Report

Caval Ridge Project EIS Supplement

Hazard Assessment for Dams

16 OCTOBER 2009

Prepared for

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Introduction

1.1 Background and Purpose

This report has been prepared for BHP Billiton Mitsubishi Alliance (BMA) to document a preliminary hazard assessment of proposed dams for the Caval Ridge project. The preliminary hazard assessment is to support the Environmental Impact Statement Supplement for the Caval Ridge project to address a submission from Queensland Department of Environment and Resource Management (DERM) which was raised in response to the Draft Environmental Impact Statement for the Caval Ridge Project.

1.2 Relevant Guidelines for Hazard Assessment

Previous guidelines to undertake hazard assessment of mine dams in Queensland were based on the State Government document "*Technical Guidelines for Environmental Management of Exploration and Mining in Queensland*" prepared the Queensland Department of Minerals and Energy 1995.

Under current legislation, the Queensland DERM regulates hazardous dams in Queensland under provisions of the *Environmental Protection Act 1994*, licensed through an Environmental Authority (EA) for the mine.

The guidelines to undertake hazard assessment of hazardous dams in Queensland are currently being revised and updated by Qld DERM. The most recent draft of the regulated dam guidelines "*Manual for Assessing Hazard Categories and Hydraulic Performance of Dams Version 1.1 – June 2009*" has been issued to peak industry organisations for comment and has not yet been finalised or endorsed as State Government policy. BMA (the project proponent) does not endorse some aspects of the June 2009 Version 1.1 draft of the regulated dam guidelines but considers the aspects of the draft guideline related to methods and criteria to determine hazard category for dams acceptable and applicable for the Caval Ridge project.

The preliminary hazard assessment outlined herein, is therefore based on the DERM "*Manual for Assessing Hazard Categories and Hydraulic Performance of Dams Version 1.1 – June 2009*" primarily for the purpose of assigning hazard category for the proposed Caval Ridge mine dams. It should be noted that the application of this draft DERM guideline for the hazard assessment does not infer that BMA endorse other aspects of the guideline for the purpose of design and performance criteria for hazardous dams.

1.3 Criteria and Assessment to Determine Hazard Category

The criteria and assessment to determine hazard category are outlined below are referenced from the DERM "*Manual for Assessing Hazard Categories and Hydraulic Performance of Dams Version 1.1 – June 2009*.

Dams are identified to be either Significant or High Hazard if triggered by any of the following criteria:

- Failure to contain the storage contents (e.g. dam overflow) can result in a level of harm determined from criteria outlined in Table 1.1;
- Loss of storage contents due to dam failure (e.g. dam break situation) can result in a level of harm determined from criteria outlined in Table 1.2;
- The contaminant characteristics and storage size exceed criteria outlined in Table 1.3; or

- The maximum height of embankments of the dam (relied upon to retain storage contents) exceeds 8m.

When a dam is determined to be either within Significant Hazard or High Hazard Category, a Significant or High Hazard is assigned based on the criteria outlined in Table 1.1 and Table 1.2.

Table 1-1 "Failure to Contain Scenarios"

ENVIRONMENTAL HARM	HAZARD CATEGORY		
	High	Significant	Low
Categories of Harm			
General environmental harm	Location such that harm to a significant environmental value is likely, or serious environmental harm is possible. Such a value might include the presence of protected or endangered flora or fauna.	The environmental value is of lesser significance and harm is possible but not likely, or material environmental harm is possible.	No environmental values of significance, or only trivial environmental harm is possible.
Loss or harm to humans	Location such that contamination of waters used for human consumption would occur, and consumption of contaminated waters by humans with consequent loss or harm is likely.	Location such that contamination of waters used for human consumption would occur, and consumption of contaminated waters by humans with consequent loss or harm is possible.	No contamination of waters used for human consumption expected.
Loss of stock	Location such that consumption of contaminated waters by stock with consequent loss or harm is likely.	Location such that consumption of contaminated waters by stock with consequent loss or harm is possible.	Contaminated water not available to stock or no harm expected from consumption.
General economic loss	Serious harm to communities, industrial, commercial or agricultural facilities, important utilities, or water resources in the failure path.	Material harm to industry, secondary roads, minor railways, public utilities, or water resources in the failure path.	Trivial harm to environmental values such as environmental nuisance arising from minor spills.

Table 1-2 "Dambreak Scenarios"

ENVIRONMENTAL HARM	HAZARD CATEGORY		
	High	Significant	Low
Categories of Harm			
General environmental harm	Location such that harm to a significant environmental value is likely, or serious environmental harm is possible. Such a value might include the presence of protected or endangered flora or fauna.	The environmental value is of lesser significance and harm is possible but not likely, or material environmental harm is possible.	No environmental values of significance, or only trivial environmental harm is possible.
Loss or harm to humans	Location such that people are routinely present in the failure path and if present loss or harm is likely. Consumption of contaminated waters by humans with consequent loss or harm is likely.	Location such that people are routinely present in the failure path and if present loss or harm is possible. Consumption of contaminated waters by humans with consequent loss or harm is possible.	Location such that people are not routinely present in the failure path. No contamination of waters used for human consumption expected.
Loss of stock	Location of stock such that loss of stock likely. Consumption of contaminated waters by stock with consequent loss or harm is likely.	Location of stock such that loss of stock possible. Consumption of contaminated waters by stock with consequent loss or harm is possible.	Stock not in path of dam break flood. Contaminated water not available to stock or no harm expected from consumption.
General economic loss	Serious harm to communities, industrial, commercial or agricultural facilities, important utilities, or water resources in the failure path.	Material harm to industry, secondary roads, minor railways, public utilities, or water resources in the failure path.	Trivial harm to environmental values such as environmental nuisance arising from minor spills.

Table 1-3 "Storage Contents Contaminant Concentrations and Minimum Volumes"

Contaminant [1]	Liquor [2]	Total Solids [3]	Dam Crest Volume
Arsenic	1.0 mg/L	500 mg/kg	2.5 ML
Boron	5.0 mg/L	15,000 mg/kg	2.5 ML
Cadmium	10 µg/L	100 mg/kg	2.5 ML
Cobalt	1.0 mg/L	500 mg/kg	2.5 ML
Copper	1.0 mg/L	5,000 mg/kg	2.5 ML
Lead	0.5 mg/L	1,500 mg/kg	2.5 ML
Mercury	2 µg/L	75 mg/kg	2.5 ML
Nickel	1.0 mg/L	3,000 mg/kg	2.5 ML
Selenium	50 µg/L	150 mg/kg	2.5 ML
Zinc	20 mg/L	35,000 mg/kg	2.5 ML
Cyanide	10 mg/L	2,500 mg/kg	2.5 ML
pH	5 to 9 (range)	Net acid generation pH < 4.5	2.5 ML
Chloride	2,500 mg/L	-	10 ML
Fluoride	2.0 mg/L	-	10 ML
Sulphate	1,000 mg/L	-	10 ML
Salinity (conductivity)	4,000 µs/cm	-	10 ML

1 Metals should be analysed in accordance with recognised test methods by a NATA certified laboratory.
2 These concentrations apply to contaminants in solution, and therefore all samples should be filtered using the techniques described in the EPA Water Quality Sampling Manual as published from time to time.
3 Applies to the solids in a dam. Total solids include suspended and colloidal solids.

2

Storage Data and Assumptions

2.1 Context of Data and Assumptions to Undertake Hazard Assessment

Key data and assumptions for the proposed Caval Ridge mine dams used to undertake the preliminary Hazard Assessment are outlined in Section 2.2 and 2.3. It is important to note the following context of this data and assumptions:

- The project is currently in planning phase and is still subject to approvals and detailed design. The dams are proposed dams and detailed certified engineering design plans of the dams have not yet been developed. It is intended that the hazard assessment outcomes will guide the requirement for detailed engineering design standards and certification of the hazardous dams.
- The role and function of each dam within the broader proposed integrated mine water management system for the Caval Ridge project has not changed compared to the functions outlined in the draft EIS and further described in Section 5.6 of the EIS Supplement.
- The proposed size of the Caval Ridge mine dams is based on information available at the time of preparation of this hazard assessment (and have not changed compared to the size of the dams reported in the draft EIS). The criteria for controlled mine water releases from the mine water management system and criteria to ensure the overall integrated mine water management system has sufficient storage capacity to limit the probability of uncontrolled (overflow) discharges have been revised for the EIS supplement in light of recent State Government documents for the approach to discharge licensing that were not available at the time that the draft EIS studies and mine water planning for the project were undertaken. Revised water balance modelling will be required to reassess the require storage capacity and capacity of mine water transfer infrastructure to meet the revised mine water performance objectives. This may alter the design storage capacity of some of the Caval Ridge mine water dams, in which case revision of this Hazard Assessment may be necessary.
- There are no dams proposed to store mineral processing waste from the proposed Coal Preparation Plant. The CPP waste (tailings/fines, and rejects) have been determined to be relatively benign for environmental contamination concerns and the processing waste strategy as outlined in the draft EIS is to dispose of waste with mixing into mine overburden spoil landforms.
- The dams are proposed (not yet constructed) and the mine is not yet operational. Hence full characterisation of the mine water dam storage contents contaminant concentrations is not available at present and cannot be determined accurately. The estimated contaminant concentrations of the proposed storage contents (outlined in Section 2.3) is based on BMA experience and knowledge from monitoring at their similar operations at Peak Downs Mine and Goonyella Riverside Mine.

In light of the above important matters to define the context of this preliminary Hazard Assessment it is recommended that regular review and revision of the Hazard Assessment will be required as a minimum for following:

1) After revised water balance modelling of the proposed mine water management system is undertaken for detailed design (to account for revised discharge criteria) if this shows that larger

mine water dams are required and would alter the outcomes of the Hazard Assessment that may be affected by storage size.

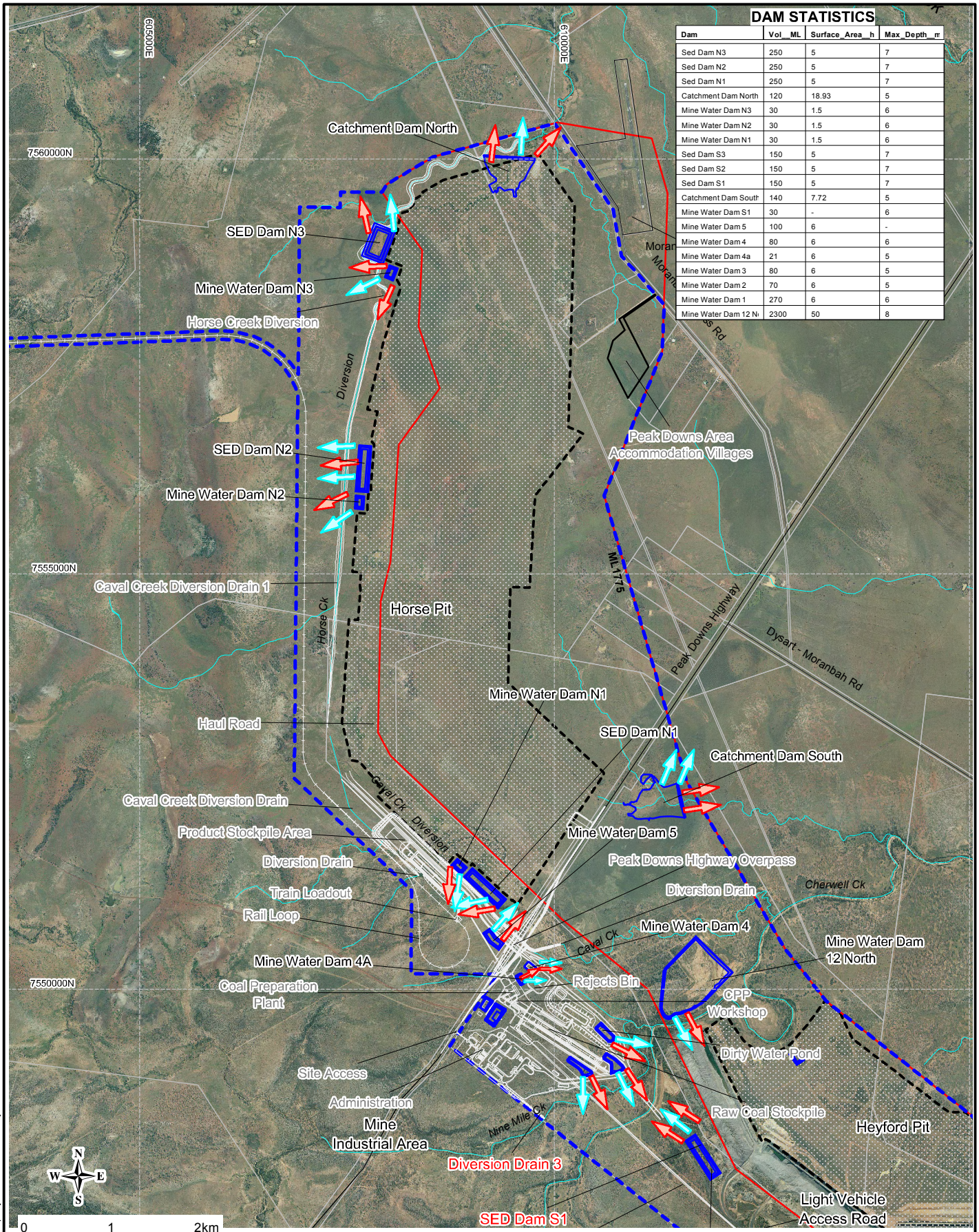
2) After initial mine operations have commenced and sufficient water quality monitoring data is available (approximately 2 years) to enable update of the estimated contaminant concentrations of the storage contents, and then on-going reviews as further monitoring data becomes available to continually improve knowledge of contaminant concentrations.

2.2 Key Data for Caval Ridge Mine Water and Sediment Dams

The volume, area, and depths of the proposed Caval Ridge Mine water dams are summarised in Table 2.1, and the location of each dam is presented in Figures 2.1,2.2 and 2.3. Detailed design have not been prepared for the dams at this stage and maximum embankment heights (as opposed to storage depths) are not yet available.

Table 2-1 Summary Dimension Data for Caval Ridge Mine Water Dams

Dam	Volume (ML)	Surface Area (Ha)	Storage Depth (m)
Sed Dam N3	250	5	7
Sed Dam N2	250	5	7
Sed Dam N1	250	5	7
Sed Dam S3	150	5	7
Sed Dam S2	150	5	7
Sed Dam S1	150	5	7
Catchment Dam North	120	19	5
Catchment Dam South	140	8	5
Mine Water Dam N3	30	1.5	6
Mine Water Dam N2	30	1.5	6
Mine Water Dam N1	30	1.5	6
Mine Water Dam S1	30	1.5	6
Mine Water Dam 5	100	6	5
Mine Water Dam 4	80	6	5
Mine Water Dam 4a	21	6	5
Mine Water Dam 3	80	6	5
Mine Water Dam 2	70	6	5
Mine Water Dam 1	270	6	5
12North Mine Dam	2300	50	8



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Project: CAVAL RIDGE PROJECT ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT

Title: **HAZARDOUS DAM ASSESSMENT - MAP 1**

Draft

Drawn: VH	Approved: RS	Date: 07-10-2009
Job No: **42626420** /6158	File No: 42626158-g-1518.wor	

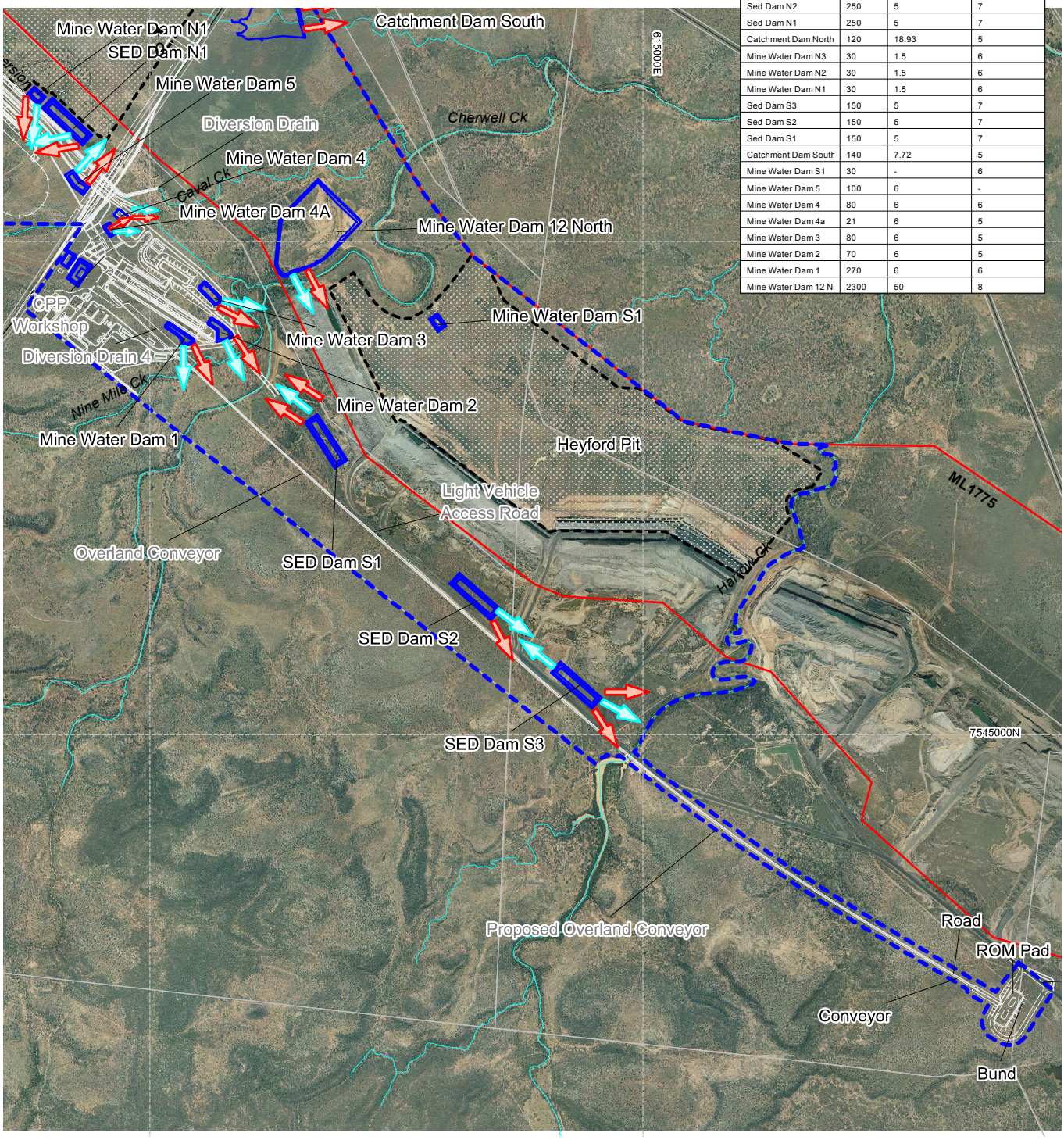
Figure: **1**

Rev:A

A4

DAM STATISTICS

Dam	Vol__ML	Surface_Area__h	Max_Depth__m
Sed Dam N3	250	5	7
Sed Dam N2	250	5	7
Sed Dam N1	250	5	7
Catchment Dam North	120	18.93	5
Mine Water Dam N3	30	1.5	6
Mine Water Dam N2	30	1.5	6
Mine Water Dam N1	30	1.5	6
Sed Dam S3	150	5	7
Sed Dam S2	150	5	7
Sed Dam S1	150	5	7
Catchment Dam South	140	7.72	5
Mine Water Dam S1	30	-	6
Mine Water Dam 5	100	6	-
Mine Water Dam 4	80	6	6
Mine Water Dam 4a	21	6	5
Mine Water Dam 3	80	6	5
Mine Water Dam 2	70	6	5
Mine Water Dam 1	270	6	6
Mine Water Dam 12 N	2300	50	8



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Datum: AGD84, AMG Zone 55

Source: Google Earth Imagery, 2008, © Copyright The State of Queensland 2009

Project Site
Mining Lease
Mine Pit

Overflow Direction
Estimated Direction of Dam Break Flows

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Project: CAVAL RIDGE PROJECT
ENVIRONMENTAL IMPACT STATEMENT
SUPPLEMENT

Title: **HAZARDOUS DAM ASSESSMENT - MAP 2**

Draft

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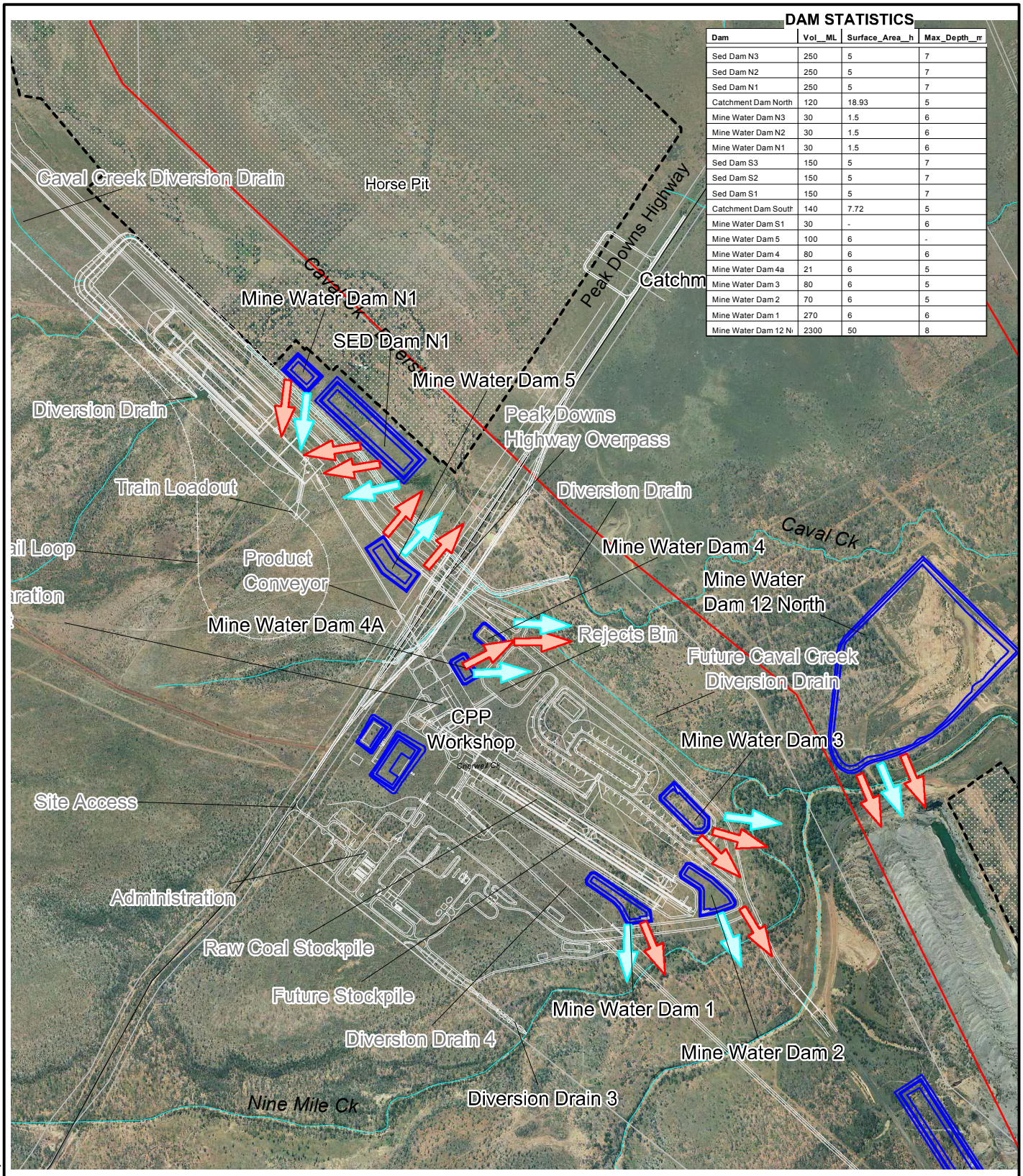
Figure: **2**

Rev:A

A4



DAM STATISTICS

Dam	Vol__ML	Surface_Area__h	Max_Depth__m
Sed Dam N3	250	5	7
Sed Dam N2	250	5	7
Sed Dam N1	250	5	7
Catchment Dam North	120	18.93	5
Mine Water Dam N3	30	1.5	6
Mine Water Dam N2	30	1.5	6
Mine Water Dam N1	30	1.5	6
Sed Dam S3	150	5	7
Sed Dam S2	150	5	7
Sed Dam S1	150	5	7
Catchment Dam South	140	7.72	5
Mine Water Dam S1	30	-	6
Mine Water Dam 5	100	6	-
Mine Water Dam 4	80	6	6
Mine Water Dam 4a	21	6	5
Mine Water Dam 3	80	6	5
Mine Water Dam 2	70	6	5
Mine Water Dam 1	270	6	6
Mine Water Dam 12 N	2300	50	8

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Scale 1:250,000 (A4)

Datum: AGD84, AMG Zone 55

Project Site
Mining Lease
Mine Pit

Overflow Direction
Estimated Direction of Dam Break Flows

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Project: CAVAL RIDGE PROJECT
ENVIRONMENTAL IMPACT STATEMENT
SUPPLEMENT

Title: **HAZARDOUS DAM ASSESSMENT - MAP 3**

Draft

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Job No: **42626420** /6158	File No: 42626158-g-1518.wor	

Figure: **3**

Rev:A

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Table 2-2 Summary Functions for Caval Ridge Mine Water Dams

Dam	Function	Overflow Destination
Sed Dam N1 Sed Dam N2 & Sed Dam N3	Sediment and runoff containment from Horse Pit Spoil dumps and haul roads. Pumps to Mine Water Dam 12N.	Sed N1 to Caval Creek Sed N2 to Horse Creek Sed N3 to Horse Creek
Catchment Dam North	Sediment and runoff containment storage of the northern Horse Pit run-off from the stripped and unstripped mine lease areas east of the high wall. Pumps to Sed Dam N3 or Mine water Dam N3 when additional water supply is required in the Mine Water Dam 12North.	Horse Creek
Mine Water Dam N1 Mine Water Dam N2 Mine Water Dam N3	No external runoff. Horse Pit dewatering transfer dams. Pumps to Mine Water Dam 12North.	Dam N1 to Caval Creek Dam N2 to Horse Creek Dam N3 to Horse Creek
Sed Dam S1 Sed Dam S2 Sed Dam S3	Sediment and runoff containment from Heyford Pit Spoil dumps and haul roads. Pumps to Mine Water Dam 12North.	Sed S1 to Cherwell Creek Sed S2 to Harrow Creek Sed S3 to Harrow Creek
Catchment Dam South	Sediment and runoff containment storage of the Southern Horse Pit runoff from the stripped and unstripped mine lease areas east of the high wall. Pumps to Mine Water Dam 12North.	Cherwell Creek
Mine Water Dam S1	No external runoff. Heyford Pit dewatering transfer dams. Pumps to Mine Water Dam 12North.	Cherwell Creek
Mine Water Dam 1 Mine Water Dam 2 Mine Water Dam 3 Mine Water Dam 4 Mine Water Dam 4a Mine Water Dam 5	Captures runoff from ROM, Coal Handling Plant area and Rejects areas. Pumped to Mine Water Dam 12North.	Dam1 to Nine Mile Creek Dam2 to Nine Mile Creek Dam3 to Nine Mile Creek Dam4 to Caval Creek Dam4a to Caval Creek Dam5 to Caval Creek
12North Mine Water Dam	Primary buffer storage for mine water management system. Receives excess pit water pumped from Mine Water Dams N1, N2 and N3. Receives excess pit water pumped from Mine Water Dams S1, S2 and S3. Receives pumped excess spoil run-off from sediment dams N1, N2 ,N3, S1,S2 and S3. Receives excess plant area runoff (including rejects area, coal stockpiles) pumped from Mine Water Dams 1,2,3,4,4a and 5. Pumps to Process Water Dam to supply CPP. Controlled release discharges to Cherwell Creek.	Cherwell Creek

2.3 Estimated Contaminant Concentrations of Proposed Dams

As outlined in Section 2.1, the subject dams are proposed and the Caval Ridge Project is not yet constructed or operational. As an estimate of the likely contaminant concentrations of the storage contents is required to fulfil the hazard assessment, estimated concentrations have been drawn from a number of sources including:

- Geochemistry investigations undertaken for the Caval Ridge project – reported in Appendix H of the draft EIS.
- Relevant water quality monitoring from the existing Peak Downs Mine; and
- The proponent's similar experience at their other mines in the region, notably Goonyella Riverside Mine for which substantial water quality monitoring data is available.

In relation to the types of contaminants for initial hazard screening (Table 1.3), this assessment has primarily focused on estimates for salinity (as Electrical Conductivity), pH, and sulphates. The proponent's experience at the Peak Downs and Goonyella Riverside mine has shown that these are the water quality parameters of concern. Furthermore, the Caval Ridge project geochemistry investigations found that soluble metals concentrations in water extracts from sampled overburden and rejects materials were low.

The range of data sources are described below, and adopted estimates of contaminant concentrations for the mine water dams are summarised in Table 2.3.

2.3.1 Geochemistry Investigations (Draft EIS Appendix H)

The geochemistry investigations for the Caval Ridge project planning reported typical water extract sample concentrations of the overburden and rejects materials were in the following ranges:

- EC of water extracts from overburden materials were in the range of 400µS/cm to 2000µS/cm, with a median value of 700µS/cm.
- Sulphate concentrations of water extracts from overburden materials were in the range of 30 to 80 mg/L.
- pH of overburden and rejects materials in the range of 7.0 to 9.0.

It should be noted that the geochemistry investigations are specific to the materials at the project site, but are undertaken under controlled laboratory conditions that may account for all factors can affect runoff quality into the respective mine water dams.

2.3.2 Peak Downs Mine Water Quality Data

Limited data is available for existing mine water quality at the Peak Downs Mine primarily for mine water dams. For interpretation of the Peak Downs Mine water quality data it is also important to recognise that Peak Downs Mine is an old mine that does not have the same degree of separation of different runoff sources into different dams such as that proposed for the Caval Ridge project. This means that the Peak Downs Mine water quality data is not readily useable to identify the differences between pit water and direct mine spoil runoff. From the available data, the following characteristics were identified:

- EC of runoff from areas disturbed by mining, but excluding influences from pit waters is typically in the range of 300µS/cm to 1500µS/cm (wet weather water quality monitoring in February and December 2007);
- pH of runoff from areas disturbed by mining, but excluding influences from pit waters is typically in the range of 6.0 to 8.0 (wet weather water quality monitoring in February and December 2007);
- EC in dams used to store pit water from the northern end of the mine typically varies between 2000µS/cm to 6000µS/cm. Occasional high values up to 8000 to 9000µS/cm can occur due to evapo-concentration in the dams, or prolonged storage of small quantities mine water in the mine pits prior to transfer to dams. Occasional low values less than 2000µS/cm can occur during large or prolonged heavy rainfall events;
- pH in dams used to store pit water from the northern end of the mine typically varies between 7.5 and 9.5. pH rarely exceeds 10.0 in the mine pit waters, and the lowest values are typically no less than pH 6.5.

The data set is relatively incomplete for sulphate concentrations. Limited data indicates sulphate concentrations are typically less than 1000mg/L, however some higher concentrations up to 2000 mg/L have been reported in isolated samples that have high EC values (typically when EC > 4000 µS/cm).

2.3.3 Goonyella Riverside Mine Water Quality Data

An extensive mine water quality monitoring programme has been in place at Goonyella Riverside mine with sampling from a wide range of mine pits, mine water dams, plant runoff dams, and sediment dams. The available data extends back to 1999. The following characterisation of typical mine water streams has been identified from this data.

- dams that receive water from pumping out of the mine pits typically have EC in the range of 2000µS/cm to 8000µS/cm and median values around 3000µS/cm to 4000µS/cm;
- dams that only receive direct runoff from mine spoil area and other disturbed areas have EC typically in range of 500µS/cm to 3000µS/cm; and median values around 1000 to 2000µS/cm;
- dams that capture runoff from the coal preparation plant and industrial areas have EC typically in the range of 1000µS/cm to 3000µS/cm;
- most mine waters irrespective of source from spoil, pits, or plant areas have pH in the range of 6.5 to 9.0; and,
- sulphate concentrations (mg/L) for all mine waters excluding tailings dams are consistently in the range of 17% to 20% of the total dissolved solids concentrations (mg/L); or in relation to EC, sulphate concentrations (mg/L) are typically in range of 10% to 15% of EC values (measured in µS/cm).

2.3.4 Adopted Estimates of Contaminant Concentrations

From the relevant sources of data to estimate likely contaminant concentrations in proposed Caval Ridge Mine dams, the adopted concentrations and water quality parameters for the purpose of hazard assessment are summarised in Table 2.3.

Table 2-3 Adopted Estimates of Contaminant Concentrations in Proposed Caval Ridge Dams

Storages	Source waters	EC Range (µS/cm)	pH Range	Sulphate Range (mg/L)
Sed Dam N1 Sed Dam N2 Sed Dam N3 Sed Dam S1 Sed Dam S2 Sed Dam S3	Mine Spoil Runoff and small quantity of haul road runoff. – No other mine waters.	500 to 3000	6.5 – 9.0	< 500
Catchment Dam North Catchment Dam South	Disturbed area runoff (typically pre-stripped surface east of highwall. Natural runoff.	500 to 2000	6.5 – 9.0	< 300
Mine Water Dam N1 Mine Water Dam N2 Mine Water Dam N3 Mine Water Dam S1	Pit dewatering (direct).	2000 to 6000 typical Maximum 9000	7.0 – 9.5	< 900 typical Maximum 1500
12North Dam	Pumping from all of the above. Water will typically be mixed.	1000 to 5000	6.5 – 9.5	< 1000
Mine Water Dam 1 Mine Water Dam 2 Mine Water Dam 3 Mine Water Dam 4 Mine Water Dam 4a Mine Water Dam 5	Plant and industrial area runoff, including ROM stockpiles, product stockpiles, and temporary rejects stockpiles. Could contain leaks from process plant water circuits.	1000 to 3000 typical	6.5 – 9.5	< 1000

3

Hazard Assessment

3.1 Storage Size Criteria

The proposed 12North dam is nominated to have a storage depth of 8m. Detailed design of the dam is not yet available, however it is likely that with embankment height above the full supply level required to safely pass the spillway design flood, the embankment height could trigger the 8m maximum height criteria. On this basis the proposed 12North dam requires a hazard category of at least Significant Hazard.

No other mine water dams are likely to trigger the hazard criteria related to maximum embankment height.

3.2 Contaminant Concentrations Criteria

For the contaminant concentration screening criteria listed in Table 1.3, the following dams will require a hazard category of at least Significant Hazard (based on the estimate storage contents listed in Table 2.3):

- Mine Water Dam N1, N2, N3, and S1 (due to their direct function of pit water collection and transfer, and corresponding pH, salinity, and sulphate concentrations of pit waters); and
- 12North mine water dam (due to influence of pit waters, after mixing with other mine waters, could result in salinity levels and possibly pH exceeding the Table 1.3 contaminant thresholds).

The dams used to contain runoff and sediment from around the coal preparation plant, stockpiles, and industrial areas (Mine Water Dams 1, 2, 3, 4, 4a, and 5) would typically have EC and pH below the Table 1.3 threshold criteria. If these dams are not pumped out to the 12North dam in a reasonable timeframe after accumulating water following rain events, there remains a possibility of occasional high EC in these dams (particularly in the event of a leak from the CPP process water circuit, or runoff from rejects or coal stockpiles). At this stage classification as significant hazard is not warranted however operational monitoring will be required to confirm the typical contaminant concentrations in these dams.

The sediment dams (N1, N2, N3, S1, S2, S3) are not expected to exceed the Table 1.3 contaminant thresholds.

3.3 Failure to Contain Criteria

To apply the failure to contain hazard criteria, an assessment of downstream receiving waterway values for environmental significance, use of waters for human consumption, use of waters for livestock drinking, and potential economic implications of water contamination is required.

3.3.1 Environmental and Economic Significance of Receiving Waters

The direct receiving waters around the Caval Ridge project, which could be impacted by failure to contain the contents of mine water dams include:

- Horse Creek; which is a tributary of Grosvenor Creek before joining the Isaac River;
- Nine Mile Creek, Caval Creek, and Harrow Creek, which are tributaries of Cherwell Creek before joining the Isaac River.

All of the creeks are highly ephemeral with flow periods limited to the duration of rainfall events and short period of receding flow after rainfall events (typically less than 3 days recession).

Limited value for reliable water supply

The flow in the creeks is not sufficiently sustainable to provide a reliable supply of water for human drinking supply, livestock water supply, or for other economic uses (such as irrigation or industrial use).

Potential exposure of livestock to contaminated water under specific conditions

Livestock drinking water is predominantly sourced from groundwater; however this does not mean that livestock will not be exposed to potentially contaminated creek waters. The creeks downstream of the mine are not fenced to exclude livestock drinking, and discharges of mine water to the creeks (failure to contain) could expose livestock to contaminated water if this were to occur during dry weather (e.g. dam piping breach with no dilution in receiving stream) and if the salinity exceeds 5000µS/cm (based on Qld DERM "*Final Model Water Conditions for Coal Mine in the Fitzroy Basin*" July 2009).

Limited aquatic habitat values except during flow periods

As the creeks are highly ephemeral there are no permanent aquatic habitat values in the waterways. It is expected that fish and macroinvertebrate biota could opportunistically utilise the stream during periods of flow. Even during occasional periods of flow the aquatic conservation values are not significant (refer EIS Supplement Section 5.9; i.e. no species of significance have been recorded).

Based on the Qld DERM guideline "*Conditions for Coal Mine in the Fitzroy Basin Approach to Discharge Licencing* " July 2009, impacts on adult fish are not likely when EC is below 1500µS/cm and impacts on Macroinvertebrate are unlikely when EC is below 1000µS/cm. Taking account that some dilution of the mine waters would occur in the event of loss of storage contents during flow periods when aquatic biota are present, impact on environmental values will likely be limited to failure of dams that have contents with EC > 3000µS/cm.

3.3.2 Application of the Failure to Contain Hazard Criteria

The application of the failure to contain hazard criteria for the estimated storage contaminants, together with the context of receiving water flow regimes, values for environmental significance, consumptive uses (outlined above) to determine "failure-to-contain" hazard categories is summarised in Table 3.1.

Table 3-1 Application of Failure to Contain Hazard Criteria

Storages	EC Range (µS/cm)	General environmental harm	Loss or harm to humans	Loss of stock	Economic loss	Overall Failure to Contain Hazard
Sed Dam N1 Sed Dam N2 Sed Dam N3 Sed Dam S1 Sed Dam S2 Sed Dam S3	500 - 3000	Low	Low	Low	Low	**LOW**
Catchment Dam North Catchment Dam South	500 - 2000	Low	Low	Low	Low	**LOW**
Mine Water Dam N1 Mine Water Dam N2 Mine Water Dam N3 Mine Water Dam S1	2000 - 6000 typical Max 9000	Significant (If failure occurs during wet weather, may be insufficient dilution to protect aquatic biota)	Low	Significant (If failure occurs during dry weather, minimal dilution, livestock exposed)	Low	**SIGNIFICANT**
12North Dam	1000 - 5000					
Mine Water Dam 1 Mine Water Dam 2 Mine Water Dam 3 Mine Water Dam 4 Mine Water Dam 4a Mine Water Dam 5	1000 - 3000 Potentially higher in limited occasions	Low	Low	Low	Low	**LOW** * *Tentative (refer Section 3.2) subject to further water quality review with operational monitoring*

3.4 Dam Break Criteria

To apply the dambreak hazard criteria, an assessment of downstream receiving waterway values for environmental significance, use of waters for human consumption, use of waters for livestock drinking, and potential economic implications of water contamination is applied only to circumstances of extreme wet periods that would contribute to dam overtopping failure. Additionally, the presence of humans, livestock, and infrastructure near watercourses that would be affected by the dam break flood is of relevance to assess the dam break hazard.

3.4.1 Environmental and Economic Consequences from Dam Break

Contamination Consequences

The contamination consequences for dam break hazard are low for all dams due to the following factors:

- Under extreme rainfall conditions that would cause dam failure, the storage contaminants concentrations will be at the lower end of the estimated ranges presented in Table 2.3; and
- Under extreme rainfall conditions that would cause dam failure, the dam break flood waters would be extensively diluted by flood waters in the receiving streams (typically by a factor of at least 10 times dilution).

Indicative Dam Break Flood Magnitude and Relativity to Natural Flood Peaks

An indicative estimate of the magnitude of the dam break flood was determined using the simplified dam break formula in the Qld NRW (now DERM) Guidelines for Failure Impact Assessment of Water Dams (2002). The estimates were generalised to two main categories as follows:

1) For all dams except the 12 North mine water dam, the maximum dam capacity is 250ML and maximum depth is 7m. The expected dam break flood for these dams is conservatively estimated using the DRNW guideline formula to be 260 m^3/s (or less for smaller dams).

   Relative to the estimates of natural flooding peak flows in the local streams (refer Draft EIS Table 6.3), the dam break flood for these dams (up to 250ML capacity and 7m height) is approximately equivalent to 1:50 AEP flood in Horse Creek and Nine Mile Creek, and approximately equivalent to 1:2 AEP flood in Harrow Creek.

2) For the 12 North mine water dam, the maximum capacity is 2300 ML and the maximum depth is 8m. The expected dam break flood for these dams is conservatively estimated using the DNRW guideline formula to be 1400 m^3/s. The 12 North mine water dambreak flood would be directly into Cherwell Creek.

   Relative to the estimate of natural flooding peak flows in Cherwell Creek, the dam break flood for the 12 North mine water dam is approximately equivalent to a 1:5 AEP flood in Cherwell Creek.

Significance of potential direct physical damage to environmental condition of waterways

The potential for direct physical damage to the environmental conditions of downstream waterways in the event of dam break of one or more of the Caval Ridge mine water dams is considered to be of low significance. A dam break flood could potentially produce high velocity and consequent erosion in the downstream waterways, however the magnitude of the dam break flood flow estimates (above) is similar to appreciable levels of natural flooding in the streams. A dam break flood could potentially also deposit quantities of sediment (e.g. from the breached embankment) and erosion of the immediate downstream flow path however this would not cause significant environmental damage to the watercourse based on the following observations:

- The natural channel characteristics of the downstream waterways have sandy bed deposits that routinely mobilise during flood events. The waterways are adaptable to moderate to significant quantities and variability of bed load sediment transport. An additional "load" from sediment deposited from a dam break flood would not be significantly impact on the watercourses.
- The downstream waterways do not have distinct riparian vegetation communities relative to broad-acre vegetation further away from the watercourse. The mapped vegetation communities do not have high conservation significance.

Infrastructure and Persons at Risk in the Event of Dam break

The dominant public concern for infrastructure dams and risk to persons in the event of dam break flood release to either Horse, Caval, Nine Mile, Harrow, or Cherwell Creeks include one or more of the following:

- Moranbah access road (north of Peak Downs Highway);
- Peak Downs Highway; and
- Dysart – Moranbah Road.

Due to the proximity to Moranbah township and the number of mines in the region, these roads carry moderate to occasional heavy traffic volumes particularly in daylight hours and early evening. It can be expected that people (specifically travelling vehicles) are routinely present in the potential path of a dam break flood from the Caval Ridge mine dams.

There are no significant third party commercial or industrial facilities in the path of the dam break flood impact downstream of the dams. The large fuel/service station near the junction of Peak Downs Highway and Moranbah Access Road is on relatively high ground and not in the impact path of a dam break from the proposed Caval Ridge mine dams.

In the event of dam break of one or more of the mine water dams near the proposed Caval Ridge main mine facilities (CPP, Industrial Area, and stockpiles) material damage to some of these facilities is likely. This could potentially include damage to railway lines such as near the proposed rail loop. Damage to the proposed Peak Downs Highway overpass could also occur.

3.4.2 Application of the Dam Break Hazard Criteria

The application of the dam break hazard criteria for the potential magnitude of dam break flood, together with the downstream consequences (outlined above) to determine “dam break” hazard categories is summarised in Table 3.2.

Table 3-2 Application of Dam break Hazard Criteria

Storages	Approximate Dam break flood (m^3/s)	General environmental harm	Contamination of water supply	Safety of people	Safety of livestock	Economic loss	Overall Dam break Hazard
Sed Dam N1 Sed Dam N2 Sed Dam N3 Sed Dam S1 Sed Dam S2 Sed Dam S3	< or = 260 m^3/s	Low	Low	Significant	Significant	Low	**SIGNIFICANT** *Refer note 1.*
Catchment Dam North Catchment Dam South	< 260 m^3/s	Low	Low	Significant	Significant	Low	**SIGNIFICANT** *Refer note 1.*
Mine Water Dam N1 Mine Water Dam N2 Mine Water Dam N3 Mine Water Dam S1	< 260 m^3/s	Low	Low	Significant	Significant	Low	**SIGNIFICANT**
12North Dam	approx 2300 m^3/s	Low	Low	Significant	Significant	Significant	**SIGNIFICANT**
Mine Water Dam 1 Mine Water Dam 2 Mine Water Dam 3 Mine Water Dam 4 Mine Water Dam 4a Mine Water Dam 5	< 260 m^3/s	Low	Low	Significant	Significant	Significant	**SIGNIFICANT** *Refer note 1.*

Note 1: Preliminary tentative classification, subject to detailed design, refer Section 4.2.

4

Summary Hazard Categories

4.1 Summary

A summary of the preliminary hazard assessment categories for the proposed Caval Ridge mine water dams is presented in Table 4.1. The hazard for "failure-to-contain" scenarios is listed separately to the hazard for "dam break scenarios" such that the design criteria to mitigate the risk of these scenarios can be considered separately. Or in other words, it is reasonable that design of the storage capacity for low hazard "failure-to-contain" dams does not need to be to the standard that would apply for significant hazard "dam break scenarios".

Table 4-1 Summary Preliminary Hazard Categories

Storages	Failure to Contain Hazard Category	Dam break Hazard Category
Sed Dam N1 Sed Dam N2 Sed Dam N3 Sed Dam S1 Sed Dam S2 Sed Dam S3	**LOW**	**SIGNIFICANT** *Preliminary tentative classification subject to detailed design, refer Section 4.2.*
Catchment Dam North Catchment Dam South	**LOW**	**SIGNIFICANT** *Preliminary tentative classification subject to detailed design, refer Section 4.2.*
Mine Water Dam N1 Mine Water Dam N2 Mine Water Dam N3 Mine Water Dam S1	**SIGNIFICANT**	**SIGNIFICANT**
12North Dam		
Mine Water Dam 1 Mine Water Dam 2 Mine Water Dam 3 Mine Water Dam 4 Mine Water Dam 4a Mine Water Dam 5	**LOW** *Tentative (refer Section 3.2) subject to contaminant concentrations review with operational monitoring*	**SIGNIFICANT** *Preliminary tentative classification subject to detailed design, refer Section 4.2.*

4.2 Scope for Revision of the Hazard Categories with More Detailed Assessments

The hazard assessment of proposal Caval Ridge mine water dams presented in this report was based on preliminary information for the purpose of the EIS Supplement for the project.

The hazard assessment should be reviewed and revised during detailed design as more information becomes available for the type and design of dams (including specific embankment heights).

The hazard assessment should also be regularly reviewed and updated during the operational phase of the project, particularly as more information becomes available regarding the actual range of mine

water quality (contaminant concentrations), operational performance of the integrated mine water management system, and corresponding consequences of failure.

Of particular note for consideration during detailed design, is that the “dam break” scenario hazards for the proposed sediment dams was identified as significant for this preliminary evaluation. These findings are based on conservative estimates of the dam break flood flow and do not account for attenuation of the dam break hydrograph within the flow path and waterway downstream of the dam prior to arrival at public roads where the consequence of harm to people may occur. It is possible that with more detailed assessment of the magnitude of the dam break flow and routing with a hydrodynamic model (e.g. MIKE11) could show less consequence at the public roads and could warrant the downgrading of the “dam break” consequence for the sediment dams to low hazard. It is therefore recommended that further more detailed evaluation of the dam break consequences for the sediment dams be undertaken as part of detailed design.

4.3 Qualifications of Personnel who Completed the Preliminary Hazard Assessment

The preliminary dam hazard assessment for the proposed Caval Ridge mine water dams was undertaken by Michel Raymond (Principal Water Engineer) who is registered professional engineer in Queensland (RPEQ No. 7245). The assessor has twenty years relevant experience in dam assessment and design and mine water management. The assessor’s qualifications meet the requirements set out for a “*suitably qualified and experienced person*” as defined in the DERM draft guideline “*Manual for Assessing Hazard Categories and Hydraulic Performance of Dams constructed as part of environmentally relevant activities pursuant to the Environmental Protection Act 1994* Version 1.1” (June 2009).

Limitations

URS Australia Pty Ltd (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of BMA and only those third parties who have been authorised in writing by URS to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the Proposal dated August 2009.

The methodology adopted and sources of information used by URS are outlined in this report. URS has made no independent verification of this information beyond the agreed scope of works and URS assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to URS was false.

This report was prepared between September and October 2009 and is based on the conditions encountered and information reviewed at the time of preparation. URS disclaims responsibility for any changes that may have occurred after this time.

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