a summary of the existing Invincible Colliery monitoring bores. **Figure 2-3** shows the location of the monitoring bores.

Table 34 Existing Invincible Colliery Groundwater Monitoring Bores

Bore ID	Hole Depth (mbgl)	Screen (mbgl)	Target
LD001	104	100 – 104	Lithgow Coal Seam (Invincible Colliery flooded underground workings)
BHTH12	36	31 – 34	Lithgow Coal Seam (Ivanhoe No.2 Colliery flooded workings)
BH2	39.5	29.9 – 32.9	Lithgow Coal Seam (Coal barrier between Ivanhoe No.2 Colliery and Invincible Colliery underground workings)

Note: mbgl (metres below ground level)

Bores BH2 and BHTH12 will be mined in the early stages of the Southern Extension Project. Two new bores (IVAN01 and IVAN02) will be established immediately east of the Southern Extension area to ensure continuity of monitoring the Ivanhoe #2 workings.

At present, water levels in the Invincible workings are monitored through LD001, which is a considerable distance north-east of the Southern Extension Area. Two new bores (INV01 and INV02) will be installed near the south-western limit of the Invincible underground workings to provide a better indication of water levels near the Southern Extension Area.

Two of the proposed bores may also be used for dewatering and transfer of water between the Ivanhoe and Invincible workings. Indicative locations of the new bores are shown on **Figure 2-3**.

5.2.4 Water Quality

Groundwater quality monitoring will be undertaken as follows:

- Monthly sampling from the Northern Void until backfilled. Water samples will be analysed for the parameters listed in **Table 10**; and
- Monthly sampling from LD001, BHTH12 (until it is mined) and the new monitoring bores to be installed.

Water quality monitoring at both new monitoring bores will indicate whether there are any water quality implications of transferring water from the Ivanhoe #2 to Invincible underground workings.

5.2.5 Water Levels

Groundwater level monitoring will be undertaken as follows:

- Monthly water level monitoring in the Northern Void;
- Monthly level monitoring of LD001, BHTH12 (until it is mined) and the new monitoring bores to be installed;
- Additional monitoring of new monitoring bores prior to and following transfer of water from Ivanhoe #2 to Invincible;
- Daily inspections of area of potential daylighting during Ivanhoe #2 dewatering; and
- Weekly inspections of area of potential daylighting while sediment dam water is still being transferred to the Invincible UG.

Given that seepage through the coal barrier is limited, water levels in the Ivanhoe #2 and Invincible underground workings will be affected predominantly by pumped transfers. Water level monitoring immediately before and after pumping will be sufficient to evaluate storage in these workings. Real time monitoring of water levels (using data loggers) is not warranted as other sources of inflow are minimal.

5.2.6 Water Quantity

Groundwater quantity monitoring will be undertaken as follows:

- The volume of water extracted under WAL 35978 in accordance with the conditions of the WAL; and
- The volume of water transferred from the Ivanhoe #2 underground workings to the Invincible underground workings.

5.2.7 Reporting

The following information relating to water management is provided in the Annual Review:

- A summary and assessment of groundwater water quality monitoring results;
- A summary and assessment of groundwater levels in the Invincible underground workings;
- Details of any complaints received in relation to groundwater; and
- An assessment of the overall effectiveness of the WMS with respect to groundwater.

5.3 Training and Awareness

All personnel and contractors working at the Invincible Colliery will undergo an induction. This induction includes information on the management measures as detailed within this WMP.

Tool-box meetings will be held to discuss whole-of-site production, management, safety and environmental issues. Matters relating to water management will be raised during these meetings, when necessary.

6.0 Trigger Action Response Plans

Section 6.1 contains Trigger Action Response Plans (TARPs) related to surface water monitoring results that are observed to be outside of the normal range (see **Table 35** to **Table 38**). **Section 6.2** contains TARPs related to groundwater and extraction depth monitoring results that are observed to be outside of the normal range. As additional monitoring data becomes available and the understanding of the Invincible underground workings stage storage relationship is developed, the Invincible Underground High Level TARP (refer to **Table 36**) will be updated as required.

The TARP includes a trigger related to the water level in the Northern Void. It was previously hypothesised that the underground storage may be nearing its capacity if the water level in the Northern Void exceeded 894.2mAHD. Recent monitoring has indicated that the Northern Void water level has reached 899.96 mAHD without any evidence of groundwater 'daylighting'. This suggests that the available underground storage is greater than previously estimated. It is proposed that a new trigger for storage in the Invincible underground workings will be developed based on water level in the new monitoring location near the Southern Extension Area. Until this occurs, a trigger based on the maximum recorded Northern Void water level (899.96 mAHD) will be used in the interim.

The water quality triggers in the TARP are currently based on monitoring data at LD001. As explained in **Section 5.2.3**, new monitoring bores are proposed to be installed near the Southern Extension Area. New trigger values will be derived based on data collected by the new bores. However, it is generally accepted that two years of baseline data is required to form a reliable dataset. The existing triggers based on LD001 will continue to be used until sufficient baseline data has been collected by the new monitoring bores.

6.1 Surface Water TARPs

Table 35 Receiving Water Quality TARP

Trigger	Strategy for Mitigation	Monitoring Point	Monitoring Action	Response
Downstream receiving water quality outside of trigger value range in **Table 7**	Water management strategy to minimise the likelihood of off-site discharges.	Cullen Creek D/S	Repeat water quality sampling and analysis if result is suspected of being in error and continue monitoring on a monthly basis.	Review monthly water quality monitoring results. TARP for additional results outside of baseline range is included below.
Three consecutive water quality results outside of the trigger value range in **Table 7**	Water management strategy to minimise the likelihood of off-site discharges.	Cullen Creek D/S	Maintain monthly monitoring until: • cause is identified; or • water quality results are confirmed not to be a result of mine operations; or water quality results return to within the trigger value range.	Investigate potential contributing factors including: • Climatic conditions • Changes in mine operating practices • Compare upstream (Cullen Creek U/S) and site (MSD, Northern Void) water quality results to downstream (Cullen Creek D/S) monitoring results to assess potential for contribution to out of range results at Cullen Creek D/S • Assess area of potential "daylighting" to confirm that there is no seepage outflow from the Invincible underground workings • Assess sediment dams for excessive seepage • Engage a water quality specialist (if required) to undertake a preliminary investigation If the investigation determines that the contributing factors are not as a result of mine operations, then the issue will be reported in the Annual Review only. If the deviation of receiving water quality is found to be a result of mine operations:

Trigger	Strategy for Mitigation	Monitoring Point	Monitoring Action	Response
				• Immediately notify the EPA, DPE and DPI Water • Take actions agreed in consultation with the EPA, DPE and DPI Water to mitigate the mine's impacts on receiving water quality. Such actions may include transferring water from any water storages contributing to the deviation in water quality to another storage Undertake remediation, if required, of the impacted receiving environment to the satisfaction of the EPA, DPE and DPI Water

6.2 Groundwater TARPs

Table 36 Invincible Underground High Level TARP

Trigger	Strategy for Mitigation	Monitoring	Monitoring Action	Response
Water level in Northern Void rises to 899.96 mAHD (historical maximum surveyed water level in Northern Void)	Continuous water level monitoring of Northern Void.	Ongoing level monitoring. Visual inspections of area of potential groundwater "daylighting".	Increase visual inspections of area of potential groundwater "daylighting" to daily. Note: If this occurs during period of Ivanhoe #2 water transfers, daily inspections will already be occurring.	If daylighting of groundwater is observed, cease all water transfers to the Invincible underground workings: • No dewatering of the Ivanhoe #2 underground workings • Segregate runoff to the Southern Extension pit from the Ivanhoe #2 underground water where possible for transfer to the MSD if required. • Dewater sediment dams to the MSD Do not recommence water transfers to the Invincible underground workings until: • The water level in the Northern Void subsides to below 899.96 mAHD

Table 37 Groundwater Seepage TARP

Observation	Strategy for Mitigation	Monitoring	Monitoring Action	Response
Apparent groundwater seepage at or near area of potential "daylighting"	Continue water level monitoring of Northern Void.	Ongoing level monitoring. Visual inspections of area of potential groundwater "daylighting".	Collect samples of water seepage. Sample to be analysed for the parameters listed in **Table 10**.	Cease all water transfers to the Invincible underground workings: • No dewatering of the Ivanhoe #2 underground workings • Segregate runoff to the Southern Extension pit from the Ivanhoe #2 underground water where possible for transfer to the MSD if required. • Dewater sediment dams to the MSD Confirm correct functionality of water level monitoring equipment at the Northern Void and complete repairs/recalibration as required. This will require surveying the water level in the Northern Void. Compare seepage water quality results with routine water quality monitoring results for the Northern Void. If the seepage is confirmed to be sourced from water stored in the Invincible underground workings: • Immediately notify the EPA, DPE and DPI Water • Take actions agreed in consultation with the EPA, DPE and DPI Water to prevent/minimise the quantity of seepage flowing to the downstream environment. Such actions may include collecting the seepage in a sump and transferring the seepage to an on-site water storage. • Undertake remediation of the impacted

Observation	Strategy for Mitigation	Monitoring	Monitoring Action	Response
				receiving environment if required, to the satisfaction of the EPA, DPE and DPI Water

Table 38 Groundwater Quality TARP

Observation	Strategy for Mitigation	Monitoring	Monitoring Action	Response
One water quality result in the Northern Void or at LD001 outside of respective trigger values in **Table 10** and **Table 12**	Monitoring of Ivanhoe #2 water quality prior to transfers to the Invincible underground workings. Sediment Dam water quality results demonstrate superior water quality to water presently stored in the Invincible underground workings.	Monthly water quality monitoring. Monitoring of water transfer volumes to Invincible underground workings.	Continue routine water quality and volume monitoring	If water quality result(s) are within the minimum and maximum range maintain routine monitoring regime. If the water quality result(s) are outside the minimum and maximum range, collect another sample and have analysed for the relevant parameters. If the result is confirmed investigate potential contributing factors: • Water transfers to the Northern Void/Invincible underground workings and compare available water quality results • Any incidents/spills that could have impacted on Northern Void/LD001 water quality • Recent climatic conditions • If no mining operational impacts can be identified maintain routine monitoring regime. • If potential mining operational impacts are identified: o Immediately take steps to stop the potential operational impact (e.g. stop a particular water transfer) o Assess for any actual or potential

Observation	Strategy for Mitigation	Monitoring	Monitoring Action	Response
				environmental harm ○ Notify the EPA, DPE and DPI Water of any actual or potential environmental harm • Undertake remediation of the impacted receiving environment, if required, to the satisfaction of the EPA, DPE and DPI Water
Three consecutive water quality results in the Northern Void or at LD001 outside of respective trigger values in **Table 10** and **Table 12**	Monitoring of Ivanhoe #2 water quality prior to transfers to the Invincible underground workings. Sediment Dam water quality results demonstrate superior water quality to water presently stored in the Invincible underground workings.	Monthly water quality monitoring. Monitoring of water transfer volumes to Invincible underground workings.	Increase water quality monitoring frequency to weekly Maintain volume monitoring regime.	Investigate potential contributing factors: • Water transfers to the Northern Void/Invincible underground workings and compare available water quality results • Any incidents/spills that could have impacted on Northern Void/LD001 water quality • Recent climatic conditions Engage a water quality specialist (if required) to undertake a preliminary investigation. If potential mining operational impacts are identified: ○ Immediately take steps to stop the potential operational impact (e.g. stop a particular water transfer) ○ Assess for any actual or potential environmental harm ○ Notify the EPA, DPE and DPI Water of any actual or potential environmental harm • Undertake remediation of the impacted receiving environment, if required, to the satisfaction of the EPA, DPE and DPI Water

7.0 Implementation

7.1 Review and Improvement

Ongoing monitoring and review on the performance and implementation of this WMP will be undertaken in accordance with the Invincible EMS and Project Approval, requires review of the plan within 3 months of the submission of:

- An annual review under Condition 4, Schedule 5 of the Project Approval;
- An incident report under Condition 7, Schedule 5 of the Project Approval;
- An Independent Environmental Audit report under Condition 9, Schedule 5 of the Project Approval; and
- Any modifications to the consent.

Shoalhaven Coal will notify DPE in writing of any review of this WMP. If a review leads to any revisions to this WMP, the revised document will be submitted to DPE within 4 weeks of the review. Updated versions of this WMP will be made publicly available on the Shoalhaven Coal website in accordance with Condition 13 Schedule 5 of the Project Approval.

7.2 Adaptive Management

In accordance with Schedule 2, Condition 7 of the Project Approval, Shoalhaven Coal will assess and manage water related risks to facilitate compliance with the water quality objectives outlined in this plan.

Where a non-compliance or exceedance of performance criteria has occurred, Shoalhaven Coal will implement the mitigation, monitoring and contingency response strategies outlined in **Section 6.0** and at the earliest opportunity:

- take all reasonable and feasible steps to ensure the exceedance ceases and does not reoccur;
- consider all reasonable and feasible options for remediation (where relevant);
- within 7 days of the exceedance occurring submit a report to the Secretary describing those options and any preferred remediation measures or other course of action; and
- implement remediation measures as directed by the Secretary to the satisfaction of the Secretary.

Following such an event, the management and monitoring measures outlined in this plan will be reviewed to determine whether any changes are required to avoid recurrence of such an incident.

Incidents will be reported to the Secretary and other relevant agencies in accordance with Schedule 5, Condition 9 of MP 07_0127. If required, specialists will be engaged to investigate the cause of the incident and develop mitigation or remediation measure. A detailed report on the incident will be provided to the relevant agencies within 7 days of the incident occurring. Incidents will also be managed in accordance with the Invincible Colliery Pollution Incident Response Management Plan.

Incidents and non-compliances will also be reported in the Annual Review in accordance with Schedule 5, Condition 4 of MP 07_0127.

7.3 Contingency Plan

Unanticipated impacts (i.e. outside the predictions of previous assessments) will generally be managed through the TARPs in **Section 7.3**. However, if an unexpected event occurs that is outside the scope of the TARPs, the following contingency plan will be implemented:

- Cease any activities that may be causing the unanticipated event;
- Conduct an investigation into the cause of the unanticipated event, with assistance from experts (where necessary);
- If the investigation determines that operational activities at Invincible have contributed to the unanticipated event, appropriate response measures will be developed;
- Notify the Secretary and relevant agencies of the unanticipated event, the outcomes of the investigation and the proposed response measures;
- Undertake the recommended response measures in consultation with the relevant agencies; and
- Update this management plan with the proposed response measures to mitigate against similar impacts occurring in the future.

If the investigation determines that the unanticipated event is not caused by operations at Invincible, regular operations can recommence without any further action.

8.0 Definitions

The terminology utilised within this WMP is defined in **Table 39** below.

Table 39 Definitions

Term	Definition
ANZG	The Australian and New Zealand Guidelines for Fresh and Marine Water Quality
CCC	Community Consultative Committee
CAA	Controlled Activity Approval
DA	Development Application
DPI	Department of Industry
DPE	Department of Planning and Environment
EC	Electrical Conductivity
EIS	Environmental Impact Statement
EPA	Environment Protection Authority
EPL	Environment Protection Licence
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
ESCP	Erosion and Sediment Control Plan
Incident	An occurrence or 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 approval.
MDB	Murray Darling Basin
OEH	Office of Environment and Heritage
Secretary	The Secretary of the NSW Department of Planning and Environment, including any authorised delegate or nominee.
SWMP	Water Management Plan
TARP	Trigger Action Response Plan
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
WAL	Water Access Licence
WMP	Water Management Plan
WSP	Water Sharing Plan

9.0 References

Umwelt (Australia) Pty Ltd, 2016, Invincible Southern Extension Project Surface Water Assessment. Umwelt (Australia) Pty Ltd, 2017, Invincible Southern Extension Project Response to Submissions Part B.

Umwelt (Australia) Pty Ltd, 2017, Response to issues raised by EPA in letter dated 13 September 2017 (letter to Clay Preshaw, Director Resource and Energy Assessments, DP&E, dated 23 October 2017)

Australian and New Zealand Governments and Australian state and territory governments, 2018. The Australian and New Zealand Guidelines for Fresh and Marine Water Quality.

Australian Groundwater and Environmental Consultants, 2016. Invincible Southern Extension Project – Groundwater Impact Assessment.

Australian Groundwater and Environmental Consultants, 2016. Invincible Southern Extension Project – Groundwater Impact Assessment – Response to Submissions.

Australian Groundwater and Environmental Consultants, 2022. Invincible Southern Extension – Information for Water Management Plan.

Department of Environment and Climate Change (DECC), 2008. Managing Urban Stormwater – Soils and Construction, Volume 2E – Mines and Quarries.

King D., 1993. Soil Landscapes of the Wallerawang 1:100 000 Map Sheet. Soil Conservation Service of NSW.

Landcom, 2004. Managing Urban Stormwater – Soils and Construction, Volume 1, 4th Edition.

WRM Water and Environment Pty Ltd, 2011. Coalpac Consolidation Project Surface Water Impact Assessment.

WRM Water and Environment Pty Ltd, 2012. Review of Surface Water Management at Invincible Colliery.

WRM Water and Environment Pty Ltd, 2014. Invincible Modification Surface Water Assessment.

APPENDIX 1

Regulatory Consultation

DOC22/425339-1

Via e-mail: almy.bryce@ccoal.com.au

20 June 2022

MISCELLANEOUS MANAGEMENT PLANS
Invincible Colliery - Licence 1095

I refer to your e-mail dated 30 May 2022 and request for the Environment Protection Authority (EPA) to review a noise management plan prepared for the Invincible Colliery. I also refer to an e-mail received from Ms Almy Bryce, dated 11 May 2022, in regard to an air quality management plan and a water management plan and a similar request for EPA comment on these plans.

The EPA encourages the development of Environmental Management Plans/Programs to ensure that proponents have determined how they will meet their statutory obligations and environmental objectives as specified by any Project/Development Approval and/or the conditions of an Environment Protection Licence. Please note however that it is not the EPA's role to endorse these plans given the EPA sets conditions/criteria for environmental protection and management and therefore cannot be directly involved in the development of strategies to comply with such conditions/criteria.

The EPA has reviewed its files and can confirm that no advice was provided to Shoalhaven Coal Pty Limited in 2018 with respect to any of the three draft management plans. Regardless, the EPA has now reviewed the following 3 plans and provides comment on each below:

- Invincible Colliery: Water Management Plan (December 2018, Draft)
- Invincible Colliery: Air Quality Management Plan (November 2018, Draft)
- Invincible Colliery: Noise Management Plan (May 2022, Draft).

Site Water Management Plan

The EPA notes that:

- The Southern Extension Project will not alter the catchment managed within the current water management system compared to the existing or approved operations.
- Sediment dam 3 is currently undersized however Shoalhaven Coal commits to enlarging this dam prior to the recommencement of mining activities.
- A clean water diversion strategy will be prepared by Shoalhaven Coal prior to the recommencement of mining activities.

Phone 131 555
Phone +61 2 6333 3800
TTY 133 677
ABN 43 692 285 758
Locked Bag 5022
Parramatta NSW 2124
Australia
4 Parramatta Square,
12 Darcy Street,
Parramatta NSW 2150
Australia
info@epa.nsw.gov.au
www.epa.nsw.gov.au

- Calculations were made in 2018 regarding the volume of water (540 ML) that would be required to be dewatered from the Ivanhoe No.2 historical workings to the old Invincible workings to enable excavation at the Southern Extension Project. The EPA queries whether the predicted volume is still accurate considering the significant rainfall within the past 2 years and the potential for this volume to be greater than the capacity of the old Invincible workings to receive this water. The EPA is also aware that Baal Bone ceased pumping groundwater in 2019 which may also diminish this capacity. The water management plan should consider what contingencies may need to manage excessive groundwater noting that a direct discharge to the environment (via surface waters) would not be viewed by the EPA as an appropriate management method.
- Environment Protection Licence number 1095 (the licence) for the Invincible Colliery will require varying to update water quality limits and associated operational conditions to reflect standard licencing conditions with respect to dam maintenance and wet weather events. It is recommended Invincible Colliery submit a licence variation application as a matter of urgency. Appropriate supporting documentation will be required with any application received.

Air Quality Management Plan

The EPA notes that:

- In section 2.2 of the Air Quality Management Plan (AQMP), a statement is made regarding the need to vary the licence to reflect the proposed monitoring as described in section 6.0 of the AQMP. The proposed changes to the air monitoring schedule include the relocation of the PM10 high volume air sampler to an off-site location and the dropping of the total suspended particulate matter sampling (to be determined via calculation from PM10 measurements). The EPA has not received any application to vary the licence at this point. A detailed rationale for the proposed changes would be required to support such an application and why there is a need to deviate away from what is currently undertaken at the premises and from what was proposed in the Mod 5 Environmental Assessment (Umwelt, 2016).
- The licence will require varying to reflect standard licencing conditions with respect to the management of dust generation at the premises and the emission of odour. These standard licencing conditions are consistent with the commitments summarised in Table 2.2 of the AQMP (re dust generation) and condition 15, Schedule 3 of Project Approval 07_0127 (Mod 5) re odour generation.

Noise Management Plan

The EPA notes that:

- Figures 1 and 2 were not included in the draft document provided to the EPA.
- The licence will require varying to reflect the noise limits in Project Approval 07_0127 (Mod 5), to update the ancillary noise conditions to reflect current standard wording and to include a reference to the Noise Policy for Industry in relation to noise modification factors.
- Prior to any licence variation, the EPA would require clarification regarding the acquisition status of the properties Hill View and Billabong (these properties have specific noise limits in the Project Consent).

If you have any specific questions regarding this matter please contact Mr Andrew Helms on 6333 3805 or via e-mail at EPA.Southopsregional@epa.nsw.gov.au. For general enquiries to the EPA please call (02) 9995 5000 or e-mail info@epa.nsw.gov.au.

Yours sincerely

SHERIDAN LEDGER
A/Manager
Regulatory Operations Regional South

Contact: Department of Planning and Environment—Water
Phone: 1800 633 362
Email: waterlicensing.servicedesk@dpie.nsw.gov.au

Our ref: DOC22/240908, V15/3875-3#25

6 September 2022

Attention:

Email:

Re: Invincible Colliery Water Management Plan (07_0127)

Thank you for giving the Department of Planning and Environment—Water the opportunity to review Invincible Colliery Water Management Plan (07_0127).

Department of Planning and Environment—Water recommends the following prior to approval of the Water Management Plan;

1. Groundwater Monitoring and Reporting
   a) Prior to further review of the WMP by the Department of Planning and Environment, the monitoring bore network should be expanded to assess potential for overall changes and impacts to water levels around the southern excavation and Invincible underground workings including any:
      i) Drawdown and/or depressurisation resulting from dewatering related to the Southern Extension.
      ii) Changes to groundwater levels from increased inflows into the Invincible underground workings as well as between Invincible underground and Baal Bone mine
      iii) changes in water quality in the Invincible underground workings resulting from inflows of water currently stored in Ivanhoe No.2 underground workings
      iv) changes to groundwater levels and quality as a result of spoil placement. Where backfilling is likely to be delayed, a schedule of proposed monitoring should be provided.
   b) Monitoring of drawdown/depressurisation should include depths down to the base of the proposed mining operations – ie to the affected base of the Lithgow coal seam, approximated in the EA at 900 mAHD; up to 97 mbgl, or to the lowest level of proposed dewatering - whichever is the greater depth.
   c) Data loggers should be installed in all monitoring bores to automatically measure water levels.
2. The revised WMP should include:
   a) details of existing and additional monitoring bores including purpose, drilling logs and construction details
   b) incorporation of additional bores in the monitoring program to cover the full extent of the dewatering cone of depression, that dewatering will create.
   c) details of a program to report on or validate the groundwater model for the project and compare the monitoring results with modelled predictions. This should include a program for monitoring and analysis of the ongoing head-storage relationship in Invincible underground, and the hydraulic head relationship between the Northern void

and Invincible workings and the potential for daylighting

d) redefined groundwater assessment criteria and TARPs once additional monitoring bores are installed.

   i) Data from LD001 should be considered as indicative only and not used to assess trigger values.

e) a commitment to installation of metering for dewatering of Ivanhoe No.2 Underground workings. Metering instruments should meet the NSW Government's requirements for water meters and relevant Australian standards

f) include an updated erosion control plans and baseline assessment of channel stability and riparian vegetation health

3. Conceptual Model
   An updated conceptual hydrogeological model (diagram) should be included in the WMP. The conceptual model should be supported with cross section(s) and a map showing expected and measured groundwater heights and flow, existing measured and predicted flooding of underground voids, locations of potential daylighting, and proposed finished levels of the Southern Extension floor.

4. Water Balance
   A revised water balance should be presented in more detail and include all estimated seepage rates, dewatering volumes, and delineation between surface water volumes which enter the ground and that which remains at surface.

5. RMP
   The RMP should incorporate the WMP once approved

6. Neighbouring Operations

   a) A protocol should be prepared in consultation with the owner of the Baal Bone mine to ensure all groundwater take, including increased inflows to the Baal Bone underground workings, is appropriately licensed.

Licencing

7. Condition 26 requests the proponent to have sufficient entitlements for all stages of the project. The proponent holds 26ML in the Murry Darling Porous Rock Groundwater Source. It is noted in the WMP that there are inflows into Invincible Underground over 600ML/year. It is unclear if sufficient entitlement is held, confirmation of licencing arrangements for the development is required.

8. Confirm licencing arrangements for the dams onsite particularly the Environmental Dam and Main Storage Dam. The WMP notes that the Main Storage Dam captures clean water from upstream on the mine working areas. Capture of this clean water should be licenced or meet an exemption.

Should you have any further queries in relation to this submission please do not hesitate to contact the Department of Planning and Environment – Water at waterlicensing.servicedesk@dpie.nsw.gov.au.

Yours Sincerely

Bryson Lashbrook
Manager (East)
Licensing and Approvals
Department of Planning and Environment—Water

Department of Planning and Environment

Mr Kevin Reed
Director, Shoalhaven Coal PTY LTD
PO Box 3011
BOWENFELS NSW 2790

18/10/2022

Dear Mr Reed

Invincible Colliery (MP 07_0127)
Water Management Plan - Request for Additional Information

I refer to the Water Management Plan submitted to the Department of Planning and Environment (the Department) as required under the conditions of approval for the Invincible Colliery. After careful consideration, the Department is requesting that you provide additional information, which is detailed in Attachment A (see attached).

You are requested to provide the information, or notification that the information will not be provided, to the Department by 1 November 2022. If you are unable to provide the requested information within this timeframe, you are required to provide, and commit to, a timeframe detailing the provision of this information.

If you have any questions, please contact Melanie Hollis, who can be contacted on 8217 2043 at melanie.hollis@planning.nsw.gov.au.

Yours sincerely
APPROVERSIGNATUREANDDETAILSWILLBEINSERTEDHERE

Attachment A - Invincible Colliery *MP 07-0127*
Water Management Plan Review

Condition 22, Schedule 3 – Water Supply	***Sufficient (Yes/No/Partial)***	***Comment***	***Action Required***	***Company Response***
The Proponent must ensure that is has sufficient water for all stages of the project, and if necessary, adjust the scale of the operations on site to match its available water supply. *Note: Under the Water Act 1912 and/or the Water Management Act 2000, the Proponent is required to obtain all necessary water licences for the project.*		Section 1.4.4 notes the WALs held by Shoalhaven Coal. Water licensing is also discussed in Section 5 of the Plan. Further licenses are required and it is noted that Shoalhaven Coal will consult with NRAR regarding the appropriate approach to obtaining the required WALs.	Nil	-
Condition 23, Schedule 3 – Compensatory Water Supply	***Sufficient (Yes/No/Partial)***	***Comment***	***Action Required***	***Company Response***
The Proponent must provide a compensatory water supply to any landowner of privately owned land whose water supply is adversely and directly impacted (other than an impact that is negligible) as a result of the project, in consultation with DPI Water, 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 attributed to the project. Equivalent water supply should be provided (at least on an interim basis) within 24 hours of the loss being identified. If the Proponent and the landowner 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 Proponent is unable to provide an alternative long-term supply of water, then the Proponent must provide alternative compensation to the satisfaction of the Secretary.	**Yes**	Section 1.4.5 outlines how Shoalhaven Coal will provide a compensatory water supply.	Nil	-
Condition 24, Schedule 3 – Discharge limits	***Sufficient (Yes/No/Partial)***	***Comment***	***Action Required***	***Company Response***

<table>
<tr><td>Any water discharged from the site must comply with Section 120 of the POEO Act and, unless expressly provided by an EPL, must not exceed:
(a) the default ANZECC electrical conductivity trigger value for lowland rivers; and
(b) all other default ANZECC trigger values for 95% species protection and relevant potential contaminants.</td><td>Yes</td><td>The discharge criteria for the site are summarised in Section 2.1.12.</td><td></td><td></td></tr>
<tr><td>Condition 25, Schedule 3 – Clean Water Diversion Strategy</td><td>Sufficient (Yes/No/Partial)</td><td>Comment</td><td>Action Required</td><td>Company Response</td></tr>
<tr><td>Prior to recommencing mining operations, unless the Secretary agrees otherwise, the Proponent must prepare a Clean Water Diversion Strategy for the project to the satisfaction of the Secretary. This strategy must:
(a) be prepared in consultation with DPI Water;
(b) investigate all reasonable and feasible measures to minimise the capture of clean water on site; and
(c) include a detailed description of the measures to be implemented and a plan for the implementation of these measures.</td><td>Yes</td><td>Described in Section 3 of the Plan.</td><td>Nil</td><td>-</td></tr>
<tr><td>Condition 26, Schedule 3 – Water Management Performance Measures</td><td>Sufficient (Yes/No/Partial)</td><td>Comment</td><td>Action Required</td><td>Company Response</td></tr>
<tr><td>The Proponent must comply with the performance measures in Table 7 to the satisfaction of the Secretary.

Table 7 Water Management Performance Measures
<table>
<tr><th>Feature</th><th>Performance Measure</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.
• No direct discharge of water dewatered from the Ivanhoe No. 2 workings.
• Design, install operate and maintain water management systems in a proper and efficient manner.</td></tr>
<tr><td>Clean water diversion & storage infrastructure</td><td>Maximise, as far as reasonable and feasible, the diversion of clean water around the disturbed areas on site.</td></tr>
<tr><td>Sediment dams</td><td>Design, install and maintain the dams generally in accordance with the series Managing Urban Stormwater: Soils and Construction – Volume 1 and Volume 2E Mines and Quarries.</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></tr>
<tr><td>Overburden, CHPP reject materials</td><td>Design, install and maintain emplacements to prevent or minimise the migration of pollutants due to seepage</td></tr>
<tr><td>Chemical and hydrocarbon storage</td><td>Chemical and hydrocarbon products to be stored in bunded areas in accordance with the relevant Australian Standards.</td></tr>
</table></td><td>Yes</td><td>Described in Section 3 of the Plan.</td><td>Nil</td><td>-</td></tr>
</table>

Attachment A - Invincible Colliery *MP 07-0127*
Water Management Plan Review

Condition 27, Schedule 3 – Water Management Plan	***Sufficient (Yes/No/Partial)***	***Comment***	***Action Required***	***Company Response***
Prior to recommencing mining operations, unless the Secretary agrees otherwise, the Proponent must prepare a Water Management Plan for the project to the satisfaction of the Secretary. This plan must:	**Yes**	This Plan has been submitted to the Secretary prior to recommencing mining operations.	Nil	-
(a) be prepared in consultation with DPI Water and the EPA, by suitably qualified and experienced persons whose appointment has been approved by the Secretary;	**Yes**	The Plan has been prepared in consultation with DPE Water and the EPA. Section 1.4.6 summarises were comments have been addressed in the Plan. Copies of the correspondence is included in Appendix A.	Nil	-
(b) include detailed performance criteria and describe measures to ensure that the Proponent complies with the water management performance measures;	**Partial**	See comments below.		
(c) in addition to the standard requirements for management plans (see Condition 3 of Schedule 5), this plan must include a: (i) Site Water Balance that: ▪ includes details of: ○ sources and security of water supply, including contingency planning for future reporting periods; ○ water use and management on site, including details of water sharing between neighbouring mining operation; ○ any off-site water transfers and discharges; ○ reporting procedures, including the preparation of a site water balance for each calendar year; and ▪ investigates and implements all reasonable and feasible measures to minimise water use on site;	**Partial**	The Site Water Balance is detailed in Section 4 of the Plan.	Please clarify the annual update of the site water balance for the Project.	An annual water balance will be prepared using actual monitored inflows and outflows. See updates to Sections 5.1.3.2 and 5.1.4.2.
(ii) Surface Water Management Plan that includes: ▪ detailed baseline data on surface water flows and quality in creeks and other waterbodies that could be affected by the project; ▪ a program to augment the baseline data over the life of the project; ▪ a detailed description of the relevant discharge limits as required by condition 24 of schedule 3;	**Partial**	Detailed baseline data is provided for both surface water and groundwater. Discharge limits are described in	Please provide further detail, that addresses DPE Water's comments	Water levels in the Northern Void are and will be monitored monthly, as the void provides an indication of

▪ a detailed description of the water management system on site, including the; ○ clean water diversions, as informed by condition 25 of this schedule; ○ sediment dams and associated infrastructure; ○ mine water management system; ○ measures to be implemented to ensure that water from Ivanhoe No.2 workings is not directly discharged off-site; and ○ reinstatement of drainage lines on the rehabilitated areas of the site; ▪ detailed objectives and performance criteria, including trigger levels for investigating any potential or actual adverse impacts associated with the project for: – dewatering the Ivanhoe No 2 workings; – downstream surface water quality; – stream and riparian vegetation health; – channel stability; – design and management for the emplacement of coal reject materials; – reinstatement of draining lines on the rehabilitation areas of the site; and – control of any potential water pollution from the rehabilitated areas of the site; ▪ a program to monitor and report on: – the effectiveness of the water management system; and – surface water flows and quality in the watercourses that could be affected by the project; – the performance measures listed in Table 7; – impacts on water users; ▪ reporting procedures for the results of the monitoring program; and ▪ a plan to respond to any exceedances of the trigger levels/and or performance criteria, and mitigate and/or offset any adverse surface water impacts of the project;		subsections of Section 2 of the Plan. Figure 3-2 shows the existing water management system. As advised by the EPA, there is a commitment to re-size SB3 prior to the recommencement of mining operations. Section 3.2.1 outlines the dewatering objectives for the Ivanhoe #2 workings. Figure 3-4 depicts the Project year 3 water management system. Section 3.4 outlines erosion and sediment controls.	on installing additional monitoring bores. ie "Where backfilling is likely to be delayed, a schedule of proposed monitoring should be provided". In Table 15 please review the footnote used for SD3.	groundwater levels (see Section 3.2.1). Further details of the additional bores are provided in Section 5.2.3, with indicative locations shown in Figure 2.3. The erroneous footnote for SD3 in Table 15 has been rectified.
(iii) Groundwater Management Plan that includes: ▪ detailed baseline data on groundwater levels, yield and quality in the region that could be affected by the development, including privately owned groundwater bores and groundwater dependent ecosystems: groundwater assessment criteria, including trigger levels for investigating any potentially adverse groundwater impacts; ▪ a program to monitor and report on: – groundwater supply of potentially affected landowners; – groundwater inflows to the open cut mining operations; – the seepages/leachate from water storages, emplacements and backfilled voids; – the background changes in groundwater yield/quality against mine-induced changes;	**Partial**	Detailed baseline data is provided for both surface water and groundwater. In section 2.2.3 it is noted that 20th and 80th percentile values from LD001 water quality parameters have been adopted as trigger values. Advice from	Please clarify how DPE Water's comments have been addressed with regard to using values from LD001 as trigger values.	Refer to Section 6.0.

– impacts of the project on: ○ regional and local (including alluvial) aquifers; ○ groundwater supply of potentially affected landowners; and ○ groundwater dependent ecosystems and riparian vegetation; – a program to validate the groundwater model for the project, and compare the monitoring results with modelled predictions; and ▪ a plan to respond to any exceedances of the trigger levels and /or performance criteria, and mitigate and/or offset any adverse groundwater impacts of the development;		DPE Water states that data from LD001 should be considered as indicative only and not used to assess trigger values. New monitoring bores will be installed prior to recommencing mining operations. The WMP will be revised to reflect new monitoring locations.	Review all TARPs for specific actions.	
(iv) a protocol that has been prepared in consultation with the owner of the Baal Bone mine to ensure all groundwater take, including increased inflows to the Baal Bone underground workings, is appropriately licensed.	**Partial**		Please clarify the assumption that the Baal Bone Colliery's existing licenses will be sufficient.	Shoalhaven Coal cannot make any warranty about Baal Bone holding sufficient licences. As explained in Section 5.2.2, Baal Bone's post-mining take is unlikely to be greater than the values previously experienced during active dewatering.
Condition 28, Schedule 3 – Water Management Plan	***Sufficient (Yes/No/Partial)***	***Comment***	***Action Required***	***Company Response***
The Water Management Plan approved by the Secretary must be implemented.	**-**	-	-	-
Condition 2, Schedule 5 – Adaptive Management	***Sufficient (Yes/No/Partial)***	***Comment***	***Action Required***	***Company Response***

The Proponent must assess and manage project-related risks to ensure that there are no exceedances of the criteria and/or performance measures in Schedule 3. Any exceedance of these criteria and/or performance measures constitutes a breach of this approval and may be subject to penalty or offence provisions under the EP&A Act or EP&A Regulation. Where any exceedance of these criteria and/or performance measures has occurred, the Proponent must, at the earliest opportunity: (a) take all reasonable and feasible steps to ensure that the exceedance ceases and does not recur; (b) consider all reasonable and feasible options for remediation (where relevant) and submit a report to the Department describing those options and any preferred remediation measures or other course of action; and (c) implement remediation measures as directed by the Secretary.	**Yes**	Described in Section 7.1.	-	-
Condition 3, Schedule 5 – Management Plans Requirements	***Sufficient (Yes/No/Partial)***	***Comment***	***Action Required***	***Company Response***
The Proponent must ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include: (a) detailed baseline data;	**Yes**	Section 2 of the Plan summarises the pre-mining environment. Baseline surface water quality data is provided in Section 2.1.9. Groundwater Baseline data is provided in Section 2.2.2.	Nil	-
(b) a description of: • the relevant statutory requirements (including any relevant approval, licence or lease conditions); • any relevant limits or performance measures/criteria; • the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures;	**Yes**	Table 2 and Sections 1.4.3 and 1.4.4 summarise the relevant statutory requirements for the Project. Water quality trigger values are described in Section 2.1.11. Discharge criteria are described in Section 2.1.12.	Nil	-
(c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;	**Yes**	Described throughout the Plan.	Nil	-

(d) a program to monitor and report on the: • impacts and environmental performance of the project; • effectiveness of any management measures (see c above);	**Yes**	Described throughout the Plan.	Nil	-
(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;	**Partial**	Contingency planning is described in Section 4, which alternate water uses.	Unclear on the reference to Section 0. Is further contingency planning missing for the Plan?	Refer to Section 7.3
(f) a program to investigate and implement ways to improve the environmental performance of the project over time;	**Yes**	Described in 5.1.4.2.	Nil	-
(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	**Partial**	A protocol for managing and reporting non-compliances is not provided. Exceedances of impact assessment criteria outlined in TARPs.		Refer to Section 7.2
(h) a protocol for periodic review of the plan.	**Yes**			
Condition 5, Schedule 5 - Revision of Strategies, Plans and Programs	***Sufficient (Yes/No/Partial)***	***Comment***	***Action Required***	***Company Response***
Within 3 months of: • the submission of an annual review under condition 4 above; • the submission of an incident report under condition 7 below; • the submission of an audit report under condition 9 below; or • any modification to the conditions of this approval, (unless the conditions require otherwise), the Proponent must review, and if necessary revise, the strategies, plans, and programs required under this approval to the satisfaction of the Secretary. Where this review leads to revisions in any such document, then within 4 weeks of the review, unless the Secretary agrees otherwise, the revised document must be submitted to the Secretary for approval. ***Note:*** *This is to ensure the strategies, plans and programs are updated on a regular basis, and incorporate any recommended measures to improve the environmental performance of the project.*	**Yes**	Described in Section 7.	Nil	

Condition 6, Schedule 5 - Updating and Staging Strategies, Plans or Programs	***Sufficient (Yes/No/Partial)***	***Comment***	***Action Required***	***Company Response***
To ensure the strategies, plans and programs are updated on a regular basis, and incorporate any recommended measures to improve the environmental performance of the project, the Proponent may submit revised strategies, plans or programs required under this approval at any time. With the agreement of the Secretary, the Proponent may also submit any strategy, plan or program required by this consent on a staged basis.	**Yes**	Noted throughout the Plan that it needs to be updated following updates to monitoring bores and sediment dam construction.	Nil	-
Condition 9, Schedule 5 – Incident Reporting	***Sufficient (Yes/No/Partial)***	***Comment***	***Action Required***	***Company Response***
The Proponent must immediately notify the Secretary and any other relevant agencies of any incident. Within 7 days of the date of the incident, the Proponent must provide the Secretary and any relevant agencies with a detailed report on the incident, and such further reports as may be requested.	**Yes**	Described in Section 5.1.4.1.	Nil	
Condition 10, Schedule 5 – Regular Reporting	***Sufficient (Yes/No/Partial)***	***Comment***	***Action Required***	***Company Response***
The Proponent must provide regular reporting on the environmental performance of the project on its website, in accordance with the reporting arrangements in any plans or programs approved under the conditions of this approval.	**Yes**		Nil	
General Comments				**Company Response**
• Correct references to Section 0 throughout the document. • Please adjust scale of Figure 3-3 so that the detail of the water management system can be clearly seen.				

Department of Planning and Environment

Our ref: MP 07_0127-PA-13

Mr Kevin Reed
Director
Shoalhaven Coal Pty Ltd
PO Box 3011
BOWENFELS NSW 2790

08/11/2022

Subject: Invincible Colliery Southern Extension – Water Management Plan

Dear Mr Reed

I refer to your submission dated September 2022, requesting approval of the Invincible Colliery Water Management Plan (Revision 1, September 2022). I also acknowledge your response to the Department's review comments and request for additional information.

I note the Invincible Colliery Water Management Plan has been prepared in consultation with the EPA and DPE Water.

The Department has carefully reviewed the document and is satisfied that it meets the requirements of the relevant conditions in approval MP 07_0127. Accordingly, as nominee of the Planning Secretary, I approve the Invincible Colliery Water Management Plan (Revision 2, November 2022).

You are reminded that if there are any inconsistencies between the Water Management Plan and the conditions of approval, the conditions prevail.

Please ensure you make the document publicly available on the project website at the earliest convenience.

If you wish to discuss the matter further, please contact Melanie Hollis on 8217 2043.

Yours sincerely

JEvans

Jessie Evans
Director, Resource Assessments
Resource Assessments

As nominee of the Planning Secretary