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兖煤澳大利亚有限公司

DURALIECOAL
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DURALIE COAL MINE
Water Management Plan

DURALIE COAL MINE
WATER MANAGEMENT PLAN

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Revision Status Register

Section/Page/ Annexure	Revision Number	Amendment/Addition	Distribution	DPIE/DAWE Approval Date
All	WMP-R01-B	Original	OEH, NOW, DP&I	-
All	WAMP-R02-A	Edits made to: • reflect amended Project Approval conditions by Order of The Land and Environment Court of NSW dated 10 November 2011; • consider recommendations (where relevant) of independent environmental audit dated November 2011; • consider any outcomes of the Annual Review for the Duralie Coal Mine (dated September 2011); and • reflect conditions of EPL 11701 varied by Notice 1502222 on 30 December 2011.	OEH, NOW, DP&I	-
All	WAMP-R02-B	Edits made to reflect DP&I and NOW comments.	DP&I	2 August 2012
SWMP	WAMP-R02-C	Edits made to reflect SEWPaC comments.	SEWPaC	15 August 2012
All	WAMP-R02-D	Annual Review Edits made to: • consider any outcomes of the Annual Review for the Duralie Coal Mine (submitted November 2012); • reflect conditions of EPL 11701 varied by Notice 1508851 on 21 March 2013; and • reflect conditions of the NSW Project Approval (08_0203) as modified on 1 November 2012.	DP&I, SEWPAC	27 September 2013
All	WAMP-R03-A	Annual Review (2013) including recommendations from DP&E Audit December 2013	DP&E, DotE	23 June 2015
All	WAMP-R04-A	Annual Review (2014) and Duralie Open Pit Modification (2014)	DP&E	22 July 2016
SWMP	WAMP-R05-A	Edits to reflect DP&E comments on Annual Review 2016. Changes to SWMP only.	DP&E	5 September 2017
WAMP	WAMP-06-A	Updated to reflect current status of DCM and mine closure planning.	EPA, DPIE-Water, DPIE and DAWE	24 December 2021 11 March 2022

SEPTEMBER 2021
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1 INTRODUCTION

1.1 DURALIE COAL MINE

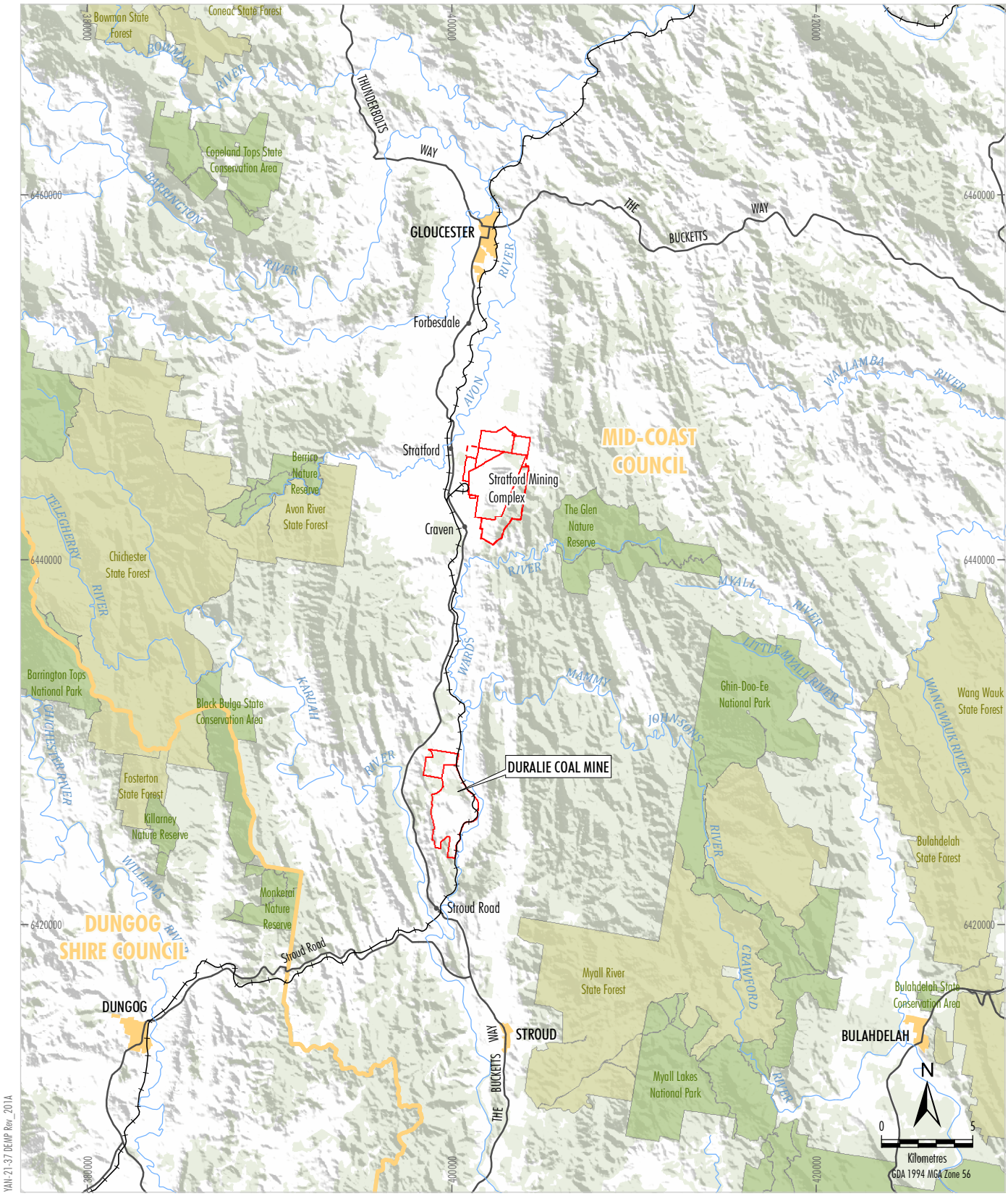
The Duralie Coal Mine (DCM) is an existing mine situated approximately 35 kilometres (km) south of Gloucester in the Gloucester Valley, New South Wales (NSW) (Figure 1). Duralie Coal Pty Ltd (DCPL) (a wholly owned subsidiary of Yancoal Australia Limited) owns and operates the DCM. The NSW Minister for Urban Affairs and Planning granted Development Consent for the DCM in August 1997 and coal production commenced in 2003.

The Duralie Extension Project involves the extension and continuation of mine operations at the DCM. DCPL was granted approval for the Duralie Extension Project under section 75J of the NSW *Environmental Planning and Assessment Act, 1979* (EP&A Act) on 26 November 2010 (NSW Project Approval [08_0203]) and under sections 130 and 133 of the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC) on 22 December 2010 (Commonwealth Approval [EPBC 2010/5396]). On 10 November 2011, the NSW Project Approval (08_0203) was amended by Order of The Land and Environment Court of NSW. On 1 November 2012, the NSW Project Approval (08_0203) was modified to reflect approval of the Duralie Rail Hours Modification. On 5 December 2014, the NSW Project Approval (08_0203) was modified to reflect approval of the Duralie Open Pit Modification. A copy of the consolidated NSW Project Approval (08_0203) and the Commonwealth Approval (EPBC 2010/5396) is available on the Duralie Coal website (http://www.duralie coal.com.au).

The main activities associated with the Duralie Extension Project (as modified) include:

- continued development of open cut mining operations at the DCM to facilitate a total run-of-mine (ROM) coal production rate of up to approximately 3 million tonnes per annum (Mtpa), including:
  - extension of the existing approved open pit in the Weismantel Seam to the north-west (i.e. Weismantel open pit) within Mining Lease (ML) 1427 and ML 1646; and
  - open cut mining operations in the Clareval Seam (i.e. Clareval open pit) within ML 1427 and ML 1646;
- ongoing exploration activities within existing exploration tenements;
- progressive backfilling of the open pits with waste rock as mining develops, and continued and expanded placement of waste rock in out-of-pit waste rock emplacements;
- increased ROM coal rail transport movements on the North Coast Railway between the DCM and the Stratford Coal Mine (SCM) in line with increased ROM coal production;
- continued disposal of excess water through irrigation (including development of new irrigation areas within the existing ML 1427 and ML 1646);
- construction of Auxiliary Dam No. 2 to relative level (RL) 100 metres (m) to provide 2,900 megalitres of on-site storage capacity to manage excess water on-site;
- progressive development of dewatering bores, pumps, dams, irrigation infrastructure and other water management equipment and structures;
- development of new haul roads and internal roads;
- upgrade of existing surface facilities and supporting infrastructure as required in line with increased ROM coal production;
- continued development of soil stockpiles, laydown areas and gravel/borrow pits;
- establishment of the permanent Coal Shaft Creek Diversion alignment adjacent to the existing DCM mining area;
- ongoing monitoring and rehabilitation; and
- other associated minor infrastructure, plant, equipment and activities.

The general arrangement of the DCM, showing modifications, is provided in Figure 2.



YAN-21-37 DEMP Rev_201A

LEGEND

- Mining Lease Boundary
- NSW State Forest
- National Park, Nature Reserve or State Conservation Area
- Local Government Area Boundary

Source: Geoscience Australia (2006); NSW Department of Planning & Environment (2017)

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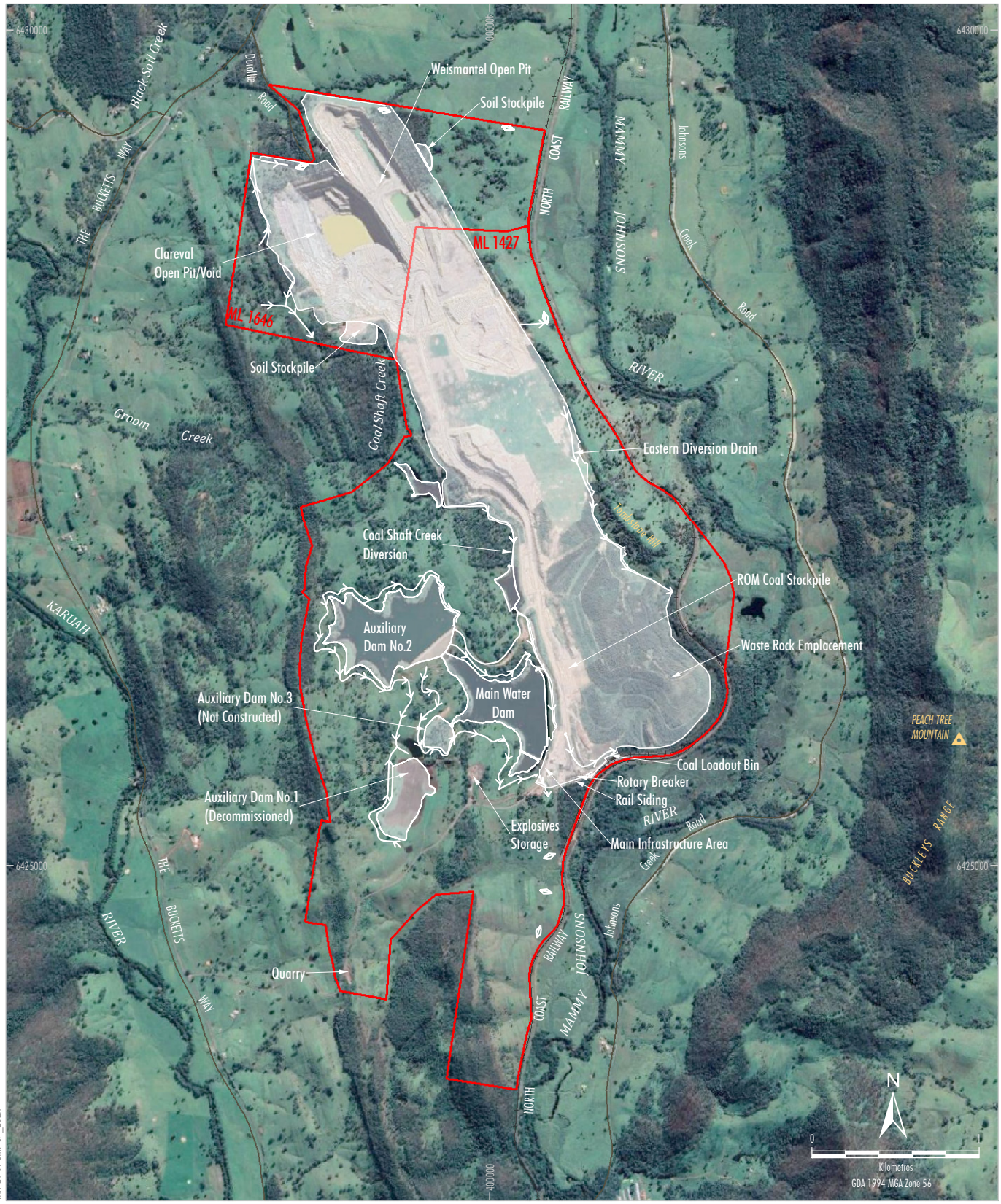
DURALIE COAL MINE

Regional Location

Figure 1



YAN-21-37 DMP CF _202A

LEGEND

- Mining Lease Boundary
- Approximate Extent of Existing/Approved Surface Development
- Existing/Approved First Flush Protocol Pump Back System
- Existing/Approved Up-catchment Diversion System

Source: © NSW Spatial Services (2019)
Orthophoto: Google Earth CENS/Airbus (2020)

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DURALIE COAL MINE

DCM General Arrangement

Figure 2

The activities associated with the approved Duralie Open Pit Modification include:

- an increase in the maximum depth of the Clareval open pit;
- a minor increase in the extent of surface development of the DCM of approximately 2.5 hectares (ha), resulting from:
  - a reduction in low wall angles of the Clareval open pit and the removal of a pillar between the Clareval and Weismantel open pits to improve geotechnical stability; and
  - associated relocation of the up-catchment diversion to the west of the Clareval open pit;
- revision of mining sequence (i.e. progression of mining in the Clareval and Weismantel open pits); and
- an increase in height of the waste rock emplacement (i.e. the backfilled open pit) from approximately 110 m Australian Height Datum (m AHD) to approximately 135 m AHD.

Current Status of the DCM

Condition 5, Schedule 2 of Project Approval (08_0203) authorises mining operations to be carried at the DCM until 31 December 2021.

Accordingly, DCPL is planning for the commencement of the mine closure phase (i.e. after the cessation of mining operations on 31 December 2021) and has revised this Water Management Plan to reflect the current stage of operations and to describe anticipated mine closure activities and associated changes to water management at the DCM for the mine closure phase.

Operations at the DCM now reflect the transition towards mine closure;

- **Clareval Open Pit:** mining of the Clareval Open Pit has now been completed, and dewatering of the pit has ceased. Partial backfilling with waste rock mined from the Weismantel Open Pit has commenced, along with shaping of the pit area to its final landform design. Mining of the Clareval Open Pit was finalised to a shallower depth than the maximum approved depth as modelled in 2014 DCM Open Pit Modification.
- **Weismantel Open Pit:** mining of the Weismantel Open Pit will continue until 31 December 2021, however, will also not occur to the maximum approved depth as modelled in 2014 DCM Open Pit Modification. Progressive backfilling of the Weismantel Open Pit has been undertaken.
- **DCM Water Management System Changes:**
  - Following the cessation of mining of the Clareval Open Pit (now final void) and the Clareval void becoming available as a water storage, Weismantel Open Pit dewatering is now preferentially transferred to the Clareval void and not stored within the Main Water Dam. As a result, all irrigation activities for the purpose of reducing the total site water inventory at the DCM have now ceased and the DCM's Irrigation Area irrigation system has been decommissioned and removed.
  - Decommissioning of other redundant water management structures has also commenced. Consistent with the approved DCM final landform design, Auxiliary Dam No. 1 has been dewatered, decommissioned and rehabilitated.
- **No new disturbance areas** are proposed.

The DCM's Mine Closure Planning Program (provided in the DCM's Mining Operations Plan and Rehabilitation Management Plan) describes the technical assessments and works that will be undertaken and implemented as the DCM progresses towards and commences the mine closure phase.

Key components of the Mine Closure Planning Program (as relevant to this Water Management Plan) include:

- Prepare a detailed final void design (that reflects the revised final depths of the Clareval and Weismantel Open Pits) which includes water qualities/equilibrium level and considers surface water runoff and drainage.
- Review the medium to long-term water quality predictions of the final void against available monitoring data to determine the need for additional/alternate management.
- Review/update the site groundwater model to ensure the model is consistent with the final landform design.
- Review the site water balance modelling to ensure the balance incorporates the final landform design, surface water inflows and outflows to/from the final void.
- Prepare a strategy for transferring mine water from the prescribed dams back to the final voids.
- Prepare a strategy for decommissioning of the mine water dams or for integration with the final land use, with consideration of future approvals or mine closure requirements in consultation with relevant agencies (e.g. Dams Safety NSW).
- Commission and undertake a detailed final design of the Coal Shaft Creek final re-alignment and reconstruction.
- Update the Coal Shaft Creek Reconstruction Plan for consultation.
- Establish biodiversity values for the reconstructed Coal Shaft Creek in consultation with relevant agencies, to ensure biodiversity outcomes are the same or better than pre-mining levels.
- Review and update as required, existing environmental management plans for the rehabilitation and mine closure stage of operations.

DCPL is progressively completing components of the Mine Closure Planning Program, including the review of the site groundwater model and site water balance (including final void water balance) based on the refined final landform design and final void design. Once compete, the outcomes from these reviews and other relevant Mine Closure Planning Program technical assessments and works will be incorporated into this Water Management Plan, and relevant supporting plans. DCPL anticipates that this revision to the Water Management Plan would occur in 2022, following the completion of mining on 31 December 2021.

1.2 PURPOSE AND SCOPE

This Water Management Plan (WAMP) has been prepared by DCPL in accordance with Condition 29, Schedule 3 of Project Approval (08_0203).

This revision of the WAMP has been prepared by DCPL to:

- describe the current status of operations at the DCM; and
- describe changes to water management at the DCM that have occurred as a result of the transition towards mine closure and are anticipated to occur following the cessation of mining operations and into the mine closure phase.

As described in Section 1.1, due to operational changes, all irrigation activities at the DCM Irrigation Areas for the purpose of reducing the total site water inventory have now ceased and the DCM's irrigation system has been decommissioned and removed. DCPL does not intend to recommence irrigation activities at the DCM Irrigation Areas during the mine closure phase. As a result, the requirement for, and the requirements of, the DCM Irrigation Management Plan are no longer applicable to the DCM.

Accordingly, the Surface Water Management Plan (Appendix 2 of the WAMP) has been revised to reflect this status (and other transitional changes) and describe the redundancy of the Irrigation Management Plan. The Site Water Balance (Appendix 1 of the WAMP) and Groundwater Management Plan (Appendix 3 of the WAMP) have also been revised where relevant.

1.3 STRUCTURE OF THE WAMP

The remainder of the WAMP is structured as follows:

Section 2: Outlines the statutory requirements applicable to the WAMP.

Section 3 Provides an overview of the DCM water management system.

Section 4: Describes the review and improvement of the environmental performance process.

Section 5: Outlines the management and reporting of incidents, complaints and non-compliances with statutory requirements.

Section 6: Lists the references cited.

In accordance with Condition 29, Schedule 3 of the NSW Project Approval (08_0203), the WAMP incorporates three documents (provided as Appendices 1 to 3), namely the:

- Site Water Balance (SWB) (Appendix 1);
- Surface Water Management Plan (SWMP) (Appendix 2); and
- Groundwater Management Plan (GWMP) (Appendix 3).

An Irrigation Management Plan (IMP) is also included as a component of the SWMP. As part of the updates to this WAMP, and as described in detail in the SWMP, due to the cessation of irrigation activities at the DCM Irrigation Areas, the requirement for, and the requirements of, the Irrigation Management Plan are no longer applicable to the DCM. Notwithstanding, DCPL would recommence the Irrigation Management Plan should irrigation activities at the DCM Irrigation Areas recommence.

1.4 SUITABLY QUALIFIED AND EXPERIENCED PERSONS

The former NSW Department of Planning and Environment (DP&E), as delegate for the then Director-General, approved the appointment of Mr Lindsay Gilbert (Gilbert & Associates Pty Limited) (now Hydro Engineering & Consulting Pty Ltd) and Dr Noel Merrick (Heritage Computing Pty Ltd) (now HydroAlgorithmics Pty Ltd) as suitably qualified and experienced persons for the preparation of the WAMP on 18 February 2011.

In August 2021, DCPL sought the NSW Department of Planning, Industry and Environment's (DPIE's) approval of the appointment of Mr Anthony Marszalek, Director of Hydro Engineering & Consulting Pty Ltd, as a suitably qualified and experienced person for the preparation of the WAMP, in replacement of Mr Lindsay Gilbert.

Relevant sections/appendices of this revised WAMP have been prepared/reviewed by Mr Anthony Marszalek (i.e. SWB and SWMP and its supporting plans). Due to the minor and administrative nature of the revisions to the GWMP and given the revisions to this WAMP are surface water related, Dr Noel Merrick's review of the GWMP is not considered warranted at this stage. Dr Merrick's involvement will be targeted for the next revision of this WAMP, which will include the results from the Mine Closure Planning Program technical assessments and works described in Section 1.1.

1.5 CONSULTATION FOR THE WAMP

The original WAMP and all revised versions have been prepared in consultation with the NSW Environment Protection Authority (EPA) and NSW Office of Water (NOW) (now DPIE–Water) in accordance with Condition 29, Schedule 3 of NSW Project Approval 08_0203. The revision and approval status of the WAMP is recorded within the Revision Status Register on the title page of this WAMP.

This revised WAMP has been provided to the EPA and DPIE-Water for consultation purposes as required by Condition 29, Schedule 3 of NSW Project Approval 08_0203, and has been submitted to the DPIE and the Commonwealth Department of Agriculture, Water and the Environment (DAWE) for approval (refer Sections 2.1 and 2.2). A record of consultation with the EPA is provided in Attachment A. The EPA's comments have been addressed where relevant in this revised WAMP. No comments on this revised WAMP were received from the DPIE-Water.

On 24 December 2021, the DPIE (Planning and Assessment division) approved this revised WAMP. The DPIE's letter of approval is provided in Attachment B. On 11 March 2022, the DAWE approved this revised WAMP. The DAWE's letter of approval is provided in Attachment C. The revision status of this WAMP is provided on the title page of this plan.

2 STATUTORY REQUIREMENTS

DCPL's statutory obligations are contained in:

(i) the conditions of the NSW Project Approval (08_0203);

(ii) the conditions of the Commonwealth Approval (2010/5396);

(iii) relevant licences and permits, including conditions attached to mining leases; and

(iv) other relevant legislation.

These are described below.

2.1 EP&A ACT APPROVAL

Water Management Plan

Condition 29, Schedule 3 of the NSW Project Approval (08_0203), requires the preparation of a WAMP for the DCM, for approval by the Secretary of the DPIE. The requirements of Condition 29 and where these requirements are addressed within this WAMP (and Appendices 1 to 3) is outlined in Table 1 below.

Table 1
Water Management Plan Requirements

Water Management Plan Requirements	WAMP Section
29. *The Proponent shall prepare and implement a Water Management Plan for the project to the satisfaction of the Secretary. This plan must be prepared in consultation with EPA and NOW by suitably qualified and experienced persons whose appointment has been approved by the Secretary, and submitted to the Secretary within 3 months of the date of this approval.* *In addition to the standard requirements for management plans (see Condition 2 of Schedule 5), this plan must include:*	This WAMP Section 1.5, Section 2 (Table 2)
(a) a Site Water Balance that: • *includes details of:* – *sources of water supply;* – *water use on site;* – *water management on site; and* – *reporting procedures; and* – *describes what measures would be implemented to minimise potable water use on site; and*	Appendix 1
(b) a Surface Water Management Plan, that includes: • *a detailed description of the water management system on site, including the:* – *clean water diversion systems;* – *erosion and sediment controls;* – *water storages; and* – *irrigation system;* • *an irrigation management plan for the irrigation system under the water management system, which includes:* – *salinity trigger levels for controlling discharges from the irrigation areas to Coal Shaft Creek and the unnamed tributary, representing the 80th percentile value of the relevant data set for the creek/unnamed tributary and Mammy Johnsons River in accordance with the methodology in ANZECC/ARMCANZ (2000), Australian Water Quality Guidelines for Fresh and Marine Water Quality, National Water Quality Strategy; and*[1]	Appendix 2 Attachment A of Appendix 2

[1] Condition added by Consequential Order by The Land and Environment Court of NSW dated 10 February 2012.

Table 1 (continued)
Water Management Plan Requirements

Water Management Plan Requirements	WAMP Section
– *provision of an automated first flush system for the additional irrigation areas. (Northern Areas) shown in the figure in Appendix 4.*	Attachment A of Appendix 2
• *a plan for identifying, extracting, handling, and the long-term storage of potentially acid forming material on site;*	Appendix 2
• *detailed plans, including design objectives and performance criteria, for:*	
– *the reconstruction of Coal Shaft Creek;*	
– *design and management of the final voids;*	
– *reinstatement of drainage lines on the rehabilitated areas of the site; and*	
– *control of any potential water pollution from the rehabilitated areas of the site;*	
• *performance criteria, including trigger levels for investigating any potentially adverse impacts for the following:*	
– *the water management system;*	
– *surface water quality of the Unnamed Tributary, Coal Shaft Creek and Mammy Johnsons River;*	
– *the stream and vegetation health of the Unnamed Tributary, Coal Shaft Creek and Mammy Johnsons River; and*	
– *channel stability of the reconstructed Coal Shaft Creek;*	
• *performance criteria for surface water quality attributes relevant to water quality impacts on biological diversity and aquatic ecological integrity, including salinity, heavy metals, sediment load, pH, hardness and biological oxygen demand;*	
• *trigger levels representing the 80th percentile value of the relevant reference data set in accordance with the methodology in ANZECC/ARMCANZ (2000). Australian Water Quality Guidelines for Fresh and Marine Water Quality Management Strategy to determine the levels for investigating any potentially adverse impacts;*	
• *a program to monitor:*	
– *the effectiveness of the water management system;*	
– *surface water flows and quality in the Unnamed Tributary, Coal Shaft Creek and Mammy Johnsons River including utilization of existing monitoring sites together with an additional monitoring site in Mammy Johnsons River immediately downstream of the mixing zone of the confluence of Coal Shaft Creek and Mammy Johnsons River:*	
– *the stream and riparian vegetation health of the unnamed Tributary, Coal Shaft Creek and Mammy Johnsons River; and*	
– *channel stability of the reconstructed Coal Shaft Creek;*	
• *a program of ecotoxicity testing of water in water storages on-site and at selected water monitoring sites in Mammy Johnsons River and macroinvertebrate sampling at selected monitoring sites in Mammy Johnsons River;*	
• *a plan to respond to any exceedances of the performance criteria, and mitigate and/or offset any adverse surface water impacts of the project; and*	
(c) a Groundwater Management Plan, which includes:	Appendix 3
• *groundwater assessment criteria, including trigger levels for investigating any potentially adverse groundwater impacts;*	
• *a program to monitor:*	
– *groundwater inflows to the open cut mining operations;*	
– *the impacts of the project on:*	
▪ *the alluvial aquifers including investigating the potential for direct interface between mine spoil and alluvium and assessment of any consequential impact on alluvial and surface water;*	
▪ *base flows to Mammy Johnsons River;*	
▪ *any groundwater bores on privately-owned land; and*	
– *the seepage/leachate from water storages or backfilled voids on site; and*	

Table 1 (continued)
Water Management Plan Requirements

Water Management Plan Requirements	WAMP Section
• *a program to validate the groundwater model for the project, and calibrate it to site specific conditions; and* • *a plan to respond to any exceedances of the assessment criteria, including,* – *if a direct interface between mine spoil and alluvium is identified, development of a trigger action response plan (TARP) for potential salinity impacts on alluvial and surface water sources; and* – *a plan to offset the loss of any base flow to Mammy Johnsons River caused by the project.*	Appendix 3
Note: The effectiveness of the Water Management Plan is to be reviewed and audited in accordance with the requirements in Schedule 5. Following this review and audit the plan is to be revised to ensure it remains up to date (see condition 4 of Schedule 5).	Section 4

Management Plan Requirements

Condition 2, Schedule 5 of the NSW Project Approval (08_0203), outlines the management plan requirements that are applicable to the preparation of the WAMP. Table 2 indicates these components and where they are addressed within this WAMP.

Table 2
Management Plan Requirements

NSW Project Approval (08_0203) Condition	WAMP Section/Appendix
Condition 2, Schedule 5	
2. The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include:	
a) detailed baseline data;	SWB, SWMP, GWMP
b) a description of:	
• the relevant statutory requirements (including any relevant approval, licence or lease conditions);	Section 2, SWB, SWMP, GWMP
• any relevant limits or performance measures/criteria;	SWMP, GWMP
• 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;	SWMP, GWMP
c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;	SWB, SWMP, GWMP
d) a program to monitor and report on the:	SWMP, GWMP
• impacts and environmental performance of the project;	
• effectiveness of any management measures (see (c) above);	
e) a contingency plan to manage any unpredicted impacts and their consequences;	SWMP, GWMP
f) a program to investigate and implement ways to improve the environmental performance of the project over time;	Section 4, SWB, SWMP, GWMP
g) a protocol for managing and reporting any;	
• incidents;	Section 5 (Refer PIRMP)
• complaints;	Section 5 (Refer EMS)
• non-compliances with statutory requirements; and	Section 5 (Refer EMS)
• exceedences of the impact assessment criteria and/or performance criteria; and	SWMP, GWMP
h) a protocol for periodic review of the plan.	Section 4, SWB, SWMP, GWMP

2.2 EPBC ACT APPROVAL

Of relevance to this WAMP are Conditions 3 and 4 of the Commonwealth Approval (EPBC 2010/5396) which require:

Water Management

3. *The person undertaking the action must ensure that all irrigation and run-off from the Project Area is managed in accordance with the Duralie Coal Mine Irrigation Management Plan (DCPL, 2008) as set out in Referral received on the 11 March 2010 (or as per any amendments approved by this Department, in consultation with the NSW Department of Planning, the NSW Department of Environment and Climate Change and Water and NSW Office of Water), and not otherwise discharged into the MJR*
4. *The release of water into the MJR catchment must only occur when Electricity Conductivity levels do not exceed 400 Micro Siemens (µS/cm) in the MJR at the "High Noon" monitoring site and 1,326 µS/cm in the Main Water Dam diversion drain sumps; or alternate thresholds as may be advised in writing by the Department.*

As described in the SWMP (Appendix 2 of this WAMP), the IMP (Attachment A of the SWMP) supersedes the former Irrigation Management Plan (DCPL, 2008a). In accordance with Condition 3 of the Commonwealth Approval (EPBC 2010/5396), the SWMP was originally approved (15th August 2012) by the then Commonwealth Department of the Environment (now DAWE) in consultation with the then DP&E (now DPIE), the NSW Office of Environment and Heritage (OEH) (now DPIE – Biodiversity and Conservation Division) and the NSW Office of Water (NOW) (now DPIE-Water). The revision and approval status of the SWMP is recorded within the Revision Status Register on the title page of the SWMP (Appendix 2).

The SWMP (Appendix 2) describes the measures that would be implemented to maintain compliance with Condition 4 of the Commonwealth Approval (EPBC 2010/5396).

In addition to the above, Condition 11 of the Commonwealth Approval (EPBC 2010/5396) requires:

Mitigation Measures

11. *In order to minimise the impacts of the project on listed threatened species, the person taking the action must implement all measures in the following plans/documents or their subsequent revisions as approved by the Minister:*
    (a) The DCM Vegetation Clearance Protocol (DCPL, 2002);
    (b) The DCM Irrigation Management Plan (DCPL, 2008);
    (c) The DCM Site Water Management Plan (DCPL, 2008); and
    (d) The DCM Rehabilitation Management Plan (DCPL, 2007).

This WAMP supersedes the original Water Management Plan and the former Site Water Management Plan (DCPL, 2008b). In accordance with Condition 11 of the Commonwealth Approval (EPBC 2010/5396), this amended WAMP (and the revised SWMP [Appendix 2]) will be submitted for approval by the Commonwealth Minister for the Environment (or delegate).

2.3 LICENCES, PERMITS AND LEASES

In addition to the NSW Project Approval (08_0203) and Commonwealth Approval (EPBC 2010/5396), all activities at the DCM will be conducted in accordance with a number of licences, permits and leases which have been issued or are pending issue.

Key licences, permits and leases pertaining to the DCM include:

- ML 1427 issued under Part 5 of the NSW *Mining Act, 1992* and approved by the NSW Minister for Mineral Resources in April 1998.

- ML 1646 issued under Part 5 of the NSW *Mining Act, 1992* and approved by the NSW Minister for Primary Industries in January 2011.
- EPL 11701 issued under Part 3 of the NSW *Protection of the Environment Operations Act, 1997* (PoEO Act) by the EPA in September 2002 (as modified by subsequent licence variations).
- Water Access Licence (WAL) 41518 for extraction of groundwater from the DCM open cut pits issued by the WaterNSW (originally granted 22 September 2002 under former Groundwater Licence 20BL168404).
- DPIE-Water Bore Licence for monitoring bores (20BL168539) dated 31 October 2002. Three bores added on 2 February 2004.
- DPIE-Water Bore Licence for monitoring bores WR1, WR2 and DB11W (20BL173570, 20BL173568, 20BL173569) dated 5 August 2013.
- Mining Operations Plan approved by the NSW Resources Regulator under the *Mining Act, 1992*.
- Water Supply Works Approval (20WA202053) under the NSW *Water Management Act, 2000* issued by the Department of Water and Energy (now DPIE-Water) on 15 May 2009 for the Coal Shaft Creek diversion and various on-site water management structures[2].
- Mining and occupational health and safety related approvals granted by the Resources Regulator and SafeWork NSW.

2.4 OTHER LEGISLATION

DCPL will operate the DCM consistent with the NSW Project Approval (08_0203), the Commonwealth Approval (EPBC 2010/5396) and any other legislation that is applicable to an approved Part 3A Project under the EP&A Act.

In addition to those Acts referred to above (Section 2.3), the following NSW Acts may be applicable to the conduct of the DCM:

- *Contaminated Land Management Act, 1997;*
- *Dangerous Goods (Road and Rail Transport) Act, 2008;*
- *National Parks and Wildlife Act, 1974;*
- *Biosecurity Act, 2015;*
- *Roads Act, 1993;*
- *Biodiversity Conservation Act, 2016;*
- *Work Health and Safety (Mines and Petroleum Sites) Act, 2013;*
- *Work Health and Safety Act, 2011;*
- *Crown Land Management Act, 2016;*
- *Dams Safety Act, 2015;*
- *Fisheries Management Act, 1994;* and
- *Petroleum (Onshore) Act, 1991.*

Relevant licences or approvals required under these Acts will be obtained as required.

[2] This approval replaced the previous *Water Act, 1912* Licence 20SL060324 for these structures.

3 WATER MANAGEMENT SYSTEM OVERVIEW

3.1 SURFACE WATER MANAGEMENT

The objectives of the DCM water management system during the mine closure transition and mine closure phases are to:

- protect the integrity of local and regional water resources;
- maintain separation between runoff from undisturbed areas and water generated within active mining and/or disturbance areas;
- operate such that there is no uncontrolled overflow of contained water storages;
- comply with the requirements of EPL 11701; and
- provide a reliable source of water for on-site mining and coal handling until the cessation of mining operations on 31 December 2021.

The DCM water management system controls waters generated from surface development areas while controlling the capture of surface water runoff by diverting upslope water around such areas (DCPL, 2010). The water management system includes a combination of permanent structures that will continue to operate post closure and temporary structures that will only be required until the completion of rehabilitation works (e.g. sediment control structures) (DCPL, 2010).

The approved water management system at the DCM includes the following components (DCPL, 2014):

- water management storages;
- diversions for runoff from catchment areas upslope of the mine disturbance area (i.e. upslope diversions);
- runoff control structures and devices on disturbed and rehabilitated areas at the mine;
- runoff control structures and devices on infrastructure areas;
- procedures, structures and devices for the control of erosion and sediment movement;
- open pit dewatering equipment;
- procedures and equipment for the disposal of excess water through on-site irrigation; and
- sewage treatment plant and a system for the disposal of effluent.

Water captured from mining-related areas includes (Gilbert & Associates Pty Limited, 2014):

- rainfall within the open pits mixing with particulate matter and relatively saline groundwater;
- groundwater seeping into the open pits;
- rainfall induced runoff and seepage from active sections of the waste rock emplacement;
- rainfall induced runoff from the main infrastructure area;
- rainfall induced runoff from haul roads;
- rainfall induced runoff from areas stripped of topsoil (typically exposing clays);
- rainfall induced runoff from areas yet to adequately revegetate within sediment dam catchments; and
- direct rainfall falling on sediment dams and water management storages.

As identified above, the DCM does not require water from external water supply sources, except for potable water. As such, the only water licensing requirement relevant to the DCM is associated with groundwater inflow to the open pits (Section 3.3.1).

Mine Closure Phase

As described in Section 1.1, operations at the DCM now reflect the transition towards mine closure:

- mining and dewatering of the Clareval Open Pit has ceased;
- mining related activities at the DCM is limited to extraction of the remining ROM coal from the Weismantel Open Pit;
- partial backfilling of the Clareval final void with waste rock mined from the Weismantel Open Pit has continued;
- shaping of the Clareval final void area to its final landform design has commenced; and
- accumulated water within the Weismantel Open Pit is now preferentially transferred to the Clareval final void and not stored within the Main Water Dam.

Due to the above operational changes, irrigation activities for the purpose of reducing the DCM's total site water inventory have now ceased and the DCM's irrigation system has been decommissioned and removed. Irrigation of mine water may be undertaken if required to control heating in temporary potentially acid forming waste emplacement areas as described in the DCM Potentially Acid Forming Material Management Plan (Section 7.2 of the SWMP).

Decommissioning of redundant water management storages has also commenced. Auxiliary Dam No. 1 has been dewatered, decommissioned and rehabilitated.

The DCM water management system is described in further detail in the Site Water Balance (Appendix 1 of the WAMP) and the Surface Water Management Plan (Appendix 2 of the WAMP), which have both been revised to reflect the changes to the DCM water management system to reflect the current status of the site and proposed changes to occur as part of mine closure.

3.2 SITE WATER BALANCE

The DCM's Site Water Balance (Appendix 1) describes the water management and use at the SMC. A predictive model of the performance of the water management system (including supply, containment and risk of disruption to mining operations) was developed by Gilbert & Associates Pty Limited (2014) as part of their *Duralie Coal Mine Open Pit Modification Surface Water Assessment*.

The water balance simulation modelling showed that there were no simulated releases of water from the MWD of the auxiliary dams in any of the 1,000 sequences simulated (Gilbert & Associates Pty Limited, 2014). This reflects a negligible risk (expected to be less than 0.1% over the mine life) of uncontrolled spill risk if the assumed operational conditions are adhered to (Gilbert & Associates Pty Limited, 2014).

The water balance simulation model also indicates that there is a low probability (<0.1%) of non-potable water shortfall occurring over the remaining mine life, with no shortages being simulated in any of the 1,000 climatic sequences (Gilbert & Associates Pty Limited, 2014).

As described in Section 1.1, DCPL will engage suitably qualified specialists to prepare a post-mining site water balance (including final void water balance) based on the refined final landform and final void design, including all surface water inflows and outflows. The DCM's Site Water Balance (Appendix 1) will be revised to the incorporate the outcomes from the post-mining site water balance, once complete.

3.3 GROUNDWATER MANAGEMENT

A Groundwater Management Plan has been prepared for the DCM (Appendix 3) to control potential impacts on local and regional groundwater resources and includes a monitoring program to validate and review the groundwater model predictions. The Groundwater Management Plan includes:

- a groundwater monitoring network;
- performance measures and indicators (trigger levels) for investigating any potentially adverse groundwater impacts to the Mammy Johnsons River or privately-owned bores; and
- a contingency plan to respond to greater than negligible impacts to the Mammy Johnsons River or privately-owned bores, including measures to offset any loss of baseflow to the Mammy Johnsons River and make-good provisions at privately-owned bores.

Further details are provided in the Groundwater Management Plan in Appendix 3.

In accordance with Condition 27, Schedule 3 of the NSW Project Approval (08_0203), DCPL will provide a compensatory water supply to the owner of any privately-owned land whose water supply is adversely and directly impacted (other than a negligible impact) as a result of the DCM.

Sections 7 and 8 of the Groundwater Management Plan provide response plans to offset the loss of any baseflows to Mammy Johnsons River and provide compensatory water supply to any landowner of privately-owned land whose water licence entitlements are impacted (other than an impact that is negligible) as a result of the Duralie Extension Project (incorporating the Open Pit Modification).

3.3.1 Groundwater Licensing

DPCL was issued with Water Access Licence (WAL) 41518 by WaterNSW as relevant to the Gloucester Basin Groundwater Source and as regulated by the *Water Sharing Plan North Coast Fractured and Porous Rock Groundwater Sources 2016*. WAL 41518 replaces former Groundwater Licence 20BL168404.

4 REVIEW AND IMPROVEMENT OF ENVIRONMENTAL PERFORMANCE

4.1 ANNUAL REVIEW

In accordance with Condition 3, Schedule 5 of the NSW Project Approval (08_0203), DCPL will prepare an Annual Review of the environmental performance of the DCM by the end of December each year. The Annual Review will be made publicly available on the Duralie Coal website, in accordance with Condition 10, Schedule 5 of the NSW Project Approval (08_0203).

The Annual Review will specifically address the following aspects of Condition 3, Schedule 5 of the NSW Project Approval (08_0203), that are directly relevant to water management:

- a description of the development implemented in the past year and proposed in the next year;
- a comprehensive review of the monitoring results and complaints records for the DCM over the past year, including a comparison of these results against the:
  - relevant statutory requirements, limits or performance measures/criteria;
  - monitoring results of previous years; and
  - relevant predictions in the Duralie Extension Project Environmental Assessment (EA);
- any non-compliance over the last year, and described what actions were (or are being) taken to ensure compliance;
- any trends in the monitoring data over the life of the DCM;
- any discrepancies between the predicted and actual impacts of the DCM, and analyse the potential cause of any significant discrepancies; and
- what measures to be implemented over the next year to improve the environmental performance of the DCM.

This WAMP is required to be reviewed within three months of the submission of an Annual Review, and revised where appropriate, as described in Section 4.2 below.

4.2 WAMP REVIEW

In accordance with Condition 4, Schedule 5 of the NSW Project Approval, this WAMP (and its Appendices) will be reviewed and if necessary revised to the satisfaction of the Secretary of the DPIE, within three months of the submission of:

- an Annual Review, in accordance with Condition 3, Schedule 5 of Project Approval 08_0203;
- an Incident Report, in accordance with Condition 6, Schedule 5 of Project Approval 08_0203;
- an audit, in accordance with Condition 8, Schedule 5 of Project Approval 08_0203;
- any modification to the conditions of Project Approval 08_0203; or
- prior to the commencement of clearing in accordance with the *Duralie Open Pit Modification Environmental Assessment* (DCPL, 2014).

The revision status of this WAMP is indicated on the title page of each copy.

This WAMP will be made publicly available on the Duralie Coal website in accordance with NSW Project Approval (08_0203). A hard copy of the WAMP will also be kept at the DCM.

5 REPORTING PROTOCOLS

In accordance with Condition 2 (g), Schedule 5 of the NSW Project Approval, DCPL has developed protocols for managing and reporting the following:

- incidents;
- complaints;
- non-compliances with statutory requirements; and
- exceedances of the impact assessment criteria and/or performance criteria.

The management of incidents is described in the DCM Pollution Incident Response Management Plan. The management of complaints and non-compliances is described in detail in the DCM Environmental Management Strategy. The management of exceedances of performance criteria is described in the SWMP (Appendix 2) and GWMP (Appendix 3).

6 REFERENCES

Duralie Coal Pty Limited (2008a) *Irrigation Management Plan*. Document IMP-F.

Duralie Coal Pty Limited (2008b) *Site Water Management Plan*. Document SWMP-F.

Duralie Coal Pty Limited (2010) *Duralie Extension Project Environmental Assessment*.

Duralie Coal Pty Ltd (2014) *Duralie Open Pit Modification Environmental Assessment.*

Gilbert & Associates Pty Limited (2014) *Duralie Open Pit Modification Surface Water Assessment*. Appendix D of Duralie Coal Pty Ltd (2014) *Duralie Open Pit Modification Environmental Assessment*.

ATTACHMENT A

RECORD OF CONSULTATION WITH EPA

DOC21/788384-1; EF12/2892

Planning and Assessment Division
Department of Planning, Industry and Environment
Locked Bag 5022
PARRAMATTA NSW 2124

Attention: The Planning Officer

22 September 2021

EPA Submission on Post Approval Planning Advice Request PAE-27755393

Dear Sir/Madam,

Thank you for the request for advice for Post Approval Consultation (PAE-27755393), requesting a review by the NSW Environment Protection Authority (EPA) of the Updated Water Management Plan and supporting Appendices. The document has been updated in accordance with Condition 4, Schedule 5 of the Duralie Coal Mine (DCM) Project Approval (MP08_0203).

The EPA understands that operations at the DCM now reflect the transition towards mine closure. The key change to water management at the DCM is that, due to the cessation of mining of the Clareval Open Pit and the void becoming available as a water storage, the requirement for irrigation of the DCM Irrigation Areas to reduce the DCM's total site water inventory, has ceased.

Other key changes to water management as the result of mine closure include:

- Weismantel Open Pit - mining of the Weismantel Open Pit will continue until 31 December 2021, however, will not occur to the maximum approved depth as modelled in the 2014 DCM Open Pit Modification. Progressive backfilling of the Weismantel Open Pit has been undertaken.
- Water Management System Changes - following the cessation of mining of the Clareval Open Pit (now final void) and the Clareval void becoming available as a water storage, Weismantel Open Pit dewatering is now preferentially transferred to the Clareval void and not stored within the Main Water Dam. As a result, all irrigation activities for the purpose of reducing the total site water inventory at the DCM have now ceased and the DCM's Irrigation Area irrigation system has been decommissioned and removed.
- Decommissioning of other redundant water management structures has also commenced. Consistent with the approved DCM Mining Operations Plan and Rehabilitation Management Plan, Auxiliary Dam No. 1 has been dewatered, decommissioned and rehabilitated.
- No new disturbance areas are proposed.

The EPA has reviewed the documentation and has the following comments and recommendations:

1. Matters to be addressed prior to determination

a. Ecotoxicity Testing

The requirement to undertake ecotoxicity testing of water in on-site storages and at selected water

monitoring sites in Mammy Johnsons River is derived from DCPL's commitment to monitoring the potential impacts from irrigation of the Additional Irrigation Areas approved under the Duralie Extension Project. DCM has advised that irrigation activities at the Irrigation Areas ceased in 2018 and that irrigation of the Additional Irrigation Areas did not commence. As there is no intention to recommence irrigation at the DCM Irrigation Areas, the DCMs irrigation system has been decommissioned and removed.

As a result of the cessation of irrigation activities at the DCM Irrigation, the WMP has been revised to remove the requirement for ecotoxicity testing of water in on-site storages and at selected water monitoring sites in Mammy Johnsons River.

Recommendation: The EPA recommends including a condition stating that should DCM choose to re-commence irrigation, then the Ecotoxicity Testing Program must be re-commenced.

b. DCM Surface Water Management Plan

Table 4 – Water Management System Monitoring Program in Section 8.2 of the Surface Water Management Plan (SWMP) defines the suite of surface water quality monitoring parameters to be undertaken at each monitoring location.

The Waste Rock Emplacement Sediment Dam (VC1) represents Environment Protection Licence 11701 (EPL 11701) monitoring Point 27. The frequency of monitoring of discharges from VC1 is defined as Special Frequency 1.

The current monitoring frequency on EPL 11701 is:

> Special frequency 1 means:
> a) A sample taken monthly from points 27, 30, 31 and 35; and
> b) A sample taken on the first day of any discharges (overflows) from points 27, 36 and 37.

Special Frequency 1 has been amended in the draft SWMP. It is proposed to be defined as:

- A sample taken monthly
- A sample taken on the first day of any discharges (overflows) from VC1. A maximum of one event sample is taken in any 21 day period.

Recommendation: The EPA does not support the frequency of monitoring proposed in the SWMP. The EPA recommends that Special Frequency 1 be defined as:

- A sample taken monthly
- A sample taken on the first day of any discharges (overflows) from VC1.

2. Matters to be addressed post approval

a. Licence Variation Required

The EPA notes that the Updated Water Management Plan and appendices proposes amendments to the water quality monitoring undertaken in accordance with EPL 11701.

EPL 11701 will be reviewed upon finalisation of the post approval consultation to reflect the amendments made.

Recommendation: The EPA recommends that upon determination of PAE-27755393, DCM review the current licence and, if necessary, submit a licence variation application that clearly outlines each of the amendments required.

This concludes the EPA's submission on the proposal.

If you have any questions about this request, please contact Emma Coombs on (02) 4908 6831 or via email at EPA.Northopsregional@epa.nsw.gov.au.

Yours sincerely

ROB HUGHES
Unit Head – Regulatory Operations Regional North
Environment Protection Authority

ATTACHMENT B

DPIE LETTER OF APPROVAL OF WAMP

Planning, Industry & Environment

John Cullen
Operations Manager
Duralie Coal Pty Ltd
3364 Bucketts Way South
Stratford, NSW 2422

24/12/2021

Dear Mr. Cullen

Duralie Extension Project (08_0203)
Water Management Plan

I refer to the Water Management Plan (WMP) submitted in accordance with Condition 29 of Schedule 3 of the approval for the Duralie Extension Project (08_0203).

The Department has carefully reviewed the document and is satisfied that it meets the water conditions in the Project Approval 08_203.

Please ensure the next revision of the WMP, DCPL expedite feedback from DPIE Water prior to submitting the WMP to DPIE Planning and Assessment for determination.

Accordingly, the Secretary has approved the Water Management Plan (Revision WAMP-06-A, dated September 2021). Please ensure that the approved plan is placed on the project website at the earliest convenience.

If you wish to discuss the matter further, please contact Scotney Moore on (02) 9995 5347.

Yours sincerely

Stephen O'Donoghue
Director

As nominee of the Secretary

ATTACHMENT C

DAWE LETTER OF APPROVAL OF WAMP

Australian Government
Department of Agriculture, Water and the Environment

Mr Michael Plain
Environment and Community Coordinator
Duralie Coal Pty Ltd
3364 Bucketts Way South
STRATFORD NSW 2422

Duralie Extension Project (EPBC 2010/5396)
Approval of revised Duralie Coal Mine Water Management Plan (WAMP-06-A, 24 December 2021)

Dear Mr Plain

I refer to your email dated 24 January 2022 to the Department of Agriculture, Water and the Environment, seeking approval of the revised *Duralie Coal Mine Water Management Plan, WAMP-06-A, dated September 2021* in accordance with conditions 3, 4 and 11 of the above project under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Officers of the Department have advised me on the *Duralie Coal Mine Water Management Plan* and the requirements of the conditions of approval for this project. On this basis, and as a delegate of the Minister for the Environment, I have decided to approve the *Duralie Coal Mine Water Management Plan, WAMP-06-A, dated September 2021*. This plan must now be implemented.

As you are aware, the Department has an active monitoring program which includes monitoring inspections, desk top document reviews and audits. Please ensure that you maintain accurate records of all activities associated with, or relevant to, the conditions of approval so that they can be made available to the Department on request.

Should you require any further information please contact Natasha Amerasinghe on 02 6274 9779 or postapproval@environment.gov.au.

Yours sincerely

Kim Farrant
Assistant Secretary
Environment Assessments (Vic, Tas) and Post Approvals Branch
Environment Approvals Division

11 March 2022

APPENDIX 1

SITE WATER BALANCE

DURALIE COAL MINE
SITE WATER BALANCE

DURALIECOAL
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Revision Status Register

Section/Page/ Annexure	Revision Number	Amendment/Addition	Distribution	DPIE Approval Date
All	SWB-R01-B	Original	OEH, NOW, DP&I	-
All	SWB-R02-A	Edits made to: • reflect amended Project Approval conditions by Order of The Land and Environment Court of NSW dated 10 November 2011; • consider recommendations (where relevant) of independent environmental audit dated November 2011; and • consider any outcomes of the Annual Review for the Duralie Coal Mine (dated September 2011).	OEH, NOW, DP&I	
All	SWB-R02-B	Edits made to reflect DP&I and NOW comments.	DP&I	
All	SWB-R02-C	Annual Review Edits made to: • consider any outcomes of the Annual Review for the Duralie Coal Mine (submitted November 2012); • reflect Duralie Coal Mine 2012 Annual Water Balance Review; and • reflect conditions of EPL 11701 varied by Notice 1508851 on 21 March 2013.	DP&I	27 September 2013
All	SWB-R03-A	Annual Review (2013) and recommendations from DP&E Audit December 2013	DP&E	23 June 2015
All	SWB-R04-A	Annual Review (2014) and Duralie Open Pit Modification (2014).	DP&E, DotE	22 July 2016
All	SWB-R05-A	Updates to reflect current status of DCM and mine closure planning.	EPA, DPIE-Water, DPIE and DAWE	24 December 2021

SEPTEMBER 2021
Document No. SWB-R05-A
ID: 01121698

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1 INTRODUCTION

1.1 DURALIE COAL MINE

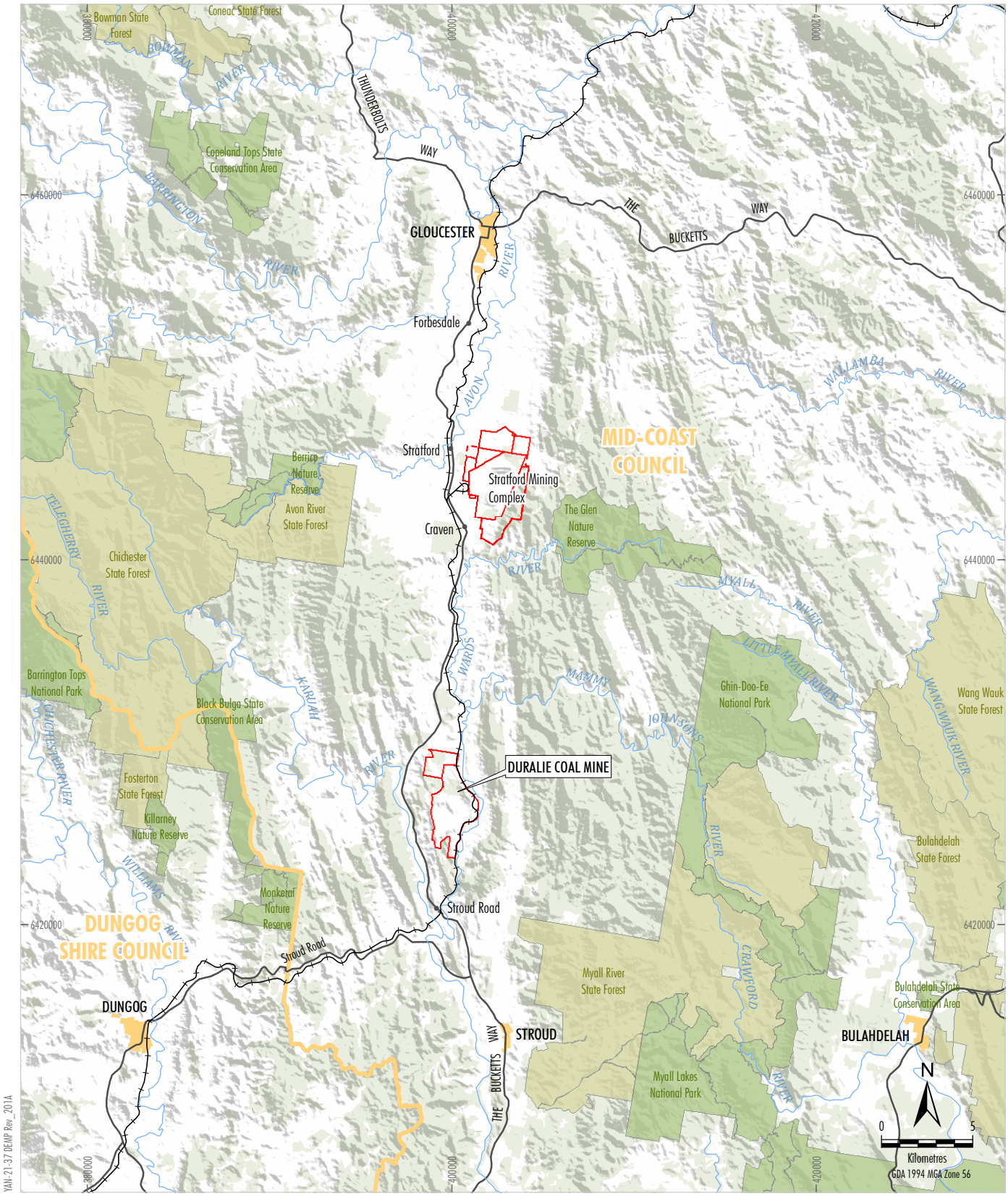
The Duralie Coal Mine (DCM) is an existing mine situated approximately 35 kilometres (km) south of Gloucester in the Gloucester Valley, New South Wales (NSW) (Figure 1). Duralie Coal Pty Ltd (DCPL) (a wholly owned subsidiary of Yancoal Australia Limited) owns and operates the DCM. The NSW Minister for Urban Affairs and Planning granted Development Consent for the DCM in August 1997 and coal production commenced in 2003.

The Duralie Extension Project involves the extension and continuation of mine operations at the DCM. DCPL was granted approval for the Duralie Extension Project under section 75J of the NSW *Environmental Planning and Assessment Act, 1979* (EP&A Act) on 26 November 2010 (NSW Project Approval [08_0203]) and under sections 130 and 133 of the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC) on 22 December 2010 (Commonwealth Approval [EPBC 2010/5396]). On 10 November 2011, the NSW Project Approval (08_0203) was amended by Order of The Land and Environment Court of NSW. On 1 November 2012, the NSW Project Approval (08_0203) was modified to reflect approval of the Duralie Rail Hours Modification. On 5 December 2014, the NSW Project Approval (08_0203) was modified to reflect approval of the Duralie Open Pit Modification. A copy of the consolidated NSW Project Approval (08_0203) and the Commonwealth Approval (EPBC 2010/5396) is available on the Duralie Coal website (http://www.duralie coal.com.au).

The main activities associated with the Duralie Extension Project (as modified) include:

- continued development of open cut mining operations at the DCM to facilitate a total run-of-mine (ROM) coal production rate of up to approximately 3 million tonnes per annum (Mtpa), including:
  - extension of the existing approved open pit in the Weismantel Seam to the north-west (i.e. Weismantel open pit) within Mining Lease (ML) 1427 and ML 1646; and
  - open cut mining operations in the Clareval Seam (i.e. Clareval open pit) within ML 1427 and ML 1646;
- ongoing exploration activities within existing exploration tenements;
- progressive backfilling of the open pits with waste rock as mining develops, and continued and expanded placement of waste rock in out-of-pit waste rock emplacements;
- increased ROM coal rail transport movements on the North Coast Railway between the DCM and the Stratford Coal Mine (SCM) in line with increased ROM coal production;
- continued disposal of excess water through irrigation (including development of new irrigation areas within the existing ML 1427 and ML 1646);
- construction of Auxiliary Dam No. 2 to relative level (RL) 100 metres (m) to provide 2,900 megalitres (ML) of on-site storage capacity to manage excess water on-site;
- progressive development of dewatering bores, pumps, dams, irrigation infrastructure and other water management equipment and structures;
- development of new haul roads and internal roads;
- upgrade of existing surface facilities and supporting infrastructure as required in line with increased ROM coal production;
- continued development of soil stockpiles, laydown areas and gravel/borrow pits;
- establishment of the permanent Coal Shaft Creek alignment adjacent to the existing DCM mining area;
- ongoing monitoring and rehabilitation; and
- other associated minor infrastructure, plant, equipment and activities.

The general arrangement of the DCM, showing modifications, is provided in Figure 2.



YAN-21-37 DEMP Rev_201A

LEGEND

- Mining Lease Boundary
- NSW State Forest
- National Park, Nature Reserve or State Conservation Area
- Local Government Area Boundary

Source: Geoscience Australia (2006); NSW Department of Planning & Environment (2017)

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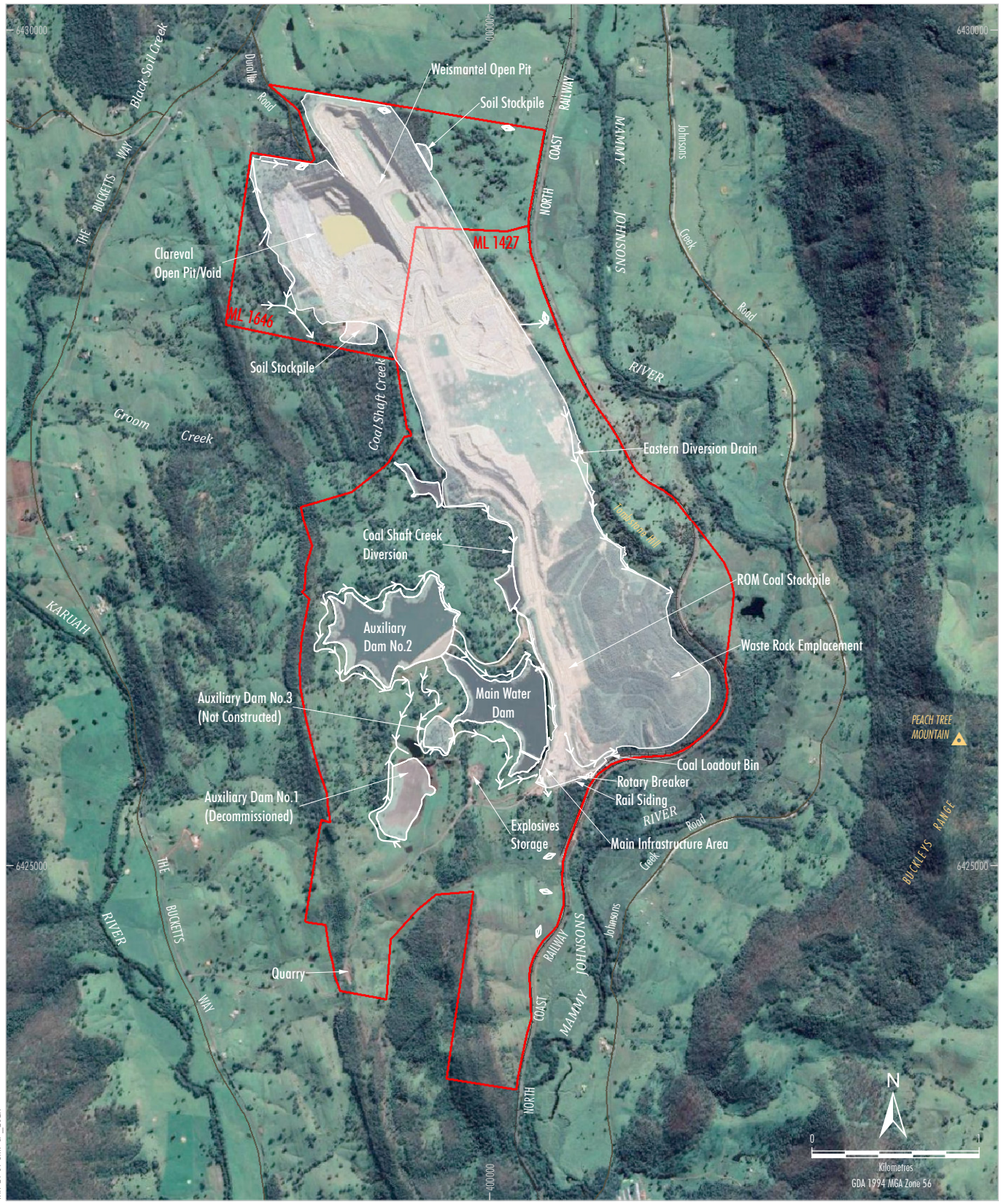
DURALIE COAL MINE

Regional Location

Figure 1



YAN-21-37 DMP CF _202A

LEGEND

- Mining Lease Boundary
- Approximate Extent of Existing/Approved Surface Development
- Existing/Approved First Flush Protocol Pump Back System
- Existing/Approved Up-catchment Diversion System

Source: © NSW Spatial Services (2019)
Orthophoto: Google Earth CENS/Airbus (2020)

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DURALIE COAL MINE

DCM General Arrangement

Figure 2

The activities associated with the approved Duralie Open Pit Modification include:

- an increase in the maximum depth of the Clareval open pit;
- a minor increase in the extent of surface development of the DCM of approximately 2.5 hectares (ha), resulting from:
  - a reduction in low wall angles of the Clareval open pit and the removal of a pillar between the Clareval and Weismantel open pits to improve geotechnical stability; and
  - associated relocation of the up-catchment diversion to the west of the Clareval open pit;
- revision of mining sequence (i.e. progression of mining in the Clareval and Weismantel open pits); and
- an increase in height of the waste rock emplacement (i.e. the backfilled open pit) from approximately 110 m Australian Height Datum (m AHD) to approximately 135 m AHD.

Current Status of the DCM

Condition 5, Schedule 2 of Project Approval (08_0203) authorises mining operations to be carried at the DCM until 31 December 2021.

Accordingly, DCPL is planning for the commencement of the mine closure phase (i.e. after the cessation of mining operations on 31 December 2021) and has revised this Site Water Balance to reflect the current stage of operations and to describe anticipated mine closure activities and associated changes to water management at the DCM for the mine closure phase.

Operations at the DCM now reflect the transition towards mine closure:

- **Clareval Open Pit:** mining of the Clareval Open Pit has now been completed, and dewatering of the pit has ceased. Partial backfilling with waste rock mined from the Weismantel Open Pit has commenced, along with shaping of the pit area to its final landform design. Mining of the Clareval Open Pit was finalised to a shallower depth than the maximum approved depth as modelled in 2014 DCM Open Pit Modification.
- **Weismantel Open Pit:** mining of the Weismantel Open Pit will continue until 31 December 2021, however, will also not occur to the maximum approved depth as modelled in 2014 DCM Open Pit Modification. Progressive backfilling of the Weismantel Open Pit has been undertaken.
- **DCM Water Management System Changes:**
  - Following the cessation of mining of the Clareval Open Pit (now final void) and the Clareval void becoming available as a water storage, Weismantel Open Pit dewatering is now preferentially transferred to the Clareval void and not stored within the Main Water Dam. As a result, all irrigation activities for the purpose of reducing the total site water inventory at the DCM have now ceased and the DCM's Irrigation Area irrigation system has been decommissioned and removed.
  - Decommissioning of other redundant water management structures has also commenced. Consistent with the approved DCM final landform design, Auxiliary Dam No. 1 has been dewatered, decommissioned and rehabilitated.
- **No new disturbance areas** are proposed.

The DCM's approved Mining Operations Plan and Rehabilitation Management Plan includes a Mine Closure Planning Program which outlines the technical assessments and works that will be undertaken and implemented as the DCM progresses towards and commences the mine closure phase. Key components of the Mine Closure Planning Program (as relevant to this Site Water Balance) include:

- Prepare a detailed final void design which includes water qualities/equilibrium level and considers surface water runoff and drainage.
- Review the medium to long-term water quality predictions of the final void against available monitoring data to determine the need for additional/alternate management.
- Review/update the site groundwater model to ensure the model is consistent with the final landform design.
- Review the site water balance modelling to ensure the balance incorporates the final landform design, surface water inflows and outflows to/from the final void.
- Prepare a strategy for transferring mine water from the prescribed dams back to the final voids.
- Prepare a strategy for decommissioning of the mine water dams or for integration with the final land use, with consideration of future approvals or mine closure requirements in consultation with relevant agencies (e.g. Dams Safety NSW).
- Review and update as required, existing environmental management plans for the rehabilitation and mine closure stage of operations.

DCPL is progressively completing components of the Mine Closure Planning Program, including the review of the site groundwater model and site water balance (including final void water balance) based on the refined final landform design and final void design. Once complete, the outcomes from these reviews and other relevant Mine Closure Planning Program technical assessments and works will be incorporated into this Site Water Balance. DCPL anticipates that this revision to the Site Water Balance would occur in 2022, following the completion of mining on 31 December 2021.

1.2 PURPOSE AND SCOPE

This Site Water Balance (SWB) has been prepared by DCPL in accordance with Condition 29(a), Schedule 3 of Project Approval (08_0203).

This revision of the SWB has been prepared by DCPL to:

- incorporate changes that reflect the current status of operations at the DCM; and
- describe changes to water management at the DCM that have occurred as a result of the transition towards mine closure and are anticipated to occur following the cessation of mining operations and into the mine closure phase.

1.3 SUITABLY QUALIFIED AND EXPERIENCED PERSONS

The former NSW Department of Planning and Environment (DP&E) (now the NSW Department of Planning, Industry and Environment [DPIE]), as delegate for the then Director-General, approved the appointment of Mr Lindsay Gilbert (Gilbert & Associates Pty Limited) (now Hydro Engineering & Consulting Pty Ltd) and Dr Noel Merrick (Heritage Computing) (now HydroAlgorithmics Pty Ltd) as suitably qualified and experienced persons for the preparation of the WAMP on 18 February 2011.

The simulated water balance for the DCM Open Pit Modification (Section 8) was conducted by Gilbert & Associates Pty Limited (2014).

In August 2021, DCPL sought the DPIE's approval of Mr Anthony Marszalek, Director of Hydro Engineering & Consulting Pty Ltd, as a suitably qualified and experienced person for the preparation of the surface water related aspects of the WAMP, in replacement of Mr Lindsay Gilbert. This revised SWB has been reviewed by Mr Marszalek.

1.4 STRUCTURE OF THE SWB

The remainder of the SWB is structured as follows:

Section 2: Outlines the statutory requirements applicable to the SWB.

Section 3: Provides detailed baseline data.

Section 4: Provides an overview of the water management system.

Section 5: Includes details of the sources of water for the DCM.

Section 6: Describes the water use and water management on-site for the DCM including measures to minimise water use.

Section 7: Discusses on-site containment capacity.

Section 8: Discusses the simulated performance of the water management system.

Section 9: Describes the review and improvement of the environmental performance process.

Section 10: Describes the management and reporting of incidents, complaints and non-compliances.

Section 11: Lists the references cited.

2 STATUTORY REQUIREMENTS

DCPL's statutory obligations are contained in:

(i) the conditions of the NSW Project Approval (08_0203);

(ii) the conditions of the Commonwealth Approval (EPBC 2010/5396);

(iii) relevant licences and permits, including conditions attached to mining leases; and

(iv) other relevant legislation.

These are described below.

2.1 EP&A ACT APPROVAL

Site Water Balance

This SWB has been prepared in accordance with Condition 29 (a), Schedule 3 of the NSW Project Approval (08_0203). Table 1 indicates where each component of Condition 29 (a) is addressed within this SWB.

Table 1
Site Water Balance Requirements

NSW Project Approval (08_0203) Condition	SWB Section
Condition 29, Schedule 3	
29. The Proponent shall prepare and implement a Water Management Plan for the project to the satisfaction of the Secretary. This plan must be prepared in consultation with EPA and NOW by suitably qualified and experienced persons whose appointment has been approved by the Secretary, and submitted to the Secretary within 3 months of the date of this approval.	
In addition to the standard requirements for management plans (see Condition 2 of Schedule 5), this plan must include:	
a) a Site Water Balance that:	
• includes details of:	
– sources of water supply;	Section 5
– water use on site;	Section 6
– water management on site; and	Section 6
– reporting procedures; and	Section 10
• describes what measures would be implemented to minimise potable water use on site.	Section 6.5
…	

In accordance with Condition 29, Schedule 3 of the NSW Project Approval (08_0203), this SWB is included as part of the WAMP for the DCM (i.e. Appendix 1 of the WAMP).

Management Plan Requirements

In addition, Condition 2, Schedule 5 of the NSW Project Approval (08_0203), outlines the requirements that are applicable to the preparation of the management plans. The WAMP indicates where each component of the conditions is addressed within the plans under the WAMP (including this SWB). Table 2 indicates where each relevant component is addressed within this SWB.

Table 2
Management Plan Requirements

NSW Project Approval (08_0203) Condition	SWB Section
Condition 2, Schedule 5	
2. The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include:	
a) detailed baseline data;	Section 3
b) a description of:	
• the relevant statutory requirements (including any relevant approval, licence or lease conditions);	Section 2
• any relevant limits or performance measures/criteria;	Refer to WAMP (Attachments SWMP and GWMP)
• 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;	Refer to WAMP (Attachments SWMP and GWMP)
c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;	Section 6
d) a program to monitor and report on the:	Refer to WAMP (Attachments SWMP and GWMP)
• impacts and environmental performance of the project;	
• effectiveness of any management measures (see c above);	
e) a contingency plan to manage any unpredicted impacts and their consequences;	Refer to WAMP (Attachments SWMP and GWMP)
f) a program to investigate and implement ways to improve the environmental performance of the project over time;	Section 9
g) a protocol for managing and reporting any;	
• incidents;	Refer to WAMP and PIRMP
• complaints;	Refer to EMS
• non-compliances with statutory requirements; and	Refer to EMS
• exceedences of the impact assessment criteria and/or performance criteria; and	Refer to SWMP and GWMP
h) a protocol for periodic review of the plan.	Section 9

2.2 EPBC ACT APPROVAL

Condition 11 of the Commonwealth Approval (EPBC 2010/5396) requires:

Mitigation Measures

11. In order to minimise the impacts of the project on listed threatened species, the person taking the action must implement all measures in the following plans/documents or their subsequent revisions as approved by the Minister:

(a) The DCM Vegetation Clearance Protocol (DCPL, 2002);

(b) The DCM Irrigation Management Plan (DCPL, 2008);

(c) The DCM Site Water Management Plan (DCPL, 2008); and

(d) The DCM Rehabilitation Management Plan (DCPL, 2007).

In accordance with Condition 11 of the Commonwealth Approval (EPBC 2010/5396), the WAMP (including this SWB) will be submitted for approval by the Commonwealth Minister for the Environment (or delegate).

2.3 LICENCES, PERMITS AND LEASES

In addition to the NSW Project Approval (08_0203), and Commonwealth Approval (EPBC 2010/5396), all activities at DCM will be conducted in accordance with a number of licences, permits and leases which have been issued or are pending issue.

A summary of the key licences, permits and leases pertaining to the DCM is provided in Section 2.3 of the WAMP.

2.4 OTHER LEGISLATION

DCPL will operate the DCM consistent with the NSW Project Approval (08_0203), the Commonwealth Approval (EPBC 2010/5396) and any other legislation that is applicable to an approved Part 3A Project under the EP&A Act.

A summary of other NSW legislation that may be applicable to the conduct of the DCM is provided in Section 2.4 of the WAMP.

3 BASELINE DATA

The site water balance model for the DCM was developed by Gilbert & Associates Pty Limited in 2010 as part of the *Duralie Extension Project Surface Water Assessment* (Gilbert & Associates, 2010) and includes relevant baseline data.

In accordance with Condition 24, Schedule 3 of the NSW Project Approval (08_0203), DCPL maintains an Automatic Weather Station (AWS) on-site. The on-site AWS continuously monitors the following meteorological parameters:

- rainfall;
- temperature;
- relative humidity;
- evapotranspiration;
- net solar radiation;
- wind direction; and
- wind speed.

In addition to the meteorological data described above, the following data from the operations and activities conducted at the DCM (from commissioning in 2003) has been used to update and calibrate the site water balance model, including:

- Daily estimated volumes of water pumped from/to mine water storages and operational open cut pits and temporary mine storages (i.e. sediment dams).
- Water storage levels for the mine water storages.
- Dust suppression records.
- Progressive mine plans for the period since mine commissioning which were used to calculate mine catchment areas.

A summary of relevant meteorological information in the DCM area is provided in the Surface Water Management Plan (SWMP) (included as Appendix 2 of the WAMP) and the DCM Annual Reviews.

Baseline data and ongoing data relevant to the Site Water Balance is contained the DCM Annual Reviews which provide a review of the status of water managed on-site, annually.

4 WATER MANAGEMENT SYSTEM

The objectives of the DCM water management system are to:

- protect the integrity of local and regional water resources;
- maintain separation between runoff from undisturbed areas and water generated within active mining areas;
- operate such that there is no uncontrolled overflow of contained water storages;
- comply with the requirements of EPL 11701; and
- provide a reliable source of water for on-site mining and coal handling.

The DCM water management system controls waters generated from surface development areas while controlling the capture of surface water runoff by diverting upslope water around such areas (DCPL, 2010). The water management system includes a combination of permanent structures that will continue to operate post closure and temporary structures that will only be required until the completion of rehabilitation works (e.g. sediment control structures) (DCPL, 2010).

The approved water management system at the DCM includes the following components (DCPL, 2010):

- water management storages;
- diversions for runoff from catchment areas upslope of the mine disturbance area (i.e. upslope diversions);
- runoff control structures and devices on disturbed and rehabilitated areas at the mine;
- runoff control structures and devices on infrastructure areas;
- procedures, structures and devices for the control of erosion and sediment movement;
- open pit dewatering equipment;
- procedures and equipment for the disposal of excess water through on-site irrigation; and
- sewage treatment plant and a system for the disposal of effluent.

As described in Section 1.1, operations at the DCM now reflect the transition towards mine closure:

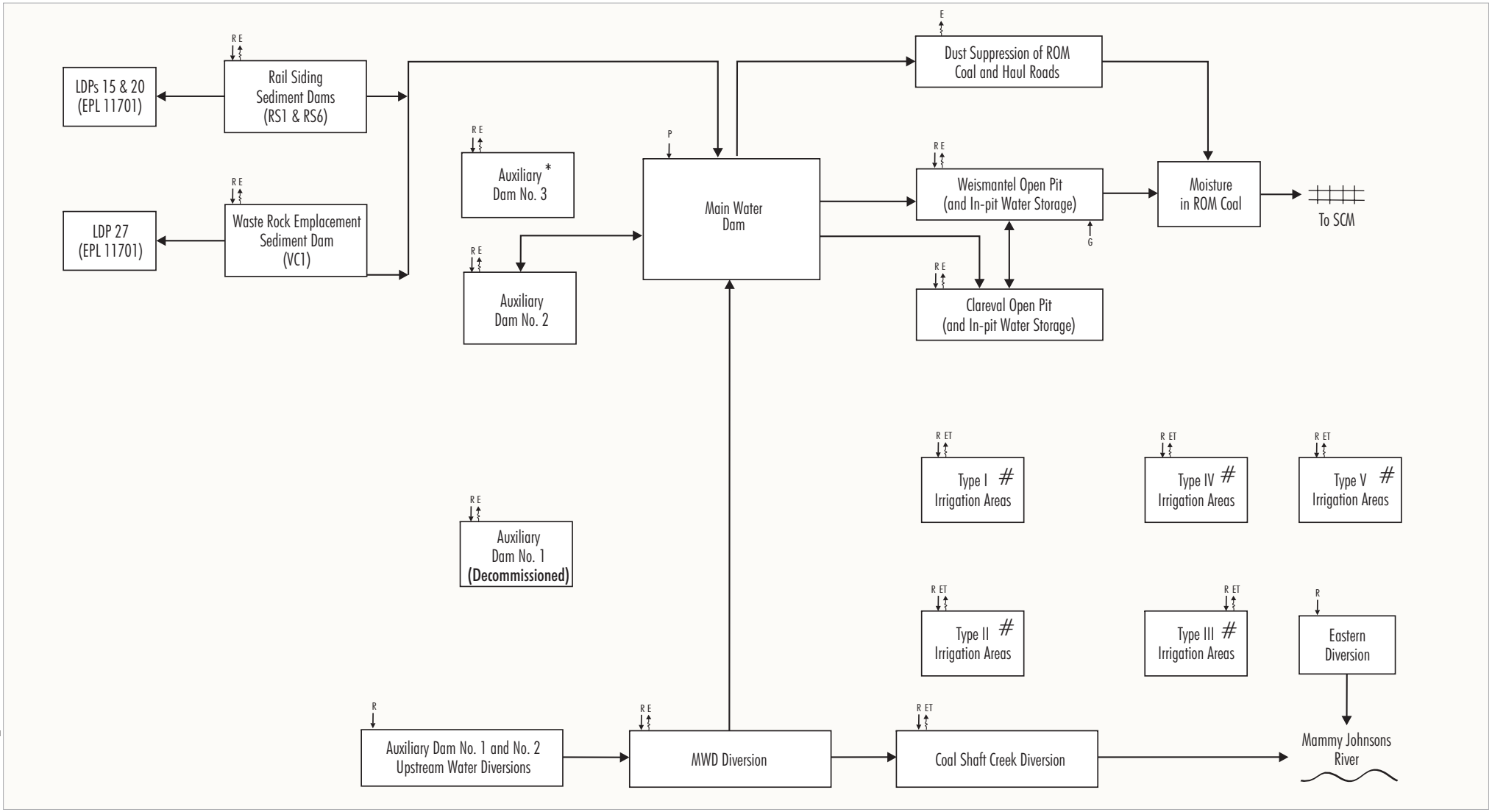
- mining and dewatering of the Clareval Open Pit has ceased;
- mining related activities at the DCM are limited to extraction of the remining ROM coal from the Weismantel Open Pit;
- partial backfilling of the Clareval final void with waste rock mined from the Weismantel Open Pit has continued;
- shaping of the Clareval final void area to its final landform design has commenced; and
- accumulated water within the Weismantel Open Pit is now preferentially transferred to the Clareval final void and not stored within the Main Water Dam.

Due to the above operational changes, irrigation activities for the purpose of reducing the DCM's total site water inventory have now ceased and the DCM's irrigation system has been decommissioned and removed. Irrigation of mine water may be undertaken if required to control heating in temporary potentially acid forming waste emplacement areas as described in the DCM Potentially Acid Forming Material Management Plan (Section 7.2 of the SWMP).

Decommissioning of redundant water management storages has also commenced. Auxiliary Dam No. 1 has been dewatered, decommissioned and rehabilitated. Other changes to the remaining mine water storages that will be undertaken as part of mine closure activities are described in Section 6.1.

The water management system is shown in schematic form on Figure 3 and has been updated to reflect the current status of operations and water management at the DCM.

The approved DCM water management system is further described in Section 2.8 of the *Duralie Extension Project Environmental Assessment* (EA) (DCPL, 2010) and in the *Duralie Extension Project Surface Water Assessment* (Gilbert & Associates Pty Limited, 2010). Changes to the DCM water management system are further described in the Surface Water Assessment for the *Duralie Open Pit Modification Environmental Assessment* (Gilbert & Associates Pty Limited, 2014).



YAN-21-37 DMP SWB_001A

LEGEND

- P — Precipitation
- R — Runoff and Precipitation
- E — Evaporation
- G — Groundwater Inflows
- ET — Evapotranspiration
- LDP — Licenced Discharge Points

* Auxiliary Dam No. 3 is approved but was never constructed.

\# Irrigation of the DCM Irrigation Areas ceased in 2018. Irrigation Areas have been decommissioned.

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DURALIE COAL MINE

Water Management Schematic

Figure 3

5 WATER SOURCES

The water management system aims to maintain separation between water generated in undisturbed areas and water generated within mining related areas.

Water captured from mining related areas includes (Gilbert & Associates Pty Limited, 2014):

- rainfall within the open pits mixing with particulate matter and relatively saline groundwater;
- groundwater seeping into the open pits;
- rainfall induced runoff and seepage from active sections of the waste rock emplacement;
- rainfall induced runoff from the main infrastructure area;
- rainfall induced runoff from haul roads;
- rainfall induced runoff from areas stripped of topsoil (typically exposing clays);
- rainfall induced runoff from areas yet to adequately revegetate within sediment dam catchments; and
- direct rainfall falling on sediment dams and water management storages.

6 WATER USE AND MANAGEMENT MEASURES

Water is required for wash-down of mobile equipment and dust suppression on haul roads and at the coal handling area (e.g. ROM coal stockpiles and conveyor systems). Some water is also used for fire fighting and other minor non-potable water uses.

The water consumption requirements and water balance of the system fluctuate with climatic conditions and as the extent of the mining operation changes over time. Fluctuations in water consumption have been accounted for in the site water balance model.

6.1 WATER STORAGES

Existing water storages at the DCM include (Figure 2):

- The Main Water Dam (MWD), which is located north-west of the main infrastructure area and has a constructed capacity of up to approximately 1,405 ML to the top of the spillway, and approximately 1,296 ML to the invert of the spill pipe.
- A smaller bunded area located in the south of the MWD, adjacent to the main infrastructure area, and other clean water sediment dams.
- Auxiliary Dam No. 2, which is located upslope of the MWD and has a constructed capacity of 2,724 ML (with an approved capacity up to 2,900 ML).

As described in Section 1.1, Auxiliary Dam No. 1 has been decommissioned and rehabilitated. The approved Auxiliary Dam No. 3 is no longer required and will not be constructed.

Post-mining Operations Phase

The MWD and Auxiliary Dam No. 2 will be retained in the DCM final landform as non-declared dams. To achieve this the dams will be reduced is size (i.e. effectively resulting in their decommissioning as mine water storages) in consultation with Dam Safety NSW. Decommissioning of Auxiliary Dam No. 2 is scheduled to be completed by the end of 2022, with decommissioning of the MWD scheduled to occur during approximately 2024 as part of DCM rehabilitation works.

A Detailed Decommissioning Strategy for the DCM's declared mine water dams has been prepared by ATC Williams Pty Ltd (ATC Williams) (2021) and is summarised in the DCM Mining Operations Plan and Rehabilitation Management Plan (MOP/RMP). Decommissioning activities will generally involve dewatering (with water transferred to the final voids), decontaminating the dams if required, and re-configuring/re-shaping the dam embankments in accordance with detailed designs. Existing diversions around the retained dams would be removed, once the dams have been re-configured, to facilitate recharge of the dams by upslope runoff from vegetated catchments. As such, the future water quality of the dams is expected to reflect up-catchment water quality.

As described in Section 1.1, mining in the Clareval Open Pit has been completed and the void is now available for secure storage of excess water from the Weismantel Open Pit.

The Surface Water Assessment prepared for the approved DCM Open Pit Modification Environmental Assessment estimated the post-mining storage capacity of the Weismantel and Clareval final voids at approximately 12,400 ML and 38,000 ML respectively (Gilbert & Associates Pty Limited, 2014). As part of the Mine Closure Planning Program (Section 1.1), a review of the site water balance (including final void water balance) will be undertaken in consideration of the refined final landform design to verify the post-mining predictions from the DCM Open Pit Modification Surface Water Assessment. Once this review is complete, this SWB will be revised if necessary.

6.2 OPEN CUT DEWATERING

Mining Operations Phase

Excavation of the open pits during mining operations forms a sink in the groundwater system towards which groundwater flows. Predicted groundwater inflows to each open cut pit over life of the DCM were modelled by HydroSimulations (2014).

The open pit workings are also collection points for incident rainfall, infiltration through mine waste rock emplacements and rainfall runoff (Gilbert & Associates Pty Limited, 2014). During mining operations, sumps are excavated in the floor of the active open pits as part of routine mining operations to facilitate efficient dewatering operations and to limit interruption to mining.

Water that accumulates in the open pit sumps is used for dust suppression over haul roads and active waste rock emplacement surfaces and/or is transferred to the MWD.

Where the potential for initially high groundwater inflows is identified during the life of the DCM, advance dewatering may be conducted using temporary bores ahead of the open pit mining operation.

Post-mining Operations Phase

During the post-mining operation phase, excavation of ROM coal and waste rock from the open pits ceases and consequently the requirement for dewatering of the open pits will also cease. As described in Sections 1.1 and 4, mining of the Clareval Open Pit has now been completed and dewatering of the pit discontinued. Extraction of ROM coal from the Weismantel Open Cut will cease on 31 December 2021. Dewatering of the Weismantel Open Cut will cease once bulk rehabilitation earthworks below the predicted final void water level have been completed to achieve the final landform design for the Weismantel final void (anticipated by end 2022).

6.3 UPSLOPE DIVERSION WORKS

Temporary and permanent upslope diversion bunds/drains and temporary interception dams were constructed over the life of the DCM, to divert runoff from undisturbed areas around the open pits and waste rock emplacements. The DCM existing and post-mining surface water management system includes continued diversion of runoff via the Coal Shaft Creek Diversion (Figure 2). Permanent upslope diversion bunds/drains will remain around final voids. Diversions upslope of the MWD and Auxiliary Dam 2 would be removed, once the dams have been re-configured, to facilitate clean water recharge of the dams by upslope runoff from vegetated catchments.

The upslope diversions have been designed to pass the peak flow generated by a 1% annual exceedance probability (AEP) rainfall event. Permanent diversion(s) including the final Coal Shaft Creek Diversion will be assessed against the probable maximum flood (PMF) event.

Upslope diversions have been designed to be stable at the design flows. Diversion stability will be achieved by providing appropriately sized channel cross-sections and bed gradients; and by incorporating bed and bank treatments such as rock fill and vegetation which will provide erosion resistance.

Upslope diversions and sediment control are described further in the SWMP (Appendix 2 of the WAMP).

6.4 IRRIGATION

As part of approved operations at the DCM, controlled irrigation was previously used to manage excess mine water in accordance with the Irrigation Management Plan, included as part of the SWMP (Appendix 2 of the WAMP).

As described in Section 1.1, due to the availability of the Clareval void as a water storage, irrigation activities for the purpose of reducing the DCM's total site water inventory have now ceased and the DCM's irrigation system has been decommissioned and removed. The Irrigation Management Plan and the SWMP have been revised to reflect this. Irrigation of mine water may be undertaken if required to control heating in temporary potentially acid forming waste emplacement areas as described in the DCM Potentially Acid Forming Material Management Plan (Section 7.2 of the SWMP).

6.5 POTABLE WATER USE

Potable water for the DCM is supplied by MidCoast Water. Potable water is transported to the DCM by a local contractor and is stored on-site in a holding tank at the main infrastructure area.

DCPL minimises potable water use on-site through staff training and awareness. DCPL places signs in all potable water use areas reminding employees and visitors to minimise waste.

7 ON-SITE CONTAINMENT CAPACITY

Mining Operations Phase

DCPL maintains a policy of no uncontrolled release of mining-related water off-site. The policy of no uncontrolled release is achieved through:

- previous controlled irrigation of excess water;
- transfer of water between the MWD and Auxiliary Dam No. 2 water storages and the open pits;
- maintaining adequate freeboard in the MWD and Auxiliary Dam No. 2 water storages below spill level for large rainfall events; and
- ensuring adequate pump and pipeline capacity is installed to transfer water between the water storages and to the open pits.

Water storage capacity is provided in Section 6.1.

Table 3 summarises key triggers for transfer between the MWD and the remaining Auxiliary Dam No. 2.

Table 3
Water Transfer Triggers

	Auxiliary Dam No. 2
Trigger volume in MWD for pumping to begin to auxiliary dam from MWD (pending auxiliary dam freeboard requirements below).	994 ML
Trigger volume in MWD for pumping to begin from auxiliary dam to MWD	800 ML
Auxiliary dam minimum freeboard for pumping from MWD	133 ML
Transfer rate from MWD to auxiliary dam	27 ML/day
Transfer rate from auxiliary dam to MWD	27 ML/day

Source: Gilbert & Associates Pty Limited, 2014.

No pumping from the open pits to the MWD will occur when the volume stored in the MWD exceeds 1,298 ML (72.5 m RL).

The MWD and Auxiliary Dam water storages are designed and operated to maintain adequate freeboard by cessation of mine dewatering operations during periods of low freeboard levels and by transferring excess water to the open pits. A water transfer system capable of transferring 1 ML/hour (24 ML/day), and 200 millimetre diameter gravity fed transfer pipeline are installed between the MWD and Clareval open pit. The above system is designed and managed to transfer water in excess of the capacity of the MWD to the open pit during periods of low freeboard levels and/or large rainfall events.

Water balance simulation modelling showed that, using the triggers in Table 3, there was a low risk (equivalent to 0.1%) of uncontrolled release of mining-related water off-site during operations (Gilbert & Associates Pty Limited, 2014). There was no overflow from the MWD and the open pits during the 1,000 climatic sequences simulated (Gilbert & Associates Pty Limited, 2014).

With the above triggers and management systems in place, the main consequence of exceeding the design capacity of the water management system will be the transfer of water to the open pits with consequential disruption to mining operations (Section 8). The risk of disruption to mining operations is an operational risk and would have no environmental consequences.

Post-mining Operations Phase

During the post-mining operations phase, dewatering of the open pits will cease and the final voids will become available for mine water storage. The above water transfer controls will then cease and decommissioning of redundant water management storages will be undertaken.

As described in Section 6.1 above, Auxiliary Dam No. 2 and the MWD will be reduced in size and retained in the final landform. The approach for Auxiliary Dam No. 2 and the MWD is to reduce the capacity of the dams such that under a dam break scenario, the consequence category would be considered 'Low', thereby having no ongoing regulated status (ATC Williams, 2021). The new configuration for the MWD allows for the containment of Auxiliary Dam No. 2's volume in the event of a dam break scenario (ATC Williams, 2021).

A summary of the final configuration dimensions for Auxiliary Dam No. 2 and the MWD are provided in Table 4.

Table 4
Retained Dam Design Configurations

Dam Parameter	MWD	Auxiliary Dam No.2
Storage Capacity	225 ML	475 ML
Embankment Crest Elevation	RL 72.0 m	RL 87.5 m
Full Supply Level	RL 65.0 m[1]	RL 86.5 m
Total Catchment Area	212.7 ha	72.4 ha
Maximum Embankment Height	14.8 m	14.8 m
Dam Break Consequence Category	Low	Low

Source: ATC Williams (2021).

[1] The full supply level for the MWD is the low flow pipe. The emergency spillway level is at 70.3 m, allowing for an additional 475 ML of flood storage from Auxiliary Dam No. 2.

The spillway design criteria reflect a 'Low' consequence category in accordance with the Consequence Category Assessment (CCA) Methodology defined in the *Declared Dams Consequence Category Assessment and Determination Methodology* published in NSW Government Gazette Number 137 dated 8 November 2019. The spillway design for each dam assumes a water level at the Full Supply Level with a congruent 0.1% annual exceedance probability rainfall event (ATC Williams, 2021). The spillways for each dam will be rock armoured.

Consistent with the DCM final landform design principles and objectives, the rehabilitated DCM final landform will be free-draining. The rehabilitation objective for the retained water structures is to create safe, stable and non-polluting systems which retain water fit for post mining land use(s).

8 WATER MANAGEMENT SYSTEM PERFORMANCE

Water is transferred between the MWD and Auxiliary Dam No. 2 water storages and the open pits during operations to minimise the disruption to mining and to maintain storm runoff storage capacity needed to achieve a negligible risk of uncontrolled release of mining-related water off-site.

As described in Section 7, existing water balance simulation modelling of the remaining mine life predicts there is a negligible risk of uncontrolled release of mining-related water off-site at the DCM. This prediction is contingent upon the assumed operating protocols and conditions described in the WAMP and adopted in the predictive modelling being adhered to on-site.

The DCM is operated with the operational risk of disruption to mining as a result of exceedance of the design capacity of the water management systems. The operational risk to the DCM as a result of the water management system has been assessed using the water balance modelling in conjunction with 1,000 climatic sequences each 4.5 years in length and has been determined to be an economically and operationally acceptable risk.

The water balance simulation modelling showed that there were no simulated releases of water from the MWD of the auxiliary dams in any of the 1,000 sequences simulated. This reflects a negligible risk (expected to be less than 0.1% over the mine life) of uncontrolled spill risk if the assumed operational conditions are adhered to (Gilbert & Associates Pty Limited, 2014).

The water balance simulation model also indicates that there is a low probability (<0.1%) of non-potable water shortfall occurring over the remaining mine life, with no shortages being simulated in any of the 1,000 climatic sequences (Gilbert & Associates Pty Limited, 2014).

As described in Section 1.1, DCPL will prepare a post-mining site water balance based on the refined final landform and final void design, and including all surface water inflows and outflows. This SWB will be revised to incorporate the outcomes from the post-mining site water balance, once complete.

9 REVIEW AND IMPROVEMENT OF ENVIRONMENTAL PERFORMANCE

9.1 ANNUAL REVIEW

In accordance with Condition 3, Schedule 5 of the NSW Project Approval (08_0203), DCPL prepares an Annual Review of the environmental performance of the DCM prior to the end of December each year. Annual Reviews are made publicly available on the Duralie Coal website, in accordance with Condition 10, Schedule 5 of the NSW Project Approval (08_0203).

The Annual Review will specifically address the following aspects of Condition 3, Schedule 5 that are directly relevant to water management:

- a description of the development implemented in the past year and proposed in the next year;
- include a comprehensive review of the monitoring results and complaints records for the DCM over the past year, including a comparison of these results against the:
  - relevant statutory requirements, limits or performance measures/criteria;
  - monitoring results of previous years; and
  - relevant predictions in the Duralie Extension Project EA;
- identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;
- identify any trends in the monitoring data over the life of the DCM;
- identify any discrepancies between the predicted and actual impacts of the DCM, and analyse the potential cause of any significant discrepancies; and
- describe what measures will be implemented over the next year to improve the environmental performance of the DCM.

This SWB will be reviewed within three months of the submission of an Annual Review, and revised where appropriate, as described in Section 9.2 below.

9.2 SWB REVIEW

In accordance with Condition 4, Schedule 5 of the NSW Project Approval (08_0203), this SWB will be reviewed and if necessary revised to the satisfaction of the Secretary of the DPIE, within three months of the submission of:

- an Annual Review, in accordance with Condition 3, Schedule 5 of Project Approval (08_0203);
- an Incident Report, in accordance with Condition 6, Schedule 5 of Project Approval (08_0203);
- an audit, in accordance with Condition 8, Schedule 5 of Project Approval (08_0203);
- any modification to the conditions of Project Approval (08_0203); or
- prior to the commencement of clearing in accordance with the *Duralie Open Pit Modification Environmental Assessment* (DCPL, 2014).

As outlined in Section 1.2 and in accordance with Condition 4(e), Schedule 5 of the NSW Project Approval (08_0203), this SWB was revised following the approval of the Duralie Open Pit Modification.

This revised SWB will be made publicly available on the Duralie Coal website in accordance with the NSW Project Approval (08_0203). A hard copy of the SWB will also be kept at the DCM.

A site water balance review will be undertaken on an annual basis to review monitoring results of the status of inflows, outflows, site water inventory and consumption (irrigation, dust suppression, vehicle wash-down) and against the DCM site water balance model predictions. The site water balance review will be used to optimise water management performance and will enable corrective actions to be implemented, if required. The results of the water balance reviews will be reported in the Annual Review (Section 9.1).

10 REPORTING PROTOCOLS

In accordance with Condition 2(g), Schedule 5 of the NSW Project Approval (08_0203), DCPL has developed protocols for managing and reporting the following:

- incidents;
- complaints;
- non-compliances with statutory requirements; and
- exceedances of the impact assessment criteria and/or performance criteria.

The management of incidents is described in the Pollution Incident Response Management Plan. The management of complaints and non-compliances is described in detail in the Environmental Management Strategy. The management of exceedances of performance criteria is described in the SWMP and GWMP.

11 REFERENCES

ATC Williams Pty Ltd (2021) Duralie Coal Mine – Detailed Water Dams Decommissioning Strategy.

Duralie Coal Pty Ltd (2010) *Duralie Extension Project Environmental Assessment*.

Duralie Coal Pty Ltd (2014) *Duralie Open Pit Modification Environmental Assessment.*

Gilbert & Associates Pty Limited (2010) *Duralie Extension Project Surface Water Assessment*. Appendix A of Duralie Coal Pty Ltd (2010) *Duralie Extension Project Environmental Assessment*.

Gilbert & Associates Pty Limited (2014) *Duralie Open Pit Modification Surface Water Assessment*. Appendix D of Duralie Coal Pty Ltd (2014) *Duralie Open Pit Modification Environmental Assessment.*

HydroSimulations (2014) *Duralie Open Pit Modification Groundwater Assessment*. Appendix C of Duralie Coal Pty Ltd (2014) *Duralie Open Pit Modification Environmental Assessment.*

APPENDIX 2

SURFACE WATER MANAGEMENT PLAN

DURALIE COAL MINE
SURFACE WATER MANAGEMENT PLAN

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Revision Status Register

Section/Page/ Annexure	Revision Number	Amendment/Addition	Distribution	DPIE/DAWE Approval Date
All	SWMP-R01-B	Original.	OEH, NOW, DP&I	-
All	SWMP-R02-A	Edits made to: • reflect amended Project Approval conditions by Order of The Land and Environment Court of NSW dated 10 November 2011; • consider recommendations (where relevant) of independent environmental audit dated November 2011; • consider any outcomes of the Annual Review for the Duralie Coal Mine (dated September 2011); and • reflect conditions of EPL 11701 varied by Notice 1502222 on 30 December 2011.	OEH, NOW, DP&I	-
All	SWMP-R02-B	Edits made to reflect DP&I and NOW comments.	DP&I	2 August 2012
All	SWMP-R02-C	Edits made to reflect SEWPaC comments.	SEWPaC	-
All	SWMP-R02-D	Annual Review. Edits made to: • consider any outcomes of the Annual Review for the Duralie Coal Mine (submitted June 2012); • reflect conditions of EPL 11701 varied by Notice 1508851 on 21 March 2013 2012; and • reflect conditions of the NSW Project Approval (08_0203) as modified on 1 November 2012.	DP&I	27 September 2013
All	SWMP-R03-A	Annual Review (2013) and recommendations from DP&E Audit December 2013.	DP&E	23 June 2015
All	SWMP-R04-A	Annual Review (2014) and Duralie Open Pit Modification (2014).	DP&E	22 July 2016
Section 8.7	SWMP-R05-A	Edits to reflect DP&E comments on Annual Review 2016. Changes to SWMP only.	DP&E	September 2017
All	SWMP-06-A	Updates to reflect current status of DCM, monitoring program changes and describe mine closure planning.	EPA, DPIE-Water, DPIE and DAWE	24 December 2021

SEPTEMBER 2021
Document No. SWMP-R06-A
ID: 01121699

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1 INTRODUCTION

1.1 DURALIE COAL MINE

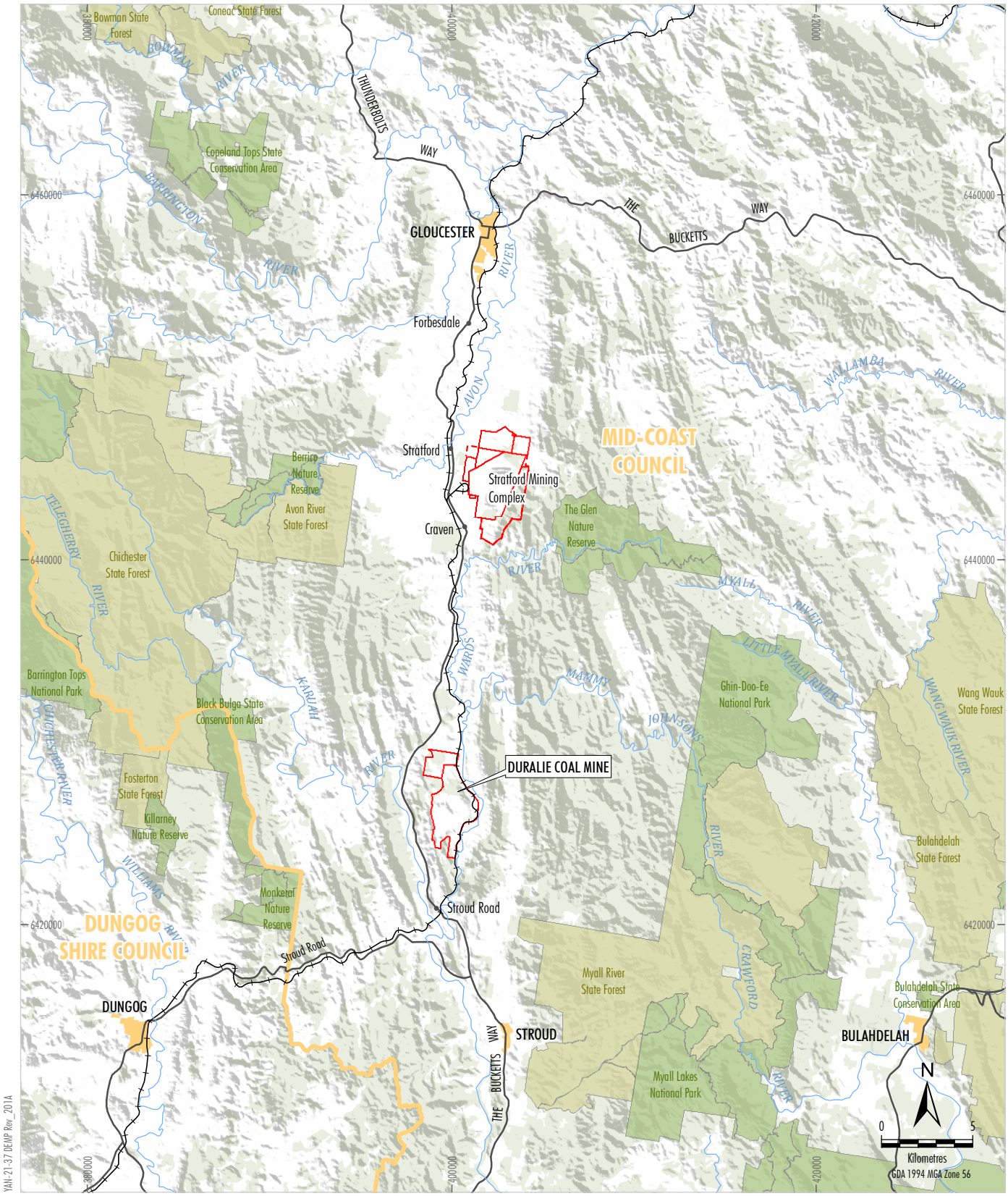
The Duralie Coal Mine (DCM) is an existing mine situated approximately 35 kilometres (km) south of Gloucester in the Gloucester Valley, New South Wales (NSW) (Figure 1). Duralie Coal Pty Ltd (DCPL) (a wholly owned subsidiary of Yancoal Australia Limited) owns and operates the DCM. The NSW Minister for Urban Affairs and Planning granted Development Consent for the DCM in August 1997 and coal production commenced in 2003.

The Duralie Extension Project involves the extension and continuation of mine operations at the DCM. DCPL was granted approval for the Duralie Extension Project under section 75J of the NSW *Environmental Planning and Assessment Act, 1979* (EP&A Act) on 26 November 2010 (NSW Project Approval [08_0203]) and under sections 130 and 133 of the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC) on 22 December 2010 (Commonwealth Approval [EPBC 2010/5396]). On 10 November 2011, the NSW Project Approval (08_0203) was amended by Order of The Land and Environment Court of NSW. On 1 November 2012, the NSW Project Approval (08_0203) was modified to reflect approval of the Duralie Rail Hours Modification. On 5 December 2014, the NSW Project Approval (08_0203) was modified to reflect approval of the Duralie Open Pit Modification. A copy of the consolidated NSW Project Approval (08_0203) and the Commonwealth Approval (EPBC 2010/5396) is available on the Duralie Coal website (http://www.duralie coal.com.au).

The main activities associated with the Duralie Extension Project (as modified) include:

- continued development of open cut mining operations at the DCM to facilitate a total run-of-mine (ROM) coal production rate of up to approximately 3 million tonnes per annum (Mtpa), including:
  - extension of the existing approved open pit in the Weismantel Seam to the north-west (i.e. Weismantel open pit) within Mining Lease (ML) 1427 and ML 1646; and
  - open cut mining operations in the Clareval Seam (i.e. Clareval open pit) within ML 1427 and ML 1646;
- ongoing exploration activities within existing exploration tenements;
- progressive backfilling of the open pits with waste rock as mining develops, and continued and expanded placement of waste rock in out-of-pit waste rock emplacements;
- increased ROM coal rail transport movements on the North Coast Railway between the DCM and the Stratford Coal Mine (SCM) in line with increased ROM coal production;
- continued disposal of excess water through irrigation (including development of new irrigation areas within the existing ML 1427 and ML 1646);
- construction of Auxiliary Dam No.2 to relative level (RL) 100 metres (m) to provide 2,900 megalitres (ML) of on-site storage capacity to manage excess water on-site;
- progressive development of dewatering bores, pumps, dams, irrigation infrastructure and other water management equipment and structures;
- development of new haul roads and internal roads;
- upgrade of existing surface facilities and supporting infrastructure as required in line with increased ROM coal production;
- continued development of soil stockpiles, laydown areas and gravel/borrow pits;
- establishment of the permanent Coal Shaft Creek Diversion alignment adjacent to the existing DCM mining area;
- ongoing monitoring and rehabilitation; and
- other associated minor infrastructure, plant, equipment and activities.

The general arrangement of the DCM, showing modifications, is provided in Figure 2.



YAN-21-37 DEMP Rev_201A

LEGEND

- Mining Lease Boundary
- NSW State Forest
- National Park, Nature Reserve or State Conservation Area
- Local Government Area Boundary

Source: Geoscience Australia (2006); NSW Department of Planning & Environment (2017)

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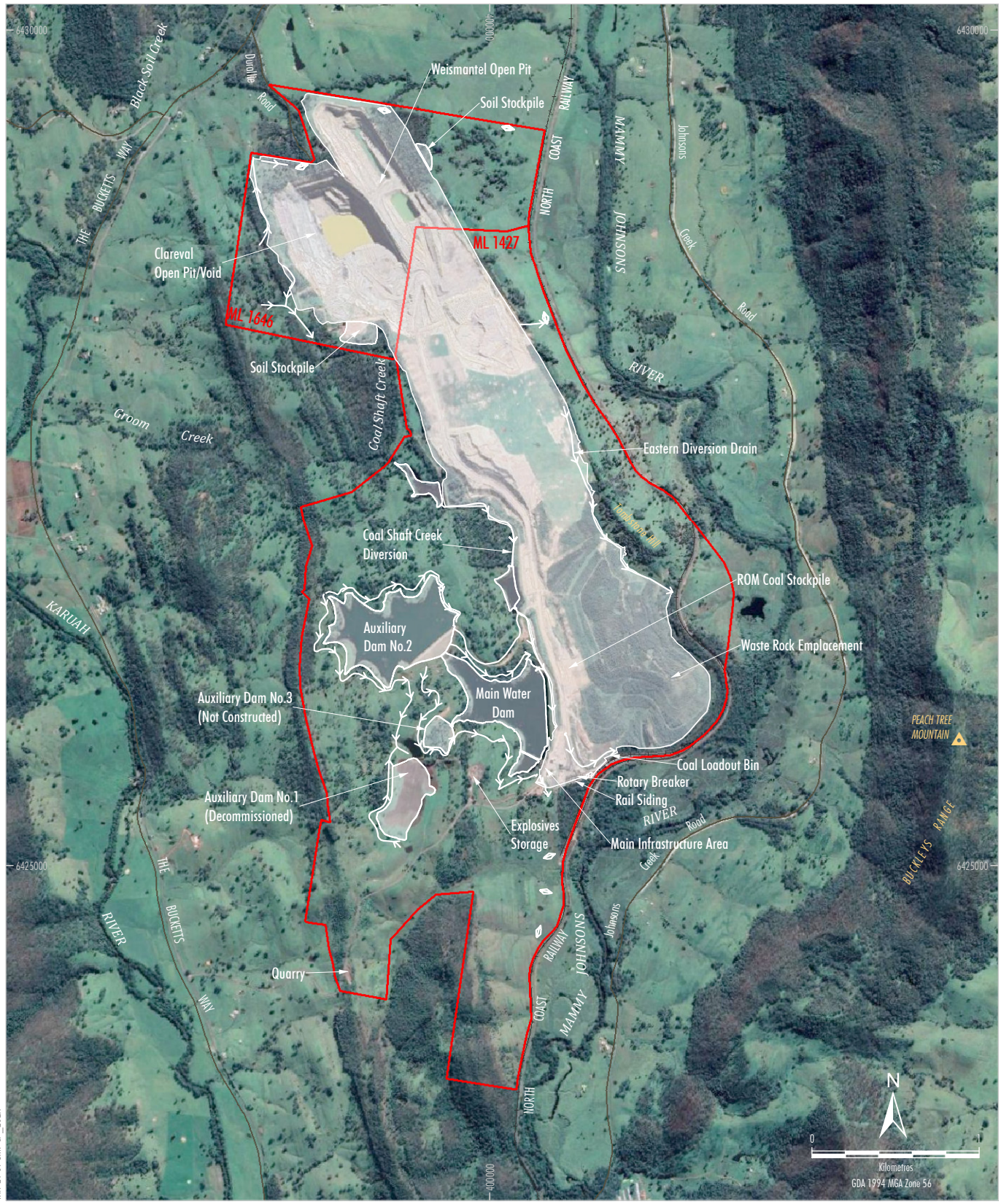
DURALIE COAL MINE

Regional Location

Figure 1



YAN-21-37 DMP CF _202A

LEGEND

- Mining Lease Boundary
- Approximate Extent of Existing/Approved Surface Development
- Existing/Approved First Flush Protocol Pump Back System
- Existing/Approved Up-catchment Diversion System

Source: © NSW Spatial Services (2019)
Orthophoto: Google Earth CENS/Airbus (2020)

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DURALIE COAL MINE

DCM General Arrangement

Figure 2

The activities associated with the approved Duralie Open Pit Modification include:

- an increase in the maximum depth of the Clareval open pit;
- a minor increase in the extent of surface development of the DCM of approximately 2.5 hectares (ha), resulting from:
  - a reduction in low wall angles of the Clareval open pit and the removal of a pillar between the Clareval and Weismantel open pits to improve geotechnical stability; and
  - associated relocation of the up-catchment diversion to the west of the Clareval open pit;
- revision of mining sequence (i.e. progression of mining in the Clareval and Weismantel open pits); and
- an increase in height of the waste rock emplacement (i.e. the backfilled open pit) from approximately 110 metres Australian Height Datum (m AHD) to approximately 135 m AHD.

Current Status of the DCM

Condition 5, Schedule 2 of Project Approval (08_0203) authorises mining operations to be carried at the DCM until 31 December 2021.

Accordingly, DCPL is planning for the commencement of the mine closure phase (i.e. after the cessation of mining operations on 31 December 2021) and has revised this Surface Water Management Plan to reflect the current stage of operations and to describe anticipated mine closure activities and associated changes to water management at the DCM for the mine closure phase.

Operations at the DCM now reflect the transition towards mine closure;

- **Clareval Open Pit:** mining of the Clareval Open Pit has now been completed, and dewatering of the pit has ceased. Partial backfilling with waste rock mined from the Weismantel Open Pit has commenced, along with shaping of the pit area to its final landform design. Mining of the Clareval Open Pit was finalised to a shallower depth than the maximum approved depth as modelled in 2014 DCM Open Pit Modification.
- **Weismantel Open Pit:** mining of the Weismantel Open Pit will continue until 31 December 2021, however, will also not occur to the maximum approved depth as modelled in 2014 DCM Open Pit Modification. Progressive backfilling of the Weismantel Open Pit has been undertaken.
- **DCM Water Management System Changes:**
  - Following the cessation of mining of the Clareval Open Pit (now final void) and the Clareval void becoming available as a water storage, Weismantel Open Pit dewatering is now preferentially transferred to the Clareval void and not stored within the Main Water Dam. As a result, all irrigation activities for the purpose of reducing the total site water inventory at the DCM have now ceased and the DCM's Irrigation Area irrigation system has been decommissioned and removed.
  - Decommissioning of other redundant water management structures has also commenced. Consistent with the approved DCM final landform design, Auxiliary Dam No. 1 has been dewatered, decommissioned and rehabilitated.
- **No new disturbance areas** are proposed.

The DCM's Mine Closure Planning Program (provided in the DCM's Mining Operations Plan and Rehabilitation Management Plan) describes the technical assessments and works that will be undertaken and implemented as the DCM progresses towards and commences the mine closure phase. Key components of the Mine Closure Planning Program (as relevant to this Surface Water Management Plan) include:

- Prepare a detailed final void design (that reflects the revised final depths of the Clareval and Weismantel Open Pits) which includes water qualities/equilibrium level and considers surface water runoff and drainage.
- Review the medium to long-term water quality predictions of the final void against available monitoring data to determine the need for additional/alternate management.
- Review/update the site groundwater model to ensure the model is consistent with the final landform design.
- Review the site water balance modelling to ensure the balance incorporates the final landform design, surface water inflows and outflows to/from the final void.
- Prepare a strategy for transferring mine water from the prescribed dams back to the final voids.
- Prepare a strategy for decommissioning of the mine water dams or for integration with the final land use, with consideration of future approvals or mine closure requirements in consultation with relevant agencies (e.g. Dams Safety NSW).
- Review and update as required, existing environmental management plans for the rehabilitation and mine closure stage of operations.

DCPL is progressively completing components of the Mine Closure Planning Program, including the review of the site groundwater model and site water balance (including final void water balance) based on the refined final landform design and final void design. Once compete, the outcomes from these reviews and other relevant Mine Closure Planning Program technical assessments and works will be incorporated into this Surface Water Management Plan, and relevant supporting plans. DCPL anticipates that this revision to the Surface Water Management Plan would occur in 2022, following the completion of mining on 31 December 2021.

1.2 PURPOSE AND SCOPE

This Surface Water Management Plan (SWMP) has been prepared by DCPL in accordance with Condition 29(b), Schedule 3 of NSW Project Approval (08_0203).

This revision of the SWMP has been prepared by DCPL to:

- incorporate changes that reflect the current status of operations at the DCM; and
- describe changes to water management at the DCM that have occurred as a result of the transition towards mine closure and are anticipated to occur following the cessation of mining operations and into the mine closure phase.

As described in Section 1.1, due to operational changes, all irrigation activities at the DCM Irrigation Areas for the purpose of reducing the total site water inventory have now ceased and the DCM's irrigation system has been decommissioned and removed. DCPL does not intend to recommence irrigation activities at the DCM Irrigation Areas during the mine closure phase. As a result, the requirement for, and the requirements of, the DCM Irrigation Management Plan are no longer applicable to the DCM.

Accordingly, this SWMP has been revised to reflect this status (and other transitional changes) and describe the redundancy of the Irrigation Management Plan. The Irrigation Management Plan has been retained as Attachment A to this SWMP and a Preface has been included that describes the status of the plan. Notwithstanding, DCPL would recommence the Irrigation Management Plan should irrigation activities at the DCM Irrigation Areas recommence.

1.3 SUITABLY QUALIFIED AND EXPERIENCED PERSONS

The former NSW Department of Planning and Environment (DP&E) (now the NSW Department of Planning, Industry and Environment [DPIE]), as delegate for the then Director-General, approved the appointment of Mr Lindsay Gilbert (Gilbert & Associates Pty Limited) (now Hydro Engineering & Consulting Pty Ltd) and Dr Noel Merrick (Heritage Computing) (now HydroAlgorithmics Pty Ltd) as suitably qualified and experienced persons for the preparation of the DCM Water Management Plan (WAMP) on 18 February 2011.

In August 2021, DCPL sought the DPIE's approval of the appointment of Mr Anthony Marszalek (Director of Hydro Engineering & Consulting Pty Ltd) as a suitably qualified and experienced person for the preparation and review of the surface water components of the WAMP, in replacement of Mr Gilbert.

This revised SWMP has been reviewed by Mr Marszalek.

1.4 STRUCTURE OF THE SWMP

The remainder of the SWMP is structured as follows:

Section 2: Outlines the statutory requirements applicable to the SWMP.

Section 3: Describes the existing surface water hydrology.

Section 4: Provides detailed baseline data.

Section 5: Provides an overview of the water management system.

Section 6: Describes the status of irrigation at the DCM.

Section 7: Describes the surface water management measures.

Section 8: Describes the monitoring programs.

Section 9: Details the measures and indicators that will be used to assess the performance of water management measures of the Duralie Extension Project.

Section 10: Describes the surface water contingency plan.

Section 11: Describes the review and improvement of the environmental performance process.

Section 12: Describes the management and reporting of incidents, complaints and non-compliances.

Section 13: Lists the references cited.

2 STATUTORY REQUIREMENTS

DCPL's statutory obligations are contained in:

(i) the conditions of the NSW Project Approval (08_0203);

(ii) the conditions of the Commonwealth Approval (EPBC 2010/5396);

(iii) relevant licences and permits, including conditions attached to mining leases; and

(iv) other relevant legislation.

These are described below.

2.1 EP&A ACT APPROVAL

Surface Water Management Plan

This SWMP has been prepared in accordance with Condition 29 (b), Schedule 3 of the NSW Project Approval (08_0203). Table 1 indicates where each component of Condition 29 is addressed within this SWMP.

Table 1
Surface Water Management Plan Requirements

NSW Project Approval (08_0203) Condition	SWMP Section
Condition 29, Schedule 3	
29. The Proponent shall prepare and implement a Water Management Plan for the project to the satisfaction of the Director-General. This plan must be prepared in consultation with EPA and NOW by suitably qualified and experienced persons whose appointment has been approved by the Secretary, and submitted to the Secretary within 3 months of the date of this approval.	
In addition to the standard requirements for management plans (see Condition 2 of Schedule 5), this plan must include:	
…	
b) a Surface Water Management Plan, that includes:	
• a detailed description of the water management system on site, including the:	
– clean water diversion systems;	Section 5.1
– erosion and sediment controls;	Section 7.1
– water storages; and	Section 5.2
– irrigation system;	Section 6
• an irrigation management plan for the irrigation system under the water management system, which includes:	IMP (Attachment A)
– salinity trigger levels for controlling discharges from the irrigation areas to Coal Shaft Creek and the unnamed tributary, representing the 80th percentile value of the relevant data set for the creek/unnamed tributary and Mammy Johnsons River in accordance with the methodology in ANZECC/ARMCANZ (2000), Australian Water Quality Guidelines for Fresh and Marine Water Quality, National Water Quality Strategy; and	
– provision of an automated first flush system for the additional irrigation areas (Northern Areas) shown in the figure in Appendix 4.	
• a plan for identifying, extracting, handling, and the long-term storage of potentially acid forming material on site;	Section 7.2

Table 1 (Continued)
Surface Water Management Plan Requirements

NSW Project Approval (08_0203) Condition	SWMP Section
• detailed plans, including design objectives and performance criteria, for:	
– the reconstruction of Coal Shaft Creek;	Sections 7.3 and 9
– design and management of the final voids;	Sections 7.5 and 9
– reinstatement of drainage lines on the rehabilitated areas of the site; and	Sections 7.4 and 9
– control of any potential water pollution from the rehabilitated areas of the site;	Sections 7.4 and 9
• performance criteria, including trigger levels for investigating any potentially adverse impacts, for the following:	
– the water management system;	Section 9
– surface water quality of the Unnamed Tributary, Coal Shaft Creek and Mammy Johnsons River;	Section 9
– the stream and vegetation health of the Unnamed Tributary, Coal Shaft Creek and Mammy Johnsons River; and	Section 9
– channel stability of the reconstructed Coal Shaft Creek;	Section 9
• performance criteria for surface water attributes relevant to water quality impacts on biological diversity and aquatic ecological integrity, including salinity, heavy metals, sediment load, pH, hardness and biological oxygen demand;	Section 9
• trigger levels representing the 80th percentile value of the relevant reference data set in accordance with the methodology in ANZECC/ARMCANZ (2000), Australian Water Quality Guidelines for Fresh and Marine Water Quality Management Strategy, to determine the levels for investigating any potential adverse impacts;	Section 9 (Attachment B)
• a program to monitor:	
– the effectiveness of the water management system;	Section 8
– surface water flows and quality in the Unnamed Tributary, Coal Shaft Creek and Mammy Johnsons River; including utilization of existing monitoring sites together with an additional monitoring site in Mammy Johnsons River immediately downstream of the mixing zone of the confluence of Coal Shaft Creek and Mammy Johnsons River;	Section 8.5
– the stream and riparian vegetation health of the unnamed Tributary, Coal Shaft Creek and Mammy Johnsons River; and	Sections 8.6 and 8.8
– channel stability of the reconstructed Coal Shaft Creek;	Section 8.8
• a program of ecotoxicity testing of water storages on-site and at selected water monitoring sites in Mammy Johnsons River and macroinvertebrate sampling at selected monitoring sites in Mammy Johnsons River;	Section 8.7
• a plan to respond to any exceedences of the performance criteria, and mitigate and/or offset any adverse surface water impacts of the project; and	Sections 9 and 10
…	

Management Plan Requirements

Condition 2, Schedule 5 of the NSW Project Approval (08_0203) outlines the requirements that are applicable to the preparation of the management plans. Table 2 indicates where each relevant component is addressed within this SWMP.

Table 2
Management Plan Requirements

NSW Project Approval (08_0203) Condition	SWMP Section
Condition 2, Schedule 5	
2. The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include:	
a) detailed baseline data;	Sections 3 and 4
b) a description of:	
• the relevant statutory requirements (including any relevant approval, licence or lease conditions);	Section 2
• any relevant limits or performance measures/criteria;	Section 9
• 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;	Section 9
c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;	Sections 5, 6 and 7
d) a program to monitor and report on the:	Sections 8, 10, 11 and 12
• impacts and environmental performance of the project;	
• effectiveness of any management measures (see c above);	
e) a contingency plan to manage any unpredicted impacts and their consequences;	Section 10
f) a program to investigate and implement ways to improve the environmental performance of the project over time;	Sections 10, 11 and 12
g) a protocol for managing and reporting any;	
• incidents;	Refer to WAMP
• complaints;	Refer to WAMP
• non-compliances with statutory requirements; and	Refer to WAMP
• exceedences of the impact assessment criteria and/or performance criteria; and	Section 9
h) a protocol for periodic review of the plan.	Section 11

2.2 EPBC ACT APPROVAL

Of relevance to this SWMP, Conditions 3 and 4 of the Commonwealth Approval (EPBC 2010/5396) require:

Water Management

3. *The person undertaking the action must ensure that all irrigation and run-off from the Project Area is managed in accordance with the Duralie Coal Mine Irrigation Management Plan (DCPL, 2008) as set out in Referral received on the 11 March 2010 (or as per any amendments approved by this Department, in consultation with the NSW Department of Planning, the NSW Department of Environment and Climate Change and Water and NSW Office of Water), and not otherwise discharged into the MJR*

4. *The release of water into the MJR catchment must only occur when Electricity* (sic) *Conductivity levels do not exceed 400 Micro Siemens (µS/cm) in the MJR at the "High Noon" monitoring site and 1,326 µS/cm in the Main Water Dam diversion drain sumps; or alternate thresholds as may be advised in writing by the Department.*

Condition 11 of the Commonwealth Approval (2010/5396) requires:

Mitigation Measures

11. *In order to minimise the impacts of the project on listed threatened species, the person taking the action must implement all measures in the following plans/documents or their subsequent revisions as approved by the Minister:*
    (a) The DCM Vegetation Clearance Protocol (DCPL, 2002);
    (b) The DCM Irrigation Management Plan (DCPL, 2008);
    (c) The DCM Site Water Management Plan (DCPL, 2008); and
    (d) The DCM Rehabilitation Management Plan (DCPL, 2007).

As described in Section 1.1, due to operational changes at the DCM and cessation of irrigation activities at the DCM Irrigation Areas, the requirement for, and the requirements of, the Irrigation Management Plan are no longer applicable to the DCM and the Irrigation Management Plan is now redundant. The Irrigation Management Plan has been retained as Attachment A to this SWMP and a Preface has been included that describes the status of the plan.

In accordance with Conditions 3 and 11 of the Commonwealth Approval (EPBC 2010/5396), the WAMP (including this SWMP) will be submitted for approval by the Commonwealth Minister for the Environment (or delegate) in consultation with DPIE, the NSW Environment Protection Authority (EPA) and the NSW DPIE-Water. A record of consultation with the EPA is provided in Attachment A of the WAMP. The EPA's comments have been addressed where relevant in this revised SWMP. No comments on the revised WAMP were received from the DPIE-Water.

Section 7 describes the measures that will be implemented to maintain compliance with Condition 4 of the Commonwealth Approval (EPBC 2010/5396).

2.3 LICENCES, PERMITS AND LEASES

In addition to the NSW Project Approval (08_0203), and Commonwealth Approval (EPBC 2010/5396), all activities at DCM will be conducted in accordance with a number of licences, permits and leases which have been issued.

A summary of the key licences, permits and leases pertaining to the DCM is provided in Section 2.3 of the WAMP.

2.4 OTHER LEGISLATION

DCPL will operate the DCM consistent with the NSW Project Approval (08_0203), the Commonwealth Approval (EPBC 2010/5396) and any other legislation that is applicable to an approved Part 3A Project under the EP&A Act.

A summary of other NSW legislation that may be applicable to the conduct of the DCM is provided in Section 2.4 of the WAMP.

3 HYDROLOGICAL SETTING

3.1 REGIONAL HYDROLOGY

A comprehensive description of the local and regional surface water resources is provided in Section 4.4 and Appendix D of the *Duralie Open Pit Modification Environmental Assessment* (DCPL, 2014). A summary of this information is provided below.

The DCM is situated in the Gloucester Valley which is bounded by Buckleys Range to the east and the Linger and Die Ridge to the west. The area surrounding the DCM has been extensively cleared for grazing on native and improved pastures, and is also used for intensive poultry farming.

The DCM area is situated within the Mammy Johnsons River catchment, a tributary of the Karuah River. The Karuah River, which rises in the Chichester State Forest, drains to Port Stephens some 40 km south of the DCM. The Karuah River is located to the north-west and south of the DCM Area (Figure 1).

Mammy Johnsons River has a similar catchment area and length to the Karuah River above their confluence near the village of Stroud Road (Gilbert & Associates Pty Limited, 2014). The Mammy Johnsons River rises in the Myall State Forest to the east of the DCM and flows generally north out of the State Forest area and then west through the locality of Tereel to its confluence with Wards River some 2.5 km south-east of the township of the same name. From the Wards River confluence the Mammy Johnsons River flows in a generally southerly direction through an undulating landscape which has been extensively cleared for cattle grazing.

Streamflows in the Karuah River and Mammy Johnsons River are characterised by low to moderate flows for long periods, with periods of higher discharge following heavy rains, typical of small and medium sized upland catchments (Gilbert & Associates Pty Limited, 2010). The Karuah River appears to have stronger low flow persistence than Mammy Johnsons River, with zero flow recorded only on 0.8% of days, compared to 5.3% of days for the Mammy Johnsons River (Gilbert & Associates Pty Limited, 2010).

3.2 LOCAL HYDROLOGY

The DCM is situated in the catchment of Coal Shaft Creek, a small tributary which flows into the lower reaches of Mammy Johnsons River, and the catchment of an unnamed minor tributary stream that flows north and east to join the Mammy Johnsons River approximately 4 km upstream of the Coal Shaft Creek confluence (Figure 2).

Coal Shaft Creek has been diverted around the current DCM workings. Tombstone Hill, at an elevation of approximately RL 130 m, and its associated ridgeline, divides the Coal Shaft Creek catchment from the Mammy Johnsons River to the east.

The Coal Shaft Creek diversion comprises an approved, purpose-built diversion channel, which re-joins the original Coal Shaft Creek alignment near the DCM rail spur. The confluence of Coal Shaft Creek with the Mammy Johnsons River is south of the DCM rail loading infrastructure and approximately 10 km upstream of the Mammy Johnsons River/Karuah River confluence.

The upper reaches of Coal Shaft Creek are ephemeral and baseflow contributions in these portions of the creek are likely to be small (Gilbert & Associates Pty Limited, 2014).

4 BASELINE DATA

4.1 CLIMATE

A summary of relevant meteorological information in the DCM area is provided in *Duralie Extension Project Appendix A Surface Water Assessment* and the *Duralie Open Pit Modification Surface Water Assessment* (Gilbert & Associates Pty Limited, 2010 and 2014) available at http://duraliecoal.com.au/environment/environmental-assessment-documents.php.

4.2 SURFACE WATER QUALITY

A summary of relevant surface water quality information in the DCM area is provided in *Duralie Extension Project Appendix A Surface Water Assessment* and the *Duralie Open Pit Modification Surface Water Assessment* (Gilbert & Associates Pty Limited, 2010 and 2014) available at http://duraliecoal.com.au/environment/environmental-assessment-documents.php.

4.3 IRRIGATION WATER QUALITY

A summary of irrigation water quality information is provided in *Duralie Extension Project Appendix A Surface Water Assessment* and the *Duralie Open Pit Modification Surface Water Assessment* (Gilbert & Associates Pty Limited, 2010 and 2014) available at http://duraliecoal.com.au/environment/environmental-assessment-documents.php.

4.4 GEOCHEMISTRY

Results of acid rock drainage (ARD) investigations indicate the presence of potentially acid forming (PAF) waste material above the Weismantel Seam and the Clareval Seam within the extent of the open pits.

Weismantel Seam overburden has been classified as non-acid forming (NAF) except for a PAF horizon within 5 m (perpendicular to bedding) immediately above the coal seam. The Weismantel Seam rock floor is also likely to be mainly PAF. The PAF zone above the coal seam, the overlying thicker NAF zone and the PAF floor rock are identified as continuous and predictable (EGi, 2009).

Partially weathered to fresh overburden for the Clareval Seam includes roughly equal proportions of NAF and PAF/low capacity PAF (PAF-LC), with some indication of thick NAF horizons (EGi, 2009). The continuity and distribution of PAF and NAF horizons for the Clareval overburden is more complex than that for the Weismantel Seam (EGi, 2009).

5 WATER MANAGEMENT SYSTEM

The objectives of the DCM water management system during the mine closure transition phase and mine closure phase are to:

- protect the integrity of local and regional water resources;
- maintain separation between runoff from undisturbed areas and water generated within active mining and/or disturbance areas;
- operate such that there is no uncontrolled overflow of contained water storages;
- comply with the requirements of EPL 11701; and
- provide a reliable source of water for on-site mining and coal handling until the cessation of mining operations on 31 December 2021.

The DCM water management system controls waters generated from surface development areas while controlling the capture of surface water runoff by diverting upslope water around such areas (DCPL, 2010). The water management system includes a combination of permanent structures that will continue to operate post closure and temporary structures that will only be required until the completion of rehabilitation works (e.g. sediment control structures) (DCPL, 2010).

The approved water management system at the DCM includes the following components (DCPL, 2014):

- water management storages;
- diversions for runoff from catchment areas upslope of the mine disturbance area (i.e. upslope diversions);
- runoff control structures and devices on disturbed and rehabilitated areas at the mine;
- runoff control structures and devices on infrastructure areas;
- procedures, structures and devices for the control of erosion and sediment movement;
- open pit dewatering equipment;
- procedures and equipment for the disposal of excess water through on-site irrigation; and
- sewage treatment plant and a system for the disposal of effluent.

As described in Section 1.1, operations at the DCM now reflect the transition towards mine closure:

- mining and dewatering of the Clareval Open Pit has ceased;
- mining related activities at the DCM are limited to extraction of the remining ROM coal from the Weismantel Open Pit;
- partial backfilling of the Clareval final void with waste rock mined from the Weismantel Open Pit has continued;
- shaping of the Clareval final void area to its final landform design has commenced; and
- accumulated water within the Weismantel Open Pit is now preferentially transferred to the Clareval final void and not stored within the Main Water Dam.

Due to the above operational changes, irrigation activities for the purpose of reducing the DCM's total site water inventory have now ceased and the DCM's irrigation system has been decommissioned and removed. Irrigation of mine water may be undertaken if required to control heating in temporary potentially acid forming waste emplacement areas as described in the DCM Potentially Acid Forming Material Management Plan (Section 7.2 of this SWMP).

Decommissioning of redundant water management storages has also commenced. Auxiliary Dam No. 1 has been dewatered, decommissioned and rehabilitated.

The DCM water management system is described in further detail in the Site Water Balance (Appendix 1 of the WAMP), which has also been revised to reflect the changes to the DCM water management system to reflect the current status of the site and proposed changes to occur as part of mine closure.

5.1 UPSLOPE DIVERSION WORKS

Temporary and permanent upslope diversion bunds/drains and temporary interception dams were constructed over the life of the DCM, to divert runoff from undisturbed areas around the open pits and waste rock emplacements. The DCM existing and post-mining surface water management system includes continued diversion of runoff via the Coal Shaft Creek Diversion (Figures 3 to 5).

The Coal Shaft Creek Diversion would remain for the DCM life. Small tributaries in the very upper reaches of Coal Shaft Creek have been diverted around the north and west of the Clareval open pit and waste rock emplacement, directing runoff back into the remnant Coal Shaft Creek upstream of the Coal Shaft Creek Diversion (Figures 3 to 5).

Portions of the upper reaches of the Unnamed Tributary have been diverted around the north and west of the Clareval open pit and waste rock emplacement, directing runoff into the Unnamed Tributary (Figures 3 to 5).

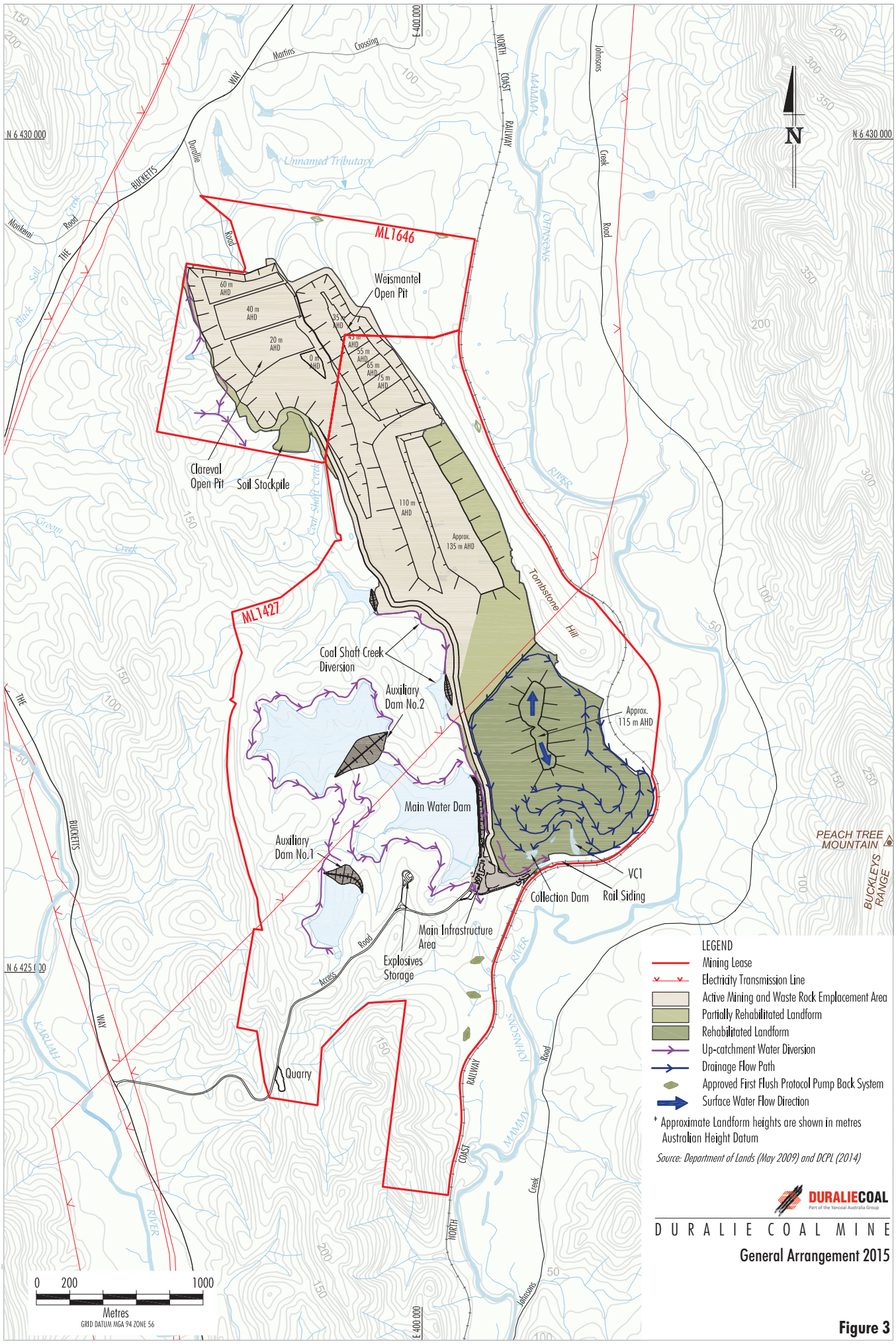
Permanent upslope diversion bunds/drains will remain around final voids.

The upslope diversions have been designed to pass the peak flow generated by a 1% annual exceedance probability (AEP) rainfall event. Permanent diversion(s) including the final Coal Shaft Creek Diversion will be assessed against the probable maximum flood (PMF) event.

Diversion stability is achieved by providing appropriately sized channel cross-sections and bed gradients; and by incorporating bed and bank treatments such as rock fill and vegetation which provide erosion resistance.

The conceptual design of the post-mining alignment of the Coal Shaft Creek Diversion is documented in the Coal Shaft Creek Reconstruction Plan (refer Section 7.3 and Attachment C of this SWMP).

The eastern toe of the backfilled waste rock emplacement will be designed to abut the Tombstone Hill ridgeline. Sediment dams will be constructed on the eastern flank of the Tombstone Hill ridgeline for sediment control whilst the eastern waste rock emplacement batters are undergoing rehabilitation/revegetation. The dams will be retained post-mining for stock watering and to provide stormwater runoff detention from the slightly increased catchment reporting eastwards. The dams will provide adequate runoff detention such that peak flow rates in culverts under the North Coast Railway line will not be increased.



LEGEND

- Mining Lease
- Electricity Transmission Line
- Active Mining and Waste Rock Emplacement Area
- Partially Rehabilitated Landform
- Rehabilitated Landform
- Up-catchment Water Diversion
- Drainage Flow Path
- Approved First Flush Protocol Pump Back System
- Surface Water Flow Direction

* Approximate Landform heights are shown in metres Australian Height Datum

Source: Department of Lands (May 2009) and DCPL (2014)

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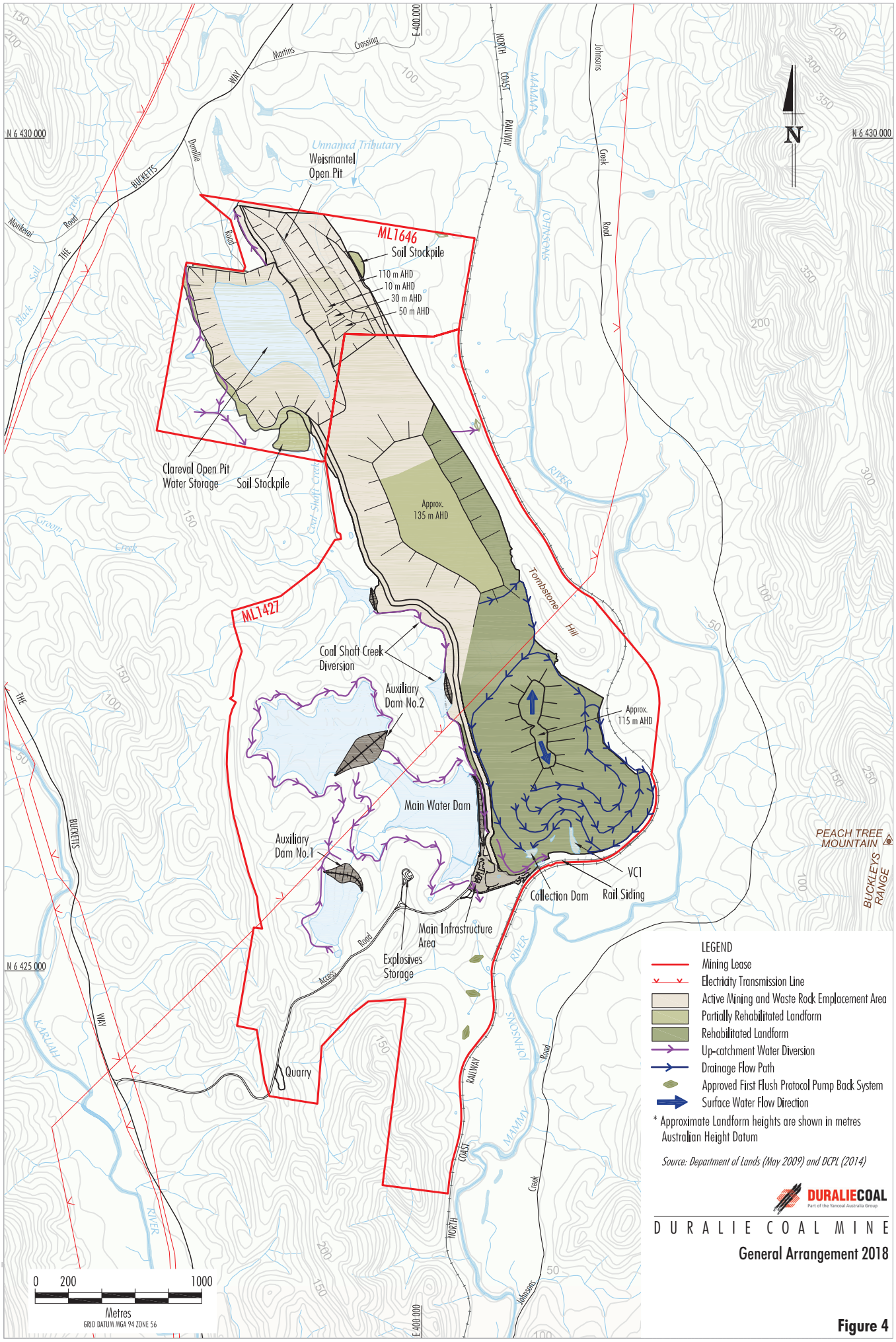
DURALIE COAL MINE

General Arrangement 2015

Figure 3

YAN-21-37 DMP SWMP_002A



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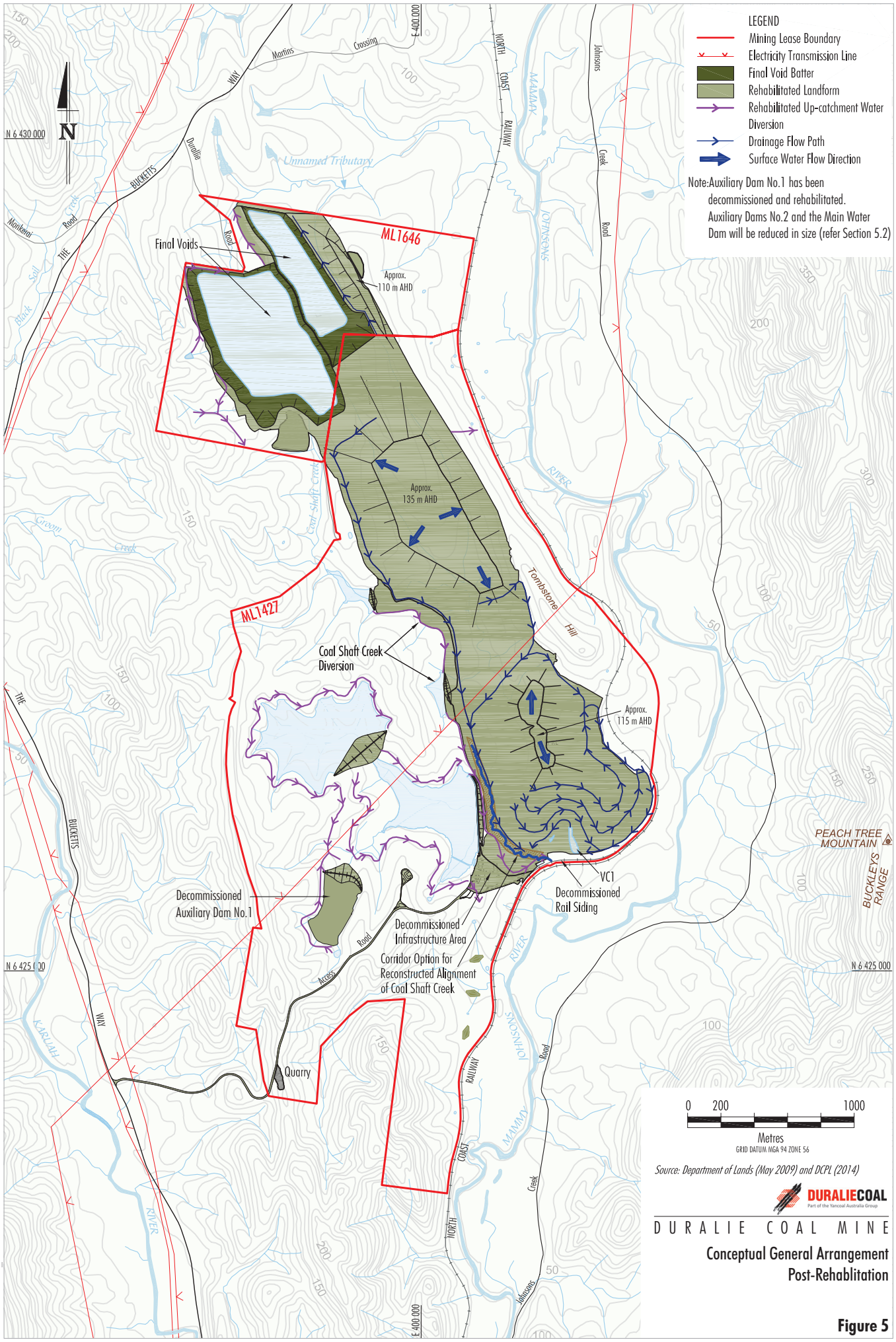
DURALIE COAL MINE

General Arrangement 2018

Figure 4

YAN-21-37 DMP SWMP_003A

GCL-10-13 SWMP 2015_104A


LEGEND
Mining Lease Boundary
Electricity Transmission Line
Final Void Batter
Rehabilitated Landform
Rehabilitated Up-catchment Water Diversion
Drainage Flow Path
Surface Water Flow Direction
Note:Auxiliary Dam No.1 has been decommissioned and rehabilitated. Auxiliary Dams No.2 and the Main Water Dam will be reduced in size (refer Section 5.2)
ML1646
ML1427
Final Voids
Approx. 110 m AHD
Approx. 135 m AHD
Approx. 115 m AHD
Coal Shaft Creek Diversion
Decommissioned Auxiliary Dam No.1
Decommissioned Infrastructure Area
Corridor Option for Reconstructed Alignment of Coal Shaft Creek
VC1 Decommissioned Rail Siding
Quarry
Unnamed Tributary
Coal Shaft Creek
Tombstone Hill
PEACH TREE MOUNTAIN
BUCKLEYS RANGE
N 6 430 000
N 6 425 000
E 400 000
Martins Crossing Road
Durallie Road
Monkerai Road
Black Soil Creek
Groom Creek
Johnsons Creek
Mammy Johnsons River
North Coast Railway
Buckets Way
Karuah River
THF
0 200 1000
Metres
GRID DATUM MGA 94 ZONE 56
Source: Department of Lands (May 2009) and DCPL (2014)
DURALIECOAL
Part of the Yancoal Australia Group
DURALIE COAL MINE
Conceptual General Arrangement
Post-Rehablitation
Figure 5
YAN-21-37 DMP SWMP_004A

5.2 WATER STORAGES

Existing water storages at the DCM during the mine closure transition phase include (Figure 2):

- The Main Water Dam (MWD), which is located north-west of the main infrastructure area and has a constructed capacity of up to approximately 1,405 ML to the top of the I-spillway, and approximately 1,296 ML to the invert of the spill pipe.
- A smaller bunded area located in the south of the MWD, adjacent to the main infrastructure area, and other clean water sediment dams.
- Auxiliary Dam No. 2, which is located upslope of the MWD and has a designed capacity of 2,724 ML (with an approved capacity up to 2,900 ML).

As described in Section 1.1, Auxiliary Dam No.1 has been decommissioned and rehabilitated. The approved Auxiliary Dam No. 3 is no longer required and will not be constructed.

Post-mining Operations Phase

The MWD and Auxiliary Dam No. 2 will be retained in the DCM final landform as non-declared dams, and therefore will be reduced in size (i.e. effectively resulting in their decommissioning as mine water storages) in consultation with Dam Safety NSW. Decommissioning of Auxiliary Dam No. 2 is scheduled to be completed by the end of 2022, with decommissioning of the MWD scheduled to occur during approximately 2024 as part of DCM rehabilitation works.

A Detailed Decommissioning Strategy for the DCM's declared mine water dams has been prepared by ATC Williams Pty Ltd (ATC Williams) (2021) and is summarised in the DCM Mining Operations Plan and Rehabilitation Management Plan (MOP/RMP). Decommissioning activities will generally involve dewatering (with water transferred to the final voids), decontaminating the dams if required, and re-configuring/re-shaping the dam embankments in accordance with detailed designs. Existing diversions around the retained dams would be removed, once the dams have been re-configured, to facilitate recharge of the dams by upslope runoff from vegetated catchments. As such, the future water quality of the dams is expected to reflect up-catchment water quality.

As described in Section 1.1, mining in the Clareval Open Pit has been completed and the void is now available for secure storage of excess water from the Weismantel Open Pit.

The Surface Water Assessment prepared for the approved DCM Open Pit Modification Environmental Assessment estimated the post-mining storage capacity of the Weismantel and Clareval final voids at approximately 12,400 ML and 38,000 ML, respectively (Gilbert & Associates Pty Limited, 2014). As part of the Mine Closure Planning Program site water balance (and final void water balance) review (Section 1.1), the post-mining predictions from the DCM Open Pit Modification Surface Water Assessment will be verified and this SWMP revised if necessary.

6 IRRIGATION

Operations at the DCM now reflect the transition towards mine closure. Due to the cessation of mining of the Clareval Open Pit (now final void), the Clareval void is available as a water storage. As a result, irrigation activities for the purpose of reducing the DCM's total site water inventory have now ceased and the DCM's irrigation system has been decommissioned and removed.

DCPL does not intend to recommence irrigation at the DCM Irrigation Areas during the mine closure phase. As a result, the requirement for, and the requirements of, the DCM Irrigation Management Plan are no longer applicable to the DCM.

A Preface has been included to the Irrigation Management Plan that describes the status of irrigation at the DCM and the redundancy of the plan. The Irrigation Management Plan has however been retained as Attachment A to this SWMP. Notwithstanding, DCPL would recommence the Irrigation Management Plan should irrigation activities at the DCM Irrigation Areas recommence.

Irrigation of mine water may be undertaken at the DCM if required to control heating in temporary potentially acid forming waste emplacement areas as described in the DCM Potentially Acid Forming Material Management Plan (Section 7.2).

7 MANAGEMENT MEASURES

7.1 EROSION AND SEDIMENT CONTROL PLAN

Sources of Erosion

Erosion and sedimentation at the DCM could potentially result directly or indirectly from:

- runoff from areas disturbed in advance of and during mining;
- runoff from topsoil stockpiles and waste rock emplacements prior to rehabilitation;
- runoff from rehabilitated areas prior to adequate stabilisation of the revegetated surface;
- runoff from infrastructure areas; and
- runoff from roads or rail embankments at erosive velocities.

In addition to the above, elevated winds may also result in erosion from exposed surfaces. Management measures for wind erosion are provided in the Air Quality and Greenhouse Gas Management Plan required under Condition 23, Schedule 3 of the NSW Project Approval (08_0203).

Erosion and Sediment Control Strategy

The primary objectives of the erosion and sediment control at the DCM are to:

- reduce and control soil erosion and sediment generation in areas disturbed by ongoing mining and associated activities at the DCM (as modified); and
- control the potential for sediment generated from site activities to adversely affect the water quality of the Mammy Johnsons River or the Karuah River.

Control strategies for soil erosion and sediment migration include:

- Separation of runoff from disturbed and undisturbed areas.
- Provision of a site drainage system (comprising clean and dirty water drains) which operates at non-erosive velocities at the specified design criteria (refer *Design Criteria* below).
- Construction of sediment dams downstream of disturbed areas sized to contain runoff up to specified design criteria (refer *Design Criteria* below).
- Water treatment before being released from sediment dams to achieve:
  - a pH range of 6 to 8;
  - <50 milligrams per litre (mg/L) of suspended solids; and
  - no visible oil and grease.
- Dewatering of sediment dams (subject to water quality criteria listed above) to well-grassed areas between runoff events via grassed buffer areas to further remove entrained sediment and its migration to down-slope watercourses and in accordance with the conditions of EPL 11701. Where a suitable vegetated dewatering area is not available, dewatering of sediment dams for priority re-use, for purposes such as dust suppression and moisture conditioning of earthworks on site.
- Selective use of benign flocculants, such as gypsum, to assist in the settlement of suspended solids in sediment dams if required.
- Construction of silt fences in overland flow areas downslope of disturbed sites.

- Rapid and progressive stabilisation of disturbed surfaces, including:
  - the use of contour banks and furrows;
  - the use of hydromulching techniques; and
  - early revegetation or armouring (i.e. jute mesh and/or compacted rock) of disturbed surfaces.

Erosion and sediment control will be designed and constructed in consideration of the recommendations for site drainage works presented in *"Managing urban storm water – Soils and Construction Volume 1"* (Landcom, 2004) *and "Managing urban storm water – Soils and Construction Volume 2e"* (Department of Environment and Climate Change [DECC], 2008*)*.

Construction activities associated with development and operation of the approved DCM's water management system have been completed. These construction activities included:

1. Construction of diversion drains (typically upslope of disturbance areas).
2. Installation of silt fences and temporary sediment traps (e.g. hay bales) in overland flow areas downslope of disturbance areas.
3. Construction of sediment dams on drainage lines downslope of disturbance areas.
4. Construction of collection drains to convey runoff to sediment dams.
5. Undertaking general construction works would only take place once all erosion and sediment control measures are in place to the satisfaction of the DCPL Environment and Community Superintendent.

Construction activities required during the mine closure phase will primarily be associated with infrastructure decommissioning activities, and are anticipated to include earthworks associated with decommissioning of the MWD and Auxiliary Dam 2, including of upslope diversions, and activities associated with re-construction of the Coal Shaft Creek corridor. These activities will continue to be undertaken in consideration of the erosion and sediment control recommendations for site drainage works presented in *"Managing urban storm water – Soils and Construction Volume 1"* (Landcom, 2004) *and "Managing urban storm water – Soils and Construction Volume 2e"* (DECC, 2008*)*.

A description of topsoil management strategies implemented at the DCM is provided in the Rehabilitation Management Plan required under Condition 57, Schedule 3 of the NSW Project Approval (08_0203).

Operations and activities at the DCM leading into and during the mine closure phase will no longer require clearing or topsoil stripping. As such erosion and sediment control structures (e.g. collection bunds and conveyance channels) will no longer be required to be constructed in advance of topsoil stripping. Existing topsoil stockpiles will continue to be managed in accordance with the Rehabilitation Management Plan until all stockpiled soil resources have been utilised for DCM rehabilitation.

Design Criteria

Design criteria for sediment control structures are summarised in Table 3.

Sediment dams will continue to be dewatered to their normal operating level within 5 days of a runoff-generating rainfall event to re-establish the design containment capacity or within 10 days where the dam has been designed with a 125% adjustment factor.

Outlets of collection and diversion drains will be armoured (e.g. compacted rock or jute mesh) in order to prevent localised erosion. Internal and external batters of sediment dams will be revegetated to minimise the potential for erosion of dam batters.

Table 3
Sediment Control Structures – Design Criteria

Sediment Control Structure	Function	Design Capacity
Temporary upslope diversion drains	Reduce runoff from undisturbed areas to disturbed areas.	Capable of passing the peak flow generated by the 5% AEP 1 hour rainfall event[1]
Downslope collection drains	Intercept and convey disturbed area runoff water to sediment dams.	Capable of passing the peak flow generated by the 5% AEP 1 hour rainfall event[1]
Sediment dams	Settlement of sediments in runoff from disturbed areas.	Volume to be determined in accordance with *Managing Urban Stormwater Soils and Construction Volume 2E Mines and quarries* (DECC, 2008).[2]
Sediment dam spillway channels	Facilitate the passage of flows in excess of the sediment dam storage capacity.	Capable of passing the peak flow generated by the 1% AEP critical duration rainfall event.

1 In accordance with Department of Land and Water Conservation (now DPIE - Water) conditions of approval received on 10 June 2002 for the superseded Erosion and Sediment Control Plan.

2 Sediment dam volume is determined with consideration to site specific soil type, runoff coefficient and designated management period (i.e. 5 or 10 days).

7.2 POTENTIALLY ACID FORMING MATERIAL MANAGEMENT PLAN

PAF waste material is segregated and selectively handled. The location of PAF material is determined by geological modelling, informed by ongoing exploration activities and field sampling. PAF material is mined to the modelled PAF limits before placement in accordance with the PAF Material Management Plan. Confirmation of the thickness of the PAF band is periodically assessed by field sampling and laboratory analysis (utilising net acid generation testing) (DCPL, 2015).

Limestone is selectively placed on the open pit floor and PAF waste rock emplacement lifts/faces to minimise the release of acid rock drainage products. PAF material is stored in two distinct manners at the DCM, both in the out-of-pit waste rock emplacement and in-pit waste rock emplacement.

In the out-of-pit waste rock emplacements at the DCM, the PAF material will be encapsulated within appropriately designed and constructed containment cells and capped with a clay capping layer.

For in-pit waste rock emplacement, once PAF material has been placed within the designated PAF management area of the open pit (i.e. below the post-mining water table), a layer of NAF material is placed above the emplaced PAF material. Upon final placement of sufficient NAF material to construct the design profile for the given section of the emplacement area, shaping, drainage construction, topsoil placement and revegetation is undertaken (DCPL, 2015).

Operational controls for treatment and storage of PAF materials at the DCM are as follows (EGi, 2009):

- Limestone treatment on exposed Weismantel Seam floor rock, all final PAF overburden lift surfaces, and interim PAF waste rock emplacement surfaces likely to be exposed for more than 3 weeks. Limestone application rates are at least 20 tonnes $CaCO_3$ per ha (t $CaCO_3$/ha) and average close to 50t $CaCO_3$/ha.
- Management, supervised segregation and limestone treatment of coal cleanings (in particular 1 to 2 m above Weismantel and Clareval Seams) to prevent ARD during operations.
- Placement of at least 20 m of NAF overburden over PAF materials to provide an oxygen barrier to help control oxidation of PAF materials. NAF cover placement will continue to follow closely behind the advancing PAF waste rock emplacement face to minimise exposure time of PAF materials.

- After final placement of NAF material, the waste rock emplacement is shaped to final contour, surface drainage is constructed, and topsoil placement and revegetation is undertaken for the given section of the emplacement area.
- The potential for acid formation in the pit is also controlled by prompt removal of water from the pit sump and by shaping dumped materials to reduce infiltration. In the event that significant acid generation did occur in open pit water, there is site capability for treatment (i.e. neutralisation with hydrated lime or limestone).

To control heating in temporary PAF waste emplacement areas, irrigation of mine water may also be undertaken if required.

If the amount of PAF overburden exceeds the maximum deposition level, long term control for the PAF material would need to rely on control of infiltration and oxygen diffusion through placement of PAF materials below a designed cover system. The details of the cover system design would require assessment of the hydraulic and physical properties of the various mine materials in conjunction with local climate controls to determine the appropriate type of cover system.

Consistent with the Duralie Coal EIS, DCPL will construct clay cut-off walls along the southern end of the waste rock emplacement toe at Coal Shaft Creek to impede potential groundwater seepage from the toe of the waste rock emplacement to lower Coal Shaft Creek and Mammy Johnsons River.

Routine monitoring at the DCM will continue to be carried out to provide checks on materials management and effects of ARD. Monitoring includes (EGi, 2009):

- routine sampling and geochemical testing of overburden materials from both seams as required during operations to monitor variations in acid potential and to reconcile the predicted distribution of ARD rock types in overburden;
- water quality monitoring of seepage and runoff from pit surfaces and waste rock emplacements to check for ARD generation, to assess the performance of management strategies, and to determine and/or refine limestone treatment requirements (refer to Section 8); and
- routine site water quality monitoring including pH, Electrical Conductivity (EC), acidity/alkalinity, sulphate (SO_4), Aluminium, Copper, Iron, Manganese, Nickel, Zinc and storage volumes and flows to monitor the performance of the ARD control program (refer to Section 8).

Limestone will continue to be applied in pit at a rate of at least 20 tonnes $CaCO_3$ per ha (t $CaCO_3$/ha) and additionally the monitoring results from geochemical testing and water quality will be used to determine the need to increase or decrease the rate of limestone application.

Additional geochemical testing is being conducted in the remaining Weismantel Seam overburden to improve knowledge of the occurrence of PAF materials and will continue until the cessation of mining operations at the DCM. The results of this geochemical testing will be used to improve PAF material selection and placement locations and will be included in revisions to this SWMP where appropriate.

Following the completion of mining operations on 31 December 2021, PAF material rehandling may continue in 2022 consistent with the operational controls for treatment and storage of PAF materials described in this section.

7.3 DEVELOPMENT OF COAL SHAFT CREEK RECONSTRUCTION PLAN

Following the completion of mining activities at the DCM, a final alignment of Coal Shaft Creek will be established, stabilised and revegetated prior to lease relinquishment.

The conceptual design of the post-mining alignment of Coal Shaft Creek is documented in the Coal Shaft Creek Reconstruction Plan (CSCRP), Attachment C of this SWMP, prepared in accordance with Condition 29(b), Schedule 3 of Project Approval (08_0203). The CSCRP includes:

- design objectives and performance criteria related to bed and bank stability, bed and bank erosion rates, changes to flow path geometry, vegetation and habitat establishment, and water quality;
- detailed design plans of the post-mining alignment and reconstruction of Coal Shaft Creek informed by geotechnical, hydrological and hydraulic analyses;
- monitoring and maintenance requirements; and
- provisions for development of a contingency plan if performance criteria are not being achieved.

A revised, final CSCRP will be prepared by HEC in consideration of the refined design of the DCM final landform. Analyses will be conducted into the geotechnical, hydrological and hydraulic design of the final alignment of the relocated corridor of Coal Shaft Creek, in consideration of the refined final landform design. The analyses will focus on long-term stability, seepage management and the creation of habitat. The outcomes of these analyses will inform the final detailed design of the relocated corridor of Coal Shaft Creek. The final CSCRP will be submitted to DPIE-Water for comment, prior to submission to DPIE Planning and Assessment Division for approval.

7.4 MANAGEMENT OF REHABILITATION AREA RUNOFF

The proposed post-mining water management strategy is shown on Figure 5. A detailed description of the management of rehabilitation areas is provided in the DCM Rehabilitation Management Plan required under Condition 57, Schedule 3 of the NSW Project Approval (08_0203) (and will also be included in future versions of the DCM Rehabilitation Management Plan prepared in accordance with the provisions of the *Mining Amendment (Standard Conditions of Mining Leases— Rehabilitation) Regulation 2021*).

The top surface of the waste rock emplacement will be designed as a ridgeline running parallel to Tombstone Hill and will generally drain towards the south to Coal Shaft Creek. Rock lined channels will be installed along the edge of the top surface to provide a stable means for surface water runoff to drain from the top of the waste rock emplacement.

On the batters of the waste rock emplacement, surface water runoff will flow perpendicularly down the slope to the toe of each batter where it will be re-directed by contour drains to drain-off points. The contour drains will be grass-lined, and wherever practicable, will discharge to the natural ground surface. If required as a contingency measure, hydraulic control structures will be constructed to allow water to be safely discharged down the emplacement batter slope to the existing ground level.

As part of development of the waste rock emplacement, waste rock will be placed against the Tombstone Hill ridgeline to the east of the waste rock emplacement area (Figure 5). In the northern portion of the waste rock emplacement, drainage from the eastern batter of the waste emplacement will drain eastwards towards Mammy Johnsons River.

Rock lined channels will be used at the base of the waste rock emplacement to direct runoff into natural creek lines (e.g. Coal Shaft Creek).

Erosion control will be achieved by the development and implementation of land stabilisation procedures and protocols as outlined in Section 7.1.

Sediment dams downstream of the waste rock emplacement will be maintained until the revegetated surface is stable and the runoff water quality is suitable for release off-site.

Sediment dams may be retained for stockwater, or as passive water control storages.

7.5 MANAGEMENT OF FINAL VOID WATER

Section 7.5.1 provides a summary of the conclusions from Gilbert & Associates (2014) final void water balance modelling undertaken for the DCM Open Pit Modification Environmental Assessment (DCPL, 2014). As described in Section 1.1, development of the Clareval Open Pit has not occurred to the maximum approved depth and nor will development of the Weismantel Open Pit. Accordingly, DCPL is preparing a revised final landform and final void design and will engage relevant specialists to conduct revised site water balance (and final void water balance) and revised site groundwater modelling. As such, the conclusions and predictions outlined in Section 7.5.1 below may be refined as part of the verification assessments described in Section 7.5.2.

7.5.1 DCM Open Pit Modification – Final Void Water Balance Summary

At the cessation of mining, final voids will remain in the Clareval open pit and Weismantel open pit (Figure 5). The surface catchment area reporting to the final voids will be reduced to a practicable minimum (Figure 5) by the use of upslope diversions, contour drains around their perimeter and backfilling of voids to the maximum practical extent. The catchment areas of the final voids would be reduced to approximately 1.2 km^2 (Gilbert & Associates, 2014).

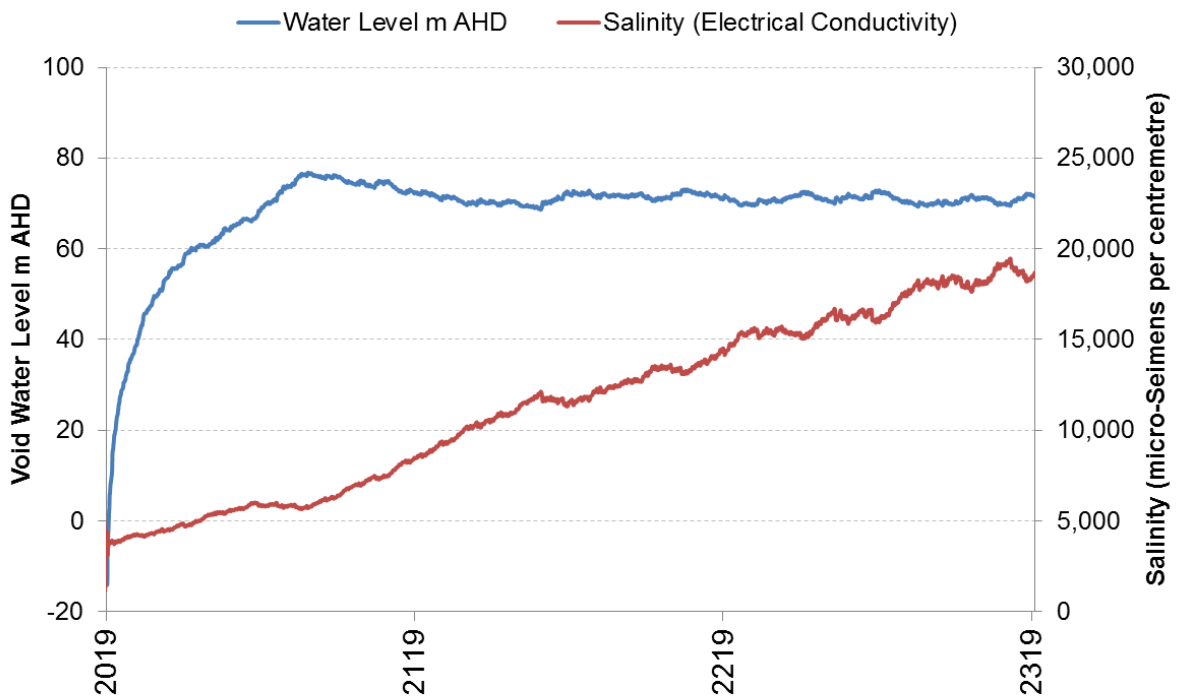
Inflows to the final open pit voids comprise incident rainfall over the void lake surface, runoff and seepage from the sides of the voids and their adjacent contributing catchment and seepage from coal seam groundwater and waste rock emplacement infiltration (Gilbert & Associates, 2014). A final void water balance model was developed by Gilbert & Associates (2014) for the combined final voids to predict the long-term behaviour of the final void water bodies.

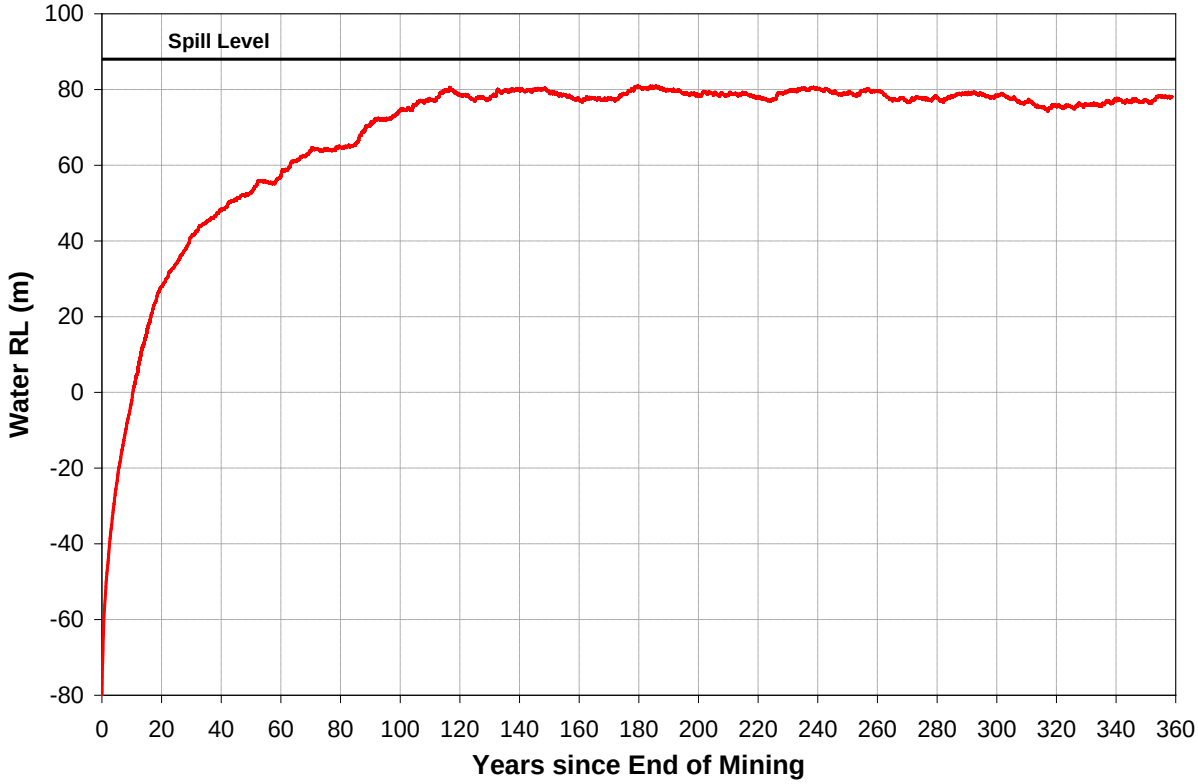
Post recovery groundwater seepage rates (including overburden infiltration) to the voids were advised by HydroSimulations (2014). Inflow rates were estimated for different final void water levels (reducing with rising water level).

Spill between the two voids was modelled as occurring at RL 86 m, while the perimeter of the final voids was assumed to be at RL 88 m (Gilbert & Associates, 2014). The long term water level in the Weismantel final void is predicted to be about 76 to 79 m AHD which is some 7 to 10 m below the level at which the water is predicted to spill over into the adjoining Clareval void (i.e. 86 m AHD). The long term water level in the Clareval final void is predicted to be around 60 m AHD as a result of the relatively higher evaporative area of the Clareval final void (Gilbert & Associates, 2014).

Model results are shown in Chart 1 and Chart 2 in terms of predicted final void water levels versus time, showing that the two voids would form an integrated pit lake over time. Chart 1 and Chart 2 show that predicted water level in the final voids will stabilise after about 80 years at a level approximately 14 m below spill level (88 m AHD), with fluctuations continuing to occur due to climatic variability (e.g. seasonal changes in rainfall and evaporation) (Gilbert & Associates, 2014). No spill was predicted in the long-term from the final voids.

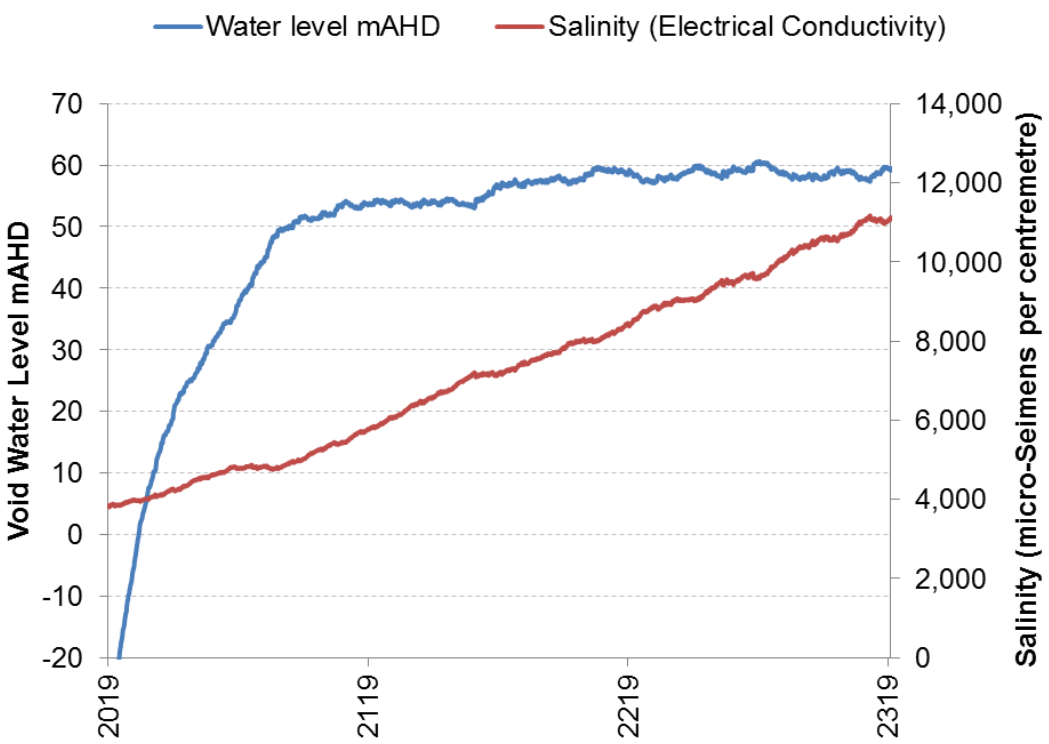
Chart 1
Simulated Water Levels and Salinity – Weismantel Final Void Post Closure





Source: Gilbert & Associates Pty Limited (2014).

Chart 2
Simulated Water Levels and Salinity – Clareval Final Void Post Closure



Source: Gilbert & Associates Pty Limited (2014).

The final voids will cause a temporary change in groundwater flow direction, often reversal of direction, until mining is completed and the aquifer system recovers to a new equilibrium (HydroSimulations, 2014). The Clareval final void will remain a groundwater sink for some time, and no impacts to groundwater quality are expected during this time as a result of the final void water quality.

Numerical modelling conducted by HydroSimulations (2014) shows that groundwater flow in the Weismantel final void may, after several decades, be restored to the direction that existed prior to mining. Once the void water levels in the Weismantel final void reach an equilibrium level, the integrated pit lake would not drive groundwater flow, but would form part of a restored pre-mine groundwater flow system.

Minor volumes of groundwater flow would occur into and out of the final voids as the water level fluctuates with climatic variability. Groundwater flow out of the pit lakes would be into the waste rock emplacement and surrounding groundwater system and may include some groundwater transmission to Coal Shaft Creek.

The final void water balance model was also used by Gilbert & Associates (2014) to simulate salinity levels in final void waters. The balance involved tracking the movement of salt (EC) into the final void and estimating changes in salt concentration (EC) in the void over time.

Once the void water levels reach an equilibrium level, HydroSimulations (2014) concluded that there would be no deleterious effect on the groundwater resource or on the quality of the water, because water quality in the surrounding groundwater is in many cases of a poorer quality than what is predicted from the final void, as final void salinity is generally predicted to slowly increase with time (Gilbert & Associates, 2014).

In addition, DCPL will construct clay cut-off walls along the southern end of the waste rock emplacement toe at Coal Shaft Creek to impede potential groundwater seepage from the toe of the emplacement to lower Coal Shaft Creek and Mammy Johnsons River. The final design of the proposed clay cut-off walls (to impede potential groundwater seepage from the toe of the emplacement to lower Coal Shaft Creek and Mammy Johnsons River) will be provided in future revisions of the DCM Mining Operations Plan.

DCPL has installed piezometers in the in-pit waste rock emplacement as described in the Groundwater Management Plan (Appendix 3 of the WAMP) to provide information on groundwater recharge rates and permeability.

7.5.2 Post-mining Final Void Water Balance and Site Groundwater Model Verification

As described earlier, mining of the Clareval and Weismantel Open Pits has not and will not occur to the maximum approved depths as modelled in the 2014 Modification EA. Accordingly, and consistent with the DCM Mine Closure Planning Program described in the DCM Mining Operations Plan and Rehabilitation Management Plan, numerous technical assessments will be undertaken based on the refined final landform design, including a Geotechnical Assessment of the final voids, a revised site water balance, including final void water balance and final void water quality review, and site groundwater model verification.

These assessments remain in preparation. Once completed, the outcomes and conclusions from these assessments will be described in a revised version of the DCM WAMP and in the DCM's Rehabilitation Management Plan to be submitted to the DPIE Planning and Assessment Division, DPIE-Biodiversity and Conservation Division (BCD), DPIE-Water and MidCoast Council (MCC) for comment and submitted to the Resources Regulator for approval, as required under Condition 57, Schedule 3 of the NSW Project Approval (08_0203).

8 MONITORING PROGRAMS

8.1 METEOROLOGY

In accordance with Condition 24, Schedule 3 of the NSW Project Approval (08_0203), DCPL maintains an Automatic Weather Station (AWS) on-site. The on-site AWS continuously monitors the following meteorological parameters:

- rainfall;
- temperature;
- relative humidity;
- evapotranspiration;
- net solar radiation;
- wind direction; and
- wind speed.

8.2 WATER MANAGEMENT SYSTEM MONITORING PROGRAM

Table 4 outlines the program that will be implemented at the DCM to monitor the effectiveness of the water management system.

Table 4
Water Management System Monitoring Program

Monitoring Location	Parameter	Frequency
MWD (SW3 [Major])[1]	Water Storage Level.	Continuously.
	pH, EC, Turbidity.	Monthly.
	Suite 2[2]	Monthly.
	Benzene, Toluene.	Annually.
SW3 (Minor)[1]	pH, EC.	Monthly
Auxiliary Dam No. 2 (AD2)[1]	Water Storage Level.	Weekly.
	pH, EC.	Monthly
Open Pit Sump (SW4) and Clareval Pit	pH, EC, Turbidity.	Monthly.
	Suite 1[2]	Monthly.
Rail Siding Sediment Dams (RS1, RS6)	TSS.	Each overflow event.
	pH, EC (RS6 only).	Monthly.
Waste Rock Emplacement Sediment Dam (VC1)	pH, EC, TSS.	Special Frequency 1[3]
Transfer Pumps	Transfer volumes measured by accumulating flow meters or pump hours.	During each period of pumping.

[1] Following decommissioning of MWD and AD2 (Section 5.2), monitoring would be discontinued at these sites.

[2] Suite 1: pH, EC, Turbidity, Total Acidity, Total Alkalinity, Total Suspended Solids (TSS), Chloride, Sulphate, Calcium, Magnesium, Aluminium, Iron, Manganese, Zinc, Copper.

Suite 2: pH, EC, Turbidity, Total Acidity, Total Alkalinity, Hardness, TSS, Total Dissolved Solids (TDS), BOD_5, Chloride, Sulphate, Carbonate, Bicarbonate, Calcium Carbonate, Calcium, Magnesium, Sodium, Aluminium, Iron, Manganese, Zinc, Arsenic, Boron, Cadmium, Copper, Lead, Chromium, Mercury, Nickel, Selenium, Silver, Barium, Uranium, Molybdenum, Nitrite, Nitrate, Total Nitrogen, Total Phosphorus, Fluoride and Ammonia.

[3] Special frequency 1

- A sample taken monthly;
- A sample taken on the first day of any discharges (overflows) from North Drain, South Drain or VC1.

A site water balance review will be undertaken on an annual basis to review monitoring results of the status of inflows, outflows, site water inventory and consumption (irrigation, dust suppression, vehicle wash-down) and against site water balance model predictions. The site water balance review will be used to optimise water management performance and will enable corrective actions to be implemented, if required. The results of the water balance reviews will be reported in the Annual Review (Section 11.1). This annual site water balance review will be continued during the mine closure phase, with results of the review compared against the revised post-mining site water balance predictions (Section 7.5.2).

8.3 IRRIGATION AREA MONITORING PROGRAM

As described in Section 1.1, the requirement for, and the requirements of, the Irrigation Management Plan (including the Irrigation Area Monitoring Program) are now redundant. The Irrigation Area Monitoring Program has ceased and is not proposed to recommence during the mine closure phase. The Irrigation Management Plan (Attachment A of this SWMP) has been updated to reflect this. Notwithstanding, DCPL would recommence the Irrigation Management Plan (including the irrigation monitoring program) should irrigation activities at the DCM Irrigation Areas recommence.

Horizon Environmental Soil Survey and Evaluation Pty Ltd (Horizon) has been conducting the DCM Irrigation Area monitoring program since 2013. Irrigation activities at the DCM Irrigation Areas ceased in 2018. Horizon's (2019) *Duralie Coal Mine Irrigation Areas Monitoring Report 2019* (prepared following the cessation of irrigation activities) provides the following key conclusions and recommendations based on the results from irrigation monitoring for the duration of the program:

Key Conclusions

- *We found no detectable adverse impact from irrigation management on pasture cover or composition. Complete ground cover is being maintained on the irrigated pasture.*
- *There does not appear to be a detrimental effect on ground cover or pasture composition in the irrigated pastures compared with the dryland, reference sites.*
- *Soil salinities in irrigation areas were comparable to respective reference sites on different geologies. However, surface soils have low levels of major nutrients (extractable phosphorus and potassium) that will limit productivity.*

Recommendations

- *The former irrigation areas can be decommissioned without detriment to pastureland use.*
- *A fertilizer management program for pH, major nutrients and trace metals would improve pasture production generally, inside and outside of former irrigation areas.*

As a result of the decommissioning of DCM Irrigation Areas, the irrigation monitoring program (including soil monitoring) is no longer required. Monitoring of DCM revegetated areas will continue as a part of the DCM's rehabilitation monitoring program in accordance with the DCM's Rehabilitation Management Plan.

8.4 EROSION AND SEDIMENT CONTROL MONITORING PROGRAM

Routine inspections of sediment control structures as well as inspections following rainfall events of 25 mm or more in a 24 hour period are conducted by the DCPL Environment and Community Superintendent. During these inspections, sediment control structures are inspected for loss of capacity due to sediment capture and structural integrity.

The Coal Shaft Creek Diversion is inspected for structural integrity, blockages or other faults after a rain event of >50 mm in seven days or at least every three months. The MWD diversion drain is inspected at least twice per year and following significant rain events (> 50 mm/day).

8.5 SURFACE WATER QUALITY MONITORING PROGRAM

An outline of the surface water quality monitoring program is provided in Table 5. Surface water monitoring locations are shown on Figures 6a and 6b.

The Coal Shaft Creek diversion and the northern and southern MWD diversions have been equipped with continuous V-notch weirs (Figures 6a and 6b). Flow monitoring at these locations commenced in 2011 and will continue during the mine closure phase prior to decommissioning.

DCPL monitoring will be used in conjunction with data from DPIE-Water gauging stations GS209002 (on the Mammy Johnsons River) and GS209018 (on the Karuah River) (Figure 6a).

Table 5
Surface Water Quality Monitoring Program[1]

Monitoring Location	Parameter[1]	Frequency
SW2 (Coal Shaft Creek [Lower])	Suite 1.	Special Frequency 1[2]
SW2(RC) (Coal Shaft Creek [Rail Culvert])	Suite 2.	Special Frequency 2[3]
SW6 (Culvert at Rail Siding)	Suite 1.	Special Frequency 2[3]
SW9 (Fisher-Webster)	Suite 2.	Special Frequency 2[3]
SW10 (Holmes)	Suite 2.	Special Frequency 2[3]
GB1 (Mammy Johnsons River [Upstream])	Suite 2.	Special Frequency 1[2]
	Benzene, Toluene.	Annually
High Noon (Mammy Johnson River)	EC.	Continuous
	Suite 2.	Special Frequency 1[2]
	Benzene, Toluene.	Annually
Site 9 (Karuah River [Stroud Road])	Suite 2.	Special Frequency 2[3]
Site 11 (Mammy Johnsons River [Downstream])	Suite 2.	Special Frequency 2[3]
Site 12 (Mammy Johnsons River [Relton])	Suite 2.	Special Frequency 2[3]
Site 15 (Mammy Johnsons River [Tereel])	Suite 2.	Special Frequency 2[3]
Site 19 (Karuah River [Washpool])	Suite 2.	Special Frequency 2[3]
DDD 2 and DDD 3 (MWD Upslope Diversion)	pH, EC.	Monthly
North Drain [ND] and South Drain [SD]	EC.	Continuous
	pH, TSS.	Special Frequency 1[2]
CSC Upstream and CSC Rail Culvert	EC.	Continuous

[1] Suite 1: pH, EC, Turbidity, Dissolved Oxygen (DO), Total Acidity, Total Alkalinity, TSS, Chloride, Sulphate, Calcium, Magnesium, Aluminium, Iron, Manganese, Zinc, Copper.

Suite 2: pH, EC, Turbidity, DO, Total Acidity, Total Alkalinity, Hardness, TSS, TDS, BOD_5, Chloride, Sulphate, Carbonate, Bicarbonate, Calcium Carbonate, Calcium, Magnesium, Sodium, Aluminium, Iron, Manganese, Zinc, Arsenic, Boron, Cadmium, Copper, Lead, Chromium, Mercury, Nickel, Selenium, Silver, Barium, Uranium, Molybdenum, Nitrite, Nitrate, Total Nitrogen, Total Phosphorus, Fluoride and Ammonia.

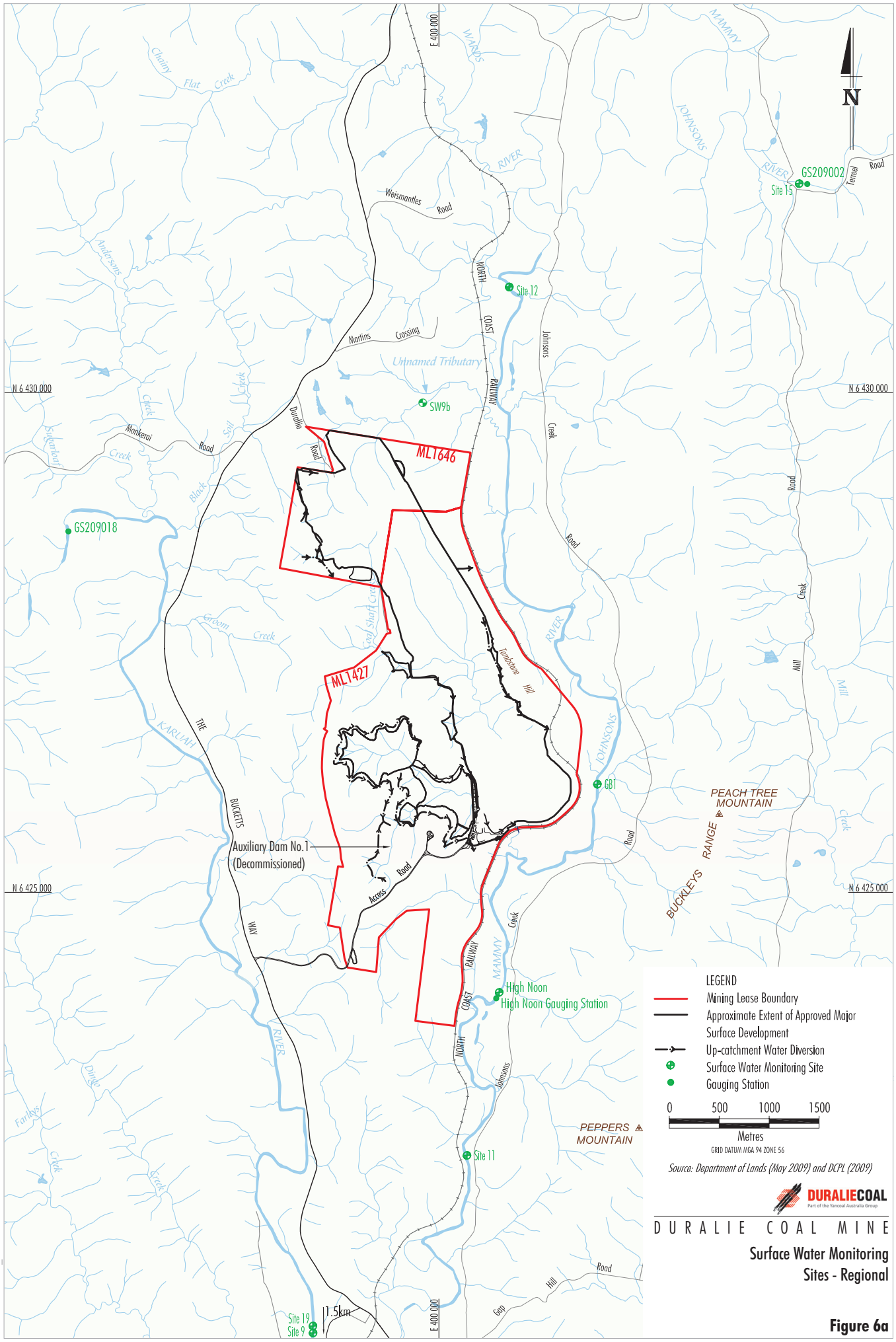
[2] Special frequency 1

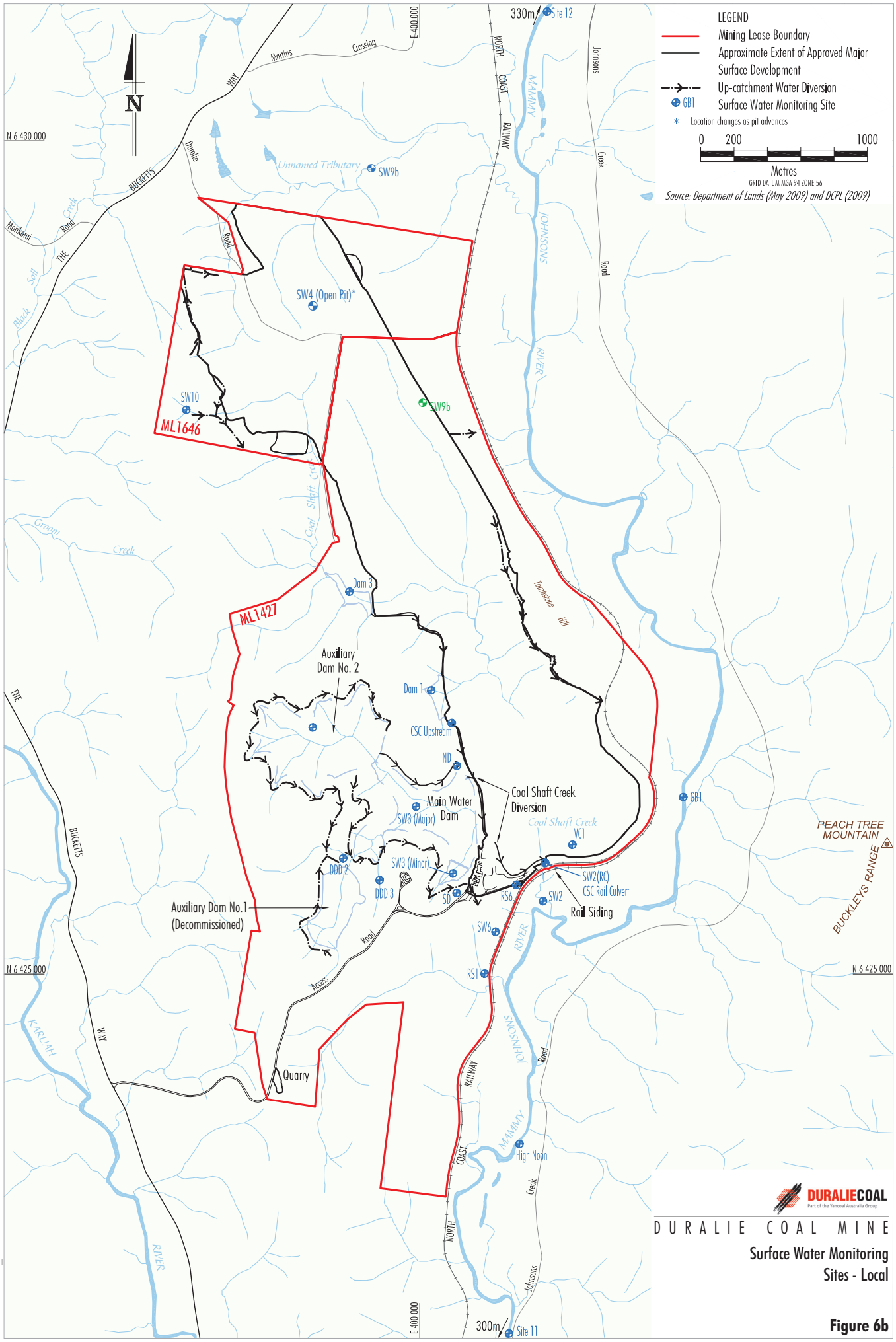
- A sample taken monthly;
- A sample taken on the first day of any discharges (overflows) from North Drain, South Drain or VC1.

[3] Special frequency 2

- A sample taken monthly;
- A sample taken on the first day of any discharge from North Drain, South Drain or VC1 and a maximum of 1 sample taken in any 21 day period.

[1] Surface Water Monitoring Locations SW1 and SW2 (U/S) have been removed in accordance with Variation 1508851 to EPL 11701.


N
E 400 000
N 6 430 000
N 6 425 000
MLT646
MLT427
GS209018
GS209002
Site 15
Site 12
SW9b
GBT
High Noon
High Noon Gauging Station
Site 11
Site 19
Site 9
Auxiliary Dam No.1
(Decommissioned)
PEACH TREE MOUNTAIN
PEPPERS MOUNTAIN
BUCKLEYS RANGE
Unnamed Tributary
Weismantles Road
Martins Crossing
Monkerai Road
Durallie Road
Tenteel Road
Access Road
Tombstone Hill
Coal Shaft Creek
Groom Creek
Black Soil Creek
Sidehill Creek
Andersons Creek
Chainy Flat Creek
Farleys Creek
Mill Creek
Johnsons Creek
MAMMY RIVER
JOHNSONS RIVER
WARDS RIVER
KARUAH RIVER
NORTH COAST RAILWAY
THE BUCKETTS WAY
1.5km
LEGEND
Mining Lease Boundary
Approximate Extent of Approved Major Surface Development
Up-catchment Water Diversion
Surface Water Monitoring Site
Gauging Station
0 500 1000 1500
Metres
GRID DATUM MGA 94 ZONE 56
Source: Department of Lands (May 2009) and DCPL (2009)
DURALIECOAL
Part of the Yancoal Australia Group
DURALIE COAL MINE
Surface Water Monitoring Sites - Regional
Figure 6a
YAN-21-37 DMP SWMP_005B


LEGEND
Mining Lease Boundary
Approximate Extent of Approved Major Surface Development
Up-catchment Water Diversion
GB1 Surface Water Monitoring Site
* Location changes as pit advances
0 200 1000
Metres
GRID DATUM MGA 94 ZONE 56
Source: Department of Lands (May 2009) and DCPL (2009)
N
N 6 430 000
N 6 425 000
E 400 000
330m
Site 12
300m
Site 11
Martins Crossing
WAY
BUCKETTS
THE
Monkerai
Road
Creek
Soil
Black
Durallie
Unnamed Tributary
SW9b
NORTH COAST RAILWAY
MAMMY
Johnsons
Creek
JOHNSONS
Road
RIVER
SW4 (Open Pit)*
SW10
ML1646
Coal Shaft Creek
Groom
Creek
Dam 3
ML1427
Tomalpine Hill
Auxiliary Dam No. 2
Dam 1
CSC Upstream
ND
Main Water Dam
SW3 (Major)
Coal Shaft Creek Diversion
Coal Shaft Creek
VC1
SW3 (Minor)
DDD 2
DDD 3
SD
RS6
SW2
SW2(RC) CSC Rail Culvert
Rail Siding
Auxiliary Dam No.1 (Decommissioned)
SW6
RS1
Road
Access
Quarry
KARUAH
RAILWAY
High Noon
GB1
PEACH TREE MOUNTAIN
BUCKLEYS RANGE
DURALIECOAL
Part of the Yancoal Australia Group
DURALIE COAL MINE
Surface Water Monitoring Sites - Local
Figure 6b
YAH-21-37 DMP SWMP_006B

8.6 STREAM AND RIPARIAN VEGETATION "HEALTH" MONITORING PROGRAM

The requirement to undertake macroinvertebrate sampling and stream and riparian vegetation health monitoring (and the ecotoxicity testing program described in Section 8.7) is derived from DCPL's commitment to monitoring the potential impacts from irrigation activities undertaken at the DCM. Additional Irrigation Areas were approved as part of the Duralie Extension Project, however, DCPL did not commence irrigation of the Additional Irrigation Areas. As irrigation activities at the DCM Irrigation Areas ceased in 2018, and DCPL does not intend to recommence irrigation of the DCM Irrigation Areas, the DCM Irrigation Areas have been decommissioned and associated irrigation equipment has been removed.

As DCPL have not undertaken irrigation of the approved Additional Irrigation Areas, the potential impact pathway to stream and riparian vegetation "health" of Coal Shaft Creek, Unnamed Tributary, Mammy Johnsons River and Karuah River associated with this activity did not commence. In consideration of this and that irrigation of the DCM Irrigation Areas has ceased, the stream and riparian vegetation "health" monitoring program, including macroinvertebrate sampling (and the ecotoxicity testing program described in Section 8.7), at selected sites in Coal Shaft Creek, Unnamed Tributary, Mammy Johnsons River and Karuah River is not applicable to the DCM and these monitoring/sampling/testing programs are now redundant. Notwithstanding, stream water quality will continue to be monitored in accordance with the monitoring program outlined in Section 8.5.

Should DCPL recommence irrigation activities at the DCM Irrigation Areas, DCPL would recommence the stream and riparian vegetation "health" monitoring program, including macroinvertebrate sampling (and the ecotoxicity testing program described in Section 8.7), at selected sites in Coal Shaft Creek, Unnamed Tributary, Mammy Johnsons River and Karuah River.

Stream health (macro-invertebrates) monitoring was undertaken over a period of 19 years between 2002 to 2021. Monitoring was undertaken in autumn and spring each year at select locations upstream and downstream of the DCM. To date, the data collected from the stream and riparian vegetation health monitoring program has been analysed to provide an overall measurement of the performance of the DCM water management system, with results reported in the DCM Annual Reviews (Section 11.1). As provided in the 2020 DCM Annual Review (DCPL, 2020), Invertebrate Identification Australasia's (2020) *Biological Monitoring of the Streams Adjacent to the Duralie Coal Mine* monitoring report concluded:

> *…the results of the current survey confirm what has previously been demonstrated, i.e. that the aquatic biodiversity is continuing to show similar trends to that recorded in previous years and under similar environmental conditions. The low numbers of EPT taxa recorded at most river sites above and below the mining operations indicates that while both river systems have been impacted by the low to no flow conditions, the biodiversity is being maintained, particularly in the Karuah and the lower sections of the Mammy Johnsons River. The other off-river sites recorded lower values than the river sites, however, as they are much smaller systems, they do not have the same scale of resources, permanence of water levels and variety of niches to support more complex biodiversity. They are also more impacted by decreases in flow or changes in environmental conditions. In conclusion, the results from the current survey suggest that while the overall biodiversity and river environmental conditions has declined, there are no apparent adverse effects on the aquatic macroinvertebrate fauna in the Mammy Johnsons River as a result of any activities arising from the operations of the Duralie Mine.*

The status of, and results to date from, the stream and riparian vegetation health monitoring program will be reported in the 2021 DCM Annual Review as required by Condition 3 of Schedule 5 of the NSW Project Approval (08_0203).

Enhancement of riparian habitat along a length of the Mammy Johnsons River will be undertaken within the DCM offset area (e.g. increasing the width of the riparian vegetation and implementing weed control measures). Monitoring programs for riparian vegetation within the DCM offset area will be described in the Biodiversity Management Plan required under Condition 43, Schedule 3 of the NSW Project Approval (08_0203).

8.7 ECOTOXICITY TESTING PROGRAM

Condition 29 (b) in the NSW Project Approval (08_0203), requires ecotoxicity testing of water in on-site storages and at selected water monitoring sites in Mammy Johnsons River. As indicated in Section 8.6, the requirement to undertake ecotoxicity testing of water in on-site storages and at selected water monitoring sites in Mammy Johnsons River is derived from DCPL's commitment to monitoring the potential impacts from irrigation on the Additional Irrigation Areas approved under the DEP. However, irrigation of the Additional Irrigation Areas was not commenced by DCPL. As irrigation activities at the DCM Irrigation Areas ceased in 2018, and DCPL does not intend to recommence irrigation of the DCM Irrigation Areas, the DCM Irrigation Areas have been decommissioned and associated irrigation equipment has been removed.

As DCPL have not undertaken irrigation of the approved Additional Irrigation Areas, the potential impact potential impact pathway to stream and riparian vegetation "health" of Coal Shaft Creek, Unnamed Tributary, Mammy Johnsons River and Karuah River associated with this activity also did not commence. In consideration of this and that irrigation of the DCM Irrigation areas has ceased, the ecotoxicity testing program in on-site storages and at selected water monitoring sites in Mammy Johnsons River is not applicable to the DCM and the requirement for ecotoxicity testing is now redundant. This conclusion is supported by Dr Barry Noller of the University of Queensland Centre for Mined Land Rehabilitation (CMLR) (as outlined below). Notwithstanding, stream water quality will continue to be monitored in accordance with the monitoring program outlined in Section 8.5.

Should DCPL recommence irrigation activities at the DCM Irrigation Areas, DCPL would recommence the ecotoxicity testing program.

Ecotoxicity monitoring in accordance with the previous versions of the SWMP was undertaken between 2013 to 2020. Specialist review reports were also prepared during this period. A summary of the ecotoxicity testing program results to date is provided below.

Testing Program Results to Date

Sampling and ecotoxicity testing was undertaken on a quarterly basis during the first year of the program before being reduced to bi-annual monitoring, based on a lack of observed toxicity.

A review of the ecotoxicity monitoring data was undertaken by the CMLR (Dr Barry Noller - Principal Research Fellow at the University of Queensland) in May 2014 and again in October 2015. The *Summary Interpretation of Duralie Coal Mine Ecotoxicity Testing Results (B Noller, Oct 2015)* indicated a continued lack of observed toxicity at sampling sites in Coal Shaft Creek and Mammy Johnsons River and recommended rationalising the monitoring frequency to annually corresponding with the commencement of summer.

In April 2019, a further review and summary interpretation of the DCM ecotoxicity monitoring program results was undertaken by the CMLR (Dr Barry Noller). The review was undertaken to assess any identified impacts over the life of the DCM and to provide recommendations for ongoing monitoring efforts. The *Summary Interpretation of Duralie Coal Mine Ecotoxicity Testing Results, Apr 2019* (CMLR, 2019) concluded;

The results for ecotoxicity testing with five aquatic species of Coal Shaft Creek, Mammy Johnsons River at two additional sampling times during 2016 – 2018 show that there was no evidence for any significant toxicity and no connection with any effects from mining. The Main Water Dam at Duralie Coal Mine showed that sporadic effects to some test species occurred, but not all. This is considered to indicate the potential for minor effects to occur on an on-going basis but does not show affects from the offsite natural waters. Based on the consistent evidence from 2013-2018 for aquatic testing in the Main Water Dam it is recommended that the Ecotoxicity Testing Program is no longer required. If any irrigation activity were to be undertaken from the Main Water Dam at Duralie Mine site, the mine site and downstream waters would require ecotoxicity testing before and after application.

Reporting

The status of, and results of the ecotoxicity testing program to date, will be reported in the next DCM Annual Review as required under Condition 3 of Schedule 5 of the NSW Project Approval (08_0203).

8.8 RECONSTRUCTED COAL SHAFT CREEK MONITORING PROGRAM

As described in Section 7.3, a CSCRP has been developed and is included as Attachment C. As the reconstruction of Coal Shaft Creek is not required until the completion of mining activities at the DCM, the CSCRP presents the proposed conceptual design for the post-mining alignment of Coal Shaft Creek.

The detailed design specifications and drawings of the relocation corridor and a construction program is to be provided in the final CSCRP. DCPL has engaged HEC to prepare the final CSCRP based on the refined final landform design (Section 7.3), which is currently in preparation. The final CSCRP will include a monitoring program that includes monitoring of bed and bank stability, bed and bank erosion rates, changes to flow path geometry, vegetation (cover, density and health) and water quality. The monitoring program will complement existing monitoring programs and will use existing monitoring locations where possible.

9 ASSESSMENT OF PERFORMANCE INDICATORS AND MEASURES

In accordance with Condition 29 (b), Schedule 3 of NSW Project Approval (08_0203), DCPL has developed:

- performance measures (criteria) and performance indicators (trigger levels) for investigating any potentially adverse surface water impacts for:
  - the water management system;
  - surface water quality of the Unnamed Tributary, Coal Shaft Creek and Mammy Johnsons River; and
  - channel stability of the reconstructed Coal Shaft Creek[2];
- performance criteria for surface water quality attributes relevant to water quality impacts on biological diversity and aquatic ecological integrity, including salinity, heavy metals, sediment load[3], pH, hardness and biological oxygen demand;
- trigger levels representing the 80th percentile value of the relevant data set in accordance with the methodology in ANZECC/ARMCANZ (2000), to determine the levels for investigating any potentially adverse impacts (Attachment B); and
- a plan to respond to any exceedances of the performance criteria, and mitigate and/or offset any adverse surface water impacts of the DCM (as modified).

DCPL will assess the DCM against the water management and water resource performance indicators and measures outlined in Table 6. Performance assessments will be undertaken on a monthly basis follow the receipt of monitoring results.

Table 6
Summary of Water Management and Water Resource Performance Indicators and Measures

Performance Measure	Performance Indicator(s) for Investigating Potential Adverse Impacts
Water Management System	
Minimal operational disruption while maintaining negligible risk of spill from the MWD and Auxiliary Dams to Mammy Johnsons River and Coal Shaft Creek.	Water levels in the MWD and Auxiliary Dams are above defined operating levels.
Surface Water Quality (including impacts to biological diversity and aquatic ecological integrity)	
No more than a negligible impact on water quality in Mammy Johnsons River, Coal Shaft Creek and the Unnamed Tributary as a result of the DCM.	80th percentile of reference, indicator water quality data at assessment sampling sites on Mammy Johnsons River, Coal Shaft Creek and Unnamed Tributary (refer Table 7 and Attachment C).

Consistent with the NSW Project Approval (08_0203), the term 'negligible' is defined as *small and unimportant, such as to be not worth considering*.

[2] Performance criteria and performance indicators for the reconstructed Coal Shaft Creek will be developed over the life of the DCM and provided in the final Coal Shaft Creek Reconstruction Plan (Section 7.3).

[3] Given the practical difficulties inherent in measuring sediment load (which incorporates both suspended and bed transport components) it is proposed to use the concentration of total suspended solids as a measure of sediment load.

Reconstructed Coal Shaft Creek

As described in Section 7.3, a CSCRP has been developed and is included as Attachment C. Performance indicators and measures will be developed over the life of the DCM and will be documented in the final CSCRP. The performance measures and indicators will include consideration of monitoring and observations during and following flood events include attributes such as bed and bank stability, bed and bank erosion rates, changes to flow path geometry, vegetation (cover, density and health) and water quality.

Rehabilitated Area Runoff

Sediment dams downstream of the waste rock emplacements will be maintained until the revegetated surface is stable and the runoff water quality is suitable for release off site.

Monthly monitoring data from sediment dams will be compared with values from the Coal Shaft Creek (pre-mine and post-mine up-catchment of the DCM). Examples of runoff water quality will be considered suitable for release off site when the median runoff water quality for 24 months of data is within 10% of the median values of the two control catchments and 25% of the 80th percentile for EC, pH and TSS, and within 25% of the 20th percentile for pH.

Baseflow to Mammy Johnsons River

Performance criteria for baseflow to Mammy Johnsons River and a plan to offset the loss of any baseflow caused by the DCM are included in the Groundwater Management Plan (Appendix 3 of the WAMP).

Riparian Vegetation within DCM Offset Area

Enhancement of riparian habitat along a length of the Mammy Johnsons River will be undertaken within the DCM offset area (e.g. increasing the width of the riparian vegetation and implementing weed control measures). Performance measures for riparian vegetation within the DCM offset area are described in the Biodiversity Management Plan required under Condition 43, Schedule 3 of the NSW Project Approval (08_0203).

Assessment of Performance Measures and Indicators

Section 8 describes the monitoring that will be conducted to inform the assessment of the DCM against the performance indicators and measures for water management and water resources. The monitoring program includes the monitoring of:

- meteorology (Section 8.1);
- water management system performance (Section 8.2);
- irrigation (Section 8.3) (ceased);
- erosion and sediment control structures (Section 8.4);
- surface water quality and flows (Section 8.5);
- stream and riparian vegetation “health” (Section 8.6) (ceased);
- ecotoxicity (Section 8.7) (ceased); and
- reconstructed Coal Shaft Creek (when established) (Section 8.8).

As described in Sections 8.3, 8.6 and 8.7, irrigation activities at the DCM Irrigation Areas have ceased, and the irrigation monitoring program, stream and riparian vegetation “health” monitoring program and ecotoxicity testing program are now redundant. Should DCPL recommence irrigation activities at the DCM Irrigation Areas, DCPL would recommence the stream and riparian vegetation “health” monitoring program and the ecotoxicity testing program, at selected sites in Coal Shaft Creek, Unnamed Tributary, Mammy Johnsons River and Karuah River.

The monitoring results will be used to assess the DCM against the performance indicators and performance measures as detailed in Table 7. If data analysis indicates a performance indicator has been exceeded or is likely to be exceeded, an assessment will be made against the performance measure. If a performance measure is considered to have been exceeded, the Contingency Plan will be implemented (Section 10). If data analysis indicates that the performance measure has not been exceeded, DCPL will continue to monitor.

Table 7
Monitoring of Environmental Consequences against Performance Indicators and Measures

Performance Measure	Monitoring of Environmental Consequences			Data Analysis to Assess against Performance Indicator(s)	Performance Indicator(s)	Assessment of Performance Indicator(s)	Assessment of Performance Measure	Relevant Management and Contingency Measures
	Sites	Parameters	Frequency					
Minimal operational disruption while maintaining negligible risk of spill from the MWD and Auxiliary Dam No. 2 to Mammy Johnsons River and Coal Shaft Creek.	• MWD, Auxiliary Dam No. 2.	• Water storage level.	• Continuously.	• Water storage levels in MWD and Auxiliary Dam No. 2 compared to defined maximum operating levels on a daily basis, or more frequently during an event. • Defined operating levels will be reviewed on an annual basis as a component of the site water balance review.	• Water levels in the MWD and Auxiliary Dam No. 2 are below defined maximum operating levels.	• The performance indicator will be considered to have been exceeded if water storage levels in the MWD and/or Auxiliary Dam No. 2 exceed defined maximum operating levels. • If the performance indicator has been exceeded, the performance measure will be assessed to determine if there is likely to be a greater than minimal risk of operational disruption and or a greater than negligible risk of spill from the MWD and Auxiliary Dam No. 2 to Coal Shaft Creek and Mammy Johnsons River.	• The performance measure is exceeded if water balance modelling indicates that water levels in the MWD and Auxiliary Dam No. 2 cannot be maintained with negligible risk of spill to Mammy Johnsons River and Coal Shaft Creek and/or without more than minimal disruption to mining operations. • The above analysis will be peer reviewed by a specialist approved by the DPIE, if required. • The results will be reported to DPIE, DPIE-Water and DPIE-BCD. • If the performance measure has been exceeded, the Contingency Plan will be implemented (Section 10).	• Transfer excess water to Clareval open pit using installed pumping equipment. • Review of system maintenance scheduling to ensure adequate performance of water management system components. • Installation of additional pipeline and/or pumping capacity. • Expansion of irrigation areas within approved irrigation areas or upgrade of irrigation infrastructure (subsequent to amendment of this SWMP) (Attachment A). • Installation of additional water storage infrastructure or expansion of irrigation outside approved irrigation areas (subsequent to obtaining appropriate regulatory approvals).
No more than a negligible impact on water quality in Mammy Johnsons River as a result of the Duralie Extension Project.	• Site 11. • GB1, Site 12.	• EC, pH, turbidity, Copper (total), Zinc (total) Aluminium (total). Hardness, TSS, BOD_5, and DO.	• Monthly.	• Water quality data analysed on a six month basis: • The 80th percentile concentrations for the relevant water quality indicators[4] (EC, pH, total copper, turbidity, total zinc, total aluminium, and TSS) will be calculated from data at Site 11, GB1 and Site 12. The 20th and 80th percentile values of pH will be calculated from data at Site 11, GB1 and Site 12.	• Water quality at Site 11 is not worse than the pre-irrigation water quality at Site 11 whilst water quality is better at GB1 and Site 12 compared to the pre-irrigation water quality at these sites.	• The performance indicator will be considered to have been exceeded if data analysis indicates that the concentration of water quality parameters at Site 11 is greater than the 80th percentile concentration calculated from the data set and the concentration of the same water quality parameter has not also been greater than the 80th percentile concentration at either GB1 or Site 12 compared to the data set at those sites or for pH that it is either above the 80th percentile or below the 20th percentile and that it has not also been either above or below the same measure at either GB1 or Site 12. • The performance indicator for dissolved oxygen will be considered to have been exceeded if the dissolved oxygen is below 85% of saturation and is also lower than the dissolved oxygen saturation level measured at either Site 12 or GB1 on the same day. • If the performance indicator has been exceeded, the performance measure will be assessed to determine if the change in water quality is a result of the Duralie Extension Project.	• The performance measure is exceeded if analysis of the monitoring data, (including any additional monitoring and testing), confirms that there has been a more than negligible risk of a decrease in the biodiversity and aquatic ecological integrity of water in the Mammy Johnsons River as a result of the Duralie Extension Project. • The above analysis will include consideration of BOD_5 and hardness levels in on-site, upstream, and downstream receiving waters, and ecotoxicity testing and macroinvertebrate sampling in Mammy Johnsons River upstream and downstream of Coal Shaft Creek. The analysis will be undertaken in accordance with the decision tree framework given on Figure 3.4.1 in ANZECC/ARMCANZ (2000) (Attachment B). • The above analysis will be peer reviewed by a specialist approved by the DPIE, if required. • The results will be reported to DPIE, DPIE-Water and DPIE-BCD. • If the performance measure has been exceeded, the Contingency Plan will be implemented (Section 10).	• Additional monitoring (e.g. increase in monitoring frequency or additional sampling). • Temporary cessation of irrigation activities, if required. • Treatment of MWD water used for irrigation, for example reverse osmosis treatment to reduce salinity. • Alteration of irrigation application procedures, for example alteration of soil moisture deficit triggers. • Implementation of additional waste rock management techniques. • Implementation of additional temporary/permanent erosion control measures. • Additional aeration to address low DO concentrations. • Offsets.

[4] Note: BOD_5 and Hardness are not considered to be aquatic ecosystem stressors – refer ANZECC/ARMCANZ (2000). BOD_5 is a measure of how much dissolved oxygen would be consumed (in a receiving water), in breaking down the organic matter present in water released into the receiving water. The hardness of water affects the toxicity of metals. BOD_5 and hardness will be monitored and used in the interpretation of trigger exceedances for dissolved oxygen and metals respectively.

Table 7 (Continued)
Monitoring of Environmental Consequences against Performance Indicators and Measures

Performance Measure	Monitoring of Environmental Consequences			Data Analysis to Assess against Performance Indicator(s)	Performance Indicator(s)	Assessment of Performance Indicator(s)	Assessment of Performance Measure	Relevant Management and Contingency Measures
	Sites	Parameters	Frequency					
No more than a negligible impact on water quality in Coal Shaft Creek as a result of the Duralie Extension Project.	• Site SW2(RC).	• EC, pH, turbidity, Copper (total), Zinc (total) Aluminium (total). Hardness, TSS, DO and BOD_5.	• Monthly.	• Water quality data analysed on a six month basis: - The 80th percentile concentrations for the relevant water quality indicators (EC, pH, turbidity, total copper, total zinc, total aluminium, and TSS) will be calculated from data at Site SW2 (RC), and Site SW2 (US). The 20th and 80th percentile values of pH will be calculated from data at Site SW2 (RC), and Site SW2 (US).	• Water quality at Site SW2 (RC) is not worse than the pre-irrigation water quality at Site SW2 (RC) whilst water quality is better at Site SW2 (US) compared to the pre-irrigation water quality at that site.	• The performance indicator will be considered to have been exceeded if data analysis indicates that the concentration of water quality parameters at Site SW2 (RC) is greater than the 80th percentile concentration calculated from the data set and the concentration of the same water quality parameter has not also been greater than the 80th percentile concentration at Site SW2 (US) compared to the data set at that site or for pH that it is either above the 80th percentile or below the 20th percentile and that it has not also been either above or below the same measure at Site SW2 (US). • The performance indicator for dissolved oxygen will be considered to have been exceeded if the dissolved oxygen is below 85% of saturation and is also lower than the dissolved oxygen saturation level measured at SW2 on the same day. • If the performance indicator has been exceeded, the performance measure will be assessed to determine if the change in water quality is a result of the Duralie Extension Project.	• The performance measure is exceeded if analysis of the monitoring data, (including any additional monitoring and testing), confirms that there has been a more than negligible risk of a decrease in the biodiversity and aquatic ecological integrity of water in the Coal Shaft Creek as a result of the Duralie Extension Project. • The above analysis will include consideration of BOD_5 and hardness levels in on-site, upstream, and downstream receiving waters, and ecotoxicity testing and macroinvertebrate sampling in Mammy Johnsons River upstream and downstream of Coal Shaft Creek. The analysis will be undertaken in accordance with the decision tree framework given on Figure 3.4.1 in ANZECC/ARMCANZ (2000) (Attachment B). The above analysis will be peer reviewed by a specialist approved by the DPIE, if required. • The results will be reported to DPIE, DPIE-Water and DPIE-BCD. • If the performance measure has been exceeded, the Contingency Plan will be implemented (Section 10).	• Additional monitoring (e.g. increase in monitoring frequency or additional sampling). • Temporary cessation of irrigation activities, if required. • Treatment of MWD water used for irrigation, for example reverse osmosis treatment to reduce salinity. • Alteration of irrigation application procedures, for example alteration of soil moisture deficit triggers. • Implementation of additional waste rock management techniques. • Implementation of additional temporary/permanent erosion control measures. • Additional aeration to address low DO concentrations. • Offsets.
No more than a negligible impact on water quality in the Unnamed Tributary as a result of the Duralie Extension Project.	• Site SW9. • SW10.	• EC, pH, turbidity, Copper (total), Zinc (total) Aluminium (total). Hardness, TSS, DO and BOD_5.	• Weekly • Weekly/ Monthly	• Water quality data analysed on a six month basis: - The 80th percentile concentrations for the relevant water quality indicators (EC, pH, turbidity, total copper, total zinc, total aluminium, and TSS) will be calculated for the pre-irrigation data at Site SW9, and Site SW10. The 20th and 80th percentile values of pH will be calculated for the pre-irrigation data at Site SW9, and Site SW10.	• Water quality at Site SW9 is not worse than the pre-irrigation water quality at Site SW9 whilst water quality at Site SW10 is also better compared to the pre-irrigation water quality at that site.	• The performance indicator will be considered to have been exceeded if data analysis indicates that the concentration of water quality parameters at Site SW9 is greater than the 80th percentile concentration calculated from the pre-irrigation data set and the concentration of the same water quality parameter has not also been greater than the 80th percentile concentration at Site SW10 compared to the pre-irrigation data set at that site or for pH that it is either above the 80th percentile or below the 20th percentile at SW9 and that it has not also been either above or below the same measure at Site SW10. • The performance indicator for dissolved oxygen will be considered to have been exceeded if the dissolved oxygen is below 85% of saturation and is also lower than the dissolved oxygen saturation level measured at SW2 on the same day. • If the performance indicator has been exceeded, the performance measure will be assessed to determine if the change in water quality is a result of the Duralie Extension Project.	• The performance measure is exceeded if analysis of the monitoring, (including any additional monitoring and testing) confirms that there has been more than a negligible decrease in the biodiversity and aquatic ecological integrity water in the Unnamed Tributary as a result of the Duralie Extension Project. • The above analysis will include consideration of BOD_5, and hardness levels in on-site, upstream, and downstream receiving waters, and ecotoxicity testing and macroinvertebrate sampling in Mammy Johnsons River upstream and downstream of Coal Shaft Creek. The analysis will be undertaken in accordance with the decision tree framework given on Figure 3.4.1 in ANZECC/ARMCANZ (2000). (Attachment B). • The above analysis will be peer reviewed by a specialist approved by the DPIE, if required. • The results will be reported to DPIE, DPIE-Water and DPIE-BCD. • If the performance measure has been exceeded, the Contingency Plan will be implemented (Section 10).	• Additional monitoring (e.g. increase in monitoring frequency or additional sampling). • Temporary cessation of any irrigation activities in the Unnamed Tributary catchment, if required. • Treatment of MWD water used for irrigation, for example reverse osmosis treatment to reduce salinity. • Alteration of any irrigation application procedures, for example alteration of soil moisture deficit triggers. • Implementation of additional waste rock management techniques. • Implementation of additional temporary/permanent erosion control measures. • Additional aeration to address low DO concentrations. • Offsets.

Table 7 (Continued)
Monitoring of Environmental Consequences against Performance Indicators and Measures

Performance Measure	Monitoring of Environmental Consequences			Data Analysis to Assess against Performance Indicator(s)	Performance Indicator(s)	Assessment of Performance Indicator(s)	Assessment of Performance Measure	Relevant Management and Contingency Measures
	Sites	Parameters	Frequency					
Negligible long-term risk of spill from the final voids.	• AWS. • Water management system.	• Rainfall, temperature, evapo-transpiration. • Inflows and outflows.	• Continuously. • Continuously.	• Site water balance and validity of modelling assumptions reviewed annually based on monitoring data.	• No significant changes required to site water balance assumptions as a result of review of monitoring data.	• The performance indicator will be considered to have been exceeded if site water balance reviews indicate that modelling assumptions could be significantly improved based on monitoring data. • If the performance indicator has been exceeded, the performance measure will be assessed to determine if there is a greater than negligible long-term risk of spill from the final voids as a result of the revised modelling assumptions.	• The performance measure is exceeded if analysis of the revised modelling indicates there is a greater than negligible long-term risk of spill from the final voids. • The above analysis will be peer reviewed by a specialist approved by the DPIE, if required. • The results will be reported to DPIE, DPIE-Water and DPIE-BCD. • If the performance measure has been exceeded, the Contingency Plan will be implemented (Section 10).	• Additional monitoring (e.g. increase in monitoring frequency or additional sampling). • Redesign of final voids or final landform water management.

[1] Log transformations (i.e. base 10 logs of the water quality concentrations) may be used to calculate the arithmetic means and standard deviations. Metal concentrations in water quality are measured as a positive value and therefore have a positively skewed distribution. Log transformations can be used to standardise the variance of a sample.

10 CONTINGENCY PLAN

In the event that water management or water resource performance indicator detailed in Section 9 is considered to have been exceeded, DCPL will implement the following Contingency Plan:

- The Environmental Coordinator will immediately report the exceedance to the General Manager within 24 hours of assessment completion.
- DCPL will report the likely exceedance of the water management or water resource performance measure to the DPIE, DPIE-Water and DPIE-BCD as soon as practicable (i.e. within 7 days) after DCPL becomes aware of the exceedance.
- DCPL will identify an appropriate course of action (e.g. potential contingency measures described in Section 10.1 & Table 7) with respect to the identified impact(s), in consultation with specialists and DPIE, DPIE-Water and/or DPIE-BCD, as necessary.
- DCPL will, on request, submit the proposed course of action to the DPIE for approval.
- DCPL will implement the approved course of action to the satisfaction of the DPIE.

10.1 POTENTIAL CONTINGENCY MEASURES

Potential contingency measures for an exceedance of the water management or water resource performance measures include, but are not necessarily limited to:

- The conduct of additional monitoring (e.g. increase in monitoring frequency or additional sampling) to inform the proposed contingency measures.
- A review of system maintenance scheduling to ensure adequate performance of water management system components.
- Installation of additional pipeline and/or pumping capacity to reduce the risk of spill from the open pits, MWD and Auxiliary Dam No. 2 to Coal Shaft Creek.
- Installation of additional water storage infrastructure (subsequent to obtaining appropriate regulatory approvals).
- Treatment of MWD water, for example reverse osmosis treatment, to reduce salinity (Note: treatment of MWD water for irrigation use is no longer required due to the cessation of irrigation at the DCM Irrigation Areas).
- Implementation of additional waste rock management techniques, for example, limestone treatment of the open pit floor and/or alternative waste rock handling techniques (e.g. paddock dump and traffic compacting PAF material) to minimise the risk of accelerated oxidation through convection.
- Implementation of soil treatment measures, for example, chemical amelioration or cultivation-based renovation.
- Implementation of additional temporary/permanent erosion control measures.
- Redesign of final voids or final landform water management (e.g. reduction in depth or catchment area of final voids through a redistribution of waste rock), where revised modelling indicates a more than negligible risk of spill from the final voids (subsequent to obtaining appropriate regulatory approvals).

11 REVIEW AND IMPROVEMENT OF ENVIRONMENTAL PERFORMANCE

11.1 ANNUAL REVIEW

In accordance with Condition 3, Schedule 5 of the NSW Project Approval (08_0203), DCPL prepares an Annual Review of the environmental performance of the DCM prior to the end of December each year. Annual Reviews are made publicly available on the Duralie Coal website, in accordance with Condition 10, Schedule 5 of the NSW Project Approval (08_0203).

The Annual Review will specifically address the following aspects of Condition 3, Schedule 5 that are directly relevant to water management:

- include a comprehensive review of the monitoring results and complaints records for the DCM over the past year, including a comparison of these results against the:
  - relevant statutory requirements, limits or performance measures/criteria;
  - monitoring results of previous years; and
  - relevant predictions in the Duralie Extension Project EA;
- identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;
- identify any trends in the monitoring data over the life of the DCM;
- identify any discrepancies between the predicted and actual impacts of the DCM, and analyse the potential cause of any significant discrepancies; and
- describe what measures will be implemented over the next year to improve the environmental performance of the DCM.

11.2 SWMP REVIEW

In accordance with Condition 4, Schedule 5 of the NSW Project Approval (08_0203), this SWMP will be reviewed and if necessary revised to the satisfaction of the Secretary of the DPIE, within three months of the submission of:

- an Annual Review, in accordance with Condition 3, Schedule 5 of Project Approval (08_0203);
- an Incident Report, in accordance with Condition 6, Schedule 5 of Project Approval (08_0203);
- an audit, in accordance with Condition 8, Schedule 5 of Project Approval (08_0203);
- any modification to the conditions of Project Approval (08_0203); or
- prior to the commencement of clearing in accordance with the *Duralie Open Pit Modification Environmental Assessment* (DCPL, 2014).

This SWMP will be made publicly available on the Duralie Coal website in accordance with the NSW Project Approval (08_0203). A hard copy of the SWMP will also be kept at the DCM.

12 REPORTING PROTOCOLS

In accordance with Condition 2(g), Schedule 5 of the NSW Project Approval (08_0203), DCPL has developed protocols for managing and reporting the following:

- incidents;
- complaints;
- non-compliances with statutory requirements; and
- exceedances of the impact assessment criteria and/or performance criteria.

The management of incidents is described in the Pollution Incident Response Management Plan. The management of complaints and non-compliances is described in detail in the Environmental Management Strategy. Management and reporting of exceedances of impact assessment criteria and/or performance criteria are described in Section 9 of this SWMP.

13 REFERENCES

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Duralie Coal Pty Ltd (2008) *Irrigation Management Plan.* Document IMP-F.

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Gilbert & Associates Pty Limited (2010) *Duralie Extension Project Surface Water Assessment*. Appendix A of Duralie Coal Pty Ltd (2010) *Duralie Extension Project Environmental Assessment*.

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Invertebrate Identification Australasia (2020) *Biological Monitoring of the Streams Adjacent to the Duralie Coal Mine.*

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

ATTACHMENT A

IRRIGATION MANAGEMENT PLAN (REDUNDANT)

DURALIE COAL MINE
IRRIGATION MANAGEMENT PLAN

DURALIECOAL
Part of the Yancoal Australia Group

Revision Status Register

Section/Page/ Annexure	Revision Number	Amendment/Addition	Distribution	DP&E/DotE Approval Date
All	IMP-F	Original	OEH, NOW, DP&I	-
All	IMP-R02-A	Edits made to: • reflect amended Project Approval conditions by Order of The Land and Environment Court of NSW dated 10 November 2011; • consider recommendations (where relevant) of independent environmental audit dated November 2011; and • consider any outcomes of the Annual Review for the Duralie Coal Mine (dated September 2011).	OEH, NOW, DP&I	-
All	IMP-R02-B	Edits made to reflect DP&I comments.	DP&I	2 August 2012
Sections 4.4 and 4.6	IMP-R02-C	Edits made to reflect SEWPaC comments.	SEWPaC	-
All	IMP-R02-D	Annual Review.	DP&I	27 September 2013
All	IMP-R03-A	Annual Review (2013) and recommendations from DP&E Audit December 2013.	DP&E	23 April 2015
All	IMP-R04-A	Annual Review (2014) and Duralie Open Pit Modification (2014).	DP&E	22 July 2016
All	IMP-05-A	Updated to include Preface describing cessation of irrigation at the DCM and redundancy of the IMP.	EPA, DPIE-Water, DPIE and DAWE	24 December 2021

SEPTEMBER 2021
Document No. IMP-R05-A
ID: 01121700

PREFACE

Condition 5, Schedule 2 of NSW Project Approval (08_0203) authorises mining operations to be carried at the Duralie Coal Mine (DCM) until 31 December 2021.

Accordingly, operations at the DCM now reflect the transition towards mine closure;

- **Clareval Open Pit:** mining of the Clareval Open Pit has now been completed, and dewatering of the pit has ceased. Partial backfilling with waste rock mined from the Weismantel Open Pit has commenced, along with shaping of the pit area to its final landform design. Mining of the Clareval Open Pit was finalised to a shallower depth than the maximum approved depth as modelled in 2014 DCM Open Pit Modification.
- **Weismantel Open Pit:** mining of the Weismantel Open Pit will continue until 31 December 2021, however, will also not occur to the maximum approved depth as modelled in 2014 DCM Open Pit Modification. Progressive backfilling of the Weismantel Open Pit has been undertaken.
- **DCM Water Management System Changes:**
  - Following the cessation of mining of the Clareval Open Pit (now final void) and the Clareval void becoming available as a water storage, Weismantel Open Pit dewatering is now preferentially transferred to the Clareval void and not stored within the Main Water Dam. **As a result, all irrigation activities for the purpose of reducing the total site water inventory at the DCM have now ceased and the DCM's Irrigation Area irrigation system has been decommissioned and removed. DCPL does not intend to recommence irrigation of the DCM Irrigation Areas during the mine closure phase.**
  - Decommissioning of other redundant water management structures has also commenced. Consistent with the approved DCM final landform design, Auxiliary Dam No. 1 has been dewatered, decommissioned and rehabilitated.
  - **No new disturbance areas** are proposed.

As a result of the operational changes at the DCM, the requirement for, and the requirements of, the DCM Irrigation Management Plan are no longer relevant to the DCM and the plan is now redundant.

In accordance with Condition 29, Schedule 3 of NSW Project Approval 08_0203, the revised DCM Water Management Plan (including this revised Irrigation Management Plan) has been provided to the NSW Environment Protection Authority and NSW Department of Planning, Industry and Environment (DPIE) – Water for comment, and will be submitted to the DPIE Planning and Assessment Division and the Commonwealth Department of Agriculture, Water and the Environment for approval. A record of consultation with the EPA is provided in Attachment A of the Water Management Plan. The EPA's comments have been addressed where relevant in the revised Water Management Plan. No comments on the revised Water Management Plan were received from the DPIE-Water.

This Preface describes the current status of the DCM and the status of the Irrigation Management Plan, therefore no further updates have been made to the Irrigation Management Plan that follows.

Notwithstanding, should irrigation activities at the DCM Irrigation Areas recommence, DCPL would recommence the Irrigation Management Plan.

Irrigation Monitoring Program

Horizon Environmental Soil Survey and Evaluation Pty Ltd (Horizon) has been conducting the DCM Irrigation Area monitoring program since 2013. Irrigation activities at the DCM Irrigation Areas ceased in 2018. Horizon's (2019) *Duralie Coal Mine Irrigation Areas Monitoring Report 2019* (prepared following the cessation of irrigation activities) provides the following key conclusions and recommendations based on the results from irrigation monitoring for the duration of the program:

Key Conclusions

- *We found no detectable adverse impact from irrigation management on pasture cover or composition. Complete ground cover is being maintained on the irrigated pasture.*
- *There does not appear to be a detrimental effect on ground cover or pasture composition in the irrigated pastures compared with the dryland, reference sites.*
- *Soil salinities in irrigation areas were comparable to respective reference sites on different geologies. However, surface soils have low levels of major nutrients (extractable phosphorus and potassium) that will limit productivity.*

Recommendations

- *The former irrigation areas can be decommissioned without detriment to pastureland use.*
- *A fertilizer management program for pH, major nutrients and trace metals would improve pasture production generally, inside and outside of former irrigation areas*.

As a result of the decommissioning of DCM Irrigation Areas, the irrigation monitoring program (including soil monitoring) is no longer required. Monitoring of DCM revegetated areas will continue as a part of the DCM's rehabilitation monitoring program in accordance with the DCM's Rehabilitation Management Plan.

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1 INTRODUCTION

1.1 DURALIE COAL MINE

The Duralie Coal Mine (DCM) is an existing mine situated approximately 35 kilometres (km) south of Gloucester in the Gloucester Valley, New South Wales (NSW) (Figure 1). Duralie Coal Pty Ltd (DCPL) (a wholly owned subsidiary of Yancoal Australia Limited [YAL]) owns and operates the DCM. The NSW Minister for Urban Affairs and Planning granted Development Consent for the DCM in August 1997 and coal production commenced in 2003.

The Duralie Extension Project involves the extension and continuation of mine operations at the DCM. DCPL was granted approval for the Duralie Extension Project under section 75J of the NSW *Environmental Planning and Assessment Act, 1979* (EP&A Act) on 26 November 2010 (NSW Project Approval [08_0203]) and under sections 130 and 133 of the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC) on 22 December 2010 (Commonwealth Approval [EPBC 2010/5396]). On 10 November 2011, the NSW Project Approval (08_0203) was amended by Order of The Land and Environment Court of NSW. On 1 November 2012, the NSW Project Approval (08_0203) was modified as a result of the Duralie Rail Hours Modification. On 5 December 2014, the NSW Project Approval (08_0203) was modified as a result of the Duralie Open Pit Modification. A copy of the consolidated NSW Project Approval (08_0203) and the Commonwealth Approval (EPBC 2010/5396) is available on the Duralie Coal website (http://www.duralie coal.com.au).

The main activities associated with the Duralie Extension Project (as modified) include:

- continued development of open cut mining operations at the DCM to facilitate a total run-of-mine (ROM) coal production rate of up to approximately 3 million tonnes per annum (Mtpa), including:
  - extension of the existing approved open pit in the Weismantel Seam to the north-west (i.e. Weismantel open pit) within Mining Lease (ML) 1427 and ML 1646; and
  - open cut mining operations in the Clareval Seam (i.e. Clareval open pit) within ML 1427 and ML 1646;
- ongoing exploration activities within existing exploration tenements;
- progressive backfilling of the open pits with waste rock as mining develops, and continued and expanded placement of waste rock in out-of-pit waste rock emplacements;
- increased ROM coal rail transport movements on the North Coast Railway between the DCM and the Stratford Coal Mine (SCM) in line with increased ROM coal production;
- continued disposal of excess water through irrigation (including development of new irrigation areas within the existing ML 1427 and ML 1646);
- construction of Auxiliary Dam No. 2 to relative level (RL) 100 metres (m) to provide 2,900 megalitres (ML) of on-site storage capacity to manage excess water on-site;
- progressive development of dewatering bores, pumps, dams, irrigation infrastructure and other water management equipment and structures;
- development of new haul roads and internal roads;
- upgrade of existing surface facilities and supporting infrastructure as required in line with increased ROM coal production;
- continued development of soil stockpiles, laydown areas and gravel/borrow pits;
- establishment of the permanent Coal Shaft Creek Diversion alignment adjacent to the existing DCM mining area;
- ongoing monitoring and rehabilitation; and
- other associated minor infrastructure, plant, equipment and activities.

The general arrangement of the DCM, showing modifications, is provided in Figure 2.

IRRIGATION MANAGEMENT PLAN

FIGURE 1

Regional Location

DURALIECOAL
Part of the Yancoal Australia Group

GCL-10-13 SWMP IMP 2015_101A

IRRIGATION MANAGEMENT PLAN

FIGURE 2

DCM General Arrangement

DURALIECOAL
Part of the Yancoal Australia Group

1.2 PURPOSE AND SCOPE

This Irrigation Management Plan (IMP) has been prepared by DCPL in accordance with Condition 29(b), Schedule 3 of Project Approval (08_0203).

This revision of the IMP has been prepared by DCPL to:

- consider the outcomes of the 2013 and 2014 Annual Reviews for the DCM (submitted October 2013 and August 2014, respectively);
- consider the recommendations from the Department of Planning & Environment (DP&E) Compliance Audit completed on 6 December 2013; and
- incorporate changes associated with the Duralie Open Pit Modification.

No significant changes have been made to this IMP as a result of the 2013 and 2014 Annual Reviews or DP&E Compliance Audit.

1.3 SUITABLY QUALIFIED AND EXPERIENCED PERSONS

The DP&E, as delegate for the Director-General, approved the appointment of Mr Lindsay Gilbert (Gilbert & Associates Pty Limited) and Dr Noel Merrick (Heritage Computing) as suitably qualified and experienced persons for the preparation of the WAMP on 18 February 2011.

The IMP was previously prepared/reviewed by Mr Lindsay Gilbert.

1.4 STRUCTURE OF THIS IMP

The remainder of this IMP is structured as follows:

Section 2: Outlines the statutory requirements applicable to the IMP.

Section 3: Provides a summary and reference to detailed baseline data.

Section 4: Provides an overview of the Irrigation System.

Section 5: Outlines the sediment and erosion control provisions within irrigation and associated areas.

Section 6: Summarises the Monitoring Program for assessing the Irrigation System.

Section 7: Outlines the procedures for reviewing and improving the environmental performance of the Irrigation System.

Section 8: Outlines the reporting procedures.

Section 9: Lists the references cited.

2 STATUTORY REQUIREMENTS

DCPL's statutory obligations are contained in:

(i) the conditions of the NSW Project Approval (08_0203);

(ii) the conditions of the Commonwealth Approval (2010/5396);

(iii) relevant licences and permits, including conditions attached to mining leases; and

(iv) other relevant legislation.

These are described below.

2.1 EP&A ACT APPROVAL

Irrigation Management

This IMP has been prepared in accordance with Condition 29 (b), Schedule 3 of the NSW Project Approval (08_0203). Table 1 indicates where each relevant irrigation component of Condition 29 (b) is addressed within this IMP.

Table 1
Irrigation System Requirements

NSW Project Approval (08_0203) Condition	IMP Section
Condition 29, Schedule 3	
29. The Proponent shall prepare and implement a Water Management Plan for the project to the satisfaction of the Secretary. This plan must be prepared in consultation with EPA and NOW by suitably qualified and experienced persons whose appointment has been approved by the Secretary, and submitted to the Secretary within 3 months of the date of this approval. In addition to the standard requirements for management plans (see Condition 2 of Schedule 5), this plan must include: … b) a Surface Water Management Plan, that includes: … • An irrigation management plan for the irrigation system under the water management system, which includes:	
• salinity trigger levels for controlling discharges from the irrigation areas to Coal Shaft Creek and the unnamed tributary, representing the 80th percentile value of the relevant data set for the creek/unnamed tributary and Mammy Johnsons River in accordance with the methodology in ANZECC/ARMCANZ (2000), Australian Water Quality Guidelines for Fresh and Marine Water Quality, National Water Quality Strategy[1]; and	Section 4.4
• provision of an automated first flush system for the additional irrigation areas (Northern Areas) shown in the figure in Appendix 4;	Section 4

[1] Condition added by Consequential Order by The Land and Environment Court of NSW dated 10 February 2012.

In accordance with Condition 29, Schedule 3 of the NSW Project Approval (08_0203, this IMP is included as part of the WAMP for the DCM (i.e. Attachment A in Appendix 2 of the WAMP).

Management Plan Requirements

Condition 2, Schedule 5 of the NSW Project Approval (08_0203) outlines the requirements that are applicable to the preparation of the management plans. Table 2 indicates where each relevant component is addressed within this IMP.

Table 2
Management Plan Requirements

NSW Project Approval (08_0203) Condition	IMP Section
Condition 2, Schedule 5	
2. The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include:	
a) detailed baseline data;	Section 3
b) a description of:	
• the relevant statutory requirements (including any relevant approval, licence or lease conditions);	Section 2
• any relevant limits or performance measures/criteria;	Refer to SWMP
• 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;	Refer to SWMP
c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;	Section 4
d) a program to monitor and report on the:	Refer to SWMP
• impacts and environmental performance of the project;	
• effectiveness of any management measures (see c above);	
e) a contingency plan to manage any unpredicted impacts and their consequences;	Refer to SWMP
f) a program to investigate and implement ways to improve the environmental performance of the project over time;	Refer to SWMP
g) a protocol for managing and reporting any;	
• incidents;	Refer to SWMP
• complaints;	Refer to SWMP
• non-compliances with statutory requirements; and	Refer to SWMP
• exceedences of the impact assessment criteria and/or performance criteria; and	Refer to SWMP
h) a protocol for periodic review of the plan.	Section 8

2.2 EPBC ACT APPROVAL

Condition 11 of the Commonwealth Approval (2010/5396) requires:

Mitigation Measures

11. In order to minimise the impacts of the project on listed threatened species, the person taking the action must implement all measures in the following plans/documents or their subsequent revisions as approved by the Minister:

(a) The DCM Vegetation Clearance Protocol (DCPL, 2002);

(b) The DCM Irrigation Management Plan (DCPL, 2008);

(c) The DCM Site Water Management Plan (DCPL, 2008); and

(d) The DCM Rehabilitation Management Plan (DCPL, 2007).

In accordance with Condition 11 of the Commonwealth Approval (2010/5396), the WAMP (including this IMP) will be submitted for approval by the Commonwealth Minister for the Environment (or delegate).

2.3 LICENCES, PERMITS AND LEASES

In addition to the NSW Project Approval (08_0203), and Commonwealth Approval (2010/5396), all activities at DCM will be conducted in accordance with a number of licences, permits and leases which have been issued or are pending issue.

A summary of the key licences, permits and leases pertaining to the DCM is provided in Section 2.3 of the WAMP.

2.4 OTHER LEGISLATION

DCPL will operate the DCM consistent with the NSW Project Approval (08_0203), the Commonwealth Approval (2010/5396) and any other legislation that is applicable to an approved Part 3A Project under the EP&A Act.

A summary of other NSW legislation that may be applicable to the conduct of the DCM is provided in Section 2.4 of the WAMP.

3 BASELINE DATA

A summary of relevant meteorological information and irrigation monitoring results in the DCM area is provided in the *Duralie Extension Project Appendix A Surface Water Assessment* and the *Duralie Open Pit Modification Surface Water Assessment* (Gilbert & Associates Pty Limited, 2010 and 2014), available at http://duraliecoal.com.au/environment/environmental-assessment-documents.php.

4 IRRIGATION SYSTEM

Irrigation of mine water is conducted at the DCM as part of the water management system. The focus of the mine water management system is on:

- minimisation of mine water generation by the interception and diversion of runoff from undisturbed and rehabilitated landforms around mining activities; and
- collection, treatment (where necessary) containment and irrigation of excess mine water over defined areas within the Project mining leases.

Details of the mine water management system are given in the Surface Water Management Plan (SWMP) (refer Appendix 2 of WAMP). The main components of the system are:

- Dams within the mine, waste emplacement and infrastructure areas to capture runoff from areas disturbed by mining and related activities.
- Clean water diversion system, designed to divert runoff from areas undisturbed by mining around the Project. This includes Coal Shaft Creek and its tributaries.
- Pit dewatering system, which allows transfer of water from a pit sump to a suitable retention dam to allow mining to proceed. In-pit treatment of pit water may be required periodically, depending on its quality.
- Main Water Dam (MWD) and associated Auxiliary Dams to which all mine water collected in dams and the pit is pumped. Waters that accumulate within the MWD will be primarily used for dust suppression, with excess mine water disposed of via the Project irrigation system.

The following subsections provide a description of the irrigation system, including mitigation measures to minimise downstream impacts (i.e. first flush protocol) and management measures for irrigation areas including erosion and weed control and pasture preparation.

4.1 SUITABILITY OF MINE WATER FOR IRRIGATION

Mine water comprises runoff from the open pit, coal handling and fuel storage areas, seepage from non-rehabilitated waste rock emplacement areas, groundwater inflows to the open pit and rainfall runoff from the MWD catchment. An assessment of the suitability of mine water for irrigation was undertaken for the Duralie Open Pit Modification by Horizon Soil Survey & Evaluation (2014).

Horizon Soil Survey & Evaluation (2014) concluded that irrigation at the DCM is sustainable and the predicted irrigation water salinities for the Duralie Open Pit Modification would not cause soil structural degradation or inhibit plant growth in irrigation areas.

4.2 OPERATION OF IRRIGATION SCHEME

The irrigation system is operated such that soil moisture levels are maintained below field capacity such that saturation will only occur during rainfall. Under such conditions evapotranspiration and plant growth will be maximised and surface runoff, due to irrigation, will be avoided.

Irrigation water is applied to maintain a 10 millimetre (mm) soil moisture deficit before, during and immediately following irrigation application. Soil moisture deficit is measured using soil moisture sensors.

Irrigation is also subject to the following restrictions:

- irrigation is only to be conducted in areas that avoid significant drainage lines; and
- irrigation is to be conducted in areas that provide a set back from clean water diversion systems sufficient to allow interception of “first flush” waters (Section 4.4).

The continued effective performance of the irrigation system is influenced by the quality of contained water used for irrigation. The quality of irrigation water is expected to vary as a result of the natural variability of rainfall and other water balance variables (e.g. quality of open pit inflows).

Current irrigation water quality is not a risk to soils and plant growth in the irrigation areas at the DCM and predicted irrigation water salinities in Gilbert & Associates (2014) are not expected to cause soil structural degradation or inhibit plant growth in irrigation areas (Horizon Soil Survey & Evaluation, 2014).

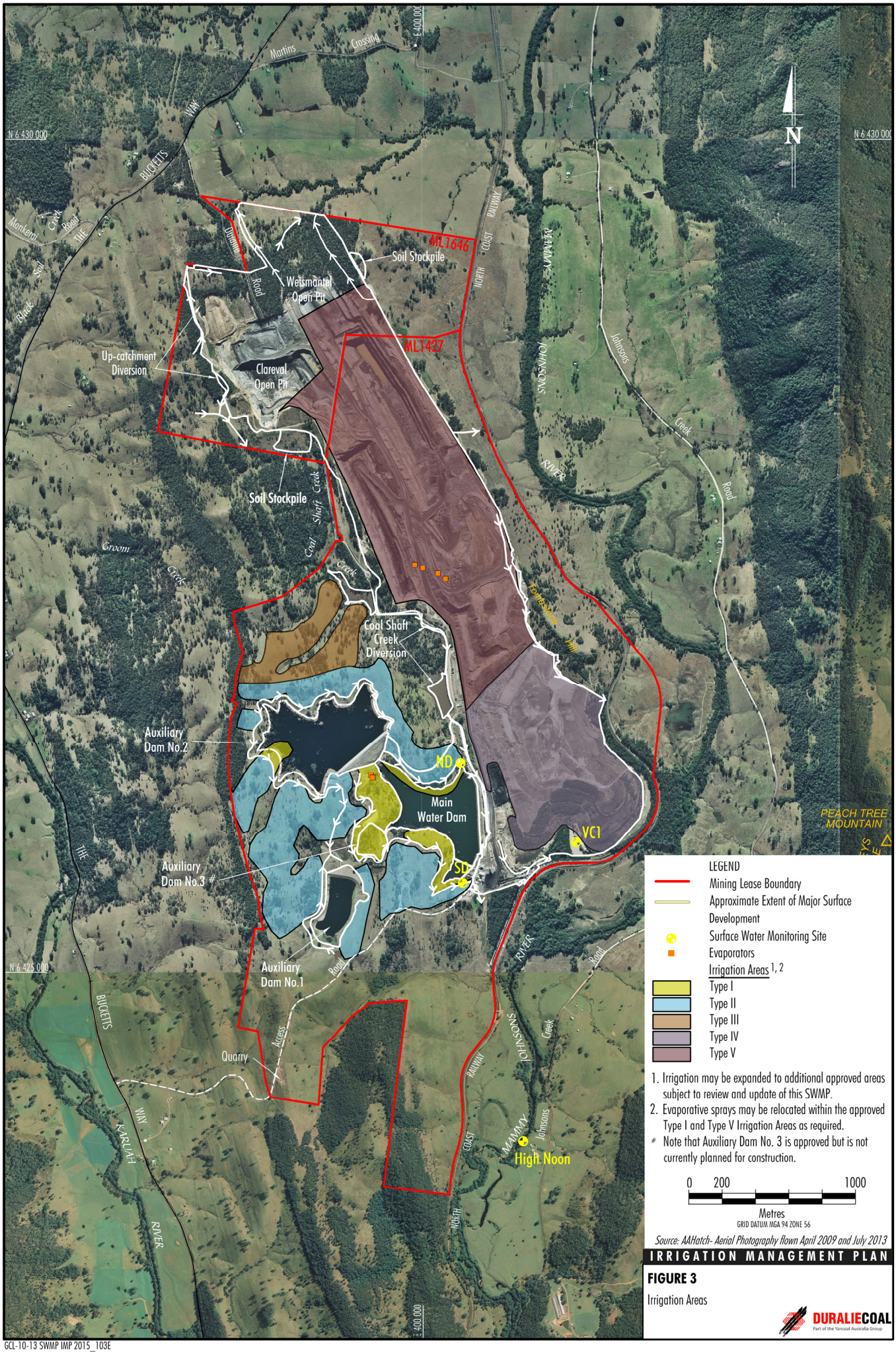
Irrigation is operated and monitored to maintain matching of available water to vegetation needs for evapotranspiration, control of salt build up and avoiding direct runoff of irrigation water.

In addition to the conventional irrigation methods, evaporative sprays (Figure 3) are used at the DCM on areas of inactive waste rock emplacement which drain back to the open pit and areas in the mine water storage footprints. Evaporative sprays are located to maximise separation from clean water areas and are positioned within earthen bunds. The operation of evaporative sprays at the DCM considers the ambient meteorological conditions including humidity, wind speed and direction and inversion strength. The operation of the evaporative sprays aims to maximise the evaporative efficiency and minimise the potential impacts of spray drift. Evaporative sprays are only operated in areas which drain directly to mine water areas and therefore no first flush system is required.

4.3 IRRIGATION AREAS

In accordance with Condition 28, Schedule 3 of the NSW Project Approval (08_0203), DCPL will only conduct irrigation within the areas shown in the Duralie Open Pit Modification Environmental Assessment (EA) (DCPL, 2014) over the life of the DCM and in accordance with the irrigation system, including this IMP, in the SWMP.

This IMP includes management and monitoring measures for the irrigation areas shown on Figure 3, which are a subset of those areas shown in the Duralie Open Pit Modification EA (DCPL, 2014). No irrigation activities in the Unnamed Tributary catchment are proposed for the period of this IMP. No irrigation activities have commenced in the additional irrigation areas described in the Duralie Extension Project EA or Duralie Open Pit Modification.



LEGEND

- Mining Lease Boundary
- Approximate Extent of Major Surface Development
- Surface Water Monitoring Site
- Evaporators
- Irrigation Areas [1, 2]
  - Type I
  - Type II
  - Type III
  - Type IV
  - Type V

1. Irrigation may be expanded to additional approved areas subject to review and update of this SWMP.
2. Evaporative sprays may be relocated within the approved Type I and Type V Irrigation Areas as required.

\# Note that Auxiliary Dam No. 3 is approved but is not currently planned for construction.

0 200 1000

Metres

GRID DATUM MGA 94 ZONE 56

Source: AAHatch- Aerial Photography flown April 2009 and July 2013

IRRIGATION MANAGEMENT PLAN

FIGURE 3

Irrigation Areas

DURALIECOAL

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GCL-10-13 SWMP IMP 2015_103E

Irrigation within additional irrigation areas will require the review and update of this IMP in consultation with the relevant government agencies and stakeholders.

This IMP includes management and monitoring measures for five types irrigation areas delineated based on location, including:

- *Type I* – Irrigation areas between the MWD diversions and the water storage inundation area of the MWD.
- *Type II* – Irrigation areas located upslope of the MWD diversions within ML 1427.
- *Type III* – Irrigation areas located upslope of the northern extent of the open pits, including the upper reaches of Coal Shaft Creek. Type III irrigation areas have not been established to date.
- *Type IV* – Irrigation areas located on partially rehabilitated and rehabilitated areas of the waste rock emplacement.
- *Type V* – Irrigation areas located on inactive (but not yet topsoiled or rehabilitated) areas of the waste rock emplacement.

A mixture of pasture, woodland and cropping occurs within the irrigation areas (with the exception of Type V irrigation areas).

4.4 DEVELOPMENT OF NEW IRRIGATION AREAS

As discussed above, prior to commencing irrigation outside the irrigation areas shown on Figure 3 this IMP will be reviewed and updated in consultation with the relevant government agencies and stakeholders.

Prior to amendments of the NSW Project Approval (08_0203) by Order of The Land and Environment Court of NSW dated 10 November 2011, irrigation of new areas in the Northern Areas within the mine expansion which do not drain to Coal Shaft Creek were proposed. As a consequence of the Order, automated first flush systems for return of first flush water from these areas will be required.

First flush protocols for these areas would be developed for EC based on procedures in ANZECC/ARMCANZ (2000). Specifically the 80th percentile EC values would be calculated from the composite pre-irrigation data set from sampling site SW9[1]. Release of first flush from irrigation in any Northern Areas within the Unnamed Tributary catchment would only be permitted when the EC of the water draining off the irrigation areas was less than the 80% trigger EC and if the EC as measured in Mammy Johnsons River at High Noon was less than 400 µS/cm.

In the event that the results of the Giant Barred Frog monitoring (as described in the Giant Barred Frog Management Plan) identify a decline of 20% or more (in comparison with the highest average results obtained from the September to April 2010-2011 surveys and then subsequently in combination with the 2011-2012 surveys) in the Giant Barred Frog population, the first flush protocol for the new irrigation areas would be modified.

[1] With data up until the end of 2011, the 80th percentile EC at SW9 was 461 µS/cm (based on 17 sample occasions). The data set will continue to be added to progressively prior to irrigation to develop the trigger. Prior to irrigation within the catchment of the Unnamed Tributary, the trigger will be included in an update of this IMP.

Prior to commencing irrigation in a new area, an assessment of the area will be undertaken by an experienced irrigation and soil expert. The assessment will include consideration of soils, vegetation and topography and other natural features which may influence irrigation outcomes. Results of the assessment will be used to set parameters for the irrigation system design in each area including the delineation of buffer areas and drainage controls. The assessment will identify the need for any soil amelioration or vegetation management measures that will need to be incorporated into the design and preparation works. The assessment will also provide the basis for first flush capture system design and the design of other drainage control works if required in new areas. These works would be completed prior to commencement of irrigation in new areas.

4.5 IRRIGATION SYSTEMS

The current irrigation system in the Type I, Type II and III areas comprises a series of banks with 8-10 fixed sprinkler heads which operate on a 14 minute run time. Irrigation on the Type IV areas is also undertaken with fixed spray operating from banks of 4 fixed sprays that operate for a 15 minute run time. Irrigation on the Type V areas is undertaken using evaporative sprays. Travelling irrigators are also used in the irrigation areas, however their use has been progressively been phased out by fixed spray and evaporative irrigation.

Water applications from fixed and travelling irrigators are managed according to soil moisture deficit which is measured using soil moisture sensors which comprise a combination of:

- manual readings of gypsum block soil moisture sensors (MEA[2] Gbugs) located within the irrigation areas at different depths; and/or
- automatic readings of an EnviroPro® probe with sensors every 10 centimetres (cm)[3].

Irrigation rates are controlled by telemetry using continuous soil moisture readings linked to automated control valves, to maintain a minimum 10 mm soil moisture deficit immediately following irrigation application. An automated system is used in Type I, II and III areas to cycle through the banks of fixed sprays. Individual applications are equivalent to about 2 mm.

The current irrigation system in the Type V area comprises 4 evaporative sprays and two evaporative sprays are also located in the Type I area. Irrigation with the Type V area may be expanded as required as this area drains the open pit. No soil moisture monitoring is conducted in Type V irrigation areas as only evaporative sprays are used in these irrigation areas.

4.6 FIRST FLUSH PROTOCOL

The first flush protocol is designed to collect initial (or “first flush”) rainfall runoff from Type II, Type III and Type IV irrigation areas. The first flush protocol described below is consistent with the protocol described in DCPL (2014) and Condition 4 of the Commonwealth Approval (2010/5396).

[2] Measurement Engineering Australia Pty Ltd.
[3] Note that EnviroPro® probes also measures temperature and salinity.

In accordance with Condition 5 of the Commonwealth Approval (2010/5396):

> *In the event that the results of Giant Barred Frog monitoring required under Condition 8 identify a decline of 20% or more (in comparison with the highest average results obtained from September to April 2010-11 surveys and then subsequently in combination with 2011-2012 surveys) in the Giant Barred Frog population, the proponent may only release water into the MJR catchment when Electrical Conductivity levels are less than 400 µS/cm in Mammy Johnsons River (as measured at the High Noon site) and less than 810 µS/cm in Coal Shaft Creek (as measured at Coal Shaft Creek monitoring site SW2 [RC]), until otherwise advised by the Department.*
>
> *Note: For clarity regarding Condition 5, the mine water to be released during this time must not exceed 810 µS/cm, as measured at monitoring site point SW2 (RC).*

4.6.1 Type I and Type V Irrigation Areas

Type I irrigation areas are within the MWD catchment area and Type V irrigation areas drain to the open pit workings, and therefore no first flush protocol is required for these areas.

4.6.2 Type II Irrigation Areas

Sensors measuring EC have been installed in the MWD diversion southern and northern drains (Figure 3) to monitor runoff from the Type II irrigation areas. The first flush system for the Type II irrigation areas generally operates as follows:

- When EC readings in the MWD diversion drain sumps are equal to or greater than 1,326 µS/cm, or if the EC reading at High Noon in the Mammy Johnsons River (approximately 1.3 km south of the confluence with Coal Shaft Creek) is equal to or greater than 400 µS/cm, motorised butterfly valves in pipelines at the downstream end of the MWD diversion northern and southern drains are left in their default, open position directing runoff from the irrigation areas to the MWD.
- When the EC readings in the MWD diversion drain sumps are below 1,326 µS/cm and the EC reading in the Mammy Johnsons River (at High Noon) is below 400 µS/cm, the valves close, allowing the runoff in the MWD diversion to report to the Coal Shaft Creek Diversion and Mammy Johnsons River downstream of the DCM.

4.6.3 Type III Irrigation Areas

Irrigation areas upslope of the northern extent of the open pits have ceased due to pit advancement. The irrigation area in the Coal Shaft creek catchment upslope of CSC Dam 3 is proposed for future irrigation. The first flush system would be established as described below:

- When water accumulates in the Temporary Diversion Dam to levels above minimum operating level a valve in the base of the diversion dam is opened.
- If the EC reading in the Temporary Diversion Dam is equal to or greater than 1,326 µS/cm or if the EC reading in the Mammy Johnsons River at High Noon is at or above 400 µS/cm the water is pumped to the MWD.

If the EC reading in the Temporary Diversion Dam is below 1,326 µS/cm and the EC reading in the Mammy Johnsons River at High Noon is below 400 µS/cm the water is released to the Coal Shaft Creek diversion.

4.6.4 Type IV Irrigation Areas

As the waste rock emplacement areas expand and are rehabilitated, irrigation occurs on these areas (Type IV irrigation areas). Runoff from these areas is collected in the collection dam in the south-west corner of the waste rock emplacement (VC1) which overflows to Coal Shaft Creek.

Where the measured EC in the collection dam is equal to or greater than 1,326 µS/cm, or if the EC reading in the Mammy Johnsons River at High Noon is equal to or greater than 400 µS/cm, the accumulated water in the collection dam will be pumped out to the MWD. Where the EC reading in the VC1 is below 1,326 µS/cm and the EC reading in the Mammy Johnsons River at High Noon is below 400 µS/cm the water is released to the Coal Shaft Creek diversion.

5 EROSION CONTROL AND CONTOUR BANK/DRAIN CONSTRUCTION

Prior to new irrigation areas (with the exception of Type V areas) being developed, the areas will be inspected and logged for the presence of apparent active areas of erosion within the areas to be irrigated. Any such areas will be ameliorated by:

- trimming back the sides of steep erosion scours;
- infilling with soil borrowed from a suitable mine source (e.g. topsoil stockpile) matching, as closely as possible, the soils of the area;
- contour ripping the infilled area;
- diverting upslope runoff using contour banks/drains;
- seeding with pasture species and fertilising;
- provision of lime for acidic soils (where required);
- construction of silt fences downslope of infilled areas;
- exclusion of stock during pasture establishment period (fencing); and
- monitoring to check on-going stability.

Effective irrigation has the potential to enhance vegetative cover and reduce erosion rates, particularly following prolonged dry weather. On the other hand, erosion in irrigation areas has the potential to be exacerbated by irrigation due to soil moisture increases leading to increased runoff. This is managed by avoiding steep areas and drainage lines. The possible effect of irrigation on increased erosion is monitored in downstream gully lines (Section 8.3 of the SWMP). In the event that erosion is exacerbated by irrigation the contingency response would include review of intensity and rates of irrigation application, construction of contour banks and drains and planting trees to enhance soil stability and erosion resistance.

Any earthworks associated with irrigation area preparation (e.g. contour banks) would be conducted in accordance with the erosion and sediment control strategies outlined in Section 7.1 of the SWMP.

5.1 WEED CONTROL

Six weed species listed as noxious under the NSW *Noxious Weeds Act, 1993* in the Great Lakes local government area (Great Lakes Council, 2008) have been recorded at the DCM, *viz*. Noogoora Burr, Bittou Bush, Blackberry, Crofton Weed, Giant Parramatta Grass and Lantana.

The proposed vegetation disturbance and irrigation associated with the DCM have the potential to act as catalysts for weed incursion and, if management measures are not in place, proliferation of weeds could occur (DCPL, 2014).

To prevent the spread of weeds, DCPL will undertake the following management measures:

- irrigation areas will be managed such that a vegetation cover is maintained as much as possible to suppress the establishment of weeds;
- identification of weeds via regular site inspections and communication with landholders and regulatory authorities;

- mechanical removal of identified weeds and/or the application of approved herbicides in authorised areas;
- follow-up site inspections to determine the effectiveness of eradication programs; and
- minimisation of seed transport from the site through the use of the site's vehicle wash bay.

5.2 PREPARATION OF PASTURES

Existing areas of thriving pasture within the irrigation areas will continue to be protected from disturbance wherever practicable. The major native grass species present within the DCM area are Blady Grass (*Imperata cylindrica* var. *major*), Kangaroo grass (*Themeda australis*), *Aristida* species, Common couch (*Cynodon dactylon*), Tufted hedgehog grass (*Echinopogon caespitosus* var. *caespitosus*) and Wiry Panic (*Entolasia stricta*). The vigour and coverage of pasture in irrigated areas will continue to be monitored.

Irrigation areas that contain existing pasture in a poor condition will be improved by establishment species drawn from the list below (note that species used is subject to seasonal seed availability, market prices, etc.):

- Phalaris;
- Browntop Bent Grass;
- Wallaby Grass;
- Red-anthered Wallaby Grass;
- Lucerne;
- Rhodes Grass;
- Cocksfoot;
- White Clover;
- Red Grass;
- Subterranean Clover;
- Ryegrass;
- Kikuyu;
- Paspalum;
- Wheat Grass;
- Kangaroo Grass;
- Strawberry Clover;
- Weeping Grass; and
- Couch.

The management of pastures will consider the retention of a minimum of 70% ground cover in order to protect the soil surface from erosion (as recommended for highly erodible soils in Hunter-Central Rivers Catchment Management Authority [2007]).

Areas of native pasture form a valuable component of the available pasture used for stock production and may be grazed (in a sustainable manner).

The establishment of improved pasture is an important component of the progressive rehabilitation programme at the DCM. It is proposed to rehabilitate waste rock emplacement (Type IV irrigation areas) to a combination of woodland and pasture. The selection of pasture species and varieties, fertilisers/ameliorants and application rates, and stocking rates will be influenced by experience at the DCM and the nearby SCM. Further details are provided in the Rehabilitation Management Plan required under Condition 57, Schedule 3 of the NSW Project Approval (08_0203).

6 MONITORING PROGRAM

DCPL's Environmental Officer is responsible for irrigation monitoring and implementation of further measures (Section 5) if the monitoring programme indicates some remedial action or further investigation is required. Details of the monitoring undertaken in support of the IMP are included in Section 8.3 of the SWMP and are reproduced in Table 3.

Table 3
Irrigation Monitoring Program

Monitoring Component	Parameter	Frequency
Irrigation Water Volume Monitoring	Application rates.	During irrigation application.
	Application times.	During irrigation application.
	Application durations.	During irrigation application.
	Application areas.	During irrigation application.
Soil Moisture Monitoring	Soil moisture deficit.	Before and after irrigation and application.
Soil Characteristics Monitoring	Soil salinity, permeability and cumulative contaminant loading.	Annually.
Irrigation Area Visual Monitoring	Signs of runoff, waterlogging and/or active erosion in gullies downstream of irrigation areas.	After each irrigation application.
	Signs of active erosion in contour banks and drains.	Monthly in new irrigation areas and every six months.
	Photographic recording of plant vigour and signs of general disturbance of groundcover species and erosion at fixed photo points.	Every six months.
Vegetation Monitoring	Pasture condition in terms of biomass, species composition and ground cover.	Annually.
	Grazing levels (where relevant).	
	Harvesting (where relevant).	
	Rotation of irrigation areas.	
Water Quality Monitoring	Refer Tables 12 and 14 of SWMP.	Refer Tables 12 and 14 of SWMP.

As described in Table 3, soil characteristic monitoring will be conducted annually with analysis of samples in accordance with Section 4.2.6 of ANZECC & ARMCANZ (2000). Soil characteristic monitoring will incorporate:

- Fixed sampling sites, where practicable, to provide consistent locations for taking soil samples over time. Each site will cover approximately 100 square metres, and each set of samples will be taken from different positions across the sampling site.
- Five samples at each sampling site to allow for the effect of local variation. The samples will be bulked to provide one sample for analysis (from each sampling site).
- Samples taken from a constant depth, of approximately 0 – 30 cm, where practicable. All plant material, including roots, will be removed from the samples.
- Sampling of reference sites (minimum of two) which are chemically similar to the irrigation areas.

The independent environmental audit (Trevor Brown & Associates, 2011) concluded that the monitoring program (including irrigation) was '*considered adequate to provide data for assessment of the Duralie operations in relation to the MCoA* [Minister's Conditions of Approval] *and EPL requirements and to assess consistency with the predictions in the EIS, Environmental Assessments and Statements of Environmental Effects.*'

7 REVIEW AND IMPROVEMENT OF ENVIRONMENTAL PERFORMANCE

7.1 ANNUAL REVIEW

In accordance with Condition 3, Schedule 5 of the NSW Project Approval (08_0203), DCPL conducted an Annual Review of the environmental performance of the DCM prior to the end of December 2011, and will annually thereafter. These will be made publicly available from the Duralie Coal website, in accordance with Condition 10, Schedule 5 of the NSW Project Approval (08_0203).

The Annual Review will specifically address the following aspects of Condition 3, Schedule 5 that are directly relevant to water management:

- include a comprehensive review of the monitoring results and complaints records for the DCM over the past year, including a comparison of these results against the:
  - relevant statutory requirements, limits or performance measures/criteria;
  - monitoring results of previous years; and
  - relevant predictions in the Duralie Extension Project EA;
- identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;
- identify any trends in the monitoring data over the life of the DCM;
- identify any discrepancies between the predicted and actual impacts of the DCM, and analyse the potential cause of any significant discrepancies; and
- describe what measures will be implemented over the next year to improve the environmental performance of the DCM.

This IMP will be reviewed within three months of the submission of an Annual Review, and revised where appropriate, as described in Section 7.2 below.

7.2 IMP REVIEW

This IMP has been prepared in accordance with NSW Project Approval (08_0203). The revision status of this IMP is indicated on the title page of each copy.

In accordance with Condition 4, Schedule 5 of the NSW Project Approval (08_0203), this IMP will be reviewed and if necessary revised to the satisfaction of the Secretary of the Department of Planning and Infrastructure, within three months of the submission of:

- an Annual Review, in accordance with Condition 3, Schedule 5;
- an Incident Report, in accordance with Condition 6, Schedule 5;
- an audit, in accordance with Condition 9, Schedule 5;
- any modification to the conditions of consent; or
- prior to the commencement of clearing in accordance with the *Duralie Open Pit Modification Environmental Assessment* (DCPL, 2014).

This IMP will be made publicly available on the Duralie Coal website in accordance with the NSW Project Approval (08_0203). A hard copy of the IMP will also be kept at the DCM.

As described in Section 4.3, a review of the IMP will be undertaken prior to commencing irrigation in new irrigation areas (i.e. within the Unnamed Tributary catchment) in consultation with the relevant government agencies and stakeholders.

8 REPORTING SYSTEMS

In accordance with Condition 2 (g), Schedule 5 of the NSW Project Approval (08_0203), DCPL has developed protocols for managing and reporting the following:

- incidents;
- complaints; and
- non-compliances with statutory requirements.

The management of incidents is described in the Pollution Incident Response Management Plan. The management of complaints and non-compliances is described in detail in the Environmental Management Strategy (available at http://duraliecoal.com.au/environment/environmental-assessment-documents.php).

9 REFERENCES

Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (2000) *Australian Water Quality Guidelines for Fresh and Marine Water Quality, National Water Quality Management Strategy*.

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ATTACHMENT B

DEVELOPMENT OF WATER QUALITY TRIGGER LEVELS FOR THE DURALIE EXTENSION PROJECT

Gilbert & Associates Pty Ltd

Development of Water Quality Trigger Levels for the Duralie Extension Project

1.0 Introduction

A Water Management Plan is required as part of the approval conditions for the Duralie Extension Project (NSW Project Approval [08_0203 (herein referred as the Project Approval). Specifically:

Water Management Plan

29. *The Proponent shall prepare and implement a Water Management Plan for the project to the satisfaction of the Director-General. This plan must be prepared in consultation with OEH and NOW by suitably qualified and experienced persons whose appointment has been approved by the Director-General, and submitted to the Director-General within 3 months of the date of this approval.*

In addition to the standard requirements for management plans (see Condition 2 of Schedule 5), this plan must include:

…

(b) a Surface Water Management Plan, that includes:

…

- *performance criteria, including trigger levels for investigating any potentially adverse impacts for the following:*

…

  - *surface water quality of the Unnamed Tributary, Coal Shaft Creek and Mammy Johnsons River;*

…

- *performance criteria for surface water quality attributes relevant to water quality impacts on biological diversity and aquatic ecological integrity, including salinity, heavy metals, sediment load, pH, hardness and biological oxygen demand;*
- *trigger levels representing the 80th percentile value of the relevant reference data set in accordance with the methodology in ANZECC/ARMCANZ (2000). Australian Water Quality Guidelines for Fresh and Marine Water Quality Management Strategy to determine the levels for investigating any potentially adverse impacts;*

…

This paper deals with development of trigger levels for the purposes of consultation and inclusion in the Surface Water Management Plan, as part of the Duralie Coal Mine Water Management Plan, and provides a rationale for the:

PO Box 2143, Toowong, QLD 4066
Ph: 07 3367 2388 Fax: 3367 2833
E-mail: gaconslt@bigpond.net.au
ABN: 62 085 419 852

- performance criteria including trigger levels for investigating potentially adverse surface water quality impacts (Section 2);
- performance criteria for surface water quality attributes (Section 2.2); and
- 80th percentile trigger levels (Section 2.2).

2.0 Performance Criteria and Associated Trigger Levels

The term 'performance criteria' has not been defined in the Project Approval and is not used in ANZECC/ARMCANZ (2000) (the guidelines). However it appears to be synonymous with the term 'water quality objective' used in the guidelines which is defined as "a numerical concentration limit or narrative statement that has been established to support and protect the designated uses of water at a specified site. It is based on scientific criteria or water quality guidelines but may be modified by other inputs such as social or political constraints"[1].

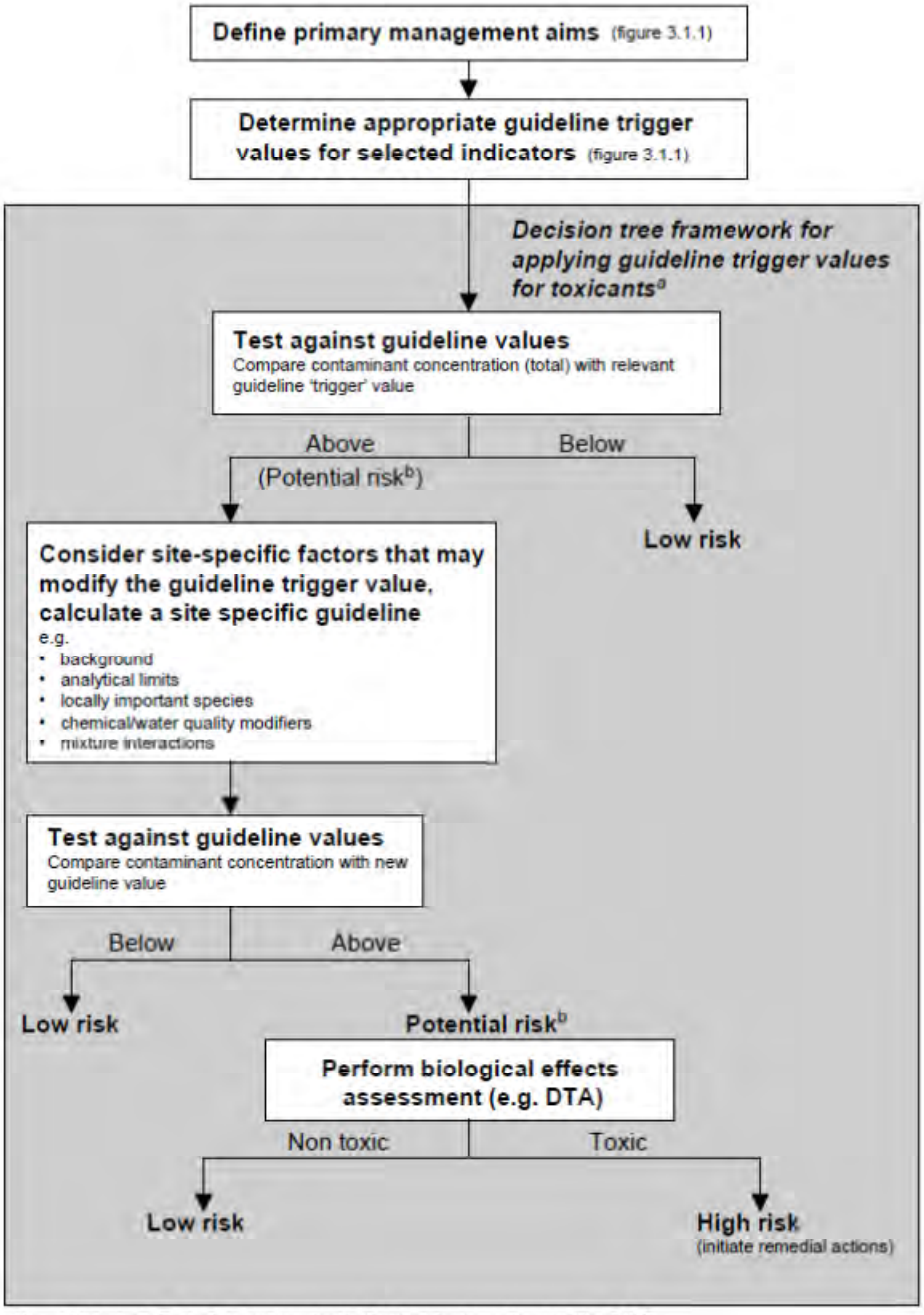
The performance criteria (water quality objectives) adopted for Mammy Johnsons River (MJR), Coal Shaft Creek (CSC) and the Unnamed Tributary (UT), are based on maintenance of existing environmental values. The existing environmental values of MJR, Coal Shaft Creek and the UT have been taken to be:

- aquatic ecosystems;
- primary industries - irrigation and general water uses, stock drinking water; and
- recreation and aesthetic.

Gloucester Coal's water management objective of preserving these environmental values would be met if there is a no more than negligible impact on water quality as a result of the Duralie Extension Project. In line with the guidelines for protection of aquatic ecosystem low risk triggers are used, if exceeded, to trigger further investigations. Trigger levels are defined in the guidelines as "concentrations (or loads) of the key performance indicators measured for the ecosystem, below which there exists a low risk that adverse biological (ecological) effects will occur. They indicate a risk of adverse impact if exceeded and should 'trigger' some action, either further ecosystem specific investigations or implementation of management/remedial actions"[2]. An example of the application of triggers in the assessment of toxicants in ambient waters is given in Figure 3.4.1 of the guidelines – refer below.

[1] ANZECC/ARMCANZ (2000) "Australian and New Zealand Guidelines for Fresh and Marine Water Quality", Appendix 1, October 2000. Note that the definition given in ANZECC/ARMCANZ (2000) for 'water quality guideline' and 'water quality objective' are, in most respects, the same.
[2] ANZECC/ARMCANZ (2000) "Australian and New Zealand Guidelines for Fresh and Marine Water Quality"

PO Box 2143, Toowong, QLD 4066
Ph: 07 3367 2388 Fax: 3367 2833
E-mail: gaconslt@bigpond.net.au
ABN: 62 085 419 852



[a] *Local biological effects data not required in the decision trees (see section 3.1.5)*
[b] *Further investigations are not mandatory; users may opt to proceed to management/remedial action.*

Figure 3.4.1 Simplified decision tree for assessing toxicants in ambient waters

PO Box 2143, Toowong, QLD 4066
Ph: 07 3367 2388 Fax: 3367 2833
E-mail: gaconslt@bigpond.net.au
ABN: 62 085 419 852

Development and quantification of trigger levels for the Duralie Extension Project has involved:

- identifying a suite of surface water quality indicators relevant to identifying impacts on biological diversity and aquatic ecological integrity; salinity, heavy metals, sediment load, pH, hardness and biological oxygen demand (BOD) have been included in this suite as required under the Project Approval Condition 29(b)s;
- identifying what is the relevant data set from which triggers should be determined; and
- developing trigger levels for the water quality indicators that would trigger an investigation of any potentially adverse impact based on the methodology in the guidelines. Where possible trigger levels represent the 80th percentile value[3] of the relevant data set has been used. Where this has not been possible, due to data limitations, interim default triggers values taken from the guidelines have been used.

2.1 Identification of the Relevant Monitoring Sites and Reference Data Sets

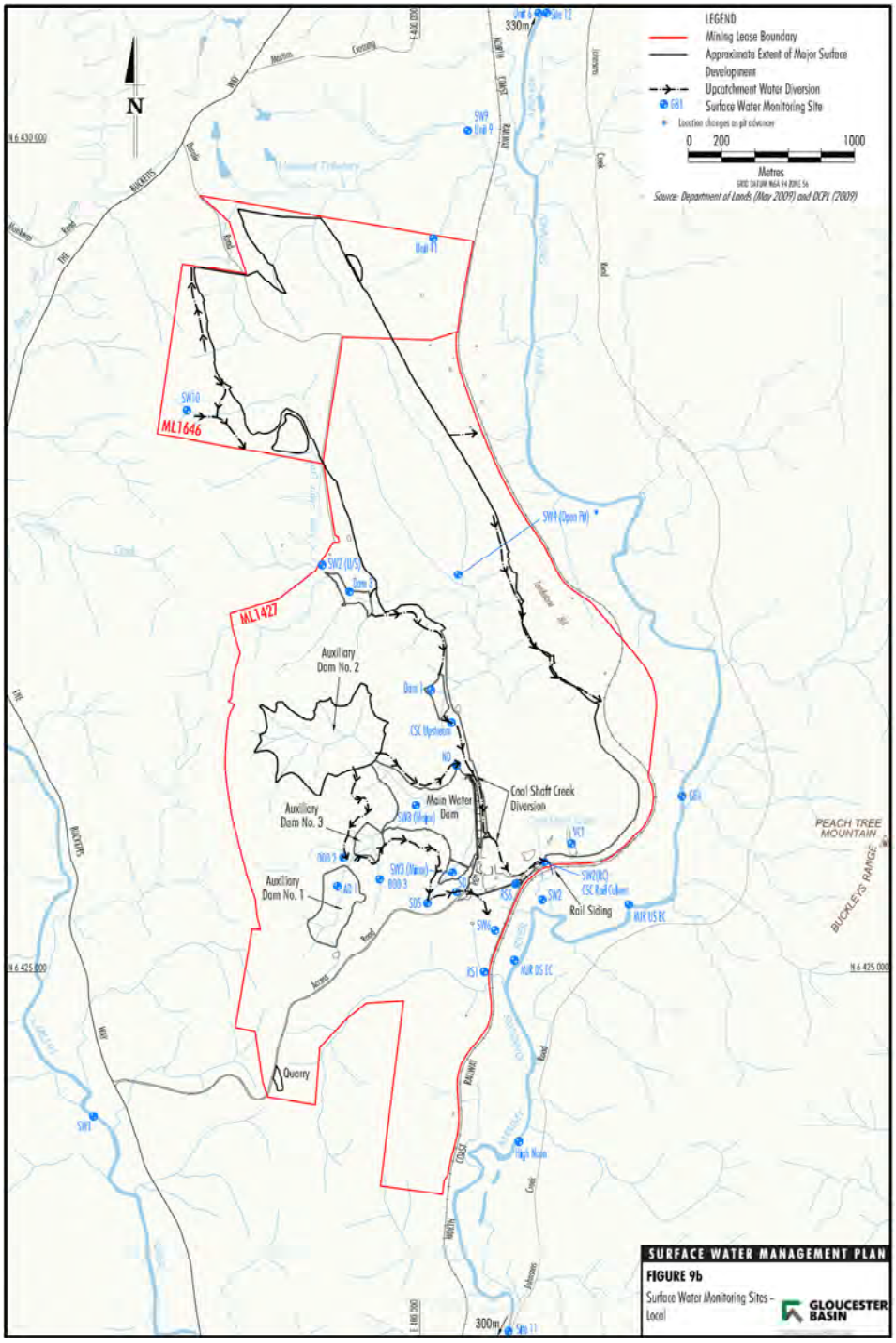
The water quality data set used in the determination of trigger values comprises all data collected up until the end of December 2011.

The surface water quality monitoring sites at the Duralie Coal Mine site are shown on Figure 1 below (Figure 9b reproduced from the SWMP).

[3] For parameters where low values have the potential to cause environmental harm (e.g. pH) the 20th percentile value has been used.

PO Box 2143, Toowong, QLD 4066
Ph: 07 3367 2388 Fax: 3367 2833
E-mail: gaconslt@bigpond.net.au
ABN: 62 085 419 852

Figure 1 - Monitoring Site Figure



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Ph: 07 3367 2388 Fax: 3367 2833
E-mail: gaconslt@bigpond.net.au
ABN: 62 085 419 852

The following sampling sites would be used in the assessment[4] of water quality objectives:

- Mammy Johnsons River:

  - Site 12 and GB1, which are upstream of the Coal Shaft Creek confluence; and

  - Site 11, which is downstream of the Coal Shaft Creek confluence.

- Coal Shaft Creek:

  - Site SW2 US, which is upstream of mining[5];

  - Site SW2 RC, which is at the entrance of the railway culvert, downstream of the existing Duralie Coal Mine and inflows to Coal Shaft Creek, and

  - Site SW10, which is on an upper arm of Coal Shaft Creek which is unaffected by drainage from the Duralie Extension Project disturbance area.

- Unnamed Tributary:

  - Site SW9, which is on the Unnamed Tributary downstream of the Duralie Extension Project disturbance area.

2.2 Identification of Water Quality Indicators and Development of Trigger Levels

Water quality indicators are defined in the guidelines as parameters that can be used to provide a measure of the quality of water or the condition of an ecosystem. Water quality indicators relevant to biological diversity and aquatic ecosystem integrity have been selected based on parameters having a direct effect (toxic and non-toxic stressors) (refer Figure 3.3.2 of the guidelines reproduced below).

[4] Note sampling sites which are upstream of mine disturbance areas would form reference sites for the interpretation of water quality data. Trigger levels would apply to sampling sites downstream of mine affected areas.

[5] Note runoff from a recently constructed mine road may have a small effect on water flow and quality at SW2 US.

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Ph: 07 3367 2388 Fax: 3367 2833
E-mail: gaconslt@bigpond.net.au
ABN: 62 085 419 852

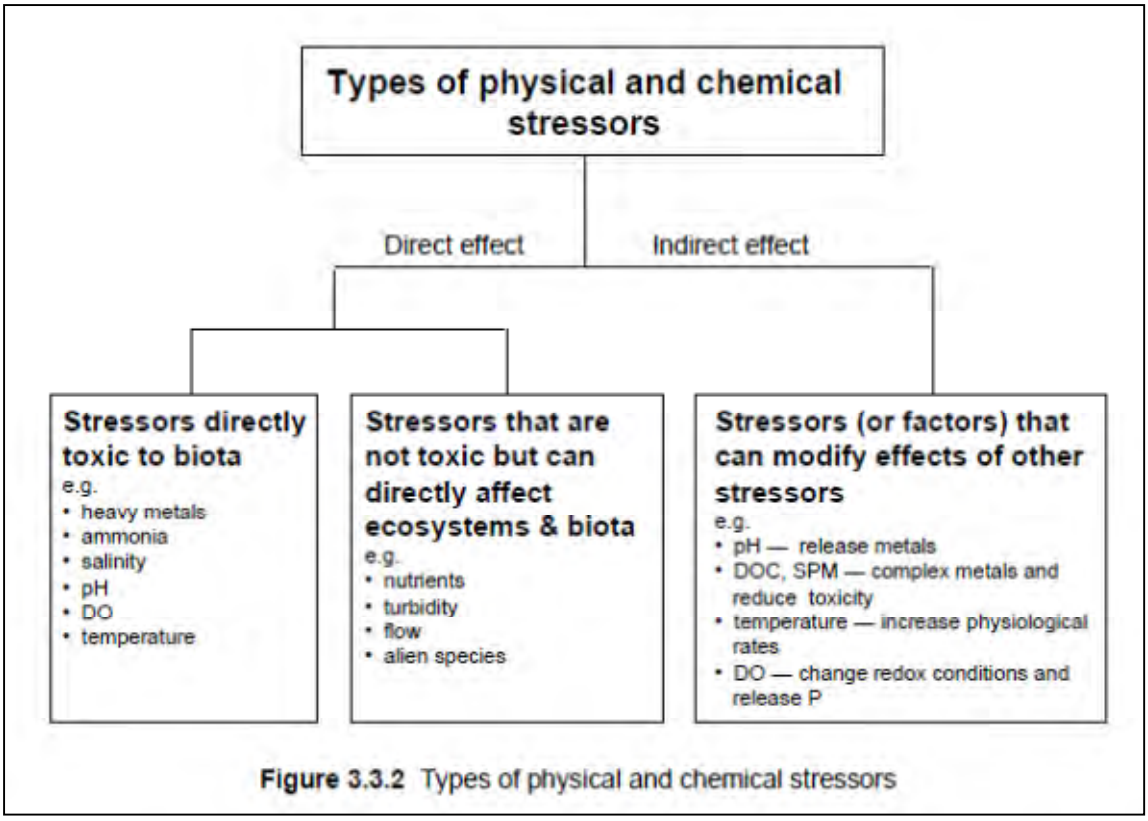

Figure 3.3.2 Types of physical and chemical stressors

The water quality indicators comprise heavy metals, ammonia, salinity, pH, dissolved oxygen (DO), temperature, nutrients, turbidity, flow, alien species, sediment load, hardness and BOD[6].

[6] Including the parameters nominated in Project Approval Condition 29(b)

PO Box 2143, Toowong, QLD 4066
Ph: 07 3367 2388 Fax: 3367 2833
E-mail: gaconslt@bigpond.net.au
ABN: 62 085 419 852

a) Heavy metals aluminium (total), chromium (total), copper (total) and zinc (total) have been selected as water quality indicators because of their history of being recorded at elevated concentrations in MJR, CSC and UT - relative to the default trigger values in the guidelines for 95% species protection). Specifically

> "Elevated aluminium and zinc concentrations are regularly recorded in the Karuah River, Mammy Johnsons River, Coal Shaft Creek and the unnamed tributary to Mammy Johnsons River (SW8 and SW9), including sites both upstream and downstream of DCM. The elevated aluminium concentrations recorded may be a function of the colloidal fraction rather than the metal in solution. Concentrations of copper and chromium have also been recorded on occasions above the ANZECC/ARMCANZ aquatic ecosystems guideline in these watercourses."[7]

Based on the available periods of record, the following site specific trigger levels for the other heavy metals are proposed:

Monitoring Site (Figure 9b)		Period of Record	Proposed Water Quality Trigger Level (80th%ile)			
			Total Aluminium (mg/L)	Total Chromium (mg/L)	Total Copper (mg/L)	Total Zinc (mg/L)
MJR	Site 11	7/95 – 28/11/11	1.24	0.001	0.002	0.011
CSC	SW2 (RC)	22/3/04 – 28/12/11	3.02	0.002	0.003	0.064
UT	SW9	7/95 – 28/12/11	2.96	0.002	0.004	0.024

[7] Refer Gilbert & Associates (2010), Appendix A "Surface Water Assessment" in "Duralie Extension Project Environmental Assessment", 2010, January.

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Ph: 07 3367 2388 Fax: 3367 2833
E-mail: gaconslt@bigpond.net.au
ABN: 62 085 419 852

b) Ammonia

Based on the available periods of record, the following site specific trigger levels for ammonia are proposed:

Monitoring Site (Figure 9b)		Period of Record	Proposed Water Quality Trigger Level (80th%ile)
			Ammonia (mg/L)
MJR	Site 11	7/95 – 28/11/11	0.06
CSC	SW2 (RC)	22/3/04 – 28/12/11	0.05
UT	SW9	7/95 – 28/12/11	0.13

c) Salinity (measured by electrical conductivity [EC]) and pH are proposed to be used as representative water quality performance indicators. Based on the available periods of record, the following site specific trigger values are proposed:

Monitoring Site (Figure 9b)		Period of Record	Proposed Water Quality Trigger Level (80th%ile)		
			pH (20th%ile)	pH (80th%ile)	EC (µS/cm)
MJR	Site 11	7/95 – 28/12/11	7.1	7.6	370
CSC	SW2 (RC)	22/3/04 – 28/12/11	7.1	7.9	544
UT	SW9	7/95 – 28/12/11	6.4	7.1	461

d) Dissolved oxygen (DO) has not been routinely measured at the Duralie Coal Mine and there is insufficient data to define site specific trigger values. Default values of 85 to 110% of saturation have been proposed in ANZECC/ARMCANZ (2000) (refer Table 3.3.2 reproduced below) and will be used as the default trigger values.

PO Box 2143, Toowong, QLD 4066
Ph: 07 3367 2388 Fax: 3367 2833
E-mail: gaconslt@bigpond.net.au
ABN: 62 085 419 852

Table 3.3.2 Default trigger values for physical and chemical stressors for south-east Australia for slightly disturbed ecosystems. Trigger values are used to assess risk of adverse effects due to nutrients, biodegradable organic matter and pH in various ecosystem types. Data derived from trigger values supplied by Australian states and territories. Chl *a* = chlorophyll *a*, TP = total phosphorus, FRP = filterable reactive phosphate, TN = total nitrogen, NO_x = oxides of nitrogen, NH_4^+ = ammonium, DO = dissolved oxygen.

Ecosystem type	Chl *a*	TP	FRP	TN	NO_x	NH_4^+	DO (% saturation)[l]		pH	
	(µg L^{-1})	(µg P L^{-1})	(µg P L^{-1})	(µg N L^{-1})	(µg N L^{-1})	(µg N L^{-1})	Lower limit	Upper limit	Lower limit	Upper limit
Upland river	na[a]	20[b]	15[g]	250[c]	15[h]	13[i]	90	110	6.5	7.5[m]
Lowland river[d]	5	50	20	500	40[o]	20	85	110	6.5	8.0
Freshwater lakes & Reservoirs	5[e]	10	5	350	10	10	90	110	6.5	8.0[m]
Wetlands	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data
Estuaries[p]	4[f]	30	5[j]	300	15	15	80	110	7.0	8.5
Marine[p]	1[n]	25[n]	10	120	5[k]	15[k]	90	110	8.0	8.4

na = not applicable;
a = monitoring of periphyton and not phytoplankton biomass is recommended in upland rivers — values for periphyton biomass (mg Chl *a* m^{-2}) to be developed;
b = values are 30 µgL^{-1} for Qld rivers, 10 µgL^{-1} for Vic. alpine streams and 13 µgL^{-1} for Tas. rivers;
c = values are 100 µgL^{-1} for Vic. alpine streams and 480 µgL^{-1} for Tas. rivers;
d = values are 3 µgL^{-1} for Chl *a*, 25 µgL^{-1} for TP and 350 µgL^{-1} for TN for NSW & Vic. east flowing coastal rivers;
e = values are 3 µgL^{-1} for Tas. lakes;
f = value is 5 µgL^{-1} for Qld estuaries;
g = value is 5 µgL^{-1} for Vic. alpine streams and Tas. rivers;
h = value is 190 µgL^{-1} for Tas. rivers;
i = value is 10 µgL^{-1} for Qld. rivers;
j = value is 15 µgL^{-1} for Qld. estuaries;
k = values of 25 µgL^{-1} for NO_x and 20 µgL^{-1} for NH_4^+ for NSW are elevated due to frequent upwelling events;
l = dissolved oxygen values were derived from daytime measurements. Dissolved oxygen concentrations may vary diurnally and with depth. Monitoring programs should assess this potential variability (see Section 3.3.3.2);
m = values for NSW upland rivers are 6.5–8.0, for NSW lowland rivers 6.5–8.5, for humic rich Tas. lakes and rivers 4.0-6.5;
n = values are 20 µgL^{-1} for TP for offshore waters and 1.5 µgL^{-1} for Chl *a* for Qld inshore waters;
o = value is 60 µgL^{-1} for Qld rivers;
p = no data available for Tasmanian estuarine and marine waters. A precautionary approach should be adopted when applying default trigger values to these systems.

e) Temperature (water temperature) outside its natural range is considered a potential stressor. Release of warm water from industrial cooling systems or cold water from low levels in deep water supply storages has been known to have had detrimental effects on aquatic life. It is not expected however that mining activities could result and any change to the thermal loading of downstream water courses and temperature is not considered relevant to the Project. It is therefore not proposed to develop trigger values for water temperature. Ambient water temperatures will however be included in the field monitoring regime for their relevance in DO measurement.

PO Box 2143, Toowong, QLD 4066
Ph: 07 3367 2388 Fax: 3367 2833
E-mail: gaconslt@bigpond.net.au
ABN: 62 085 419 852

f) Nutrients and Indicators of Eutrophication

Total Nitrogen and Total Phosphorous and Chlorophyll α have been selected as indicators of the major nutrient relevant to eutrophication. Chlorophyll α has not been routinely monitored at the Duralie Coal Mine and a trigger value of 0.005 mg/L based on the relevant default trigger values given in ANZECC/ARMCANZ (2000) – refer Table 3.3.2 reproduced above, is proposed.

Based on the available periods of record, the following site specific trigger values for Total Nitrogen and Total Phosphorous are proposed:

Monitoring Site (Figure 9b)		Period of Record	Proposed Water Quality Trigger Level (80th%ile)	
			Total Nitrogen (mg/L) (80th%ile)	Total Phosphorous (mg/L) (80th%ile)
MJR	Site 11	7/95 – 28/12/11	0.8	0.15
CSC	SW2 (RC)	22/3/04 – 28/12/11	1.2	0.08
UT	SW9	7/95 – 28/12/11	2.6	0.68

g) Turbidity

Based on the available periods of record, the following site specific trigger values are proposed:

Monitoring Site (Figure 9b)		Period of Record	Proposed Water Quality Trigger Level (80th%ile)
			Turbidity [NTU] (80th%ile)
MJR	Site 11	7/95 – 28/12/11	24
CSC	SW2 (RC)	22/3/04 – 28/12/11	119
UT	SW9	7/95 – 28/12/11	94

h) Flow is highly variable naturally ranging from zero to very large rates. The Surface Water Assessment in the Environmental Assessment predicts changes to flows in all three watercourses (UT, CSC and MJR) as a result of capture and reuse of drainage from mine catchment areas. It is assumed that inclusion of flow as a parameter relevant to biological diversity and aquatic ecological integrity means a trigger is needed for "unnatural flow regime" leading to "habitat change - % wetted area" (refer Table 3.3.1 ANZECC/ARMCANZ [2000] reproduced below). Applying this to MJR would seem to imply a criterion based on a change to the flow duration curve which could only be

PO Box 2143, Toowong, QLD 4066
Ph: 07 3367 2388 Fax: 3367 2833
E-mail: gaconslt@bigpond.net.au
ABN: 62 085 419 852

assessed using long periods of data or using a predictive model where model results should show a non-negligible change to catchment behaviour (i.e. modelled to monitored data using a model calibrated to pre-impact data). These assessments would be undertaken as part of the annual review process and no specific flow trigger value is proposed.

i) Alien species are recognised as a potential stressor however it is not considered that alien species could be introduced as a result of the Project and it is not proposed to develop triggers for alien species.

Table 3.3.1 Summary of the condition indicators, performance indicators, and location of default trigger value tables, for each issue

Issue	Condition indicator/target	Performance indicators	Preferred method for obtaining trigger values [a]	Default trigger value for each ecosystem-type	Consider ecosystem-specific modifiers
1. Nuisance aquatic plants	Species composition Cell numbers Chlorophyll *a* conc	TP conc TN conc Chl *a* conc	Reference data Reference data Reference data	Tables 3.3.2, 3.3.4, 3.3.6, 3.3.8, 3.3.10	Yes — Section 3.3.3.1
2. Lack of DO	Reduced DO conc Species composition/ abundance	DO conc	Reference data	Tables 3.3.2, 3.3.4, 3.3.6, 3.3.8, 3.3.10	Yes — Section 3.3.3.2
3. Excess of SPM	Species composition/ abundance	SPM conc	Reference data	Tables 3.3.3, 3.3.5, 3.3.7, 3.3.9, 3.3.11	Yes — Section 8.2.3.2
4. Unnatural change in salinity	Species composition/ abundance	EC (salinity)	Reference data	Tables 3.3.3, 3.3.5, 3.3.7, 3.3.9, 3.3.11	No
5. Unnatural change in temperature	Species composition/ abundance	Temperature	Reference data	> 80%ile < 20%ile	No
6. Unnatural change in pH	Species composition/ abundance	pH	Reference data	Tables 3.3.2, 3.3.4, 3.3.6, 3.3.8, 3.3.10	No
7. Poor optical properties	Species composition/ abundance	Turbidity Light regime	Reference data Reference data	Tables 3.3.3, 3.3.5, 3.3.7, 3.3.9, 3.3.11	No
8. Unnatural flow regime	Species composition/ abundance Habitat change % wetted area	Flow regime			

[a] Where local biological and ecological effects data are unavailable.

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Ph: 07 3367 2388 Fax: 3367 2833
E-mail: gaconslt@bigpond.net.au
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j) Sediment load, per se, is not dealt as a stressor in ANZECC/ARMCANZ (2000) rather turbidity as a surrogate for suspended particulate matter or total suspended solids is listed as a stressor. It is proposed to use total suspended solids (TSS) concentration as a trigger for sediment load.

Monitoring Site (Figure 9b)		Period of Record	Proposed Water Quality Trigger Level (80th%ile)
			Total Suspended Solids (mg/L) (80^{th}%ile)
MJR	Site 11	7/95 – 28/12/11	15
CSC	SW2 (RC)	22/3/04 – 28/12/11	80
UT	SW9	7/95 – 28/12/11	57

k) Hardness and BOD are not defined as stressors in ANZECC/ARMCANZ (2000). BOD is a measure of how much DO would be consumed during the process of breaking down organic matter present in water released into the receiving water (i.e. it is a potential causal factor for reduced DO). The hardness of water affects the toxicity of metals (refer Tables 3.4.3 and 3.4.4 of ANZECC reproduced below). BOD (as BOD_5) and hardness will be monitored and used as 'modifying factors' in the interpretation of any trigger exceedences for DO and heavy metals above respectively.

PO Box 2143, Toowong, QLD 4066
Ph: 07 3367 2388 Fax: 3367 2833
E-mail: gaconslt@bigpond.net.au
ABN: 62 085 419 852

Table 3.4.3 General form of the hardness-dependent algorithms describing guideline values for selected metals in freshwaters

Metal	Hardness-dependent algorithm
Cadmium	$HMTV = TV\ (H/30)^{0.89}$
Chromium(III)	$HMTV = TV\ (H/30)^{0.82}$
Copper	$HMTV = TV(H/30)^{0.85}$
Lead	$HMTV = TV(H/30)^{1.27}$
Nickel	$HMTV = TV(H/30)^{0.85}$
Zinc	$HMTV = TV(H/30)^{0.85}$

HMTV, hardness-modified trigger value (µg/L); TV, trigger value (µg/L) at a hardness of 30 mg/L as $CaCO_3$; H, measured hardness (mg/L as $CaCO_3$) of a fresh surface water (≤2.5‰). From Markich et al (in press).

Table 3.4.4 Approximate factors to apply to soft water trigger values for selected metals in freshwaters of varying water hardness[a]

Hardness category[b] (mg/L as $CaCO_3$)	Water hardness[c] (mg/L as $CaCO_3$)	Cd	Cr(III)	Cu	Pb	Ni	Zn
Soft (0–59)	30	TV	TV	TV	TV	TV	TV
Moderate (60–119)	90	X 2.7	X 2.5	X 2.5	X 4.0	X 2.5	X 2.5
Hard (120–179)	150	X 4.2	X 3.7	X 3.9	X 7.6	X 3.9	X 3.9
Very hard (180–240)	210	X 5.7	X 4.9	X 5.2	X 11.8	X 5.2	X 5.2
Extremely hard (400)	400	X 10.0	X 8.4	X 9.0	X 26.7	X 9.0	X 9.0

a Trigger values from table 3.4.1;

b Range of water hardness (mg/L as $CaCO_3$) for each category as defined by CCREM (1987);

c Mid-range value of each water hardness category. For example, a copper trigger value of 1.4 µg/L (from table 3.4.1) with 95% protection level chosen (e.g. slightly–moderately disturbed system) is applied to a site with very hard water (e.g. 210 mg/L as $CaCO_3$) by multiplying the trigger value by 5.2 to give a site-specific trigger value of 7.3 µg/L. If the hardness is away from the mid-range, it may be preferable to use the algorithm.

PO Box 2143, Toowong, QLD 4066
Ph: 07 3367 2388 Fax: 3367 2833
E-mail: gaconslt@bigpond.net.au
ABN: 62 085 419 852

ATTACHMENT C

COAL SHAFT CREEK RECONSTRUCTION PLAN

DURALIE COAL MINE

COAL SHAFT CREEK RECONSTRUCTION PLAN

Section/Page/ Annexure	Revision Number	Amendment/Addition	Distribution	Approval Date
All	CSCRP-R01-A	Original.	DP&I, NOW	December 2012
All	CSCRP-R02-A	Updates to reflect current status of DCM and to describe mine closure planning.	DPIE-Water, DPIE	24 December 2021

SEPTEMBER 2021
Document No. CSCRP-R02-A
Document No. 01121702

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1 INTRODUCTION

1.1 DURALIE COAL MINE

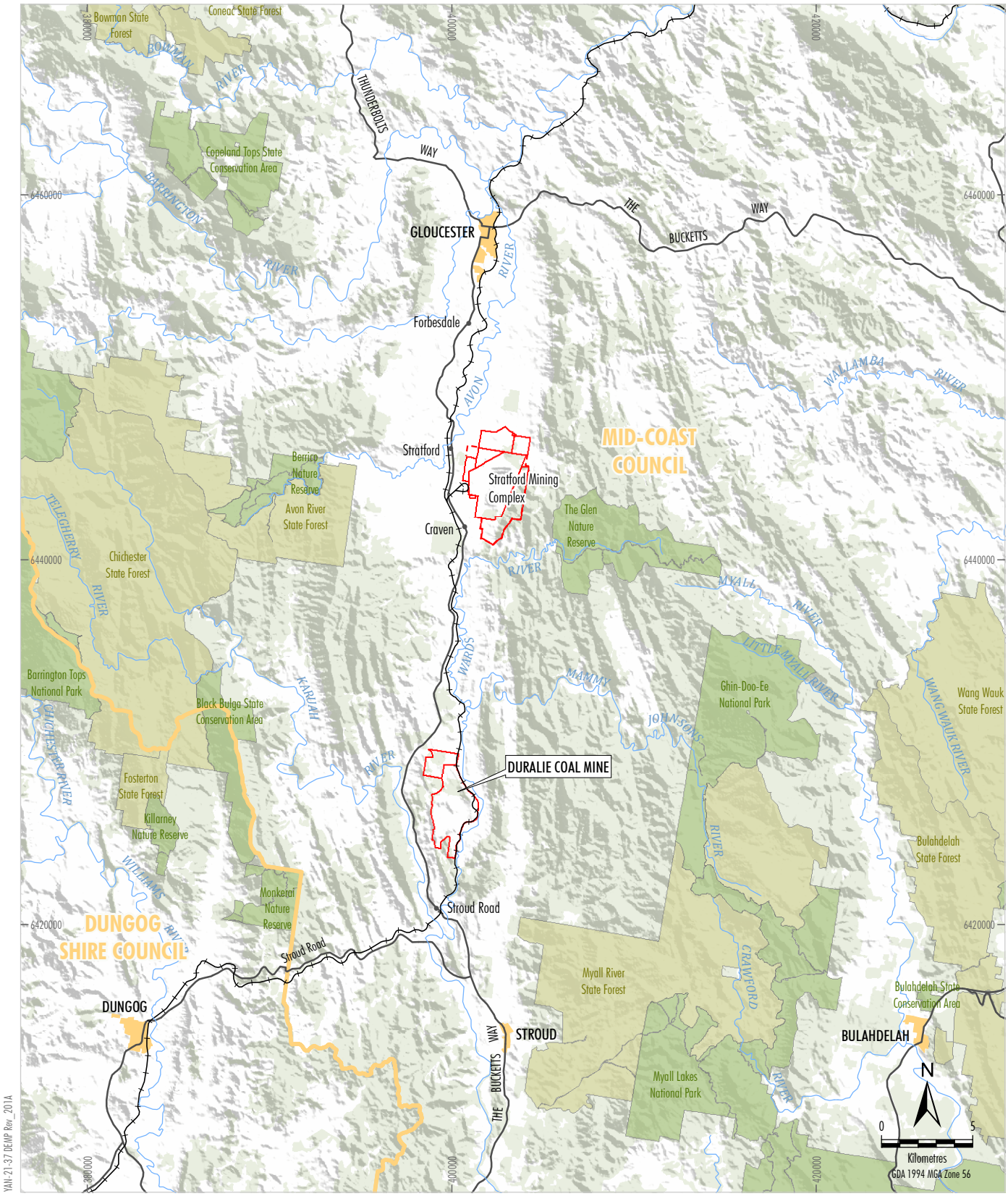
The Duralie Coal Mine (DCM) is an existing mine situated approximately 35 kilometres (km) south of Gloucester in the Gloucester Valley, New South Wales (NSW) (Figure 1). Duralie Coal Pty Ltd (DCPL) (a wholly owned subsidiary of Yancoal Australia Limited [Yancoal]) owns and operates the DCM. The NSW Minister for Urban Affairs and Planning granted Development Consent for the DCM in August 1997 and coal production commenced in 2003.

DCPL was granted approval for the Duralie Extension Project under section 75J of the NSW *Environmental Planning and Assessment Act, 1979* (EP&A Act) on 26 November 2010 (Project Approval [08_0203]) and under sections 130 and 133 of the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC) on 22 December 2010 (EPBC 2010/5396). On 10 November 2011, the Project Approval was amended by Order of The Land and Environment Court of NSW.

The main activities associated with the Duralie Extension Project (as modified) include:

- continued development of open cut mining operations at the DCM to facilitate a total run-of-mine (ROM) coal production rate of up to approximately 3 million tonnes per annum, including:
  - extension of the existing approved open pit in the Weismantel Seam to the north-west (i.e. Weismantel Extension open pit) within Mining Lease (ML) 1427 and ML 1646; and
  - open cut mining operations in the Clareval Seam (i.e. Clareval North West open pit) within ML 1427 and ML 1646;
- ongoing exploration activities within existing exploration tenements;
- progressive backfilling of the open pits with waste rock as mining develops, and continued and expanded placement of waste rock in out-of-pit waste rock emplacements;
- increased ROM coal rail transport movements on the North Coast Railway between the DCM and the Stratford Coal Mine (SCM) in line with increased ROM coal production;
- continued disposal of excess water through irrigation (including development of new irrigation areas within the existing ML 1427 and ML 1646);
- construction of Auxiliary Dam No.2 to relative level (RL) 100 metres (m) to provide 2,900 megalitres (ML) of on-site storage capacity to manage excess water on-site;
- progressive development of dewatering bores, pumps, dams, irrigation infrastructure and other water management equipment and structures;
- development of new haul roads and internal roads;
- upgrade of existing surface facilities and supporting infrastructure as required in line with increased ROM coal production;
- continued development of soil stockpiles, laydown areas and gravel/borrow pits;
- establishment of permanent Coal Shaft Creek alignment adjacent to the existing DCM mining area;
- ongoing surface monitoring and rehabilitation; and
- other associated minor infrastructure, plant, equipment and activities.

The general arrangement of the DCM, showing modifications, is provided in Figure 2.



YAN-21-37 DEMP Rev_201A

LEGEND

- Mining Lease Boundary
- NSW State Forest
- National Park, Nature Reserve or State Conservation Area
- Local Government Area Boundary

Source: Geoscience Australia (2006); NSW Department of Planning & Environment (2017)

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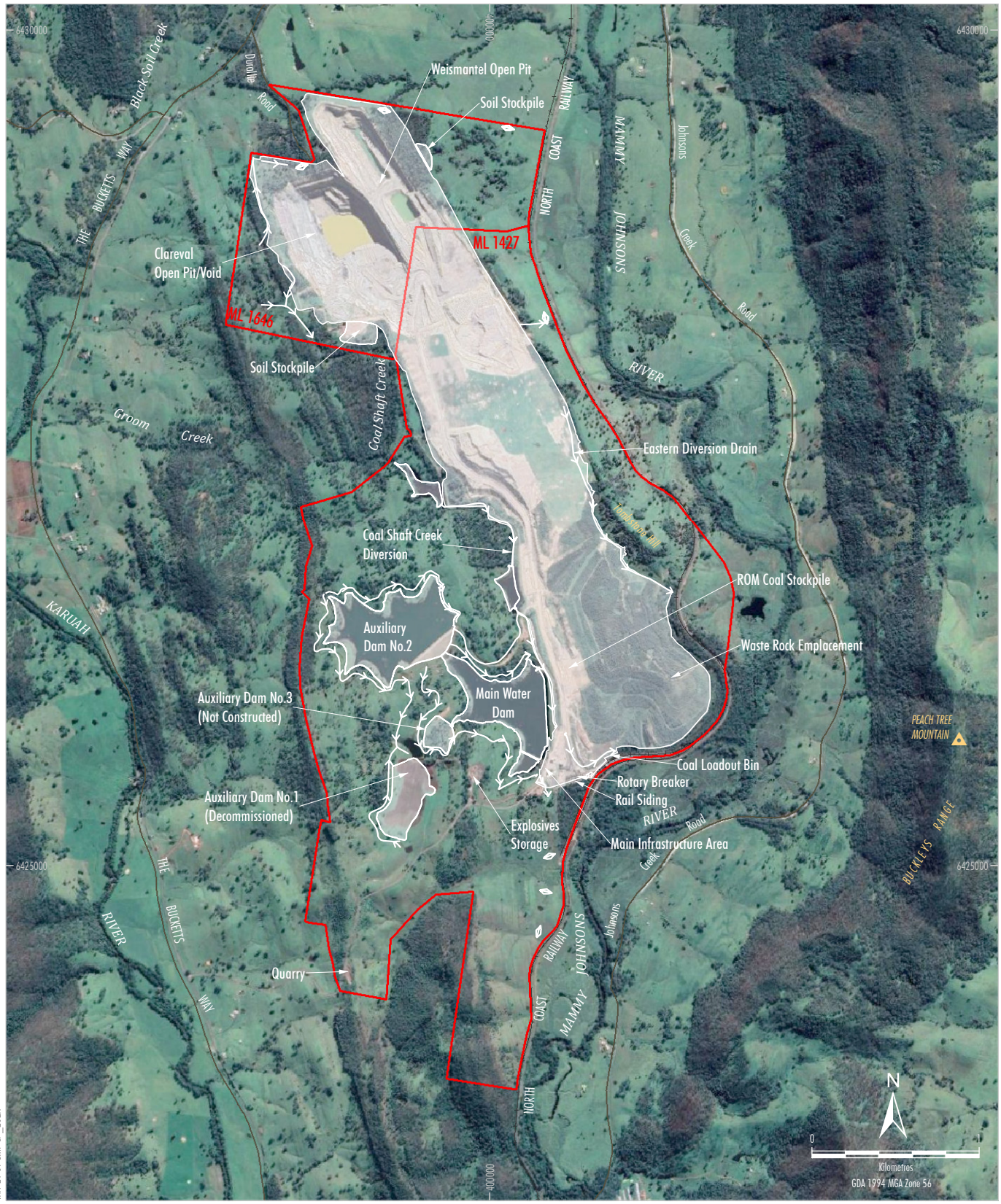
DURALIE COAL MINE

Regional Location

Figure 1



YAN-21-37 DMP CF _202A

LEGEND

- Mining Lease Boundary
- Approximate Extent of Existing/Approved Surface Development
- Existing/Approved First Flush Protocol Pump Back System
- Existing/Approved Up-catchment Diversion System

Source: © NSW Spatial Services (2019)
Orthophoto: Google Earth CENS/Airbus (2020)

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DURALIE COAL MINE

DCM General Arrangement

Figure 2

DCPL subsequently made an application to the NSW Minister for Planning and Infrastructure under section 75W of the EP&A Act to modify the Project Approval to extend the approved rail hours for the Duralie shuttle train. The application was accompanied by the *Duralie Rail Hours Modification Environmental Assessment* (DCPL, 2012). Approval to modify the Project Approval to extend the approved rail hours was granted by the NSW Planning Assessment Commission (under delegation of the NSW Minister for Planning and Infrastructure) on 1 November 2012. On 5 December 2014, Project Approval (08_0203) was modified to reflect approval of the Duralie Open Pit Modification.

The activities associated with the approved Duralie Open Pit Modification include:

- an increase in the maximum depth of the Clareval open pit;
- a minor increase in the extent of surface development of the DCM of approximately 2.5 hectares (ha), resulting from:
  - a reduction in low wall angles of the Clareval open pit and the removal of a pillar between the Clareval and Weismantel open pits to improve geotechnical stability; and
  - associated relocation of the up-catchment diversion to the west of the Clareval open pit;
- revision of mining sequence (i.e. progression of mining in the Clareval and Weismantel open pits); and
- an increase in height of the waste rock emplacement (i.e. the backfilled open pit) from approximately 110 m Australian Height Datum (m AHD) to approximately 135 m AHD.

A copy of the consolidated NSW Project Approval (08_0203) and the Commonwealth Approval (EPBC 2010/5396) is available on the Duralie Coal website (http://www.duralie coal.com.au).

Current Status of the DCM

Condition 5, Schedule 2 of Project Approval (08_0203) authorises mining operations to be carried at the DCM until 31 December 2021.

Accordingly, DCPL is planning for the commencement of the mine closure phase (i.e. after the cessation of mining operations on 31 December 2021) and has updated this plan to reflect the current stage of operations and to describe anticipated mine closure activities and associated changes to water management at the DCM for the mine closure phase.

Operations at the DCM now reflect the transition towards mine closure;

- **Clareval Open Pit:** mining of the Clareval Open Pit has now been completed, and dewatering of the pit has ceased. Partial backfilling with waste rock mined from the Weismantel Open Pit has commenced, along with shaping of the pit area to its final landform design. Mining of the Clareval Open Pit was finalised to a shallower depth than the maximum approved depth as modelled in 2014 DCM Open Pit Modification.
- **Weismantel Open Pit:** mining of the Weismantel Open Pit will continue until 31 December 2021, however, will also not occur to the maximum approved depth as modelled in 2014 DCM Open Pit Modification. Progressive backfilling of the Weismantel Open Pit has been undertaken.
- **DCM Water Management System Changes:**
  - Following the cessation of mining of the Clareval Open Pit (now final void) and the Clareval void becoming available as a water storage, Weismantel Open Pit dewatering is now preferentially transferred to the Clareval void and not stored within the Main Water Dam. As a result, all irrigation activities for the purpose of reducing the total site water inventory at the DCM have now ceased and the DCM's Irrigation Area irrigation system has been decommissioned and removed.

- Decommissioning of other redundant water management structures has also commenced. Consistent with the approved DCM final landform design, Auxiliary Dam No. 1 has been dewatered, decommissioned and rehabilitated.

- **No new disturbance areas are proposed.**

The DCM's Mining Operations Plan and Rehabilitation Management Plan includes a Mine Closure Planning Program which outlines the technical assessments and works that will be undertaken and implemented as the DCM progresses towards and commences the mine closure phase. Key components of the Mine Closure Planning Program (as relevant to this Coal Shaft Creek Reconstruction Plan) include:

- Prepare a detailed final void design (that reflects the revised final depths of the Clareval and Weismantel Open Pits) which includes water qualities/equilibrium level and considers surface water runoff and drainage.
- Review the site water balance modelling to ensure the balance incorporates the final landform design, surface water inflows and outflows to/from the final void.
- Commission and undertake a detailed final design of the Coal Shaft Creek final re-alignment and reconstruction.
- Update the Coal Shaft Creek Reconstruction Plan for consultation.
- Establish biodiversity values for the reconstructed Coal Shaft Creek in consultation with relevant agencies, to ensure biodiversity outcomes are the same or better than pre-mining levels.
- Review and update as required, existing environmental management plans for the rehabilitation and mine closure stage of operations.

DCPL is progressively completing components of the Mine Closure Planning Program. Review of the design of the Coal Shaft Creek final re-alignment is to be undertaken by Hydro Engineering & Consulting Pty Ltd (HEC) based on the refined final landform design. Following the completion of mining at the DCM and completion of the detailed design of the Coal Shaft Creek re-alignment, the final CSCRP will be prepared. The final CSCRP will include details of the biodiversity values for the reconstructed Coal Shaft Creek and outcomes from other analyses as described in Section 1.3.

1.2 PURPOSE AND SCOPE

This Coal Shaft Creek Reconstruction Plan (CSCRP) has been prepared by DCPL in accordance with the requirements of Condition 29(b), Schedule 3 of the NSW Project Approval (08_0203) and to satisfy the commitments made in the *Duralie Extension Project Environmental Assessment* (EA) (DCPL, 2010) *viz*.:

> ***Coal Shaft Creek - Reconstruction***
>
> *DCPL Commitment*
>
> *Following the completion of mining activities at the DCM, a final alignment of Coal Shaft Creek will be established, stabilised and revegetated prior to relinquishment of ML 1427. DCPL commits to a final alignment with the following components:*
>
> - *a reworked section of the existing Coal Shaft Creek Diversion channel;*
> - *a reconstructed meandering channel within a corridor over the in-pit waste rock emplacement; and*
> - *a drop-down section between the two above components.*
>
> *DCPL commits to the development of a Surface Water Management Plan that documents the final design of the post-mining alignment of Coal Shaft Creek.*

In accordance with Condition 29, Schedule 3, DCPL prepared the DCM Water Management Plan (including a Surface Water Management Plan [SWMP]) in February 2012, which was subsequently approved by the NSW Department of Planning and Infrastructure (DP&I) on 2 August 2012.

As provided for in Condition 14, Schedule 2 of the NSW Project Approval (08_0203), the Coal Shaft Creek Reconstruction Plan was not included in the approved version of the SWMP. The SWMP described that the CSCRP would be developed and subsequently included in the SWMP prior to the end of 2012.

1.3 MINE PLANNING CONTEXT

Coal Shaft Creek has been diverted around the existing Weismantel open pit to allow mining at the DCM. The approved DCM surface water management system includes the continued use of the Coal Shaft Creek Diversion (Figure 2).

Following the completion of mining activities at the DCM, a final alignment of Coal Shaft Creek will be established, stabilised and revegetated prior to relinquishment of ML 1427.

As part of HEC's review of the Coal Shaft Creek final re-alignment design, further analyses are being conducted into the geotechnical, hydrological and hydraulic design of the final alignment focussing on long-term stability, seepage management and the creation of habitat. The outcomes of these analyses will inform the final detailed design of the post-mining alignment and reconstruction of Coal Shaft Creek.

Following the completion of detailed design, this CSCRP will be revised (herein referred to as the final CSCRP) and submitted to the NSW Department of Planning, Industry and Environment (DPIE) – Water (DPIE-Water) for comment, prior to submission to the Secretary of the DPIE for approval. The final CSCRP will be submitted prior to the scheduled reconstruction of Coal Shaft Creek, which is not required until following the completion of mining activities at the DCM (on 31 December 2021). DCPL anticipates submission of the final CSCRP by mid-2022.

This CSCRP does however provide a framework for the development of the final CSCRP, which will be submitted including all of the relevant requirements of Condition 29(b), Schedule 3 of the NSW Project Approval (08_0203).

2 STATUTORY REQUIREMENTS

DCPL's statutory obligations are contained in:

(i) the conditions of the NSW Project Approval (08_0203);

(ii) the conditions of the Commonwealth Approval (EPBC 2010/5396);

(iii) relevant licences and permits, including conditions attached to mining leases; and

(iv) other relevant legislation.

Statutory requirements relevant to this CSCRP are described below.

2.1 EP&A ACT APPROVAL

This CSCRP has been prepared in accordance with Condition 29(b), Schedule 3 of the NSW Project Approval (08_0203) which states:

> *29. The Proponent shall prepare and implement a Water Management Plan for the project to the satisfaction of the Secretary. This plan must be prepared in consultation with EPA and NOW by suitably qualified and experienced persons whose appointment has been approved by the Secretary, and submitted to the Secretary within 3 months of the date of this approval.*
>
> *In addition to the standard requirements for management plans (see Condition 2 of Schedule 5), this plan must include:*
>
> *…*
>
> *b) a Surface Water Management Plan, that includes:*
>
> *…*
>
> - *detailed plans, including design objectives and performance criteria, for:*
>   - *the reconstruction of Coal Shaft Creek;*
>
> *…*

In accordance with Condition 29, Schedule 3 of the NSW Project Approval (08_0203), this CSCRP forms part of the SWMP for the DCM.

2.2 LICENCES, PERMITS AND LEASES

In addition to the NSW Project Approval (08_0203) and Commonwealth Approval (EPBC 2010/5396), all activities at DCM will be conducted in accordance with a number of licences, permits and leases which have been issued or are pending issue.

A summary of the key licences, permits and leases pertaining to the DCM is provided in Section 2.3 of the WAMP.

2.3 OTHER LEGISLATION

DCPL will operate the DCM consistent with the NSW Project Approval (08_0203), the Commonwealth Approval (EPBC 2010/5396) and any other legislation that is applicable to an approved Part 3A Project under the EP&A Act.

A summary of other NSW legislation that may be applicable to the conduct of the DCM is provided in Section 2.4 of the WAMP.

3 COAL SHAFT CREEK WATER CONTROL SYSTEM

The Coal Shaft Creek Diversion channel allows for the flow of up-catchment runoff reporting to Coal Shaft Creek to traverse the DCM site and avoid the open pit, waste rock emplacement and infrastructure areas. The diversion is required until the watercourse is re-established at the cessation of mining. The diversion was approved by Approval Number 20WA202053 under the Karuah River Water Sharing Plan and has a design capacity to safely pass the 100-year ARI peak flow event (Gilbert & Associates Pty Limited, 2010).

The existing Coal Shaft Creek Diversion comprises a series of diversion dams (Dams 1 to 5), connected with open channels and flowing in a general north to south direction. The open channels are constructed as cut-to-fill channels and bunds (Gilbert & Associates Pty Limited, 2010). In the upper reaches of the diversion, the channels are generally grassed or lined with rockfill (with grass and shrubs now established through the rockfill). In the lower reaches of the diversion, channels are either excavated in rock or are lined with rockfill mattresses. Most of the diversion (upper reaches) is constructed at higher levels than the original Coal Shaft Creek. This necessitated the construction of three drop structures on the lower reaches of the diversion, in the form of engineered stepped cascades, to dissipate flow energy and lower the elevation of the diversion back down to the elevation of the original Coal Shaft Creek channel into which the diversion discharges near the rail siding at the southern end of the DCM (Gilbert & Associates Pty Limited, 2010).

The majority of the Coal Shaft Creek Diversion would remain for the life of the DCM. The original upper (northern) reaches of the diversion have been consumed by the advancing mine open pits and waste rock emplacement areas (refer Figure 2). Small tributaries in the very upper reaches of Coal Shaft Creek have been diverted around the Clareval North West open pit and waste rock emplacement, directing runoff back into the remnant Coal Shaft Creek upstream of the Coal Shaft Creek Diversion (Gilbert & Associates Pty Limited, 2010).

4 DESIGN SPECIFICATIONS AND CONSTRUCTION PROGRAM

The reconstruction of Coal Shaft Creek is not required until the completion of mining activities at the DCM. As described in Section 1.1, detailed design of the relocation corridor will commence following completion of the DCM final landform design. Detailed design specifications and drawings of the relocation corridor and a construction program will be provided in the final CSCRP. Notwithstanding, a proposed conceptual design for the post-mining alignment of Coal Shaft Creek is provided below.

A conceptual final alignment of Coal Shaft Creek was presented in the Duralie Extension Project Surface Water Assessment (Gilbert & Associates Pty Limited, 2010) prepared for the EA and is reproduced on Figure 3. Preliminary design work undertaken since the Duralie Extension Project EA (DCPL, 2010) has refined the conceptual design as shown in Attachment 1.

The proposed design concept for the post-mining alignment of Coal Shaft Creek currently comprises a reworked section of the existing Coal Shaft Creek diversion channel, a drop-down section outside the in-pit waste rock emplacement, and reconstructed section of the creek within a corridor within the in-pit waste rock emplacement at the southern end of the Weismantel open pit extent. The confirmation of the conceptual and final design of the reconstructed Coal Shaft Creek will be based on geotechnical, hydrological and hydraulic characteristics of similar natural drainage systems with particular emphasis on stream channel and bank stability, seepage management and habitat creation. Analyses into the post-mining alignment and reconstruction of Coal Shaft Creek will use information collected from similar natural features surrounding the DCM area to inform the final design of the channel, including:

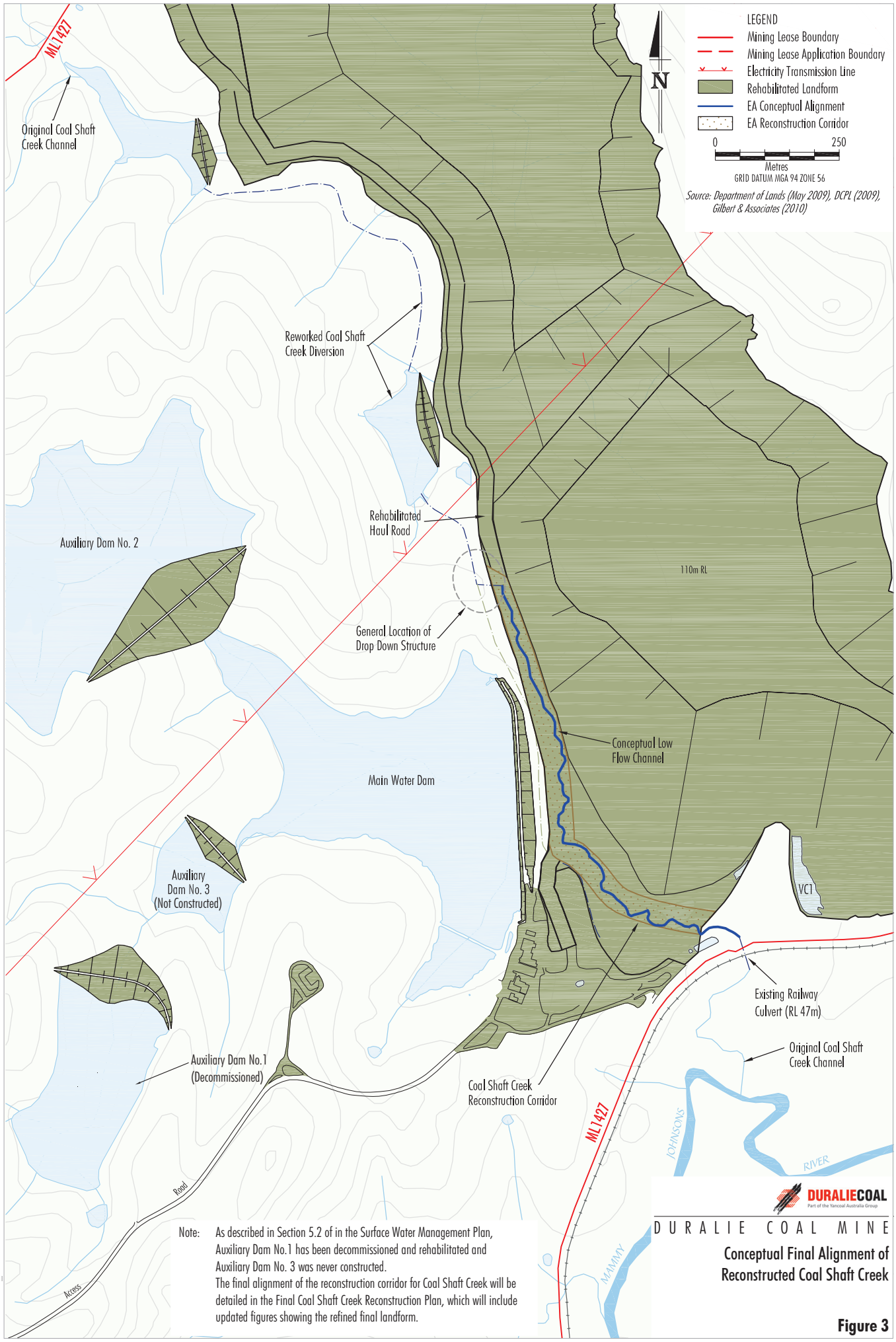
- stream energy, stream power and critical tractive stress;
- energy relationships at bankfull stage and at peak flow;
- channel longitudinal profiles and cross-sections;
- upstream and downstream controls;
- bed and bank material, including critical entrainment and destabilisation thresholds;
- changes in energy profiles and constriction and resultant changes in afflux through, past and over structures; and
- natural mechanisms of bedload transport.

A description of the components of the proposed design for the reconstructed Coal Shaft Creek is provided below.

Reworked Section of Existing Diversion Channel

Photographs of the existing Coal Shaft Creek Diversion are shown on Plate 1.

The main elements of the upper section of the Coal Shaft Creek diversion will be retained as a primarily engineered structure, depending on the outcome of the geomorphic, hydraulic and geotechnical analyses. Sediments and vegetation will establish within the channel over time (Gilbert & Associates Pty Limited, 2010). The banks of the diversion will continue to be revegetated and maintained throughout the mine life and during rehabilitation to enhance stability and create fauna habitat. The performance of the diversion channel will continue to be assessed following significant flow events.



Note: As described in Section 5.2 of in the Surface Water Management Plan, Auxiliary Dam No.1 has been decommissioned and rehabilitated and Auxiliary Dam No. 3 was never constructed.
The final alignment of the reconstruction corridor for Coal Shaft Creek will be detailed in the Final Coal Shaft Creek Reconstruction Plan, which will include updated figures showing the refined final landform.

DURALIE COAL MINE

Conceptual Final Alignment of Reconstructed Coal Shaft Creek

Figure 3

YAH-21-37 CSCRP_001A

Coal Shaft Creek Diversion Looking Upstream

Coal Shaft Creek Diversion Looking Downstream

Coal Shaft Creek Diversion Looking Downstream to Dam 1

Coal Shaft Creek Diversion Looking Upstream from Haul Road Culvert

YAN-21-37 CSCRP_003A

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DURALIE COAL MINE

Existing Coal Shaft Creek Diversion (2009)

Plate 1

Following the completion of mining, the upper section of the existing Coal Shaft Creek diversion channel will be reworked, if required, to improve its longer-term stability (e.g. minor reinforcement and other maintenance) and geomorphologic and ecological function. The objective of any reworking will be to transform the existing engineered diversion channel into a more natural and self-sustaining form which has geomorphologic and hydraulic characteristics consistent with other watercourses and features in the surrounding area.

Drop-Down Section

DCPL has engaged HEC to undertake a study into the long-term geotechnical stability and maintenance requirements of the proposed drop-down section of the reconstructed Coal Shaft Creek. The study will include input from hydrologists (HEC) and geotechnical engineers. The results of this study will be used to confirm the viability of this component of the conceptual design and would be incorporated into the final design and post-mining alignment of the reconstructed Coal Shaft Creek to be documented in the final CSCRP, which will be prepared in consultation with the DPIE-Water and submitted to the DPIE for approval.

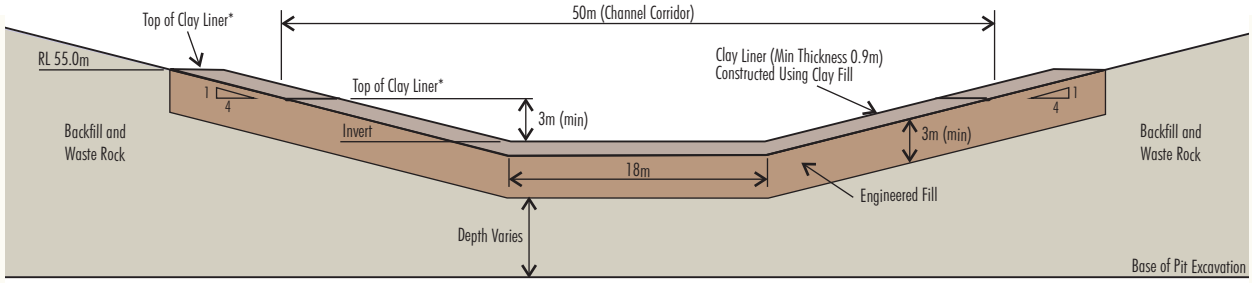
Reconstructed Section of Coal Shaft Creek

The creek will be designed with a meandering channel contained within a reconstructed 50 m wide corridor, which will generally replicate the original meandering geometry. The reconstructed creek design will aim to be similar to pre-mining (surveyed) creek cross-sections as far as practicable and adopt a design with a “main” flow channel, with overbank areas for large flows. The main channel will be sized appropriately to drain expected catchment yields such that channel stability is not compromised, habitat is created and seepage is managed (Figure 4).

The design channel profile will comprise a regular plan form which oscillates between right and left hand dominant profiles with right and left bends transitioning to a symmetrical profile in the straight sections between meander bends (Figure 4). The design bed slope will involve a regular pattern of flatter sections in bend areas and steeper sections in straighter sections between bends. The channel will be designed with similar hydraulic and geomorphic characteristics as the southern reach of the original creek channel. For example, the channel profile will be designed to have a similar stream power as the modelled stream power for the original Coal Shaft Creek.

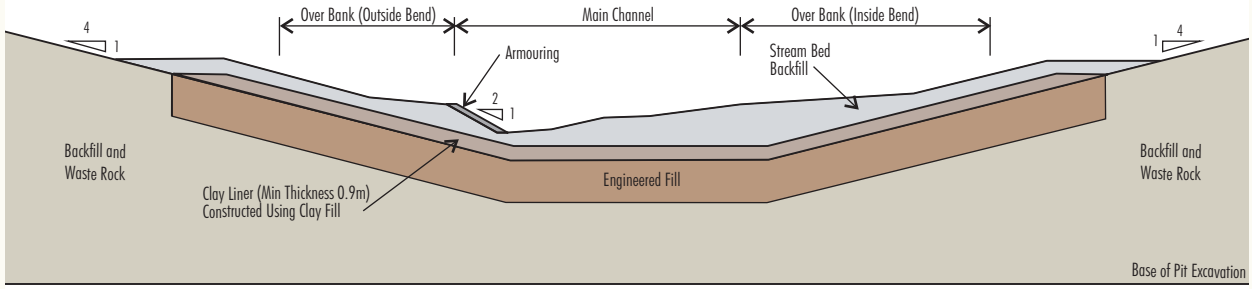
The stability of the original creek was dependent on relatively dense vegetation along the creek banks and it is envisaged that short-term stability of the outer banks of the reconstructed channel will be enhanced by selective armouring using rocky backfill or large timber debris (Gilbert & Associates Pty Limited, 2010).

The geotechnical requirements for the bulk fill and engineered fill (Figure 4) will be determined as part of further analyses and will include control over the engineering properties and placement of waste rock material in the reconstructed Coal Shaft Creek corridor. In areas where the channel would be formed over backfilled waste material the channel would incorporate an engineered low permeability liner (Figure 4) to restrict the movement of water between Coal Shaft Creek and the waste rock emplacement. As part of the final detailed design, seepage analysis, geotechnical testing and modelling will be undertaken to confirm an appropriate liner material, thickness and extension above the channel invert.

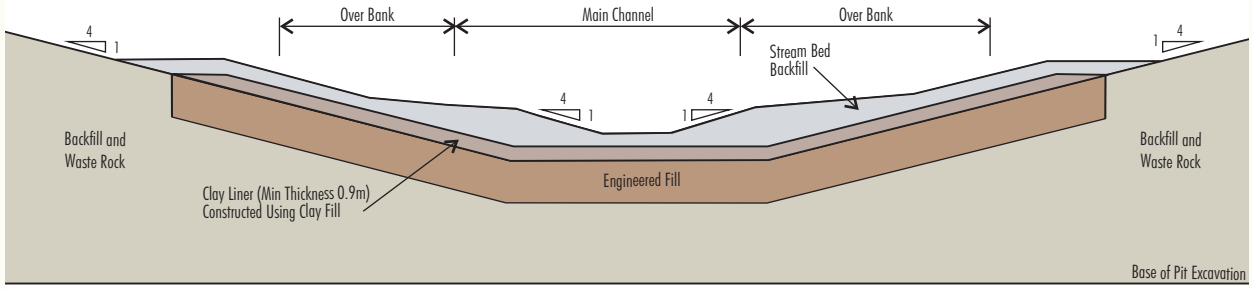


*Channel Corridor Clay Liner to extend up batters to RL 55m or 3m(min) vertically from corridor invert (whichever is greater).

Typical Channel Corridor Section



Typical Section - Reconstructed Creek (Bend)



Typical Section - Reconstructed Creek (Straight)

YAH-21-37 CSCRP_002A

Source: Allan Watson Associates (2006)

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DURALIE COAL MINE

Coal Shaft Creek Reconstruction
(Typical Sections)

Figure 4

Whilst the design concepts are based on characteristics of the original creek, the reconstructed creek is expected to be dynamic and to evolve over time. This will inevitably result in preferential erosion and deposition in some sections which may be initially greater than might be expected in the natural creek, depending on the pattern of flows experienced post commissioning (Gilbert & Associates Pty Limited, 2010). Selection of final form and alignment of the creek channel will be subject to a detailed hydraulic analysis, as part of final design, together with an assessment of the likelihood of bed/bank erosion on the outside of bends under a range of flow conditions. Examples of habitat in the existing Coal Shaft Creek Diversion are shown on Plate 1.

The conceptual longitudinal channel profile will also include habitat creation initiatives such as the provision of irregular pool and riffle sequences, use of material recovered from the existing channel or some other suitable source, placement of large boulders and/or timber to form pools upstream and promote aquatic habitat and planting of riverine vegetation on banks to enhance stability.

The channel would be formed progressively from south to north and creek flows would not be reinstated until the completion of mining and/or when vegetation was well established throughout. In concept, the creek would be constructed by:

- forming the 50 m wide corridor in the waste rock material;
- constructing the engineered low permeability liner to control leakage from the reconstructed creek to the waste rock emplacement and seepage from the waste rock emplacement to the creek;
- forming the channel and banks using material recovered from the existing channel or some other suitable source;
- placement of large boulders and/or timber to form pools upstream and promote aquatic habitat; and
- planting of riverine vegetation on banks to enhance stability.

5 MONITORING PROGRAM

A monitoring program will be developed and documented in the final CSCRP to assess the performance of the reconstructed Coal Shaft Creek against the performance criteria (Section 6). The monitoring program will complement existing monitoring programs and will use existing monitoring locations where possible.

The monitoring program will include monitoring of bed and bank stability, bed and bank erosion rates, changes to flow path geometry, vegetation (cover, density and health) and water quality.

Baseline and control monitoring will be conducted in three comparable creek systems identified in the Gloucester Valley to develop and monitor performance against performance measures and indicators.

6 ASSESSMENT OF PERFORMANCE INDICATORS AND MEASURES

Performance indicators and measures will be developed and documented in the final CSCRP. The performance measures and indicators will include consideration of monitoring and observations during and following flood events include attributes such as bed and bank stability, bed and bank erosion rates, changes to flow path geometry, vegetation (cover, density and health) and water quality.

The performance measures and indicators will be based on demonstrating substantial achievement of equivalent stability and geomorphic and ecological function as exist in other comparable creek systems (identified through the baseline and control monitoring described in Section 5) to the original Coal Shaft Creek.

7 CONTINGENCY PLAN

A Contingency Plan will be developed in the final CSCRP to be implemented by DCPL in the event that the performance indicators (to be developed as described in Section 6) demonstrate that equivalent stability and geomorphic and ecological function (as exist in other comparable creeks systems) is not being substantially achieved.

8 REVIEW AND IMPROVEMENT OF ENVIRONMENTAL PERFORMANCE

8.1 ANNUAL REVIEW

In accordance with Condition 3, Schedule 5 of the NSW Project Approval (08_0203), DCPL will prepare an Annual Review of the environmental performance of the DCM by the end of December each year. Annual Reviews are made publicly available on the Duralie Coal website, in accordance with Condition 10, Schedule 5 of Project Approval (08_0203).

The Annual Review will specifically address the following aspects of Condition 3, Schedule 5 that are directly relevant to water management:

- include a comprehensive review of the monitoring results and complaints records for the DCM over the past year, including a comparison of these results against the:
  - relevant statutory requirements, limits or performance measures/criteria;
  - monitoring results of previous years; and
  - relevant predictions in the Duralie Extension Project EA;
- identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;
- identify any trends in the monitoring data over the life of the DCM;
- identify any discrepancies between the predicted and actual impacts of the DCM, and analyse the potential cause of any significant discrepancies; and
- describe what measures will be implemented over the next year to improve the environmental performance of the DCM.

8.2 CSCRP REVIEW

In accordance with Condition 4, Schedule 5 of Project Approval (08_0203), the SWMP (including the requirements relevant to this CSCRP) will be reviewed and if necessary revised to the satisfaction of the Secretary of the DPEI, within three months of the submission of:

- an Annual Review, in accordance with Condition 3, Schedule 5 of Project Approval (08_0203);
- an Incident Report, in accordance with Condition 6, Schedule 5 of Project Approval (08_0203);
- an audit, in accordance with Condition 8, Schedule 5 of Project Approval (08_0203;
- any modification to the conditions of Project Approval (08_0203); or
- prior to the commencement of clearing in accordance with the *Duralie Open Pit Modification Environmental Assessment* (DCPL, 2014).

The revision status of this CSCRP is indicated on the title page of each copy.

As described in Section 1.3, the review of the Coal Shaft Creek final re-alignment design is currently being completed by HEC based on the refined final landform design. Following the completion of mining at the DCM and completion of the detailed design of the Coal Shaft Creek re-alignment, the final CSCRP will be prepared and submitted for DPIE approval, in consultation with DPIE-Water.

This CSCRP forms part of the DCM SWMP (Attachment C of the SWMP) which is made publicly available on the Duralie Coal website in accordance with the NSW Project Approval (08_0203). A hard copy of the SWMP will also be kept at the DCM.

9 REPORTING PROTOCOLS

In accordance with Condition 2(g), Schedule 5 of the NSW Project Approval (08_0203), DCPL has developed protocols for managing and reporting the following:

- incidents;
- complaints;
- non-compliances with statutory requirements; and
- exceedances of the impact assessment criteria and/or performance criteria.

The management of incidents is described in the Pollution Incident Response Management Plan. The management of complaints and non-compliances is described in detail in the DCM Environmental Management Strategy. The management of exceedances of performance criteria is described in the SWMP (Appendix 2) and GWMP (Appendix 3).

10 REFERENCES

Duralie Coal Pty Limited (2010) *Duralie Extension Project Environmental Assessment*.

Duralie Coal Pty Limited (2012) *Duralie Rail Hours Modification Environmental Assessment.*

Duralie Coal Pty Limited (2014) *Duralie Open Pit Modification Environmental Assessment.*

Gilbert & Associates Pty Limited (2010) *Duralie Extension Project Surface Water Assessment*. Appendix A of Duralie Coal Pty Ltd (2010) *Duralie Extension Project Environmental Assessment*.

ATTACHMENT 1

CONCEPTUAL FINAL ALIGNMENT OF RECONSTRUCTED COAL SHAFT CREEK –

DECEMBER 2012

YAN-21-37 CSCRP_201A

LEGEND
Mining Lease Boundary
Conceptual Alignment - Dec 2012
Reconstruction Corridor - Dec 2012

Source: © NSW Spatial Services (2019)
Orthophoto:DCPL (2012)

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DURALIE COAL MINE

Conceptual Final Alignment of Reconstructed Coal Shaft Creek (December 2012)

Attachment 1

APPENDIX 3

GROUNDWATER MANAGEMENT PLAN

DURALIE COAL MINE
GROUNDWATER MANAGEMENT PLAN

Revision Status Register

Section/Page/ Annexure	Revision Number	Amendment/Addition	Distribution	DPIE Approval Date
All	GWMP-R01-B	Original	OEH, NOW, DP&I	-
All	GWMP-R02-A	Edits made to: • reflect amended Project Approval conditions by Order of The Land and Environment Court of NSW dated 10 November 2011; • consider recommendations (where relevant) of independent environmental audit dated November 2011; and • consider any outcomes of the Annual Review for the Duralie Coal Mine (dated September 2011).	OEH, NOW, DP&I	-
All	GWMP-R02-B	Edits made to reflect DP&I and NOW comments.	DP&I	2 August 2012
All	GWMP-R02-C	Annual Review	DP&I	27 September 2013
All	GWMP-R03-A	Annual Review (2013) and recommendations from DP&E Audit December 2013	DP&E	23 April 2015
All	GWMP-R04-B	Annual Review (2014) and Duralie Open Pit Modification (2014).	DP&E, DotE	22 July 2016
All	GWMP-R05-A	Updates to reflect current status of DCM, monitoring program changes and describe mine closure planning.	DPIE, DAWE	24 December 2021

SEPTEMBER 2021
Project No. YAN-21-35
Document No. GWMP-R05-A
(01121701)

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1 INTRODUCTION

1.1 DURALIE COAL MINE

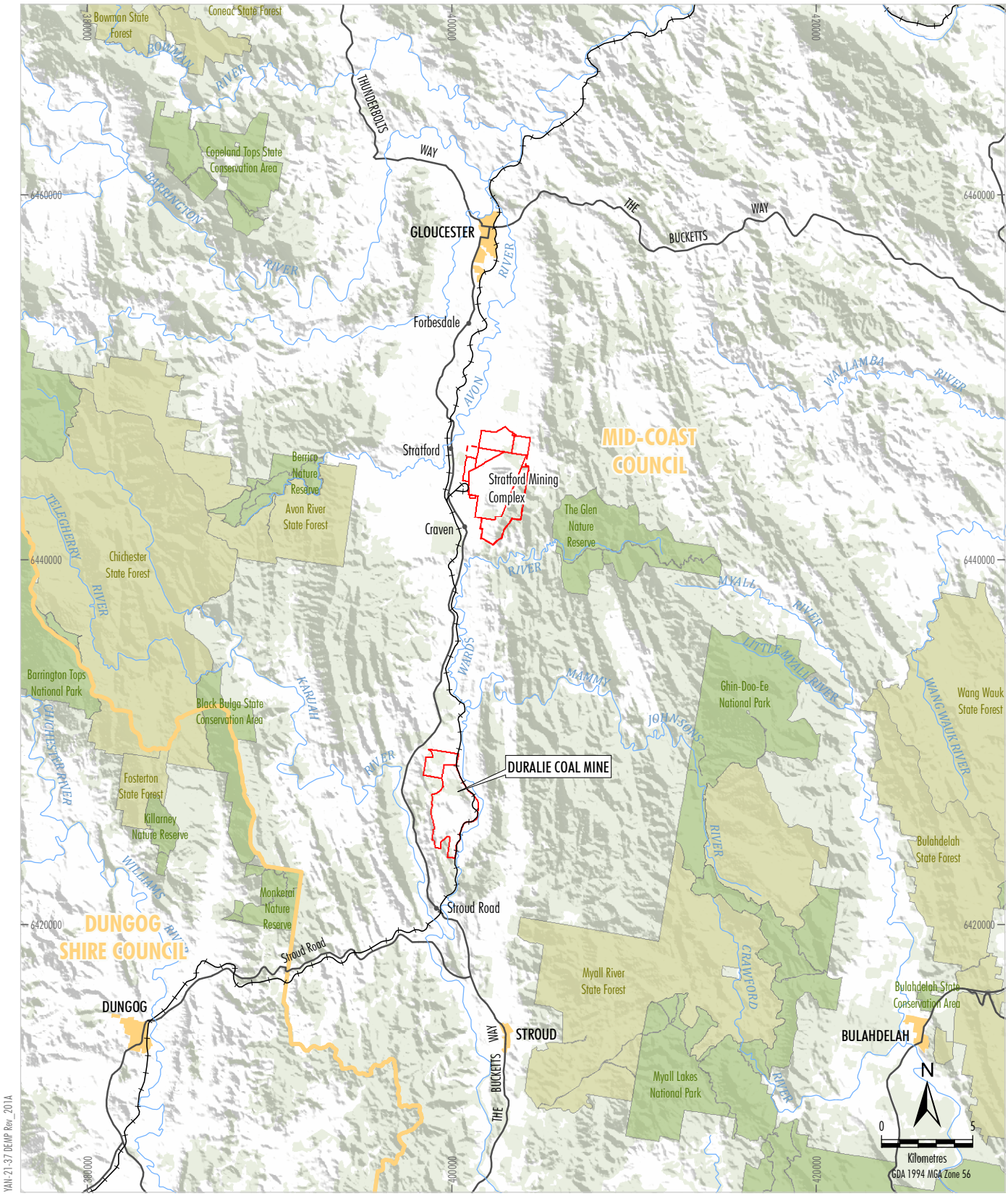
The Duralie Coal Mine (DCM) is an existing mine situated approximately 35 kilometres (km) south of Gloucester in the Gloucester Valley, New South Wales (NSW) (Figure 1). Duralie Coal Pty Ltd (DCPL) (a wholly owned subsidiary of Yancoal Australia Limited) owns and operates the DCM. The NSW Minister for Urban Affairs and Planning granted Development Consent for the DCM in August 1997 and coal production commenced in 2003.

The Duralie Extension Project involves the extension and continuation of mine operations at the DCM. DCPL was granted approval for the Duralie Extension Project under section 75J of the NSW *Environmental Planning and Assessment Act, 1979* (EP&A Act) on 26 November 2010 (NSW Project Approval [08_0203]) and under sections 130 and 133 of the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC) on 22 December 2010 (Commonwealth Approval [EPBC 2010/5396]). On 10 November 2011, the NSW Project Approval (08_0203) was amended by Order of The Land and Environment Court of NSW. On 1 November 2012, the NSW Project Approval (08_0203) was modified to reflect approval of the Duralie Rail Hours Modification. On 5 December 2014, the NSW Project Approval (08_0203) was modified to reflect approval of the Duralie Open Pit Modification. A copy of the consolidated NSW Project Approval (08_0203) and the Commonwealth Approval (EPBC 2010/5396) is available on the Duralie Coal website (http://www.duralie coal.com.au).

The main activities associated with the Duralie Extension Project (as modified) include:

- continued development of open cut mining operations at the DCM to facilitate a total run-of-mine (ROM) coal production rate of up to approximately 3 million tonnes per annum, including:
  - extension of the existing approved open pit in the Weismantel Seam to the north-west (i.e. Weismantel open pit) within Mining Lease (ML) 1427 and ML 1646; and
  - open cut mining operations in the Clareval Seam (i.e. Clareval open pit) within ML 1427 and ML 1646;
- ongoing exploration activities within existing exploration tenements;
- progressive backfilling of the open pits with waste rock as mining develops, and continued and expanded placement of waste rock in out-of-pit waste rock emplacements;
- increased ROM coal rail transport movements on the North Coast Railway between the DCM and the Stratford Coal Mine (SCM) in line with increased ROM coal production;
- continued disposal of excess water through irrigation (including development of new irrigation areas within the existing ML 1427 and ML 1646);
- construction of Auxiliary Dam No. 2 to relative level (RL) 100 metres (m) to provide 2,900 megalitres of on-site storage capacity to manage excess water on-site;
- progressive development of dewatering bores, pumps, dams, irrigation infrastructure and other water management equipment and structures;
- development of new haul roads and internal roads;
- upgrade of existing surface facilities and supporting infrastructure as required in line with increased ROM coal production;
- continued development of soil stockpiles, laydown areas and gravel/borrow pits;
- establishment of permanent Coal Shaft Creek Diversion alignment adjacent to the existing DCM mining area;
- ongoing surface monitoring and rehabilitation; and
- other associated minor infrastructure, plant, equipment and activities.

The general arrangement of the DCM, showing modifications, is provided in Figure 2.



YAN-21-37 DEMP Rev_201A

LEGEND

- Mining Lease Boundary
- NSW State Forest
- National Park, Nature Reserve or State Conservation Area
- Local Government Area Boundary

Source: Geoscience Australia (2006); NSW Department of Planning & Environment (2017)

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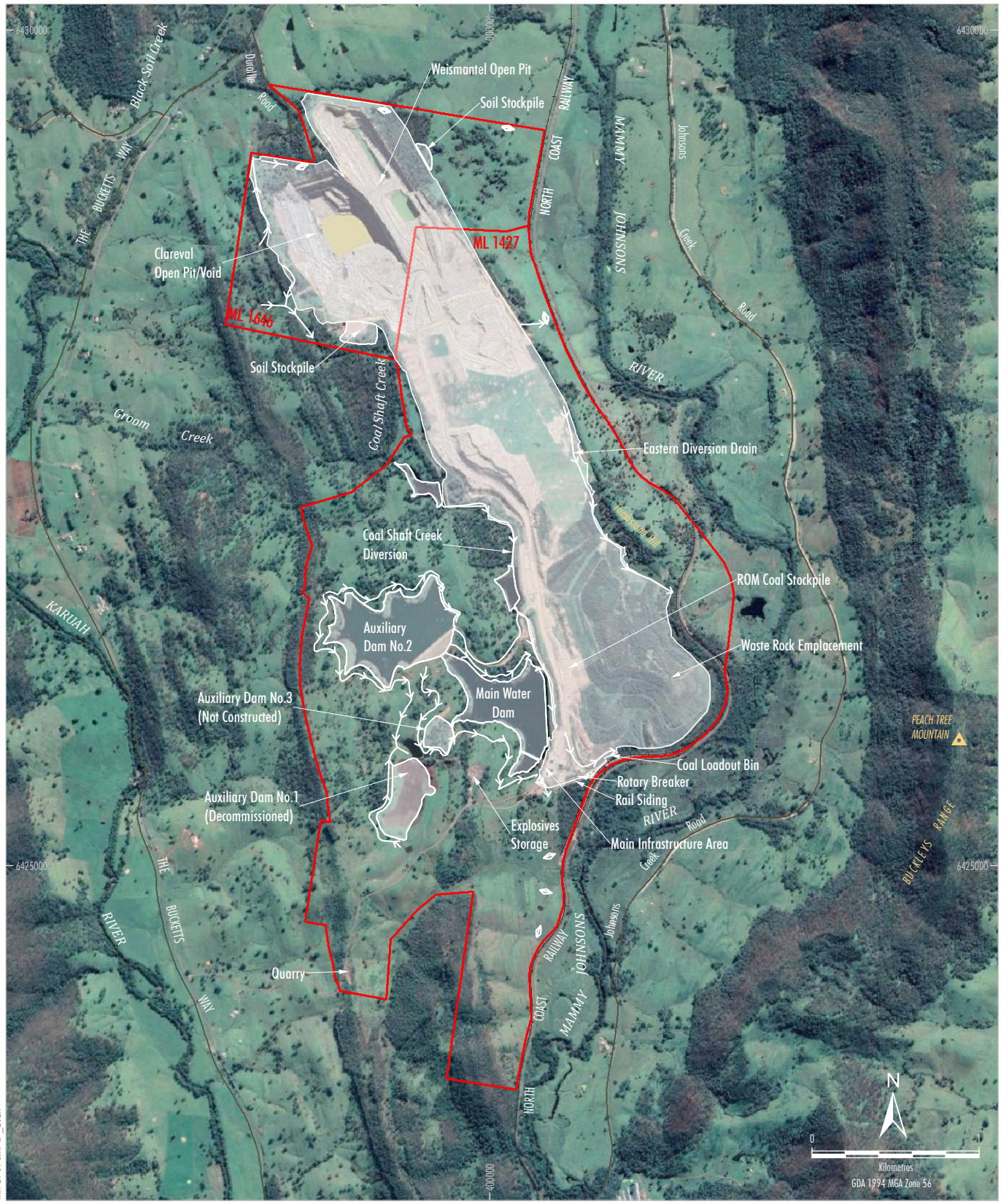
DURALIE COAL MINE

Regional Location

Figure 1



YAN-21-37 DMP CF _202A

LEGEND

- Mining Lease Boundary
- Approximate Extent of Existing/Approved Surface Development
- Existing/Approved First Flush Protocol Pump Back System
- Existing/Approved Up-catchment Diversion System

Source: © NSW Spatial Services (2019)
Orthophoto: Google Earth CENS/Airbus (2020)

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DURALIE COAL MINE

DCM General Arrangement

Figure 2

The activities associated with the approved Duralie Open Pit Modification include:

- an increase in the maximum depth of the Clareval open pit;
- a minor increase in the extent of surface development of the DCM of approximately 2.5 hectares (ha), resulting from:
  - a reduction in low wall angles of the Clareval open pit and the removal of a pillar between the Clareval and Weismantel open pits to improve geotechnical stability; and
  - associated relocation of the up-catchment diversion to the west of the Clareval open pit;
- revision of mining sequence (i.e. progression of mining in the Clareval and Weismantel open pits); and
- an increase in height of the waste rock emplacement (i.e. the backfilled open pit) from approximately 110 m Australian Height Datum (m AHD) to approximately 135 m AHD.

Current Status of the DCM

Condition 5, Schedule 2 of Project Approval (08_0203) authorises mining operations to be carried at the DCM until 31 December 2021.

Accordingly, DCPL is planning for the commencement of the mine closure phase (i.e. after the cessation of mining operations on 31 December 2021) and has revised this Groundwater Management Plan to reflect the current stage of operations and to describe anticipated mine closure activities and associated changes to water management at the DCM for the mine closure phase.

Operations at the DCM now reflect the transition towards mine closure;

- **Clareval Open Pit:** mining of the Clareval Open Pit has now been completed, and dewatering of the pit has ceased. Partial backfilling with waste rock mined from the Weismantel Open Pit has commenced, along with shaping of the pit area to its final landform design. Mining of the Clareval Open Pit was finalised to a shallower depth than the maximum approved depth as modelled in 2014 DCM Open Pit Modification.
- **Weismantel Open Pit:** mining of the Weismantel Open Pit will continue until 31 December 2021, however, will also not occur to the maximum approved depth as modelled in 2014 DCM Open Pit Modification. Progressive backfilling of the Weismantel Open Pit has been undertaken.
- **DCM Water Management System Changes:**
  - Following the cessation of mining of the Clareval Open Pit (now final void) and the Clareval void becoming available as a water storage, Weismantel Open Pit dewatering is now preferentially transferred to the Clareval void and not stored within the Main Water Dam. As a result, all irrigation activities for the purpose of reducing the total site water inventory at the DCM have now ceased and the DCM's Irrigation Area irrigation system has been decommissioned and removed.
  - Decommissioning of other redundant water management structures has also commenced. Consistent with the approved DCM final landform design, Auxiliary Dam No. 1 has been dewatered, decommissioned and rehabilitated.
- **No new disturbance areas** are proposed.

The DCM's Mining Operations Plan and Rehabilitation Management Plan includes a Mine Closure Planning Program which outlines the technical assessments and works that will be undertaken and implemented as the DCM progresses towards and commences the mine closure phase. Key components of the Mine Closure Planning Program (as relevant to this Groundwater Management Plan) include:

- Prepare a detailed final void design (that reflects the revised final depths of the Clareval and Weismantel Open Pits) which includes water qualities/equilibrium level and considers surface water runoff and drainage.
- Review/update the site groundwater model to ensure the model is consistent with the final landform design.
- Review the medium to long-term water quality predictions of the final void against available monitoring data to determine the need for additional/alternate management.
- Review the site water balance modelling to ensure the balance incorporates the final landform design, surface water inflows and outflows to/from the final void.
- Review and update as required, existing environmental management plans for the rehabilitation and mine closure stage of operations.

DCPL is progressively completing components of the Mine Closure Planning Program, including the review of the site groundwater model and site water balance (including final void water balance) based on the refined final landform design and final void design. Once compete, the outcomes from these reviews and other relevant Mine Closure Planning Program technical assessments and works will be incorporated into this Groundwater Management Plan and will include updates, if necessary, to Attachment C (Groundwater Predictions at the End of Mining) and Attachment E (Simulated Pit Inflows). DCPL anticipates that this revision to the Groundwater Management Plan would occur in 2022, following the completion of mining on 31 December 2021.

1.2 PURPOSE AND SCOPE

This Groundwater Management Plan (GWMP) has been prepared by DCPL in accordance with Condition 29(c), Schedule 3 of Project Approval (08_0203).

This revision of the GWMP has been prepared by DCPL to:

- incorporate changes that reflect the current status of operations at the DCM; and
- describe changes to water management at the DCM that have occurred as a result of the transition towards mine closure and are anticipated to occur following the cessation of mining operations and into the mine closure phase.

1.3 SUITABLY QUALIFIED AND EXPERIENCED PERSONS

The former NSW Department of Planning and Environment (DP&E) (now the Department of Planning, Industry and Environment [DPIE]) as delegate for the then Director-General of the DP&E, approved the appointment of Dr Noel Merrick (Heritage Computing Pty Ltd [now HydroAlgorithmics Pty Ltd]) as a suitably qualified and experienced person for the preparation of the DCM Water Management Plan (WAMP) on 18 February 2011.

The GWMP (and its revisions) was previously prepared/reviewed by Dr Noel Merrick. The Interface Investigation Program – Waste Emplacement and Alluvium (Attachment F) was also prepared by Dr Noel Merrick.

Due to the minor and administrative nature of the revisions to this GWMP and given the revisions to the WAMP are surface water related, Dr Noel Merrick's review of this revised GWMP is not considered warranted at this stage. Dr Merrick's involvement will be targeted for the next revision of the WAMP and this GWMP, which will include the results from the Mine Closure Planning Program technical assessments and works described in Section 1.1.

1.4 STRUCTURE OF THE GWMP

The remainder of the GWMP is structured as follows:

Section 2: Outlines the statutory requirements applicable to the GWMP.

Section 3: Describes the existing groundwater conditions, including groundwater use.

Section 4: Provides detailed baseline data.

Section 5: Provides summary of predicted groundwater impacts and provides processes to validate the DCM groundwater model and further calibrate the model to site specific conditions.

Section 6: Describes the monitoring programs.

Section 7: Details the measures and indicators that will be used to assess the performance of the Duralie Extension Project (incorporating the Open Pit Modification) in relation to groundwater.

Section 8: Describes the groundwater contingency plan.

Section 9: Describes the review and improvement of the environmental performance process.

Section 10: Describes the management and reporting of incidents, complaints and non-compliances.

Section 11: Lists the references cited.

2 STATUTORY REQUIREMENTS

DCPL's statutory obligations are contained in:

(i) the conditions of the NSW Project Approval (08_0203);

(ii) the conditions of the Commonwealth Approval (EPBC 2010/5396);

(iii) relevant licences and permits, including conditions attached to mining leases; and

(iv) other relevant legislation.

These are described below.

2.1 EP&A ACT APPROVAL

Groundwater Management Plan

This GWMP has been prepared in accordance with Condition 29(c), Schedule 3 of the NSW Project Approval (08_0203). Table 1 indicates where each component of Condition 29 is addressed within this GWMP.

Table 1
Groundwater Management Plan Requirements

NSW Project Approval (08_0203) Condition	GWMP Section
Condition 29, Schedule 3	
29. The Proponent shall prepare and implement a Water Management Plan for the project to the satisfaction of the Secretary. This plan must be prepared in consultation with EPA and NOW by suitably qualified and experienced persons whose appointment has been approved by the Secretary, and submitted to the Secretary within 3 months of the date of this approval.	
In addition to the standard requirements for management plans (see Condition 2 of Schedule 5), this plan must include:	
…	
c) a Groundwater Management Plan, which includes:	
• groundwater assessment criteria, including trigger levels for investigating any potentially adverse groundwater impacts;	Section 7
• a program to monitor:	Section 6
– groundwater inflows to the open cut mining operations;	Section 6.1
– the impact of the project on:	
o the alluvial aquifers including investigating the potential for direct interface between mine spoil and alluvium and assessment of any consequential impact on alluvial and surface water;	Section 6.2
o base flows to Mammy Johnsons River;	Section 6.3
o any groundwater bores on privately-owned land; and	Section 6.4
– the seepage/leachate from water storages or backfilled voids on site; and	Section 6.5
• a program to validate the groundwater model for the project, and calibrate it to site specific conditions; and	Section 5.2
• a plan to respond to any exceedences of the performance criteria, including,	Sections 7 and 8
- if a direct interface between mine spoil and alluvium is identified, development of a trigger action response plan (TARP) for potential salinity impacts on alluvial and surface water sources; and	
- a plan to offset the loss of any base flow to Mammy Johnsons River caused by the project.	

In accordance with Condition 29, Schedule 3 of the NSW Project Approval (08_0203), this GWMP is included as part of the WAMP for the DCM (i.e. Appendix 3 of the WAMP).

Of relevance to this GWMP, Condition 26, Schedule 3 of the NSW Project Approval (08_0203) requires:

> *26. The Proponent shall offset the loss of any base flow to Mammy Johnsons River. This condition does not apply if the Secretary determines this loss to be negligible.*

Additionally, Condition 27, Schedule 3 of the NSW Project Approval (08_0203) requires:

> *27. The Proponent shall provide compensatory water supply to any landowner of privately-owned land whose water licence entitlements are impacted (other than an impact that is negligible) as a result of the project, in consultation with NOW, 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 must 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 shall provide alternative compensation to the satisfaction of the Secretary.*

Sections 7 and 8 provide response plans to offset the loss of any baseflows to Mammy Johnsons River and provide compensatory water supply to any landowner of privately-owned land whose water licence entitlements are impacted (other than an impact that is negligible) as a result of the Duralie Extension Project (incorporating the Open Pit Modification).

Management Plan Requirements

In addition, Condition 2, Schedule 5 of the NSW Project Approval (08_0203), outlines the requirements that are applicable to the preparation of the management plans. The WAMP indicates where each component of the conditions is addressed within the plans under the WAMP (including this GWMP). Table 2 indicates where each relevant component is addressed within this GWMP.

Table 2
Management Plan Requirements

NSW Project Approval (08_0203) Condition	GWMP Section
Condition 2, Schedule 5	
2. The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include:	
a) detailed baseline data;	Sections 3 and 4
b) a description of:	
• the relevant statutory requirements (including any relevant approval, licence or lease conditions);	Section 2
• any relevant limits or performance measures/criteria;	Section 7
• 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;	Section 7

Table 2 (Continued)
Management Plan Requirements

NSW Project Approval (08_0203) Condition		GWMP Section
c)	a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;	Sections 5, 6, 7 and 8
d)	a program to monitor and report on the:	Sections 6, 9 and 10
	• impacts and environmental performance of the project;	
	• effectiveness of any management measures (see c above);	
e)	a contingency plan to manage any unpredicted impacts and their consequences;	Sections 7, 8 and Appendix A
f)	a program to investigate and implement ways to improve the environmental performance of the project over time;	Sections 5, 7, 9 and 10
g)	a protocol for managing and reporting any;	
	• incidents;	Refer to Section 10 and the PIRMP
	• complaints;	Refer to Section 10 and EMS
	• non-compliances with statutory requirements; and	Refer to Section 10 and EMS
	• exceedances of the impact assessment criteria and/or performance criteria; and	Section 7 and 8
h)	a protocol for periodic review of the plan.	Section 9

2.2 EPBC ACT APPROVAL

Condition 11 of the Commonwealth Approval (EPBC 2010/5396) requires:

Mitigation Measures

11. In order to minimise the impacts of the project on listed threatened species, the person taking the action must implement all measures in the following plans/documents or their subsequent revisions as approved by the Minister:

(a) The DCM Vegetation Clearance Protocol (DCPL, 2002);

(b) The DCM Irrigation Management Plan (DCPL, 2008);

(c) The DCM Site Water Management Plan (DCPL, 2008); and

(d) The DCM Rehabilitation Management Plan (DCPL, 2007).

In accordance with Condition 11 of the Commonwealth Approval (2010/5396), the WAMP (including this GWMP) will be submitted for approval by the Commonwealth Minister for the Environment (or delegate) in consultation with DPIE, the NSW Environment Protection Authority (EPA) and the DPIE-Water. A record of consultation with the EPA is provided in Attachment A of the WAMP. The EPA's comments have been addressed where relevant in the revised WAMP. No comments on the revised WAMP were received from the DPIE-Water.

2.3 GROUNDWATER LICENCE

Consistent with Condition 4 of former Groundwater Licence – Duralie Coal Open Cut (20BL168404) issued under Part 5 of the NSW *Water Act, 1912* by the Department of Land and Water Conservation (now PDIE-Water) in September 2002, DCPL developed a Groundwater Monitoring and Contingency Plan using the template provided by the former NSW Office of Water (NOW) (Attachment A).

DPCL was issued with Water Access Licence (WAL) 41518 by DPIE-Water as relevant to the Gloucester Basin Groundwater Source and as regulated by the *Water Sharing Plan North Coast Fractured and Porous Rock Groundwater Sources 2016*. WAL 41518 replaces former Groundwater Licence 20BL168404. DCPL continues to implement the Groundwater Monitoring and Contingency Plan provided in Attachment A.

2.4 LICENCES, PERMITS AND LEASES

In addition to the NSW Project Approval (08_0203), and Commonwealth Approval (EPBC 2010/5396), all activities at DCM will be conducted in accordance with a number of licences, permits and leases which have been issued or are pending issue.

A summary of the key licences, permits and leases pertaining to the DCM is provided in Section 2.3 of the WAMP. The WAMP is available on the Duralie Coal website (www.duraliecoal.com.au).

2.5 OTHER LEGISLATION

DCPL will operate the DCM consistent with the NSW Project Approval (08_0203), the Commonwealth Approval (EPBC 2010/5396) and any other legislation that is applicable to an approved Part 3A Project under the EP&A Act.

A summary of other NSW legislation that may be applicable to the conduct of the DCM is provided in Section 2.4 of the WAMP.

3 EXISTING GROUNDWATER CONDITIONS

The various sedimentary rocks in the DCM area have low permeability due to their fine grained nature, the predominance of cemented lithic sandstones and the common occurrence of a clayey matrix in the sandstones and conglomerates (HydroSimulations, 2014). The permeability of the aquifer system is therefore related to the spacing of fissures, the degree of opening of individual fissures and the permeabilities of the coal seams. Permeability of the aquifer generally decreases with depth as the fissures tighten and become less frequent, however, relatively higher permeabilities are encountered in the coal seams (HydroSimulations, 2014).

A conceptual model of the hydrogeological regime was developed by HydroSimulations (2014) based on review of the available hydrogeological data. The data supports two groundwater systems including (HydroSimulations, 2014):

- shallow groundwater system – associated with alluvium and regolith; and
- deeper groundwater system, including:
  - the Weismantel and Clareval coal seams; and
  - low permeability/disconnected fractured rock/coal measures of the Mammy Johnsons, Weismantels and Durallie Road Formations (Figure 3).

Alluvial deposits are associated with Mammy Johnsons River to the east of the DCM area (Figure 3). The alluvium consists of silty sands and silts with lenses of gravelly sands and sandy, coarse gravel with an average thickness of approximately 9 m (HydroSimulations, 2014).

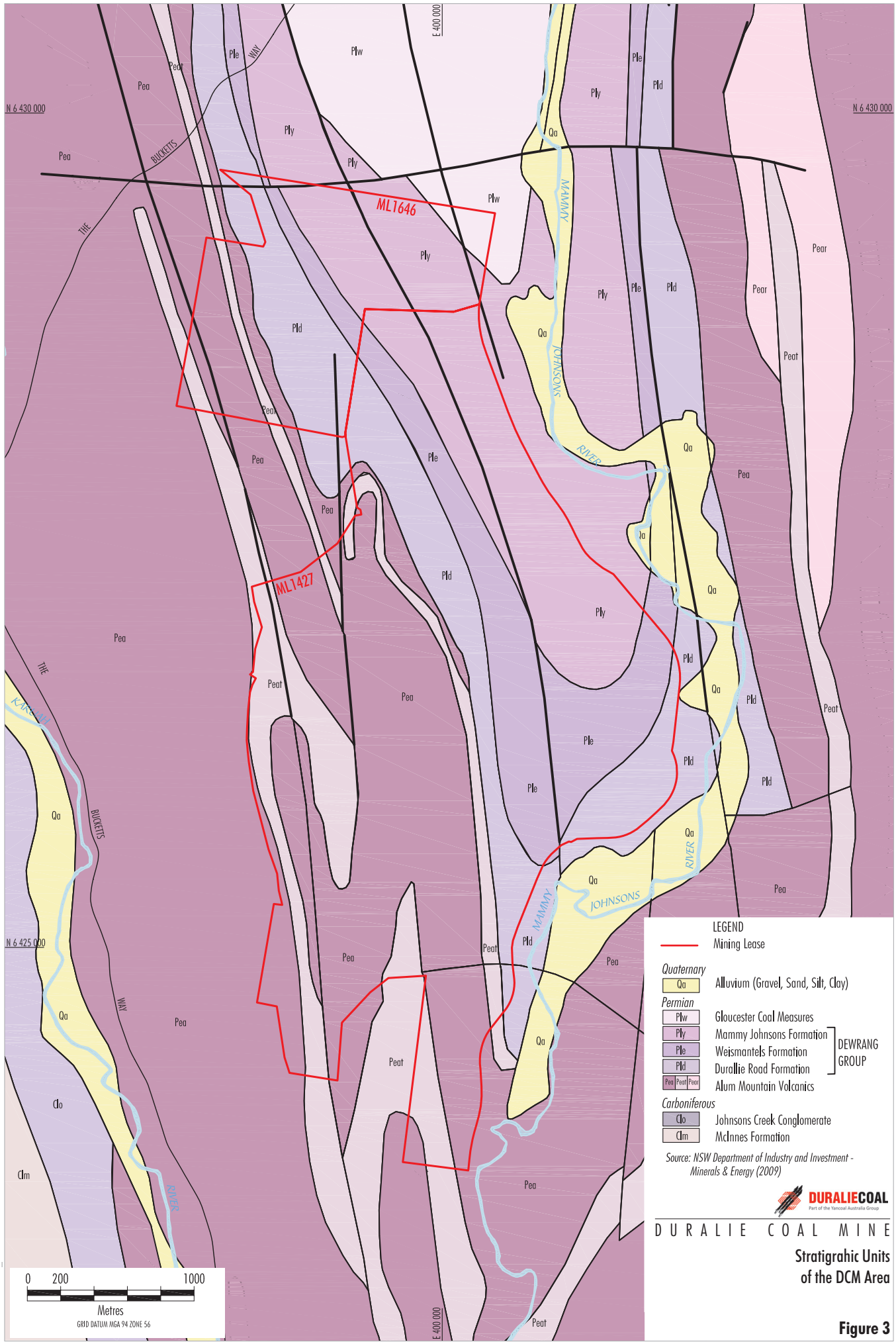
Recharge to the groundwater system is from rainfall and from lateral groundwater flow at the boundaries of the study area. Although groundwater levels are sustained by rainfall infiltration, they are controlled by topography, geology and surface water levels. Local groundwater mounds develop beneath hills and ridgelines. Groundwater moves from these higher elevations toward incised creeks and waterbodies. Groundwater is also lost to evapotranspiration through outcropping sandstone/shales and vegetation where the watertable is within a few metres of the ground surface (HydroSimulations, 2014).

During short events of high surface flow, streams can lose water to the aquifers that host the streams (i.e. leakage), but during recession, the aquifer would discharge water slowly back into the stream from bank storage and slow drainage from the surrounding rock strata (i.e. baseflow) (HydroSimulations, 2014). Baseflow is caused by slow drainage of groundwater from the surrounding rock strata or alluvium. In places where mining has occurred, groundwater discharge is expected to occur to the mined pit in proportion to local permeabilities (HydroSimulations, 2014).

Groundwater recharge is focused into the coal seams where the seams subcrop or outcrop (HydroSimulations, 2014). The deeper groundwater system is of low to very low permeability. The Weismantel and Clareval coal seams are the more permeable layers of the deeper groundwater system.

3.1 GROUNDWATER USE

Groundwater use in the DCM area is predominantly related to mine dewatering at the DCM. The number of privately held bores in the DCM area and surrounds is low due to the high rainfall and subsequent high rates of runoff and widespread use of surface water storages.


N 6 430 000
N 6 425 000
E 400 000
ML1646
ML1427
BUCKETTS WAY
THE KREAN
MAMMY JOHNSONS RIVER
Qa
Pea
Peat
Pear
Plw
Ply
Ple
Pld
Clo
Clm
0 200 1000
Metres
GRID DATUM MGA 94 ZONE 56
LEGEND
Mining Lease
Quaternary
Qa Alluvium (Gravel, Sand, Silt, Clay)
Permian
Plw Gloucester Coal Measures
Ply Mammy Johnsons Formation
Ple Weismantels Formation
Pld Durallie Road Formation
Pea Peat Pear Alum Mountain Volcanics
DEWRANG GROUP
Carboniferous
Clo Johnsons Creek Conglomerate
Clm McInnes Formation
Source: NSW Department of Industry and Investment - Minerals & Energy (2009)
DURALIECOAL
Part of the Yancoal Australia Group
DURALIE COAL MINE
Stratigrahic Units of the DCM Area
Figure 3
YAH-21-37 DMP GWMP_001A

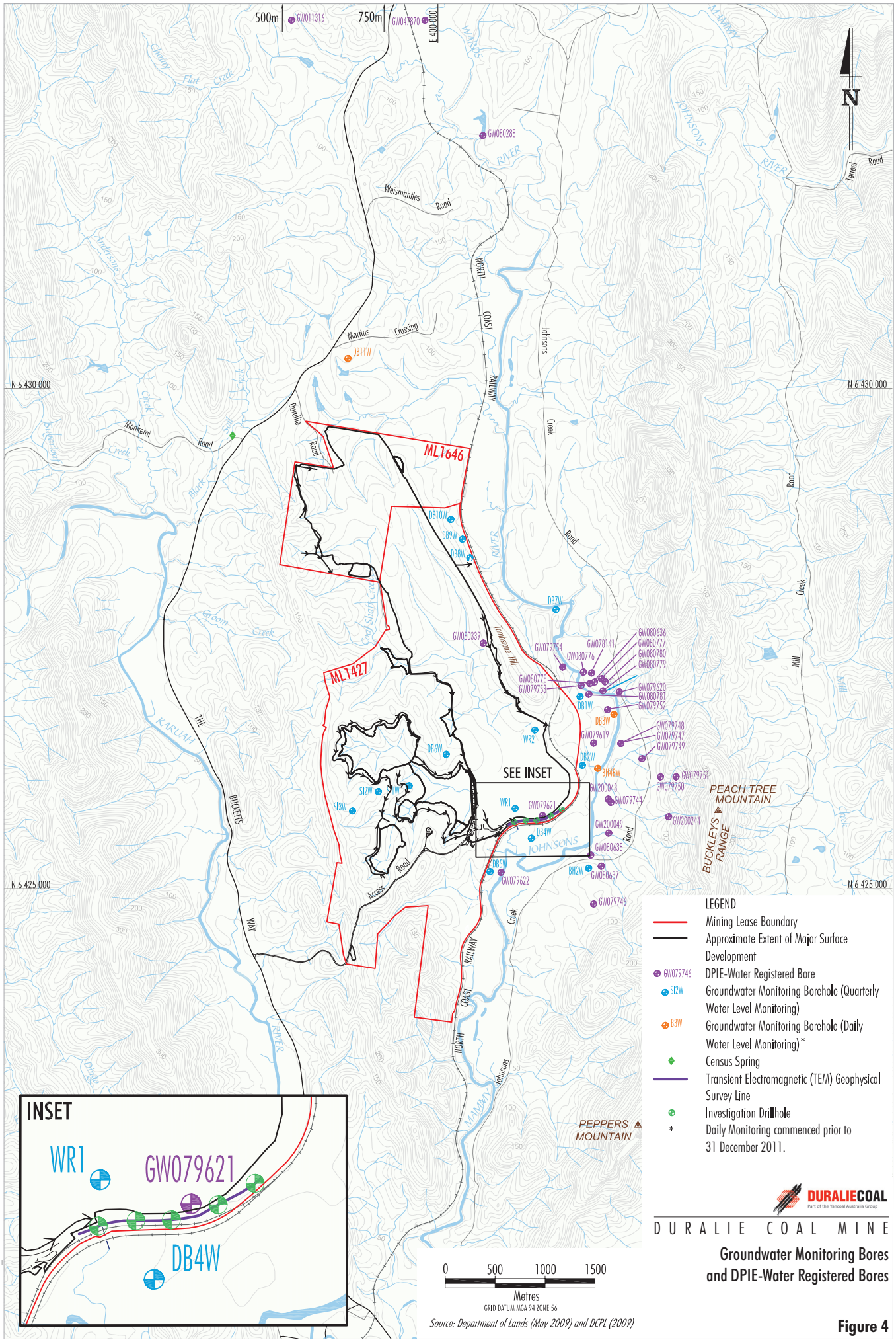
According to the NSW Pinnena bore database (2013), there are 37 registered bores within 5 km of the DCM, three of which are registered production bores (GW080288, GW047870, GW011316) located on privately owned land located at least approximately 3 km to the north of the DCM (Figure 4) (i.e. the remainder of the bores are on GCL-owned land). The licensed use of these bores is stock watering, irrigation and industrial applications.

Bore details for registered bores in the vicinity of the DCM are provided in Attachment B.

A supplementary bore census was undertaken by DCPL in October 2009 to locate any unregistered bores that may also be located on adjacent private properties and obtain additional data on the depth and use of local bores.

No unregistered bores were identified by the bore census, however one spring was recorded on privately owned land in the vicinity of the DCM in a drainage line in or near Black Soil Creek (Figure 4). The spring is located west of the groundwater divide described by Woodward-Clyde (1996), which lies to the west of the ridgeline that effectively screens the DCM from The Bucketts Way (Figure 4).

Since the cessation of mining of the Clareval open pit (now final void), dewatering of the pit has ceased (Section 1.1), and consequently monitoring results indicate commencement of recharge of the Clareval void (DCPL, 2020), which is consistent with the DCM groundwater model predictions (Section 5.1).


500m
750m
E 400 000
N 6 430 000
N 6 425 000
ML1646
ML1427
SEE INSET
INSET
WR1
GW079621
DB4W
Weismantles Road
Martins Crossing
Monkerai Road
Duralie Road
Access Road
Tarbat Road
NORTH COAST RAILWAY
Johnsons Creek
Groom Creek
Red Shard Creek
Tomahawk Hill
KARUAH THE BUCKETS WAY
PEACH TREE MOUNTAIN
BUCKLEYS RANGE
PEPPERS MOUNTAIN
Chainy Flat Creek
Andersons Creek
Sugarloaf Creek
Black Creek
Duke Creek
Mill Creek
MAMMY JOHNSONS RIVER
0 500 1000 1500
Metres
GRID DATUM MGA 94 ZONE 56
Source: Department of Lands (May 2009) and DCPL (2009)
LEGEND
Mining Lease Boundary
Approximate Extent of Major Surface Development
GW079746 DPIE-Water Registered Bore
SI2W Groundwater Monitoring Borehole (Quarterly Water Level Monitoring)
B3W Groundwater Monitoring Borehole (Daily Water Level Monitoring)*
Census Spring
Transient Electromagnetic (TEM) Geophysical Survey Line
Investigation Drillhole
* Daily Monitoring commenced prior to 31 December 2011.
DURALIECOAL
Part of the Yancoal Australia Group
DURALIE COAL MINE
Groundwater Monitoring Bores and DPIE-Water Registered Bores
Figure 4
YAH-21-37 DMP GWMP 002A

4 BASELINE DATA

4.1 HYDROGEOLOGICAL DATA

A detailed description of baseline hydrogeological data is provided in the *Duralie Extension Project Groundwater Assessment* (Heritage Computing, 2009) and *Duralie Coal Mine Extension Project Modification Groundwater Assessment* (HydroSimulations, 2014) which is available on the Duralie Coal website (www.duraliecoal.com.au).

4.2 GROUNDWATER QUALITY MONITORING DATA

A detailed description of baseline groundwater quality is provided in the *Duralie Extension Project Groundwater Assessment* (Heritage Computing, 2009) and *Duralie Coal Mine Extension Project Modification Groundwater Assessment* (HydroSimulations, 2014) which is available on the Duralie Coal website (www.duraliecoal.com.au).

4.3 METEOROLOGICAL MONITORING DATA

A summary of relevant meteorological information in the DCM area is provided in *Duralie Extension Project Groundwater Assessment* (Heritage Computing, 2009) and *Duralie Coal Mine Extension Project Modification Groundwater Assessment* (HydroSimulations, 2014) which is available on the Duralie Coal website (www.duraliecoal.com.au).

5 GROUNDWATER PREDICTIONS AND VALIDATION PROCESS

5.1 GROUNDWATER MODEL PREDICTIONS

A numerical groundwater model developed by HydroSimulations (2014) was used to simulate the potential impacts of the Duralie Extension Project (incorporating the Open Pit Modification) on the local aquifer systems and to estimate the potential quantity of groundwater inflow to the open pits. A summary of the potential impacts on local groundwater aquifers, surface water resources (i.e. Mammy Johnsons River) and on existing groundwater users is presented below.

Shallow (Alluvial) Groundwater System

The analysis of the conceptual groundwater system and modelling results supports the assessment that the shallow alluvial groundwater system in which the Mammy Johnsons River sits, is hydraulically disconnected from the deeper groundwater system. Dewatering of the deeper groundwater system by mining is predicted not to affect the shallow alluvial groundwater system (HydroSimulations, 2014).

Predicted changes in baseflow and natural river leakage as a result of the Duralie Extension Project (incorporating the Open Pit Modification) were modelled by HydroSimulations (2014) for the Mammy Johnsons River. River-aquifer exchanges were compared for transient simulations with and without mining.

The numerical modelling demonstrated that negligible impact on stream baseflow and natural river leakage from the Mammy Johnsons River to the deeper groundwater system is predicted to occur due to drawdown in the deeper system caused by the Duralie Extension Project (incorporating the Open Pit Modification) (HydroSimulations, 2014). The modelling results show that the maximum predicted reduction in groundwater baseflow and river leakage is 0.00005 megalitres per day per square kilometre (ML/day/km^2, equivalent to mm/day) in the Mammy Johnsons River when the size of the catchment is taken into consideration.

This loss of water is anticipated to be immeasurable and 'negligible' as defined in the NSW Project Approval (08_0203), that is *small and unimportant, such as to be not worth considering*.

Deeper Groundwater System

The deeper groundwater system would be partially dewatered/depressurised by the Duralie Extension Project (incorporating the Open Pit Modification). The results of the numerical groundwater model indicate that groundwater flow would move toward the open pit as mining progresses. The numerical model shows substantial reduction in potentiometric head in the aquifers of the deeper groundwater system to the east and north of the DCM area (HydroSimulations, 2014). The numerical model also shows negligible impacts on surface stream baseflows (HydroSimulations, 2014).

The numerical model indicates inflows to the open pits would range from approximately 204 megalitres per annum (ML/annum) to 252 ML/annum over the five years of mining and final pit inflows would equilibrate in the order of 0.1 ML/day at the completion of mining (HydroSimulations, 2014).

Numerical modelling of the post-mining groundwater levels shows slow but complete recovery of the groundwater system over many decades and that the Clareval void, once filled with water, would act as a sink, while the Weismantel void lake would act as a flow-through lake system. To the east of the mine, groundwater flow is expected to be restored to a dominant easterly direction. At the mine itself, the spoil infill would encourage preferential flow in south-southeast direction (HydroSimulations, 2014).

Because the Clareval void will act as a hydraulic sink, any changes in water quality within that will not result in noticeable changes to water quality in surrounding areas. However the Weismantel void lake will act as a flow through system, with the predominant groundwater flow toward the south and south-east, and so there may be an increase in the salinity within the fractured rock and coal measures in this direction (HydroSimulations, 2014).

Surface Water Resources

HydroSimulations (2014) concluded that the coal seams and the alluvium of the Mammy Johnsons River are hydraulically disconnected. Numerical modelling indicates that there would be negligible effect on water levels in the alluvials of the Mammy Johnsons River, on river leakage or on groundwater contribution to baseflow as a result of the Duralie Extension Project (incorporating the Open Pit Modification) (HydroSimulations, 2014).

The spring identified during the bore census is located west of the groundwater divide, which lies to the west of the ridgeline that effectively screens the DCM from The Bucketts Way (HydroSimulations, 2014). HydroSimulations (2014) concluded that the spring is unlikely to be affected by the Duralie Extension Project (incorporating the Open Pit Modification).

Given the localised disturbance of open pit mining, and the negligible effects on river leakage, baseflow and groundwater quality, inconsequential effects on the Mammy Johnsons River are anticipated (HydroSimulations, 2014).

Registered Production Bores

Depressurisation in the deeper groundwater system as a result of the development of the open pits would be naturally limited to the east, west and south by outcropping volcanics (HydroSimulations, 2014). Depressurisation in the aquifers of the deeper groundwater system is therefore expected to propagate only to the north (HydroSimulations, 2014). Attachment C shows the drawdown magnitude and pattern for the Weismantel Seam and Clareval Seam.

Three relatively shallow (<60 m depth) private production bores are located to the north of the DCM area. The maximum predicted drawdown in the Weismantel coal seam varies from 4 to 7 m at the three bores, but the potentiometric level would remain close to ground level (HydroSimulations, 2014). Therefore, the predicted drawdown in the water level in each bore is expected to be negligible (HydroSimulations, 2014).

5.2 GROUNDWATER MODEL VERIFICATION AND REFINEMENT

The numerical model developed by HydroSimulations (2014) as part of the groundwater assessment for the Duralie Open Pit Modification would be used as a management tool for the review and calibration of the prediction of groundwater impacts throughout the DCM life.

The results of the groundwater monitoring program (Section 6) would inform progressive refinement of the numerical model. Revised outputs from the numerical model would be reported periodically over the life of the Duralie Coal Mine and used to inform the site water balance review as described in the Surface Water Management Plan (SWMP) (Appendix 2 of the WAMP).

In addition, core sampling and testing will be conducted during appropriate DCPL drilling within the DCM area, where practicable, to determine aquifer properties within the natural rock strata (e.g. porosity and permeability). DCPL will create a database of testing data throughout the DCM area, which will be used to guide potential future groundwater assessments.

The results of the groundwater model verification and any model refinements will be reported in the Annual Review (Section 9.1).

In the event that actual groundwater drawdown levels exceed the predicted groundwater drawdown levels over the life of the DCM, the groundwater model will be further refined using any new data available to characterise the aquifer systems (Section 7). The groundwater model refinement process (if necessary) will be conducted in consultation with the DPIE-Water.

As described in Section 1.1, a review of the site groundwater model predictions for the post-mining phase of the DCM and a review of the DCM's site water balance (including final void water balance) in consideration of the refined final landform design will be prepared. Once these reviews are complete, this GWMP will be updated to incorporate the results from these assessments.

6 MONITORING PROGRAM

The following groundwater monitoring program has been developed in accordance with Condition 29 (c), Schedule 3 of the NSW Project Approval (08_0203). Table 3 provides a summary of the DCM groundwater monitoring program.

Table 3
Groundwater Monitoring Program

Monitoring Locations[1]		Frequency	Parameters
Open Cut Operations	• Open pit sump(s).	During pumping	• Volume of water extracted.
		Monthly	• Water level[2], pH, EC and Turbidity.
		Monthly	• Total Acidity, Total Alkalinity, Total Suspended Solids (TSS), Chloride, Sulphate (SO_4), Calcium, Magnesium, Aluminium, Iron, Manganese, Zinc.
Mammy Johnsons River	• DB3W, BH4BW (Alluvium).	Daily	• Water level.
		Quarterly	• pH, EC, dissolved oxygen, Total Dissolved Solids (TDS), Total Acidity, Total Alkalinity, Chloride, SO_4, Calcium, Magnesium, Sodium, Aluminium, Iron, Manganese, Zinc.
	• DB1W, DB2W, DB4W, DB5W, DB7W, DB9W, DB10W (Deeper Groundwater).	Quarterly	• Water level, pH, EC, dissolved oxygen, TDS, Total Acidity, Total Alkalinity, Chloride, SO_4, Calcium, Magnesium, Sodium, Aluminium, Iron, Manganese, Zinc.
	• DB8W (Deeper Groundwater)	Quarterly	• Water level.
	• DB11W (Deeper Groundwater).	Daily	• Water level.
		Quarterly	• pH, EC, dissolved oxygen, TDS, Total Acidity, Total Alkalinity, Chloride, SO_4, Calcium, Magnesium, Sodium, Aluminium, Iron, Manganese, Zinc.
Coal Shaft Creek	• DB6W, SI1W, SI2W, SI3W (Deeper Groundwater).	Quarterly	• Water level, pH, EC, dissolved oxygen, TDS, Total Acidity, Total Alkalinity, Chloride, SO_4, Calcium, Magnesium, Sodium, Aluminium, Iron, Manganese, Zinc.
In-pit Waste Rock Emplacement	• WR1, WR2.	Daily	• Water level.
		Quarterly	• pH, EC, dissolved oxygen, TDS, Total Acidity, Total Alkalinity, Chloride, SO_4, Calcium, Magnesium, Sodium, Aluminium, Iron, Manganese, Zinc.

[1] Monitoring locations are shown on Figure 4.

[2] Visual observation of sump level. Sumps are generally kept at a minimum for operations.

Monitoring bores have and will continue to be constructed in accordance with the *Minimum Construction Requirements for Water Bores in Australia* (National Uniform Drillers Licensing Committee, 2020) by an appropriately qualified water bore driller. Bore licences have been and will continue to be obtained from the WaterNSW prior to installation of any new monitoring bores.

A summary of the characteristics of the existing groundwater monitoring bores is provided in Table 4.

Table 4
Groundwater Monitoring Bore Characteristics

Bore	RL (mAHD) (Collar)	RL (mAHD) (Ground)	Date Drilled	Depth (m)	Screen (m)	Formation
DB1W	62.8	62.3	11/2002	36.5	17.5-36.5	Upper Durallie Road Formation
DB2W	63.8	63.3	11/2002	60	40-60	Upper Durallie Road Formation
DB3W	53.5	52.9	01/2003	5.8	4.0-5.5	Alluvium
DB4W	54.1	53.6	11/2002	40	25-40	Upper Durallie Road Formation
DB5W	56.0	55.5	11/2002	40	30-40	Upper Durallie Road Formation
DB6W	93.9	93.5	11/2002	40	25-40	Upper Durallie Road Formation
DB7W	70.5	70	11/2007	15.5	12.5-15.5	Mammy Johnsons Formation
DB8W	-	78	10/2008	51	-	Mammy Johnsons Formation
DB9W	-	75	10/2008	50	44-50	Mammy Johnsons Formation
DB10W	-	75	10/2008	34	28-34	Mammy Johnsons Formation
BH4BW	53.7	53.1	01/2003	5.8	4.3-5.8	Alluvium
SI1W	83.4	82.5	01/2004	16.4	13.4-16.4	Lower Durallie Road Formation
SI2W	108.6	107.7	02/2004	35.7	32.7-35.7	Lower Durallie Road Formation
SI3W	124.2	123.3	01/2004	28.2	25.2-28.2	Lower Durallie Road Formation
WR1	55.0	54.0	03/09/2013	19.3	14-19.3	Waste Emplacement
WR2	78.14	-[#]	03/09/2013	80.0	71-77	Waste Emplacement
DB11W	97.95	-[#]	03/09/2013	51	38-50	Waukivory Creek Formation

[#] Elevation to be included in next revision of the GWMP once survey has been completed.

Groundwater monitoring, water level measurements and sample collection, storage and transportation are undertaken in accordance with the procedures outlined in the *Approved Methods for the Sampling and Analysis of Water Pollutants in NSW* (EPA, 2004). A copy of the EPA's Approved Methods guideline is provided in Attachment D.

Analysis is undertaken by a laboratory which has been accredited by the National Association of Testing Authorities, Australia (NATA) to undertake testing for the parameters being determined. Field testing is undertaken using field equipment that is well maintained and calibrated in accordance with the manufacturer's recommendations.

Data collected by the GWMP will: enable verification and refinement (where necessary) of the groundwater modelling results presented in HydroSimulations (2014); be used in the continued development of groundwater impact assessment criteria and investigation triggers (Section 7); and provide input to annual reviews of groundwater monitoring data (Section 9).

The independent environmental audit (Trevor Brown & Associates, 2011) concluded that the monitoring program (including groundwater) was '*considered adequate to provide data for assessment of the Duralie operations in relation to the MCoA* [Minister's Conditions of Approval] *and EPL requirements and to assess consistency with the predictions in the EIS, Environmental Assessments and Statements of Environmental Effects.*'

6.1 GROUNDWATER INFLOWS TO OPEN CUT MINING OPERATIONS

Groundwater seepage and surface water runoff will collect in pit sumps. Water level[1], pH, EC and turbidity of the collected water will be monitored on a monthly basis[2], with more comprehensive water quality analysis also undertaken on a monthly basis. The volumes of water extracted from the pit sumps will also be recorded. Maintenance of the device used to measure the volume of water extracted from the pit sumps will continue to be undertaken in a manner which is acceptable to DPIE-Water.

A site water balance review will be undertaken on an annual basis to monitor the status of inflows (including groundwater inflows to open pits), storage and consumption. The site water balance review will be used to optimise water management performance and will enable corrective actions to be implemented, if required (as described in the SWMP [Appendix 2 of the WAMP]). The results of the water balance reviews will be reported in the Annual Review (Section 9.1).

As described in Section 1.1, dewatering of the Clareval open pit (i.e. pumping from the Clareval pit sump) has now ceased. Notwithstanding, inflow and water level monitoring will continue to be conducted at the Clareval void to verify groundwater model predictions. Following the cessation of mining in the open pits, access to the pit sumps may become unsafe and direct water quality monitoring would cease. Water level monitoring would continue.

6.2 ALLUVIAL AQUIFERS

Two alluvium bores will be monitored in the vicinity of Mammy Johnsons River (i.e. DB3W and BH4BW) (Figure 4). Alluvium bores are equipped to measure water level daily. Field pH, field EC, and field dissolved oxygen will be monitored on a quarterly basis. Laboratory analyses for TDS, total acidity, total alkalinity, chloride, sulphate, calcium, magnesium, sodium, aluminium, iron, manganese and zinc, will also be undertaken quarterly.

To address the requirements of Condition 29(c), Schedule 3 of the Project Approval (08_0203) which requires a program to investigate the potential for direct interface between mine spoil and alluvium and an assessment of any consequential impact on alluvial and surface water, DCPL commissioned Dr Noel Merrick (HydroSimulations) to prepare the Interface Investigation Program – Waste Emplacement and Alluvium (Attachment F).

In accordance with the recommendations of this report, DCPL will conduct an investigation program which will include three stages (Attachment F):

- investigation;
- monitoring; and
- analysis.

These phases are discussed further below.

Investigation

The investigation phase of the program will include (Attachment F):

- Transient Electromagnetic (TEM) geophysical survey along one transect along or near the southern boundary of ML 1427 (Figure 4).

[1] Visual observation of sump level. Sumps are generally kept at a minimum for operations.

[2] Subject to safe access to the pit sumps.

- Drilling and logging of up to five holes at regular (100 to 150 m) intervals along the TEM transect (selected based on the results of TEM and drilling results).
- Installation of up to two shallow monitoring bores at the most appropriate drillhole sites (selected based on the results of TEM and drilling results).

The TEM geophysical survey was completed in 2020, with the next phases (drilling and logging of holes; and installation of shallow monitoring bores) anticipated to be completed by the end of 2021.

Monitoring

The monitoring program for the additional monitoring bore(s) is outlined in Table 5.

Table 5
Additional Monitoring Program

Location	Frequency	Parameter
Additional monitoring bore(s)	Continuously*	Water level
	Quarterly	pH, EC, DO, temperature
	Quarterly	pH, reduction potential (Eh), EC, major cations, major anions and metals

* Continuous monitoring would be undertaken for a period of two years (i.e. up to July 2017) and quarterly thereafter.

Analysis

The following information will be analysed to inform the potential of any interface between mine spoil and alluvium (Attachment F):

- degree of saturation of any alluvium or unconsolidated deposits;
- direction of any discernible shallow groundwater gradient, based on:
  - water levels in new monitoring bores;
  - local surveyed Mammy Johnsons River bed level and High Noon Gauging Station records; and
  - groundwater levels in existing monitoring bores BH4W, WR1 and DB4W;
- groundwater chemistry changes suggesting potential groundwater movement from the overburden emplacement toward Mammy Johnsons River; and
- comparison of monitored water levels near the Coal Shaft Creek confluence with modelled results to verify the model.

6.3 CONNECTIVITY AND BASEFLOWS TO MAMMY JOHNSONS RIVER

The potential for any increase in connectivity between the Mammy Johnsons River and deeper groundwater systems will be monitored through monitoring of groundwater inflows to open pits (Section 6.1) and water levels in alluvium bores (Section 6.2). Flow monitoring will be undertaken as described in the SWMP (Appendix 2 of the WAMP).

In the unlikely event that groundwater inflows to open pits and water levels in alluvium bores indicate an increase in connectivity between the Mammy Johnsons River and deeper groundwater systems, DCPL monitoring at High Noon may be used in conjunction with data from the DCM automatic weather station (AWS) and DPIE-Water gauging station GS209002 (on the Mammy Johnsons River) to determine any potential impact on stream baseflow and/or natural river leakage from the Mammy Johnsons River to the deeper groundwater system (Section 7).

6.4 LANDHOLDER BORES AND DCPL MONITORING BORES

As described in Section 5.1, predicted drawdown as a result of the Duralie Extension Project (incorporating the Open Pit Modification) in the water levels in known privately-owned bores are expected to be negligible.

Groundwater monitoring will be undertaken at existing bores surrounding the DCM area at the request of relevant landholders. DCPL has contacted relevant landholders to inform them that their bores could be monitored if requested.

In addition, monitoring of DCPL bores (Table 3 and Figure 4) will be conducted on a regular basis (Table 2) to monitor groundwater levels and quality compared to groundwater model predictions.

6.5 WATER STORAGES AND BACKFILLED VOIDS – GROUNDWATER SEEPAGE

Monitoring bores WR1 and WR2 (Figure 4) monitor groundwater levels and quality within the waste rock emplacement to provide information on the recharge rates and spoil permeabilities and to validate modelling assumptions and predictions (Table 3). In addition, groundwater inflows to the open pits will be monitored as described in Section 6.1. Consistent with groundwater modelling predictions (Section 5.1), the waste emplacement monitoring bores (WR Series) indicate signs of recharging of the partially backfilled Clareval void, particularly at WR1 (DCPL, 2020).

In addition, as described in the SWMP (Appendix 2 of the WAMP), water quality monitoring will be conducted in water storages, Coal Shaft Creek and Mammy Johnsons River to detect any anomalous changes in water quality that may be attributed to groundwater seepage.

7 ASSESSMENT OF PERFORMANCE INDICATORS AND MEASURES

In accordance with Condition 29 (c), Schedule 3 of NSW Project Approval (08_0203), DCPL has developed:

- performance measures (groundwater assessment criteria), including performance indicators (trigger levels) for investigating any potentially adverse groundwater impacts; and
- a plan to respond to any exceedances of the performance criteria, including:
  - development of a trigger action response plan (TARP) for potential salinity impacts on alluvial and surface water sources, in the event a direct interface between mine spoil and alluvium is identified; and
  - a plan to offset the loss of any base flow to Mammy Johnsons River caused by the Duralie Extension Project (incorporating the Open Pit Modification).

7.1 PERFORMANCE MEASURES

DCPL will assess the Duralie Extension Project (incorporating the Open Pit Modification) against the groundwater performance indicators and measures outlined in Table 6.

Table 6
Summary of Groundwater Performance Indicators and Measures

Performance Measure	Performance Indicator(s)
No more than negligible[1] impact on stream baseflow and/or natural river leakage of Mammy Johnsons River to the deeper groundwater system as a result of the Duralie Extension Project (incorporating the Open Pit Modification).	Groundwater inflows to open pits are consistent with Duralie Open Pit Modification Environmental Assessment (EA) predictions (refer Section 5.1 and Table 7).
	Groundwater levels in alluvium bores are consistent with Duralie Open Pit Modification EA predictions (accounting for temporal changes in rainfall recharge[2]) (refer Section 5.1 and Table 7).
No more than negligible[1] impact on water levels in groundwater production bores on privately-owned land as a result of the Duralie Extension Project (incorporating the Open Pit Modification).	No groundwater related complaints received (refer Table 7).

[1] Consistent with the NSW Project Approval (08_0203), the term 'negligible' is defined as "*small and unimportant, such as to be not worth considering*".

[2] Refer to Section 4.1.

Section 6 describes the monitoring that will be conducted to inform the assessment of the DCM against the performance indicators and measures for groundwater. The monitoring program includes the monitoring of:

- groundwater inflows to open cut mining operations (Section 6.1);
- water levels and quality of alluvial aquifers (Section 6.2);
- water levels and quality of alluvial aquifer investigation bores (Section 6.2)
- water levels and quality of DCPL monitoring bores (Section 6.4); and
- indicators of potential groundwater seepage from water storages and backfilled voids (Section 6.5).

The monitoring results will be used to assess the DCM against the performance indicators and performance measures as detailed in Table 7 (refer over page). If data analysis indicates a performance indicator has been exceeded or is likely to be exceeded, an assessment will be made against the performance measure. If a performance measure is considered to have been exceeded, the Contingency Plan will be implemented (Section 8). DCPL will implement suitable contingency measures (Section 8) and continue to monitor (Section 6). If data analysis indicates that the performance measure has not been exceeded, DCPL will continue to monitor.

7.2 TRIGGER ACTION RESPONSE PLAN (TARP)

In the event the investigation into alluvial connectivity outlined in Section 6.2 identifies a direct interface between mine spoil and alluvium, DCPL will develop a TARP to avoid potential salinity impacts on alluvial and surface water sources in accordance with Condition 29(c), Schedule 3 of Project Approval (08_0203). The TARP will be based on the conceptual TARP outlined in Table 8.

The TARP will be based on results of ongoing water quality sampling for pH and EC levels at the shallow monitoring bore(s) (developed as part of the investigation into alluvial connectivity [Section 6.2]), DCPL will develop three water quality trigger levels for these bore(s) in consultation with the DPIE-Water and DPIE. The proposed actions corresponding to each proposed trigger are outlined in Table 8.

Table 8
Conceptual Trigger Action Response Plan

Trigger		Action/Response
Level 1	pH and EC levels above Trigger Level 1	• Detailed analysis of water quality sampling data to assess the likely source of such a result.
Level 2	pH and EC levels above Trigger Level 2	• Detailed analysis of water quality sampling data to assess the likely source of such a result. • Notification of DPIE-Water. • Immediate sampling and laboratory analysis of pH, EC, Eh, cations, anions, and metals.
Level 3	pH and EC levels above Trigger Level 3	• Notification of DPIE-Water. • Consideration of actions to prevent further migration of plume with relative poor water quality (i.e. installation of new bore or pumping from existing bore to capture any plume).

Table 7
Monitoring Against Performance Indicators and Measures

Performance Measure	Monitoring of Environmental Consequences			Data Analysis to Assess against Performance Indicator(s)	Performance Indicator(s)	Assessment of Performance Indicator(s)	Assessment of Performance Measure	Relevant Management and Contingency Measures
	Sites	**Parameters**	**Frequency**					
No more than negligible impact on stream baseflow and/or natural river leakage of the Mammy Johnsons River to the deeper groundwater system as a result of the Duralie Extension Project (incorporating the Open Pit Modification).	• Open pit sump(s) • Meteorological Station • High Noon	• Volume of water extracted • Rainfall • Streamflow	• During pumping • Daily • Monthly/Event	• Analysis of water collected in pit sumps to calculate approximate groundwater inflows (i.e. by taking account of rainfall/runoff to the pit sumps) on an annual basis and comparison to predictions in the Duralie Open Pit Modification EA.	• Groundwater inflows to open pits are consistent with Duralie Open Pit Modification EA predictions.	• The performance indicator will be considered to have been exceeded if data analysis indicates that groundwater inflows to the open pits are greater than the predictions in the Duralie Open Pit Modification EA (i.e. outside the bounds of the sensitivity analysis, refer to Attachment E). • If data analysis indicates the performance indicator has been exceeded, the performance measure will be assessed to determine if there has been a greater than negligible change in the stream baseflow and/or natural river leakage of Mammy Johnsons River caused by the Duralie Extension Project (incorporating the Open Pit Modification).	The performance measure is exceeded if: • Analysis of the monitoring and modelling results confirms that the Duralie Extension Project (incorporating the Open Pit Modification) has resulted in a greater than negligible change in the stream baseflow and/or natural river leakage of Mammy Johnsons River. • The above analysis will include consideration of streamflow gaugings at High Noon and DPIE-Water gauging stations. • The above analysis will also consider groundwater EC results from the groundwater monitoring program (Table 5). • The above analysis will be peer reviewed by a specialist approved by the DPIE. • The results will be reported to DPIE and DPIE-Water. • If the performance measure has been exceeded, the Contingency Plan will be implemented (Section 8).	• Additional monitoring (e.g. increase in monitoring frequency or additional sampling). • Offsets – retirement of water entitlements.
	• DB3W, BH4BW • High Noon	• Water Level • Streamflow	• Daily • Monthly/Event	• Analysis of groundwater levels in alluvial bores on an annual basis.	• Groundwater levels in alluvium bores are consistent with Duralie Open Pit Modification EA predictions (accounting for temporal changes in rainfall recharge).	• The performance indicator will be considered to have been exceeded if data analysis indicates there has been a statistically significant reduction in groundwater levels in alluvial bores, specifically: - if the sliding 7-day averages in water levels fall more than 2 standard deviations below the long-term (at least one year) average. • If data analysis indicates the performance indicator has been exceeded, the performance measure will be assessed to determine if there has been a greater than negligible change in the stream baseflow and/or natural river leakage of Mammy Johnsons River caused by the Duralie Extension Project (incorporating the Open Pit Modification).		

Table 7 (continued)
Monitoring Against Performance Indicators and Measures

Performance Measure	Monitoring of Environmental Consequences			Data Analysis to Assess against Performance Indicator(s)	Performance Indicator(s)	Assessment of Performance Indicator(s)	Assessment of Performance Measure	Relevant Management and Contingency Measures
	Sites	Parameters	Frequency					
No more than negligible impact on water levels in groundwater production bores on privately-owned land as a result of the Duralie Extension Project (incorporating the Open Pit Modification).	• N/A • DB11W	• Complaints • Water Level	• When received • Daily	• Review of complaints register.	• No groundwater related complaints received.	• If a complaint is received, the performance measure will be assessed to determine if the Duralie Extension Project (incorporating the Open Pit Modification) has resulted in a greater than negligible change in water levels in groundwater production bores on privately-owned land	The performance measure is exceeded if: • Analysis of the monitoring and modelling results confirms that the Duralie Extension Project (incorporating the Open Pit Modification) has resulted in a greater than negligible change in water levels in groundwater production bores on privately-owned land. • The above analysis will include consideration of monitoring results at DB11W. • The above analysis will be peer reviewed by a specialist approved by the DPIE. • The results will be reported to DPIE and DPIE-Water. • If the performance measure has been exceeded, the Contingency Plan will be implemented (Section 8).	• Additional monitoring (e.g. increase in monitoring frequency or additional sampling). • Provision of equivalent water supply or compensation.

8 CONTINGENCY PLAN

In the event a performance measure detailed in Section 7 is considered to have been exceeded, DCPL will implement the following Contingency Plan:

- The Environmental Coordinator will immediately report the likely exceedance to the General Manager within 24 hours of assessment completion.
- DCPL will report the exceedance of the performance measure to the DPIE and DPIE-Water as soon as practicable after DCPL becomes aware of the exceedance.
- DCPL will identify an appropriate course of action (e.g. potential contingency measures described below) with respect to the identified impact(s), in consultation with specialists and DPIE and/or DPIE-Water, as necessary.
- DCPL will, on request, submit the proposed course of action to the DPIE for approval.
- DCPL will implement the approved course of action to the satisfaction of the DPIE.

DCPL holds two surface water licences on the Mammy Johnsons River, which have a total extraction allowance equivalent to 19 megalitres per annum. In the unlikely event that more than negligible losses are recorded, DCPL would use these licences as a contingency to account for any losses from the Mammy Johnsons River, and would retire adequate water entitlements to account for the loss calculated as attributable to the Duralie Extension Project (incorporating the Open Pit Modification).

Privately-owned Landholder Bores

If the performance measure is exceeded such that there is a more than negligible impact on water levels in groundwater production bores on privately-owned land as a result of the Duralie Extension Project (incorporating the Open Pit Modification), DCPL will investigate appropriate remedial measures which may include:

- deepening the affected groundwater supply;
- construction of a new groundwater supply; and/or
- provision of an alternative water supply.

The exact nature of remedial measures will be determined in consultation with the affected landholder. Equivalent water supply will be provided (at least on an interim basis) within 24 hours of the loss being identified.

If an alternative water supply source is to be provided, it will be DCPL's responsibility to obtain a licence and pay for this source, in consultation with the relevant landholder(s). The nature of the source will depend on the location of the affected landholder and the availability of nearby sources.

If an alternative long-term water supply source is unable to be provided, DCPL may provide alternative compensation in consultation with the relevant landholder(s) and to the satisfaction of the Secretary of DPIE.

The nature of the measures implemented will be reported to DPIE-Water and DPIE. Where agreement cannot be reached on the measures to be implemented, DCPL may refer the matter to DPIE for resolution.

9 REVIEW AND IMPROVEMENT OF ENVIRONMENTAL PERFORMANCE

9.1 ANNUAL REVIEW

In accordance with Condition 3, Schedule 5 of the NSW Project Approval (08_0203), DCPL prepares an Annual Review of the environmental performance of the DCM prior to the end of December each year. Annual Reviews are made publicly available on the Duralie Coal website, in accordance with Condition 10, Schedule 5 of the NSW Project Approval (08_0203).

The Annual Review will specifically address the following aspects of Condition 3, Schedule 5 that are directly relevant to water management:

- include a summary of any new bores or pits constructed over the past year;
- include a comprehensive review of the monitoring results and complaints records for the DCM over the past year, including a comparison of these results against the:
  - relevant statutory requirements, limits or performance measures/criteria;
  - monitoring results of previous years; and
  - relevant predictions in the Duralie Open Pit Modification EA;
- identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;
- identify any trends in the monitoring data over the life of the DCM;
- identify any discrepancies between the predicted and actual impacts of the DCM, and analyse the potential cause of any significant discrepancies; and
- describe what measures will be implemented over the next year to improve the environmental performance of the DCM.

This GWMP will be reviewed within three months of the submission of an Annual Review, and revised where appropriate, as described in Section 9.2.

9.2 GWMP REVIEW

In accordance with Condition 4, Schedule 5 of the NSW Project Approval (08_0203), this GWMP will be reviewed and if necessary revised to the satisfaction of the Secretary of the DPIE, within three months of the submission of:

- an Annual Review, in accordance with Condition 3, Schedule 5 of Project Approval (08_0203);
- an Incident Report, in accordance with Condition 6, Schedule 5 of Project Approval (08_0203);
- an audit, in accordance with Condition 9, Schedule 5 of Project Approval (08_0203);
- any modification to the conditions of Project Approval (08_0203); or
- prior to the commencement of clearing in accordance with the *Duralie Open Pit Modification Environmental Assessment* (DCPL, 2014).

This GWMP will also be reviewed and if necessary revised, if results of the groundwater monitoring programme indicate that refinement of the numerical groundwater model is required (Section 5.2).

This GWMP will be made publicly available on the Duralie Coal website in accordance with NSW Project Approval (08_0203). A hard copy of the GWMP will also be kept at the DCM.

10 REPORTING PROTOCOLS

In accordance with Condition 2(g), Schedule 5 of the NSW Project Approval (08_0203), DCPL has developed protocols for managing and reporting the following:

- incidents;
- complaints;
- non-compliances with statutory requirements;
- exceedances of the impact assessment criteria and/or performance criteria.

The management of incidents is described in the Pollution Incident Response Management Plan. The management of complaints and non-compliances is described in detail in the Environmental Management Strategy. Management and reporting of exceedances of impact assessment criteria and/or performance criteria are described in Sections 7 and 8.

11 REFERENCES

Duralie Coal Pty Ltd (2014) Duralie Open Pit Modification Environmental Assessment.

Duralie Coal Pty Ltd (2020) *Duralie Coal Mine Annual Review 2020*.

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HydroSimulations (2015) *Duralie Coal Mine Interface Investigation Program – Waste Emplacement and Alluvium*.

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ATTACHMENT A

GROUNDWATER MONITORING AND CONTINGENCY PLAN

Groundwater Monitoring and Contingency Plan

Water Level and Quality

Alluvial Groundwater Monitoring - (Shallow Bores)

Bore Description	Licence Number	Type of bore (e.g. monitoring or production)	Location Description	Property Id Lot/DP	Coordinates (GPS)		Monitoring Target/s	Monitoring Effect of - e.g. Natural and any Pumping-Induced Water Level Changes.	Height (mAHD)	Depth (m)	Monitoring Depth/s	Sampling Frequency, e.g. Dedicated water level loggers, measurements at hourly intervals. Field EC, pH, DO weekly for first month then review whether monthly to be adopted. Bore marked * have telemetry facilities rather than data loggers	Sampling Parameters, e.g. SWL, field testing EC, pH, DO. Laboratory analysis of TDS and major anions and cations.	Frequency of Data Download, e.g. Weekly with field chemistry for the first month then review whether monthly frequency may be adopted. Retain weekly until reviewed.	Trigger Value or level indicating potential impact, Gradual reduction in water level or dramatic decline. Relevance or otherwise to be determined by monitoring prior to pumping after a rain fall event to assess if a water level is ever present.			Action Required Assess data, establish trends and relate to pumping regimes and climatic data. Also report in Contingency worksheet.	Any follow up actions Progressive assessment of trends with prediction of any potential impacts. Determine whether the changes due to impacts from pumping, if so modify the pumping schedule so that impact is removed.	Additional reporting to Office of Water, If agreed trigger parameters exceed , further reporting on parameters @ month 1, 2, 3 & 6
					Easting	Northing									Level*	pH	EC			
DB3W	20BL168404	Monitoring	See Figure 1	Lot 125 DP 95694	401762	6426743	Water Quality and Drawdown Gradient	Natural and pumping-induced water level changes and groundwater quality	53.5	5.8	4.0-5.5	Daily Quarterly	Water Level pH, EC, dissolved oxygen, TDS, Total Acidity, Total Alkalinity, Chloride, SO_4, Calcium, Magnesium, Sodium, Aluminium, Iron, Manganese, Zinc.	Quarterly Quarterly	Consistent with Duralie Extension Project EA Predictions. No groundwater complaints.	Min: 6.0 Max 8.0	Min: 100 Max: 7600	Assess data and establish trends	Progressive assessment of trends to determine causes and predict potential impacts	Quarterly reporting of Trigger Level Exceedances to NOW
BH4BW	20BL168404	Monitoring	See Figure 1	Lot 126 DP 95695	401600	6426205	Water Quality and Drawdown Gradient	Natural and pumping-induced water level changes and groundwater quality	53.7	5.8	4.3-5.8	Daily Quarterly	Water Level pH, EC, dissolved oxygen, TDS, Total Acidity, Total Alkalinity, Chloride, SO_4, Calcium, Magnesium, Sodium, Aluminium, Iron, Manganese, Zinc.	Quarterly Quarterly	Consistent with Duralie Extension Project EA Predictions. No groundwater complaints.	Min: 6.0 Max 8.0	Min: 100 Max: 7600	Assess data and establish trends	Progressive assessment of trends to determine causes and predict potential impacts	Quarterly reporting of Trigger Level Exceedances to NOW

Groundwater Monitoring and Contingency Plan

Metered pumps

Mine Pits - water quantity and quality														
Pit	**Licence Number**	**Location Description**	**Property Id Lot/DP**	**Coordinates (GPS)**	**Monitoring Target/s**, e.g. water quantity	**Monitoring Effect of,** e.g. Natural and any Pumping-Induced Water Level Changes.	**Monitoring Points**	**Measuring Device Meter**	**Annual set water budget,** Volume in KL)	**Frequency of Data Download,** e.g. Weekly with field chemistry, including parameters pH, etc	**Trigger Value or level indicating potential impact,** Gradual reduction in water level or dramatic decline. Relevance or otherwise to be determined by monitoring prior to pumping after a rain fall event to assess if a water level is ever present.	**Action Required.** Calculate volume of groundwater extraction, variation in water quality. **Also report in Contingency worksheet.**	**Any follow up actions,** Monitor the volume against the annual set water budget volume	**Additional reporting to Office of Water,** If agreed trigger parameters exceed, further reporting on parameters on quarterly (3-months) basis
Weismantel	20BL168404	Weismantel Pit	Lot 22 DP 95765	N/A	Water Quantity	Pumping-Induced Water Level Changes	Discharge End	Dopler Electromagnetic Flow Meter	300000	Real-time	300 ML	Calculate level of Groundwater Extraction	Monitor volume against Annual Set Water Budget	Quarterly reporting of Budget Exceedances to NOW
Clareval	20BL168404	Clareval Pit	Lot 1 DP 595876	N/A	Water Quantity	Pumping-Induced Water Level Changes	Pump	Pump rates	N/A	Weekly	N/A	Calculate level of Groundwater Extraction	Monitor volume against Annual Set Water Budget	Quarterly reporting of Budget Exceedances to NOW

Groundwater Monitoring and Contingency Plan

Hard Rock Groundwater Monitoring (Monitoring/Dewatering/ Production Bores)

Bore Description (see note)	**Licence Number**	**Location Description**	**Property Id Lot/DP**	**Coordinates** (GPS)		**Monitoring Target/s,** e.g. Water Quality plus Drawdown gradient	**Monitoring Effect of,** e.g. Pumping at Design Flow Rates and investigate a number of pumping arrangements to determine sensitivities	**Height (mAHD)**	**Depth (m)**	**Monitoring Depth/s**	**Sampling Frequency**, e.g. Telemetry Used to record water level . Baseline then weekly water quality sampling individual bore and testing for first month then monthly thereafter on a composite basis. *Bore 9 has chemical testing only - not equipped for water level data collection	**Sampling Parameters,** e.g. Field testing EC, pH, DO. Laboratory analysis of TDS and major anions and cations for each bore, Monitor for Hydrocarbons at No.11	**Frequency of Data Download**, e.g. Monthly with field chemistry for the first month then review whether quarterly frequency may be adopted. Retain monthly until reviewed.	**Trigger Value or level indicating potential impact,** e.g. Excessive level of contamination, isolate bore ASAP, increase sampling frequency			**Action Required** Assess data, establish trends and relate to pumping regimes and climatic data. **Also report in Contingency worksheet.**	**Any follow up actions -** Progressive assessment of trends with prediction of any potential impacts. Determine whether the changes due to impacts from pumping, if so modify the pumping schedule so that impact is removed. Increased frequency on monitoring as required	**Additional reporting to Office of Water,** If agreed trigger parameters exceed, further reporting on parameters on quarterly (3-months) basis
				Easting	**Northing**									**Water Level**	**pH**	**EC**			
DB1W	20BL168404	See Figure 1	Lot 125 DP 95694	401423	6426922	Water Quality and Drawdown	Natural and pumping-induced water level changes and groundwater quality	62.8	36.5	17.5-36.5	Quarterly	Water Level, pH, EC, Dissolved oxygen, TDS, Total Acitidity, Total Alkalinity, Chloride, SO_4, Calcium, Magnesium, Sodium, Aluminium, Iron, Manganese, Zinc.	Quarterly	Consistent with Duralie Extension Project EA Predictions. No groundwater complaints.	Min: 6.0 Max 8.0	Min: 100 Max: 7600	Assess data and establish trends.	Progressive assessment of trends to determine causes and predict potential impacts.	Quarterly reporting of Trigger Level Exceedances to NOW.
DB2W	20BL168404	See Figure 1	Lot 126 DP 95695	401447	6426235	Water Quality and Drawdown	Natural and pumping-induced water level changes and groundwater quality	63.8	5.8	4.0-5.5	Quarterly	Water Level, pH, EC, Dissolved oxygen, TDS, Total Acitidity, Total Alkalinity, Chloride, SO_4, Calcium, Magnesium, Sodium, Aluminium, Iron, Manganese, Zinc.	Quarterly	Consistent with Duralie Extension Project EA Predictions. No groundwater complaints.	Min: 6.0 Max 8.0	Min: 100 Max: 7600	Assess data and establish trends.	Progressive assessment of trends to determine causes and predict potential impacts.	Quarterly reporting of Trigger Level Exceedances to NOW.
DB4W	20BL168404	See Figure 1	Lot 130 DP 95768	400936	6425505	Water Quality and Drawdown	Natural and pumping-induced water level changes and groundwater quality	54.1	40	25-40	Quarterly	Water Level, pH, EC, Dissolved oxygen, TDS, Total Acitidity, Total Alkalinity, Chloride, SO_4, Calcium, Magnesium, Sodium, Aluminium, Iron, Manganese, Zinc.	Quarterly	Consistent with Duralie Extension Project EA Predictions. No groundwater complaints.	Min: 6.0 Max 8.0	Min: 100 Max: 7600	Assess data and establish trends.	Progressive assessment of trends to determine causes and predict potential impacts.	Quarterly reporting of Trigger Level Exceedances to NOW.
DB5W	20BL168404	See Figure 1	Lot C DP 160430	400522	6425170	Water Quality and Drawdown	Natural and pumping-induced water level changes and groundwater quality	56	40	30-40	Quarterly	Water Level, pH, EC, Dissolved oxygen, TDS, Total Acitidity, Total Alkalinity, Chloride, SO_4, Calcium, Magnesium, Sodium, Aluminium, Iron, Manganese, Zinc.	Quarterly	Consistent with Duralie Extension Project EA Predictions. No groundwater complaints.	Min: 6.0 Max 8.0	Min: 100 Max: 7600	Assess data and establish trends.	Progressive assessment of trends to determine causes and predict potential impacts.	Quarterly reporting of Trigger Level Exceedances to NOW.
DB6W	20BL168404	See Figure 1	Lot 6 DP 876013	400083	6426345	Water Quality and Drawdown	Natural and pumping-induced water level changes and groundwater quality	93.9	40	25-40	Quarterly	Water Level, pH, EC, Dissolved oxygen, TDS, Total Acitidity, Total Alkalinity, Chloride, SO_4, Calcium, Magnesium, Sodium, Aluminium, Iron, Manganese, Zinc.	Quarterly	Consistent with Duralie Extension Project EA Predictions. No groundwater complaints.	Min: 6.0 Max 8.0	Min: 100 Max: 7600	Assess data and establish trends.	Progressive assessment of trends to determine causes and predict potential impacts.	Quarterly reporting of Trigger Level Exceedances to NOW.
DB7W	20BL168404	See Figure 1	Lot 636 DP 95742	401183	6427793	Water Quality and Drawdown	Natural and pumping-induced water level changes and groundwater quality	70.5	15.5	12.5-15.5	Quarterly	Water Level, pH, EC, Dissolved oxygen, TDS, Total Acitidity, Total Alkalinity, Chloride, SO_4, Calcium, Magnesium, Sodium, Aluminium, Iron, Manganese, Zinc.	Quarterly	Consistent with Duralie Extension Project EA Predictions. No groundwater complaints.	Min: 6.0 Max 8.0	Min: 100 Max: 7600	Assess data and establish trends.	Progressive assessment of trends to determine causes and predict potential impacts.	Quarterly reporting of Trigger Level Exceedances to NOW.
DB8W	20BL168404	See Figure 1	Lot 30 DP 95765	400245	6428495	Drawdown	Natural and pumping-induced water level changes	78	51	Equal to Water Level	Quarterly	Water Level	Quarterly	Consistent with Duralie Extension Project EA Predictions. No groundwater complaints.	N/A	N/A	Assess data and establish trends.	Progressive assessment of trends to determine causes and predict potential impacts.	Quarterly reporting of Trigger Level Exceedances to NOW.
DB9W	20BL168404	See Figure 1	Lot 30 DP 95765	400321	6428310	Water Quality and Drawdown	Natural and pumping-induced water level changes and groundwater quality	75	50	44-50	Quarterly	Water Level, pH, EC, Dissolved oxygen, TDS, Total Acitidity, Total Alkalinity, Chloride, SO_4, Calcium, Magnesium, Sodium, Aluminium, Iron, Manganese, Zinc.	Quarterly	Consistent with Duralie Extension Project EA Predictions. No groundwater complaints.	Min: 6.0 Max 8.0	Min: 100 Max: 7600	Assess data and establish trends.	Progressive assessment of trends to determine causes and predict potential impacts.	Quarterly reporting of Trigger Level Exceedances to NOW.
DB10W	20BL168404	See Figure 1	Lot 30 DP 95765	400130	6428694	Water Quality and Drawdown	Natural and pumping-induced water level changes and groundwater quality	75	34	28-34	Quarterly	Water Level, pH, EC, Dissolved oxygen, TDS, Total Acitidity, Total Alkalinity, Chloride, SO_4, Calcium, Magnesium, Sodium, Aluminium, Iron, Manganese, Zinc.	Quarterly	Consistent with Duralie Extension Project EA Predictions. No groundwater complaints.	Min: 6.0 Max 8.0	Min: 100 Max: 7600	Assess data and establish trends.	Progressive assessment of trends to determine causes and predict potential impacts.	Quarterly reporting of Trigger Level Exceedances to NOW.
DB11W	20BL168404	See Indicative Location onFigure 1	Lot 9 DP 804536	399176.0441 (Indicative)	6430350.1351 (Indicative)	Water Quality and Drawdown	Natural and pumping-induced water level changes and groundwater quality	To be confirmed once drilled.			Daily	Water Level	Quarterly	TBC	Min: 6.0 Max 8.0	Min: 100 Max: 7600	Assess data and establish trends.	Assess data and establish trends.	Assess data and establish trends.
											Quarterly	pH, EC, dissolved oxygen, TDS, Total Acidity, Total Alkalinity, Chloride, SO_4, Calcium, Magnesium, Sodium, Aluminium, Iron, Manganese, Zinc.	Quarterly						
SI1W	20BL168404	See Figure 1	Lot C DP 160430	399713	6426029	Water Quality and Drawdown	Natural and pumping-induced water level changes and groundwater quality	83.4	16.4	13.4-16.4	Quarterly	Water Level, pH, EC, Dissolved oxygen, TDS, Total Acitidity, Total Alkalinity, Chloride, SO_4, Calcium, Magnesium, Sodium, Aluminium, Iron, Manganese, Zinc.	Quarterly	Consistent with Duralie Extension Project EA Predictions. No groundwater complaints.	Min: 6.0 Max 8.0	Min: 100 Max: 7600	Assess data and establish trends.	Progressive assessment of trends to determine causes and predict potential impacts.	Quarterly reporting of Trigger Level Exceedances to NOW.
SI2W	20BL168404	See Figure 1	Lot C DP 160430	399404	6425971	Water Quality and Drawdown	Natural and pumping-induced water level changes and groundwater quality	108.6	35.7	32.7-35.7	Quarterly	Water Level, pH, EC, Dissolved oxygen, TDS, Total Acitidity, Total Alkalinity, Chloride, SO_4, Calcium, Magnesium, Sodium, Aluminium, Iron, Manganese, Zinc.	Quarterly	Consistent with Duralie Extension Project EA Predictions. No groundwater complaints.	Min: 6.0 Max 8.0	Min: 100 Max: 7600	Assess data and establish trends.	Progressive assessment of trends to determine causes and predict potential impacts.	Quarterly reporting of Trigger Level Exceedances to NOW.
SI3W	20BL168404	See Figure 1	Lot C DP 160430	399145	6425777	Water Quality and Drawdown	Natural and pumping-induced water level changes and groundwater quality	124.2	28.2	25.2-28.2	Quarterly	Water Level, pH, EC, Dissolved oxygen, TDS, Total Acitidity, Total Alkalinity, Chloride, SO_4, Calcium, Magnesium, Sodium, Aluminium, Iron, Manganese, Zinc.	Quarterly	Consistent with Duralie Extension Project EA Predictions. No groundwater complaints.	Min: 6.0 Max 8.0	Min: 100 Max: 7600	Assess data and establish trends.	Progressive assessment of trends to determine causes and predict potential impacts.	Quarterly reporting of Trigger Level Exceedances to NOW.
WR1	20BL168404	See Indicative Location onFigure 1	Lot 131 DP 95773	400851 (Indicative)	6425891 (Indicative)	Water Quality and Groundwater Recovery	Natural and pumping-induced water level changes and groundwater quality	To be confirmed once drilled.			Daily	Water Level	Quarterly	TBC	Min: 6.0 Max 8.0	Min: 100 Max: 7600	Assess data and establish trends.	Assess data and establish trends.	Assess data and establish trends.
											Quarterly	pH, EC, dissolved oxygen, TDS, Total Acidity, Total Alkalinity, Chloride, SO_4, Calcium, Magnesium, Sodium, Aluminium, Iron, Manganese, Zinc.	Quarterly						
WR2	20BL168404	See Indicative Location onFigure 1	Lot 6 DP 876013	400973 (Indicative)	6426588 (Indicative)	Water Quality and Groundwater Recovery	Natural and pumping-induced water level changes and groundwater quality	To be confirmed once drilled.			Daily	Water Level	Quarterly	TBC	Min: 6.0 Max 8.0	Min: 100 Max: 7600	Assess data and establish trends.	Assess data and establish trends.	Assess data and establish trends.
											Quarterly	pH, EC, dissolved oxygen, TDS, Total Acidity, Total Alkalinity, Chloride, SO_4, Calcium, Magnesium, Sodium, Aluminium, Iron, Manganese, Zinc.	Quarterly						

Surface Water Monitoring

Surface Water Monitoring Location	**Coordinates** (GPS)		**Monitoring Target**	**Monitoring Effect of,** e.g. Pumping at Design Flow Rates and investigate a number of pumping arrangements to determine sensitivities	**Sampling Frequency**	**Sampling Parameters,** e.g. Field testing EC, pH, DO. Laboratory analysis of TDS and major anions and cations for each bore, Monitor for Hydrocarbons at No.11	**Action Required** Assess data, establish trends and relate to pumping regimes and climatic data. **Also report in Contingency worksheet.**	**Trigger Level**	**Any follow up actions -** Progressive assessment of trends with prediction of any potential impacts. Determine whether the changes due to impacts from pumping, if so modify the pumping schedule so that impact is removed. Increased frequency on monitoring as required
	Easting	**Northing**							
High Noon Gauging Station	400571	6423925	Flow in Mammy Johnsons River	Loss of Baseflow to Mammy Johnsons River	At least monthly (on an event basis).	Flow (Vus)	Assess data to develop an accurate rating relationship.	N/A	N/A

Groundwater Monitoring Plan And Contingency Plan

Contingency measures

Date of incident	**Type of contingency:** Examples: Extraction likely to exceed entitlement; Failure of a monitoring Bore, Failure of equipment, Reading above threshold	**Location details**	**Action taken**	**Verification that action taken worked**	**Report date to the Office of Water - within 10 days of incident**

Groundwater Monitoring and Contingency Plan

Bores

Date	Bore number	Location	Abandonment procedures

ATTACHMENT B

KNOWN REGISTERED BORES IN THE VICINITY OF THE DURALIE COAL MINE (HYDROSIMULATIONS, 2014)

Table B-1
Known Registered Bores in the Vicinity of the DCM

Bore ID (Work No)	DCM bore ID	Work Licence	Type	Owner	Easting (zone 56)	Northing (zone 56)	Depth	Year Completed	Property	Groundwater Management Area	Salinity	Bore yield l/s	Standing water level (mBG)	Ground elevation or TOC (mAHD)	Distance to DCM mine workings (m)
GW022488			Bore	Private	402721	6414346	25.3	1955		Gloucester Basin	(Unknown)				11400
GW052650		20BL117175	Bore open t	Private	391794	6424674	36.6	1981		New England Fold Belt	(Unknown)				8000
GW054253		20BL114844	Bore	Private	403228	6413304	25	1980		Gloucester Basin	Good				12600
GW047870			Bore open t	Private	399805	6434366	30	1981		Gloucester Basin	(Unknown)				4800
GW051643		20BL112285	Bore open t	Private	403021	6415765	23	1980		Gloucester Basin	Good				10100
GW032846		20BL025489	Bore	Other Govt	399499	6420443	15.2	1970		Gloucester Basin	(Unknown)				5200
GW011316		20BL004470	Well	Private	398447	6434075	18.3	1955		Gloucester Basin	Good Stock				4500
GW011988		20BL005309	Bore	Private	402003	6415663	20.1	1956		Gloucester Basin	(Unknown)				10000
GW078141	DB1W	20BL166741	Bore	Mines	401423	6426930	36.5	1997		Gloucester Basin		0.8	14.09	62.246	500
GW078171			Bore	Mines	401122	6444326	0			Gloucester Basin				133	14900
GW078219		20BL167122	Bore		401700	6418851	31.5	1999	20PT910681	Gloucester Basin		0.526	3		6800
GW079610		20BL167416	Bore	Mines	401228	6444142	0			Gloucester Basin					14700
GW079612		20BL167416	Bore	Mines	401280	6444204	0			Gloucester Basin					14800
GW079614		20BL167416	Bore	Mines	401332	6444235	0			Gloucester Basin					14800
GW079615		20BL167416	Bore	Mines	401366	6444296	0			Gloucester Basin					14900
GW079619	DB2W	20BL166741	Bore	Mines	401444	6426228	60			Gloucester Basin				63.37	100
GW079620		20BL166741	Bore	Mines	401700	6426741	60	1997		Gloucester Basin		5	14.78	55.112	600
GW079621	DB4W	20BL166741	Bore	Mines	400932	6425503	40	1997		Gloucester Basin		1.81	7.26	53.6	200
GW079742		20BL167297	Bore		400597	6420147	30	1999		Gloucester Basin			4		5400
GW200048		20BL166741	Bore	Mines	401589	6425668	6	1996		Karuah Alluvium			5.72		400
GW079746		20BL166741	Bore	Mines	401445	6424619	11	1997		Gloucester Basin					1100
GW079744		20BL166741	Bore	Mines	401618	6425637	9.5	1996		Karuah Alluvium					400
GW079747		20BL166741	Bore	Mines	401717	6426224	7	1996		Gloucester Basin					400
GW079748		20BL166741	Bore	Mines	401717	6426224	10	1996		Gloucester Basin					400
GW079749		20BL166741	Bore	Mines	401928	6426072	10	1996		Gloucester Basin					600
GW079751		20BL166741	Bore	Mines	402269	6425890	9.5	1996		Gloucester Basin					1000
GW079752		20BL166741	Bore	Mines	401583	6426561	9.5	1996		Karuah Alluvium					500

Bore ID (Work No)	DCM bore ID	Work Licence	Type	Owner	Easting (zone 56)	Northing (zone 56)	Depth	Year Completed	Property	Groundwater Management Area	Salinity	Bore yield l/s	Standing water level (mBG)	Ground elevation or TOC (mAHD)	Distance to DCM mine workings (m)
GW079753		20BL166741	Bore	Mines	401319	6426805	7.5	1996		Gloucester Basin					300
GW079761			Well	Private	399996	6443251	13.39	1994		Gloucester Basin			13.39		13700
GW079758			Bore	Private	401497	6440788	0			Gloucester Basin					11500
GW079759			Bore	Private	401176	6438783	0			Gloucester Basin					9400
GW079618			Bore	Mines	401175	6444265	0			Gloucester Basin				130	14800
GW078349			Bore		398789	6416340	22	1996		New England Fold Belt					9400
GW078759		20BL166869	Bore		400610	6419041	22	1998		Gloucester Basin			1.5		6500
GW079049		20BL167416	Bore	Private	401944	6443867	0			Gloucester Basin				124	14600
GW078585		20BL167242	Bore	Private	402432	6417275	19	1999		Gloucester Basin	Good	9.3	3		8500
GW078586		20BL167454	Bore	Private	402152	6413376	33.5	1999		Gloucester Basin		0	9		12300
GW080578		20BL168966	Bore		403063	6414614	33	2004		Gloucester Basin		1	7		11200
GW080508		20BL168893	Bore	Local Govt	404720	6413293	0	2003		New England Fold Belt					12900
GW080509		20BL168893	Bore	Local Govt	404801	6413159	0	2003		New England Fold Belt					13100
GW080288		20BL166921	Bore		400436	6432706	0	2002	20PT910726	Karuah Alluvium					3300
GW064028		20BL135976	Bore	Private	387111	6427087	25.9	1987		New England Fold Belt	1001-3000 ppm				11700
GW066016			Excavation	Private	390494	6428726	2	1991		New England Fold Belt			2		8100
GW067275			(Unknown)	(Unknown)	387366	6425365	10	1991		New England Fold Belt			10	115.8	11800
GW079613		20BL167416	Bore	Mines	401306	6444235	0			Gloucester Basin					14800
GW079617		20BL167416	Bore	Mines	401207	6444274	0			Gloucester Basin					14900
GW079622		20BL166741	Bore	Mines	400517	6425167	40	1997		Gloucester Basin		0.6		55.97	400
GW079750		20BL166741	Bore	Mines	402113	6425889	10.5	1996		Gloucester Basin					800
GW079754		20BL166741	Bore	Mines	401134	6426988	12	1996		Gloucester Basin					300
GW079048		20BL167416	Bore	Mines	401532	6444000	5.97			Gloucester Basin				125	14600
GW050402		20BL111604	Bore	Private	403134	6420263	26	1980		Gloucester Basin	Good				5800
GW080571		20BL169147	Bore	Private	403129	6414366	0	2004		Gloucester Basin					11500
GW080778		20BL168404	Bore		401407	6426825	36.5	2002	20PT910957	Gloucester Basin		0.75	18		400
GW080776		20BL168404	Bore		401342	6426938	40	2002	20PT910957	Gloucester Basin		0.25	9		400
GW080777		20BL168404	Bore		401522	6426872	40	2002	20PT910957	Gloucester Basin		1	22		500
GW080779		20BL168404	Bore		401537	6426751	60	2002	20PT910957	Gloucester Basin		4	40		500

Bore ID (Work No)	DCM bore ID	Work Licence	Type	Owner	Easting (zone 56)	Northing (zone 56)	Depth	Year Completed	Property	Groundwater Management Area	Salinity	Bore yield l/s	Standing water level (mBG)	Ground elevation or TOC (mAHD)	Distance to DCM mine workings (m)
GW080780		20BL168404	Bore		401599	6426842	40	2002	20PT910957	Gloucester Basin		0.3	22		600
GW080781		20BL168404	Bore		401396	6426717	58	2002	20PT910957	Gloucester Basin		0.35	25		300
GW080636		20BL168404	Bore		401453	6426839	35.7	2004	20PT910957	Gloucester Basin		0.25	33.7		400
GW080637		20BL168539	Bore		401520	6424997	16.4	2004		Gloucester Basin			14		800
GW080638		20BL168539	Bore		401416	6425106	28.2	2004		Gloucester Basin					700
GW079050		20BL167416	Bore	Mines	401701	6443473	8.28			Gloucester Basin				125	14100
GW079611		20BL167416	Bore	Mines	401254	6444173	0			Gloucester Basin					14800
GW200049		20BL166741	Bore	Mines	401595	6425329	7	1996		Gloucester Basin					600
GW080484		20BL168934	Bore		402734	6414554	39	2004		Gloucester Basin		2	8.5		11200
GW200244		20BL168404	Bore		402195	6425490	40	2002	20PT910957	Gloucester Basin		0.25	9		1000
GW200431		20BL169316	Bore		403353	6435280	60	2004		New England Fold Belt		0.25	8		7000
GW200432		20BL169271	Bore		398903	6434728	60	2004		Gloucester Basin					5100

ATTACHMENT C

GROUNDWATER PREDICTIONS AT THE END OF MINING (FROM HYDROSIMULATIONS, 2014)

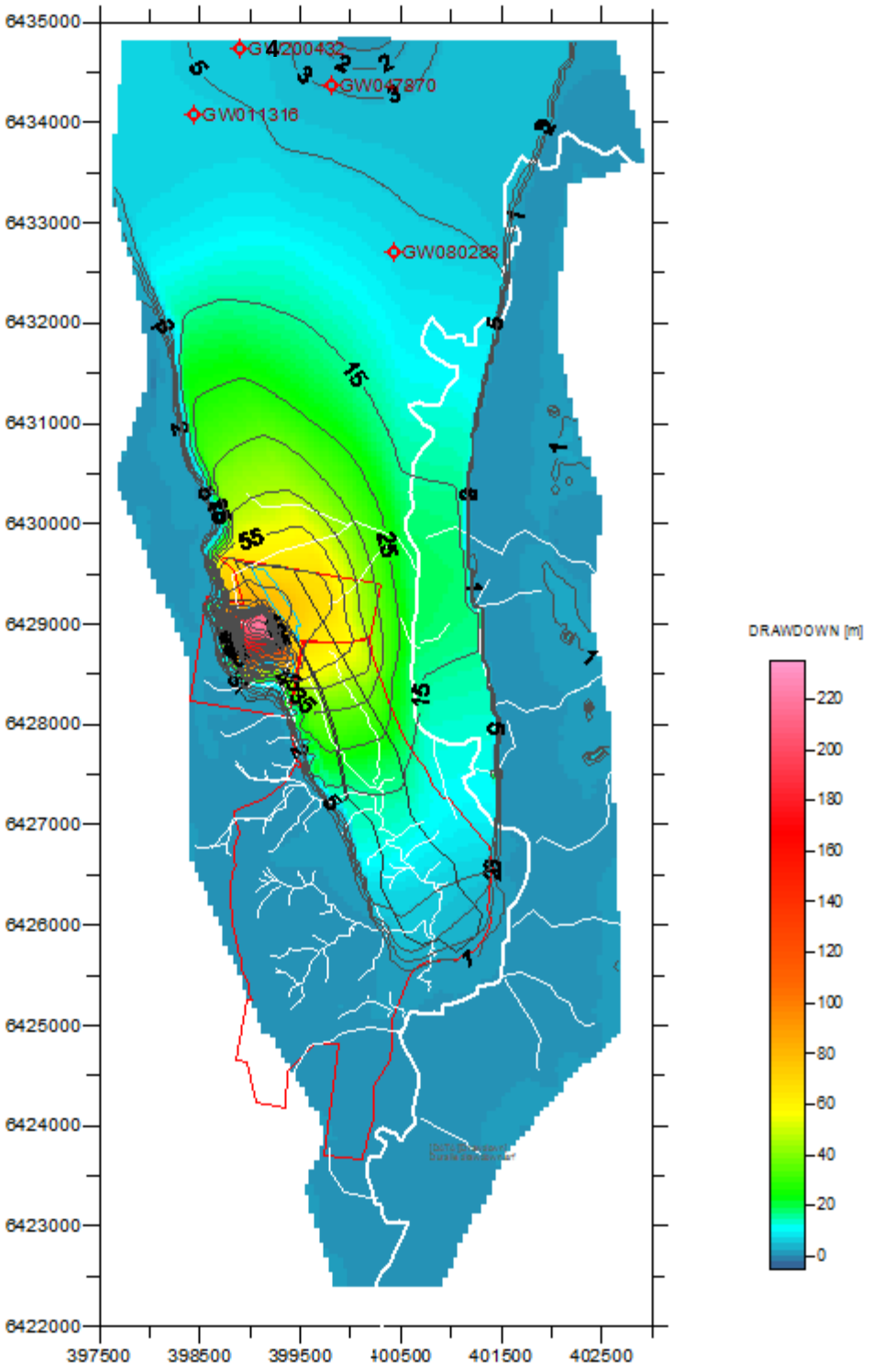

Figure C-1 **Simulated Drawdown in Groundwater Levels at the End of Mining in Model Layer 3 (Weismantel Coal Seam)**

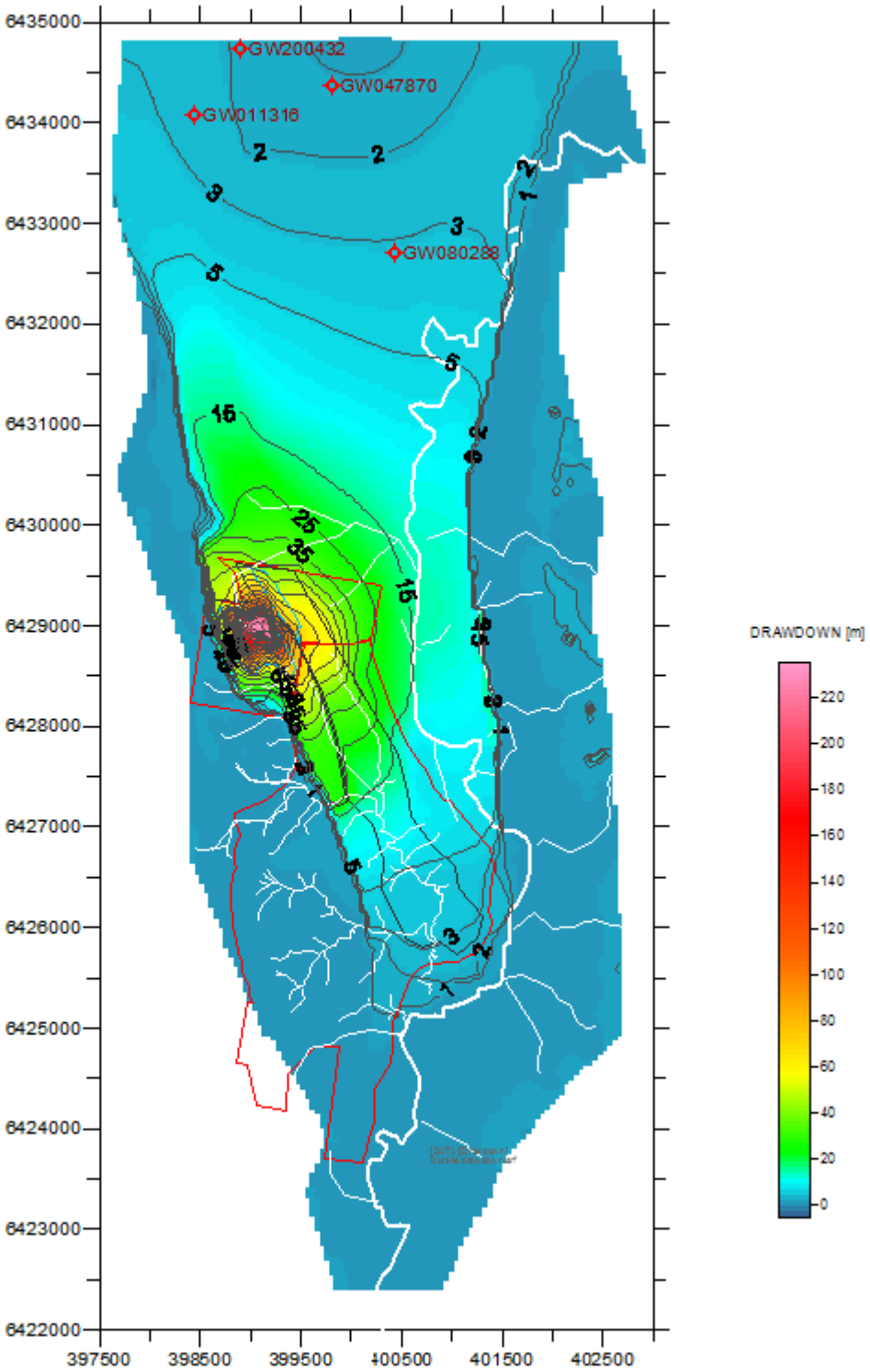

Figure C-2 **Simulated Drawdown in Groundwater Levels at the End of Mining in Model Layer 5 (Clareval Coal Seam)**

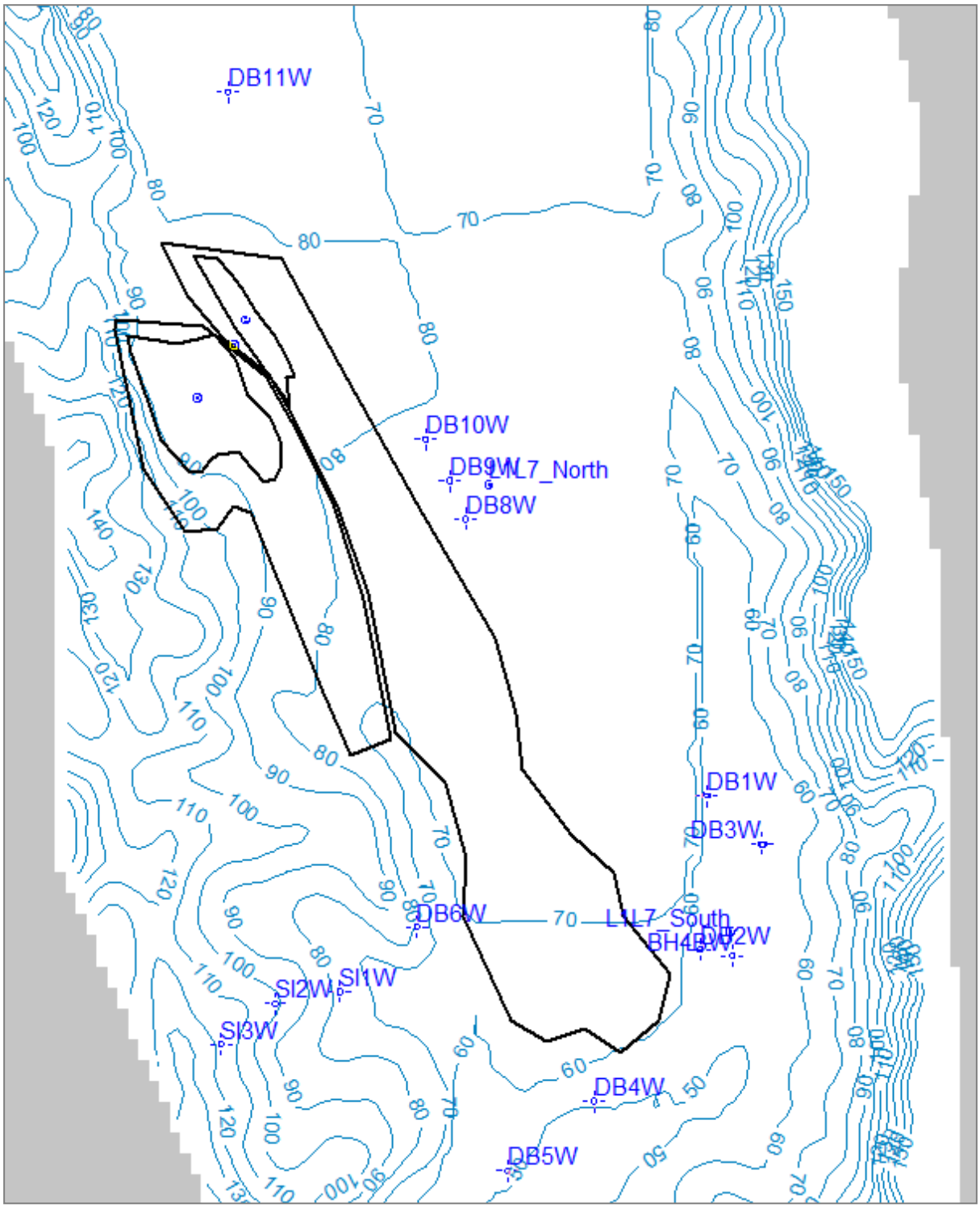

Figure C-3 Simulated Post-mining Equilibrium Groundwater Levels in Model Layer 2 [mAHD]

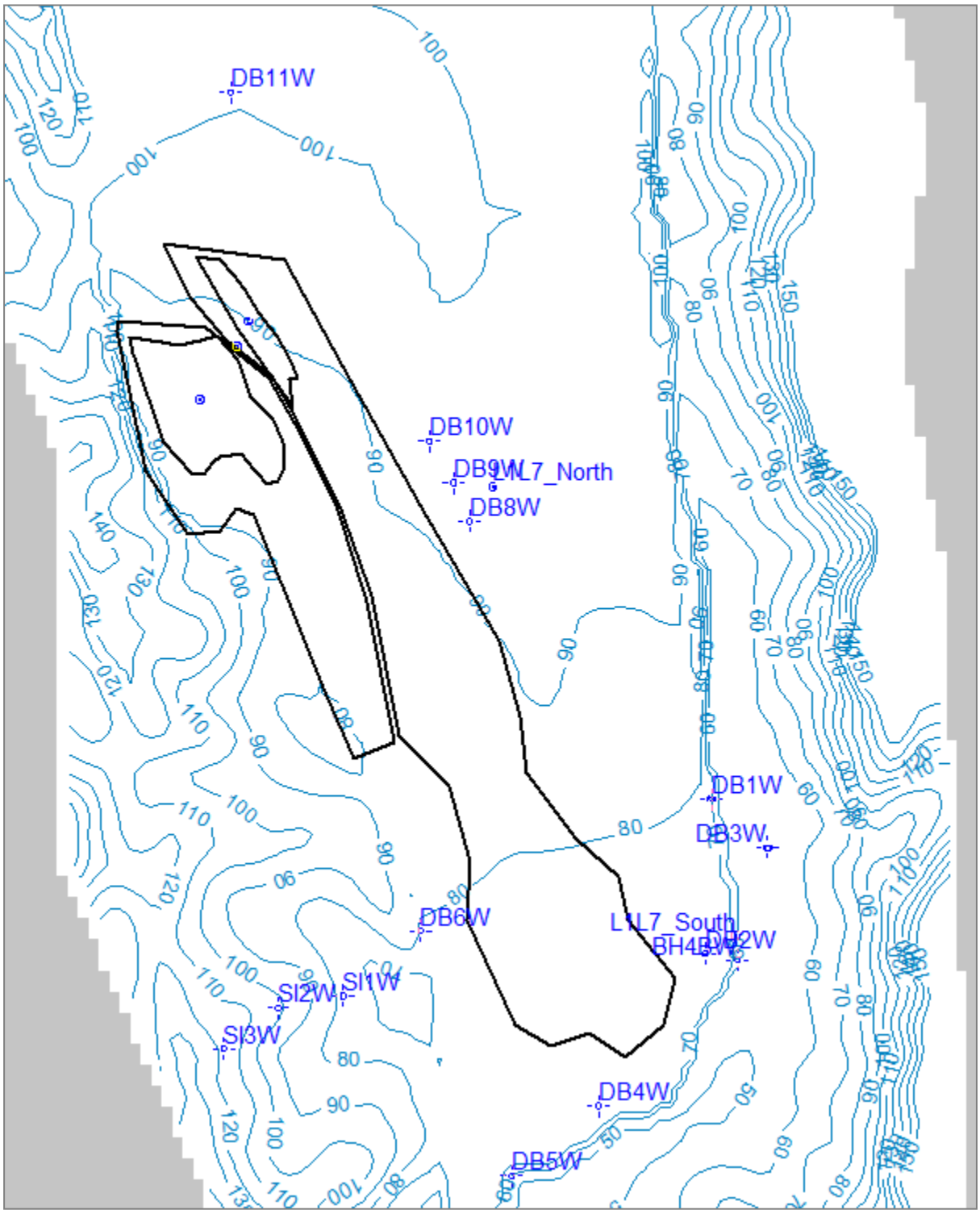

Figure C-4 Simulated Post-mining Equilibrium Groundwater Levels in Model Layer 5 [mAHD]

ATTACHMENT D

APPROVED METHODS FOR THE SAMPLING AND ANALYSIS OF WATER POLLUTANTS IN NEW SOUTH WALES (EPA, 2004)

Approved Methods
for the Sampling and Analysis of Water Pollutants
in New South Wales

Department of
Environment and Conservation (NSW)

The Environment Protection Authority (EPA) is a statutory body with specific powers under environment protection legislation. In September 2003, the EPA became part of the Department of Environment and Conservation (DEC).

This document was prepared by Environment Protection Authority and is published by DEC on behalf of the EPA.

For technical information on the matters discussed in this document, contact the Department of Environment and Conservation (NSW) on (02) 9995 5555.

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Department of Environment and Conservation (NSW)
59–61 Goulburn Street Sydney
PO Box A290
Sydney South 1232
Phone: (02) 9995 5000 (switchboard)
Phone: 131 555 (information & publications requests)
Fax: (02) 9995 5999
E-mail: info@epa.nsw.gov.au
Website address: www.epa.nsw.gov.au

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CONTENTS

INTRODUCTION

This document lists the sampling and analysis methods to be used when complying with a requirement by, or under, the environment protection legislation, or a licence or notice under that legislation, to test for the presence or concentration of matter in water and the volume, depth and flow of water or wastewater.

The **environment protection legislation** includes, among other legislation, the *Protection of the Environment Operations Act 1997* and regulations under it.

This document is referred to in:

- the Protection of the Environment Operations (General) Regulation 1998
- the Clean Waters Regulations 1972 (for the purposes of Classification of Waters)
- the Load Calculation Protocol.

This document also may be referred to in conditions attached to statutory instruments issued by the Environment Protection Authority, New South Wales (EPA).

The following process should be followed in determining the sampling and analysis methods to be used:

1. Use the specified method(s) on the relevant environment protection licence.
2. If no method is specified on a licence, use the method(s) specified in this document.
3. If no method is specified in this document, or if you wish to use another method for sampling or analysis that is not included in this document, you must seek approval from the EPA **before** you commence sampling or analysis using that method.

In exceptional circumstances, the EPA may approve the use of alternative methods. Approval to use alternative methods must be sought in writing from the EPA. In the first instance, licensees should contact the EPA regional office that issues the licence.

Where there is a choice of more than one approved method for an analyte, unless stated otherwise by the relevant environment protection licence, a licensee may use any of the approved methods given for that analyte, provided that the method can achieve the reporting limits required for compliance with the licence. If there are no methods that will achieve the reporting limits required, licensees should contact the EPA. Once a licensee has selected an approved method, however, that licensee must not then change to another method for the same analyte without seeking permission in writing from the EPA.

In the sampling and analysis of water pollutants, the procedural details specified in the relevant method in this document may be varied by the person carrying out the sampling or analysis, provided that the variation is not such as can affect the results of the test and the person conducting the test can establish that.

SAMPLE COLLECTION AND HANDLING GUIDELINES

A sample should be collected so that it is representative of the condition being investigated, and in a manner consistent with the collection, handling and preservation principles enunciated in Standards Association of Australia (1998) AS/NZS 5667.1:1998, and APHA (1998) section 1060. If there is any inconsistency between these references, Standards Association of Australia (1998) prevails.

METHODS OF ANALYSIS

Analyses should be undertaken by a laboratory accredited to perform those analyses by an independent accreditation body acceptable to the EPA, such as the National Association of Testing Authorities (NATA), or equivalent.

Such analyses should conform to the generic methods prescribed at Part 1000 of APHA (1998), covering quality assurance, data quality, expression of results, method development and evaluation, and laboratory procedures. These generic methods are applicable to each of the methods approved below for specific analytes.

Methods approved by the EPA for specific analytes are listed in Table 1. Where there are multiple methods, some may be indicated as preferred methods. These methods are preferred because they use modern equipment and/or particular techniques that are most practicable and/or give the most reliable results. However, because in some circumstances it may not be possible to gain access to the most up-to-date equipment or laboratories accredited for all methods, acceptable alternatives are given.

How to find an analyte in the table

Analytes are listed in alphabetical order, generally on the basis of the main analyte considered. For instance, Faecal Coliforms are listed under Coliforms, and Total Suspended Solids under Solids. Both the groups of analytes and the individual analytes that fall into each group are listed. For instance, Organochlorine Pesticides include Aldrin and Dieldrin, among others: both of these are also listed separately. If the analytes listed on the licence are not listed in Table 1, refer to Appendix 1, which gives alternative names that are sometimes used for the listed analytes.

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Acenaphthene	APHA (1998) section 6410; or APHA (1998) section 6440; or *USEPA (1986a) method 8100; or *USEPA (1996a) method 8270C; or *USEPA (1986b) method 8310
Acenaphthylene	APHA (1998) section 6410; or APHA (1998) section 6440; or *USEPA (1986a) method 8100; or *USEPA (1996a) method 8270C; or *USEPA (1986b) method 8310
Acrolein	USEPA (40 CFR, 1994d) method 603; or UESPA (1994a) method 8316; or USEPA (1996b) method 8260B
Acrylonitrile	USEPA (40 CFR, 1994d) method 603; USEPA (1994a) method 8316; or USEPA (1996b) method 8260B
Aldrin	APHA (1998) section 6630; or APHA (1998) section 6410; or *USEPA (1998c) method 8081B; or *USEPA (1996a) method 8270C
Alkalinity (bicarbonate)	APHA (1998) section 2320
Alkalinity (total)	APHA (1998) section 2320

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Aluminium (acid extractable)	Preliminary treatment APHA (1998) section 3030(E – K); or USEPA (1992a) method 3005A; or USEPA (1992b) method 3010A; or USEPA (1994g) method 3015; or USEPA (1992c) method 3020A Then use *APHA (1998) section 3111D; or *APHA (1998) section 3111E; or *APHA (1998) section 3113; or *APHA (1998) section 3120; or *APHA (1998) section 3125†; or USEPA (1994b) method 200.7; or USEPA (1994b) method 200.8†; or *USEPA (1996c) method 6010B; or *USEPA (1994f) method 6020†; or *APHA (1998) section 3500-Al Note: For the purposes of this document, the term "acid extractable" is as defined in APHA (1998) section 3030A.
Anionic surfactants	APHA (1998) section 5540
Anthracene	APHA (1998) section 6410; or APHA (1998) section 6440; or *USEPA (1986a) method 8100; or *USEPA (1996a) method 8270C; or *USEPA (1986b) method 8310

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Antimony (acid extractable)	Preliminary treatment APHA (1998) section 3030(E – K); or USEPA (1992a) method 3005A; or USEPA (1992b) method 3010A; or USEPA (1994g) method 3015; or USEPA (1992c) method 3020AThen use *APHA (1998) section 3111B; or *APHA (1998) section 3113; or *APHA (1998) section 3120; or *APHA (1998) section 3125†; or USEPA (1994b) method 200.7; or USEPA (1994b) method 200.8†; or *USEPA (1996c) method 6010B; or *USEPA (1994f) method 6020† Note: For the purposes of this document, the term "acid extractable" is as defined in APHA (1998) section 3030A.
Arsenic (acid extractable)	Preliminary treatment APHA (1998) section 3030(E – K); or USEPA (1992a) method 3005A; or USEPA (1992b) method 3010A; or USEPA (1994g) method 3015; or USEPA (1992c) method 3020A Then use *APHA (1998) section 3113; or *APHA (1998) section 3114; or *APHA (1998) section 3120; or *APHA (1998) section 3125†; or USEPA (1994b) method 200.7; or USEPA (1994b) method 200.8†; or *USEPA (1996c) method 6010B; or *USEPA (1994f) method 6020†; or *APHA (1998) section 3500-As Note: For the purposes of this document, the term "acid extractable" is as defined in APHA (1998) section 3030A

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Atrazine	USEPA (1998a) method 8141B
Barium (acid extractable)	Preliminary treatment APHA (1998) section 3030(E – K); or USEPA (1992a) method 3005A; or USEPA (1992b) method 3010A; or USEPA (1994g) method 3015; or USEPA (1992c) method 3020A Then use *APHA (1998) section 3111D; or *APHA (1998) section 3113; or *APHA (1998) section 3120; or *APHA (1998) section 3125†; or USEPA (1994b) method 200.7; or USEPA (1994b) method 200.8†; or *USEPA (1996c) method 6010B; or *USEPA (1994f) method 6020† Note: For the purposes of this document, the term "acid extractable" is as defined in APHA (1998) section 3030A.
Benzene	APHA (1998) section 6200; or *USEPA (1996d) method 8021B; or *USEPA (1996b) method 8260B
Benzidine	APHA (1998) section 6410; or *USEPA (1996a) method 8270C
Benzo(a)anthracene *Benzo(a)pyrene* *Benzo(b)fluoranthene* *Benzo(e)pyrene* *Benzo[ghi]perylene* *Benzo(k)fluoranthene*	APHA (1998) section 6410; or APHA (1998) section 6440; or *USEPA (1986a) method 8100; or *USEPA (1996a) method 8270C; or *USEPA (1986b) method 8310

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Beryllium (acid extractable)	Preliminary treatment APHA (1998) section 3030(E – K); or USEPA (1992a) method 3005A; or USEPA (1992b) method 3010A; or USEPA (1994g) method 3015; or USEPA (1992c) method 3020A Then use *APHA (1998) section 3111D; or *APHA (1998) section 3111E; or *APHA (1998) section 3113; or *APHA (1998) section 3120; or *APHA (1998) section 3125†; or USEPA (1994b) method 200.7; or USEPA (1994b) method 200.8†; or *USEPA (1996c) method 6010B; or *USEPA (1994f) method 6020† Note: For the purposes of this document, the term "acid extractable" is as defined in APHA (1998) section 3030A.
alpha-BHC *beta-BHC*	APHA (1998) section 6630; or APHA (1998) section 6410; or *USEPA (1998c) method 8081B; or *USEPA (1996a) method 8270C
Biochemical oxygen demand	APHA (1998) section 5210B, using APHA (1998) section 4500-O for the determination of dissolved oxygen

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Boron (acid extractable)	Preliminary treatment APHA (1998) section 3030(E – K); or USEPA (1992a) method 3005A; or USEPA (1992b) method 3010A; or USEPA (1994g) method 3015; or USEPA (1992c) method 3020A Then use *APHA (1998) section 3120; or USEPA (1994b) method 200.7; or *USEPA (1996c) method 6010B; or *USEPA (1994f) method 6020†; or *APHA (1998) section 4500-B Note: For the purposes of this document, the term "acid extractable" is as defined in APHA (1998) section 3030A.
Bromide	APHA (1998) section 4110; or APHA (2001 supplement) section 4110; or APHA (1998) section 4140; or APHA (1998) section 4500-Br
Bromoform	APHA (1998) section 6200; or APHA (1998) section 6232; or *USEPA (1996d) method 8021B; or *USEPA (1996b) method 8260B

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Cadmium (acid extractable)	Preliminary treatment APHA (1998) section 3030(E – K); or USEPA (1992a) method 3005A; or USEPA (1992b) method 3010A; or USEPA (1994g) method 3015; or USEPA (1992c) method 3020A Then use *APHA (1998) section 3111B; or *APHA (1998) section 3111C; or *APHA (1998) section 3113; or *APHA (1998) section 3120; or *APHA (1998) section 3125†; or USEPA (1994b) method 200.7; or USEPA (1994b) method 200.8†; or *USEPA (1996c) method 6010B; or *USEPA (1994f) method 6020† Note: For the purposes of this document, the term "acid extractable" is as defined in APHA (1998) section 3030A.
Calcium (acid extractable)	Preliminary treatment APHA (1998) section 3030(E – K); or USEPA (1992a) method 3005A; or USEPA (1992b) method 3010A; or USEPA (1994g) method 3015; or USEPA (1992c) method 3020A Then use *APHA (1998) section 3111B; or *APHA (1998) section 3111D; or *APHA (1998) section 3120; or USEPA (1994b) method 200.7; or *USEPA (1996c) method 6010B; or *USEPA (1994f) method 6020†; or *APHA (1998) section 3500-Ca Note: For the purposes of this document, the term "acid extractable" is as defined in APHA (1998) section 3030A.

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Carbamate pesticides *Includes:* *carbaryl* *methomyl*	APHA (1998 or 2001 supplement) section 6610; or *USEPA (1994e) method 8318; or USEPA (1996e) method 8321A
Carbaryl	APHA (1998 or 2001 supplement) section 6610; or *USEPA (1994e) method 8318; or USEPA (1996e) method 8321A
Carbon tetrachloride	APHA (1998) section 6200; or *USEPA (1996d) method 8021B; or *USEPA (1996b) method 8260B
Chemical oxygen demand	APHA (1998) section 5220
Chlordane and isomers (cis, trans and total)	APHA (1998) section 6410; or APHA (1998) section 6630; or *USEPA (1998c) method 8081B; or *USEPA (1996a) method 8270C
Chloride	APHA (1998) section 4110; or APHA (2001 supplement) section 4110; or APHA (1998) section 4140; or APHA (1998) section 4500-Cl B; or APHA (1998) section 4500-Cl D; or APHA (1998) section 4500-Cl E
Chlorinated phenoxy acid herbicides *Includes:* *2,4-D* *pentachlorophenol* *2,4,5-T*	APHA (1998) section 6640; or *USEPA (1996f) method 8151A; or USEPA (1996e) method 8321A **Note:** When using method 8321A it is recommended that samples be hydrolysed to the ester form to simplify analysis.

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Chlorine (combined residual)	APHA (1998) section 4500-Cl D; or APHA (1998) section 4500-Cl F; or APHA (1998) section 4500-Cl G **Note:** The loss of free chlorine because of reaction with organic material and / or with reducing agents, and / or by volatilisation from water samples can make analysing for Chlorine (total residual), Chlorine (free residual) or Chlorine (combined residual) difficult. As a result, the most appropriate analytical technique to demonstrate compliance with a licence limit is likely to be analysis on site using a kit. The only kits that are acceptable to the EPA are those that use a portable spectrophotometer or colorimeter to measure the colour development that indicates the concentration of chlorine present. Kits that use comparison with a colour chart to determine concentration are not acceptable. Normal QA procedures must be followed. These include the analysis of blanks with every batch of samples, and the use of certified chlorine standards on each occasion the kit is used (if it is not used every day) or weekly if the kit is used constantly. Samples need to be taken immediately before analysis and need to be taken in bottles, such as BOD bottles, that can be filled completely. The bottles should be wrapped in foil. These directions are based on the requirements set down in the APHA methods listed above for chlorine analysis. If the concentration of chlorine being measured is likely to be around 0.05–0.2 mg / L, it will be necessary to validate the detection limit for the specific wastewater being analysed and the kit being used for the analysis.
Chlorine (free residual)	APHA (1998) section 4500-Cl D; or APHA (1998) section 4500-Cl F; or APHA (1998) section 4500-Cl G; or APHA (1998) section 4500-Cl H Refer to note on the use of kits, under *Chlorine (combined residual).*

* Preferred methods

† Used when very low concentrations (< 100 µg / L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Chlorine (total residual)	APHA (1998) section 4500-Cl B; or APHA (1998) section 4500-Cl C; or APHA (1998) section 4500-Cl D; or APHA (1998) section 4500-Cl E; or APHA (1998) section 4500-Cl F; or APHA (1998) section 4500-Cl G; or APHA (1998) section 4500-Cl I Refer to note on the use of kits, under *Chlorine (combined residual).*
Chlorobenzene	APHA (1998) section 6200; or *USEPA (1996d) method 8021B; or *USEPA (1996b) method 8260B
Chloroform	APHA (1998) section 6200; or APHA (1998) section 6232; or *USEPA (1996d) method 8021B; or *USEPA (1996b) method 8260B
1-Chloronaphthalene	APHA (1998) section 6410; or *USEPA (1996a) method 8270C
2-Chlorophenol	APHA (1998) section 6410; or APHA (1998) section 6420; or *USEPA (1996) method 8041; or *USEPA (1996a) method 8270C
Chlorophyll a	APHA (1998) section 10200 H
Chlorpyrifos	USEPA (1998a) method 8141B; or USEPA (1996a) method 8270C **Note:** Chlorpyrifos may be analysed using USEPA method 8270C, provided that the extraction is performed at a neutral pH as per method USEPA 8141B.

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Chromium (acid extractable)	Preliminary treatment APHA (1998) section 3030(E – K); or USEPA (1992a) method 3005A; or USEPA (1992b) method 3010A; or USEPA (1994g) method 3015; or USEPA (1992c) method 3020A Then use *APHA (1998) section 3111C; or *APHA (1998) section 3113; or *APHA (1998) section 3120; or *APHA (1998) section 3125†; or USEPA (1994b) method 200.7; or USEPA (1994b) method 200.8†; or *USEPA (1996c) method 6010B; or *USEPA (1994f) method 6020 Note: For the purposes of this document, the term "acid extractable" is as defined in APHA (1998) section 3030A.
Chromium (hexavalent)	APHA (1998) section 3500-Cr; or AS 2882—1986; or USEPA (1994b) method 218.6; or USEPA (1992d) method 7196A
Chromium (trivalent)	Trivalent chromium is to be calculated: Cr^{3+} = Cr (acid extractable) – Cr^{6+}
Chrysene	APHA (1998) section 6410; or APHA (1998) section 6440; or *USEPA (1986a) method 8100; or *USEPA (1996a) method 8270C; or *USEPA (1986b) method 8310

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Cobalt (acid extractable)	Preliminary treatment APHA (1998) section 3030(E – K); or USEPA (1992a) method 3005A; or USEPA (1992b) method 3010A; or USEPA (1994g) method 3015; or USEPA (1992c) method 3020A Then use *APHA (1998) section 3111B; or *APHA (1998) section 3111C; or *APHA (1998) section 3113; or *APHA (1998) section 3120; or *APHA (1998) section 3125†; or USEPA (1994b) method 200.7; or USEPA (1994b) method 200.8†; or *USEPA (1996c) method 6010B; or *USEPA (1994f) method 6020† Note: For the purposes of this document, the term "acid extractable" is as defined in APHA (1998) section 3030A.
Coliforms: *(a) Total coliforms*	APHA (1998 or 2001 supplement) section 9221; or APHA (1998) section 9222; or APHA (1998) section 9223; or AS 4276.4—1995 and AS 4276.5—1995
(b) Faecal coliforms	APHA (1998 or 2001 supplement) section 9221; or APHA (1998) section 9222 or AS 4276.7—1995
Colour (true)	APHA (1998) section 2120
Conductivity	APHA (1998) section 2510

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Copper (acid extractable)	Preliminary treatment APHA (1998) section 3030(E – K); or USEPA (1992a) method 3005A; or USEPA (1992b) method 3010A; or USEPA (1994g) method 3015; or USEPA (1992c) method 3020A followed by *APHA (1998) section 3111B; or *APHA (1998) section 3111C; or *APHA (1998) section 3113; or *APHA (1998) section 3120; or *APHA (1998) section 3125†; or USEPA (1994b) method 200.7; or USEPA (1994b) method 200.8†; or *USEPA (1996c) method 6010B; or *USEPA (1994f) method 6020† Note: For the purposes of this document, the term "acid extractable" is as defined in APHA (1998) section 3030A.
Coronene	APHA (1998) section 6410; or APHA (1998) section 6440; or *USEPA (1986a) method 8100; or *USEPA (1996a) method 8270C; or *USEPA (1986b) method 8310
Cyanide (amenable to chlorination)	Preliminary treatment, if required, APHA (1998 or 2001 supplement) section 4500-CN^- B; followed by APHA (1998) section 4500-CN^- G; or APHA (1998) section 4500-CN^- H
Cyanide (free)	Preliminary recovery ASTM (2002) method D4282-02; followed by APHA (1998) section 4500-CN^- D; or APHA (1998) section 4500-CN^- E; or APHA (1998) section 4500-CN^- F; or ASTM (2002) D4282-02

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Cyanide (total)	Preliminary treatment, if required, APHA (1998 or 2001 supplement) section 4500-CN^- B; followed by distillation APHA (1998 or 2001 supplement) section 4500-CN^- C; followed by APHA (1998) section 4500-CN^- D; or APHA (1998) section 4500-CN^- E; or APHA (1998) section 4500-CN^- F or USEPA (1980) method 335.2 **Note:** If your discharge is a slurry—that is, contains a high fraction of solids—contact your licensing officer for further advice on the appropriate method.
Cyanide (weak acid dissociable)	Preliminary treatment, if required, APHA (1998 or 2001 supplement) section 4500-CN^- B; followed by APHA (1998) section 4500-CN^- I **Note:** If your discharge is a slurry—that is, contains a high fraction of solids—contact your licensing officer for further advice on the appropriate method.
2,4-D	APHA (1998) section 6640; or *USEPA (1996f) method 8151A; or USEPA (1996e) method 8321A **Note:** When using method 8321A it is recommended that samples be hydrolysed to the ester form to simplify analysis.
4,4′-DDD *4,4′-DDE* *4,4′-DDT*	APHA (1998) section 6410; or APHA (1998) section 6630; or *USEPA (1998c) method 8081B; or *USEPA (1996a) method 8270C
Depth	AS 3550.7—1993; or AS 3778—2001
Diazinon	USEPA (1998a) method 8141B; or USEPA (1996a) method 8270C **Note:** Diazinon may be analysed using USEPA method 8270C provided that the extraction is performed at a neutral pH as per method USEPA 8141B.

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Dibenzo(a,h)anthracene	APHA (1998) section 6410; or APHA (1998) section 6440; or *USEPA (1986a) method 8100; or *USEPA (1996a) method 8270C; or *USEPA (1986b) method 8310
Dibromochloromethane	APHA (1998) section 6200; or APHA (1998) section 6232; or *USEPA (1996d) method 8021B; or *USEPA (1996b) method 8260B
1,2-Dichlorobenzene *1,3-Dichlorobenzene* *1,4-Dichlorobenzene*	APHA (1998) section 6200; or APHA (1998) section 6410; or *USEPA (1996d) method 8021B; or *USEPA (1996b) method 8260B; or *USEPA (1996a) method 8270C
3,3ℓ-Dichlorobenzidine	APHA (1998) section 6410; or *USEPA (1996a) method 8270C
1,1-Dichloroethane *1,2-Dichloroethane* *1,1-Dichloroethene*	APHA (1998) section 6200; or *USEPA (1996d) method 8021B; or *USEPA (1996b) method 8260B
2,4-Dichlorophenol	APHA (1998) section 6410; or APHA (1998) section 6420; or *USEPA (1996g) method 8041; or *USEPA (1996a) method 8270C
Dieldrin	APHA (1998) section 6410; or APHA (1998) section 6630; or *USEPA (1998c) method 8081B; or *USEPA (1996a) method 8270C
2,4-Dimethylphenol	APHA (1998) section 6410; or APHA (1998) section 6420; or *USEPA (1996g) method 8041; or *USEPA (1996a) method 8270C

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
1,2-Diphenylhydrazine	USEPA (1996a) method 8270C
Diquat	USEPA (1992e) method 549.1 (EPA-500 Series Supplement II, Aug 1992)
Dissolved organic carbon	APHA (1998) section 5310
Dissolved organic halogen *Includes:* *Trihalomethanes* *Trichloroethene* *Tetrachloroethene* *Other halogenated alkanes and alkenes* *Chlorinated and brominated pesticides* *Polychlorinated biphenyls* *Hexachlorobenzene* *2,4-Dichlorophenol*	APHA (1998) section 5320 B **Note:** this is a general screening method. Individually listed compounds should preferably be tested by their specific methods, where included in this list.
Dissolved oxygen	APHA (1998) section 4500-O
Diuron	USEPA (1998b) method 8321B
DTPA	There is no approved method for DTPA. Contact your licensing officer for further information
Endosulfan I *Endosulfate II* *Endosulfan sulfate*	APHA (1998) section 6410; or APHA (1998) section 6630; or *USEPA (1998c) method 8081B; or *USEPA (1996a) method 8270C
Endrin	APHA (1998) section 6410; or APHA (1998) section 6630; or *USEPA (1998c) method 8081B; or *USEPA (1996a) method 8270C
Enterococci	APHA (1998) section 9230; or AS 4276.8—1995; or AS 4276.9—1995
Ethanol	USEPA (1996h) method 8015B
Ethyl benzene	APHA (1998) section 6200; or *USEPA (1996d) method 8021B; or *USEPA (1996b) method 8260B

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Extractable base/neutrals and acids *Includes:* *Acenaphthene* *Acenaphthylene* *Aldrin* *Anthracene* *Benzo(a)anthracene* *Benzo(a)pyrene* *Benzo(b)fluoranthene* *Benzo(ghi)perylene* *Benzo(k)fluoranthene* *beta-BHC* *Chlordane* *2-Chlorophenol* *Chrysene* *4,4ℓ-DDD* *4,4ℓ-DDE* *4,4ℓ-DDT* *Dibenzo(a,h)anthracene* *1,2-Dichlorobenzene* *1,3-Dichlorobenzene* *1,4-Dichlorobenzene* *3,3ℓ-Dichlorobenzidine* *2,4-Dichlorophenol* *Dieldrin* *2,4-Dimethylphenol* *Endosulfan sulfate* *Fluoranthene* *Heptachlor* *Heptachlor epoxide* *Hexachlorobenzene* *Indeno(1,2,3-cd)pyrene* *Naphthalene* *Nitrobenzene* *Pentachlorophenol* *Phenol* *Polychlorinated biphenyls (PCB-1016, PCB-1221, PCB-1232, PCB-1242, PCB-1248, PCB-1254, PCB-1260)* *Pyrene* *2,4,6-Trichlorophenol*	APHA (1998) section 6410; or *USEPA (1996a) method 8270C
Faecal coliforms	Refer to section on *Coliforms*
Floatables	APHA (1998) section 2530

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Flow	AS 3778 (several volumes) **Note:** This standard covers methods for use in open channels and waterways. To determine flow in pipes, use pumping capacity, pressure differences, or electromagnetic, ultrasonic or other techniques.
Fluoranthene	APHA (1998) section 6410; or APHA (1998) section 6440; or *USEPA (1986a) method 8100; or *USEPA (1996a) method 8270C; or *USEPA (1986b) method 8310
Fluoride	Preliminary distillation step, if required, APHA (1998) section 4500-F^- B; followed by APHA (1998) section 4140; or APHA (1998) section 4500-F^- C; or APHA (1998) section 4500-F^- D; or APHA (1998) section 4500-F^- E
Formaldehyde	USEPA (1996i) method 8315A
Glyphosate	APHA (1998) section 6651; or USEPA (1990) method 547
Heptachlor *Heptachlor epoxide*	APHA (1998) section 6410; or APHA (1998) section 6630; or *USEPA (1998c) method 8081B; or *USEPA (1996a) method 8270C
Hexachlorobenzene	APHA (1998) section 6410; or *USEPA (1996a) method 8270C; or USEPA (1998c) method 8081B
Hydrogen sulfide (un-ionised)	Refer to section on *Sulfide*
Indeno(1,2,3-cd)pyrene	APHA (1998) section 6410; or APHA (1998) section 6440; or *USEPA (1986a) method 8100; or *USEPA (1996a) method 8270C; or *USEPA (1986b) method 8310

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Iron (acid extractable)	Preliminary treatment APHA (1998) section 3030(E – K); or USEPA (1992a) method 3005A; or USEPA (1992b) method 3010A; or USEPA (1994g) method 3015; or USEPA (1992c) method 3020A Then use *APHA (1998) section 3111B; or *APHA (1998) section 3111C; or *APHA (1998) section 3113; or *APHA (1998) section 3120; or USEPA (1994b) method 200.7; or *USEPA (1996c) method 6010B; or *USEPA (1994f) method 6020† Note: For the purposes of this document, the term "acid extractable" is as defined in APHA (1998) section 3030A.
Iron (dissolved)	Preliminary treatment APHA (1998) section 3030B; then treat according to *Iron (acid extractable)*
Iron (suspended)	Preliminary treatment APHA (1998) section 3030B; then treat according to *Iron (acid extractable)*
Lead (acid extractable)	Preliminary treatment APHA (1998) section 3030(E – K); or USEPA (1992a) method 3005A; or USEPA (1992b) method 3010A; or USEPA (1994g) method 3015; or USEPA (1992c) method 3020A Then use *APHA (1998) section 3111B; or *APHA (1998) section 3111C; or *APHA (1998) section 3113; or *APHA (1998) section 3120; or *APHA (1998) section 3125†; or USEPA (1994b) method 200.7; or USEPA (1994b) method 200.8†; or *USEPA (1996c) method 6010B; or *USEPA (1994f) method 6020† Note: For the purposes of this document, the term "acid

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
	extractable" is as defined in APHA (1998) section 3030A.
Lead (dissolved)	Preliminary treatment APHA (1998) section 3030B; then treat according to *Lead (acid extractable)*
Lead (suspended)	Preliminary treatment APHA (1998) section 3030B; then treat according to *Lead (acid extractable)*
Lindane	APHA (1998) section 6410; or APHA (1998) section 6630; or *USEPA (1998c) method 8081B; or *USEPA (1996a) method 8270C
Lithium (acid extractable)	Preliminary treatment APHA (1998) section 3030(E – K); or USEPA (1992a) method 3005A; or USEPA (1992b) method 3010A; or USEPA (1994g) method 3015; or USEPA (1992c) method 3020A Then use USEPA (1994b) method 200.7; or *APHA (1998) section 3111B; or *APHA (1998) section 3120; or USEPA (1996c) method 6010B Note: For the purposes of this document, the term "acid extractable" is as defined in APHA (1998) section 3030A.
Magnesium (acid extractable)	Preliminary treatment APHA (1998) section 3030(E – K); or USEPA (1992a) method 3005A; or USEPA (1992b) method 3010A; or USEPA (1994g) method 3015; or USEPA (1992c) method 3020A Then use *APHA (1998) section 3111B; or *APHA (1998) section 3120; or USEPA (1994b) method 200.7; or *USEPA (1996c) method 6010B; or *USEPA (1994f) method 6020[†] Note: For the purposes of this document, the term "acid extractable" is as defined in APHA (1998) section 3030A.

* Preferred methods

[†] Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Malathion	USEPA (1998a) method 8141B; or USEPA (1996a) method 8270C

* Preferred methods
† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Manganese (acid extractable)	Preliminary treatment APHA (1998) section 3030(E – K); or USEPA (1992a) method 3005A; or USEPA (1992b) method 3010A; or USEPA (1994g) method 3015; or USEPA (1992c) method 3020A Then use *APHA (1998) section 3111B; or *APHA (1998) section 3111C; or *APHA (1998) section 3113; or *APHA (1998) section 3120; or *APHA (1998) section 3125†; or USEPA (1994b) method 200.7; or USEPA (1994b) method 200.8†; or *USEPA (1996c) method 6010B; or *USEPA (1994f) method 6020† Note: For the purposes of this document, the term "acid extractable" is as defined in APHA (1998) section 3030A.
Manganese (dissolved)	Preliminary treatment APHA (1998) section 3030B; then treat according to *Manganese (acid extractable)*
MCPA	APHA (1998) section 6640; or *USEPA (1996f) method 8151A; or USEPA (1996e) method 8321A **Note:** When using method 8321A samples should be hydrolysed to the ester form to simplify analysis.
Mercury (dissolved)	Preliminary treatment APHA (1998) section 3030B; then treat according to *Mercury (total)*

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Mercury (total)	Preliminary treatment APHA (1998) section 3030(E – K); or USEPA (1992a) method 3005A; or USEPA (1992b) method 3010A; or USEPA (1994g) method 3015; or USEPA (1992c) method 3020A Then use APHA (1998) section 3112; or USEPA (1994b) method 200.7; or USEPA (1994b) method 200.8†; or USEPA (1994b) method 245.1; or *USEPA (1996c) method 6010B; or *USEPA (1994f) method 6020† or USEPA (2002) 1631E
Methane	APHA (1998) section 6211
Methomyl	APHA (1998 or 2001 supplement) section 6610; or *USEPA (1994e) method 8318; or USEPA (1996e) method 8321A
Methoxychlor	APHA (1998) section 6410; or APHA (1998) section 6630; or *USEPA (1998c) method 8081B; or *USEPA (1996a) method 8270C
Methyl azinphos	USEPA (1998a) method 8141B; or USEPA (1996a) method 8270C
Methylene blue active substances	Refer to section on *Anionic surfactants*
Methyl ethyl ketone	USEPA (1996b) method 8260B
2-Methylphenol *3-Methylphenol* *4-Methylphenol*	USEPA (1996g) method 8041; or USEPA (1996a) method 8270C
Metolachlor	USEPA (1998c) method 8081B; or USEPA (1998a) method 8141B; or USEPA (1996a) method 8270C
Molinate	*USEPA (1996a) method 8270C; or USEPA (1993a) method 634

* Preferred methods
† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Molybdenum (acid extractable)	Preliminary treatment APHA (1998) section 3030(E – K); or USEPA (1992a) method 3005A; or USEPA (1992b) method 3010A; or USEPA (1994g) method 3015; or USEPA (1992c) method 3020A Then use *APHA (1998) section 3111D; or *APHA (1998) section 3113; or *APHA (1998) section 3120; or *APHA (1998) section 3125†; or USEPA (1994b) method 200.7; or USEPA (1994b) method 200.8†; or *USEPA (1996c) method 6010B; or *USEPA (1994f) method 6020† Note: For the purposes of this document, the term "acid extractable" is as defined in APHA (1998) section 3030A.
Molybdenum (dissolved)	Preliminary treatment APHA (1998) section 3030B; then treat according to *Molybdenum (acid extractable)*
Naphthalene	APHA (1998) section 6200; or APHA (1998) section 6410; or APHA (1998) section 6440; or *USEPA (1986a) method 8100; or *USEPA (1996b) method 8260B; or *USEPA (1996a) method 8270C; or *USEPA (1986b) method 8310

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Nickel (acid extractable)	Preliminary treatment APHA (1998) section 3030(E – K); or USEPA (1992a) method 3005A; or USEPA (1992b) method 3010A; or USEPA (1994g) method 3015; or USEPA (1992c) method 3020A Then use *APHA (1998) section 3111B; or *APHA (1998) section 3111C; or *APHA (1998) section 3113; or *APHA (1998) section 3120; or *APHA (1998) section 3125†; or USEPA (1994b) method 200.7; or USEPA (1994b) method 200.8†; or *USEPA (1996c) method 6010B; or *USEPA (1994f) method 6020† Note: For the purposes of this document, the term "acid extractable" is as defined in APHA (1998) section 3030A.
Nickel (dissolved)	Preliminary treatment APHA (1998) section 3030B; then treat according to *Nickel (acid extractable)*
Nitrobenzene	APHA (1998) section 6410; or *USEPA (1996a) method 8270C
Nitrogen (ammonia)	APHA (1998) section 4500-NH_3; or APHA (1998) section 4120; or APHA (1998) section 4130; or USEPA (1993b) method 350.1 **Note:** For trade waste samples distillation is required using APHA 4500-NH_3-C

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Nitrogen (nitrate)	APHA (1998) section 4110; or APHA (1998) section 4120; or APHA (1998) section 4130; or APHA (2001 supplement) section 4110; or APHA (1998) section 4500-NO_3 D; or APHA (1998) section 4500-NO_3 E; or APHA (1998) section 4500-NO_3 F; or APHA (1998) section 4500-NO_3 I
Nitrogen (nitrite)	APHA (1998) section 4110; or APHA (2001 supplement) section 4110; or APHA (1998) section 4120; or APHA (1998) section 4130; or APHA (1998) section 4500-NO_2; or APHA (1998) section 4500-NO_3 F (with cadmium column removed); or APHA (1998) section 4500-NO_3 I (with cadmium column removed); or USEPA (1993b) method 354.1
Nitrogen (organic)	Organic nitrogen is to be calculated as: *Nitrogen (organic) = Total Kjeldahl nitrogen – Nitrogen (ammonia)*; or *Nitrogen (organic) = Nitrogen (total)* – [*Nitrogen (ammonia) + Nitrogen (total oxidised)*]
Nitrogen (total)	Nitrogen (total) can be determined through calculation, using: *Nitrogen (total) = Total Kjeldahl nitrogen + Nitrogen (total oxidised);* or measured directly using APHA (1998) section 4500-N C Where a licensee can demonstrate equivalent results, the following direct Nitrogen (total) methods can also be used: APHA (1998) section 4120; or APHA (1998) section 4130. **Note:** The direct persulfate digestion method (4500-N C) for analysis of *Nitrogen (total)* may not be suitable where there are high levels of particulates in the sample.

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Nitrogen (total oxidised)	This is the sum total of oxidised forms of nitrogen, i.e. *Nitrogen (nitrate)* + *Nitrogen (nitrite)*. For the approved methods, refer to *Nitrogen (nitrate)*.
Total Kjeldahl nitrogen	APHA (1998) section 4120; or APHA (1998) section 4130; or APHA (1998) section 4500-N_{org}; or APHA (1998) section 4500-N_{org} with Jirka modification (Jirka et al. 1976); or USEPA (1993b) method 351.2
Nonylphenol ethoxylates *Octylphenol ethoxylates*	There are no standard methods for these analytes. If you need to monitor for these analytes, seek advice from your licensing officer before commencing sampling or analysis.
Odour	APHA (1998) section 2150 **Note:** Exercise great care if undertaking this method of analysis. There are potential hazards to the tester.
Oil and grease	APHA (1998) section 5520B; or APHA (1998) section 5520C; or APHA (1998) section 5520D; or *USEPA (1994c) method 1664; or APHA (1998) section 5520F (hydrocarbons only)
Organochlorine pesticides *Includes:* *Aldrin* *alpha-BHC* *beta-BHC* *4,4ŧ-DDD* *4,4ŧ-DDE* *4,4ŧ-DDT* *Dieldrin* *Endosulfan sulfate* *Endrin* *Heptachlor* *Heptachlor epoxide* *Lindane* *Methoxychlor*	APHA (1998) section 6410; or APHA (1998) section 6630; or *USEPA (1998c) method 8081B; or *USEPA (1996a) method 8270C

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Organophosphorus pesticides *Includes:* *Chlorpyrifos* *Chlorpyrifos Methyl* *Diazinon* *Dimethoate* *Ethion* *Malathion* *Methyl azinphos* *Parathion* *Parathion methyl*	USEPA (1996a) method 8270C; or USEPA (1998a) method 8141B
Oxidation–reduction potential	APHA (1998) section 2580
Paraquat	USEPA (1992e) method 549.1 (EPA-500 Series Supplement II, Aug. 1992)
Parathion	USEPA (1998a) method 8141B; or USEPA (1996a) method 8270C
Pentachlorophenol	APHA (1998) section 6410; or APHA (1998) section 6420; or APHA (1998) section 6640; or *USEPA (1996g) method 8041; or *USEPA (1996f) method 8151A; or *USEPA (1996a) method 8270C; or USEPA (1996e) method 8321A **Note:** When using method 8321A, samples should be hydrolysed to the ester form to simplify analysis.
Perylene	APHA (1998) section 6410; or APHA (1998) section 6440; or *USEPA (1986a) method 8100; or *USEPA (1996a) method 8270C; or *USEPA (1986b) method 8310

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Petroleum hydrocarbons and BTEX: *(a) Total petroleum hydrocarbons* *(b) BTEX (equals **B**enzene +**E**thyl benzene +**T**oluene +**X**ylene, including: m-Xylene, o-Xylene and p-Xylene)*	(a) Petroleum hydrocarbons: USEPA (1996h) method 8015B (b) BTEX: APHA (1998) section 6200; or *USEPA (1996d) method 8021B; or *USEPA (1996b) method 8260B
pH value	APHA (1998) section 4500-H^+
Phenol and individual phenolic compounds *Includes:* *2-Chlorophenol* *2,4-Dichlorophenol* *2,4-Dimethylphenol* *Phenol* *2,4,6-Trichlorophenol*	APHA (1998) section 6410; or APHA (1998) section 6420; or *USEPA (1996g) method 8041; or *USEPA (1996a) method 8270C For individual phenolic compounds, refer to their individual listings or look under *Extractable base/neutrals and acids*
Substituted phenols and cresols	APHA (1998) section 6410; or APHA (1998) section 6420; or *USEPA (1996g) method 8041; or *USEPA (1996a) method 8270C
Total phenolics	APHA (1998) section 5530
Phosphorus (dissolved reactive)	APHA (1998) section 4500-P B; followed by APHA (1998) section 4110; or APHA (2001 supplement) section 4110; or APHA (1998) section 4120; or APHA (1998) section 4130; or APHA (1998) section 4500-P E; or APHA (1998) section 4500-P F; or APHA (1998) section 4500-P G; or USEPA (1971) method 365.2; or USEPA (1978a) method 365.3

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Phosphorus (total)	APHA (1998) section 4500-N_{org} with Jirka modification—Jirka et al. (1976); or APHA (1998) section 4500-P B; Persulfate digestion; followed by: APHA (1998) section 4500-P E; or APHA (1998) section 4500-P F; or APHA (1998) section 4500-P H or USEPA (1971) method 365.2; or USEPA (1978a) method 365.3; or USEPA (1996c) method 6010B **Note:** The direct persulfate digestion method (4500-P B) for analysis of *Phosphorus (total)* may not be suitable where there are high levels of particulates in the sample.
Phosphorus (total dissolved)	Filtration through 0.45-µm membrane filter followed by: APHA (1998) section 4500-N_{org} with Jirka modification—Jirka et al. (1976); or APHA (1998) section 4500-P B; Persulfate digestion; followed by: APHA (1998) section 4500-P E; or APHA (1998) section 4500-P F; or APHA (1998) section 4500-P H or USEPA (1971) method 365.2; or USEPA (1978a) method 365.3
Polychlorinated biphenyls	APHA (1998) section 6431; or *USEPA (2000) method 8082A

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Polynuclear aromatic hydrocarbons *Includes:* *Acenaphthene* *Acenaphthylene* *Anthracene* *Benzo(a)anthracene* *Benzo(a)pyrene* *Benzo(b)fluoranthene* *Benzo(ghi)perylene* *Benzo(k)fluoranthene* *Chrysene* *Dibenzo(a,h)anthracene* *Fluoranthene* *Indeno(1,2,3-cd)pyrene* *Naphthalene* *Pyrene*	APHA (1998) section 6410; or APHA (1998) section 6440; or *USEPA (1986a) method 8100; or *USEPA (1996a) method 8270C; or *USEPA (1986b) method 8310
Potassium (acid extractable)	Preliminary treatment APHA (1998) section 3030(E – K); or USEPA (1992a) method 3005A; or USEPA (1992b) method 3010A; or USEPA (1994g) method 3015; or USEPA (1992c) method 3020A Then use *APHA (1998) section 3111B; or *APHA (1998) section 3120; or *APHA (1998) section 3500-K; or USEPA (1994b) method 200.7; or *USEPA (1996c) method 6010B; or *USEPA (1994f) method 6020† Note: For the purposes of this document, the term "acid extractable" is as defined in APHA (1998) section 3030A.
Pyrene	APHA (1998) section 6410; or APHA (1998) section 6440; or *USEPA (1986a) method 8100; or *USEPA (1996a) method 8270C; or

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
	*USEPA (1986b) method 8310

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Quaternary salts *Includes:* *Diquat* *Paraquat*	USEPA (1992e) method 549.1 (EPA-500 Series Supplement II, Aug. 1992)
Radionuclide(s)	For gross alpha and beta: AS 3550.5—1990; or APHA (1998) section 7110 B; or APHA (1998) section 7110 C For gamma-emitting radionuclides: APHA (1998) section 7120 B; or APHA (1998) section 7500-Cs B (Caesium); or APHA (1998) section 7500-I (Iodine); or APHA (1998) section 7500-Ra (Radium) For Strontium: APHA (1998) section 7500-Sr B For Tritium: APHA (1998) section 7500-^{3}HB For Uranium: APHA (1998) section 7500-U
Salinity *Includes:* *Use for calculation of salt load [in the load calculation protocol only]*	Conductivity—APHA (1998) section 2510; or Salinity—APHA (1998) section 2520

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Selenium (acid extractable)	Preliminary treatment APHA (1998) section 3030(E – K); or USEPA (1992a) method 3005A; or USEPA (1992b) method 3010A; or USEPA (1994g) method 3015; or USEPA (1992c) method 3020AThen use *APHA (1998) section 3113; or *APHA (1998) section 3114; or *APHA (1998) section 3120; or *APHA (1998) section 3125†; or APHA (1998) section 3500-Se; or USEPA (1994b) method 200.7; or USEPA (1994b) method 200.8; or *USEPA (1996c) method 6010B; or *USEPA (1994f) method 6020† Note: For the purposes of this document, the term "acid extractable" is as defined in APHA (1998) section 3030A.
Semi-volatile organic hydrocarbons	APHA (1998) section 6410; or *USEPA (1996a) method 8270C
Silver (acid extractable)	Preliminary treatment APHA (1998) section 3030(E – K); or USEPA (1992a) method 3005A; or USEPA (1992b) method 3010A; or USEPA (1994g) method 3015; or USEPA (1992c) method 3020A; or acid digestion by the method of Yang *et al.* (2002) Then use *APHA (1998) section 3111B; or *APHA (1998) section 3111C; or *APHA (1998) section 3113; or *APHA (1998) section 3120; or *APHA (1998) section 3125†; or USEPA (1994b) method 200.7; or USEPA (1994b) method 200.8†; or *USEPA (1996c) method 6010B; or *USEPA (1994f) method 6020†

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
	Note: For the purposes of this document, the term "acid extractable" is as defined in APHA (1998) section 3030A.
Simazine	USEPA (1998a) method 8141B; or USEPA (1996a) method 8270C **Note:** Simazine may be analysed using USEPA method 8270C provided the extraction is performed at a neutral pH as per method USEPA 8141B.
Sodium (acid extractable)	Preliminary treatment APHA (1998) section 3030(E – K); or USEPA (1992a) method 3005A; or USEPA (1992b) method 3010A; or USEPA (1994g) method 3015; or USEPA (1992c) method 3020A Then use *APHA (1998) section 3111B; or *APHA (1998) section 3120; or APHA (1998) section 3500-Na; or USEPA (1994b) method 200.7; or *USEPA (1996c) method 6010B; or *USEPA (1994f) method 6020† Note: For the purposes of this document, the term "acid extractable" is as defined in APHA (1998) section 3030A.
Solids: *(a) Total dissolved solids* *(b) Total suspended solids*	 APHA (1998) section 2540C APHA (1998) section 2540D; or USEPA (1999) method 160.2; or AS 3550.4—1990
Standing water level	Refer to section on *Depth*
Styrene	APHA (1998) section 6200; or *USEPA (1996d) method 8021B; or *USEPA (1996b) method 8260B
Substituted phenols and cresols	Refer to sections on *Phenol*

* Preferred methods
† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Sulfate	APHA (1998) section 4110; or APHA (2001 supplement) section 4110; or APHA (1998) section 4140; or APHA (1998) section 4500-SO_4^{2-} E; or APHA (1998) section 4500-SO_4^{2-} F; or USEPA (1978b) method 375.4
Sulfide (dissolved)	APHA (1998 or 2001 supplement) section 4500-S^{2-} **Note:** If sample contains suspended solids, then use 4500-S^{2-}-B followed by 4500-S^{2-}-D; If sample contains no suspended solids then use 4500-S^{2-}-D.
Sulfide (total)	APHA (1998 or 2001 supplement) section 4500-S^{2-}
Hydrogen sulfide (un-ionised)	APHA (1998 or 2001 supplement) section 4500-S^{2-}H **Note:** Use dissolved sulfide value in the calculations
2,4,5-T	APHA (1998) section 6640; or *USEPA (1996f) method 8151A; or USEPA (1996e) method 8321A **Note:** When using method 8321A, samples should be hydrolysed to the ester form to simplify analysis.
Temperature	APHA (1998) section 2550
Tetrachloroethene	APHA (1998) section 6200; or *USEPA (1996d) method 8021B; or *USEPA (1996b) method 8260B
2,3,4,6-Tetrachlorophenol	APHA (1998) section 6410; or APHA (1998) section 6420; or *USEPA (1996g) method 8041; or *USEPA (1996a) method 8270C
Thermotolerant coliforms *(also known as faecal coliforms)*	APHA (1998 or 2001 supplement) section 9221; or APHA (1998) section 9222 or AS 4276.6—1995 or AS 4276.7—1995
Thiobencarb	USEPA (1996a) method 8270C

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Tin (acid extractable)	Preliminary treatment APHA (1998) section 3030(E – K); or USEPA (1992a) method 3005A; or USEPA (1992b) method 3010A; or USEPA (1994g) method 3015; or USEPA (1992c) method 3020A Then use APHA (1998) section 3111B; or *APHA (1998) section 3111D; or *APHA (1998) section 3113; or APHA (1998) section 3125; or *USEPA (1996c) method 6010B; or USEPA (1994b) method 200.7; or USEPA (1994b) method 200.8; or USEPA (1994f) method 6020 Note: For the purposes of this document, the term "acid extractable" is as defined in APHA (1998) section 3030A.
Titanium (acid extractable)	Preliminary treatment APHA (1998) section 3030(E – K); or USEPA (1992a) method 3005A; or USEPA (1992b) method 3010A; or USEPA (1994g) method 3015; or USEPA (1992c) method 3020A Then use *APHA (1998) section 3111D; or USEPA (1994b) method 200.7; or *USEPA (1996c) method 6010B Note: For the purposes of this document, the term "acid extractable" is as defined in APHA (1998) section 3030A.
Toluene	APHA (1998) section 6200; or *USEPA (1996d) method 8021B; or *USEPA (1996b) method 8260B
Toluene 2,4-diisocyanate (TDI)	USEPA (1996a) method 8270C
Total Kjeldahl nitrogen	Refer to sections on *Nitrogen*
Total organic carbon (in water)	APHA (1998) section 5310
Total dissolved solids *Total suspended solids*	Refer to section on *Solids*

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Toxicity testing	Where toxicity testing is required, the details should be negotiated on a case-by-case basis with the licensing officer and specialist staff from DEC. Guidance on appropriate methods for toxicity testing will be provided as part of these negotiations.
Tributyltin	Greaves and Unger (1988); or USEPA (1989) method 282.3 or USEPA (2003) method 8323. **Note:** USEPA method 282.3 has not been promulgated and may be hard to obtain (USEPA regional method)
1,1,1-Trichloroethane *1,1,2-Trichloroethane*	APHA (1998) section 6200; or *USEPA (1996d) method 8021B; or *USEPA (1996b) method 8260B
Trichloroethene	APHA (1998) section 6200; or *USEPA (1996d) method 8021B; or *USEPA (1996b) method 8260B
2,4,6-Trichlorophenol	APHA (1998) section 6410; or APHA (1998) section 6420; or *USEPA (1996g) method 8041; or *USEPA (1996a) method 8270C
Trifluralin	USEPA (1998c) method 8081B; or USEPA (1996a) method 8270C
Trihalomethanes and chlorinated organic solvents *Includes:* *Bromoform* *Bromodichloromethane* *Carbon tetrachloride* *Chloroform* *Dibromochloromethane* *Tetrachloroethene* *1,1,1-Trichloroethane* *1,1,2-Trichloroethane* *Trichloroethene*	APHA (1998) section 6232; or APHA (1998) section 6200; or *USEPA (1996d) method 8021B; or *USEPA (1996b) method 8260B
Turbidity	APHA (1998) section 2130

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Vanadium (acid extractable)	Preliminary treatment APHA (1998) section 3030(E – K); or USEPA (1992a) method 3005A; or USEPA (1992b) method 3010A; or USEPA (1994g) method 3015; or USEPA (1992c) method 3020A Then use *APHA (1998) section 3111D; or *APHA (1998) section 3120; or *APHA (1998) section 3125†; or USEPA (1994b) method 200.7; or USEPA (1994b) method 200.8†; or *USEPA (1996c) method 6010B; or *USEPA (1994f) method 6020† Note: For the purposes of this document, the term "acid extractable" is as defined in APHA (1998) section 3030A.
Velocity [of flow]	AS 3778 (several volumes)
Vinyl chloride	APHA (1998) section 6200; or USEPA (1996b) method 8260B; or USEPA (1996d) method 8021B
Volatile halogenated compounds	APHA (1998) section 6200; or USEPA (1996b) method 8260B; or USEPA (1996d) method 8021B

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Volatile organic compounds	APHA (1998) section 6200; or
Includes:	*USEPA (1996b) method 8260B; or
Benzene	*USEPA (1996d) method 8021B
Bromoform	
Carbon tetrachloride	
Chlorobenzene	
Chloroform	
Dibromochloromethane	
1,2-Dichlorobenzene	
1,3-Dichlorobenzene	
1,4-Dichlorobenzene	
1,1-Dichloroethane	
1,2-Dichloroethane	
1,1-Dichloroethene	
Ethyl benzene	
Naphthalene	
Styrene	
Tetrachloroethene	
Toluene	
1,1,1-Trichloroethane	
1,1,2-Trichloroethane	
Trichloroethene	
Vinyl chloride	
m-Xylene	
o-Xylene	
p-Xylene	

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

Table 1: EPA-approved methods for the analysis of water pollutants

Analyte	Method
Volume	AS 3778 covers methods for determining width, depth and velocity in open channels and waterways. For a standing water body, volume can be calculated as: *Volume = width × length × depth* A volume of flowing water can be calculated as: *Volume = cross-sectional area × flow (velocity),* where *cross-sectional area = width × depth* For pipes, the volume can be estimated from the known pump capacity multiplied by the duration of pumping. In all calculations, ensure that measuring instruments are calibrated and the units of measurement are the same. Averages of several measurements should be used when calculating values. See also *Depth*, *Flow* and *Velocity*.
Xylene *Includes:* *m-Xylene* *o-Xylene* *p-Xylene*	APHA (1998) section 6200; or *USEPA (1996b) method 8260B; or *USEPA (1996d) method 8021B
Zinc (acid extractable)	Preliminary treatment APHA (1998) section 3030(E – K); or USEPA (1992a) method 3005A; or USEPA (1992b) method 3010A; or USEPA (1994g) method 3015; or USEPA (1992c) method 3020A Then use *APHA (1998) section 3111B; or *APHA (1998) section 3111C; or *APHA (1998) section 3120; or *APHA (1998) section 3125†; or *APHA (1998) section 3130B; or USEPA (1994b) method 200.7; or USEPA (1994b) method 200.8†; or *USEPA (1996c) method 6010B; or *USEPA (1994f) method 6020† Note: For the purposes of this document, the term "acid extractable" is as defined in APHA (1998) section 3030A.
Zinc (dissolved)	Preliminary treatment APHA (1998) section 3030B; then treat according to *Zinc (acid extractable)*

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

* Preferred methods

† Used when very low concentrations (< 100 µg/L) are tested

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APPENDIX 1 ALTERNATIVE NAMES FOR ANALYTES

Table A1 this appendix gives the alternative names of analytes that are held to be synonymous with those given in the Approved Methods table. Table A2 gives the names of the Approved Methods analytes and possible synonymous alternative names. Alternative names may appear in regulations, in the load calculation protocol or on licences.

Table A1: Alternative names and their synonyms in the Approved Methods table

Alternative analyte name	Analyte name in Approved Methods table
AOX	Dissolved organic halogen
Adsorbable organic halogens	Dissolved organic halogen
Alkalinity (as calcium carbonate)	Alkalinity (total)
Aluminium	Aluminium (acid extractable)
Ammonia	Nitrogen (ammonia)
Ammonia nitrogen	Nitrogen (ammonia)
Antimony	Antimony (acid extractable)
Arsenic	Arsenic (acid extractable)
Barium	Barium (acid extractable)
Benzo(ghl)perylene, benzo(g,h,l)perylene (**Note:** incorrect names)	Benzo(ghi)perylene
Beryllium	Beryllium (acid extractable)
a-BHC	alpha-BHC
b-BHC	beta-BHC
Bicarbonate	Alkalinity (bicarbonate)
Biochemical oxygen demand	Biochemical oxygen demand (5-day)
BOD, BOD_5	Biochemical oxygen demand (5-day)
BOD (for the purpose of determining the 3DGM)	Biochemical oxygen demand (5-day)
Boron	Boron (acid extractable)
Boron (total)	Boron (acid extractable)
Cadmium	Cadmium (acid extractable)
Calcium	Calcium (acid extractable)
COD	Chemical oxygen demand
Chloramines	Chlorine (combined residual)
Chlorine	Chlorine (free residual)
Chloronaphthalene	1-Chloronaphthalene

Table A1: Alternative names and their synonyms in the Approved Methods table

Alternative analyte name	Analyte name in Approved Methods table
Chloronaphthalene(1)	1-Chloronaphthalene
Chromium (VI) compounds	Chromium (hexavalent)
Chromium (III) compounds	Chromium (trivalent)
Chromium (total)	Chromium (acid extractable)
Copper	Copper (acid extractable)
DDD	4,4′-DDD
DDE	4,4′-DDE
DDT	4,4′-DDT
2,4-Dichlorophenoxyacetic acid	2,4-D
Dichlorobenzidine	3,3′-Dichlorobenzidine
Diphenyl hydrazine	1,2-Diphenyl hydrazine
DO	Dissolved oxygen
DOX	Dissolved organic halogen
FC, fc	Faecal coliforms [see under *Coliforms* in approved methods table]
FRC	Chlorine (free residual)
Free cyanide	Cyanide (free)
Free residual chlorine	Chlorine (free residual)
Filterable iron	Iron (dissolved)
Filterable manganese	Manganese (dissolved)
gamma-BHC (lindane)	Lindane
g-BHC (lindane)	Lindane
Guthion (methyl azinphos)	Methyl azinphos
Hexachlorobenzene (HCB)	Hexachlorobenzene
Hexavalent chromium	Chromium (hexavalent)
Insoluble lead	Lead (suspended)
Iron	Iron (acid extractable)
Lead	Lead (acid extractable)
Lithium	Lithium (acid extractable)
Magnesium	Magnesium (acid extractable)
Manganese	Manganese (acid extractable)
MBAS	Anionic surfactants
MCPA	2-Methyl-4-chlorophenoxyacetic acid
Mercury	Mercury (total)

Table A1: Alternative names and their synonyms in the Approved Methods table

Alternative analyte name	Analyte name in Approved Methods table
Mercury (inorganic)	Mercury (total)
Methylene blue active substances	Anionic surfactants
3-Methylphenol (*m*-cresol)	3-Methylphenol
2-Methylphenol (*o*-cresol)	2-Methylphenol
4-Methylphenol (*p*-cresol)	4-Methylphenol
Molybdenum	Molybdenum (acid extractable)
NH_3-N	Nitrogen (ammonia)
Nickel	Nickel (acid extractable)
Nitrate	Nitrogen (nitrate)
Nitrate + nitrite (oxidised nitrogen)	Nitrogen (total oxidised)
Nitrite	Nitrogen (nitrite)
Nitrogen	Nitrogen (total)
Nitrogen as ammonia	Nitrogen (ammonia)
Non-filterable iron	Iron (suspended)
Non-filterable residue	Total suspended solids
o-Dichlorobenzene	1,2-Dichlorobenzene
Organic nitrogen	Nitrogen (organic)
Organophosphate pesticides	Organophosphorus pesticides
Orthophosphate	Phosphorus (dissolved reactive)
PAHs	Polynuclear aromatic hydrocarbons
PCBs	Polychlorinated biphenyls
Polyaromatic hydrocarbons	Polynuclear aromatic hydrocarbons
p,*p*′-DDD, *p*,*p*′-DDD (4,4)	4,4′-DDD
p,*p*′-DDE, *p*,*p*′-DDE (4,4)	4,4′-DDE
p,*p*′-DDT, *p*,*p*′-DDT (4,4)	4,4′-DDT
Reactive phosphorus	Phosphorus (dissolved reactive)
Redox potential	Oxidation–reduction potential
Salt	Salinity, conductivity
Silicate (SiO_2)	Silica (acid extractable)
Soluble lead	Lead (dissolved)
Soluble phosphorus	Phosphorus (dissolved reactive)
Sulfur	May mean sulfate or hydrogen sulfide (un-ionised). Seek further advice from your EPA regional office.

Table A1: Alternative names and their synonyms in the Approved Methods table

Alternative analyte name	Analyte name in Approved Methods table
TDS	Total dissolved solids
Thermotolerant coliforms	Faecal coliforms
TKN	Total Kjeldahl nitrogen
TKN-N	Total Kjeldahl nitrogen
TN	Nitrogen (total)
TOC	Total organic carbon
Total aluminium	Aluminium (acid extractable)
Total cadmium	Cadmium (acid extractable)
Total chromium	Chromium (acid extractable)
Total copper	Copper (acid extractable)
Total cyanide	Cyanide (total)
Total iron	Iron (acid extractable)
Total lead	Lead (acid extractable)
Total manganese	Manganese (acid extractable)
Total nitrogen	Nitrogen (total)
Total PAHs	Polynuclear aromatic hydrocarbons
Total phosphorus	Phosphorus (total)
Total phosphorus—filtered	Phosphorus (total dissolved)
Total phosphorus—unfiltered	Phosphorus (total)
Total residual chlorine	Chlorine (total residual)
Total zinc	Zinc (acid extractable)
TP	Phosphorus (total)
TRC	Chlorine (total residual)
Trivalent chromium	Chromium (trivalent)
TSS	Total suspended solids
Vanadium	Vanadium (acid extractable)
WAD cyanide	Cyanide (weak acid dissociable)
% Water-stable aggregates	Aggregate stability
WSA—Water-stable aggregates	Aggregate stability
Zinc	Zinc (acid extractable)

Table A2: Names of analytes, as listed in the Approved Methods table, and their common alternative names

Analyte name in Approved Methods table	Alternative analyte name
Anionic surfactants	Methylene blue active substances
Acrylonitrile	Acrylonitrile (2-propenenitrile)
Alkalinity (bicarbonate)	Bicarbonate
Alkalinity (total)	Alkalinity (as calcium carbonate)
Aluminium (acid extractable)	Aluminium, total aluminium
Antimony (acid extractable)	Antimony
Arsenic (acid extractable)	Arsenic
Barium (acid extractable)	Barium
Benzo(ghi)perylene	Benzo(ghl)perylene, benzo(g,h,l)perylene (**Note:** incorrect names)
Beryllium (acid extractable)	Beryllium
alpha-BHC	a-BHC
beta-BHC	b-BHC
Biochemical oxygen demand (5-day)	Biochemical oxygen demand, BOD, BOD_5, BOD (for the purpose of determining the 3DGM)
Boron (acid extractable)	Boron, boron (total)
Cadmium (acid extractable)	Cadmium, total cadmium
Calcium (acid extractable)	Calcium
Chemical oxygen demand	COD
Chlorine (combined residual)	Chloramines
Chlorine (free residual)	Chlorine, FRC, free residual chlorine
Chlorine (total residual)	TRC, total residual chlorine
1-Chloronaphthalene	Chloronaphthalene(1)
Chromium (acid extractable)	Chromium (total), total chromium
Chromium (hexavalent)	Chromium (VI) compounds, hexavalent chromium
Chromium (trivalent)	Chromium (III) compounds, trivalent chromium
Conductivity	Salt [load calculation protocol only]
Copper (acid extractable)	Copper, total copper
Cyanide (free)	Free cyanide
Cyanide (total)	Total cyanide
Cyanide (weak acid dissociable)	WAD cyanide
4,4′-DDD	DDD, *p*,*p*′-DDD, *p*,*p*′-DDD (4,4)

Table A2: Names of analytes, as listed in the Approved Methods table, and their common alternative names

Analyte name in Approved Methods table	Alternative analyte name
4,4′-DDE	DDE, *p*,*p*′-DDE, *p*,*p*′-DDE (4,4)
4,4′-DDT	DDT, *p*,*p*′-DDT, *p*,*p*′-DDT (4,4)
1,2-Dichlorobenzene	*o*-Dichlorobenzene
3,3′-Dichlorobenzidine	Dichlorobenzidine
1,2-Diphenyl hydrazine	Diphenyl hydrazine
Dissolved organic halogen	AOX, absorbable organic halogens
Dissolved oxygen	DO
DTPA	Diethylenetriaminepentaacetic acid pentasodium salt
Faecal coliforms	FC, fc,
Hexachlorobenzene	Hexachlorobenzene (HCB)
Iron (acid extractable)	Iron, total iron
Iron (dissolved)	Filterable iron
Iron (suspended)	Non-filterable iron
Lead (acid extractable)	Lead, total lead
Lead (dissolved)	Soluble lead
Lead (suspended)	Insoluble lead
Lindane	gamma-BHC (lindane), g-BHC (lindane)
Lithium (acid extractable)	Lithium
Magnesium (acid extractable)	Magnesium
Manganese (acid extractable)	Manganese, total manganese
Manganese (dissolved)	Filterable manganese
Mercury (total)	Mercury, mercury (inorganic)
Methyl azinphos	Guthion (methyl azinphos)
2-Methyl-4-chlorophenoxyacetic acid	MCPA
2-Methylphenol	2-Methylphenol (*o*-cresol)
3-Methylphenol	3-Methylphenol (*m*-cresol)
4-Methylphenol	4-Methylphenol (*p*-cresol)
Molybdenum (acid extractable)	Molybdenum
Nickel (acid extractable)	Nickel
Nitrogen (ammonia)	Nitrogen as ammonia, ammonia, ammonia nitrogen, NH_3-N
Nitrogen (organic)	Organic nitrogen
Nitrogen (nitrate)	Nitrate

Table A2: Names of analytes, as listed in the Approved Methods table, and their common alternative names

Analyte name in Approved Methods table	Alternative analyte name
Nitrogen (nitrite)	Nitrite
Nitrogen (total)	Nitrogen, TN, total nitrogen
Nitrogen (total oxidised)	Nitrate + nitrite (oxidised nitrogen)
Organophosphorus pesticides	Organophosphate pesticides
Oxidation–reduction potential	Redox potential
Phosphorus (dissolved reactive)	Orthophosphate, reactive phosphorus, soluble phosphorus
Phosphorus (total)	TP, total phosphorus, total phosphorus—unfiltered
Phosphorus (total dissolved)	Total phosphorus—filtered
Polychlorinated biphenyls	PCBs
Polynuclear aromatic hydrocarbons	Total PAHs
Salinity	Salt [load calculation protocol only]
Silica (acid extractable)	Silicate (SiO_2)
2,4,5-T	2,4,5-Trichlorophenoxyacetic acid
Total dissolved solids	TDS
Total Kjeldahl nitrogen	TKN, TKN-N
Total organic carbon	TOC
Total suspended solids	TSS
Vanadium (acid extractable)	Vanadium
Aggregate stability	% Water-stable aggregates, WSA—water-stable aggregates
Zinc (acid extractable)	Total zinc, zinc

ATTACHMENT E

SIMULATED PIT INFLOWS (HYDROSIMULATIONS, 2014)

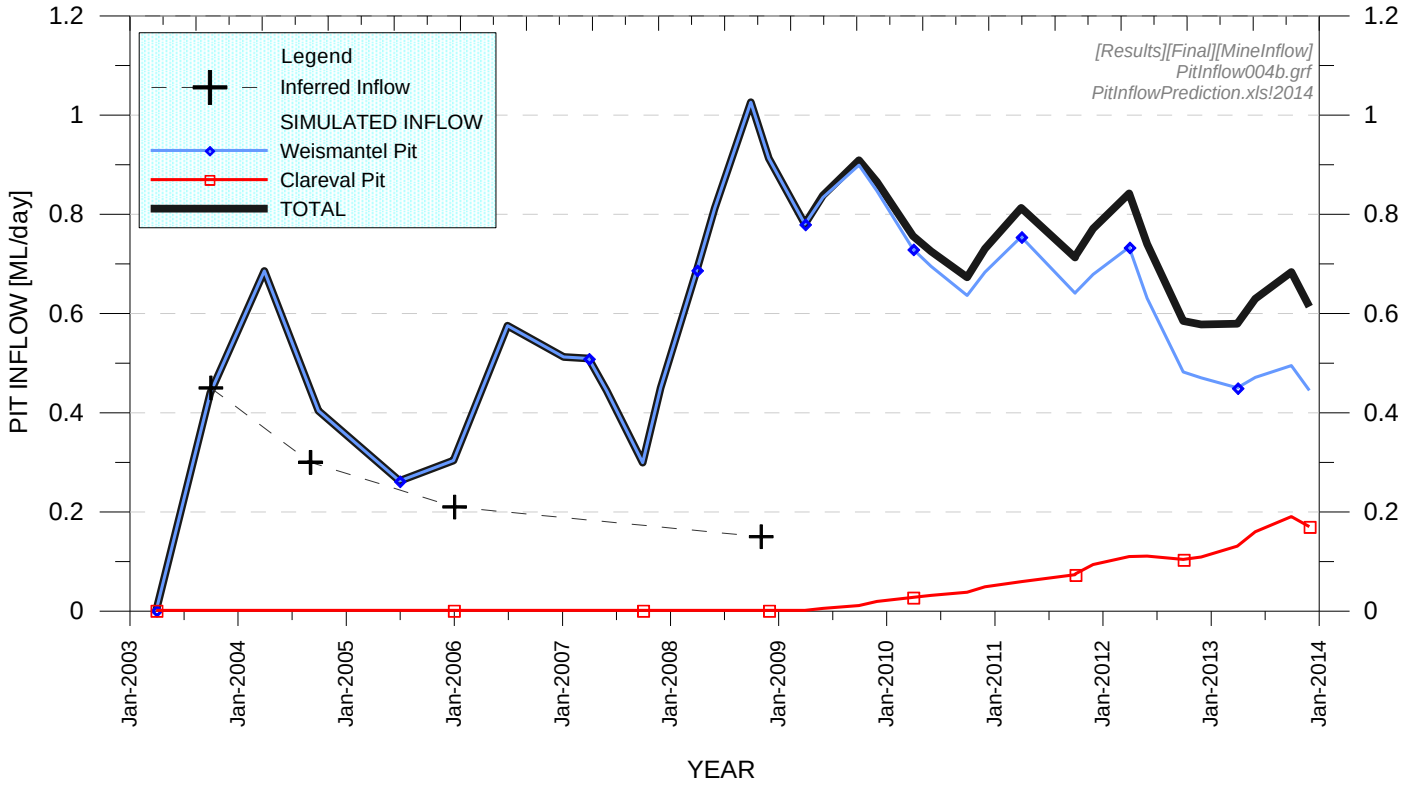

Figure E-1 Simulated Pit Inflows [ML/day]

ATTACHMENT F

INTERFACE INVESTIGATION PROGRAM – WASTE EMPLACEMENT AND ALLUVIUM
(HYDROSIMULATIONS, 2015)

Heritage Computing Pty Ltd ● ABN 75 392 967 126 ● T/A **HydroSimulations**
PO Box 241, Gerringong NSW 2534. Phone: (+61 2) 4234 3802

will.minchin@hydrosimulations.com

DATE:	10 August 2015
TO:	Scott Mitchell Environmental Manager Duralie Coal Pty Ltd
	Duralie Coal (Yancoal) PO Box 168, Gloucester NSW 2422
FROM:	Will Minchin and Dr Noel Merrick
RE:	Interface Investigation Program – Waste Emplacement and Alluvium
OUR REF:	YAN004– HC2015/11c

1. INTRODUCTION

The Duralie Coal Mine (DCM) is an existing coal mine situated approximately 35 kilometres (km) south of Gloucester in the Gloucester Valley, New South Wales (NSW) (**Figure 1**). Duralie Coal Pty Ltd (DCPL) (a wholly owned subsidiary of Yancoal Australia Limited) owns and operates the DCM. The NSW Minister for Urban Affairs and Planning granted Development Consent for the DCM in August 1997 and coal production commenced in 2003.

The Duralie Extension Project involves the extension and continuation of mine operations at the DCM. DCPL was granted approval for the Duralie Extension Project under section 75J of the NSW *Environmental Planning and Assessment Act, 1979* on 26 November 2010 (NSW Project Approval [08_0203]) and under sections 130 and 133 of the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* on 22 December 2010 (Commonwealth Approval [EPBC 2010/5396]). On 10 November 2011, the NSW Project Approval (08_0203) was amended by Order of The Land and Environment Court of NSW. On 1 November 2012, the NSW Project Approval (08_0203) was modified as a result of the Duralie Rail Hours Modification. On 5 December 2014, the NSW Project Approval (08_0203) was modified as a result of the Duralie Open Pit Modification. A copy of the consolidated NSW Project Approval (08_0203) and the Commonwealth Approval (EPBC 2010/5396) is available on the Duralie Coal website (http://www.duralie coal.com.au).

Condition 29, Schedule 3 of the NSW Project Approval (08_0203), requires the preparation of a Water Management Plan for the DCM.

Figure 1 Location of Duralie Coal Mine

This report has been prepared by HydroSimulations to provide assistance in addressing the following components of the Water Management Plan, required by Condition 29(c), Schedule 3 of the NSW Project Approval (08_0203), specifically:

> *29. The Proponent shall prepare and implement a Water Management Plan for the project to the satisfaction of the Secretary. This plan must be prepared in consultation with EPA[1] and NOW[2] by suitably qualified and experienced persons whose appointment has been approved by the Secretary, and submitted to the Secretary within 3 months of the date of this approval. In addition to the standard requirements for management plans (see Condition 2 of Schedule 5), this plan must include:*
>
> *...*
>
> *(c) a Groundwater Management Plan, which includes:*
>
> *...*
>
> - *a program to monitor:*
>
> *...*
>
> - *the impact of the project on:*
>   - *the alluvial aquifers including investigating the potential for direct interface between mine spoil and alluvium and assessment of any consequential impact on alluvial and surface water;*
>
> *...*
>
> - *a plan to respond to any exceedances of the assessment criteria, including,*
>   - *if a direct interface between mine spoil and alluvium is identified, development of a trigger action response plan (TARP) for potential salinity impacts on alluvial and surface water sources; and*
>   - *a plan to offset the loss of any base flow to Mammy Johnsons River caused by the project.*

2. OVERVIEW OF REGIONAL AND LOCAL HYDROGEOLOGY

The following overview is sourced primarily from HydroSimulations (2014a), with additional local detail regarding the extent of alluvium sourced from HydroSimulations (2014b).

2.1 Regional Setting

The DCM coal resource is located within the Permian-aged Gloucester Basin in NSW. To the west of the DCM, the Karuah River flows south (**Figures 1** and **2**). To the east of the DCM the Mammy Johnsons River flows south and then west just outside the DCM Mining Lease (ML) 1427 before flowing south again before joining the Karuah River (**Figure 2**). A small tributary of the Mammy Johnsons River, Coal Shaft Creek, used to flow south through the middle of the DCM mine lease, exiting at the southern edge of the lease. This is now diverted around the DCM, and still discharges to the Mammy Johnsons River (**Figure 2**).

The DCM is located in the southern closure of the main synclinal structure of the Gloucester Basin and is associated with the coal bearing strata of the Dewrang Group. The Dewrang Group comprises three main stratigraphic units, namely:

- Mammy Johnsons Formation;
- Weismantels Formation; and
- Durallie Road Formation.

The outcrop mapping on **Figure 2** is the 1:100k Dungog map-sheet (Roberts *et al*, 1991).

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[1] EPA: Environment Protection Authority

[2] NOW: NSW (Department of Primary Industries) Office of Water

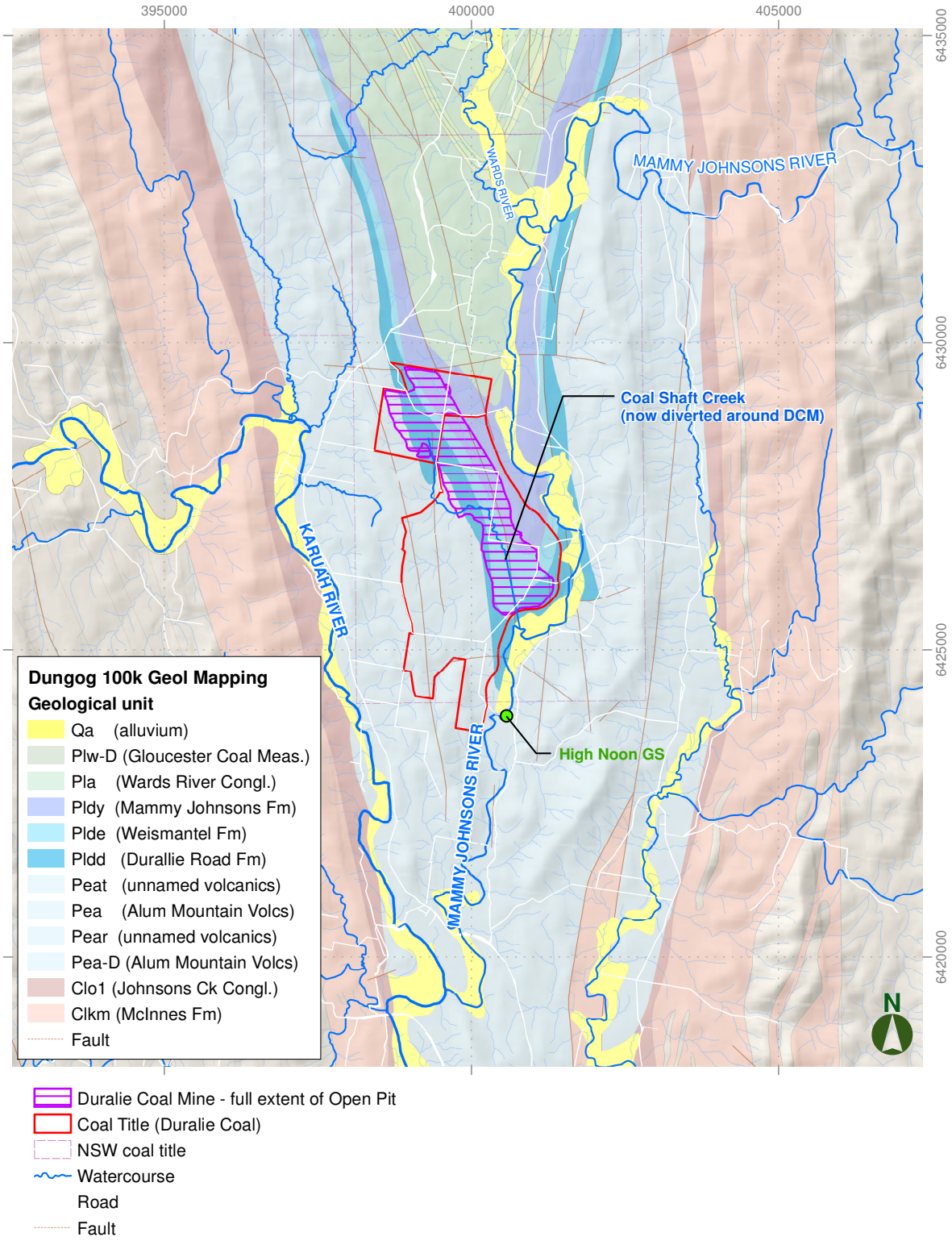

Figure 2 **Outcrop Geology and Watercourses around DCM**

2.1.1 Alluvium and Regolith

At land surface in this area there is typically either a weathered profile (regolith) which developed across the Permian or other hard-rock strata, or there is alluvium, deposited along current or prior drainage lines.

Based on the 1:100k scale mapping in **Figure 2**, a thin, narrow and discontinuous deposit of Quaternary to recent alluvial deposits occurs along the river flats of Mammy Johnsons River. The alluvium consists of silty sands and silts with lenses of gravelly sands and sandy, coarse gravel, particularly towards the base of the alluvium. The gravel lenses correspond to former channel deposits of the river and are evident in the present bed and banks of the river. Monitoring bores in the alluvium are drilled to depths of 5.8 to 10.1 m; other evidence from exploration holes suggests an average thickness of about 9 m for the alluvium, but the maximum thickness is unknown.

In recent months, a series of new datasets have become available, and of these the relevant depth of regolith (essentially depth to unweathered rock) data set (CSIRO, 2014) suggests that the maximum depth of alluvium in this area is 10-13 m. This is in good agreement with the earlier description from HydroSimulations (2014a).

2.2 Local Hydrogeology

During the preparation of the *Duralie Coal Mine Extension Project Modification Groundwater Assessment* (HydroSimulations, 2014a), NOW indicated that their mapping of 'Highly Productive' alluvium (**Figure 3**) extends to the toe of the existing DCM waste rock emplacement (i.e. the southern extent of the waste rock emplacement), whereas the conceptualisation in the Groundwater Assessments carried out for DCPL (including the *Duralie Coal Mine Extension Project Modification Groundwater Assessment* [HydroSimulations, 2014a]) have not included this northward 'tongue' of alluvium, and nor did they have alluvium extending into the waste rock emplacement area on the southern and eastern edge of the DCM.

HydroSimulations understand that the NOW mapping is based on NSW 'Soil Landscape' mapping, which indicates that Highly Productive alluvium is present in the southern part of the DCM disturbance area (an area that was mined in the early 2000s). HydroSimulations (2014b) showed that the Soil Landscape mapping, and therefore the mapping for Highly Productive alluvium, was different to the alluvium mapped in any of the available geological maps (1:500k, 1:250k, and 1:100k).

Subsequent analysis of bore locations and bore logs (HydroSimulations, 2014b) showed that there are a number of bores in the area, although perhaps not in the area mapped as Highly Productive alluvium between the Mammy Johnsons River and the waste rock emplacement. The 15 bores present showed varied depths of unconsolidated material (up to 8 m), with most showing a thin unconsolidated horizon or only clay-dominant material above rock. Only three showed coarse grained material that is consistent with the concept of potentially Highly Productive alluvium (subject to salinity and yield criteria) and capable of providing a preferential flow path to connect the waste rock emplacement to the Mammy Johnsons River.

However the recently released 'depth to rock' mapping (CSIRO, 2014) is also presented on **Figure 3**. This shows a channel-like feature, more or less congruent with the NOW's Highly Productive alluvium. This, along with the current bore distribution, guides the recommended investigation and monitoring program outlined in **Section 3**.

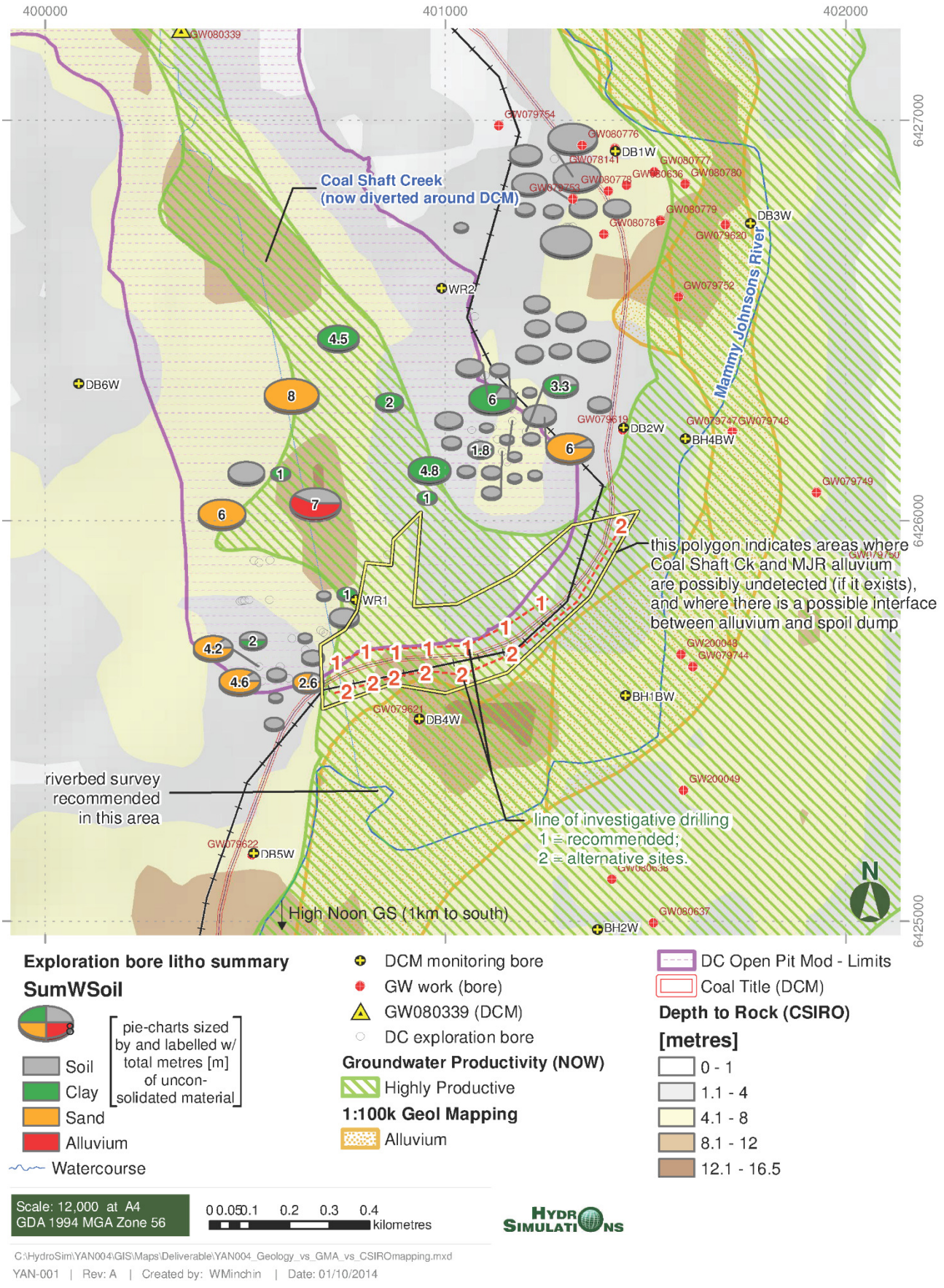

Figure 3 Transects recommended for TEM and Drilling investigation

3 RECOMMENDED MONITORING PROGRAM

As described in **Section 1**, the DCM Groundwater Management Plan is required to include a program to monitor the potential impacts of the DCM on the alluvial aquifers including investigating the potential for direct interface between mine spoil (waste rock emplacement) and alluvium and assessment of any consequential impact on alluvial and surface water.

This section outlines a recommended monitoring program to address this requirement.

3.1 Field Investigations

To obtain additional information regarding the extent of alluvium in the vicinity of the southern extent of the DCM waste rock emplacement, HydroSimulations recommend the following field investigations:

- Transient Electromagnetic (TEM) geophysical survey - one transect along or near the southern boundary of ML 1427 (alternative transect lines are marked “1” and 2” on **Figure 3**). Advice will need to be taken from the TEM operator regarding the transect or survey area. The results of this survey will guide
- Drilling and logging of up to five drillholes at regular intervals (approximately 100-150 m spacing) near the southern boundary of ML 1427 along either transects suggested in **Figure 3** (but guided by the results of the TEM survey); followed by
- Installation on one, possibly two, shallow monitoring bores at the most appropriate drillhole sites, selected on the basis of TEM and drilling results. With respect to potential baseflow capture in the case of more alluvium being encountered in the previous investigations, one of these bores might need to be located within about 50 m of the river, (i.e. beyond ML 1427, just south of the [original] Coal Shaft Creek confluence).

These recommendations are based on the existing hydrogeological information described in **Section 2**.

Further details of those three recommended field investigations are as follows.

It is recommended that the TEM survey and any bores be located inside ML 1427, but as close to the boundary as possible to avoid investigating ground previously disturbed by mining. However space and access may be constrained in the field, and so may mean that the TEM survey and bore drilling cannot be conducted within ML 1427, in which case further approvals may be required. However, the recommendation is to investigate within 100 m of the ML 1427 boundary or the railway line, and the preference is as close as possible to the DCM footprint. TEM surveys are not usually affected by the presence of a rail line beyond about 10 m.

The TEM survey should be conducted first. After initial interpretation, sites for the drillholes can be selected considering the data displayed in **Figure 3**. Drilling should continue at least a couple of metres into ‘fresh’ rock (i.e. to the base of any alluvium and weathered profile) and can then be discontinued at that hole.

Once drilling has been completed and logs completed, the TEM interpretation can be finalised.

Finally, it is recommended that one, but possibly two depending on the lithology encountered, of the drillholes be completed as monitoring bores and the ground level and top of casing surveyed. It is possible that further investigative drilling may be recommended based on the finding of this initial round of investigative drilling. The preference for choosing a site is the location with the thickest horizon of coarse materials, however sites aligned with the channel features in the Highly Productive alluvium and CSIRO (2014) mapping are *probably* also favoured. The second of these could be located to further assess gaining and losing conditions to the south of the Coal Shaft Creek confluence (which is currently assessed using DB3W vs BH4BW, which are located over 1 km upstream).

3.2 Monitoring

Once the field investigations are completed, the following monitoring at the new monitoring bores should be undertaken:

- Water levels: use of water level data loggers is recommended for the first two years, mainly to investigate the response of water levels to high rainfall events as well to as high river level events. After that, water levels can be dipped in the regular round of water level monitoring;
- Field parameters (pH, EC, DO, temperature): every 3 months for the first year, then done with the usual monitoring rounds after that;
- Water chemistry: sampling for water chemistry analysis should be carried out. Monitoring is to be for pH, Eh, EC, major cations, major anions, and metals. This is to be done 3-monthly for the first year, then as per the TARP (below).

The Groundwater Management Plan should be updated to incorporate this additional monitoring.

3.3 Analysis

Following the installation of monitoring bores (one or more) along the southern edge of ML 1427 (near the former Coal Shaft Creek confluence with Mammy Johnsons River) and monitoring data becomes available, analysis of the following should be conducted:

- Degree of saturation of any alluvium or unconsolidated deposits.
- Direction of any discernible shallow groundwater gradient, comparing water levels from new monitoring bore(s), local surveyed Mammy Johnsons River river bed level and High Noon stage records, and groundwater levels from existing monitoring bores BH4W, WR1, DB4W.
- Assessment of local groundwater chemistry changes suggesting potential groundwater movement from waste rock emplacements toward the Mammy Johnsons River.
- Comparison of any monitored water levels near the Coal Shaft Creek confluence with modelled results to verify the numerical model. This may need to include findings from the investigation of alluvium described above. Discrepancy between modelled and observed groundwater levels may then indicate more or less baseflow capture than predicted in HydroSimulations (2014a).

The information collected from the recommended monitoring program should allow DCPL to confirm if there is any direct interface between mine spoil (the waste rock emplacement) and alluvium. An assessment of any consequential impact on alluvial and surface water should also be able to be conducted at this stage.

4 TRIGGER ACTION RESPONSE PLAN (TARP) AND BASEFLOW OFFSET PLAN

As outlined in Section 1, Condition 29(c), Schedule 3 includes the requirement for:

a plan to respond to any exceedances of the assessment criteria including,

- *if a direct interface between mine spoil and alluvium is identified, development of a trigger action response plan (TARP) for potential salinity impacts on alluvial and surface water sources; and*
- *a plan to offset the loss of any base flow to Mammy Johnsons River caused by the project.*

These requirements are discussed in the following sections.

4.1 Trigger Action Response Plan

In accordance with Condition 29(c), Schedule 3 of the NSW Project Approval (085_0203), the development of the TARP is conditional on the investigation outlined in Section 3 identifying a "direct interface between mine spoil and alluvium". DCPL will develop a TARP (if required) once the investigation and monitoring program (Section 3) has been completed.

Notwithstanding the above, a suggested 'conceptual' TARP is outlined below:

Water Quality Triggers

Level 1 Trigger – set trigger for pH, EC based on historical data, e.g. 50th and 80th percentiles → detailed analysis by a Qualified Person to assess likely source of such a result.

Level 2 Trigger – set trigger for pH, EC (as above) → Notification to NOW, plus immediate sampling and laboratory analysis of EC, pH, Eh, cations, anions and metals.

Level 3 Trigger – set trigger for pH, EC → Notification to NOW. Consider actions to prevent or minimise further migration, e.g. the need to install a new bore, or pump from existing bore, to capture any plume.

4.2 Mammy Johnsons River Baseflow Offset Plan

Modelling in HydroSimulations (2014a) suggested that mining would result in baseflow capture of about 0.016 ML/d (16 m^3/d) (peak rate of loss is estimated at 0.02 ML/d). This rate of loss is negligible, i.e. at Q90, this reduction is less than 2% of Mammy Johnsons River flow, and at Q95 this reduction is approximately 5% of Mammy Johnsons River flow.

To assess whether baseflow capture exceeds this predicted amount, HydroSimulations recommend the following.

Comparison with modelled groundwater levels: compare modelled groundwater levels in the alluvium near to the transect sites. Deviation between modelled and observed may indicate greater leakage than predicted. This to be done on an annual basis, i.e. in Annual Reviews.

If investigative drilling suggests that alluvium is more extensive than indicated by published geological maps, revision of the conceptual model and numerical model may be necessary. As a result, the predicted baseflow capture may change.

Water Level

Analysis to be carried out with records from High Noon gauging station (**Figure 3**), groundwater levels from new monitoring bore(s) and surveyed elevation of riverbed near 400850, 6425325 (MGA94 zone 56 coordinates, marked roughly on **Figure 3**).

Level 1 – water level falls or remains below river stage for a period (to be determined, maybe weeks) → detailed analysis by a Qualified Person to assess likely source and implication of such a result. Check model predictions.

Level 2 – water level falls or remains below river stage for a period (to be determined, maybe 3-4 months) → Check model predictions, possible need for model recalibration, and prediction of baseflow loss from revised model. Possible need for baseflow offset. Notification to NOW.

HydroSimulations (2014a) predicted that any potential baseflow capture as a result of the Duralie Extension Project (incorporating the Open Pit Modification) would be negligible. In the event that the baseflow capture is determined by either of the methods above to be greater than negligible, it is recommended that an administrative offset be implemented.

The administrative offset should involve DCPL purchasing and retiring a surface water licence to cover estimated future effects – the licence would need to be relatively small (7 ML/a) to cover peak baseflow capture.

5 REFERENCES

CSIRO (Wilford, J.; Searle, R.; Thomas; M., Grundy, M.), 2014. Soil and Landscape Grid National Soil Attribute Maps - Depth of Regolith (3" resolution) - Release 1. v3. CSIRO. Data Collection. 10.4225/08/546F06DFDFAC1.
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