Centennial Coal

Centennial Myuna Pty Ltd

Myuna Colliery
Water Management Plan

June 2017

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Glossary

Alkalinity	A measure of the ability of an aqueous solution to neutralise acids. Alkalinity of natural waters is due primarily to the presence of hydroxides, bicarbonates and carbonates. It is expressed in units of calcium carbonate ($CaCO_3$).
Alluvial	Deposition from running waters.
Ambient	Pertaining to the surrounding environment or prevailing conditions.
Aquifer	An underground layer of permeable material from which groundwater can be usefully extracted.
Australian Height Datum	A common national surface level datum approximately corresponding to sea level
Average recurrence interval	A statistical estimate of the average period in years between the occurrence of a flood of a given size or larger, e.g. floods with a discharge equivalent to the 1 in 100 year average recurrence interval flood event will occur on average once every 100 years.
Baseflow	The component of flow in a watercourse that is driven from the discharge of underground water.
Baseline monitoring	Monitoring conducted over time to collect a body of information to define specific characteristics of an area (e.g. species occurrence or water quality) prior to the commencement of a specific activity.
Bore	Constructed connection between the surface and a groundwater source that enables groundwater to be transferred to the surface either naturally or through artificial means.
Catchment	The land area draining through the main stream, as well as tributary streams, to a particular location.
Clean water	Water that has not come into physical contact with coal or mined carbonaceous material.
Dewatering	The removal or pumping of water from an above or below ground storage, including the mine water within the water collection system of mine workings. Water removed from mine workings is regarded as dewatering unless the workings are flooded and at equilibrium with the surrounding strata (in which case the removal is considered groundwater extraction).
Dirty water	Water that has an elevated sediment load.
Discharge	The quantity of water per unit of time flowing in a stream, for example cubic metres per second or megalitres per day.
Electrical conductivity	A measure of the concentration of dissolved salts in water.
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or overland runoff before entering a watercourse and/or coastal inundation resulting from super elevated sea levels and/or waves overtopping coastline defences.

Floodplain	Area of land that is periodically inundated by floods up to the probable maximum flood event.
Geomorphology	Scientific study of landforms, their evolution and the processes that shape them. In this report relates to the form and structure of waterways.
Goaf	The part of a mine from which the mineral has been partially or wholly removed, including the waste left in workings.
Groundwater	Water occurring naturally below ground level.
Groundwater extraction	For the purposes of this plan, groundwater extraction has been defined as the removal of groundwater from a groundwater source or aquifer, either via direct removal for use via a production bore or via incidental flow of groundwater from the aquifer into the mine workings during and after mining. Groundwater extraction includes the pumping of underground water from flooded mine workings in equilibrium with the surrounding strata as well as the removal of water from perched aquifers recharged directly from rainfall infiltration.
Guideline	A numerical concentration or narrative statement that provides appropriate guidance for a designated water use or impact.
Hardness	The concentration of multivalent cations in water. Generally, hardness is a measure of the concentration of calcium and magnesium ions in water and is expressed in units of calcium carbonate ($CaCO_3$) equivalent. Hardness may influence the toxicity and bioavailability of substances in water.
Ion	Electrically charged atom.
Licensed discharge point	A location where the premises discharge water in accordance with conditions stipulated within the site Environmental Protection License.
Median	The middle value, such that there is an equal number of higher and lower values. Also referred to as the 50th percentile.
Percentile	The value of a variable below which a certain percent of observations fall. For example, the 80th percentile is the value below which 80 percent of values are found.
pH	The value taken to represent the acidity or alkalinity of an aqueous solution. It is defined as the negative logarithm of the hydrogen ion concentration of the solution.
Potable water	Water of a quality suitable for drinking.
Riparian	Pertaining to, or situated on, the bank of a river or other water body.
Runoff	The amount of rainfall which actually ends up as streamflow, also known as rainfall excess.
Run of mine	Raw coal production (unprocessed).
Sediment	Soil or other particles that settle to the bottom of lakes, rivers, oceans and other waters.
Stream order	Stream classification system, where order 1 is for headwater (new) streams at the top of a catchment. Order number increases downstream using a defined methodology related to the branching of streams.

Subsidence	The vertical difference between the pre-mining surface level and the post-mining surface level at a point.
Surface water	Water that is derived from precipitation or pumped from underground and may be stored in dams, rivers, creeks and drainage lines.
Topography	Representation of the features and configuration of land surfaces.
Toxicity	The inherent potential or capacity of a substance to cause adverse effects in a living organism.
Tributary	A stream or river that flows into a main river or lake.
Trigger value	The concentration or load of physicochemical characteristics of an aquatic ecosystem, below which there exists a low risk that adverse ecological effects will occur. They indicate a risk of impact if exceeded and should 'trigger' action to conduct further investigations or to implement management or remedial processes.
Turbidity	A measure of clarity (turbidity) of water. Turbidity in excess of 5 NTU is just noticeable to the average person.

Abbreviations

AHD	Australian Height Datum
ARI	Average recurrence interval
BOM	Bureau of Meteorology
Centennial	Centennial Coal Company Limited
Centennial Myuna	Centennial Myuna Pty Limited
CHP	Coal handling plant
DPI-Water	Department of Primary Industry – Water
DRE	Department of Industry – Resources and Energy
EPA	Environment Protection Authority
EPL	Environment protection licence
ESCP	Erosion and sediment control plan
ha	Hectare
HWC	Hunter Water Corporation
kL/day	Kilolitre per day
km	Kilometre
L/s	Litre per second
LDP	Licensed discharge point
LMCC	Lake Macquarie City Council
LOR	Limit of reporting
m	Metre
mg/L	Milligram per litre
ML	Megalitre
ML/day	Megalitre per day
ML/year	Megalitre per year
mm	Millimetre
Mtpa	Million tonnes per annum
NTU	Nephelometric turbidity unit
OEH	Office of Environment and Heritage
PIRMP	Pollution Incident Response Management Plan
ROM	Run of mine
RWMP	Regional water management plan
SILO	Scientific Information for Land Owners
SSTV	Site-specific trigger value
TARP	Trigger action response plan
TDS	Total dissolved solids
TOC	Top of casing

TSS	Total suspended solids
WMP	Water management plan
WSP	Water sharing plan
µS/cm	Microsiemens per centimetre

1. Introduction

Myuna Colliery is an underground coal mine owned and operated by Centennial Myuna Pty Limited (Centennial Myuna), a wholly owned subsidiary of Centennial Coal Company Limited (Centennial). Myuna Colliery's Surface Facilities Area is located in Wangi Wangi on the western side of Lake Macquarie, 25 km south-west of Newcastle, as shown in Figure 1-1.

Myuna Colliery was originally developed as a source of extractable coal for Eraring Power Station in 1982, with mining operations commencing at an average rate of 1.3 million tonnes per annum (Mtpa) of run of mine (ROM) coal. On 27 February 2012 Centennial Myuna received approval for the Myuna Coal Project under Part 3A of the *Environmental Planning and Assessment Act 1979.* The new approval (PA 10_0080) allowed for the continuation of mining at the Myuna Colliery at a maximum extraction rate of 2 Mtpa of ROM coal for a period of 21 years up to 31 December 2032. On 27 February 2015, Centennial Myuna was granted a modification to this approval (MOD 1) which allowed for an increased rate of production up to a maximum of 3 Mtpa and an increase in personnel from 210 to up to 300 full time employees. Mining of three seams, the Wallarah, Great Northern and Fassifern coal seams, using a bord and pillar extraction method has been undertaken at the mine since operations commenced and remains the method of mining today.

This site-specific Water Management Plan (WMP) has been prepared for Myuna Colliery as a sub-plan of the Northern Operations Regional Water Management Plan (RWMP) that encompasses the northern coal operations owned by Centennial. Both the site-specific and regional management plans apply to all operations at Myuna Colliery and include the existing and approved operations and associated infrastructure within the site boundary. The WMP will be progressively updated as water management requirements change over time.

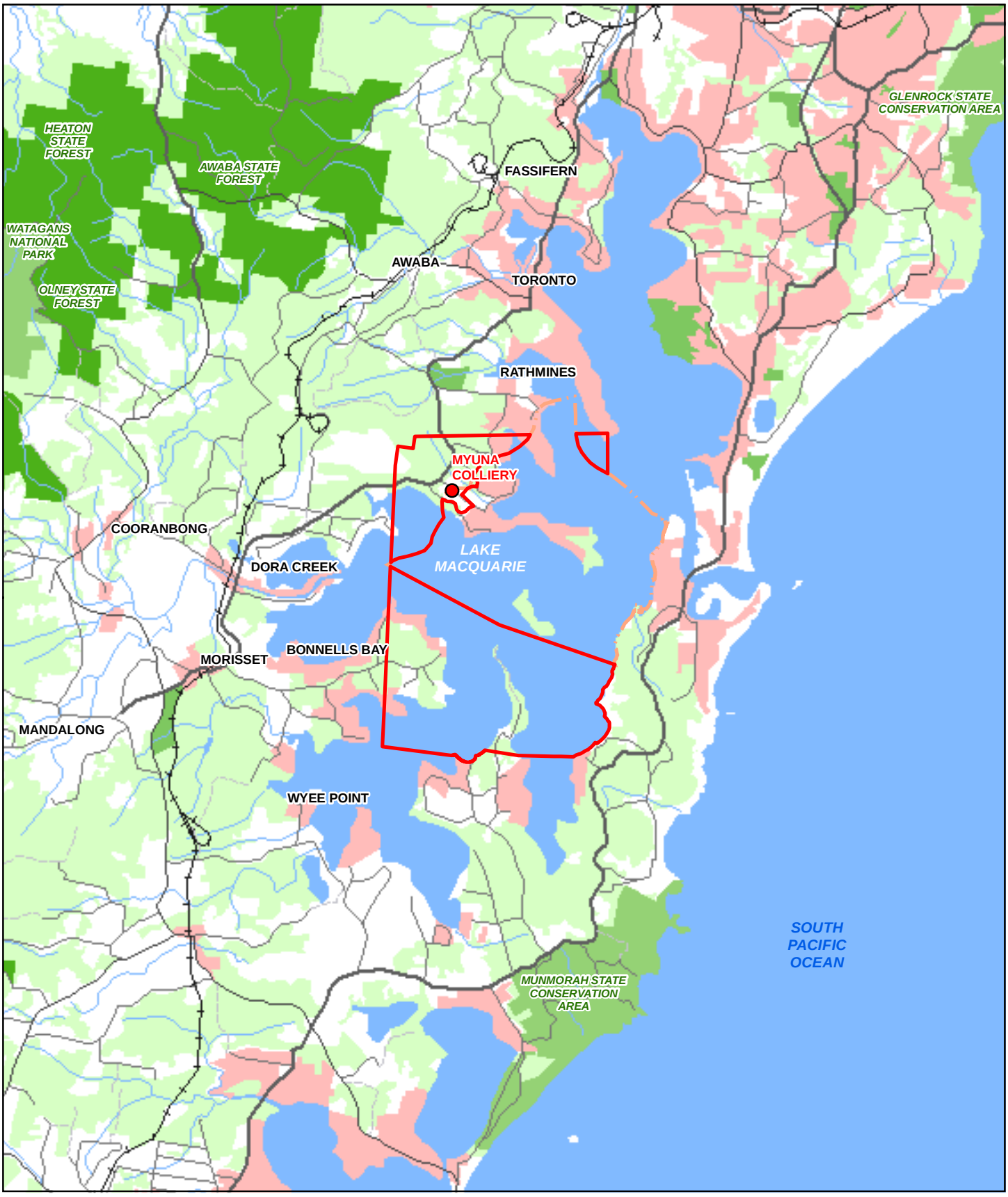
In the development of this WMP, a number of key assessments and management plans related to water management at Myuna Colliery have been reviewed, including:

- Water Management Plan (GHD, 2013a).
- Surface Water Management Plan (GHD, 2012a).
- Groundwater Monitoring Program (GHD, 2012b).
- Water and Salt Balance Assessment (GHD, 2012c).
- Surface and Groundwater Response Plan (GHD, 2012d).
- Erosion and Sediment Control Plan (GHD, 2013b).
- Hydrogeological Model (GHD, 2014a).
- Northern Operations Water and Salt Balance (GHD, 2014b).
- Annual Groundwater Management Report, prepared for 2016 (GHD, 2017).
- ANZECC Water Quality Assessment (GHD, 2015b).

In accordance with the conditions of development consent PA 10_0080 MOD 1 for Myuna Colliery, this WMP has been prepared by Lachlan Hammersley and reviewed by Dr Stuart Gray of GHD Pty Ltd in consultation with Centennial Myuna.

The WMP has been provided to the following regulatory authorities for consultation in July 2017:

- NSW Department of Primary Industries – Water (DPI-Water, formerly NSW Office of Water).
- NSW Environment Protection Authority (EPA).



LEGEND

- Existing Rail
- Principal Road
- Secondary Road
- Minor Road
- Track
- Watercourse
- Lake
- Built up areas
- Recreation area
- Nature Conservation Reserve
- State Forest
- Forest Or Shrub
- Project approval boundary
- Development consent boundary

Paper Size A4

0 500 1,000 2,000 3,000 4,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

Centennial Myuna

Centennial Myuna Pty Ltd
Water Management Plan

Locality Plan

Job Number	22-19224
Revision	A
Date	17 Aug 2016

Figure 1-1

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com **W** www.ghd.com.au

G:\22\0105001\GIS\Maps\Deliverables\Hunter\Regional\2219224\Myuna_WMP\2219224_WMP_001_Locality plan_A.mxd

Data source: © Commonwealth of Australia (Geoscience Australia): 250K Topographic Data Series 3 2006; Centennial: Boundaries. Created by: smacdonald

- NSW Department of Industry – Resources and Energy (DRE, formerly Division of Resources and Energy in the Department of Trade and Investment, Regional Infrastructure and Services).
- Lake Macquarie City Council (LMCC).
- NSW Office of Environment and Heritage (OEH).

Consultation received is provided in Appendix A. A register of comments addressed is provided in Appendix B.

1.1 Overview of site operations

1.1.1 Site features

Approved Project Area

The approved Project Area for Myuna Colliery includes areas covered by Project Approval 10_0080 and development consent SH110/148. The encompasses the mining leases of:

- Mining Lease 1632.
- Mining Lease 1370.
- Mining Purpose Lease 334.

Mine access and surface facilities

Infrastructure at the Surface Facilities Area is shown in Figure 1-2. Materials and personnel access to the underground workings is achieved from the Surface Facilities Area via the men and materials drift. Personnel and materials are transported underground from the Surface Facilities Area to the pit bottom by a combination of rail mounted drift winders and mobile vehicles.

The Surface Facilities Area is located on Wangi Point Road, near the township of Wangi Wangi. The primary items of existing approved infrastructure include mine infrastructure (i.e. portals, drive houses, ventilation shafts and fan houses, bore holes, switch rooms, diesel, oil and water storage tanks and an emergency coal stockpile area), coal handling plant (CHP) (i.e. breakers, crushers, feeders, storage bins and conveyors), workshop and administration infrastructure (i.e. workshop, store and wash-down facilities, laydown areas, administration offices, a bathhouse, a service bay, hardstand areas, parking areas, haul roads, an emergency helipad and a fire station), and pollution control infrastructure (i.e. washdown bay/oil-water separator, primary settlement tanks (sump), sediment dams, a pump house, dust suppression systems and a hydrocarbon recycling depot).

Coal handling, processing and transport

ROM coal produced at Myuna Colliery is transferred from the underground workings to the surface CHP via a number of underground conveyors. Coal is initially delivered to the ROM bin and then fed through a primary screen before being transported to a rotary breaker for initial breaking. From the rotary breaker, the coal travels through feeders, screens and into crushers before being loaded into a final product bin. From the final product bin the coal is loaded onto the Origin Energy-owned enclosed overland conveyor and delivered to the Eraring Power Station.

In the event of break downs or servicing of the enclosed overland conveyor, Centennial Myuna temporarily stores coal in a dedicated stockpile area in the north of the Surface Facilities Area, as shown in Figure 1-2.

Paper Size A4

0 12.525 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Licensed Discharge Point
- Watercourse
- 10m Contours

GHD

Centennial Myuna

Centennial Myuna Pty Ltd
Water Management Plan

Job Number	22-18127-02
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Surface Facilities Area and Licensed Discharge Points

Figure 1-2

G:\22\0105001\GIS\Maps\Deliverables\Hunter\Regional\2218127\Myuna_WMP\221812702_WMP_002_SurfaceFacilities_LDPs_A.mxd

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com **W** www.ghd.com.au

Data source: © LPMA: DCTB & DTDB, 2007/2012; AECOM: LDP data, 2009. Nearmap: Aerial dated 20160504, extracted on 20160720. Created by: smacdonald

Coal is recovered from the stockpile by front end loader, loaded onto trucks and dumped into a CHP reclaim hopper for transportation to Eraring Power Station via the enclosed overland conveyor, as required.

As Myuna Colliery does not wash ROM coal, there is no coal reject material produced on site. A negligible amount of waste rock from the CHP is transported from the waste bin to the Awaba Waste Management Facility for disposal.

1.1.2 Coal production

The approved Project Area encompasses the coal measures and three seams previously mined at Myuna Colliery and as such, includes some previous workings and areas requiring new workings to be developed. Access to new areas is via previous workings. Mining operations continue to be carried out using continuous miner methods in the Wallarah, Great Northern and Fassifern coal seams. Product coal is produced at a maximum rate of 3 Mtpa of ROM coal.

1.1.3 History

A summary of the history of the Myuna Colliery is provided in Table 1-1.

Table 1-1 History of Myuna Colliery

Date	Event
1977	Construction of Eraring Power Station commenced.
1977	Myuna Colliery granted development consent (SH 110/148) to supply coal to Eraring Power Station.
1979	Development of Myuna Colliery commenced.
1982	Coal production at Myuna Colliery commenced at a maximum rate of 1.3 Mtpa of ROM coal.
2002	Centennial purchased Myuna Colliery as part of the Powercoal acquisition.
2012	Centennial Myuna received PA 10_0080 for the continuation of mining up to 2032 at a maximum rate of 2 Mtpa of ROM coal and a maximum of 210 full time employees.
2015	Centennial Myuna received a modification to PA 10_0080 (MOD 1) allowing an increase in production to a maximum rate of 3 Mtpa of ROM coal and a maximum of 300 full time employees.

1.2 Approvals and licensing requirements

1.2.1 Project approval

The WMP addresses specific water components of the conditions of development consent PA 10_0080 (MOD 1), which was granted in February 2015. The relevant requirements of the WMP are outlined in Table 1-2, along with the sections of the WMP where each of these have been addressed.

Table 1-2 Project approval 10_0080 (MOD 1) conditions

Condition		Where addressed
Schedule 3 22.	The Proponent shall prepare and implement a Water Management Pan for the surface facilities sites to the	Section 1

Condition		Where addressed
	satisfaction of the Secretary and in consultation with NOW, DRE and LMCC. This plan must:	
(a)	Be prepared by suitably qualified and experienced persons whose appointment has been approved by the Secretary.	Section 1
(b)	Be submitted for approval to the Secretary within seven months of the date of this approval.	Section 1
(c)	Include: • A Site Water Balance. • An Erosion and Sediment Control Plan. • A Surface Water Management Plan. • A Groundwater Monitoring Program. • A Surface and Ground Water Response Plan.	See below
Site Water Balance		
Schedule 3 23. (a)	The Site Water Balance must include details of: • Sources and security of water supply. • Water use on site. • Water management on site. • Any off-site water transfers. • Groundwater transfers from the underground operations to the surface.	Section 3
(b)	Investigate and implement all reasonable and feasible measures to minimise potable water use from the town water supply and to reuse and recycle water.	
Erosion and Sediment Control Plan		
Schedule 3 24. (a)	The Erosion and Sediment Control Plan must: Be consistent with the requirements of the *Managing Urban Stormwater – Soils and Construction, Volume 2E: Mines and Quarries* (DECC 2008, or its latest version).	Section 3 Section 5 Appendix E
(b)	Identify activities that could cause soil erosion and generate sediment particularly in relation to activities near waterways.	
(c)	Describe the location, function, and capacity of erosion and sediment control structures.	
(d)	Describe what measures would be implemented to maintain the structures over time.	
(e)	Describe the sediment and erosion control measures to be implemented for all activities undertaken at the site.	
Surface Water Management Plan*		
Schedule 3 25. (a)	The Surface Water Management Plan must: Include detailed baseline data on surface water flows and quality of Wangi Creek.	Section 2 Section 4 Section 5

Condition		Where addressed
(b)	Provide a geomorphic description of Wangi Creek up and downstream of the mine water discharge point.	Section 5.4
(c)	Detail surface water quality and stream health assessment criteria, including trigger levels for investigating any potentially adverse surface water impacts.	Section 6
(d)	Provide a program to monitor: • Surface water discharges from the surface facilities sites. • Stream health, channel stability, water flows and water quality within Wangi Creek. • Water quality of Lake Macquarie.	Section 4
(e)	Investigate mitigation and management measures to prevent/limit any incision and degradation of the channel of Wangi Creek from mine discharge water.	Section 3
(f)	Include a detailed review of water management at the Myuna Colliery surface facilities site, with particular reference to the water storages within the dirty water management system and in consultation with EPA, to: • Determine whether the capacity, integrity, retention time and management of the dirty water storages (particularly the CHP Dam) are sufficient to ensure that water discharged from the site. • Meets all relevant ANZECC water quality criteria, including for metals and suspended solids. • Assess all reasonable and feasible options for reducing salt load and/or salt concentration for discharges into Wangi Creek. • Assess appropriate options to improve storage and retention times in accordance with *The Blue Book – Managing Urban Stormwater (MUS): Soils and Construction* (Landcom). • Propose upgrades of the dirty water storages sufficient that discharges meet all relevant ANZECC criteria. • Propose any other appropriate changes to the water management system.	Section 5
(g)	Identify and assess practical measures to minimise potable water consumption, maximise recycled water use and improve the management of sewage and surface rainfall runoff for the project, including quantifying the abatement potential of identified measures and their related costs and benefits.	Section 3

Condition		Where addressed
Groundwater Monitoring Program		
Schedule 3 26. (a)	The Groundwater Monitoring Program must include: Baseline data of groundwater levels (including alluvial and weathered rock aquifers), yield and quality in the region, and any privately owned groundwater bores that may be affected by mining operations on site.	Section 2.4 Section 5.3 Section 4.3
(b)	Groundwater assessment criteria based upon analysis of baseline data for groundwater, surface water, including trigger levels for investigating any potentially adverse groundwater impacts.	Section 6
(c)	A program to monitor and/or validate the impacts of the project on alluvial and coal seam aquifers, and any groundwater bores.	Section 4.3 Section 7
Surface and Ground Water Response Plan		
Schedule 3 27. (a)	The Surface and Ground Water Response Plan must describe what measures and/or procedures would be implemented to: Respond to any exceedances of the surface water, stream health, and groundwater assessment criteria.	Section 6 Appendix A
(b)	Mitigate and/or offset any adverse impacts on riparian vegetation located within and adjacent to the site.	Section 6 Appendix E
Environmental Management, Reporting and Auditing		
Schedule 5 2. (a)	The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include: • detailed baseline data;	Section 5
(b)	A description of: • the relevant statutory requirements (including any relevant approval, licence or lease conditions); • any relevant limits or performance measures/criteria; • the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures;	Section 1.2 Section 6
(c)	A description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;	Section 3 Section 4 Section 6
(d)	A program to monitor and report on the: • impacts and environmental performance of the project; • effectiveness of any management measures (see c above);	Section 4
(e)	A contingency plan to manage any unpredicted impacts and their consequences and to ensure that ongoing impacts	Section 6.1

Condition		Where addressed
	reduce to levels below relevant impact assessment criteria as quickly as possible;	
(f)	A program to investigate and implement ways to improve the environmental performance of the project over time;	Northern Operations Regional Water Management Plan
(g)	A protocol for managing and reporting any: • incidents; • complaints; • non-compliances with statutory requirements; and • exceedances of the impact assessment criteria and/or performance criteria; and	Northern Operations Regional Water Management Plan
(h)	A protocol for periodic review of the plan.	Northern Operations Regional Water Management Plan

** The Secretary may require the Proponent to implement upgrades and other changes identified under paragraph (f), in accordance with condition 4 of schedule 2. EPA may also require measures to be implemented under the terms of the site's environment protection licence.*

1.2.2 Statement of commitments

The environmental assessment for the 2012 project approval (AECOM, 2011) included a Statement of Commitments detailing additional environmental management measures proposed by Centennial Myuna for the project. Commitments made that are relevant to operational water management at the Myuna Colliery are summarised in Table 1-3.

Table 1-3 Water management actions from Statement of Commitments

Commitment	Action	Where addressed
Operations carried out in a manner that minimises potential impacts to groundwater	Within six months of project approval, a variation to EPL 366 will be lodged with the OEH to: • Combine licensed discharge points LDP001 and LDP002 into a single licensed discharge point, LDP B, with a combined discharge volume of 13 ML/day. • Establish a licensed discharge point at the Emergency Coal Stockpile Sediment Dam, LDP A, for event-based discharges where rainfall exceeds 80 mm in 24 hours. • Enable volumetric exceedances during rainfall events greater than:	Section 1.2.3

Commitment	Action	Where addressed
	– 15 mm in the preceding 24 hours at LDP B. – 140 mm in the preceding 24 hours at LDP A.	
	The Proponent (i.e. Myuna Colliery) will undertake an investigation of water reuse options at Myuna Colliery within six months of Project Approval	Section 3

1.2.3 Environment protection licence

Myuna Colliery currently holds environment protection licence (EPL) 366, which includes requirements to monitor water quality and quantity of discharges from the site. Water is currently licensed to be discharged from the mine through the following licensed discharge points (LDPs), as shown in Figure 1-2:

- LDP A – Emergency discharge to Wangi Creek via the Emergency Coal Stockpile Dam for event based discharges where rainfall exceeds 140 mm in the preceding 24 hours.
- LDP B – Discharge of up to 13 ML/day to Wangi Creek via the Mine Water Settling Pond 3.

Water quality concentration limits specified by EPL 366 for LDP A and LDP B are presented in Table 1-4.

Table 1-4 LDP A and LDP B water quality concentration limits

Parameter	100th percentile concentration limit
Oil and grease	10 mg/L
pH	6.5–8.5
Total suspended solids (TSS)	50 mg/L

1.2.4 Groundwater bore licences

Centennial Myuna currently holds bore licence 20BL172565 under the *Water Act 1912* for the extraction of up to 4,380 ML/year from underground workings. The licence was renewed by DPI-Water on 12 December 2015; however, Centennial Myuna has not yet received the conditions of the licence.

The *Water Act 1912* is currently being progressively phased out and replaced by water sharing plans (WSPs) under the *Water Management Act 2000*. The North Coast Fractured and Porous Rock Groundwater Sources WSP commenced on 1 July 2016. Groundwater take (i.e. the flow of groundwater into underground workings) will be required to be licensed under the WSP in the future, replacing bore licence 20BL172565.

Myuna Colliery also holds bore licence 20BL173259 for groundwater monitoring bores.

1.3 Water Management Plan objectives

The WMP has been developed to address the approvals and licensing requirements presented in Section 1.2 through the completion of the following:

- Collation and review of existing information and studies relating to the operation of the water management system at Myuna Colliery.
- Establish an understanding of the water management system at the site.
- Categorise the existing conditions that are specific to water management requirements.
- Develop catchment plans for the site.
- Identify the clean and dirty water management systems.
- Undertake a review of the capacity of the dirty water surface storages in accordance with *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom, 2004) and *Volume 2* (DECC, 2008).
- Determine the suitability of waterway conditions.
- Undertake a water quality assessment and review of existing water quality assessment criteria.
- Determine the future water management requirements.
- Review and develop water monitoring requirements.

2. Environment

2.1 Climate

2.1.1 Rainfall

Myuna Colliery has site-based rainfall and weather stations located on site. Site-specific rainfall data has been collected on a daily basis since 2005. For assessments requiring a large historical set of rainfall data (i.e. greater than 50 years), daily rainfall data is obtained from the Scientific Information for Land Owners (SILO) database operated by the Queensland Department of Science, Information Technology and Innovation. SILO patched point data is based on historical data from a particular Bureau of Meteorology (BOM) station with missing data 'patched in' by interpolation with nearby stations.

Rainfall data was obtained from the SILO database for the Toronto WWTP Station (BOM station number 61322), located approximately 8 km north-east of Myuna Colliery. The rainfall data was selected based on the length and quality of the data record and proximity to the site.

Figure 2-1 presents the historical SILO patched point daily rainfall data from the Toronto WWTP Station between 1901 and 2016.

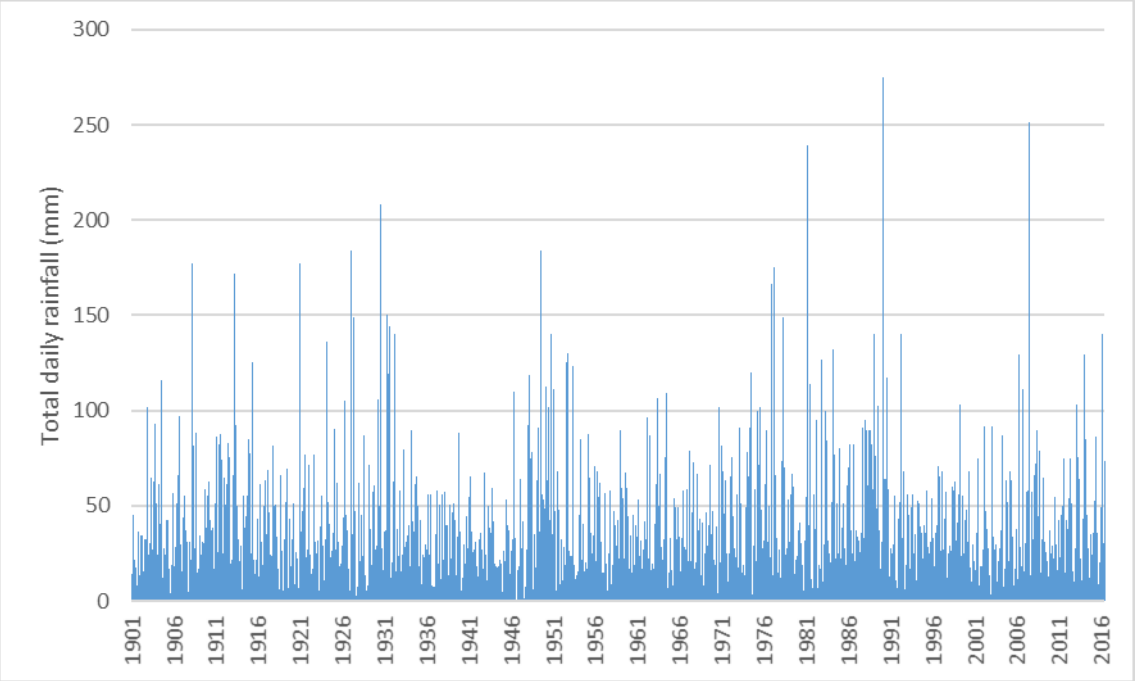


Figure 2-1 Historical daily rainfall at Toronto WWTP Station

The annual statistics associated with Figure 2-1 are:

- Minimum rainfall total – 595 mm in 1944.
- Average rainfall total – 1,116 mm.
- Median rainfall total – 1,062 mm.
- Maximum rainfall total – 2,059 mm in 1990.

2.1.2 Evaporation

Evaporation estimates are not collected by the meteorological station at Myuna Colliery. Evapotranspiration has been collected historically however no basis for this data has been detailed. Historical SILO patched point daily evaporation data was also obtained for the Toronto WWTP Station, which has been interpolated from long term averages from 1901 to 1969 and interpolated daily averages from 1970 to 2016. This data was reviewed and average monthly evaporation rates were determined. The average daily evaporation rates are presented in Figure 2-2.

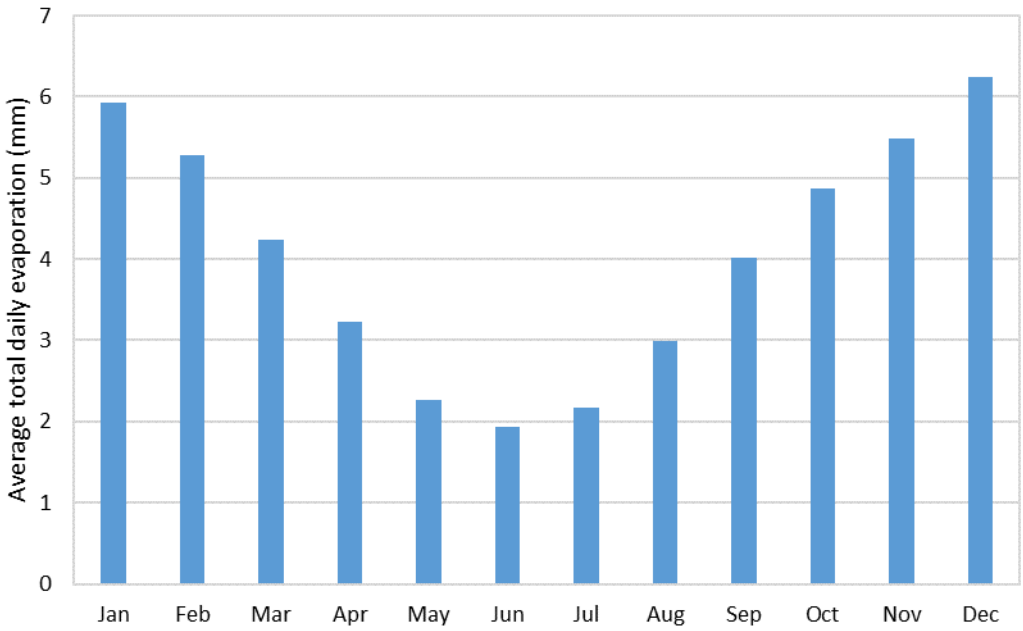


Figure 2-2 Average daily evaporation each month at Toronto WWTP Station

Total average annual evaporation is approximately 1,471 mm, compared to the annual average rainfall total of approximately 1,116 mm. This gives an annual deficit (difference between annual rainfall and annual evaporation) of approximately 355 mm.

2.2 Topography and hydrology

The Surface Facilities Area is located within the catchment of Wangi Creek, which flows into Lake Macquarie. The majority of existing workings in the Wallarah, Great Northern and Fassifern coal seams are located beneath Lake Macquarie. Ground elevations range from 0 m Australian Height Datum (AHD) to approximately 70 m AHD within the Myuna Colliery holding boundary.

The Surface Facilities Area at Myuna Colliery is located in the lower reaches of Wangi Creek. Water discharged from Myuna Colliery enters the estuarine reach of Wangi Creek before discharging into Lake Macquarie. Upstream of the Surface Facilities Area, the creek is a freshwater environment. Adjacent to the Surface Facilities Area, Wangi Creek is reasonably well-defined, with a width in the order of 5 m and vegetated along the invert of the creek.

Downstream of LDP A and LDP B, discharges flow through a piped network prior to outflowing into an earthen channel. This channel runs parallel to Wangi Creek for approximately 200 m. The channel is constrained by fill material along the left bank, which is steep and up to 4 m to 5 m high. Along the left bank, a levee type structure exists which separates flows from the LDP discharge channel and flows in Wangi Creek.

Wangi Creek is the only watercourse directly influenced by mine water discharge from Myuna Colliery. However, mine workings are located beneath several other watercourses as well as Lake Macquarie.

The watercourses and catchments within the approved Project Area is shown on Figure 2-3.

2.3 Geology

The geology within the approved Project Area affects both the mining operations and management of water. Water management is affected by the stratigraphy, which influences the potential for infiltration into the workings. The location of regional aquifers in relation to the workings also affects the management of water on-site.

The Newcastle Coalfields Regional Geology 1:100,000 map (NSW Department of Mineral Resources, 1995) indicates that land within the approved Project Area is characterised by outcropping of Triassic Age Munmorah Conglomerate across the on-shore areas and Quaternary sand and mud deposits across Lake Macquarie. These deposits are underlain by the late Permian Newcastle Coal Measures.

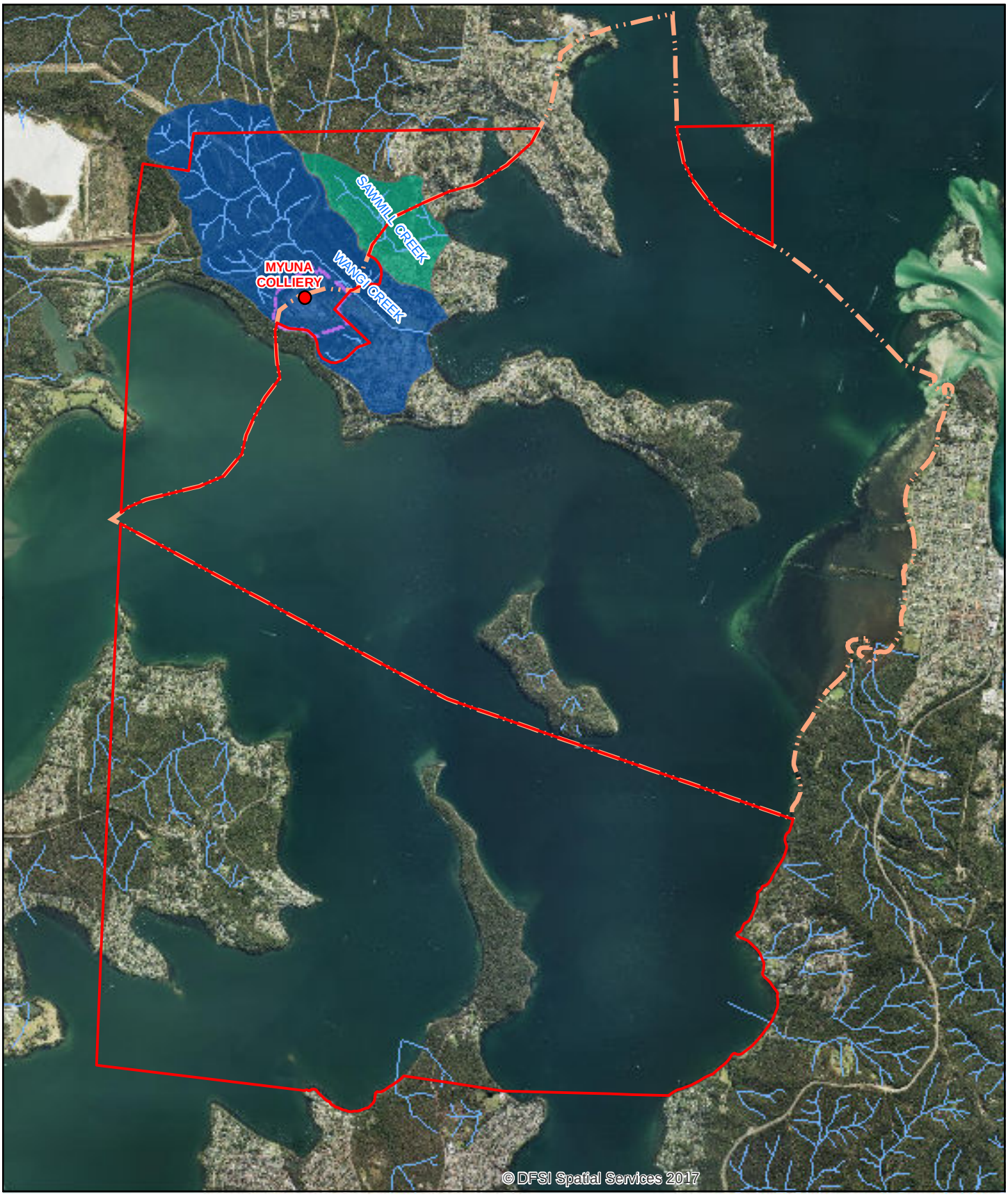
The stratigraphic sequence at Myuna Colliery is outlined in Table 2-1.

Table 2-1 Stratigraphic sequence

Period	Stratigraphy		Unit/lithology
	Group	Subgroup	
Quaternary			Alluvium
Triassic	Narrabeen	Clifton	Munmorah Conglomerate Dooralong Shale
Permian	Newcastle Coal Measures	Moon Island Beach	Vales Point Seam Karignan Conglomerate Wallarah Seam Mannering Park Tuff Teralba Conglomerate Great Northern Seam Karingal Conglomerate
		Awaba Tuff	Awaba Tuff
		Boolaroo	Fassifern Seam

The coal seams mined at Myuna Colliery are part of the late Permian Age Newcastle Coal Measures, which dip to the south east at a grade of generally less than 1 in 20. The Moon Island Beach, Awaba Tuff and Boolaroo Formations of the Newcastle Coal Measures outcrop and/or subcrop to the north-west, north, north-east, east and south-east of the Myuna Colliery approved Project Area.

The Wallarah Seam ranges in thickness from between 2 m and 3 m across the approved Project Area and is predominantly overlain by Karignan Conglomerate, described as a medium to coarse grained pebble conglomerate. The Dooralong Shale makes up the roof of the Wallarah Seam in the east and the Wallarah Seam is underlain by Mannering Park Tuff claystone/mudstone.



LEGEND

- Project approval boundary
- Development consent boundary
- Surface Facilities Area
- Watercourse
- Sawmill Creek Catchment
- Wangi Creek Catchment

Paper Size A4

0 180 360 720 1,080 1,440

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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Watercourses within Approved Project Area

Job Number	22-19224
Revision	A
Date	17 Aug 2016

Figure 2-3

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com **W** www.ghd.com.au

G:\22\0105001\GIS\Maps\Deliverables\Hunter\Regional\2219224\Myuna_WMP\2219224_WMP_003_Watercourses_A.mxd

Data source: © LPMA: DCTB & DTDB, 2012; GSS: Aerial; Centennial: Boundaries. Created by: smacdonald

The Great Northern Seam generally varies in thickness between 2.5 m and 3 m across the approved Project Area. Teralba Conglomerate tends to form the roof of the Great Northern Seam in most areas, although this is replaced by shale, mudstone or tuffaceous siltstones in some areas. The Awaba Tuff siltstone/claystone underlies the Great Northern Seam in most areas.

Both the Wallarah and Great Northern seams tend to split, deteriorate and thin along the north/south zone to the west and south-west of the approved Project Area.

The Fassifern Seam is the most extensive coal reserve throughout the lease area, with a thickness in excess of 6 m in areas where the seam is not split. The seam is at its greatest thickness at Wangi Point. Between the Wangi Peninsula and Pulbah Island the seam splits in two. The lower split is the preferred mining section in this area. The splits coalesce to the south of Pulbah Island and beyond the approved Project Area. Awaba Tuff generally overlies the Fassifern Seam, while the floor is composed of claystones. A schematic of the coal seam stratigraphy and the mining process has been presented in Figure 2-4 (Centennial Myuna, 2014).

2.4 Hydrogeology

The groundwater sources in the vicinity of Myuna Colliery are generally low yielding and predominantly within the Quaternary alluvium, weathered and/or fractured rock and coal seams.

The Quaternary material includes alluvium, which occurs along the watercourses draining into Lake Macquarie and lake sediment underlying Lake Macquarie. The alluvium forms and unconfined shallow aquifer with a thickness of up to 10 m.

Groundwater flow within the Triassic and Permian rocks underlying the Myuna Colliery approved Project Area is predominantly within the coal seams. The overburden and interseam strata tend to have very low hydraulic conductivities (unless fracturing creates a secondary permeability).

2.4.1 Groundwater users

A search of the NSW groundwater bore database was undertaken in order to identify registered bores within a 3 km radius of the Myuna Colliery underground workings. The search of the database identified 59 bores, most of which are used to extract groundwater from the sandy strata on the eastern side of Lake Macquarie. The remaining bores extract groundwater from the weathered sandstone. The shallow bores were predominantly used for domestic purposes and ranged from depths of 1 m to 10.1 m below ground level.

Approximate groundwater bore locations identified from searches of the NSW groundwater bore database are shown on Figure 2-5. Bore details are provided in the Northern Operations RWMP.

2.4.2 Groundwater dependant ecosystems

Potential groundwater dependent ecosystems (GDEs) within the vicinity of Myuna Colliery have been mapped in the *Groundwater Dependent Ecosystem Atlas* (BOM, 2015). Potential GDEs within 3 km of Myuna Colliery include various vegetation communities that surround Lake Macquarie. Whiteheads Lagoon, Lake Petite and Lake Macquarie are listed by BOM (2015) as potential GDEs.

High priority GDEs are listed in WSPs. The closest high priority GDE listed in the Hunter Unregulated and Alluvial Water Sources WSP are coastal wetlands located approximately 20 km to the north of Myuna Colliery (GHD, 2015b). These are outside the zone of potential influence by the operations.

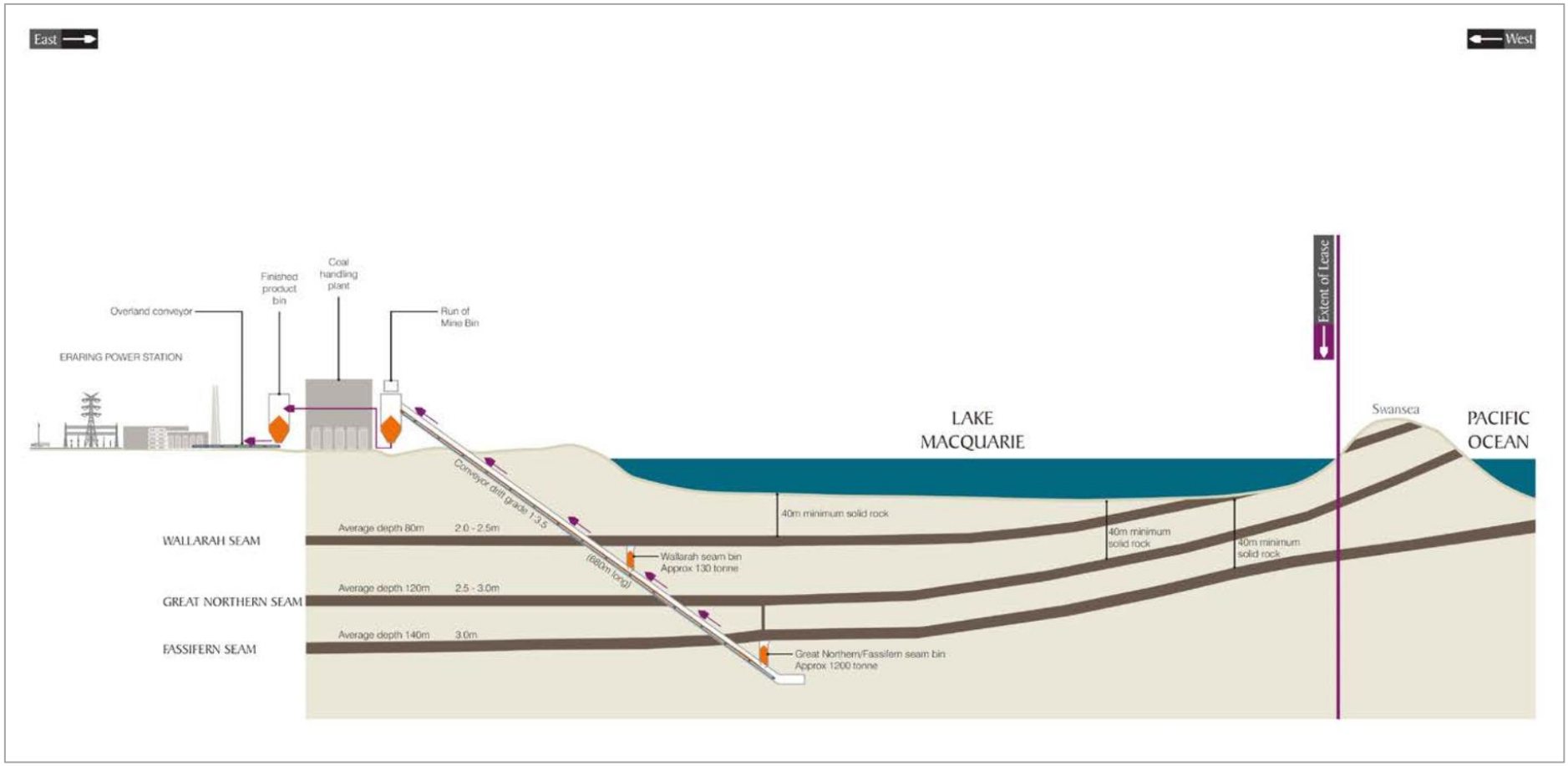
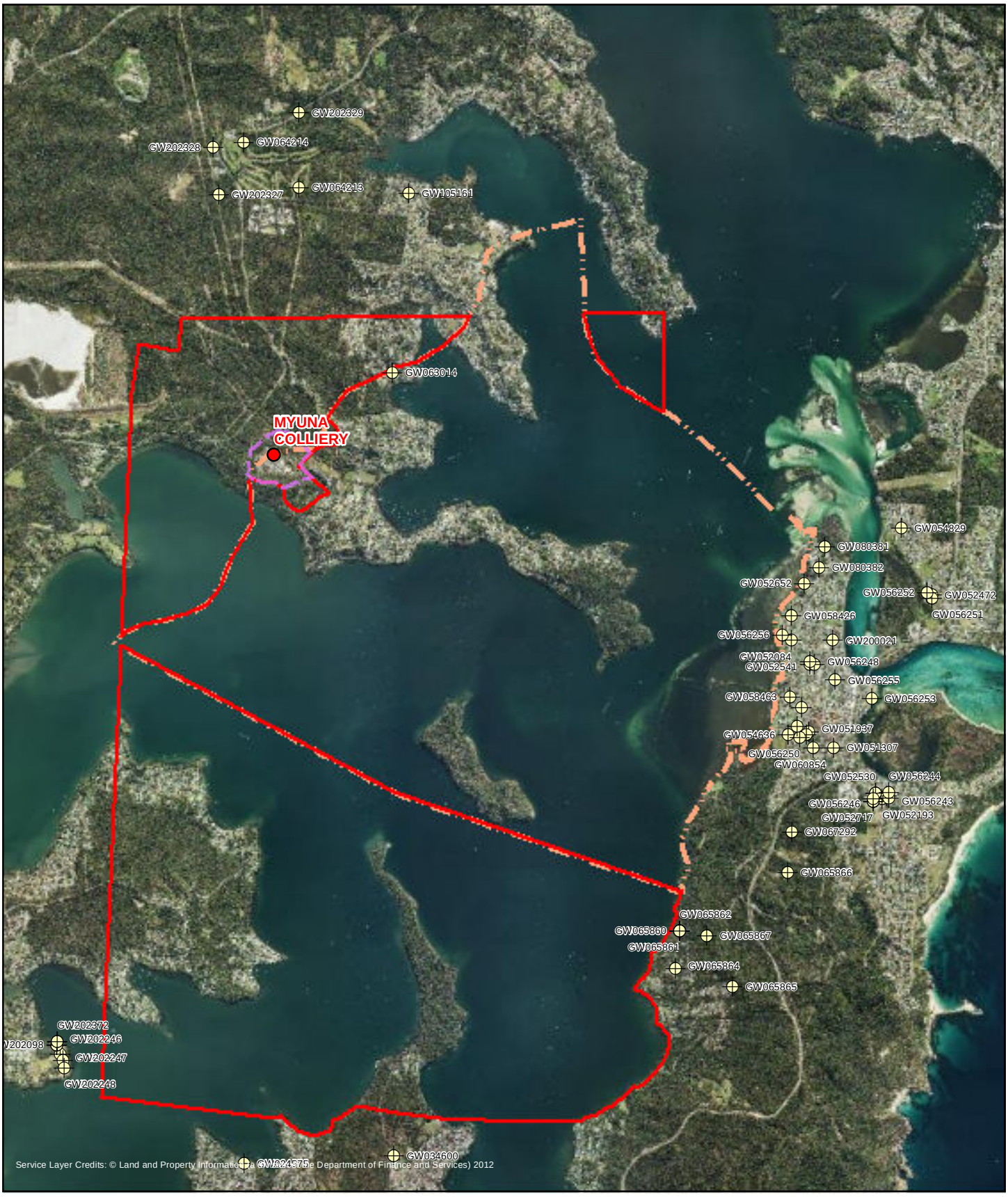


Figure 2-4 Coal seam stratigraphy and mining process (Centennial Myuna, 2014)



LEGEND

- Myuna Colliery Surface Facilities
- Registered bores
- Surface Facilities Area
- Project approval boundary
- Development consent boundary

Paper Size A4

0 215 430 860 1,290 1,720

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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NSW groundwater bore database search results

Job Number	22-19224
Revision	A
Date	17 Aug 2016

Figure 2-5

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G:\22\0105001\GIS\Maps\Deliverables\Hunter\Regional\2219224\Myuna_WMP\2219224_WMP_013_NSWBoreDatabaseSearch_A.mxd

Data source: ESRI: Imagery, 2016; NSW Office of Water: Groundater bores, 2015. Created by: smacdonald

3. Water management

3.1 Water management overview and objectives

The water management system at Myuna Colliery is comprised of clean and dirty surface, potable, waste and underground elements. Sources of water include potable water supply, rainfall, runoff and groundwater inflow into the underground mine workings. The primary water demands are for underground operations, machinery washdown, fire-fighting storage and staff amenities.

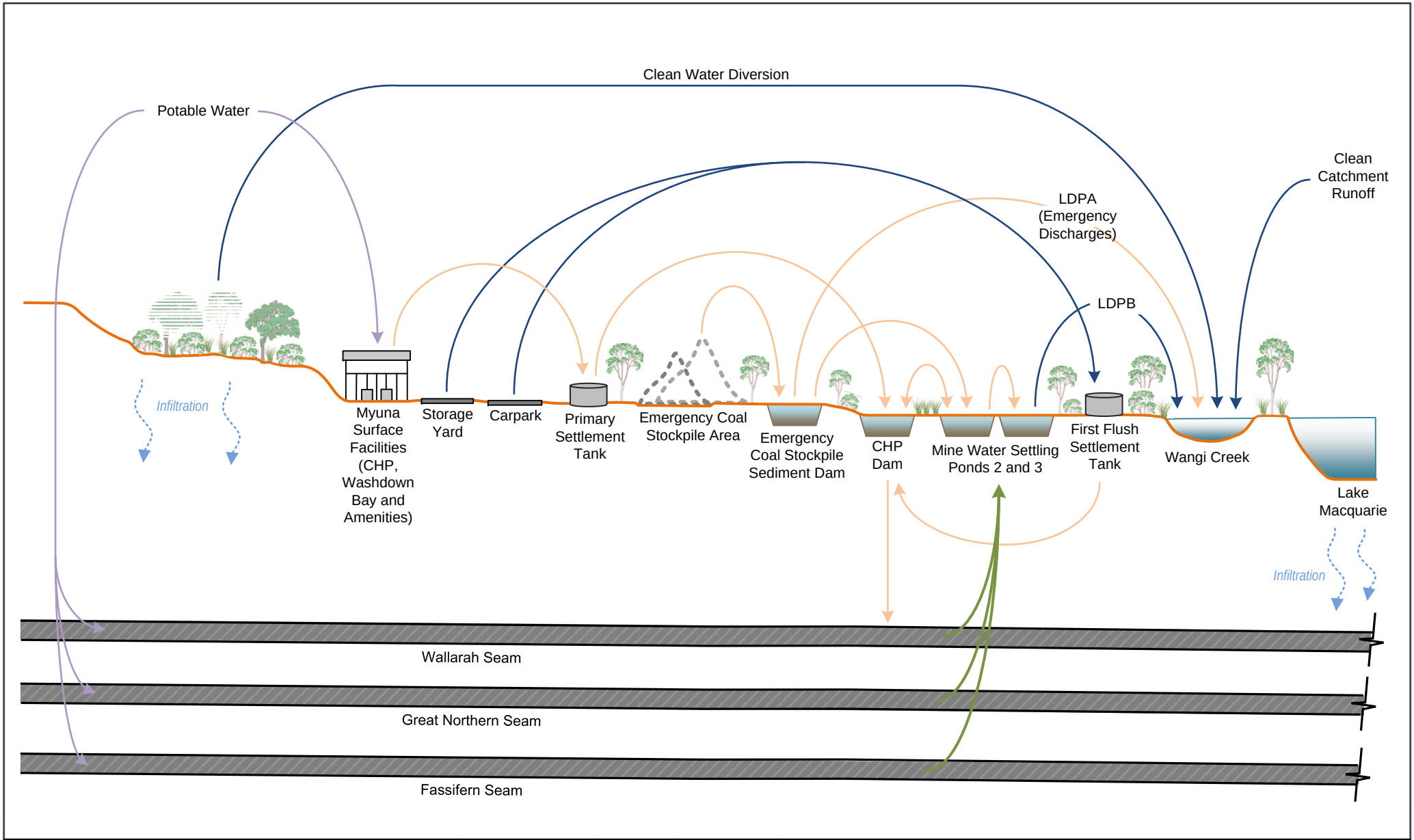
Surface water runoff from areas where there is no coal storage, transportation, handling or processing or any disturbance is considered to be clean water, as it is unlikely to be contaminated with coal fines or sediment. Runoff is diverted around dirty water and coal-contact catchments to avoid mixing with clean water runoff. Clean water runoff is typically from natural and impervious catchments such as areas of vegetation, sealed roads and sealed car parks.

Dirty water is runoff from disturbed areas and areas likely to contain suspended sediment, oils, grease and hydrocarbons. This typically includes workshop and fuel storage areas. Coal-contact water is runoff from catchments where coal storage, transportation, handling or processing occurs and is managed within the dirty water management system.

Figure 3-1 provides a schematic of the overall inputs and outputs of the water management system.

Myuna Colliery has site-specific water management objectives that include:

- Maximise the separation of clean and dirty water systems.
- Manage water discharge from site, in terms of volume and quality, to a level that is acceptable for environmental management and community expectations.
- Minimise water discharges from the premises by maximising, where practicable, opportunities for the reuse and recycling of water on site.
- Minimise discharges of dirty water from the premises.
- Manage discharge to natural waterways in accordance with EPL 366 conditions or as agreed with the EPA.



Clean water
Potable water
Wastewater
Dirty water
Groundwater

LOCATION	Myuna
SEAM	NA
DRAWN	SM
CHECKED	TD
APPROVED	LH
SCALE	NTS

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Water Management Plan

Water Management Schematic

Centennial Coal

DATE November 2017

Figure 3-1

G:\22\19224\Tech\Visio\Figure_4_4-Myuna_Colliery.vsd

3.2 Surface water management

An assessment of the water management structures associated with the Surface Facilities Area has previously been undertaken by GHD (2012a) and has been summarised in Table 3-1.

Table 3-1 Water management structures

Location	Purpose	Water type	Catchment area (ha)	Capacity (ML)
Primary Settlement Tank	Provides a primary capture and settlement function for the CHP Dam	Dirty (coal-laden water)	3.07	0.04
First Flush Tank	Capture typical materials yard and carpark pollutants.	Clean (sediment-laden water)	3.60	0.30
CHP Dam	Receives water from the captured flow in the Primary Settlement Tank.	Dirty (coal-laden water)	N/A	1.05
Mine Water Settling Pond 2	Receives mine water from the underground, overflows from the CHP Dam and some surrounding runoff.	Dirty (coal-laden and underground mine water)	0.80	1.80
Mine Water Settling Pond 3	Receives overflows from Mine Water Settling Pond 2.	Dirty (coal-laden and underground mine water)	Minimal	1.65
Emergency Coal Stockpile Sediment Dam (including additional spill volume)	Receives dirty water from the Stockpile Area and provides a settlement function.	Dirty (coal-laden water)	2.33	4.55

Of the storages listed in Table 3-1, the First Flush Tank is defined as catering for a clean water inflow. The other storages cater for either a mine or dirty water inflow.

3.2.1 Inputs

The inputs into the surface water system consist of:

- Runoff from contributing catchment areas (both clean and dirty) as a direct result of rainfall events.
- Transfer of water from underground working and storages.
- Capture of water from plant washdown activities.

Myuna Colliery manages inputs to the surface water system through:

- Transfers of water from underground workings and storages.
- Washdown activities.

3.2.2 Outputs

The locations where the surface water system can discharge from the Myuna Colliery are:

- LDP A – Emergency discharge to Wangi Creek via the Emergency Coal Stockpile Dam (only after a rainfall event of over 140 mm in a 24-hour period).
- LDP B – Discharge of up to 13 ML/day to Wangi Creek via the CHP Dam and Mine Water Settling Pond 3.

3.2.3 Clean water management

Clean water diversions and pipe network

Within the approved Project Area, the diversion of surrounding clean water catchments is an effective way of mitigating concentrated runoff away from areas of coal operations. Clean water diversions are constructed to convey the 20-year average recurrence interval (ARI) storm event and are lined such that erosion within the channel is mitigated. The 20 year ARI design storm event is in accordance with the guidance documented in *Managing Urban Stormwater – Soils and Construction Volume 2E: Mines and Quarries* (DECC; 2008) for non-erosive hydraulic capacity of drainage controls.

Figure 3-2 and Figure 3-3 present the clean water catchments and diversions at Myuna Colliery respectively. Table 3-2 summarises the features of the clean water diversions in place at Myuna Colliery.

Table 3-2 Clean water catchment diversion flows

Diversion location	Purpose	Approximate catchment area (ha)	Estimated channel flow (L/s)
Clean Water Diversion 1	Diverting the south eastern external catchment around the pit top to the clean water drainage network and onto Wangi Creek.	3.10	440
Clean Water Diversion 2	Diverting the southern external catchment to the clean water drainage network.	4.80	630
Clean Water Diversion 3	Diverting the western external catchment to the clean water drainage network.	1.10	180
Clean Water Diversion 4	Diverting the northern external catchment to clean water drainage network.	1.00	170
Clean Water Diversion 5	Diverting the northern external catchment to clean water drainage network.	3.40	470
Clean Water Diversion 6	Diverting the western catchment of the Coal Stockpile to Wangi Creek.	2.30	340
Clean Water Diversions 7	Diverting the western catchment of the Coal Stockpile to Wangi Creek.	0.50	90

Diversion location	Purpose	Approximate catchment area (ha)	Estimated channel flow (L/s)
Clean Water Diversion 8	Diverting the clean water from the internal Haul Road to Wangi Creek.	1.60	250
Clean Water Diversion 9	Diverting the north western external catchment to the clean water drainage network.	1.00	200

Surface Facilities Area

The topography surrounding the Surface Facilities Area makes the diversion of external clean catchment runoff critical to an effective water management system. The Surface Facilities Area has a series of five diversions that feed into a stormwater pit and pipe network.

Diversion 1 diverts clean water from the southern aspect of the surface facilities around to a stormwater network which discharges to a drainage line and onto Wangi Creek. This portion of the clean water system includes the workshop and store roof and helipad catchments.

Diversions 2, 3, 4, 5 and 9 include the diversions of catchments around the western and northern aspects of the Surface Facilities Area. These catchment areas are conveyed to LDP B via a stormwater network through the middle of the facilities area. Located within this same network are the catchments that contribute to the First Flush Tank. This includes catchments from the carpark, bathhouse and office roof area and runoff from around the washdown bay.

Emergency stockpile area

To reduce the runoff loads on the Emergency Stockpile Dam, clean water diversions have been constructed around the stockpile pad. These diversions, identified as channels 6, 7 and 8, effectively reduce the dirty water catchment to the Emergency Stockpile Area by approximately 55%. These diversions all convey water to Wangi Creek via open channels.

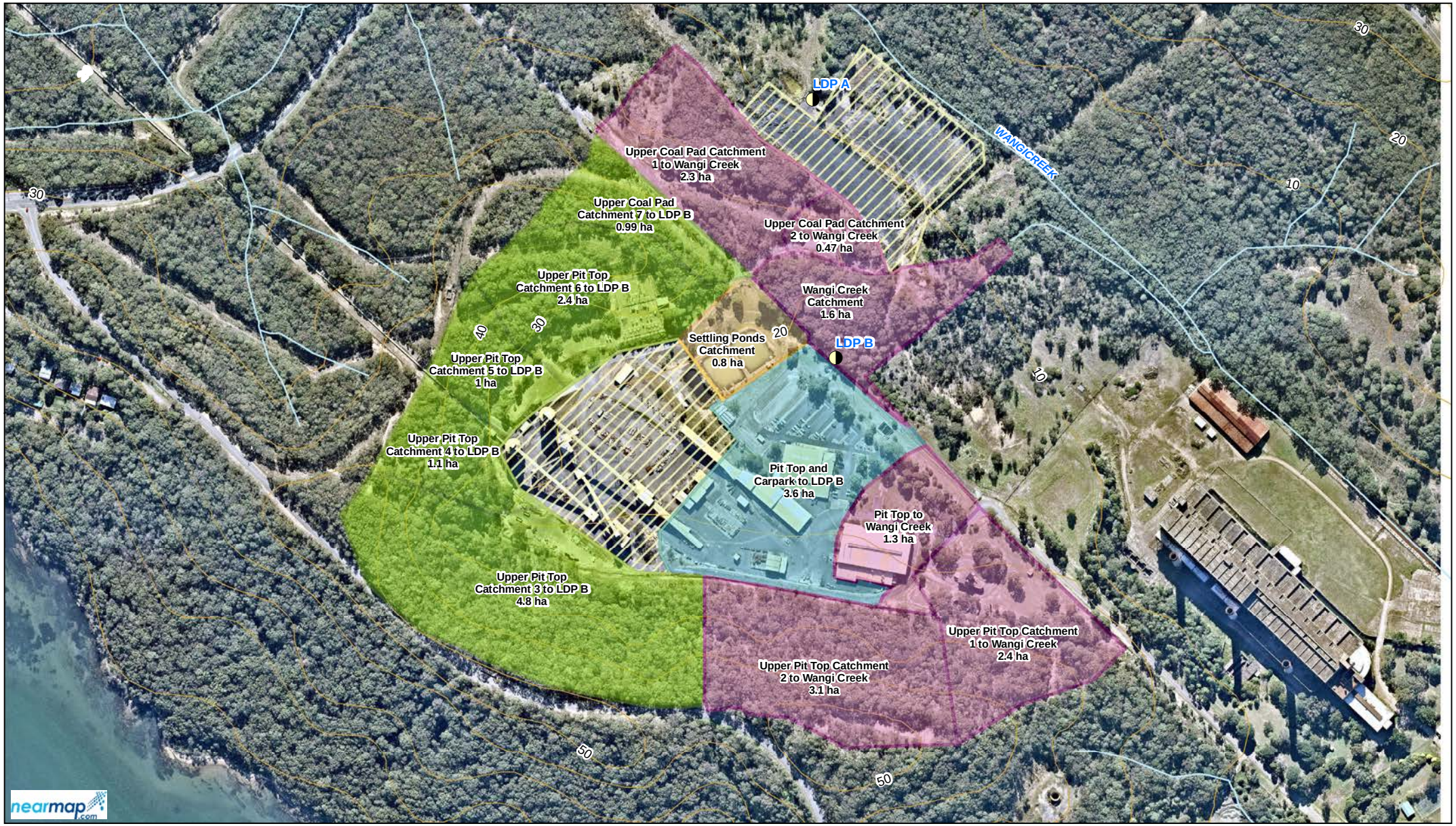
3.2.4 Dirty Water Management

Dirty water management network overview

Dirty water management structures are to be consistent with the requirements of *Managing Urban Stormwater – Soils and Construction Volume 1* (Landcom, 2004) and *Volume 2E: Mines and Quarries* (DECC 2008).

Within the Surface Facilities Area there are two key areas where dirty water management is required to mitigate the risk of coal-laden water being discharged from the colliery downstream into Wangi Creek. These two areas can be identified as the CHP processing area and storage yard and the Emergency Stockpile Area.

Dirty water runoff from the CHP processing area and storage yard is directed through a series of open drains, and a drainage network to the Primary Settlement Tank. The Primary Settlement Tank has a limited volume and acts to capture large sediment material conveyed in runoff before discharging into the CHP Dam. The CHP Dam is where the settlement of coal material occurs.



Paper Size A4

0 15 30 60 90 120

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- First Flush Tank, LDP B
- LDP001, LDP B
- LDP B
- Wangi Creek
- Dirty Water Catchments
- Licensed Discharge Point
- Watercourse
- 10m Contours

GHD

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Water Management Plan

Job Number	22-18127-02
Revision	A
Date	17 Aug 2016

Clean Water Catchment Areas **Figure 3-2**

G:\22\0105001\GIS\Maps\Deliverables\Hunter\Regional\2218127\Myuna_WMP\221812702_WMP_004_CleanWaterCatchments_A.mxd

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com **W** www.ghd.com.au

Data source: © LPMA: DCTB & DTDB, 2007/2012; AECOM: LDP data, 2009; Nearmap: Aerial dated 20160504, extracted 20160720. Created by: smacdonald

Paper Size A4

0 12.525 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Licensed Discharge Point
- Clean Water Pit and Pipe Network
- Clean Water Diversions
- Watercourse
- 10m Contours

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Water Management Plan

Job Number	22-18127-02
Revision	A
Date	17 Aug 2016

Clean Water Diversion and Stormwater Network

Figure 3-3

G:\22\0105001\GIS\Maps\Deliverables\Hunter\Regional\2218127\Myuna_WMP\221812702_WMP_005_CleanWaterDiversions_A.mxd

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com **W** www.ghd.com.au

Data source: © LPMA: DCTB & DTDB, 2007/2012; AECOM: LDP data, 2009; Nearmap: Aerial dated 20160504, extracted 20160720; Centennial: Drainage network, 2012. Created by: smacdonald

Dirty water runoff from the Emergency Stockpile Area is directed to the Emergency Stockpile Dam. From this dam, water is able to settle under gravity with stored water transferred to the CHP Dam via a bi-directional pipeline. The bi-directional pipeline can be utilised to transfer stored water to the Emergency Stockpile Area for dust suppression when required.

The dirty water catchments are shown on Figure 3-4 while the dirty water flow paths and drainage network are shown on Figure 3-5.

Primary Settlement Tank

The Primary Settlement Tank only has a limited storage volume and acts to capture a percentage of the large sediment material draining towards the CHP Dam. It receives inflows from a drainage network of surface inlet pits and sheet flow from the immediate surrounding catchment including in and around the CHP processing area. This tank does not aim to enhance the surface storage capacity of the dirty water system but acts as a filter for the CHP Dam. The tank has a small pipe which discharges to the CHP Dam and in larger events the tank will simply overflow to the CHP Dam.

CHP Dam

The CHP Dam is an essential part of the dirty water management system for the Surface Facilities Area. Working together with the Primary Settling Tank, the dam is not to receive any runoff from the catchment surrounding it, and is only to receive controlled inflows from the Primary Settling Tank.

The CHP Dam is dewatered continually down to a low operating water level by an air driven pump to a borehole delivering water to the underground workings water storage.

In the typical day-to-day operation of the CHP Dam, it is not allowed to discharge. This allows for the controlled management of any water stored within the dam via the air driven pump and siphon to the underground workings water storage via a borehole. In the unlikely event that the dam reaches capacity, overflows occur into the Mine Water Settling Pond 2 and 3 providing an opportunity to mix with the mine water settling pond water before being conveyed through LDP B into Wangi Creek.

Measures currently installed to improve the discharge quantity and quality from the CHP Dam are:

- Oil booms and a silt curtain installed within CHP Dam.
- Week day visual monitoring of the CHP Dam.
- Annual removal of captured sediment from the CHP Dam.
- Weekly removal of captured sediment from the Primary Settling Tank.
- Under/over weir installed in CHP Dam.

The CHP dirty water catchment and pipe network is presented in Figure 3-6.

Emergency Stockpile Dam

Within the western corner of the Emergency Stockpile Area is the Emergency Stockpile Dam which is bound by a bund approximately 1 m high and a storage depth of approximately 0.5 m. The dam uses the Emergency Coal Stockpile area as extended detention depth in larger events.

Paper Size A4

0 12.525 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Licensed Discharge Point
- 10m Contours
- Watercourse
- CHP Processing Area and Storage Yard
- Emergency Coal Stockpile Area

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Revision	A
Date	17 Aug 2016

Dirty Water Catchment Areas

Figure 3-4

G:\22\0105001\GIS\Maps\Deliverables\Hunter\Regional\2218127\Myuna_WMP\221812702_WMP_006_DirtyWaterCatchments_A.mxd

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com **W** www.ghd.com.au

Data source: © LPMA: DCTB & DTDB, 2007/2012; AECOM: LDP data, 2009. Nearmap: Aerial dated 20160504, extracted 20160720. Created by: smacdonald

Paper Size A4

0 12.525 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Licensed Discharge Point
- 10m Contours
- Transfer Pipeline
- Dirty Water Pit and Pipe Network
- Watercourse
- Dirty Water Flow Paths

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Water Management Plan

Job Number	22-18127-02
Revision	A
Date	17 Aug 2016

Dirty Water Flow Paths and Pipe Network

Figure 3-5

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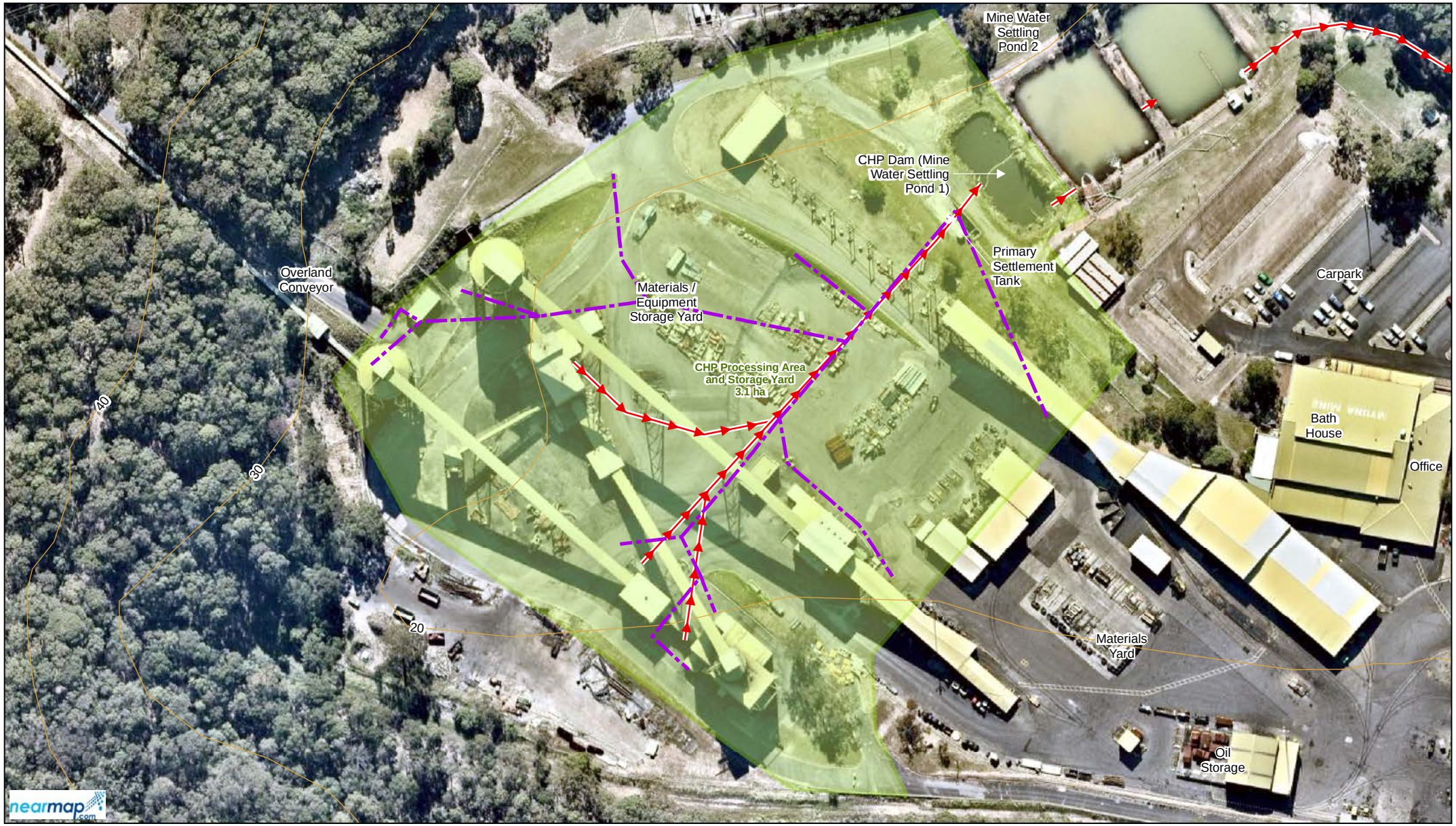
Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com **W** www.ghd.com.au

Data source: © LPMA: DCTB & DTDB, 2007/2012; AECOM: LDP data, 2009; Centennial: Drainage network, 2012; Nearmap: Aerial dated 20160504, extracted 20160720. Created by: smacdonald



Paper Size A4

0 5 10 20 30 40

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Dirty Water Pit and Pipe Network
- Dirty Water Flow Paths
- 10m Contours
- CHP Processing Area and Storage Yard

GHD

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Job Number	22-18127-02
Revision	A
Date	17 Aug 2016

CHP Dirty Water Catchment and Pipe Network

Figure 3-6

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Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com **W** www.ghd.com.au

Data source: © LPMA: DCTB & DTDB, 2007; AECOM: LDP data, 2009; Centennial: Drainage network, 2012; Nearmap: Aerial dated 20160504, extracted 20160720. Created by: smacdonald

Dirty water runoff from the Emergency Stockpile Area is directed to the Emergency Stockpile Dam. From the dam, captured water is able to settle coal-laden runoff whilst at the same time water is pumped (via a transfer pipeline) at a controlled rate to Mine Water Settling Pond 2. In additional to the transfer pipeline, another pipeline is available for extraction of water from Mine Dam 2 for dust suppression of the Emergency Stockpile Area.

In the event that the capacity of the dam is exceeded then the dam will overflow through a small diameter pipe to a channel which leads to Wangi Creek. This overflow point is from LDP A.

The Emergency Stockpile Dam catchment and clean water diversions are presented on Figure 3-7.

Mine Water Settling Ponds 2 and 3

Inflow to the Mine Water Settling Pond 2 includes the transfer of pumped water from the underground workings and some surface runoff from the surrounding grassed areas. The storage capacity of Mine Water Settling Pond 2 and the inflows that it receives in day-to-day operations means that it is constantly overflowing via its concrete weir. The concrete weir connects Mine Water Settling Pond 2 to Mine Water Settling Pond 3.

Mine Water Settling Pond 3 discharges through an overflow weir outlet. This discharge flows through LDP B before reaching Wangi Creek. The current LDP volumetric limit for LDP B is 13 ML/day. The discharge volumes through LDP B can be controlled with the operation of valves and the various underground pumps to the surface. The standard transfer rates from the underground to the surface are dependent upon operational conditions at any one point in time. Three main transfer pumps can operate simultaneously with a maximum rate of 10.5 ML/day to the surface.

3.2.5 Management of potential contamination

The stormwater network at Myuna Colliery for both the clean and dirty water systems is a critical element of the site's water management system. The adequate capture and conveyance of surface flows to their respective control points ensures the surface remains serviceable.

The clean water drainage network conveys surrounding catchments to Wangi Creek in the vicinity of LDP B. It also conveys rooftop and carpark catchments to the First Flush Tank. In the event of a spill or the operation of leaking machinery the concern is that the contamination of the clean stormwater system may occur.

The First Flush Tank provides a level of treatment and potential containment of runoff in the event of an emergency. The clean water network that runs from west to east across the Surface Facilities Area does not have any treatment options available. To mitigate the risk of a contaminated stormwater system, Myuna Colliery has installed a new oil mop system.

The management of the existing oil/water separator located at the washdown bay is defined as part of the wastewater management system. The treated water from the separator is now pumped to the primary settling tank. The capacity of this device is limited and there is a risk that this device may fail resulting in the contamination of the clean water system. To mitigate this risk, water stored within the separator is monitored through automatic level sensors and maintenance is undertaken on a quarterly basis. Visual inspections are undertaken on a weekly basis to make sure that the system is working effectively and that no contamination is occurring.

Paper Size A4

0 5 10 20 30 40

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Licensed Discharge Point
- Clean Water Diversions
- Dirty Water Flow Paths
- Emergency Coal Stockpile Area
- Dirty Water Pit and Pipe Network
- Watercourse
- 10m Contours

GHD

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Emergency Stockpile Dam Catchment and Clean Water Diversions

Job Number	22-18127-02
Revision	A
Date	17 Aug 2016

Figure 3-7

G:\22\0105001\GIS\Maps\Deliverables\Hunter\Regional\2218127\Myuna_WMP\221812702_WMP_009_ESDCatchmentandDiversions_A.mxd

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com **W** www.ghd.com.au

Data source: © LPMA: DCTB & DTDB, 2007/2012; AECOM: LDP data, 2009; Nearmap: Aerial dated 20160504, extracted 20160720; Centennial: Drainage network, 2012. Created by: smacdonald

Currently the Surface Facilities Area includes above ground fuel storage tanks which are sources of potential surface water and groundwater contaminants if fuel is leaked.

Other locations around site that pose similar risks include washdown facilities, the carpark and hydrocarbon storage areas. Contamination risks in these areas are mitigated through the establishment of 'dirty' areas for activities with the potential to cause contamination (e.g. re-fuelling), through establishing spill containment areas and by locating emergency spill kits in high-risk areas.

Spills of any hazardous materials, of either a minor or major nature are managed in accordance with Myuna Colliery's Pollution Incident Response Plan (PIRP). Clean up equipment and absorbent materials are readily available from clearly defined spill stations. They are also available in bulk from the Myuna Colliery store.

3.2.6 Sediment, erosion and drainage controls

Myuna Colliery will undertake progressive rehabilitation of disturbed areas within the Surface Facilities Area on an as required basis. Areas of rehabilitation will be inspected regularly and assessed for evidence of erosion or sedimentation. In monitoring of rehabilitated areas, the focus will be on both the level of vegetation establishment and the adequacy of erosion, sediment and drainage controls.

Drainage controls through areas of rehabilitation will typically be in the form of contour banks progressively installed down the rehabilitated landform as required. In some instances, the use of check dams made from rock will be used to stabilise drainage controls. Sediment fences will also be used where there is potential for sediment to enter watercourses or migrate off-site. Sediment trapped behind sediment fences will be regularly cleaned out and stockpiled in an appropriate area away from drainage lines.

The condition of erosion and sediment controls will be recorded during site inspections and maintenance will be undertaken as required in response to observed defects. Refer to the Erosion and Sediment Control Plan (GHD, 2013b) for details on sediment loads and location, function and capacity of sediment control structures. The Erosion and Sediment Control Plan (GHD, 2013b) is consistent with the requirements of the guideline document *Managing Urban Stormwater – Soils and Construction, Volume 2E: Mines and Quarries* (DECC, 2008).

3.3 Groundwater and underground water management

The underground mine water management system is modified from time to time to adapt to the current mining conditions. Within the current area of operations and within each seam, water in the underground workings is collected and then transferred to a number of underground storages to allow the settling of fines prior to being pumped to the surface.

The underground storages include:

- Great Northern Seam Dam (421 Dam) – 520 Pump.
- New Fassi Fish Tank (Main South 9 Cut-through).
- 642 Dam.
- Old Fassi Dam (720 Dam).
- Wallarah Dam.

The storages of New Fassi Dam, 642 Dam and New Fassi Fish Tank are a series of cascading storages within the Great Northern Seam. Figure 3-8 shows areas of underground stored water within each seam, as at March 2016 following a survey.

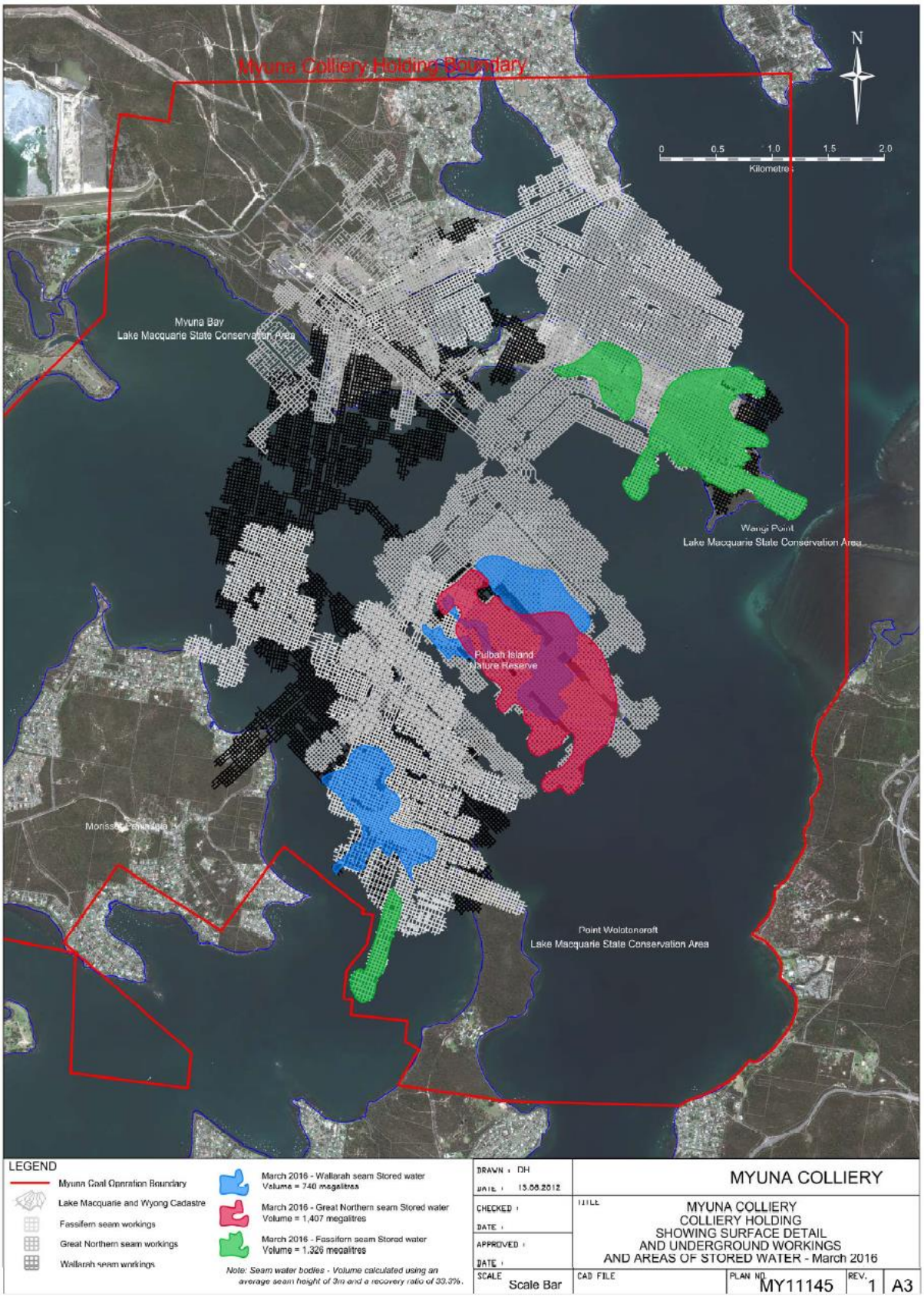


Figure 3-8 Areas of underground stored water

3.3.1 Inputs

The inputs into the underground water system consist of groundwater recharge through natural hydrogeological processes, transfers from the CHP Dam at the surface and potable supply for mining operations.

3.3.2 Outputs

Water from the underground water system is transferred to the surface for storage and discharge through LDP B into Wangi Creek.

Myuna Colliery manages water quality in a preliminary way within the underground storages prior to discharge at the surface. The groundwater make of the Fassifern Seam is mixed with the Great Northern Seam groundwater make to dilute any instances of high concentrations of TSS. Discharge management also includes water quality monitoring as outlined in Section 4.

3.3.3 Hydrogeological model

A three-dimensional eight-layer numerical hydrogeological model has been constructed to estimate groundwater inflow into the underground workings at Myuna Colliery up to 2200. The original hydrogeological model was developed in 2010 to support the Part 3A development application for Myuna Colliery (GHD, 2010). GHD (2014a) has revised the hydrogeological model for Myuna Colliery as part of the preparation of the Northern Operations Water and Salt Balance (GHD, 2014b).

Figure 3-9 presents the groundwater inflows predicted by hydrogeological modelling for Myuna Colliery. Current groundwater inflows into the active mining areas are estimated to be approximately 6.8 ML/day. Predicted inflows into the mine are expected to peak in 2032 at approximately 7.5 ML/day.

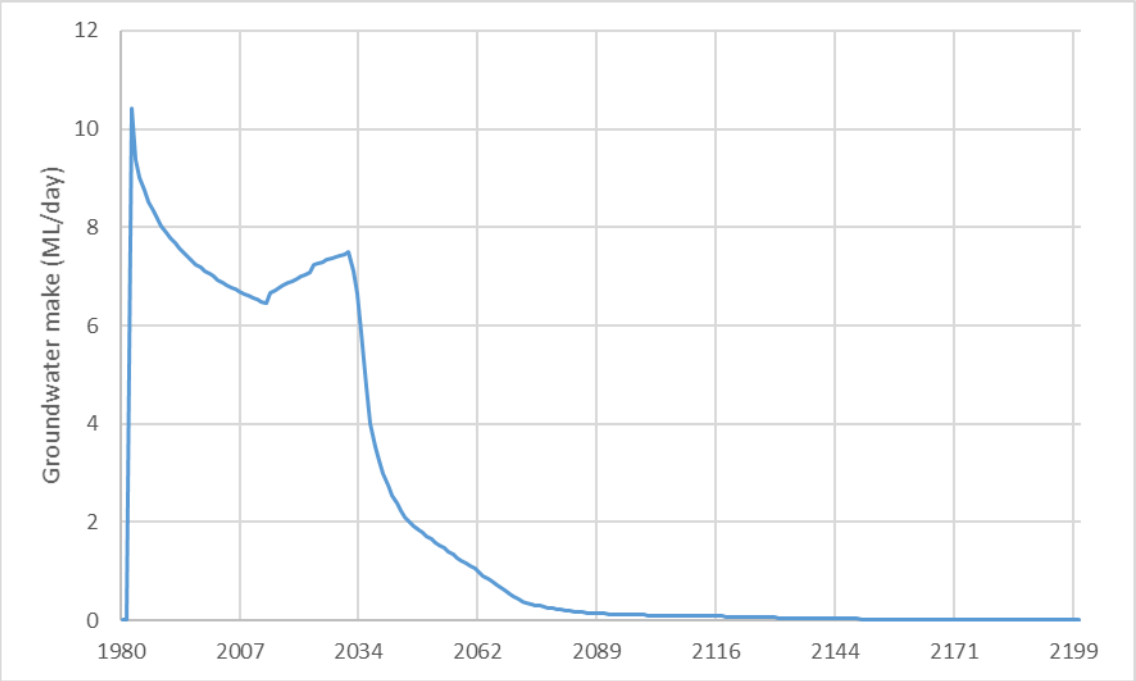


Figure 3-9 Predicted groundwater inflows into underground workings

As part of the Annual Groundwater Management Report, prepared in 2016, the hydrogeological model also reviewed the potential impact to alluvial aquifers. It was predicted that there will be no drawdown of alluvial aquifers greater than 0.1 m due to mining at Myuna Colliery.

3.4 Potable and wastewater systems

Potable water is provided to Myuna Colliery by HWC, through the Toronto and Wangi Wangi systems. The Wangi Wangi system provides water on demand to the underground workings and Surface Facilities Area while the Toronto system provides a secondary supply and can be switched over to supply the Surface Facilities Area and underground in an emergency.

Waste water at Myuna Colliery includes grey water, sewage and some trade waste (residual water from the workshop oil/water separator system). Each of these waste water streams is directed to the sewer system in accordance with a Trade Waste Agreement that has been operable since 1995. In accordance with this agreement, annual water quality sampling is conducted with the results provided to HWC.

3.4.1 Inputs

The inputs into the site potable and wastewater systems consist of potable water provided to the underground workings, washdown bay, amenities, CHP and on-site storage tanks.

3.4.2 Outputs

The outputs from the site potable and wastewater system are grey water and sewage from buildings directed to the HWC Trade Waste system and residual water from the workshop oil-water separator system directed to the HWC Trade Waste system under permit number D-171027.

3.5 Maximisation of water reuse and recirculation

Potable water provided to Myuna Colliery by HWC is the primary and only source of potable water used by the colliery. Future investigations into the possibility of reuse options regarding the utilisation of the high volume of groundwater inflows within the underground operations is currently being considered.

Water reuse within Myuna Colliery is generally limited to dust suppression within the Emergency Stockpile Area and fire-fighting. The recirculation of stored water within the water management system is a more common practice, with recirculation used to improve water quality within both the surface and underground water management systems.

At Myuna Colliery there is no permanent stockpile and the majority of trafficked areas are paved. Therefore, opportunities for dust suppression within the Surface Facilities Area are limited. Within the Emergency Stockpile Area, the infrastructure exists to reuse water stored from Mine Water Settling Pond 2 for dust suppression activities. While this is an option for the site, it occurs rarely and the annual volume of this reuse is negligible.

To actively increase reuse of surface and underground water at Myuna Colliery it would require the introduction of some form of desalination infrastructure due to the salt content of the groundwater into the underground workings. This infrastructure at Myuna Colliery is highly unfeasible for the size of the operation but is a key part of any increased reuse system.

The Surface Facilities Area has a number of paths where recirculation of water is used to both dilute and increase detention treatment times. The key instances of recirculation within the surface water management structures are:

- Emergency Stockpile Dam to CHP Dam.
- CHP Dam to underground workings water storage areas.

These two recirculation paths typically have functions to reduce high concentrations of TSS and to actively draw down storage water levels to a minimum, readying the respective storage for the next rainfall event.

With respect to underground operations, the recirculation of water serves the purpose of improving water quality levels within storages which may have a high concentration of TSS. This is best shown in the mixing of water collected within the Great Northern Seam and the water collected within the Fassifern Seam.

The reuse of captured underground water in mining activities is not possible due to the high electrical conductivity (EC) of the water. This is due to the nature of the groundwater environment and the influence of salt content present within Lake Macquarie. A high EC means that water cannot be reused in any underground mining infrastructure or in any surface processes that require water.

3.6 Site water balance

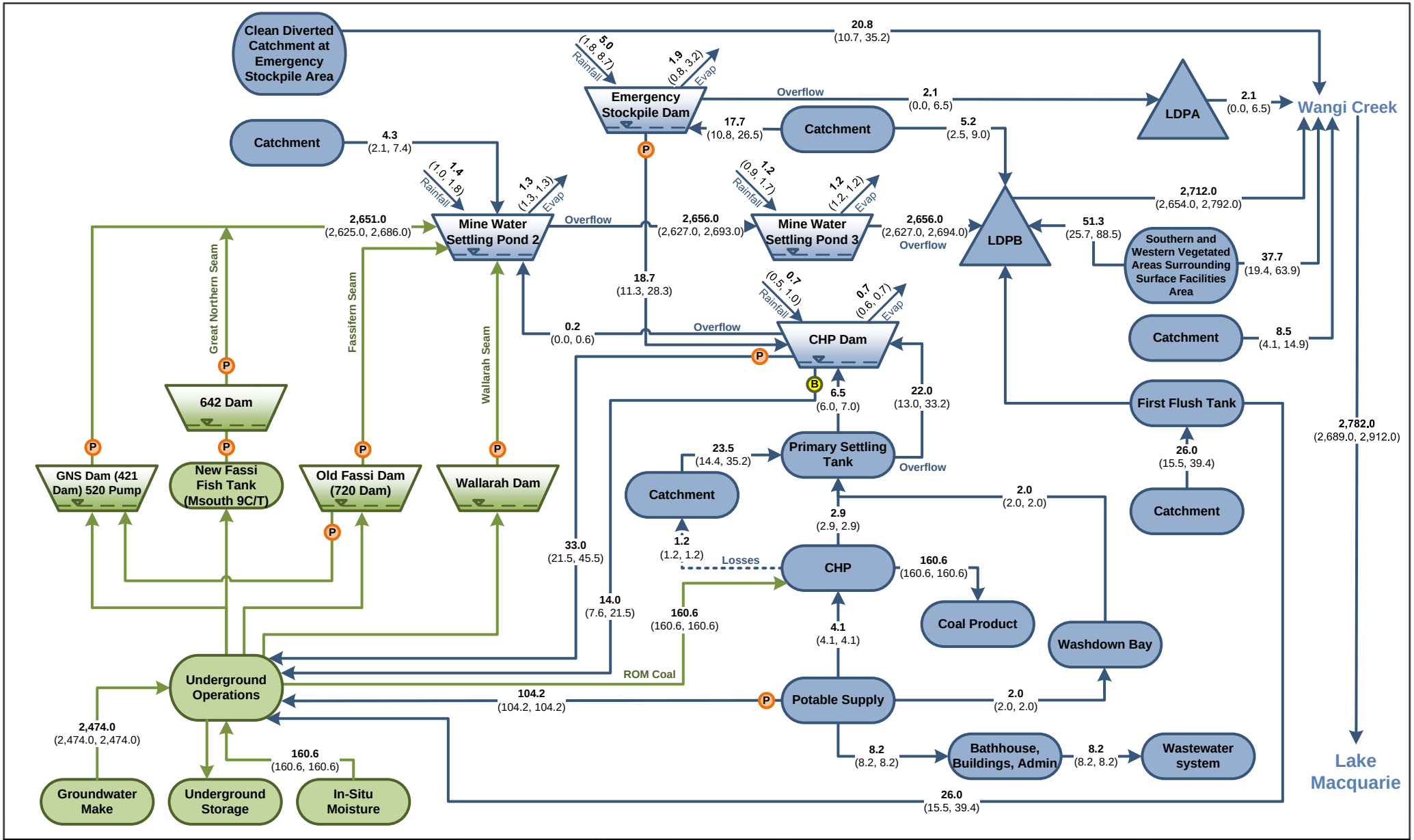
A site water balance was developed for Myuna Colliery in 2010 and has been progressively updated over time (GHD, 2016). The water balance was developed to quantify transfers within the site under existing and future operational conditions using various rainfall patterns.

3.6.1 Annual water balance

A summary of the predicted average annual inputs and outputs for the Myuna Colliery water management system under existing conditions in 2016 is provided in Table 3-3. A water cycle schematic for existing conditions (2016) is shown in Figure 3-10.

Table 3-3 Average annual water balance

Water management element	Volume (ML/year)
INPUTS	
Direct rainfall onto storages and runoff	8.3
Catchment runoff	128.0
Groundwater make	2,474.0
Potable water supply	118.5
TOTAL INPUTS (rounded)	**2,889**
OUTPUTS	
Evaporation	5.1
Discharges through LDP A	2.1
Discharges through LDP B	2,712.0
Wastewater system	8.2
CHP losses	1.2
TOTAL OUTPUTS (rounded)	**2,899**
CHANGE IN STORAGE	
Surface water storages	-0.4
Underground water storage	0.2
TOTAL CHANGE IN STORAGE (rounded)	**0**
BALANCE	
Inputs – outputs – change in storage	0



Surface Transfers

Underground Transfers

Pump

Borehole

LOCATION	Myuna
SEAM	Wall., G.N., Gt Nrth
DRAWN	SM
CHECKED	LH
APPROVED	SG
SCALE	NTS

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Annual water cycle
Existing conditions

Centennial Coal

DATE Nov 2017

Figure 3-10

G:\22\19224\Tech\Visio\2218127_FIGX-X_Myuna Water Cycle Schematic-Existing.vsdm

3.6.2 Discharge frequency

Discharges through LDP A occur infrequently as a result of heavy rainfall. The frequency and magnitude of discharges from LDP A are expected to remain rainfall-dependant for the life of the site.

The percentiles of the range of daily flow rates predicted to pass through LDP B under existing and future conditions are presented in Figure 3-11. For clarity, the results are shown on a single graph with the current EPL limit of 13 ML/day. Discharges of approximately 7.2 ML/day and 7.8 ML/day for existing and future conditions respectively, consisting predominantly of groundwater make, were modelled to occur for over 80% of days. Discharge greater than this is attributable to the variation in direct rainfall and runoff contributing to storages due to the wide range of possible rainfall conditions modelled.

The maximum discharge modelled was approximately 31 ML/day for both existing and future conditions. The maximum discharge under both existing and future conditions was modelled to occur on less than 0.1% of days. Discharges greater than the current EPL limit of 13 ML/day were predicted to occur on less than 2% of days in the year for both existing and proposed conditions.

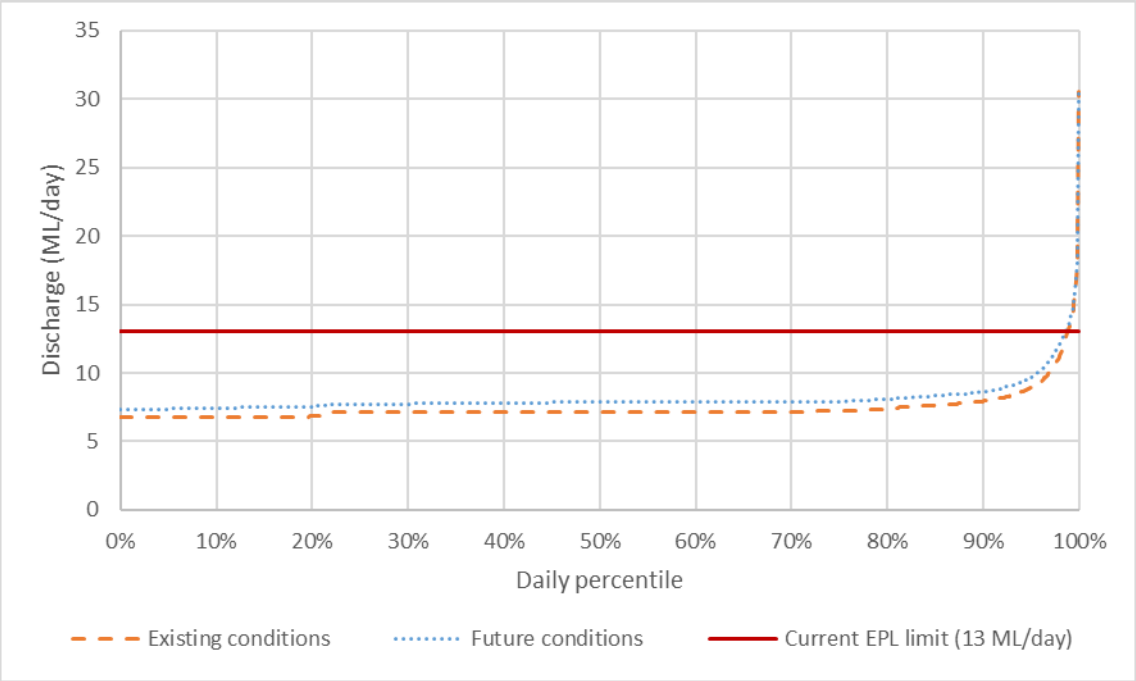


Figure 3-11 Predicted daily discharges from LDP B

4. Monitoring requirements

4.1 Inspections

Site inspections are completed by the Centennial Myuna Environment and Community Coordinator and occur:

- At least weekly.
- Immediately following rainfall events that exceed 40 mm in 24 hours.

An example of a self-audit is undertaking the following activities:

- Walking around the site systematically.
- Inspecting water management and sediment control structures for capacity, structural integrity and effectiveness.
- Recording and reporting on the condition of each water management and sediment control structure in place.
- Recording where around the site sediment is deposited.

Maintenance of the water management and sediment control structures will be implemented when visual defects are observed.

4.2 Surface water monitoring

Surface water quality at Myuna Colliery is currently monitored at the following locations:

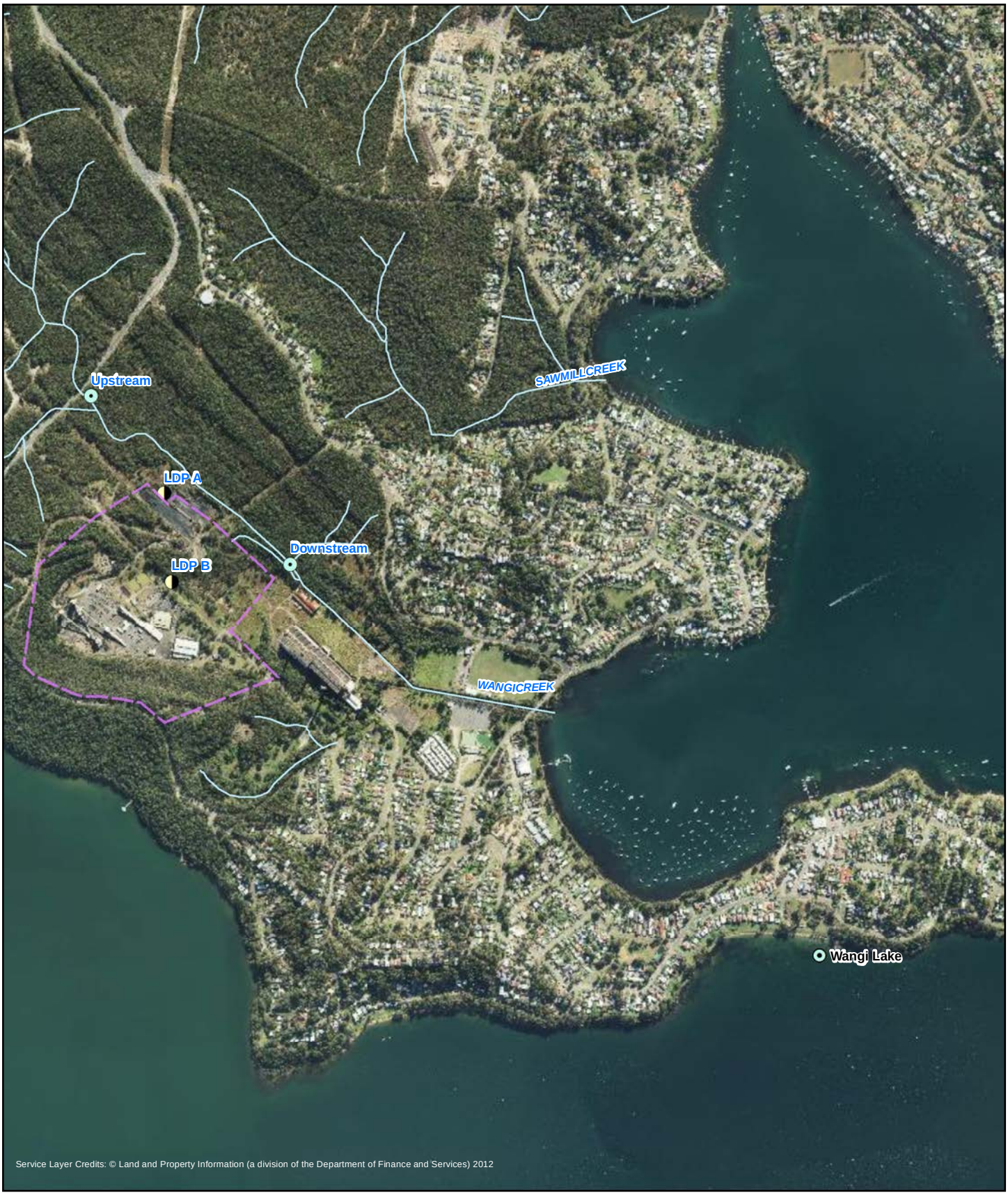
- Upstream – located on Wangi Creek approximately 500 m upstream of LDP B.
- Downstream – located on Wangi Creek approximately 180 m downstream of LDP B.
- Wangi Lake – located in Lake Macquarie.

The locations of surface water quality monitoring sites are shown in Figure 4-1. All sites are monitored monthly. Water quality parameters are summarised in Table 4-1.

Table 4-1 Surface water quality monitoring parameters

Category	Parameter
Physicochemical	EC, pH, TSS, turbidity.
Nutrients	Total phosphorus.
Cations	Calcium, magnesium, potassium, sodium.
Metals (dissolved and total)	Aluminium, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, silver, titanium, vanadium, zinc
Other parameters	Oil and grease, silica.

There currently is no Wangi Creek or other waterway flow monitoring undertaken at Myuna Colliery. Contribution of discharges to Wangi Creek is monitored through LDP B. Potential water loss from waterways that exist above areas of mining are monitored through the assessment of alluvial monitoring bores.



LEGEND

- Surface Facilities Area
- Surface Water Monitoring Location
- Licensed Discharge Point
- Watercourse

Paper Size A4

0 55 110 220 330 440

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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Centennial Myuna Pty Ltd
Water Management Plan

Surface water quality monitoring locations

Job Number	22-19224
Revision	A
Date	17 Aug 2016

Figure 4-1

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Data source: © LPMA: DCTB & DTDB, 2007/2012; AECOM: Aerial & LDP data, 2009. Centennial: Monitoring, 2012; ESRI: Imagery, 2016. Created by: smacdonald

4.3 Groundwater monitoring

4.3.1 Underground water quality data

The water quality of groundwater transferred from the underground workings to the surface is assessed quarterly (when possible) for pH, total dissolved solids (TDS), TSS and turbidity. The underground water storages are also sampled quarterly (when accessible) and analysed for pH and TDS.

4.3.2 Underground water transfers

Daily monitoring of the following underground water transfers is undertaken:

- Supply of potable water to mining equipment within the Myuna workings.
- Transfer of water from underground storage area to mine water settling ponds.

Annual monitoring of water levels within the underground storage area will also be undertaken.

4.3.3 Alluvial groundwater monitoring

The groundwater monitoring network at Myuna includes ten shallow alluvial monitoring bores. These alluvial bores were installed in July 2012. Groundwater level monitoring at these locations will commence in November 2017 sampled on monthly basis. Details of the groundwater monitoring bores are provided in Table 4-2 and locations are shown in Figure 4-2.

Table 4-2 Groundwater monitoring bore details

Bore	Easting	Northing	Bore depth[1] (m)	TOC (m AHD)	Groundwater level July 2012 (m AHD)
MW01	366421.196	6340666.725	6	20.6	19.357
MW05	366382.919	6340757.928	18.5	20.6	13.229
MW06	366352.036	6340702.937	13	20.6	13.211
MW07	366099.275	6340745.900	8.5	25.8	22.134
MW08	366166.975	6340855.902	9	24.6	21.364
MW09	366358.936	6340904.374	7	19.427	17.272
MW10	366253.961	6341072.879	10	30.1	24.666
MW11	366298.845	6341178.276	7	14.4	12.306
MW12	366523.721	6340866.437	8	9.3	6.779
MW13	366673.814	6340926.691	11	5.1	0.53

Notes:

TOC: Top of casing

1. Measured from TOC

4.4 Discharge water monitoring

4.4.1 Surface water discharge flows

Myuna Colliery has recently established monitoring at LDP A and LDP B. The discharge monitoring program is outlined in Table 4-3.

Table 4-3 Discharge monitoring

Location	Frequency	Monitoring device
LDP A	Daily during any discharge	Level sensor
LDP B	Daily during any discharge	Continuous electronic flow meter

4.4.2 Surface water discharge quality

Table 4-4 outlines the discharge water quality monitoring requirements for Myuna Colliery, which fulfils the specifications of EPL 366.

Table 4-4 Discharge quality monitoring

Location	Frequency	Parameter
LDP A	Daily during any discharge	Oil and grease, pH, TSS.
LDP B	Daily during any discharge	Oil and grease, pH, TSS.

4.5 Watercourse stability monitoring

Centennial Myuna monitor the extent of channel incision at the downstream extent of reach W2, as shown in Figure 4-3. In the event of substantial incision of a channel (as defined by formation of a head-cut greater than 0.3 m high), structural intervention is likely to be required to stabilise the waterway. Channel incision will be monitored visually during inspections and in accordance with the triggers and actions stipulated within the stream health trigger action response plan (TARP) (refer to Section 6 and Appendix E). Channel incision inspections at the downstream extent of reach W2 will typically occur at least once every six months or during routine water quality sampling events at nearby monitoring locations.

Stream health and channel stability inspections will also be undertaken in areas along reaches W1, W2 and W3 annually. Visual monitoring of watercourses is to be carried out by suitably qualified professionals to identify any instabilities that may form as a result of discharge activities.

Inspections will identify if any of the following potential impacts occur within the creek lines or immediate catchment flow paths:

- Change in stream bed or bank conditions.
- Incision or head cut development.
- Ponding (particularly ‘out of channel’ ponding).
- Step changes in bed profile.
- Any notable/indicative changes in stream vegetation.

The monitoring locations for assessing watercourse stability (W1, W2, and W3) are presented in Figure 4-3

LEGEND

Groundwater Monitoring Location

Surface Facilities Area

Paper Size A4

0 35 70 140 210 280

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Job Number	22-19224
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Date	17 Aug 2016

Groundwater monitoring locations Figure 4-2

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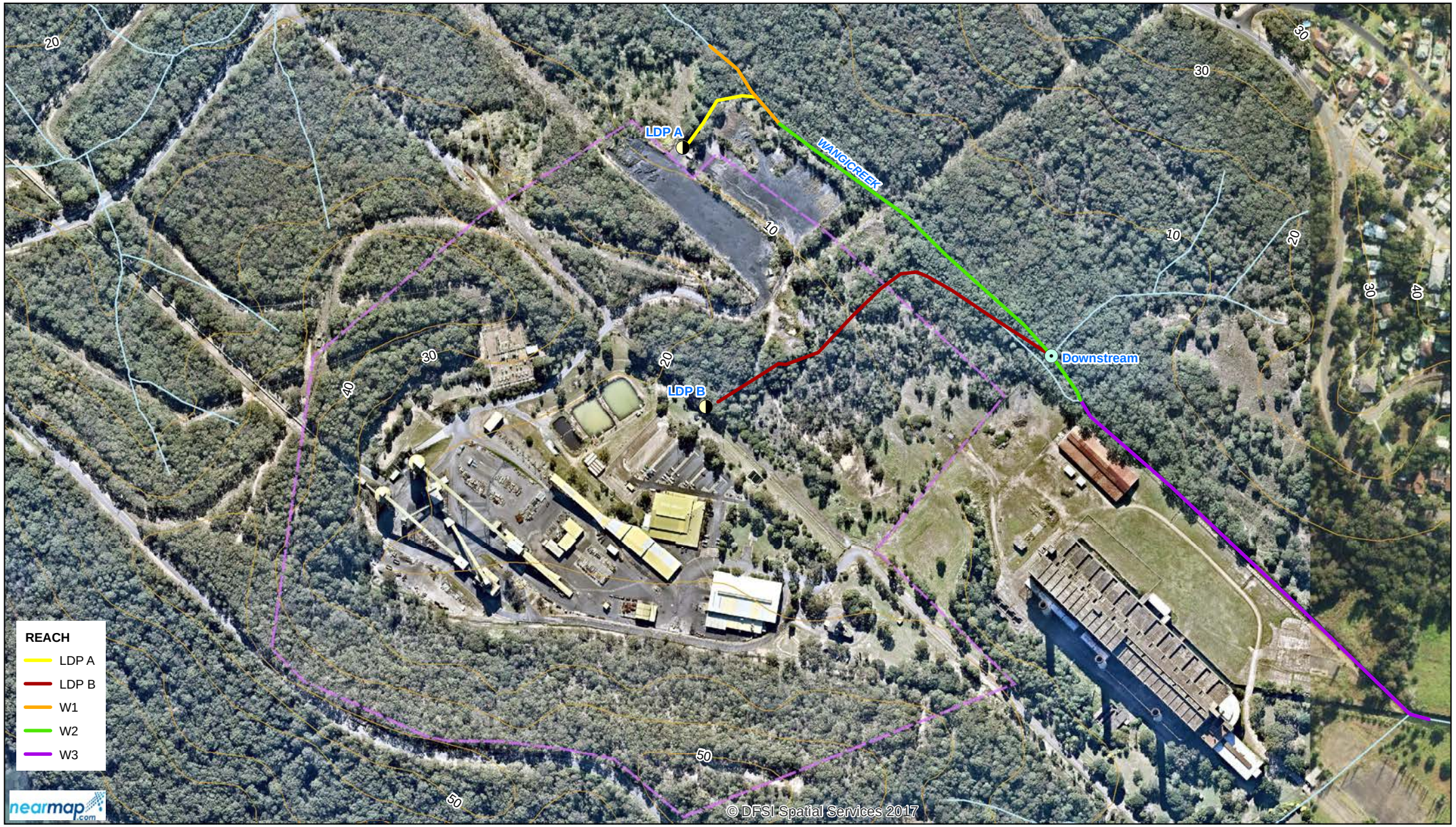
Data source: © LPMA: DCTB & DTDB, 2007/2012; AECOM: Aerial & LDP data, 2009. Centennial: Monitoring, 2012; ESRI: Imagery, 2016. Created by: smacdonald



Paper Size A4

0 15 30 60 90 120

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Surface Water Monitoring Location
- Licensed Discharge Point
- Surface Facilities Area
- Waterways
- 10m Contours

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Watercourse geomorphic stability monitoring locations

Figure 4-3

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Data source: © LPMA: DCTB & DTDB, 2007/2012; AECOM: Aerial & LDP data, monitoring, 2009; Nearmap: Aerial dated 20160504, extracted 20160720. Created by: smacdonald

5. Baseline data

5.1 Surface water flow

Myuna Colliery do not currently undertake flow monitoring of Wangi Creek or any other waterway. Contribution of discharges to Wangi Creek is monitored through LDP B with discharges from LDP A.

Discharge monitoring at LDP B between 2013 and 2017 is provided in Figure 5-1.

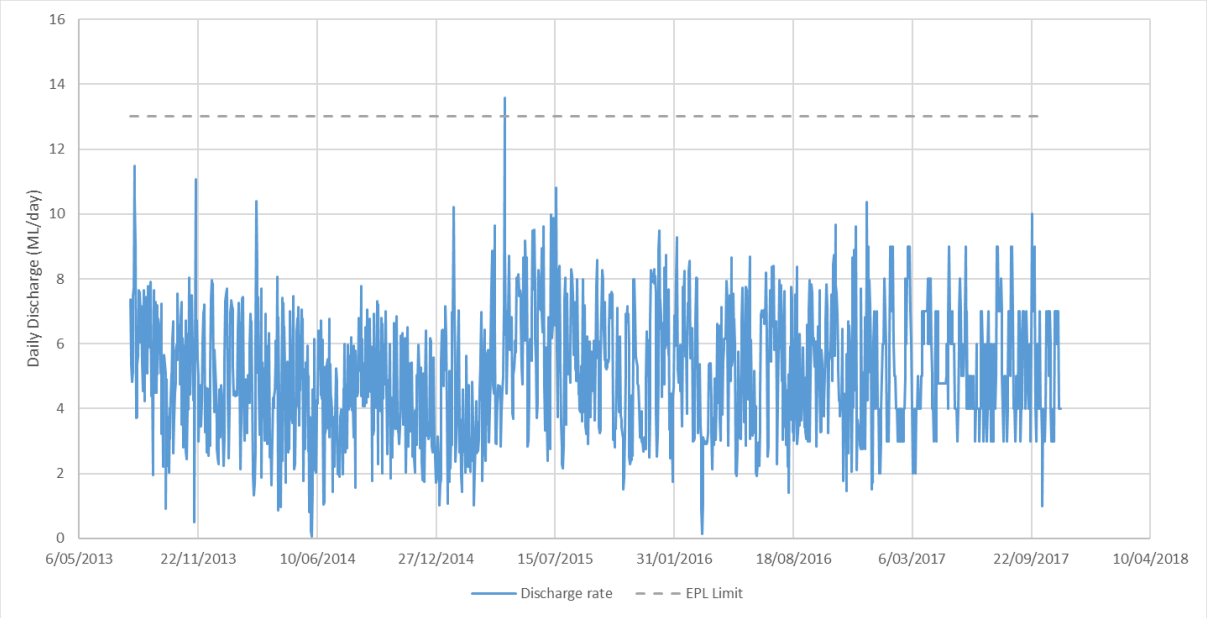


Figure 5-1 LDPB daily discharges between 2013 and 2017

The discharge limit for LDP B is 13 ML/day. From historical monitoring, one event has occurred that exceed this limit in 2015. This event was as a result of a large rainfall event (299.2 mm in three days) in April, which increased the stored volume in the mine water settling ponds, resulting in an increased discharge volume. More details have been defined within the Annual Review completed for that year. Typically daily discharge volumes as part of normal operation range between 3 and 8 ML/day

Potential water loss from waterways that exist above areas of mining are monitored through the assessment of alluvial monitoring bores.

5.2 Surface water quality

A surface water quality assessment was undertaken by GHD (2015b) for the following locations, as shown in Figure 4-1:

- Upstream.
- LDP B.
- Downstream.
- Wangi Lake.

Summary statistics for these sites have also been provided in Appendix A. Time series graphs for selected water quality parameters monitored at LDP B over the period January 2011 to December 2015 are provided in Appendix D. The EPL limits for oil and grease, pH and TSS specified by EPL 366 for LDP B discharges are also presented in the relevant figures. In cases

where results were less than the limit of reporting (LOR), the relevant LOR value has been plotted. Below is a summary of the baseline water quality data from January 2011 to December 2014.

5.2.1 Upstream

Water quality results for the Upstream site on Wangi Creek indicates the water is slightly acidic with elevated levels of TSS, turbidity and total phosphorus having been reported in recent samples.

Relatively low concentrations of the major ions have been recorded at the Upstream site.

The majority of results for dissolved and total metals were generally reported to be below the LOR, with the exception of aluminium, barium, iron, manganese, nickel, titanium and zinc.

Data from the Upstream monitoring location was used, in conjunction with ANZECC (2000) guidance, to develop site-specific trigger values (SSTVs). Further details on SSTVs are provided in Section 6.1.1.

5.2.2 LDP B

Based on the available water quality data for the monitoring period, the water sampled at LDP B is slightly alkaline with low levels of TSS, turbidity and oil and grease. All parameters were within the limits specified by EPL 366 for the most recent 24 monthly monitoring events, from March 2013 to February 2015. EC has not been addressed since the receptor is a marine environment.

The majority of total phosphorus results have been reported to be below the LOR for the most recent data.

Concentrations of the major ionic species were generally greater than those recorded at the Upstream monitoring site.

For assessed dissolved and total metals, the majority of parameters were generally found to be below the LOR for the most recent data, with the exception of barium, boron, iron and manganese. Barium, boron and manganese concentrations at LDP B were generally elevated compared to the Upstream monitoring site, however iron results were generally lower.

5.2.3 Downstream

Downstream monitoring results followed similar trends to LDP B results. The water sampled at the Downstream monitoring site was slightly alkaline, with low levels of TSS, turbidity and oil and grease. Levels of pH were within SSTVs, with the majority of TSS and turbidity results also below SSTVs. One sampling event in April 2013 recorded TSS and turbidity levels exceeding SSTVs. However, as the results for the Upstream monitoring site and LDP B discharge do not show the same increase in TSS and turbidity, these results are considered to be anomalous.

The majority of total phosphorus results were found to be at or below the LOR for the Downstream monitoring site, however the SSTV of 0.035 mg/L was found to be exceeded in approximately 18% of sampling events in the most recent 24 monthly monitoring events.

Results for the major ions at the Downstream site indicated a similar range as for LDP B discharge.

Dissolved and total metal results at the Downstream monitoring site followed similar trends to LDP B discharge. The majority of metals were found to be below the LOR and relevant SSTVs for the most recent 24 monthly monitoring events. Recent exceedances of SSTVs at the Downstream site have been reported for dissolved barium, boron and silver.

Dissolved barium and boron results have consistently been detected at the Downstream site and exceeded SSTVs. Concentrations for both barium and boron at this site are similar in range to the results reported for LDP B discharge, which is elevated compared to the Upstream monitoring site.

The SSTV for silver has been exceeded on three occasions in the past 24 months; however, no dissolved silver has been detected at the Downstream monitoring site since March 2014. Dissolved silver at the Upstream monitoring site and in LDP B discharge has not been detected in any monitoring events, with all samples reported to be below the LOR. This indicates that the dissolved silver detected at Downstream was not associated with the upstream conditions or discharges from Myuna Colliery.

Overall, median concentrations of the most recent 24 months monitoring at site Downstream are below SSTVs with the exception of dissolved barium and boron. These concentrations are most likely attributable to the mine water discharge at LDP B, although it is noted that dissolved boron concentrations are higher in Wangi Lake.

5.2.4 Wangi Lake

Water quality results for Lake Macquarie from the Wangi Lake monitoring site indicate that the water is slightly alkaline, with very low levels of TSS, turbidity and oil and grease reported.

Total phosphorus results were mostly reported to be at or below the LOR and similar to the results in Wangi Creek and LDP B discharge.

The major ionic species concentrations were slightly elevated compared to the LDP B and Downstream site results.

The majority of dissolved and total metal results were found to be at or below the LOR for the Wangi Lake site over the most recent 24 monthly monitoring events, with the exception of barium, boron and molybdenum. Barium concentrations within Lake Macquarie were reported to be lower than the results recorded within Wangi Creek at the Upstream, LDP B and Downstream monitoring locations. Boron and molybdenum concentrations at the Wangi Lake site were reported to be elevated compared to all three Wangi Creek monitoring sites, indicating these parameters may be associated with background levels in Lake Macquarie rather than discharge from Myuna Colliery.

5.3 Groundwater levels and quality

5.3.1 Underground extractions

GHD (2017) has recently undertaken an assessment of the long-term daily underground extraction rate from Myuna Colliery. Daily transfer volumes over the period 2011 to 2015 are shown in Figure 5-2 and ranged from 0 ML/day to 13.6 ML/day. Review of the extraction data indicates that approximately 40% of the extracted volumes are from the Wallarah Seam workings. Note that extraction volumes overestimate groundwater inflows into the mine since they also include potable water transfers to the mine (GHD, 2017).

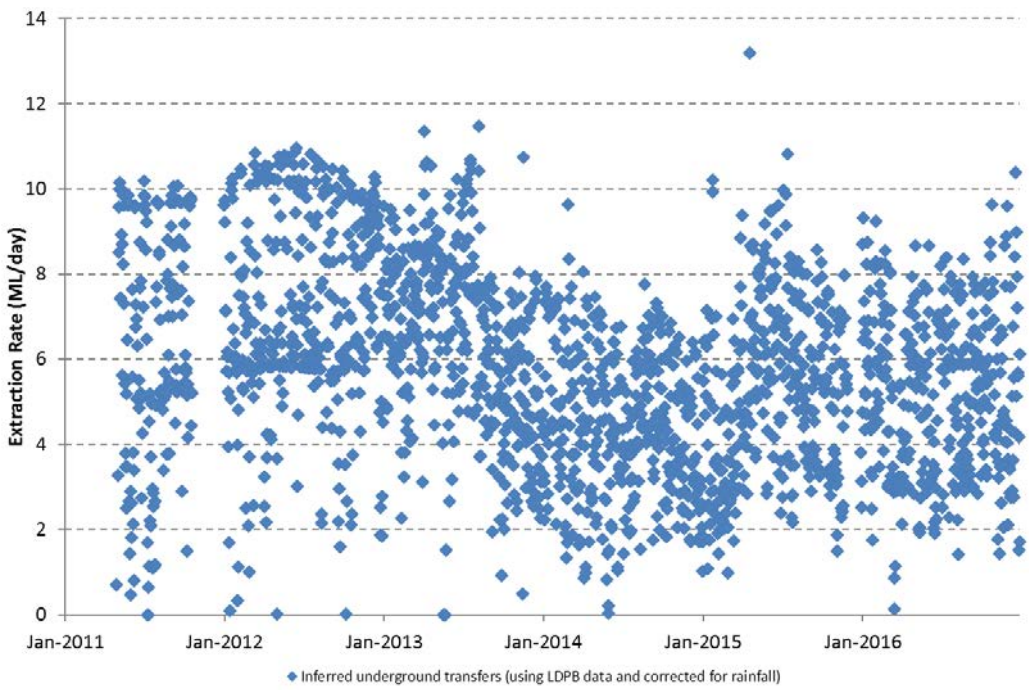


Figure 5-2 Daily total underground water extraction (inferred from LDP B discharge volumes)

Visual inspection of the trend in Figure 5-2 indicates that extraction from the underground workings was decreasing from mid-2013 to 2014. Extraction rates began to increase in 2015. This is most likely attributable to the storage of groundwater inflows within old workings and/or underground dams rather than the immediate extraction of groundwater inflows.

Annual extraction volumes between 2011 and 2015 are listed in Table 5-1. Based on these recorded volumes, Centennial Myuna has consistently met Condition 17 of bore licence 20BL172565 which limits the annual extraction of groundwater to 4,380 ML (GHD, 2017).

Table 5-1 Annual transfers of water from the underground workings

Year	Annual volume (ML)
2011	2,047
2012	2,580
2013	2,281
2014	1,614
2015	1,930
2016	1,902

5.3.2 Underground water storages

The underground water storages in the Wallarah Seam, the Great Northern Seam and the Fassifern Seam have been surveyed in March 2016 by Centennial Myuna. Based on assumptions around seam height, water storage areas and recovery rate, an underground stored volume can be determined. From survey in 2016, Table 4-3 provides the assumed storage volume, in 2016, held underground.

The hydrogeological model developed for Myuna Colliery assumes that the volumes of each of these storages are constant. Follow up survey is to be conducted as part of the next Annual

Groundwater Management Report to determine whether storage volumes have changed and the hydrogeological model recalibrated as required.

Table 5-2 Underground water storage volumes – March 2016

Seam	Water storage volume (ML)
Wallarah Seam	740
Great Northern Seam	1407
Fassifern Seam	1326

5.3.3 Underground water quality

The underground water quality was slightly alkaline and saline throughout 2014 and 2015. Generally, the underground water from the Fassifern Seam has a higher EC and dissolved iron concentration that the other seams. Underground water from the Great Northern Seam generally has lower dissolved manganese concentrations.

Key monitoring results from both underground water storages and underground water transfers are provided in Appendix C.

5.3.4 Groundwater monitoring network

The groundwater monitoring network at Myuna Colliery includes ten alluvial monitoring bores. Observed groundwater levels at these monitoring bores are shown in Table 5-3. Due to the limited number of monitoring rounds undertaken it is considered by that a trend analysis of groundwater levels is not possible at this time.

Table 5-3 Groundwater monitoring bore details

Bore	Easting	Northing	Groundwater level July 2012 (m AHD)	Groundwater level November 2016 (m AHD)
MW01	366421.196	6340666.725	19.357	18.965
MW05	366382.919	6340757.928	13.229	12.994
MW06	366352.036	6340702.937	13.211	12.834
MW07	366099.275	6340745.900	22.134	21.64
MW08	366166.975	6340855.902	21.364	20.312
MW09	366358.936	6340904.374	17.272	14.447
MW10	366253.961	6341072.879	24.666	23.393
MW11	366298.845	6341178.276	12.306	10.895
MW12	366523.721	6340866.437	6.779	6.568
MW13	366673.814	6340926.691	0.53	2.065

5.4 Watercourse stability

Overall, Wangi Creek was defined as generally well vegetated and stable, although the creek is modified in places due to past disturbances (GHD, 2012a). The reaches inspected as part of the baseline assessment (W1, W2, W3, LDPA and LDPB) were shown previously on Figure 4-3.

The five reaches are described in Table 5-4.

Table 5-4 Summary of baseline conditions of Wangi Creek

Reach identifier	Description
W1	This reach exhibits largely a natural channel of between 2 to 3 m and is generally 1 to 2 m deep. Banks are well-vegetated and there is no evidence of channel instabilities or significant bedload transport. At the downstream extent of this reach, a loose rock structure extends across the creek. Being similar to a rock grade control, this structure limits the potential for channel bed incision within the reach. Discharges from LDP A would enter into this reach upstream of the rock structure.
W2	Downstream of the loose rock structure, the channel loses definition and Wangi Creek exhibits a swamp like environment. In this reach flows are dissipated across the entire valley floor which is well vegetated with *melaleuca sp.* and *gahnia sp.* There is largely no evidence of significant instabilities, erosion or bedload transport in this reach. However, the downstream 20 to 30 m of the reach steepens as the streamline drops to converge with the LDP B channel. Along this section, there are a number (4 to 5) of low headcut features less than 0.1 m high. These are stabilised by tree roots and/or small logs. Future decay of the tree roots or logs could result in the reactivation of these headcuts resulting in channelisation of the reach.
W3	This reach exhibits a concrete lined channel invert up to 5 m wide and 1 to 2 m deep. Banks are generally graded and consist of cohesive fine-grained sediments. Given the concrete lining and grassed, graded banks, this reach is considered stable.
LDPA	The discharges from LDP A flow into an earthen channel confined and inset by 4 to 5 m within previously placed fill materials. The invert of this channel is generally 2 to 3 m wide and has a gentle gradient as evidenced by pooling along its extent. The upstream half of this reach is defined by the outlet of the Emergency Stockpile Dam which has created some instability in the channel cross section. Discharges from LDP A enter this reach at its upstream extent via a pipe connected to the sedimentation dam that services the emergency coal stockpile area.
LDPB	Downstream of the LDP B discharge point, discharges flow through a piped network before outflowing into an earthen channel. This channel runs parallel to Wangi Creek in Reach W3 for approximately 200 m. The channel is constrained by fill materials along the left bank, which is steep and up to 4 – 5 m high. Along the left bank, a levee type structure exists which separates flows from the LDP B discharge channel from flows in Wangi Creek. Towards the upstream extent of this reach, a breach of a levee structure that had occurred in the past was repaired in October 2017 and is no longer a source of sediment.

The geomorphic assessment undertaken in 2012 as part of the Surface Water Management Plan (GHD, 2012a) described in Table 5-4 indicates that mine water discharges are not expected to have any significant impacts on the stability of Wangi Creek.

Myuna Colliery will continue to monitor channel stability within Wangi Creek in accordance with the inspection process outlined in Section 4.5.

6. Response plans

6.1 Triggers

6.1.1 Surface water quality triggers

GHD (2015b) has undertaken a water quality assessment of background levels at surface water and mine discharge monitoring sites within and surrounding the Myuna Colliery (described in Section 5.1). The SSTVs for surface water sites at Wangi Creek, based on ANZECC (2000) guidelines and site-specific water quality monitoring data, are listed in Table 6-1 (GHD, 2015b).

Table 6-1 Site-specific trigger values for Wangi Creek

Parameter	Units	SSTV
Physicochemical parameters		
pH	pH unit	6.2–8.5
TSS	mg/L	77
Nutrients		
Total phosphorus	mg/L	0.035
Dissolved metals		
Aluminium	mg/L	0.724
Antimony	mg/L	0.27
Arsenic	mg/L	0.023
Barium	mg/L	0.04
Boron	mg/L	5.1
Cadmium	mg/L	0.0055
Cobalt	mg/L	0.001
Copper	mg/L	0.0013
Iron	mg/L	2.1
Lithium	mg/L	0.001
Manganese	mg/L	0.095
Molybdenum	mg/L	0.023
Nickel	mg/L	0.07
Selenium	mg/L	0.01
Silica	mg/L	22.94
Titanium	mg/L	0.01
Vanadium	mg/L	0.1
Zinc	mg/L	0.016

6.1.2 Groundwater levels

Groundwater level monitoring within alluvial aquifers commenced in November 2017. Until a statistically valid data set (at least one year of monthly data, ideally two years) can be gathered, management triggers cannot be determined. Monitoring will continue monthly with each set of results reviewed against 2012 and 2016 sampling rounds to identify whether there is any ongoing downward trends that are not correlated to monthly or annual rainfall trends.

Based on modelling undertaken as part of the Annual Groundwater Review in 2016, it was predicted that there would be no drawdown greater than 0.1 m within the alluvial aquifers as a result of mining at Myuna Colliery. Whilst this prediction is important for the definition of groundwater management triggers, without a review of environment variability in the monitoring bores currently in service, the only trigger that can be used currently is complaints from surrounding users.

6.1.3 Groundwater quality

Groundwater quality within each seam is variable and influenced by Lake Macquarie (specifically EC). Groundwater quality can also be compared to the limits for EPL 366 for pH and TSS. Based on underground water quality sampling undertaken between 2014 and 2016, 20th and 80th percentiles were determined for selected parameters monitored in each seam. These are provided in Table 6-2. All metal parameters are representative of filtered concentrations.

Table 6-2 Underground water quality ranges

Percentile	pH	EC (µS/cm)	TSS (mg/L)	Iron (mg/L)	Manganese (mg/L)	Barium (mg/L)	Boron (mg/L)
Fassifern Seam							
20th	7.4	48360	5	0.1	0.421	0.097	0.84
80th	7.8	49920	13.6	2.04	0.677	0.110	1.31
Great Northern Seam							
20th	7.6	40080	5	0.05	0.005	0.193	0.3
80th	8.1	41640	24	0.082	0.095	0.273	0.81
Wallarah Seam							
20th	6.8	35740	5	0.05	0.601	0.105	0.05
80th	7.7	40500	7	0.5	1.130	0.136	0.50

Above in Table 6-2 are the range of water qualities monitored within the underground over a period of two years. Typically, sample numbers for the above data was limited to between 7 to 11 over the two year period resulting in a frequency of greater than a month. Ultimately, underground is pumped to the surface and regulated through LDPB. In the event that groundwater quality is monitored outside the defined 20th and 80th percentile for each seam, this would be defined as a statistically significant change.

The values provided in Table 6-2 are intended to inform further management actions in order to mitigate potential risk at water quality exceeding limits at LDPB.

6.1.4 Underground water management

Underground stored water is an issue of operational management with no specific level or volume trigger defined as part of the overall water management system. Monitoring will be undertaken to support calibration and validation exercises for the Hydrogeological Model.

6.1.5 Discharge triggers

Water quality monitoring data for LDP A and LDP B discharges are compared to EPL 366 concentration limits where applicable, as shown in Table 1-4. The discharge volume limit for LDP B outlined by EPL 366 is 13 ML/day.

6.2 Performance criteria

Performance criteria have been developed based on baseline information and the approach presented within the Northern Operations RWMP. These criteria form the basis of the TARPs provided in Appendix E.

6.2.1 Surface site operations

The performance criteria for on-site surface water management at Myuna Colliery is outlined in Table 6-3.

Table 6-3 On-site surface water management criteria

Aspect	Criteria
Surface storages	Storages sized in accordance with Landcom (2004) and DECC (2008) and maintained within the capacity of each storage.
Water quality management	Clean and dirty water separation.
Erosion and sediment control	Minimising disturbance area. Pit top disturbance and other construction activities to be managed in accordance with the approach and guidelines outlined in the Northern Operations RWMP. Where construction works are significant an erosion and sediment control plan (ESCP) and construction environmental management plan will be prepared.
Hydrocarbon management	Chemical and hydrocarbon storage to be in accordance Australian Standard AS1940:2004.

6.2.2 Watercourses

Criteria for the management of water quality within watercourses are provided in Table 6-4.

Table 6-4 Watercourse criteria

Aspect	Criteria
Watercourse quality	Below SSTVs provided in Table 6-1.

6.2.3 Groundwater environment

Based on the triggers derived in Section 5.3, Table 6-5 presents the groundwater management performance criteria for Myuna Colliery.

Table 6-5 Groundwater environment criteria

Aspect	Criteria
Groundwater level	Level thresholds to be determined following at least one year, preferably two years of monitoring. No complaints from surrounding groundwater users.
Groundwater quality	Groundwater quality is maintained within a range of historical monitoring defined by the 20th and 80th percentile statistic. No complaints from surrounding groundwater users.
Underground water level/storage	Within safe operating levels determined by the Myuna Colliery.

6.2.4 Discharge management

Discharge management includes both discharge volume and quality. The criteria applied for Myuna Colliery is presented in Table 6-6.

Table 6-6 Discharge management criteria

Aspect	Criteria
Discharge volume	Discharge is to only to occur in accordance with event-based criterion and the daily discharge limit specified in EPL 366.
Discharge quality	Discharge water quality must be less than EPL criteria provided in Table 1-4.

6.2.5 Stream health

The condition of riparian and in-stream vegetation and channel stability will be used during observation monitoring (in addition to the water quality criteria listed above in Table 6-1) to assess the health of Wangi Creek. The specific stream health assessment criteria (GHD, 2012a) to be followed during observation monitoring are detailed in Table 6-7.

Table 6-7 Stream health assessment criteria

Element	Parameter	Criteria
Riparian and in-stream vegetation	Vegetation condition – photographic log	Photographic log indicates that vegetation has not been detrimentally impacted over time.
Channel stability	Erosion – photographic log	Photographic log indicates occurrence of erosional processes has not occurred as a result of water discharges over time.
Watercourse subsidence	Subsidence – photographic log	Photographic log indicates no ponding, changes in stream bed or bank conditions, incision, head cut development, or surface cracking as a result of subsidence.

6.3 Trigger action response plans

TARPs are provided in Appendix E for the following:

- Surface site operation.
- Watercourses.
- Groundwater environment.
- Discharge management.
- Stream health.

7. Site-specific reviews and reports

7.1 Bore Licence Annual Groundwater Report

In accordance with Condition 4 of bore licence 20BL172565, Centennial Myuna is required to prepare an annual groundwater report to present:

- All raw monitoring data, an interpretation of that data and a discussion of trends identified in the data and the implications.
- All groundwater extraction data (volumes and rates) taken by the works, the extent of aquifer depressurisation and the salinity impacts, compared with the predictions of aquifer performance made in the environmental impact statement(s) or similar.
- An overall comparison of groundwater performance with predictions for the life of the mine provided in the development application and supporting documentation.
- Water related activities performed and the level of compliance with the WMP and an outline of proposed adaptive or remediation actions.
- Assessment of extraction or other depressurisation impacts caused by the work(s) to external water sources, water users or groundwater dependent ecosystems.

In accordance with Condition 6 of bore licence 20BL172565, a five yearly groundwater audit is required. This was last undertaken in 2016. As part of the 2016 audit, a number of recommendations were provided and addressed as part of the Annual Groundwater Report. The next audit is due for completion in 2021.

7.2 Hydrogeological model

Centennial Myuna will review the hydrogeological model for Myuna Colliery on an annual basis and update as necessary. The review should be undertaken in conjunction with the annual groundwater report and include a review of groundwater monitoring data collected from the groundwater monitoring network. Groundwater monitoring data should be used for verification of the hydrogeological model. If the review of monitoring data indicates trends that differ from the predictions of the hydrogeological model, then the hydrogeological model should be recalibrated using monitoring data.

It is recommended that following collection of two years of monitoring data from the groundwater monitoring bores listed in Table 4-2, this WMP is updated to include trigger values for the alluvial groundwater monitoring bores.

7.3 Site water balance

Centennial Myuna will review the site water balance at least every three years or in response to significant changes to water management practices on site.

8. References

AECOM (2011), *Myuna Colliery Extension of Mining Environmental Assessment*, prepared by AECOM Australia Pty Ltd for Centennial Myuna Pty Limited.

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

Centennial Myuna Pty Ltd (2014) *Environmental Assessment Myuna Colliery*, Section 75W Modification to Project Approval PA 10_0080

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

GHD (2010) *Myuna Colliery – Water Management Assessment*, prepared by GHD Pty Ltd for Centennial Myuna Pty Ltd.

GHD (2012a) *Myuna Colliery – Surface Water Management Plan*, prepared by GHD Pty Ltd for Centennial Myuna Pty Ltd.

GHD (2012b) *Myuna Colliery – Groundwater Monitoring Program*, prepared by GHD Pty Ltd for Centennial Myuna Pty Ltd.

GHD Pty Ltd (2012c) *Myuna Colliery – Water and Salt Balance Assessment*, prepared by GHD Pty Ltd for Centennial Myuna Pty Ltd.

GHD Pty Ltd (2012d) *Myuna Mine – Surface and Groundwater Response Plan*, prepared by GHD Pty Ltd for Centennial Myuna Pty Ltd.

GHD (2013a) *Myuna Colliery – Water Management Plan*, prepared by GHD Pty Ltd for Centennial Myuna Pty Ltd.

GHD (2013b) *Myuna Colliery – Erosion and Sediment Control Plan*, prepared by GHD Pty Ltd for Centennial Myuna Pty Ltd.

GHD (2014a) *Myuna Colliery – Hydrogeological Model*, prepared by GHD Pty Ltd for Centennial Myuna Pty Ltd.

GHD (2014b) *Northern Operations Water and Salt Balance*, prepared by GHD Pty Ltd for Centennial Coal Company Limited.

GHD (2015b) *Myuna Colliery – ANZECC Water Quality Assessment*, prepared by GHD Pty Ltd for Centennial Myuna Pty Ltd.

GHD (2016) *Myuna Colliery Site Water Balance Update*, prepared by GHD Pty Ltd for Centennial Myuna Pty Ltd.

GHD (2017) *Myuna Colliery – Annual Groundwater Management Report*, prepared for 2016 by GHD Pty Ltd for Centennial Myuna Pty Ltd.

Landcom (2004), *Managing Urban Stormwater: Soils and Construction – Volume 1, 4th Edition*, Landcom NSW.

NSW Department of Mineral Resources (1995), *Newcastle Coalfields Regional Geology 1:100,000 map*.

Appendices

Appendix A – Correspondence with regulators

Planning Services
Resource Assessments
Contact: Megan Dawson
Phone: 9274 6391
Email: megan.dawson@planning.nsw.gov.au

Ms Angela van der Kroft
Environment and Community Coordinator
Centennial Myuna
Wangi Point Road
WANGI WANGI NSW 2283

Dear Ms van der Kroft

Myuna Colliery (PA 10_1080)
Management Plan Review and Approval

The Department refers to the following management plans, submitted on 25 July 2017 in accordance with the Myuna Colliery project approval (PA 10_1080) following the 2016 Annual Review:

- **Biodiversity Management Plan** (dated June 2017) – prepared in accordance with condition 28 of Schedule 3;
- **Non-Indigenous Cultural Heritage Management Plan** (dated June 2017) – prepared in accordance with condition 29 of Schedule 3; and
- **Environmental Management System (EMS)** (dated June 2017) – prepared in accordance with condition 1 of Schedule 5.

The Department has reviewed the management plans and is satisfied that they generally meet the requirements of the project approval. Accordingly, the Secretary's nominee approves the plans. However, prior to submitting the final documents, please update the EMS to address the minor comment in **Attachment C**.

The Department also refers to the **Myuna Water Management Plan (Myuna WMP)** (dated June 2017), prepared in accordance with conditions 22 to 27 of Schedule 3, which also forms Appendix B of the **Regional Water Management Plan**. The Department has reviewed the Myuna WMP and is not satisfied that it meets all the requirements of the project approval. Please update the Myuna WMP to adequately address the issues noted in **Attachment C**, and resubmit by 17 November 2017.

If you require any more information, please contact Megan Dawson on 9274 6391.

Yours sincerely

Howard Reed
11·10·17

Howard Reed
Director Resource Assessments
as nominee for the Secretary

10 October 2017 OUT17/40954

James Wearne
Group Approvals Manager
Centennial Coal
PO Box 1000
Toronto NSW 2283

Dear James,

Myuna Colliery Water Management Plan, Consultation with Department of Planning and Environment – Division of Resources and Geoscience

Pursuant to 10_0080 Project Approval Schedule 3 Condition 22, Myuna Colliery is required to prepare and implement a Water Management Plan for the mine to the satisfaction of the Secretary of the Department of Planning and Environment. The revised Water Management Plan is to be prepared in consultation with regulatory stakeholders, including the Division of Resources and Geoscience.

The Myuna Colliery Water Management Plan was submitted to the Department of Planning and Environment – Division of Resources and Geoscience (the Division) on 13 July 2017 (Department Reference: INW17/42617 & INW17/42620).

The Department provides the following comment:

1. Myuna Colliery must ensure that the Myuna Colliery Water Management Plan and the Mining Operations Plan (MOP) are consistent. Mining activities must be conducted in accordance with an approved MOP.
2. The Myuna Colliery Management Plan should:
   a) determine (with reference to the groundwater assessment) the likelihood and associated impacts of groundwater accumulating and subsequently discharging (e.g. acid or neutral mine drainage) from the underground workings should dewatering of workings be suspended or at the cessation of mining; and
   b) consider the likely controls required to either prevent or mitigate against these impacts as part of the closure plan for the site.

It is the responsibility of the Authorisation Holder to fulfil their obligations and commitments to the rehabilitation outcomes and performance standards as approved by the relevant consent authority to ensure the rehabilitation outcomes identified are achieved.

DEFINITIONS

In this letter, words have the meaning given to those terms in the *Mining Act 1992*, unless otherwise specified below.

Division means the NSW Department of Planning and Environment – Division of Resources and Geoscience.

Water Management Plan means the Myuna Colliery Water Management Plan (INW17/42617 & INW17/42620) prepared by Centennial Myuna Pty Ltd and dated June 2017.

Mining Operations Plan means the project, mining and mining related operations described in the "Myuna Colliery Mine Mining Operations Plan and Rehabilitation Management Plan – January 2016 to December 2022" prepared by Centennial Myuna Pty Limited and dated 10 November 2015, or as by approved amendments

For clarification or further information please contact Marianne Bonnay at the Maitland Office on (02) 4931 6575.

Yours sincerely

MONIQUE MEYER
Manager & Principal Inspector
Environmental Sustainability Unit
Division of Resources and Geoscience
NSW Department of Planning and Environment
Signed under delegation from the Secretary of the NSW Department of Planning and Environment.

Appendix B - Consultation outcomes

Comment	Response
NSW Department of Planning and Environment - letter dated 11 October 2017 (responses to components deemed as not satisfactory)	
Baseline surface water quality data is included in Section 5 of the Myuna WMP (upstream, LDP B, downstream and Wangi Lake). No information on baseline surface water flow monitoring, however it is noted that flow monitoring has recently commenced at LDPs. *Include baseline flow monitoring data in the Myuna WMP.*	Comments added to Section 4.2 and 5.1.
Section 5.3 of the Myuna WMP includes a very general description of the stability of Wangi Creek. Note: incomplete sentence (1st para). *Include a more detailed geomorphic description of Wangi Creek up and downstream on the mine water discharge point.*	Paragraph updated to include more detail on the baseline conditions. Refer to Table 5-4 which details the outcomes of the geomorphic assessment.
General description of baseline groundwater quality included in Section 5.2.2. of the Myuna WMP. Considered inadequate. No data on baseline groundwater levels or yield. *Include baseline data on groundwater levels, yield and quality in the Myuna WMP*	Additional information added to Section 5.3
No groundwater assessment criteria included in Section 6.1 (Triggers) of the Myuna WMP. The groundwater TARP at Appendix C indicates that groundwater level and quality triggers are based on complaints from adjacent bore owners and/or a statistically significant change in quality/depth of groundwater. Triggers cannot be determined without baseline data. Groundwater triggers should be better defined (ie. what is a statically significant change)?. *Include groundwater assessment criteria in the Myuna WMP and reflect this in the TARP.*	Information added to sections 6.1.2 and 6.1.3 in addition to a review of Section 6.2.3. Groundwater level criteria unable to be determined until a statistically valid set of data is gathered from alluvial monitoring bores.
Groundwater monitoring described in Section 4.3 of the Myuna WMP. Section 4.3.3 “recommends” monthly monitoring from 10 alluvial monitoring bores. *Remove recommendations for monitoring and include clear commitments of what will be done.*	Section updated with current commitments to monitoring
Surface water quality, discharge and stream health triggers and performance criteria included in Sections 6.1 and 6.2 of the Myuna WMP respectively. These criteria form the basis of the TARPs provided in Appendix C. Considered adequate.	Information added to sections 6.1.2 and 6.1.3 in addition to a review of Section 6.2.3.

Comment	Response
Refer to comments on groundwater assessment criteria above. *Include groundwater assessment criteria in the Myuna WMP and reflect this in the TARP.*	Groundwater level criteria unable to be determined until a statistically valid set of data is gathered from alluvial monitoring bores.
The Myuna WMP would benefit from a document control register to record the document, approval and circulation details.	Addressed
NSW Department of Planning and Environment – Division of Resources and Geoscience - letter dated 10 October 2017	
Myuna Colliery must ensure that the Myuna Colliery Water Management Plan and the Mining Operations Plan (MOP) are consistent. Mining activities must be conducted in accordance with an approved MOP	Noted, however the management requirements relevant to closure (indicated below in points a and b) are not relevant to the current stage of the operations. These aspects have not been included in the plan at this stage to provide focus to the key issues and risks requiring management that are of relevance.
The Myuna Colliery Management Plan should: a) determine (with reference to the groundwater assessment) the likelihood and associated impacts of groundwater accumulating and subsequently discharging (e.g. acid or neutral mine drainage) from the underground workings should dewatering of workings be suspended or at the cessation of mining; and	This information is currently not relevant for the Water Management Plan in the Projects current stage. During the stages of the operation's transition towards closure (within the last 5 years of production) these aspects will be incorporated into the plan.
b) consider the likely controls required to either prevent or mitigate against these impacts as part of the closure plan for the site.	The current phase of the Project does not warrant the discussion of these aspects in the Water Management Plan. During the stages of the operation's transition towards closure (within the last 5 years of production) these aspects will be incorporated into the plan

Appendix C – Baseline surface and groundwater water quality data

Table C-1 Statistical summary for water quality monitoring at site Upstream (July 2012 to February 2015)

Parameter	Units	Count	Minimum	Maximum	50th percentile	80th percentile
Physicochemical parameters						
EC	µS/cm	24	137	731	241	306
pH	pH units	24	5.7	6.7	6.1	6.4
TSS	mg/L	24	5	490	19.5	77
Nutrients						
Total phosphorus	mg/L	24	0.01	0.26	0.02	0.04
Major ions						
Calcium	mg/L	24	2	4	3	3
Magnesium	mg/L	24	2	6	5	6
Potassium	mg/L	24	2	3	2	3
Sodium	mg/L	24	21	52	37	45
Sulfur	mg/L	24	1	9	3	4
Filterable/dissolved metals						
Aluminium	mg/L	24	0.05	1.38	0.34	0.72
Antimony	mg/L	24	0.001	0.01	0.001	0.01
Arsenic	mg/L	24	0.001	0.01	0.001	0.005
Barium	mg/L	24	0.025	0.046	0.037	0.040
Boron	mg/L	24	0.05	0.07	0.05	0.05
Cadmium	mg/L	24	0.0001	0.001	0.0001	0.0005
Cobalt	mg/L	24	0.001	0.01	0.001	0.005
Copper	mg/L	24	0.001	0.01	0.001	0.002
Iron	mg/L	24	0.5	7.5	1.1	2.1
Lithium	mg/L	24	0.001	0.004	0.003	0.003
Manganese	mg/L	24	0.028	0.187	0.060	0.095
Molybdenum	mg/L	24	0.001	0.01	0.001	0.001
Nickel	mg/L	24	0.001	0.01	0.001	0.001
Selenium	mg/L	24	0.01	0.1	0.01	0.05
Silica	mg/L	24	13.5	25.6	20.1	22.9
Titanium	mg/L	24	0.01	0.1	0.02	0.06
Vanadium	mg/L	24	0.01	0.1	0.01	0.01
Zinc	mg/L	24	0.005	0.05	0.012	0.016
Total metals						
Aluminium	mg/L	24	0.32	4.05	1.14	1.93

Parameter	Units	Count	Minimum	Maximum	50th percentile	80th percentile
Antimony	mg/L	24	0.001	0.01	0.001	0.005
Arsenic	mg/L	24	0.001	0.01	0.001	0.002
Barium	mg/L	24	0.031	0.136	0.043	0.058
Boron	mg/L	24	0.05	0.06	0.05	0.05
Cadmium	mg/L	24	0.0001	0.001	0.0001	0.0001
Cobalt	mg/L	24	0.001	0.01	0.001	0.001
Copper	mg/L	24	0.001	0.01	0.002	0.004
Iron	mg/L	24	0.8	163.0	5.6	21.4
Lithium	mg/L	24	0.002	0.01	0.003	0.004
Manganese	mg/L	24	0.029	0.247	0.071	0.127
Molybdenum	mg/L	24	0.001	0.01	0.001	0.001
Nickel	mg/L	24	0.001	0.01	0.001	0.002
Selenium	mg/L	24	0.01	0.1	0.01	0.01
Silica	mg/L	24	16.9	33.4	21.8	25.1
Titanium	mg/L	24	0.001	0.07	0.001	0.010
Vanadium	mg/L	24	0.01	0.1	0.01	0.01
Zinc	mg/L	24	0.005	0.24	0.016	0.023
Other parameters						
Oil and grease	mg/L	24	2	3	2	2

Table C-2 Statistical summary for water quality monitoring at site LDP B (March 2013 to February 2015)

Parameter	Units	Count	Minimum	Maximum	50th percentile	80th percentile
Physicochemical parameters						
EC	µS/cm	24	31,700	46,700	43,350	44,720
pH	pH units	24	7.6	7.8	7.7	7.8
TSS	mg/L	24	5	28	7	9
Nutrients						
Total phosphorus	mg/L	24	0.01	0.07	0.02	0.05
Major ions						
Calcium	mg/L	24	596	910	743	789
Magnesium	mg/L	24	905	1,370	1,150	1,234
Potassium	mg/L	24	152	247	186	210
Sodium	mg/L	24	6,400	10,000	8,340	9,000

Parameter	Units	Count	Minimum	Maximum	50th percentile	80th percentile
Sulfur	mg/L	24	377	686	547	609
Filterable/dissolved metals						
Aluminium	mg/L	24	0.01	0.01	0.01	0.01
Antimony	mg/L	24	0.001	0.01	0.010	0.010
Arsenic	mg/L	24	0.001	0.01	0.010	0.010
Barium	mg/L	24	0.111	0.301	0.147	0.178
Boron	mg/L	24	0.05	1.04	0.73	0.88
Cadmium	mg/L	24	0.0001	0.0027	0.0010	0.0010
Cobalt	mg/L	24	0.001	0.01	0.010	0.010
Copper	mg/L	24	0.001	0.066	0.010	0.010
Iron	mg/L	24	0.1	0.5	0.5	0.5
Lithium	mg/L	24	0.332	0.619	0.491	0.544
Manganese	mg/L	24	0.206	0.762	0.450	0.656
Molybdenum	mg/L	24	0.001	0.01	0.010	0.010
Nickel	mg/L	24	0.001	0.01	0.010	0.010
Selenium	mg/L	24	0.01	0.1	0.10	0.10
Silica	mg/L	24	9.8	17.0	13.4	15.7
Titanium	mg/L	24	0.1	0.1	0.1	0.1
Vanadium	mg/L	24	0.01	0.1	0.10	0.10
Zinc	mg/L	24	0.050	0.073	0.050	0.050
Total metals						
Aluminium	mg/L	24	0.01	0.46	0.01	0.01
Antimony	mg/L	24	0.001	0.01	0.010	0.010
Arsenic	mg/L	24	0.001	0.01	0.010	0.010
Barium	mg/L	24	0.116	0.304	0.152	0.187
Boron	mg/L	24	0.50	1.06	0.74	0.91
Cadmium	mg/L	24	0.0001	0.0031	0.0001	0.0001
Cobalt	mg/L	24	0.001	0.01	0.010	0.010
Copper	mg/L	24	0.003	0.075	0.010	0.010
Iron	mg/L	24	0.59	1.5	0.88	1.09
Lithium	mg/L	24	0.372	0.921	0.514	0.577
Manganese	mg/L	24	0.229	0.741	0.480	0.689
Molybdenum	mg/L	24	0.001	0.01	0.010	0.010
Nickel	mg/L	24	0.001	0.01	0.010	0.010

Parameter	Units	Count	Minimum	Maximum	50th percentile	80th percentile
Selenium	mg/L	24	0.01	0.1	0.10	0.10
Silica	mg/L	24	9.2	17.6	14.1	15.6
Titanium	mg/L	24	0.01	0.1	0.10	0.10
Vanadium	mg/L	24	0.01	0.1	0.10	0.10
Zinc	mg/L	24	0.050	0.103	0.050	0.052
Other parameters						
Oil and grease	mg/L	24	2	3	2	2

Table C-3 Statistical summary for water quality monitoring at site Downstream (March 2013 to February 2015)

Parameter	Units	Count	Minimum	Maximum	50th percentile	80th percentile
Physicochemical parameters						
EC	µS/cm	24	13,200	45,700	40,700	44,080
pH	pH units	24	7.3	8.1	7.7	7.8
TSS	mg/L	24	5	88	8	11
Nutrients						
Total phosphorus	mg/L	24	0.01	0.13	0.02	0.05
Major ions						
Calcium	mg/L	24	209	938	709	760
Magnesium	mg/L	24	322	1,270	1,120	1,206
Potassium	mg/L	24	61	237	174	203
Sodium	mg/L	24	2,160	9,290	7,925	8,726
Sulfur	mg/L	24	147	675	526	571
Filterable/dissolved metals						
Aluminium	mg/L	24	0.01	0.1	0.10	0.10
Antimony	mg/L	24	0.001	0.01	0.010	0.010
Arsenic	mg/L	24	0.001	0.01	0.010	0.010
Barium	mg/L	24	0.051	0.391	0.139	0.173
Boron	mg/L	24	0.18	1.08	0.68	0.86
Cadmium	mg/L	24	0.0001	0.01	0.010	0.010
Cobalt	mg/L	24	0.001	0.01	0.010	0.010
Copper	mg/L	24	0.001	0.01	0.010	0.010
Iron	mg/L	24	0.01	0.5	0.50	0.50

Parameter	Units	Count	Minimum	Maximum	50th percentile	80th percentile
Lithium	mg/L	24	0.100	0.600	0.479	0.507
Manganese	mg/L	24	0.194	0.809	0.371	0.595
Molybdenum	mg/L	24	0.001	0.01	0.010	0.010
Nickel	mg/L	24	0.001	0.01	0.010	0.010
Selenium	mg/L	24	0.01	0.1	0.10	0.10
Silica	mg/L	24	9.2	16.7	12.6	15.4
Titanium	mg/L	24	0.01	0.1	0.10	0.10
Vanadium	mg/L	24	0.01	0.1	0.10	0.10
Zinc	mg/L	24	0.031	0.058	0.050	0.050
Total metals						
Aluminium	mg/L	24	0.01	1.24	0.10	0.26
Antimony	mg/L	24	0.001	0.01	0.010	0.01
Arsenic	mg/L	24	0.001	0.01	0.010	0.010
Barium	mg/L	24	0.057	0.298	0.153	0.179
Boron	mg/L	24	0.05	1.00	0.74	0.91
Cadmium	mg/L	24	0.0001	0.0027	0.0010	0.0010
Cobalt	mg/L	24	0.001	0.01	0.010	0.010
Copper	mg/L	24	0.001	0.01	0.010	0.010
Iron	mg/L	24	0.52	2.14	1.17	1.40
Lithium	mg/L	24	0.117	0.789	0.492	0.546
Manganese	mg/L	24	0.225	0.826	0.402	0.623
Molybdenum	mg/L	24	0.001	0.01	0.010	0.010
Nickel	mg/L	24	0.001	0.01	0.010	0.010
Selenium	mg/L	24	0.01	0.1	0.10	0.10
Silica	mg/L	24	10.0	17.6	14.6	16.0
Titanium	mg/L	24	0.01	0.1	0.10	0.10
Vanadium	mg/L	24	0.01	0.1	0.10	0.10
Zinc	mg/L	24	0.048	0.073	0.050	0.052
Other parameters						
Oil and grease	mg/L	24	2	3	2	2

Table C-4 Statistical summary for water quality monitoring at site Wangi Lake (July 2012 to February 2015)

Parameter	Units	Count	Minimum	Maximum	50th percentile	80th percentile
Physicochemical parameters						
EC	µS/cm	24	23,700	56,300	51,350	52,940
pH	pH units	24	7.7	8.2	8.0	8.1
TSS	mg/L	24	5	16	6	7
Nutrients						
Total phosphorus	mg/L	24	0.01	0.12	0.02	0.05
Major ions						
Calcium	mg/L	24	202	478	423	461
Magnesium	mg/L	24	612	1,480	1,285	1,382
Potassium	mg/L	24	246	631	465	513
Sodium	mg/L	24	5,140	13,400	11,250	12,040
Sulfur	mg/L	24	458	1,220	972	1,062
Filterable/dissolved metals						
Aluminium	mg/L	24	0.1	0.16	0.10	0.10
Antimony	mg/L	24	0.001	0.01	0.010	0.010
Arsenic	mg/L	24	0.001	0.01	0.010	0.010
Barium	mg/L	24	0.001	0.021	0.011	0.013
Boron	mg/L	24	0.23	5.14	3.93	4.64
Cadmium	mg/L	24	0.0001	0.0027	0.0010	0.0010
Cobalt	mg/L	24	0.001	0.01	0.010	0.010
Copper	mg/L	24	0.001	0.08	0.010	0.010
Iron	mg/L	24	0.1	0.5	0.50	0.50
Lithium	mg/L	24	0.091	0.245	0.183	0.201
Manganese	mg/L	24	0.01	0.019	0.010	0.010
Molybdenum	mg/L	24	0.001	0.017	0.014	0.016
Nickel	mg/L	24	0.001	0.01	0.010	0.010
Selenium	mg/L	24	0.01	0.1	0.10	0.10
Silica	mg/L	24	0.1	3.9	0.1	1.3
Titanium	mg/L	24	0.1	0.1	0.1	0.1
Vanadium	mg/L	24	0.01	0.1	0.10	0.10
Zinc	mg/L	24	0.05	0.05	0.05	0.05

Parameter	Units	Count	Minimum	Maximum	50th percentile	80th percentile
Total metals						
Aluminium	mg/L	24	0.01	0.36	0.10	0.13
Antimony	mg/L	24	0.001	0.01	0.010	0.010
Arsenic	mg/L	24	0.001	0.01	0.010	0.010
Barium	mg/L	24	0.010	0.02	0.012	0.014
Boron	mg/L	24	2.27	6.04	3.86	4.78
Cadmium	mg/L	24	0.0001	0.003	0.0010	0.0010
Cobalt	mg/L	24	0.001	0.01	0.010	0.010
Copper	mg/L	24	0.001	0.077	0.010	0.010
Iron	mg/L	24	0.01	0.52	0.50	0.52
Lithium	mg/L	24	0.100	0.300	0.181	0.201
Manganese	mg/L	24	0.001	0.023	0.010	0.010
Molybdenum	mg/L	24	0.001	0.019	0.014	0.015
Nickel	mg/L	24	0.001	0.01	0.010	0.010
Selenium	mg/L	24	0.01	0.1	0.10	0.10
Silica	mg/L	24	0.1	3.9	0.1	1.34
Titanium	mg/L	24	0.001	0.1	0.10	0.10
Vanadium	mg/L	24	0.01	0.1	0.10	0.10
Zinc	mg/L	24	0.05	0.06	0.05	0.05
Other parameters						
Oil and grease	mg/L	24	2	2	2	2

Table C-8-1 Underground water storages – water quality data (2014 to 2016)

Location	Date	pH	EC (µS/cm)	TDS (mg/L)	TSS (mg/L)	Turbidity (NTU)	Fe (filt) (mg/L)	Mn (filt) (mg/L)	Ba (filt) (mg/L)	B (filt) (mg/L)
2014 Data										
720 Dam	28/03/2014	7.77	48200	ND	ND	ND	<0.05	0.755	0.11	0.84
324 Dam	3/04/2014	7.54	37000	ND	ND	ND	<0.05	0.843	0.124	<0.05
325 Dam	3/04/2014	7.95	30700	ND	ND	ND	<0.05	0.022	0.164	<0.05
930 Dam	24/09/2014	8.07	19300	ND	6	ND	ND	ND	ND	ND
2015 Data										
324 Dam	18/12/2015	7.63	ND	ND	<5	18.1	<0.50	0.709	ND	ND
720 Dam	18/12/2015	7.82	ND	ND	13	2.7	<0.10	0.157	ND	ND
642 Dam	18/12/2015	8.06	ND	ND	90	33.9	<0.05	0.007	ND	ND
421 Dam	18/12/2015	7.96	ND	ND	88	55.7	<0.05	<0.001	ND	ND
2016 Data										
324 Dam	31/03/2016	7.73	ND	ND	<5	ND	<0.5	0.17	0.099	<0.5
720 Dam	5/04/2016	7.59	ND	ND	14	ND	<0.1	0.62	0.096	1.43
421 Dam	20/04/2016	8.14	ND	7190	17	ND	ND	0.008	0.279	0.17
642 Dam	22/04/2016	8.02	ND	22300	24	ND	<0.05	0.005	0.585	0.38
324 Dam	22/06/2016	7.5	ND	25120	5	ND	ND	ND	ND	ND
421 Dam	22/06/2016	8.2	ND	6770	19	ND	ND	ND	ND	ND
720 Dam	28/06/2016	8	ND	28000	14	ND	ND	ND	ND	ND
642 Dam	29/06/2016	8	ND	13970	15	ND	ND	ND	ND	ND
642 Dam	15/09/2016	7.9	ND	29840	ND	ND	ND	ND	ND	ND
421 Dam	15/09/2016	8.2	ND	6340	ND	ND	ND	ND	ND	ND
324 Dam	15/09/2016	7.8	ND	21680	ND	ND	ND	ND	ND	ND

Location	Date	pH	EC (µS/cm)	TDS (mg/L)	TSS (mg/L)	Turbidity (NTU)	Fe (filt) (mg/L)	Mn (filt) (mg/L)	Ba (filt) (mg/L)	B (filt) (mg/L)
720 Dam	15/09/2016	7.8	ND	30800	ND	ND	ND	ND	ND	ND
324 Dam	15/11/2016	7	ND	26300	ND	ND	ND	ND	ND	ND
720 Dam	17/11/2016	7.5	ND	35240	ND	ND	ND	ND	ND	ND
421 Dam	17/11/2016	7.9	ND	12880	ND	ND	ND	ND	ND	ND
642 Dam	17/11/2016	7.6	ND	32040	ND	ND	ND	ND	ND	ND

Notes:

720 Dam – underground storage dam within the Fassifern Seam / 324 Dam – underground storage dam within the Wallarah Seam

325 Dam – underground storage dam within the Wallarah Seam / 930 Dam – underground storage dam within the Fassifern Seam

642 Dam – underground storage dam within the Great Northern Seam / 421 Dam – underground storage dam within the Great Northern Seam

ND – no data

Table C-8-2 Underground water transfers – water quality data (2014 to 2016)

Location	Date	pH	EC (µS/cm)	TDS (mg/L)	TSS (mg/L)	Turbidity (NTU)	Fe (filt) (mg/L)	Mn (filt) (mg/L)	Ba (filt) (mg/L)	B (filt) (mg/L)
2014 Data										
Fassi	29/09/2014	7.34	49100	ND	9	15.2	1.85	0.549	0.104	0.84
GN	29/09/2014	7.56	39600	ND	6	23.9	0.53	0.095	0.218	0.65
Fassi	1/10/2014	7.53	49600	ND	8	32.4	2.35	0.677	0.106	1.28
Wallarah	1/10/2014	7.3	40400	ND	<5	16.6	0.46	1.21	0.144	0.54
GN	1/10/2014	7.68	40200	ND	<5	26.8	0.13	0.099	0.22	0.93
Fassi	2/10/2014	7.68	50000	ND	5	21.4	2.04	0.554	0.102	0.83
GN	2/10/2014	7.78	40400	ND	<5	0.9	<0.05	0.077	0.204	0.65
Fassi	3/10/2014	7.54	49000	ND	9	33	2.02	0.559	0.086	0.91
Wallarah	3/10/2014	7.34	40000	ND	7	16.2	<0.05	0.846	0.108	<0.05

Location	Date	pH	EC (µS/cm)	TDS (mg/L)	TSS (mg/L)	Turbidity (NTU)	Fe (filt) (mg/L)	Mn (filt) (mg/L)	Ba (filt) (mg/L)	B (filt) (mg/L)
GN	3/10/2014	7.73	45800	ND	8	9.6	<0.05	0.239	0.12	0.76
Fassi	8/10/2014	7.52	50300	ND	<5	23.8	3.04	0.692	0.098	1.24
Wallarah	8/10/2014	7.27	40900	ND	<5	15.2	0.34	0.905	0.116	0.49
GN	8/10/2014	7.64	40600	ND	<5	0.8	<0.05	0.077	0.198	0.88
2015 Data										
Fassi	16/12/2015	7.33	ND	ND	6	18.4	1.4	0.471	ND	ND
Wallarah	16/12/2015	6.79	ND	ND	<5	2.5	0.11	1.17	ND	ND
2016 Data										
Fassi	18/04/2016	7.7	ND	36300	<5	23.4	1.39	0.398	0.11	1.26
Wallarah	19/04/2016	6.82	ND	27500	<5	ND	<0.5	0.889	0.103	0.34
GN	19/04/2016	7.54	ND	26100	<5	ND	<0.5	0.056	0.186	0.71
Fassi	4/07/2016	7.4	ND	31140	19	ND	<0.05	0.421	0.136	1.35
GN	4/07/2016	8.1	ND	6430	5	ND	ND	0.005	0.269	0.18
Wallarah	5/07/2016	7	ND	25600	7	ND	ND	1.12	0.125	0.34
Wallarah	13/09/2016	6.7	ND	29340	12	19	ND	ND	ND	ND
Wallarah	17/11/2016	6.8	ND	26200	14	1.3	ND	ND	ND	ND
Fassi	24/11/2016	7.3	ND	30060	5	11	ND	ND	ND	ND
GN	25/11/2016	7.4	ND	25920	24	3.4	ND	ND	ND	ND

Notes:

Fassi – underground water transfer from the Fassifern Seam / Wallarah – underground water transfer from the Wallarah Seam

GN – underground water transfer from the Great Northern Seam / ND – no data

Appendix D – Time series water quality graphs for Licensed Discharge Point B

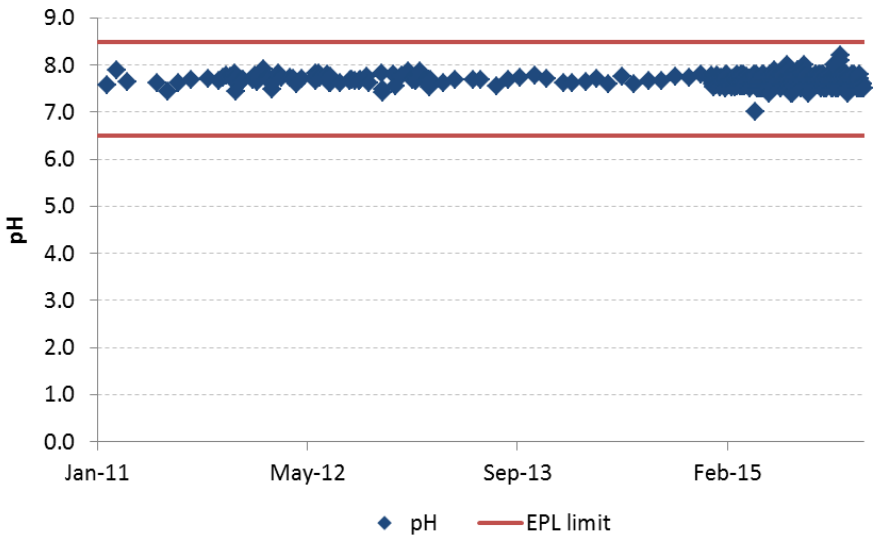


Figure D-1 pH recorded at monitoring site LDP B

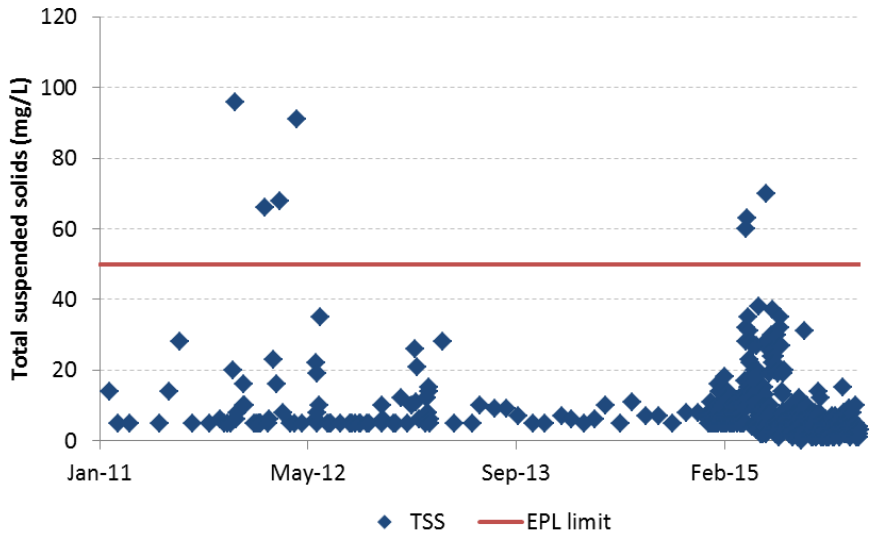


Figure D-2 Total suspended solids recorded at monitoring site LDP B

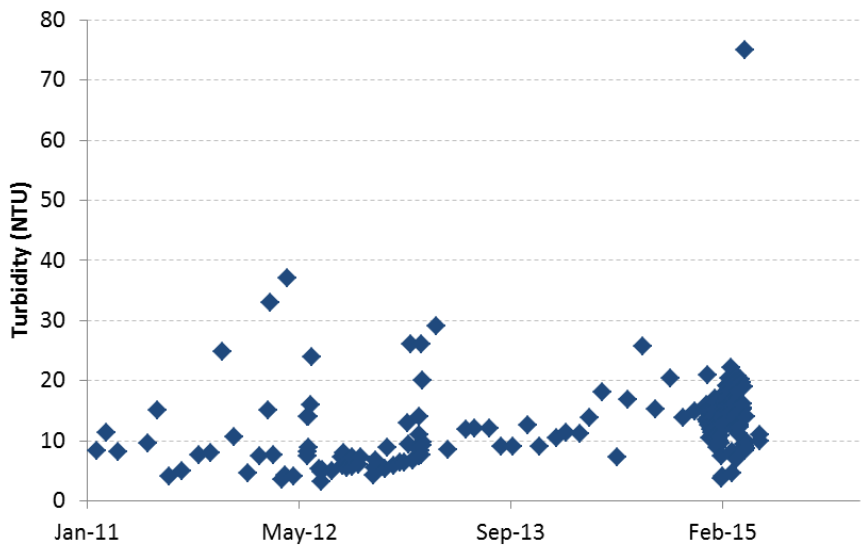


Figure D-3 Turbidity recorded at monitoring site LDP B

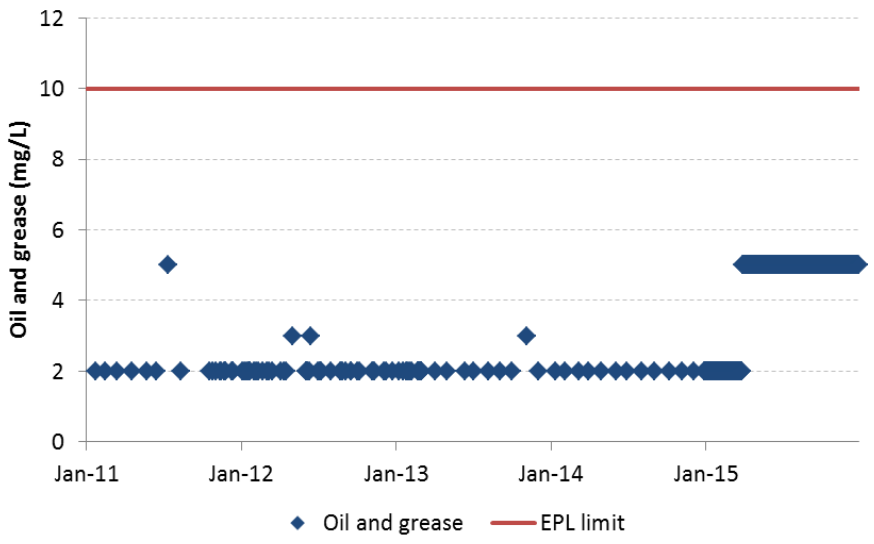


Figure D-4 Oil and grease recorded at monitoring site LDP B

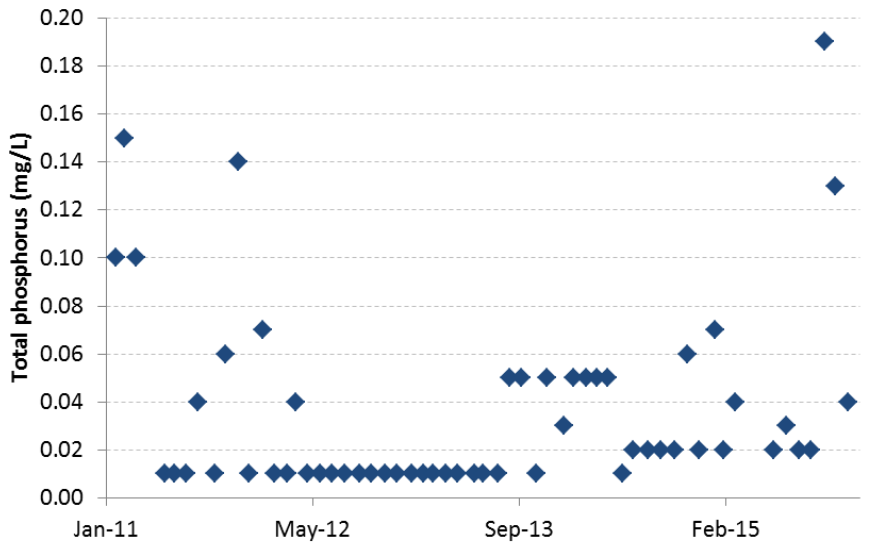


Figure D-5 Total phosphorus recorded at monitoring site LDP B

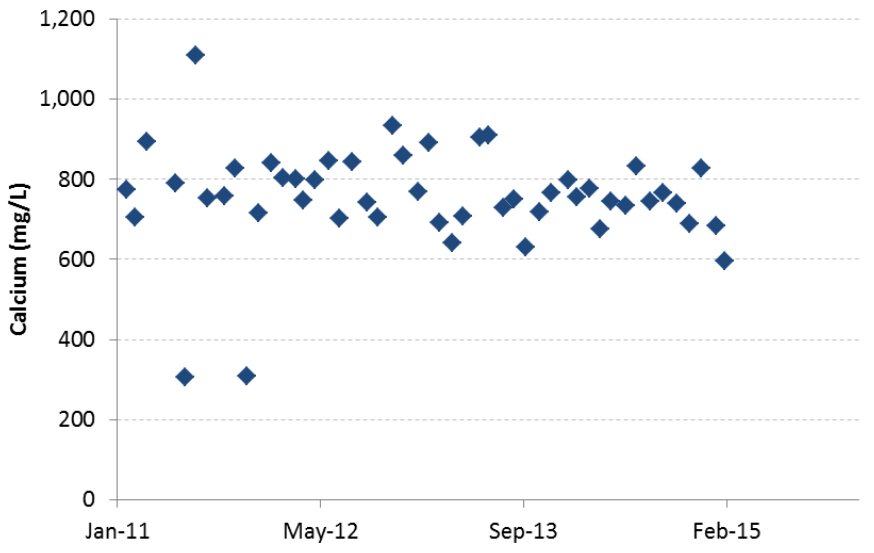


Figure D-6 Calcium recorded at monitoring site LDP B

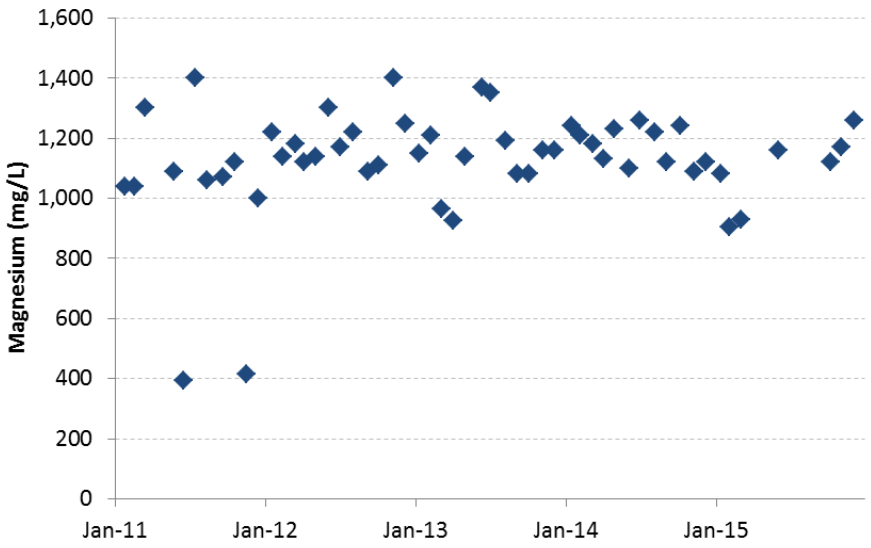


Figure D-7 Magnesium recorded at monitoring site LDP B

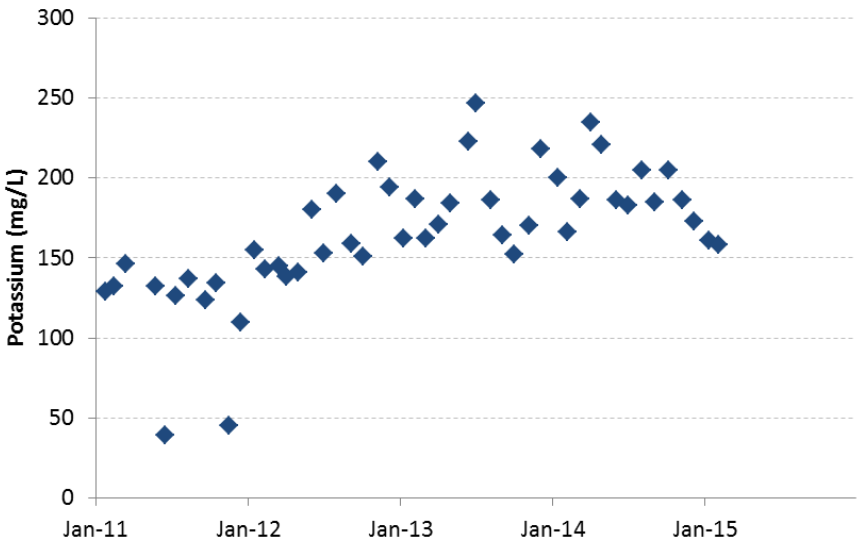


Figure D-8 Potassium recorded at monitoring site LDP B

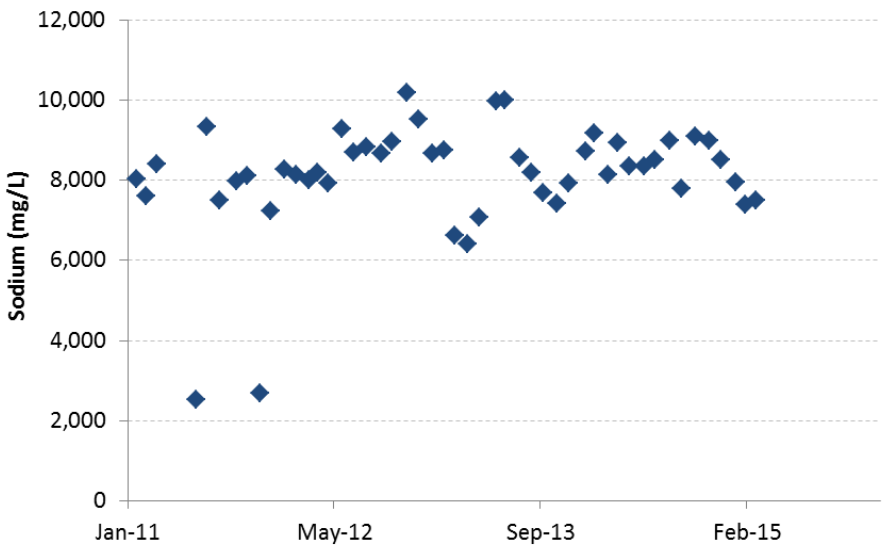


Figure D-9 Sodium recorded at monitoring site LDP B

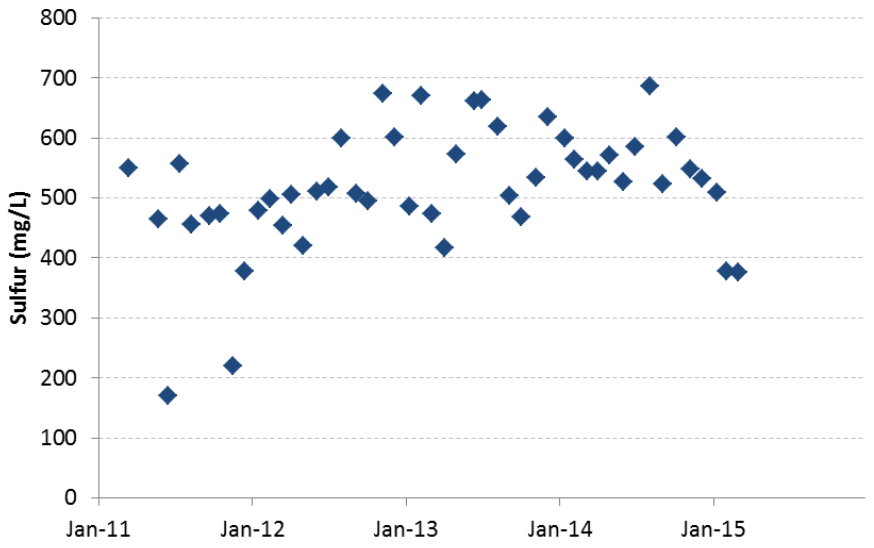


Figure D-10 Sulfur recorded at monitoring site LDP B

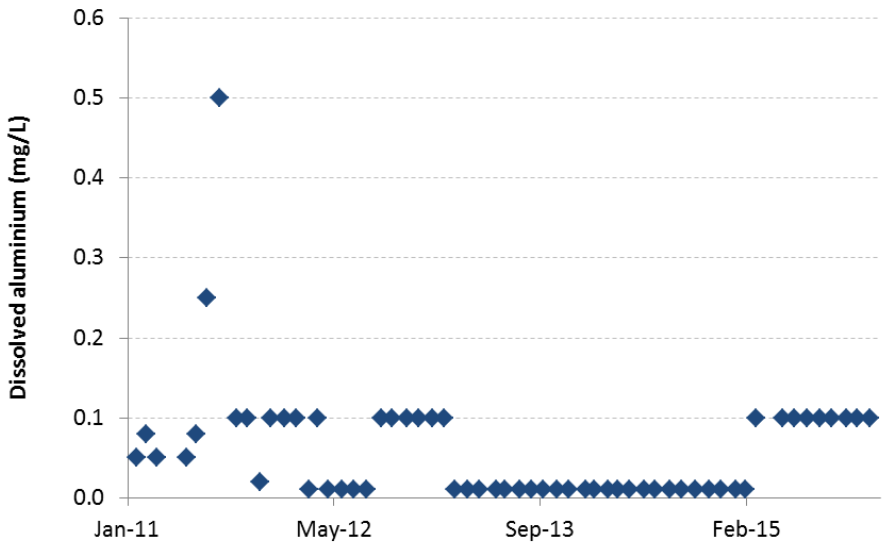


Figure D-11 Dissolved aluminium recorded at monitoring site LDP B

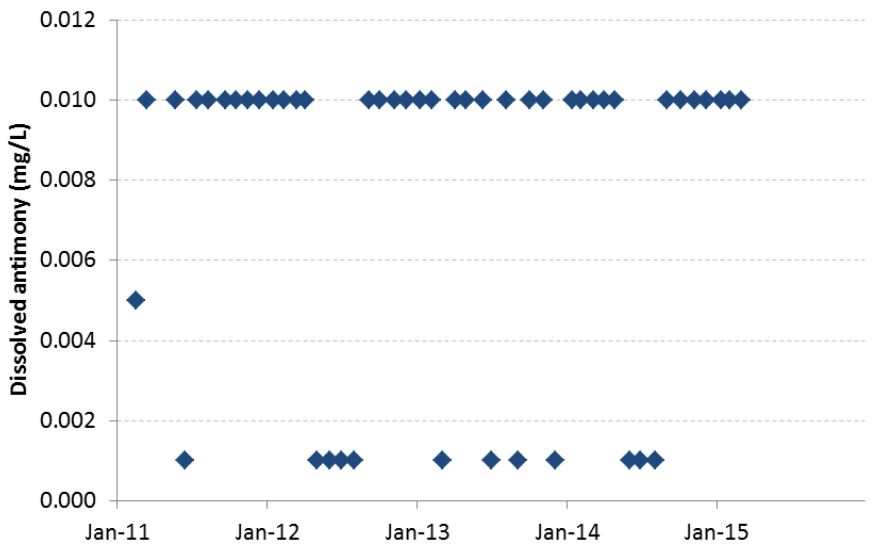


Figure D-12 Dissolved antimony recorded at monitoring site LDP B

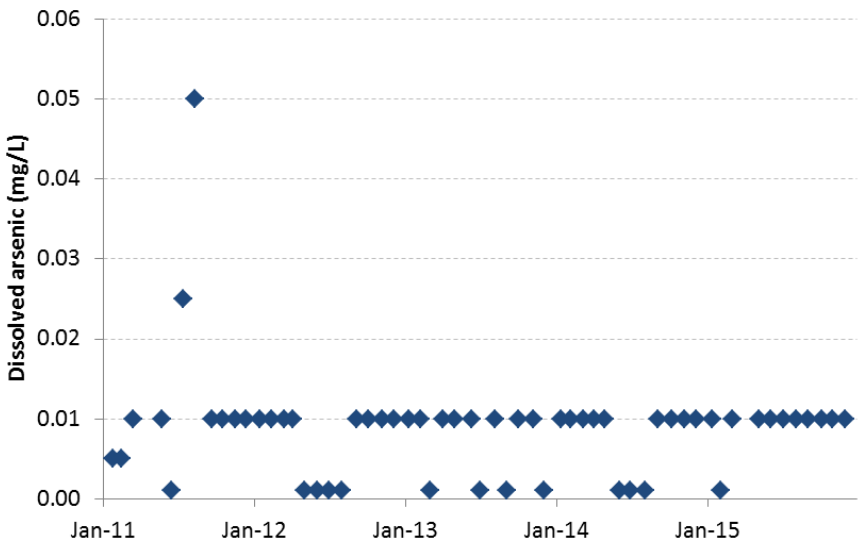


Figure D-13 Dissolved arsenic recorded at monitoring site LDP B

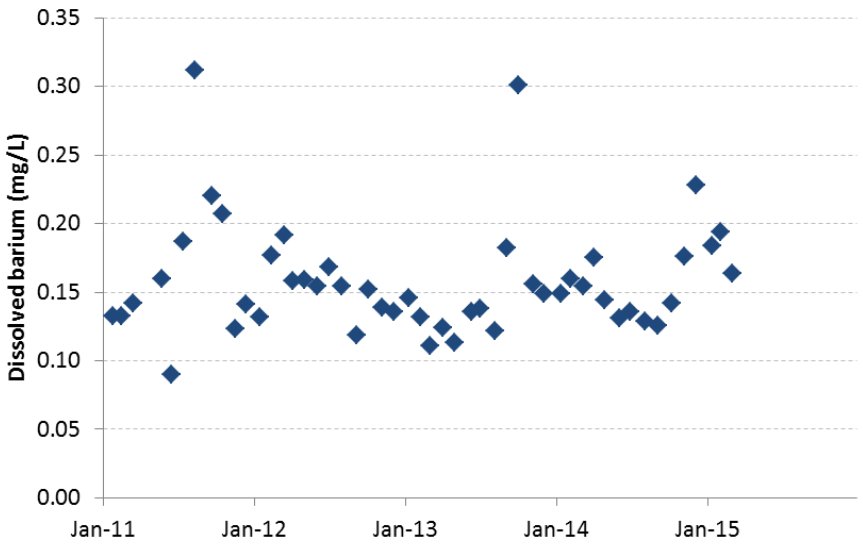


Figure D-14 Dissolved barium recorded at monitoring site LDP B

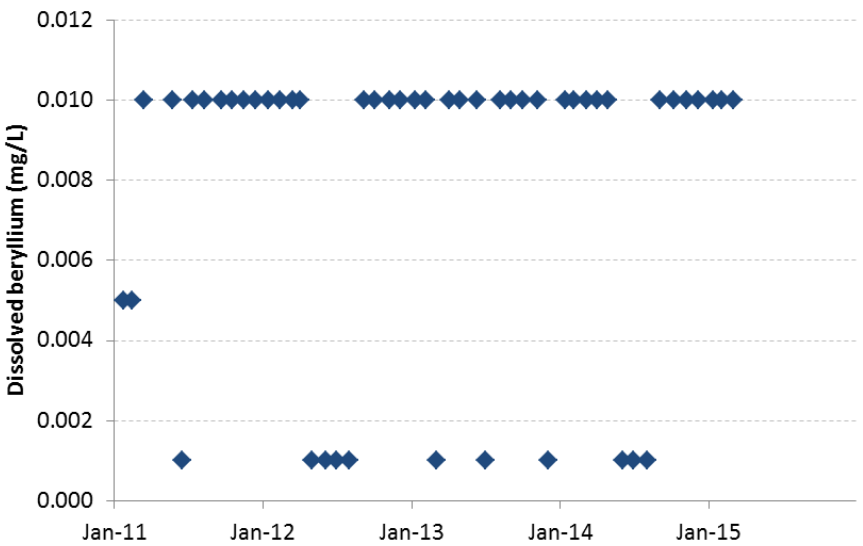


Figure D-15 Dissolved beryllium recorded at monitoring site LDP B

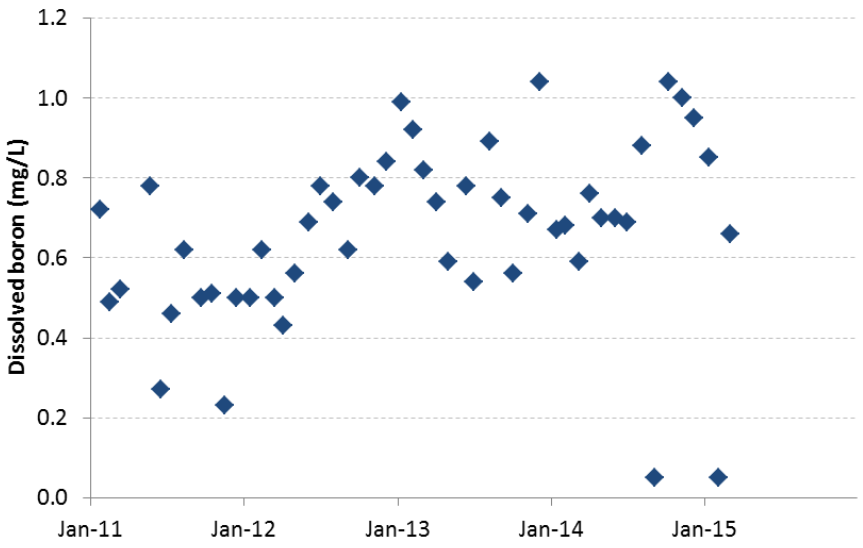


Figure D-16 Dissolved boron recorded at monitoring site LDP B

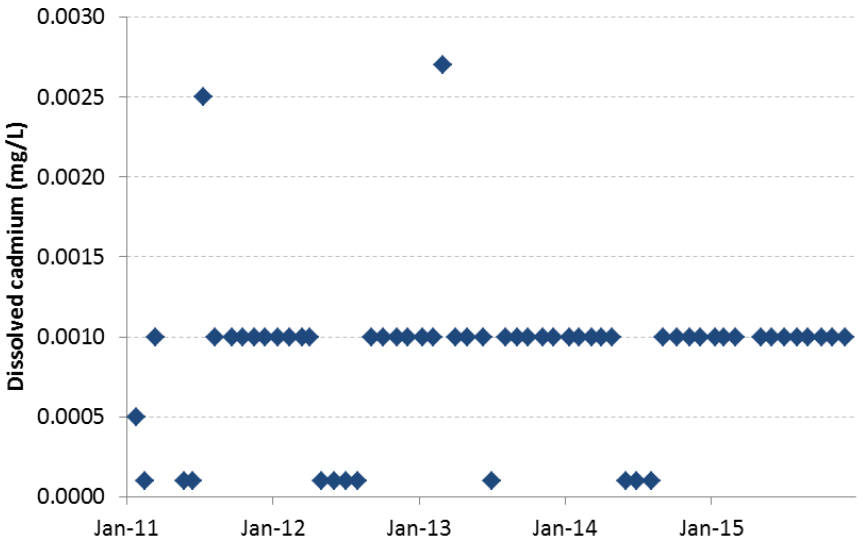


Figure D-17 Dissolved cadmium recorded at monitoring site LDP B

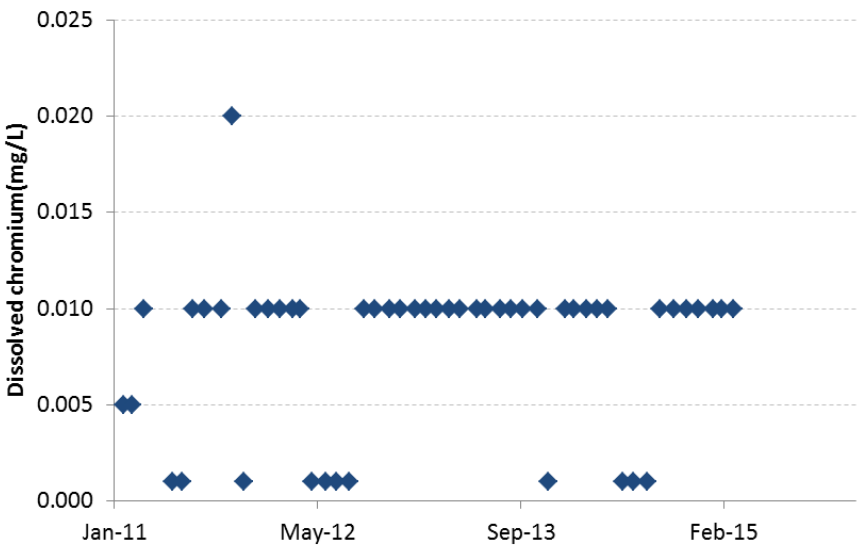


Figure D-18 Dissolved chromium recorded at monitoring site LDP B

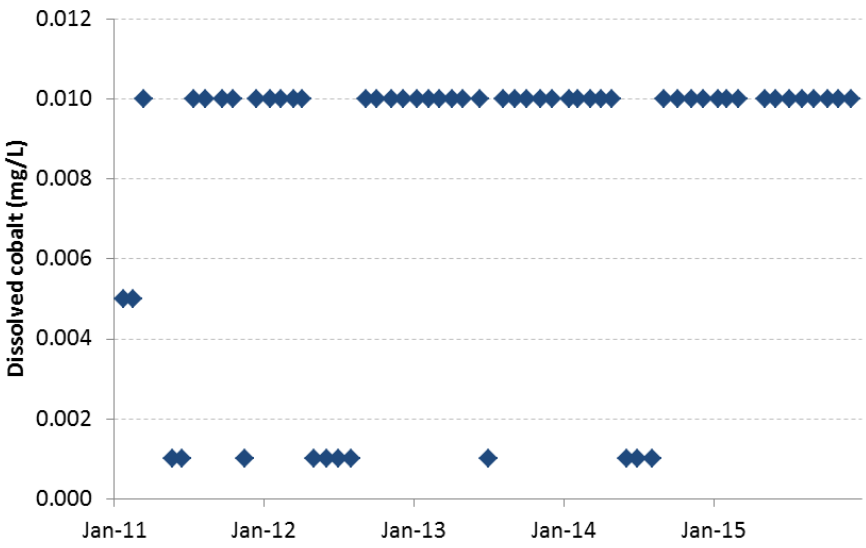


Figure D-19 Dissolved cobalt recorded at monitoring site LDP B

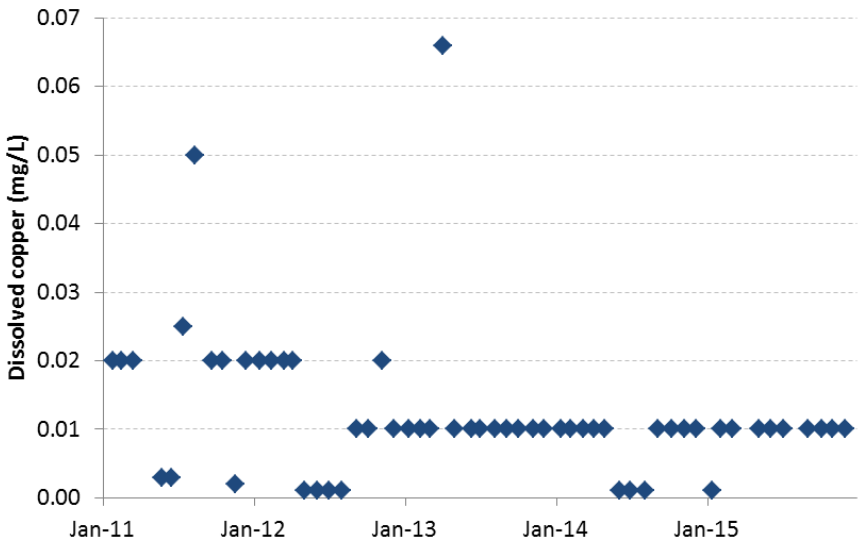


Figure D-20 Dissolved copper recorded at monitoring site LDP B

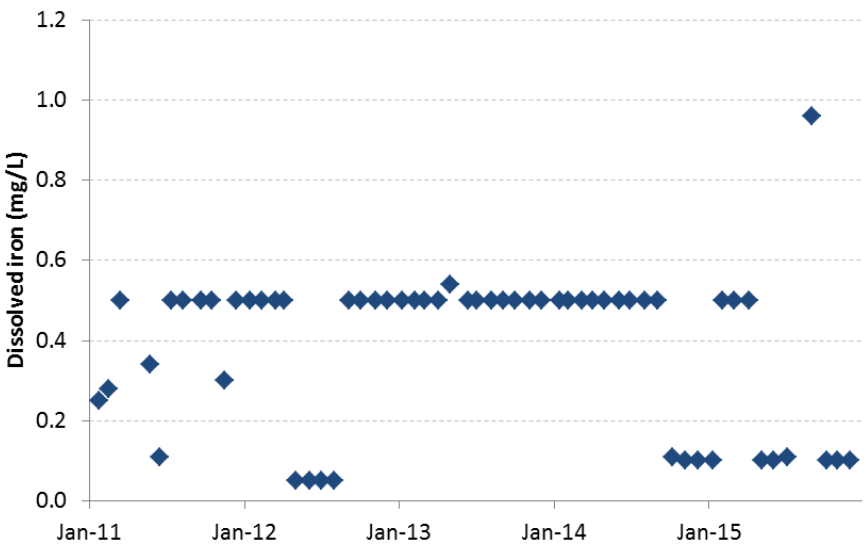


Figure D-21 Dissolved iron recorded at monitoring site LDP B

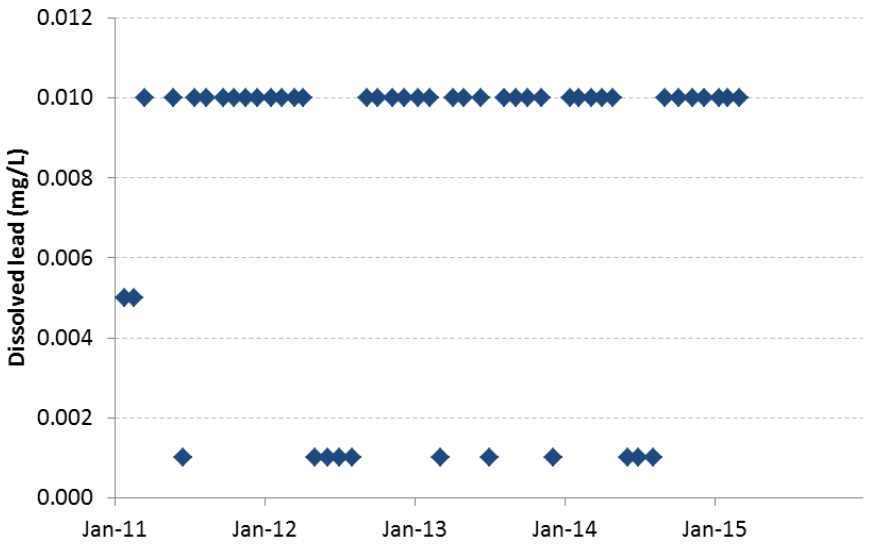


Figure D-22 Dissolved lead recorded at monitoring site LDP B

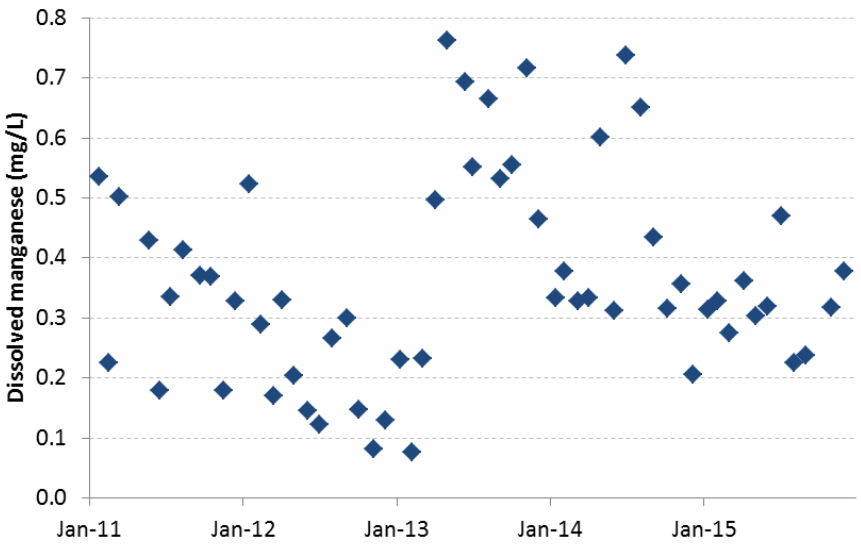


Figure D-23 Dissolved manganese recorded at monitoring site LDP B

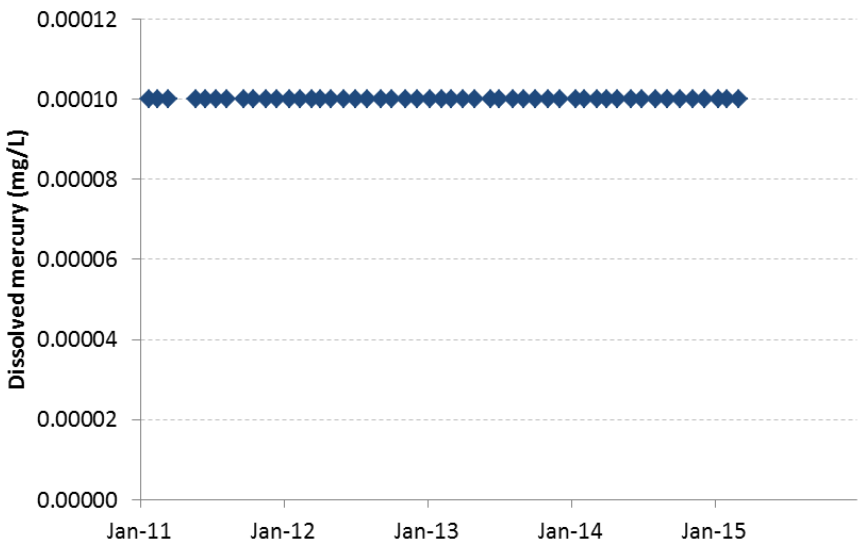


Figure D-24 Dissolved mercury recorded at monitoring site LDP B

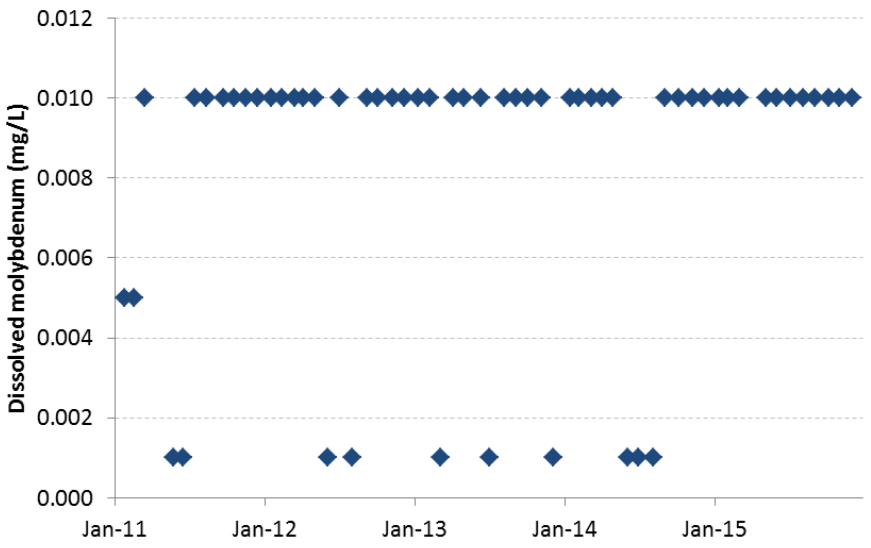


Figure D-25 Dissolved molybdenum recorded at monitoring site LDP B

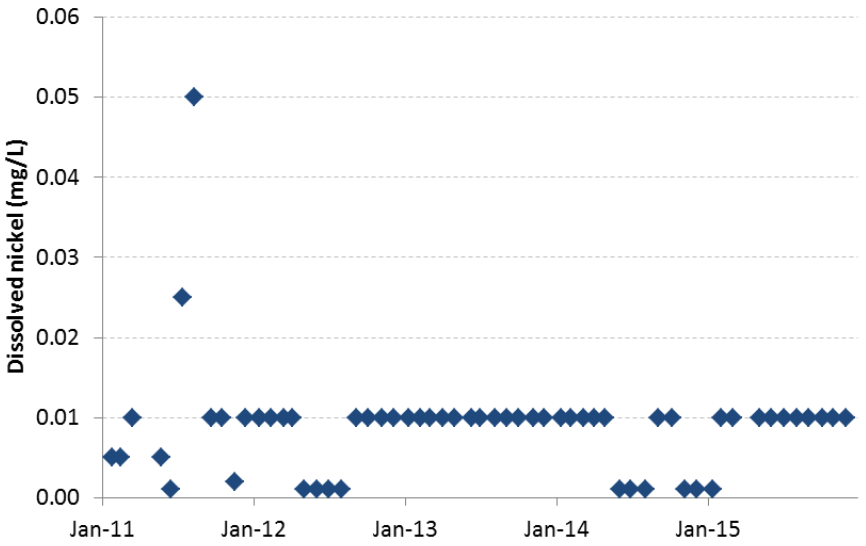


Figure D-26 Dissolved nickel recorded at monitoring site LDP B

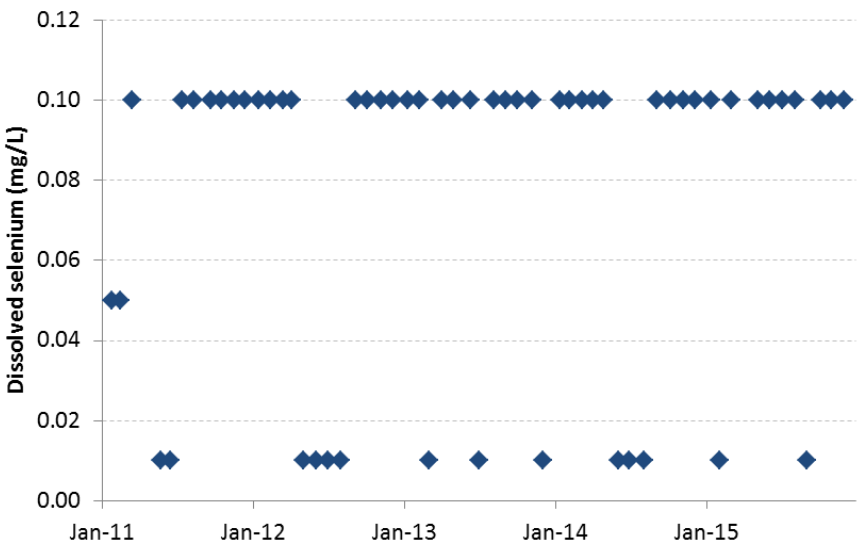


Figure D-27 Dissolved selenium recorded at monitoring site LDP B

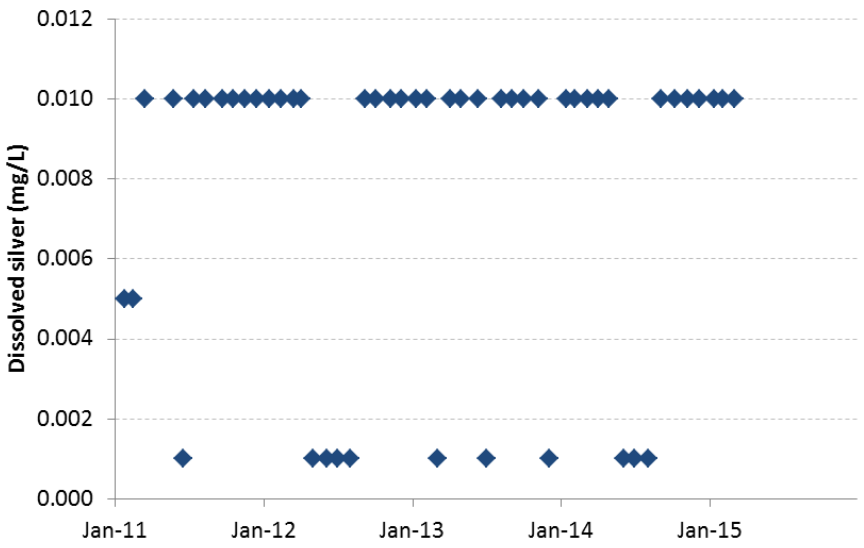


Figure D-28 Dissolved silver recorded at monitoring site LDP

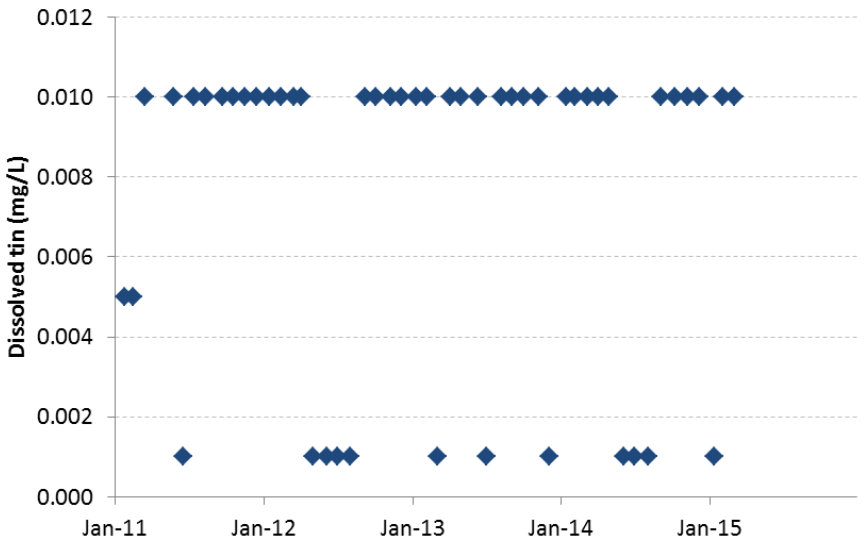


Figure D-29 Dissolved tin recorded at monitoring site LDP B

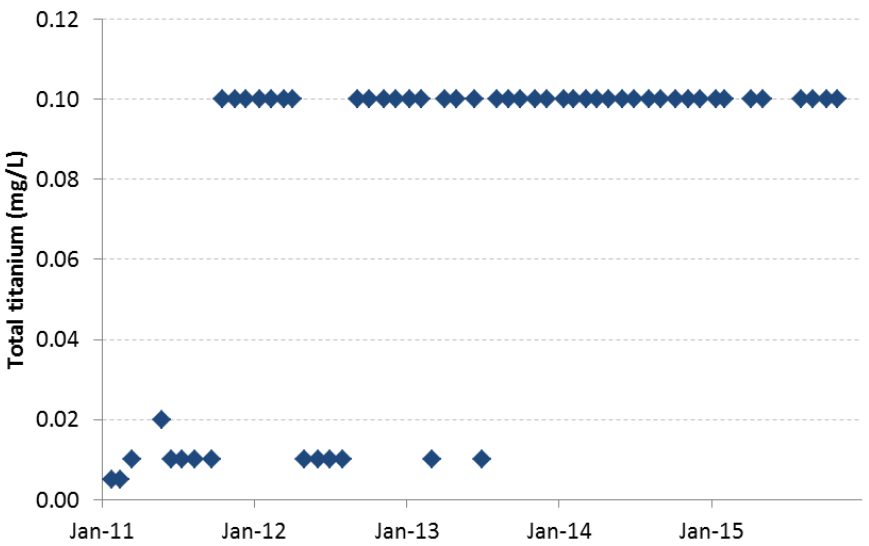


Figure D-30 Dissolved titanium recorded at monitoring site LDP B

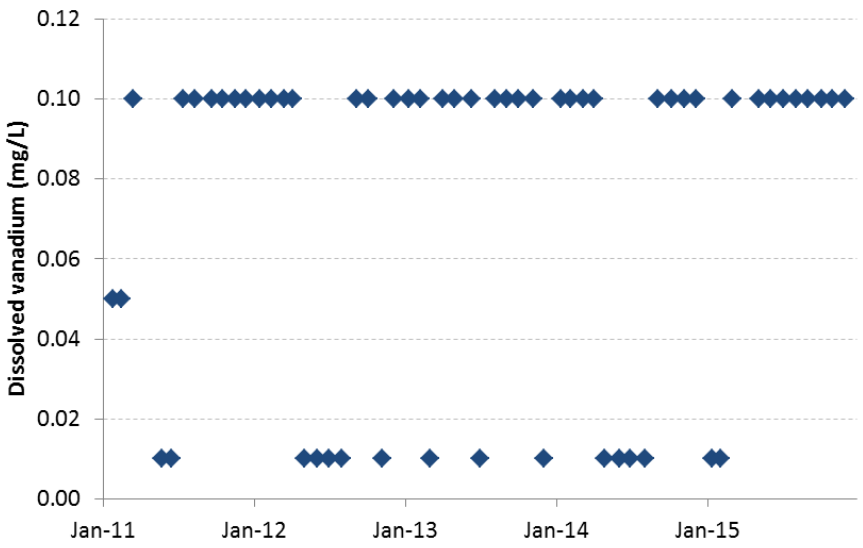


Figure D-31 Dissolved vanadium recorded at monitoring site LDP B

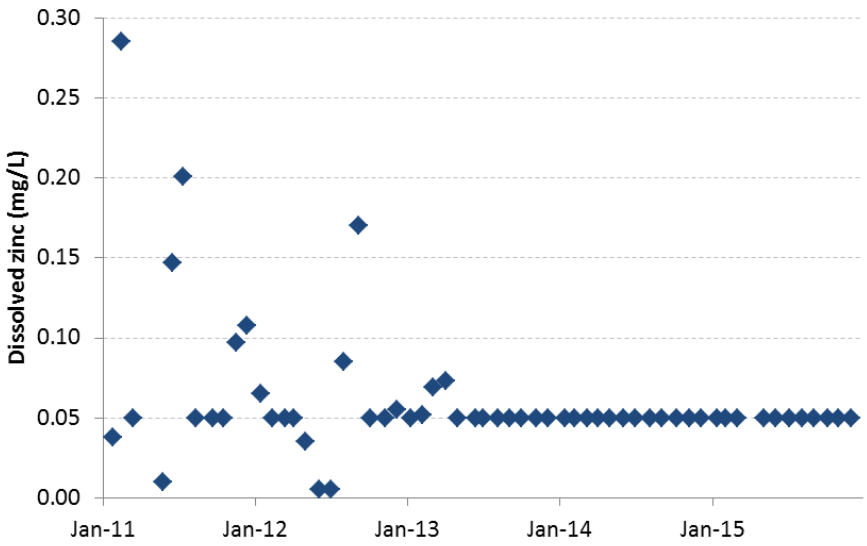
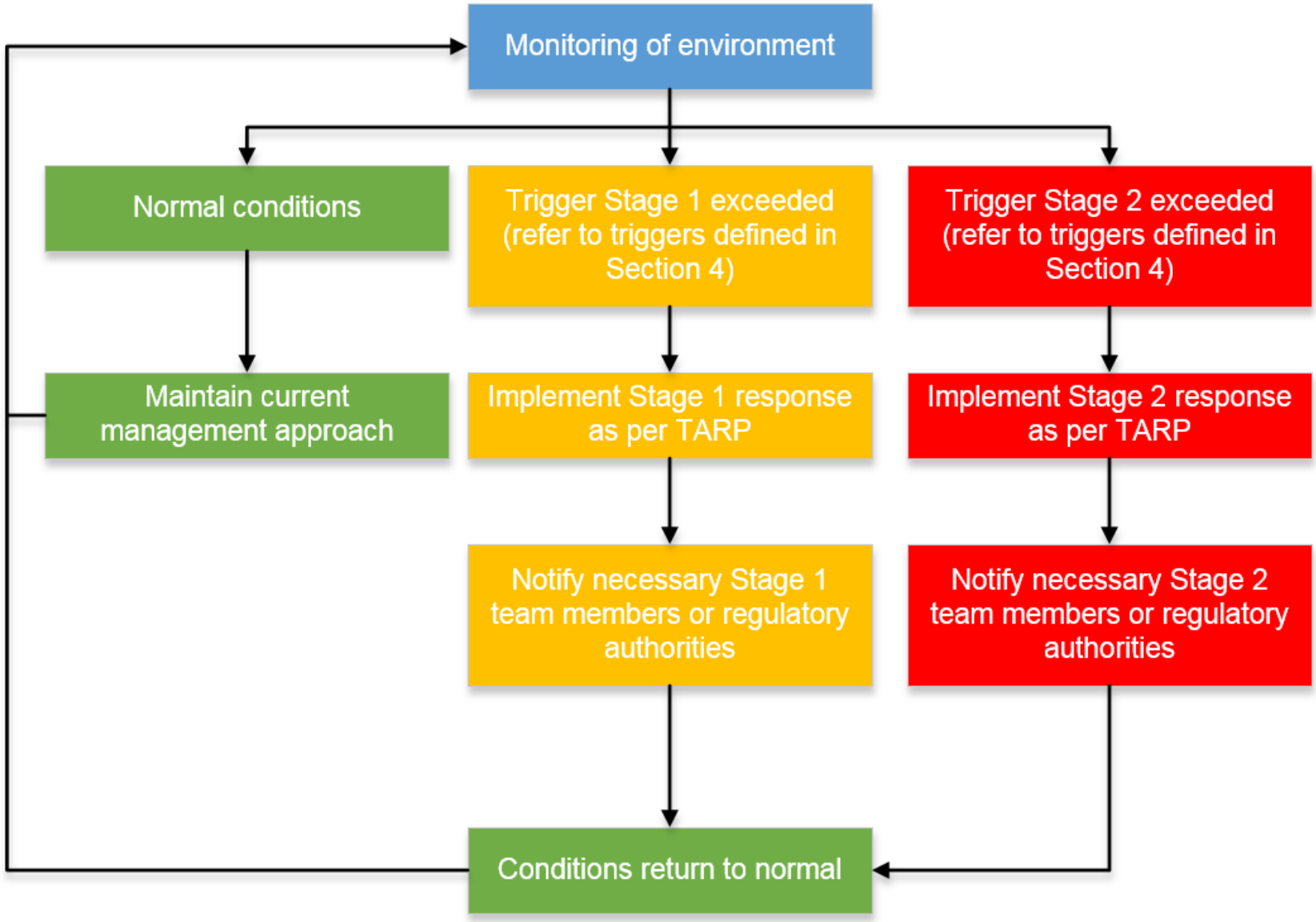


Figure D-32 Dissolved zinc recorded at monitoring site LDP B

Appendix E – Trigger action response plan


Monitoring of environment
Normal conditions
Trigger Stage 1 exceeded (refer to triggers defined in Section 4)
Trigger Stage 2 exceeded (refer to triggers defined in Section 4)
Maintain current management approach
Implement Stage 1 response as per TARP
Implement Stage 2 response as per TARP
Notify necessary Stage 1 team members or regulatory authorities
Notify necessary Stage 2 team members or regulatory authorities
Conditions return to normal

Surface site operation TARP

Aspect	Normal	Stage 1	Stage 2	Notifications
Surface water storage volume	Storage captures events up to and including the design criteria.	Storage is not dewatered appropriately following storm event in accordance with design event. **Action: Investigate storage operation and dewatering options.** **Increase inspection frequency as required.** **Education for staff.**	Storage is discharging as a result of a storm event less than design criteria. **Action: Investigate design criteria.** **Review catchment plan.** **Undertake water quality sampling of discharge and add flocculant if necessary**.	**Trigger 1: Notify Environment and Community Coordinator/Mine Manager immediately.** **Trigger 2: Notify relevant agencies in accordance with PIRMP requirements or if material harm has occurred.**
Dewatering pump operation	Dewatering pump operates within the pump specification.	Power outage. **Action: Utilise back up power source or diesel pump if available.** **Investigate alternate power sources or diesel pumps.**	Pump does not operate due to mechanical failure or pump rate not sufficient to meet demands. **Action: Prepare downstream storages to receive overflows.** **Undertake water quality sampling of discharge and add flocculant if necessary.**	**Trigger 1: Notify Environment and Community Coordinator/Mine Manager immediately.** **Trigger 2: Notify relevant agencies in accordance with PIRMP requirements or if material harm has occurred.** **Notify DP&E if exceedance of limit occurs.**

Aspect	Normal	Stage 1	Stage 2	Notifications
Clean water diversions	Clean water diverted around dirty water areas.	Clean water bypass through dirty water areas: **Action: Review catchment plan.** **Review design capacity of clean water system.** **Appropriately treat and manage dirty water.** **Facilitate works to resolve clean water flow diversion failure.**	Clean water creates flooding problems through site. **Action: Evacuate site if danger exists.** **Establish temporary bunding around clean water source.** **Utilise earthworks machinery to cut appropriate channel to manage clean water.** **Protect equipment and infrastructure.** **Utilise portable pumps to dewater flooded areas into sediment basins.**	**Trigger 1: Notify Environment and Community Coordinator/Mine Manager immediately.** **Trigger 2: Notify relevant agencies in accordance with PIRMP requirements or if material harm has occurred.** **Notify DP&E if exceedance of limit occurs.**
Erosion and sediment control	All controls are appropriately in place and well maintained. No unstable disturbance areas or migration of sediment away from designated development areas.	One or more areas of surface erosion in the form of rilling, bank erosion or other movement of sediment from an area of disturbance. Controls are not maintained or are inappropriately installed. **Action: Seek to stabilise the area to stop the erosion process. This can include the use of groundcover or other temporary measures.** **Investigate works undertaken prior to the disturbance activities.**	Controls are not in place. Rainfall event has led to sediment migrating off site. **Action: Isolate the area through diverting contributing surface flows to another appropriate control structure.**	**Trigger 1: Notify Environment and Community Coordinator/Mine Manager immediately.** **Trigger 2: Notify relevant agencies in accordance with PIRMP requirements or if material harm has occurred.** **Notify DP&E if exceedance of limit occurs.**

Aspect	Normal	Stage 1	Stage 2	Notifications
Hydrocarbon management	No spills on site. All hydrocarbon supplies are stored appropriately.	Minor spill occurs on site with limited risk of off site migration. **Action: Implement procedures in the PIRMP.** **Utilise spill kit.**	Major spill occurs on site with risk of off site migration. **Action: Isolate area and divert contributing surface flows.** **Engage waste contractor to clean up spill.** **Investigate potential for contamination of waterways.**	**Trigger 1: Notify Environment and Community Coordinator/Mine Manager immediately.** **Trigger 2: Notify relevant agencies in accordance with PIRMP requirements or if material harm has occurred.** **Notify DP&E if exceedance of limit occurs.**

Watercourse TARP

Aspect	Normal	Stage 1	Stage 2	Notifications
Water quality	Water quality at monitoring locations consistent with historical baseline or are below SSTVs provided in Table 6-1.	Water quality is outside or above SSTVs downstream of operations for at least one parameter and one round. **Action: Review recent monitoring results and any relevant operational data (e.g. mining activities, meteorological data).** **Investigate the source of the exceedance.** **Develop and implement corrective/preventative actions based on the outcomes of the investigation.**	Water quality is outside or above SSGVs downstream of operations for at least two parameters and more than one round. **Action: Investigate the source of the exceedance and determine if an incident has potentially occurred.** **Increase monitoring frequency and undertake additional monitoring where relevant.** **Develop and implement corrective/preventative actions based on the outcomes of the investigation and additional monitoring.**	**Trigger 1: Notify Environment and Community Coordinator/Mine Manager immediately.** **Trigger 2: Notify DP&E and DPI-Water as soon as practicable.**

Groundwater environment TARP

Aspect	Normal	Stage 1	Stage 2	Notifications
Groundwater level - alluvial aquifer	Continue monitoring until sufficient data is obtained to undertake a statistical review. No complaints from adjacent bore owners regarding groundwater quality.	Complaint from an adjacent bore owner regarding declining groundwater quality. **Action: Review recent monitoring results and any relevant operational data (e.g. mining activities, meteorological data).** **Undertake investigation to determine if the change in groundwater level is due to mining related activity.**	Investigation into Stage 1 Trigger identifies that change in groundwater quality is due to mining related activity. **Action: Loss of water supply from an adjacent landholder will need to be replaced by Centennial Myuna. If environmental impacts are unacceptable, remediation options will be considered.**	**Trigger 1: Notify Environment and Community Coordinator/Mine Manager immediately.** **Trigger 2: Notify DP&E, DPI-Water and any potentially affected landowners as soon as practicable.**
Groundwater quality	No complaints from adjacent bore owners regarding groundwater quality. No statistically significant change in groundwater quality.	Complaint from an adjacent bore owner regarding declining groundwater quality. Annual review of data identifies a statistically significant change in groundwater quality. **Action: Review recent monitoring results and any relevant operational data (e.g. mining activities, meteorological data).** **Undertake investigation to determine if the change in groundwater quality is due to mining related activity.**	Investigation into Stage 1 Trigger identifies that change in groundwater quality is due to mining related activity. **Action: Loss of water supply from an adjacent landholder will need to be replaced by Centennial Myuna. If environmental impacts are unacceptable, remediation options will be considered.**	**Trigger 1: Notify Environment and Community Coordinator/Mine Manager immediately.** **Trigger 2: Notify DP&E, DPI-Water and any potentially affected landowners as soon as practicable.**

Discharge management TARP

Aspect	Normal	Stage 1	Stage 2	Notifications
Discharge quality from LDP	Discharge quality is within limits defined by EPL.	Water quality parameters exceed discharge SSTVs. **Action: Undertake investigation.** **Repeat sampling.** **Reduction in pumping from underground storage if appropriate.**	Water quality parameters exceed discharge limits. **Action: Consider reconfiguration of pit top surface water management infrastructure.** **Reduction in pumping from underground storage if appropriate.**	**Trigger 1: Notify Environment and Community Coordinator/Mine Manager immediately.** **Trigger 2: Notify relevant agencies in accordance with PIRMP requirements or if material harm has occurred.** **Notify DP&E if exceedance of limit occurs.**
Discharge volume from LDP	Discharge volume is within limits defined by EPL.	Discharge volume exceeds limit for no more than one day. **Action: Undertake investigation.** **Review monitoring equipment on discharge volume.**	Discharge volume exceeds limit for more than one day. **Action: Undertake review of water management on site.** **Review on site transfers.**	**Trigger 1: Notify Environment and Community Coordinator/Mine Manager immediately.** **Trigger 2: Notify relevant agencies in accordance with PIRMP requirements or if material harm has occurred.** **Notify DP&E if exceedance of limit occurs.**
Emergency discharges	No discharge from emergency locations.	Discharge from a non-EPL defined, emergency discharge location. **Action: Undertake investigation.** **Increase monitoring frequency downstream and undertake additional monitoring as required.**	Continued discharge from a non-EPL defined, emergency discharge location. **Action: Take photographs.** **Undertake investigation.** **Increase monitoring frequency downstream and undertake additional monitoring as required.**	**Trigger 1: Notify Environment and Community Coordinator/Mine Manager immediately.** **Trigger 2: Notify relevant agencies in accordance with PIRMP requirements or if material harm has occurred.** **Notify DP&E if exceedance of limit occurs.**

Stream health TARP

Aspect	Normal	Stage 1	Stage 2	Notifications
Watercourse instabilities	Watercourse monitoring indicates no areas of instabilities from visual inspections.	Watercourse monitoring indicates one or more areas of minor instabilities in watercourses. **Action: Review historical monitoring records.** **Investigate the factors contributing to the instability, which may include advice from technical specialists.** **Implement corrective actions as required as soon as practicable to stabilise the surface and/or watercourses based on the outcomes of the investigation.** **Increase monitoring frequency and undertake additional monitoring where relevant.**	Watercourse monitoring indicates one or more areas of major instabilities in watercourses, causing sediment loads to migrate and or impact to riparian vegetation. **Action: Immediately isolate areas of instability and implement remediation measures to stabilise surface and/or watercourse.** **Investigate the factors contributing to the instability, which may include advice from technical specialists.** **Implement corrective/preventative actions based on the outcomes of the investigation and/or additional monitoring. Prioritise actions based on the risk to the environment and likelihood of further impact.** **Increase monitoring frequency and undertake additional monitoring where relevant.**	**Trigger 1: Notify Environment and Community Coordinator/ Mine Manager immediately.** **Trigger 2: Notify DP&E and DPI-Water as soon as practicable.**

Aspect	Normal	Stage 1	Stage 2	Notifications
Riparian vegetation	No significant change in vegetation quality or extent compared with previous monitoring results.	Visual inspections show change in extent and density of vegetation not specific to season. Introduction of increase number of exotic species. **Action: Review activities likely to influence vegetation.** **Review flow data or rainfall events.**	Visual inspections show significant change in extent and density of instream vegetation as a result of clearing or impact. **Action: Increase monitoring frequency and undertake additional monitoring where relevant.** **Undertake water quality monitoring to determine potential impact on in-situ conditions.** **Stabilise creek banks as necessary.**	**Trigger 1: Notify Environment and Community Coordinator/ Mine Manager immediately.** **Trigger 2: Notify DP&E and DPI-Water as soon as practicable.**

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The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section(s) 1 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

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