

Appendix 3 Surface Water and Groundwater Risk Assessment

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1. INTRODUCTION

This appendix presents a preliminary Surface Water and Groundwater Risk Assessment (RA) and Risk Register for the proposed Bickham coal mine project. The appendix summarises the aims and objectives of the RA, describes the methodology used throughout the RA process, as well as detailing the various findings and presenting them as a Risk Register.

2. AIMS AND OBJECTIVES

The RA assesses the risk of various activities associated with the water-related aspects of the project and suggests relevant management protocols. The risk management process consists of four steps:

1. Establish the context for the risk assessment process;
2. Identify the water-related risks;
3. Analyse the risks;
4. Evaluate the risks to determine the significant issues.

The following specific aims and objectives were established for the Bickham project RA:

- Identify the activities, aspects and possible environmental impacts associated with the operation of the proposed project;
- Consider these activities in isolation of any controls and determine a raw risk rating;
- Identify any controls required to mitigate or minimise the potential for environmental impacts in order to reduce the risk to the lowest level possible;
- Provide the basis for the development of an action plan which identifies the various issues that require further consideration during the environmental impact assessment of the proposed project.

3. SCOPE

This RA covers the proposed coal project, including the mine construction phase, as outlined below:

- Haul roads, mine infrastructure and workforce facilities;
- Overburden excavation plus progressive resource extraction and rehabilitation;
- Operation of the pit and the out-of-pit dumps;
- Coal crushing and stockpiling facilities;
- A rail loop and train loading facilities to allow coal transport to the Port of Newcastle;
- Site rehabilitation and final landform.

4. METHODOLOGY

This section outlines the methodology used to assign a Risk Rating to surface water and groundwater aspects of the proposed coal mining project. Risk assessment is the formalised means by which hazards and associated dangers are systematically identified, assessed and ranked according to perceived risk and managed by means of appropriate and effective controls.

Environmental Risk is the chance of something happening that will have an adverse impact upon the environment. The impact will vary in consequence from Catastrophic (a major event which could cause severe damage to the environment) through to Insignificant (no detrimental impact on the environment is measured or envisaged). The Environmental Risk Rating is measured in terms of consequence (severity) and likelihood (probability) of the event happening.

The allocation of an Environmental Risk Rating was based on the following qualitative measures of impact:

1	<p>Catastrophic</p> <p>A major event which could cause severe or irreversible damage to the natural and/or human environment.</p> <p>Involves death, toxic release off-site with detrimental effect, huge financial loss.</p> <ul style="list-style-type: none">• Major closure costs (i.e. estimated closure costs > \$5M).• Permanent premature closure of the mine.• Severe or irreversible damage to natural environment.• Could kill or permanently disable people.• Actual or potential loss of credibility with key stakeholders (community /government).• Long term environmental liability/legacy to the company.• Loss of global reputation for the company.• Regulatory intervention, prosecution would occur (i.e. fines).• Negative publicity/complaints (national and global media exposure).• Pollution event causes major downstream damage that is rectified by a long term remediation program over 12 months (eg failure of major tailings dam that pollutes international waters).• Total destruction of cultural heritage sites and artefacts.
2	<p>Major</p> <p>An event which could have a substantial and permanent consequence to the natural and / or human environment.</p> <p>Involves extensive injuries, loss of production capability, off-site release contained with outside assistance and little detrimental impact, major financial loss.</p> <ul style="list-style-type: none">• Major closure costs (i.e. estimated closure costs \$1M - \$5M).• Could cause temporary or long term closure of mine.• Substantial and permanent consequences to the natural environment.• Could cause serious injury or disease to people.• Potential loss of credibility with key stakeholders (community /government).• Reported incident, regulatory intervention which would result in prosecution.• Adverse publicity and community complaints (national media exposure).

	<ul style="list-style-type: none">• Pollution event which causes serious downstream damage that is rectified by a medium term remediation program over 1-12 months (e.g. failure of major tailings dam that pollutes regional/national waters).• Major permanent unrepairable damage to cultural heritage sites and artefacts.
3 Moderate	<p>An event which could create substantial temporary or minor permanent damage to the natural and / or human environment.</p> <p>Medical treatment required, on-site release contained with outside assistance, high financial loss.</p> <ul style="list-style-type: none">• Moderate closure costs (i.e. estimated closure costs \$500K - \$1M).• Could cause temporary closure of the mine or disruptions to the operation.• Substantial temporary or minor permanent damage to the natural environment.• A reportable incident not likely to result in prosecution.• Could cause typical lost time injury (LTI) to people.• Potential loss of credibility with key stakeholders (community / government).• Adverse local publicity and community complaints (local media exposure).• Event which causes substantial temporary damage that is rectified by medium term remediation program over 3 – 6 months (i.e. earthworks to fix surface cracking under public roads or works required to stop water leaking from water storage structures).• Substantial permanent unrepairable damage to cultural heritage sites and artefacts.
4 Minor	<p>An event which could have temporary and minor effects to the natural and / or human environment.</p> <p>First Aid treatment required, on-site release immediately contained, medium financial loss.</p> <ul style="list-style-type: none">• Minor closure costs (i.e. estimated closure costs \$100K - \$500K).• Temporary minor damage to the natural environment.• Could cause a first aid injury to people.• Complaints received from near neighbours.• Could result in government intervention but not likely to result in prosecution.• Event which causes temporary minor damage which may require some minor rectification works (i.e. cracking on surface causing minor erosion in drainage lines).• Minor repairable damage to cultural heritage sites and artefacts.
5 Insignificant	<p>No detrimental impact on the natural and / or human environment is measured or envisaged.</p> <p>No injuries, low financial loss, negligible environmental impact.</p> <ul style="list-style-type: none">• Minor closure costs (i.e. estimated closure costs <\$100K)• No detrimental impact to the natural environment.• Couldn't cause injury or disease to people.• No detrimental impacts to cultural heritage sites and artefacts.

The likelihood (or probability) of each impact occurring was also rated according to the qualitative measures.

Level	Descriptor	Description
A	Almost certain	Is expected to occur in most circumstances
B	Likely	Will probably occur in most circumstances
C	Possible	Could occur
D	Unlikely	Could occur but not expected
E	Rare	Occurs only in exceptional circumstances

A risk matrix based on these qualitative measures of consequence and likelihood was then used to measure risk and enable risk prioritisation.

Likelihood		Consequence				
		Catastrophic	Major	Moderate	Minor	Insignificant
		1	2	3	4	5
Almost Certain	A	E	E	E	H	H
Likely	B	E	E	H	H	M
Possible	C	E	E	H	M	L
Unlikely	D	E	H	M	L	L
Rare	E	H	H	M	L	L

These risks are prioritised such that:

Risk Ranking	Symbol	Description
Extreme Risk	E	Immediate action required
High Risk	H	Senior management attention needed
Moderate risk	M	Management responsibility must be specified
Low risk	L	Manage by routine procedures

Risk Rankings were allocated to surface and groundwater aspects of the project, based on two separate scenarios. The first considered no controls, which is a measure of the raw risk associated with the activity. The second considered the risk rating with either current controls (where applicable) or with the proposed controls recommended as part of the WMP (Part C).

In the context of this Risk Assessment a control is considered to be either a hard engineering control (e.g. bunds, diversions, etc) or administrative control (e.g. work procedure(s) and/or management plan).

5. RISK REGISTER

The following preliminary Risk Register documents the risk assessment outcomes for water-related aspects.

Appendix 3 - Surface Water and Groundwater Risk Register

Item	SW or GW	Activity	Aspect	Impact	Potential Risk			Proposed Controls			Residual Risk		
					C ¹	L ²	R ³	C ¹	L ²	R ³	C ¹	L ²	R ³
1	GW	Mining operations	Leakage from Pages River to pit through coal seam	Reduction in volume of surface water in Pages River	3	C	H	* C ¹ = Consequence, L ² = Likelihood, R ³ = Risk Rank * Refer Contingency Plan in Part C draft WMP * Cease pumping/dewatering * Implement remedial measures in Part C draft WMP	4	D	L		
2	GW	Mining operations	Excess groundwater inflows to pit requiring disposal	Change in water quantity in Pages River and/or Kingdon Ponds	3	D	M	* Refer Contingency Plan in Part C draft WMP * Independent investigation * Redesign mine plan * Expand program of disposal by irrigation/reuse of excess water	4	D	L		
3	GW	Mining operations	Baseflow impacts on Pages River or Kingdon Ponds	Baseflow reduction	3	C	H	* Refer Contingency Plan in Part C draft WMP * Provide additional suitable quality groundwater discharge to Pages River or Kingdon Ponds.	4	D	L		
4	GW	Mining operations	Very low groundwater inflow to pit	Inadequate supply of water for operational requirements	3	D	M	* Refer Contingency Plan in Part C draft WMP * Source alternative supply * Change mine plan or mining rate to accommodate available supply.	4	E	L		
5	GW	Mining operations	Interception of saline or acidic groundwater	Use and/or treatment depends on available water quality	3	D	M	* Refer Contingency Plan in Part C draft WMP * Investigate cause, continue monitoring, increase treatment if necessary	4	D	L		
6	GW	Mining operations	Drawdown interference with existing water supply bores	Existing water supply adversely impacted by mining operation	3	D	M	* Refer Contingency Plan in Part C draft WMP * Investigate cause, continue monitoring * Independent hydrogeologist to provide advice on remedial action	4	D	L		
7	GW	Mining operations	Change in groundwater quantity/quality	Impact on terrestrial groundwater dependent ecosystems	4	C	M	* Terrestrial ecology study (refer App 23) indicates majority of vegetation on and around the mine site unlikely to be groundwater dependent * Vegetation management will maintain or improve ecosystem function (App 23) * Refer Part C draft WMP for management and monitoring requirements	4	D	L		
8	GW	Mining operations	Change in groundwater quantity/quality	Impact on aquatic groundwater dependent ecosystems	4	C	M	* Aquatic ecology study (refer App 24) indicates existing aquatic habitat within affected drainage lines is not significant. * Rehabilitation should enhance aquatic habitat (App 24) * Refer Part C draft WMP for management and monitoring requirements	4	D	L		
9	GW	Construction of final landform	Existence of final void	Change in final water table levels and quality	4	C	M	* Refer Part C draft WMP for rehabilitation, management and monitoring actions * Vegetation management will maintain or improve ecosystem function (App 23)	4	D	L		
10	SW	Construction of haul roads Construction of mine pit Construction of surface facilities Construction of coal handling facility Construction of coal loader and rail loop Construction of water storages & sed.dams	Dust generation	Sediment discharge off-site	4	C	M	* Implementation of the ESC Plan (refer Part C draft WMP) * Staff inductions * Use of suitably qualified contractor * Contingency Plan for sediment discharge off-site (refer Part C draft WMP)	4	E	L		
11	SW	Operation of processing plant/crusher Transport of trucks on haul roads	Dust generation	Sediment discharge off-site	4	C	M	* Water balance modelling (refer App 19) indicates there will be adequate water for dust control * Part C draft WMP provides operating rules for water storages to ensure adequate water supply for dust suppression * Contingency Plan for sediment discharge off-site (refer Part C draft WMP)	4	E	L		
12	SW	Operation of coal loader and rail loop	Coal spillage	Mine water discharge off-site	4	C	M	* Runoff from processing area directed to mine water dam, from which there is no discharge to the environment * Earthworks design and drainage control * Contingency Plan for inadvertent discharge of mine water in Part C draft WMP	4	E	L		
13	SW	Transport of trucks on haul roads	Runoff from haul roads	Mine water discharge off-site	4	C	M	* Runoff from haul roads directed to mine water dams, from which there is no discharge to the environment * Earthworks design and drainage control * Contingency Plan for inadvertent discharge of mine water in Part C draft WMP	4	E	L		
14	SW	Operation of permanent surface facilities (office, bath house, workshop etc)	Runoff from permanent surface facilities	Mine water discharge off-site	4	D	L	* Runoff from facilities directed to mine water dams, from which there is no discharge to the environment * Earthworks design and drainage control * Contingency Plan for inadvertent discharge of mine water in Part C draft WMP	4	E	L		
15	SW	Operation of permanent surface facilities (workshop etc)	Oil spillage/leakage from workshop	Contaminated discharge off-site	4	D	L	* Runoff from facilities directed to mine water dams, from which there is no discharge to the environment * Earthworks design and drainage control * Contingency Plan for inadvertent discharge of mine water in Part C draft WMP	4	E	L		
16	SW	Operation of mine water management system	Leakage from pipelines	Contaminated discharge off-site	3	B	H	* Runoff from transfer pipes directed to mine water dams, from which there is no discharge to the environment * Earthworks design and drainage control * Contingency Plan for leakage from transfer pipes in Part C draft WMP	5	C	L		

Appendix 3 - Surface Water and Groundwater Risk Register

Item	SW or GW	Activity	Aspect	Impact	Potential Risk			Proposed Controls			Residual Risk		
					C ¹	L ²	R ³	C ¹	L ²	R ³	C ¹	L ²	R ³
17	SW	Operation of mine water management system	Overflow from sediment dams	Sediment discharge off-site	4	D	L	C ¹ = Consequence, L ² = Likelihood, R ³ = Risk Rank * Sediment basins designed for 95 th ile 5 day rainfall according to DECC's managing Urban Stormwater : Soils and Construction: Volume 2E * Discharge after 5 days settlement * Contingency Plan for sediment discharge off site	5	D	L		
18	SW	Operation of mine water management system	Sediment dam wall breach	Sediment discharge off-site	3	E	M	* Engineering design and controls * Inspections and maintenance * Contingency Plan for sediment discharge off site	4	E	L		
19	SW	Operation of mine water management system	Mine water dam wall breach	Contaminated discharge off-site	2	E	H	* Engineering design and controls * Inspections and maintenance * Contingency Plan for inadvertent discharge of mine water	4	E	L		
20	SW	Operation of mine water management system	Excess of mine water	Contaminated discharge off-site	4	C	M	* No discharge of mine water off-site (refer Part C draft WMP & App 19) * Excess water retained in pit until it can be used for dust suppression or irrigation * Contingency Plan to deal with excess of mine water (refer Part C draft WMP)	4	E	L		
21	SW	Operation of mine water management system	Shortage of mine water	Inadequate supply of water for operational requirements	4	C	M	* Water balance modelling (refer App 19) indicates that operational needs for water can be met at all times * WMP provides operating rules for water storages to ensure adequate water supply for dust suppression * Contingency Plan for shortage of mine water (refer Part C draft WMP)	4	E	L		
22	SW	Construction of overburden dumps	Erosion of overburden dumps Scouring of toe of overburden dump due to flooding	Sediment discharge off-site	3	C	H	* Geomorphology report (App 21) provides recommendations to ensure overburden stability (eg re-vegetation and stock exclusion) * Overburden slope designed to minimise erosion * Progressive rehabilitation * Construction of sediment dams to accept all runoff * Contingency Plan for scouring of overburden dump provided in Part C draft WMP	4	E	L		
23	SW	Alteration of landform within mine site	Alteration of surface water catchments within mine site	Reduction in flow in Pages River d/s mine	4	C	M	* Catchment draining to Pages River post-mine will reduce slightly. Refer Part B Section B8. * Monitor rehabilitated overburden runoff - when quality adequate allow runoff back into catchment. Refer Part C draft WMP	4	D	L		
24	SW	Alteration of landform within mine site	Alteration of surface water catchments within mine site	Reduction in flow in Kingdon Ponds d/s mine	4	C	M	* Area of catchment draining to Kingdon Ponds will temporarily decrease during life of mine but will revert back to pre-mining area on completion of mining	5	D	L		
25	SW	Alteration of landform within mine site	Alteration of surface water catchments within mine site	Reduction in flow to farm dams (on Glencoe) in Kingdon Ponds catchment	4	C	M	* Area of catchment draining to Kingdon Ponds will temporarily decrease during life of mine but will revert back to pre-mining area on completion of mining * Contingency Plan to provide additional water to Kingdon Ponds users if required	5	D	L		
26	SW	Construction of overburden dumps	Alteration of floodplain	Increase in flood levels in the Pages River	5	D	L	* Flood modelling indicates 100 y ARI flood levels increase by a maximum of 40 mm upstream of overburden (Refer App 20) * No significant impact	5	D	L		
27	SW	Construction of overburden dumps	Alteration of floodplain	Increase in velocities leading to channel stability in the Pages River	3	D	M	* Geomorphology report (App 21) provides recommendations to ensure overburden stability (eg re-vegetation and stock exclusion) * Overburden slope designed to minimise erosion. * Progressive rehabilitation to provide stabilisation. * Contingency Plan for scouring of overburden dump provided in Part C draft WMP	4	D	L		

6. RESULTS AND RECOMMENDATIONS

The findings of the RA indicate that the risks associated with groundwater and surface water can be mitigated using the measures proposed in the draft Water Management Plan (Part C). Once mitigation measures have been applied, all of the identified impacts have a low risk ranking.

Groundwater issues that may lead to adverse impacts include:

- Direct leakage from the Pages River to the pit;
- Excessive inflow rates to the pit;
- Excessive baseflow impacts to either the Pages River or Kingdon Ponds;
- Very low groundwater inflow rates to the pit;
- Drawdown interference with neighbouring water supply bores, wells or soaks;
- Interception of saline groundwater that might significantly elevate the salinity or lower the pH of the groundwater discharge into the pit or the dewatering bores;
- Salinity of in-pit water post-mining and whether this could adversely impact groundwater quality around the pit;
- Salinity of stormwater infiltrating through the out-of-pit dump and if this could adversely impact on groundwater/surface water quality;
- pH changes from any potential acid mine drainage, its occurrence and whether this could adversely impact on groundwater/surface water quality.

Surface water issues that may lead to adverse impacts include:

- Sediment discharge from the construction of the mine facilities or overburden dumps;
- Scouring at the toe of the northern overburden dump;
- Inadvertent discharge or leakage of mine water to the Pages River;
- Reduction of surface runoff to Kingdon Ponds;
- Impacts on water quality in the Pages River and Kingdon Ponds;
- Mine water exceeds predicted volumes;
- Mine water is significantly less than predicted.