Report

Caval Ridge Project EIS Supplement

Derivation of End-of-Pipe Discharge Criteria for Electrical Conductivity

1 OCTOBER 2009

Prepared for

BMA Coal Pty Ltd

Level 23 Riparian Plaza
123 Eagle Street
Brisbane Qld 4000

42626420

URS

Project Manager:

Rob Storrs
Associate Environmental Scientist

Project Director:

Chris Pigott
Senior Principal

Author:

Michel Raymond
Principal Water Engineer

URS Australia Pty Ltd

Level 16, 240 Queen Street
Brisbane, QLD 4000
GPO Box 302, QLD 4001
Australia
T: 61 7 3243 2111
F: 61 7 3243 2199

Date: **1 October 2009**
Reference: 42626420/01/01
Status: Rev A

Document delivery

URS Australia provides this document in either printed format, electronic format or both. URS considers the printed version to be binding. The electronic format is provided for the client's convenience and URS requests that the client ensures the integrity of this electronic information is maintained. Storage of this electronic information should at a minimum comply with the requirements of the Commonwealth Electronic Transactions Act (ETA) 2000.

Where an electronic only version is provided to the client, a signed hard copy of this document is held on file by URS and a copy will be provided if requested.

Table of Contents

Tables

Figures

Introduction

1.1 Background and Purpose

This report has been prepared for BHP Billiton Mitsubishi Alliance (BMA) to document data and analyses used to derive proposed end-of-pipe water quality criteria for controlled releases of mine water for the Caval Ridge project. The 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.

The assessment outlined herein is primarily limited to establishing end-of-pipe discharge criteria for salinity measured as Electrical Conductivity (EC).

1.2 Relevant Documents dor Derivation of End-of-Pipe Discharge Limits

The Queensland DERM has recently revised the approach to setting of Environmental Authority (EA) criteria for mine water discharges in the Fitzroy Basin. Relevant documents cited in the DERM submissions to the draft EIS and their use to set discharge criteria are summarised as:

1. "*A study of the cumulative impacts on water quality of mining activities in the Fitzroy River Basin*" prepared by Qld Environmental Protection Agency (now DERM) in April 2009.

   This report primarily focussed on salinity as the contaminant of concern. It recommended improvements to standardise the approach to licensing of discharges from mines, further review of current data and further monitoring is needed to develop local water quality objectives for waterways, and that a model will be required to determine the cumulative impacts on salinity in the Fitzroy Basin.

2. "*Conditions for Coal Mines in the Fitzroy Basin - Approach to Discharge Licensing*" Version 10 June 2009 prepared by Qld DERM.

   This documents sets out the need to manage and characterise discharges, discusses the effects of salinity of aquatic organisms, and provides recommendations for the approach to setting end-of-pipe discharge limits linked to flow conditions and limiting discharge to a specified upper limit for salinity (electrical conductivity) and a maximum discharge rate as a portion of the receiving waterway upstream flow.

3. "*Final Model Water Conditions for Coal Mines in the Fitzroy Basin*" July 2009 prepared by Qld DERM.

   The relevant aspects of this document sets how the discharge conditions will be prescribed in Environmental Authority conditions and provides more specific definitions of key parameters such as minimum flow trigger for discharges and maximum flow rate of discharges.

Methodology

2.1 Summary Methodology

The methodology used to derive the end-of-pipe discharge conditions is based on the documents outlined in Section 1.2 and is summarised as:

- Discharges should be managed such that the water quality (EC) downstream of discharge point should not exceed 1000µS/cm. This is based on information in the "*Conditions for Coal Mines in the Fitzroy Basin - Approach to Discharge Licensing*" which cites a review of Fitzroy Basin water quality (Hart 2008) that salinity effects on macroinvertebrates are unlikely at or below 1000µS/cm.
- Discharges should only be allowed when there is a minimum natural flow in the receiving stream (upstream of the discharge point, and not affected by other point sources). The "*Conditions for Coal Mines in the Fitzroy Basin - Approach to Discharge Licensing*" recommends that the 20th percentile of natural flow be used to set the minimum flow trigger level. The definitions in the "*Final Model Water Conditions for Coal Mines in the Fitzroy Basin*" also clarify that the 20th percentile flow should only include days where flow has been measured or estimated (i.e. not dry weather days).
- The discharge rate should be limited to 20% of the receiving stream upstream flow. Or, in other words the minimum volumetric dilution of the discharge is to be 1:4 (discharge flow relative to receiving stream upstream flow).

From the prescribed constraints outlined above, an end-of-pipe discharge limit can be set for EC based on the flow rates in Cherwell Creek, natural Cherwell Creek flow EC, dilution ratios, and the maximum limit of the receiving water EC downstream of the discharge (i.e. 1000µS/cm).

URS

Derivation of Minimum Flow Trigger for Cherwell Creek

3.1 Data Sources

Assessment of the natural flow hydrology for Cherwell Creek is required to determine the minimum flow trigger that will set criteria for controlled releases from the Caval Ridge water management system at the 12North mine water dam.

There are no DERM or other agency stream gauges in the Cherwell Creek catchment. Peak Downs Mine have recently installed telemetry continuous recording stream flow and water quality gauges on Cherwell Creek upstream and downstream of the mine. The period of available data (from October 2007) was identified to have too few recorded stream flow events to characterise the hydrology of flow in Cherwell Creek.

The explanatory notes in the Qld DERM document "*Final Model Water Conditions for Coal Mines in the Fitzroy Basin*" recommend that the flow trigger should be based on at least ten years of flow data. Furthermore the explanatory notes state that where gauging data is not available, or is in insufficient, stream flow estimate should be based on appropriate hydrological calculations or models and known catchment area and climate inputs. On this basis hydrological modelling was undertaken to determine the flow statistics for Cherwell Creek.

3.2 Derivation of Cherwell Creek Stream Flow Hydrology

A hydrology model using AWBM software (Australian Water Balance Model) was prepared for the Cherwell Creek catchment. This software is commonly used in Australia for continuous simulation of runoff (streamflow) from catchments using a daily time step. Further information on the AWBM model is available from: http://www.toolkit.net.au/Tools/RRL

The AWBM model was established to represent the catchment of Cherwell Creek to the existing Peak Downs Mine upstream Cherwell Creek telemetry gauging station, and the total catchment area at this location is 268km^2.

Daily rainfall and evapotranspiration data for the project site was obtained from the NRW (now DERM) Silo data drill data base. The period of climate data used in the model extended from January 1900 to November 2008.

Key parameters for the AWBM model were adopted from previous calibration of an AWBM model for the Eureka Creek catchment near the BMA Goonyella Riverside mine. Previous hydrological studies undertaken for the BMA Goonyella Riverside Mine as part of an Environmental Evaluation (November 2007) had calibrated flow for the Eureka Creek catchment (70km^2) using an AWBM model with three years of recorded flow data at the Eureka Creek gauge (operated by Goonyella Riverside mine). The previous hydrological study had also verified the AWBM model parameters with recorded flows at the DERM stream gauge on the Isaac River at Goonyella (station no. 130414A). DERM have copies of these hydrological studies that were undertaken for the Goonyella Riverside Mine Environmental Evaluation.

The Eureka Creek catchment characteristics were considered to be adequately similar in terms of topography, slopes, typical soils, vegetation cover, and creek channel substrates as the Cherwell Creek catchment, to reasonably apply the Eureka Creek AWBM model parameters to Cherwell Creek. The adopted AWBM model parameters are presented in Table 3-1. The adopted AWBM model parameters are the same parameters currently used in the Peak Downs Mine water balance model to represent runoff from undisturbed (natural) catchments.

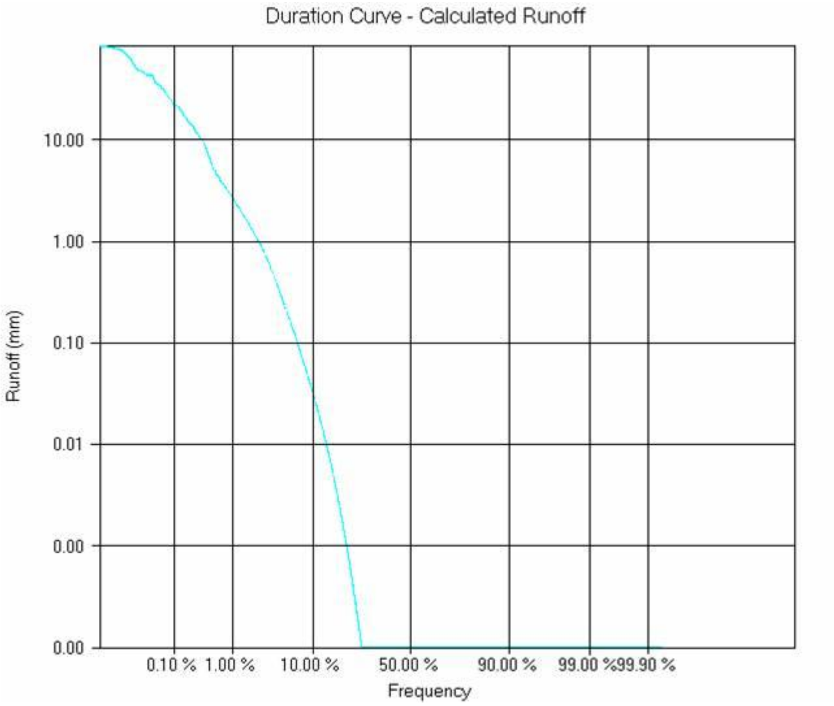
For comparative purposes post analysis of the stream flows derived using the adopted AWBM parameters shows that the long term average annual runoff is approximately 8% of rainfall. This is consistent with past experience for runoff rates for medium size catchments in the Bowen Basin.

Table 3-1 AWBM Runoff Model Parameters

AWBM Parameters	Value
A1	0.134
A2	0.433
A3	0.433
C1	12
C2	71
C3	141
BFI	0.35
Kbase	0.6
Ksurf	0.1

Simulation of the AWBM model with the Cherwell Creek catchment area, AWBM parameters listed above, and the climate data from January 1900 to November 2008 was used to derive a time-series stream flow record of Cherwell Creek flow from January 1900 to November 2008. A flow-duration plot of the derived stream flows (output from the AWBM program) is presented in Figure 3-1. It is important to note that the flow duration curve is in accordance with conventional hydrological practice with all periods (including no flow) used for the probability scale and that the probabilities are for the time that flow exceeds a certain value (i.e. opposite of conventional percentiles statistics). The flows are shown as daily average runoff rate in mm/day.

Figure 3-1 Flow Duration Plot of Derived Cherwell Creek Flows



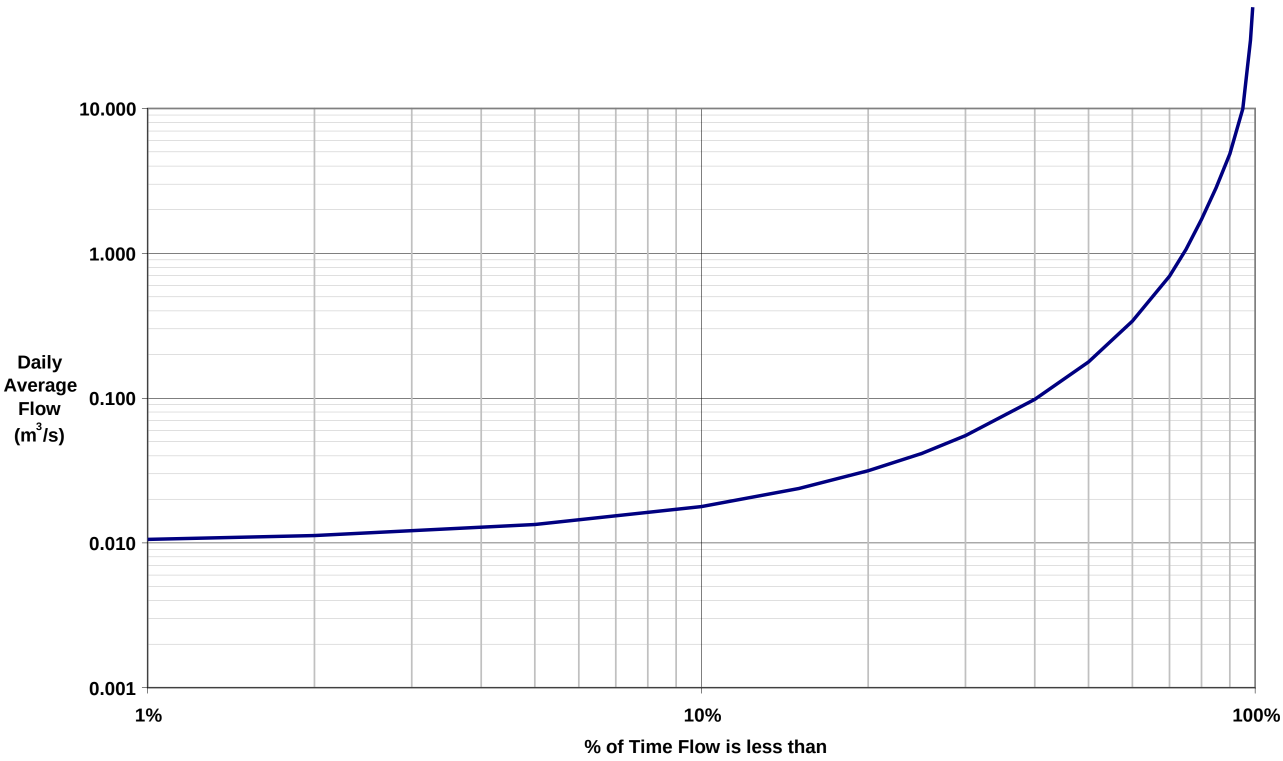
3.3 Statistical Analysis of Stream Flows to Determine Minimum Flow Trigger for Controlled Release

The derived stream flow times series record for Cherwell Creek were statistically analysed to determine the 20th percentile stream flow for flow periods only, as defined in the "*Final Model Water Conditions for Coal Mines in the Fitzroy Basin*" July 2009. It is important to note that the percentile statistics are for the portion of time that stream flow is less than a specific value, as opposed to flow duration statistics (shown in Figure 3-1) which report the portion of time that flow exceeds a specific value.

The derived AWBM model stream flow time series data set inherently includes representation of base flow recession which shows some extended periods of very low flow after rainfall events. Hence to avoid biasing the statistics of percentiles of flow periods only, no flow periods were assumed to be when the Cherwell Creek flow is less than 0.01m^3/s daily average flow. The derived flow data set was reduced to days when flow exceeds 0.01m^3/s daily average flow and percentiles analysis was undertaken on the reduced data set. The resultant percentile statistics plot of flow periods only is presented on Figure 3-2.

The analysis determined that the 20th percentile flow in Cherwell Creek (at the upstream Peak Downs Mine gauge is 0.03 m^3/s daily average flow. To allow a "safety margin", a minimum flow trigger slightly higher than the calculated 20th percentile flow is recommended and a flow trigger of 0.05 m^3/s has been adopted for this component of the controlled release criteria.

Figure 3-2 Flow Percentile Plot of Derived Cherwell Creek Flows- For Flow Periods Only Peak Downs Mine Upstream Gauge – Catchment = 268km²



Derivation of End-of-Pipe EC Limit

4.1 Calculation Methodology

An acceptable End-of-Pipe EC limit for controlled releases was determined with calculations of dilution rates taking account of:

- Typical upstream Cherwell Creek EC values from monitoring;
- The restriction of discharge rate relative to upstream natural flow rate that will be applied (i.e. discharge will be limited to 20% of the upstream flow, or ratio of 1:4 dilution); and
- Ensuring that the EC in the Cherwell Creek receiving waters will be limited to 1000µS/cm or less.

4.2 Natural Upstream Cherwell Creek EC Levels

Data previously reported in the draft EIS for baseline monitoring of upstream Cherwell Creek EC has been supplemented with additional sample laboratory analysis results from monitoring undertaken by Peak Downs Mine and is summarised in Table 4-1 below.

Table 4-1 Baseline Electrical Conductivity at upstream Cherwell Creek Monitoring Site

Sample Date	Comment / Source	Electrical Conductivity µS/cm
26/02/2008	From draft EIS	356
28/03/2008	From draft EIS	309
11/02/2009	Sampled by Peak Downs Mine	113
27/01/2009	Sampled by Peak Downs Mine	150
3/01/2009	Sampled by Peak Downs Mine	158
15/12/2008	Sampled by Peak Downs Mine	193

For the purpose of defining a typical EC value for upstream natural Cherwell Creek flow, a conservative high value of 400µS/cm. A value near, or above the high range of sample results is conservative for the purpose of determining end-of-pipe EC limits as it infers less assimilative capacity for the natural flow to accept salt load from the controlled discharges.

4.3 Calculations of Theoretical End-of-Pipe EC Discharge limit

With an adopted value for the natural upstream Cherwell Creek flow EC of 400µS/cm, an EC dilution ratio of 2.5 will be required for 1:1 volume dilution (controlled discharge rate to stream flow rate) to limit the downstream EC to 1000µS/cm or less.

With application of the restriction of discharge rate to be a maximum of 20% of the upstream creek flow (i.e. 1:4 dilution as defined in the "*Final Model Water Conditions for Coal Mines in the Fitzroy Basin*"), a minimum EC dilution ratio of 10 (i.e. 2.5 x 4) is required to ensure that the controlled discharge impact on downstream receiving water EC is limited to 1000µS/cm. Based on these calculations the theoretical acceptable EC limit for controlled releases is 4000µS/cm to ensure that downstream receiving water EC is limited to 1000µS/cm or less.

4.4 Recommended Practical End-of-Pipe EC Discharge Limit

The assumptions and calculations outlined in Section 4.2 and 4.3 indicate a theoretical acceptable End-of-Pipe discharge EC limit could be as high as 4000µS/cm to ensure that the receiving water EC in Cherwell Creek downstream of the discharge is limited to 1000µS/cm or less. In practice the management of controlled discharges needs to recognise that there will be some degree of residual error in measurements of flow and/or EC, and a safety margin is recommended. On this basis it is recommended that the EC limit for end-of-pipe discharges be limited to 3000µS/cm.

Summary

Based on the revised approach to licensing of discharges from mine in the Bowen Basin outlined in recent DERM documents, and the data and calculations presented in this report, the recommended End-of-Pipe discharge criteria for flow conditions, maximum controlled discharge rate, and EC for controlled discharge from the 12North mine water dam are:

- Controlled discharges only permissible when upstream Cherwell Creek flow is > or = 0.05 m^3/s (measured at the Peak Downs Mine upstream gauge on Cherwell Creek;
- The maximum discharge rate is 20% of the upstream Cherwell Creek flow;
- The maximum EC of the discharge is 3000µS/cm; and
- The maximum EC in Cherwell Creek downstream receiving waters is 1000µS/cm.

The controlled discharge criteria for other water quality parameters of the end-of-pipe discharge waters is recommended to be as defined in the "*Final Model Water Conditions for Coal Mines in the Fitzroy Basin*" July 2009 prepared by Qld DERM.

Limits on the concentration of metalloid contaminants in controlled discharge (end-of-pipe) is not recommended due to lack of adequate baseline data, limited knowledge of assimilative capacity of metalloid contaminants, and that the geochemistry investigations that indicate low potential for metalloid contaminants in the mine water. However it is recommended that monitoring be undertaken for the metalloid contaminant concentrations in end-of-pipe discharges and in downstream receiving waters. Trigger investigation levels should be established for metalloid contaminant concentrations in downstream receiving waters linked to ANZECC 2000 guideline values. Exceedance of the metalloid trigger levels in downstream receiving waters will trigger an investigation into the significance, cause, and mitigation as outlined in condition W5 in the "*Final Model Water Conditions for Coal Mines in the Fitzroy Basin*" July 2009. It is also recommended that downstream Cherwell Creek receiving water monitoring include sampling and analysis for Hardness to allow review of the metalloid trigger levels using Hardness Modified Trigger Values (as outlined ANZECC 2000 guidelines).

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 information available at the time of preparation. URS disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

URS Australia Pty Ltd
Level 16, 240 Queen Street
Brisbane, QLD 4000
GPO Box 302, QLD 4001
Australia
T: 61 7 3243 2111
F: 61 7 3243 2199

www.ap.urscorp.com