Appendix 11

Surface Water Assessment

SURFACE WATER ASSESSEMENT

Northparkes Mines Step Change Project

July 2013

SURFACE WATER ASSESSEMENT

Northparkes Mines Step Change Project

July 2013

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
North Mining Limited

Project Director:	**Barbara Crossley**
Project Manager:	**Tim Crosdale**
Report No.	**2949/R11/FINAL**
Date:	**July 2013**

Newcastle

PO Box 3024
75 York Street
Teralba NSW 2284

Ph. 02 4950 5322

www.umwelt.com.au

Executive Summary

Northparkes Mines (NPM) is an existing copper-gold mine located approximately 27 kilometres north-west of Parkes in the central west region of New South Wales (NSW). NPM has been operational since 1993 and has included the development of open cut and underground mining operations targeting a number of ore bodies, as well as associated ore processing and tailings storage infrastructure. The existing operations have been developed in accordance with a number of development consents and project approvals, the most recent of which being PA06_0026 (as modified), which provides for continued mining operations through to 2025.

NPM are seeking approval for the Step Change Project (the Project) which encompasses the continuation of underground block cave mining in two existing ore bodies, the development of underground block cave mining in the E22 resource, additional campaign open cut mining located in existing mining leases and an extended mine life of seven years until 2032.

This Surface Water Assessment Report has been prepared by Umwelt (Australia) Pty Limited (Umwelt) to support an Environmental Assessment (EA) for the Project required under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The Project Area is located within the headwaters of the Macquarie-Bogan River catchment, which forms part of the Murray-Darling Basin System. The Project Area is located within three subcatchments of the Macquarie-Bogan River Catchment, i.e. Tenandra Creek, Goonumbla Creek and Cookopie Creek.

The NPM Water Management System aims to economically and efficiently collect and store water on site to minimise the need for external water supply inputs and supplement external water supply. The water management strategy includes the separation of clean, dirty and contaminated water, preventing the contamination of clean water by mining activities and ensuring compliance with NPM statutory obligations.

The Project includes changes to the size and shape of the approved tailings storage facility (TSF3), extension of the approved waste rock stockpile to the east of E26 and an additional waste rock stock pile to the west, and five open cut mining areas (one within the subsidence zone associated with E26).

The existing WMS at NPM will continue to be implemented to control and treat runoff from the site, with all pit water and mine surface runoff directed to the mine water management system. Additional controls will be designed to supplement existing controls measures and will be integrated into the existing surface water management control measures at NPM. As a result NPM are unlikely to have a significant impact of the existing water qualities of the surrounding environment, and will therefore be consistent with the river flow objectives and receiving water quality objectives.

NPM will continue to have a net water deficit with the Project in the order of up to 4050 Mega Litres (ML) per year. The predicted annual water demands for NPM will remain consistent with the currently approved water demands with a predicted increase in on site water supply volumes is equivalent to approximately 6 per cent of the annual site water demand of 6290 ML. NPM will continue to manage water deficits through external water sources in accordance with existing licences and approvals.

All of the existing and proposed mining activities and associated infrastructure, including WMS components, are located outside of the 100 year ARI flood extent. To manage potential flood risk associated with the proposed waste rock stockpiles located adjacent to Goonumbla Creek NPM proposes to include a 1 metre high bank at the toe of the proposed waste rock stockpiles which will incorporate the proposed catch drain. Impacts on flood regimes are therefore considered to be unlikely as a result of the Project compared to the currently approved development.

The Project will result in a reduction in the natural catchment area of the Bogan River at Bogan Weir of approximately 0.2 per cent. It is therefore considered that the Project is unlikely to result in significant changes in annual flow volumes within the Bogan River system. In addition, the potential for impacts on baseflows within the Bogan River system (and surrounding area) with the proposed Project is considered to be negligible.

There are no known licensed water users within Cookapie Creek downstream of NPM that will be effected by the small reduction in catchment area. Impacts are therefore limited to basic landholder rights to harvest surface water. In addition, no farm dams have been identified offline (i.e. outside of drainage lines) within the flow shadow area (i.e. downslope) of the existing, approved or proposed tailings storage facilities. As a result, no changes to inflows into private offline farm dams are expected as a result of the proposed changes to the tailings storage facilities.

NPM will continue the current surface water monitoring program with all new proposed water management structures to be included in the current monitoring programs.

NPM plans to maintain their existing surface water and groundwater licences and do not propose to increase licence limits.

TABLE OF CONTENTS

FIGURES

1.0 Introduction

Northparkes Mines (NPM) is an existing copper-gold mine located approximately 27 kilometres north-west of Parkes (refer to **Figure 1.1**) in the central west region of New South Wales (NSW). NPM has been operational since 1993 and has included the development of open cut and underground mining operations targeting a number of ore bodies, as well as associated ore processing and tailings storage infrastructure. The existing operations have been developed in accordance with a number of development consents and project approvals, the most recent of which being PA06_0026 (as modified), which provides for continued mining operations through to 2025.

NPM are seeking approval for the Step Change Project (the Project) which encompasses the continuation of underground block cave mining in two existing ore bodies, the development of underground block cave mining in the E22 resource, additional campaign open cut mining located in existing mining leases and an extended mine life of seven years until 2032.

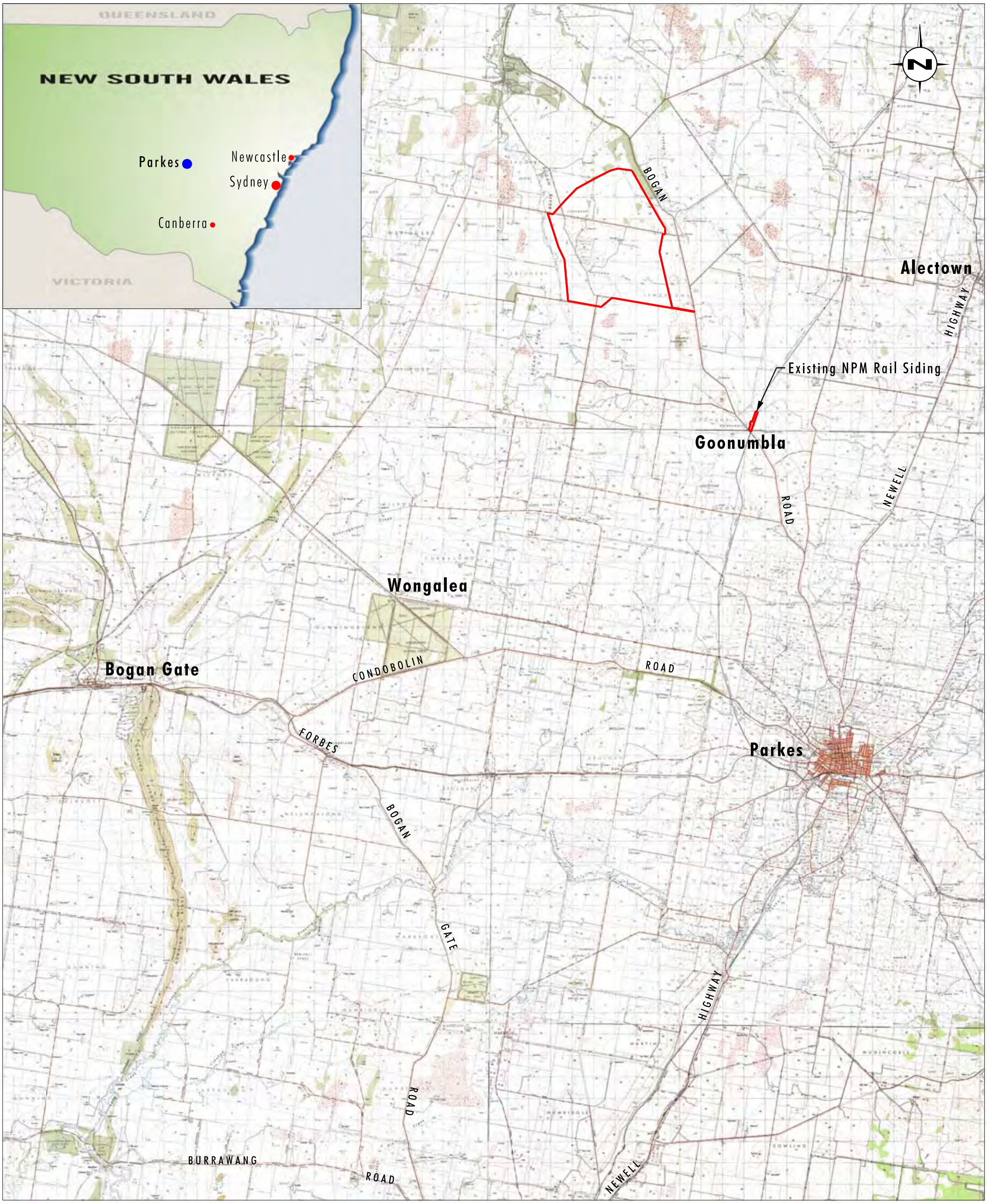
This Surface Water Assessment Report has been prepared by Umwelt (Australia) Pty Limited (Umwelt) to support an Environmental Assessment (EA) for the Project required under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

This assessment has been undertaken in consideration of the Department of Planning and Infrastructure (DP&I) Director-General's Environmental Assessment Requirements (DGRs) for the Project (refer to **Section 2.0**).

1.1. The Project

The Project Area is shown in **Figure 1.2** and consists of existing and proposed mining operations and associated infrastructure. **Figure 1.2** shows the major components of the Project which include:

- continuation of approved underground block cave mining in the E48 and E26 ore bodies, and associated underground infrastructure;
- development of underground block caving in the E22 resource beneath the E22 open cut void;
- campaign open cut mining through development of five open cut resources including:
  - development of four small open cut pits E31, E31N, E28, E28N;
  - proposed E26 open cut which is located in an area of previous underground block cave subsidence (existing vertical extent of subsidence void is approximately 200 metres);
- amendments to the configuration of tailings storage facilities (TSFs) including:
  - continuation of tailings disposal to the existing and approved TSFs (TSF 1 and 2, infill between TSF 1 and 2, and Estcourt) to an approved height of 28 metres;
  - provision for additional raises on Estcourt TSF to provide for an increased height from the approved 25 metres to up to approximately 28 metres above ground surface;
  - development of a new TSF 3, which will extend to the south and from the southern embankment of TSF 2 to a height of approximately 28 metres above ground surface, which incorporates the approved Rosedale TSF;

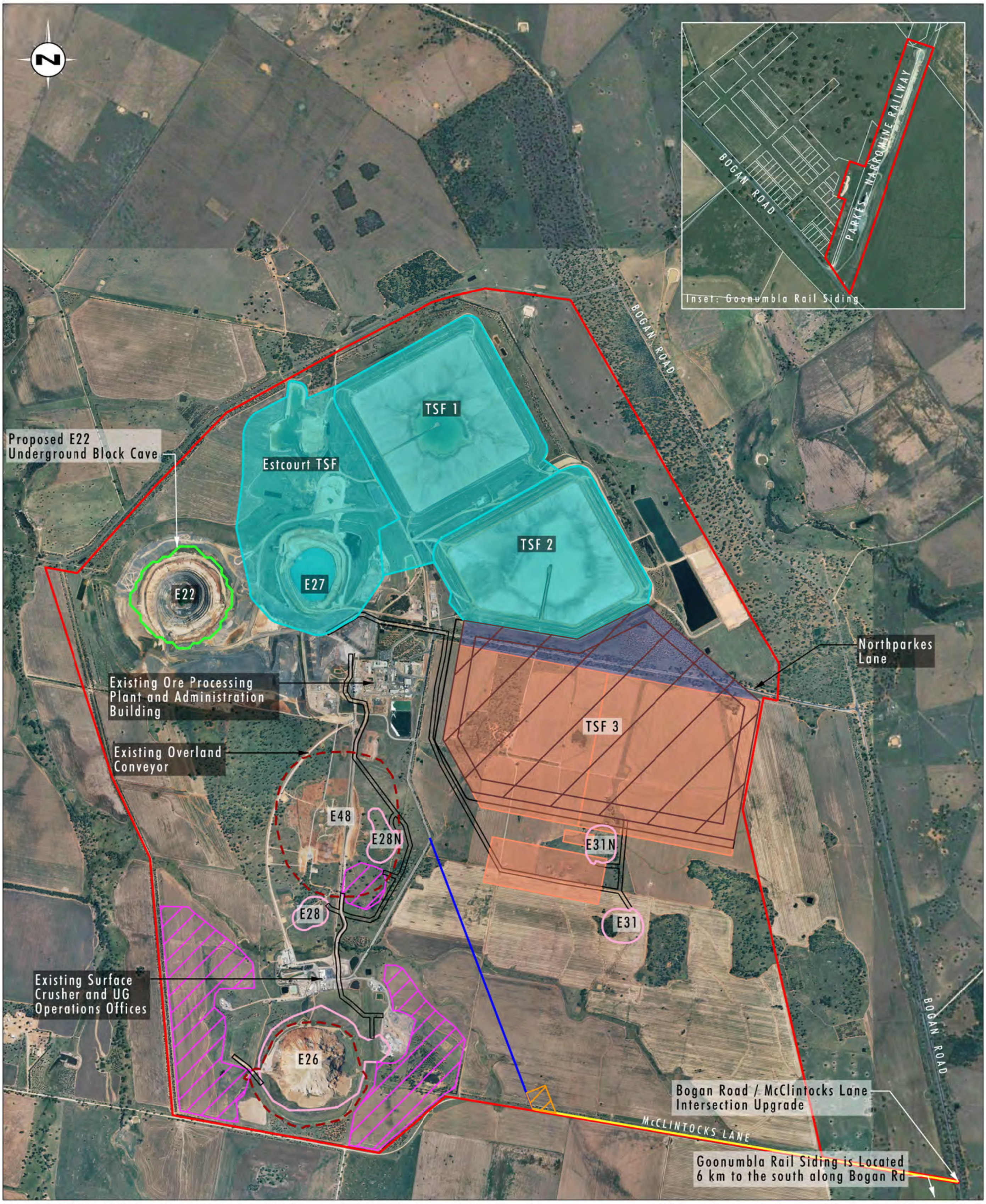


Source: NPM (2013), Department of Lands (2006)

Legend
Project Area

FIGURE 1.1

Locality Map



Source: NPM (2013), Google Earth (2010)

0 200 400 800m — Inset 1:16 000

0 0.5 1 2km — 1:40 000

Legend

- Project Area
- Approved Tailings Storage Facility (Rosedale)
- Approved Subsidence Management Areas
- Existing Tailings Storage Facility
- Proposed Tailings Storage Facility Extension
- Proposed TSF3
- New Underground Block Cave Mining Area
- Proposed Open Cut Areas
- Proposed Upgrade to McClintocks Lane
- Proposed Access Control and Visitor Car Park
- Proposed Waste Dumps
- Proposed Site Access Road
- Proposed Haul Road

FIGURE 1.2

Northparkes Mines Step Change Project

- development of new waste dumps for the management of E28/E28N and E26 open cut waste rock. Waste rock from E31 and E31N open cut mining areas will be utilised in the development of TSF 3;

- continuation of approved ore processing infrastructure up to 8.5 million tonnes per annum (Mtpa) capacity, and road haulage of copper concentrate to the existing Goonumbla rail siding;

- continued use of existing site infrastructure including administration buildings, workshop, internal access roads and service infrastructure;

- continued use of surface mining infrastructure including ventilation shafts, hoisting shaft and ore conveyors;

- continuation of existing approved water supply and management processes;

- development of an amended access road to service all mine related traffic entering the site;

- establishment of new visitor car parking facilities and access control to support the amended mine site access;

- continuation of approved mining operations for an extended life of an additional seven years until end of 2032; and

- rehabilitation and closure of the mine site will be carried out after the end of the operational life of the Project in accordance with relevant approvals.

The Project provides the opportunity for the integration, update and consolidation of existing approvals for underground mining, open cut mining and infrastructure within the NPM Project Area. This process will include surrendering of the existing project approval PA06_0026 (as modified) and existing development consents following any granting of a Project Approval for this Project.

The conceptual design of the Project has been developed to maximise recovery efficiency and is based on detailed geological exploration, engineering design and detailed analysis of potential environmental and community constraints. A description of the key features that comprise the Project are summarised in **Table 1.1**.

Table 1.1 – Key Features of the Project

Major Project Components/Aspects	Existing and Approved Operations	Proposed Operations
Mining Areas	• Underground block cave mining of E26 and E48 ore bodies. • Open cut mining of E22 (ceased in 2010).	• Continued block caving of the E26 and E48 ore bodies (as per current approval). • Development of block cave mining in the E22 resource (previously subject to open cut mining). • Development of open cut mining area in existing mine subsidence zone for E26. • Development of four small open cuts to extract ore from E28, E28N, E31 and E31N. • All proposed open cut mining areas are located within the existing PA 06_0026 Project Area and existing Mining leases.
Ore Processing	• Up to 8.5 Mtpa of ore, sourced from underground and open cut mining areas.	• Continuation of processing up to 8.5 Mtpa of ore through the existing processing plant sourced from underground and open cut mining areas.
Mine Life	• Until 2025.	• Extension of mining by seven years until end of 2032.
Operating Hours	• 24 hours a day, seven days per week.	• No Change.
Number of Employees	• Approximately 700 full time equivalents.	• No Change.
Mining Methods	• Multiple Underground Block Cave. • Campaign open cut mining yielding up to 2 Mtpa for stockpiling and processing as required.	• Multiple Underground Block Cave; and • Campaign Open cut mining of up to 7 Mtpa for stockpiling and processing as required.

Table 1.1 – Key Features of the Project (cont.)

Major Project Components/Aspects	Existing and Approved Operations	Proposed Operations
Infrastructure	**Operation of:** • TSF 14. • Ore processing plant including surface crusher, crushed ore stockpiles, active grinding mills, froth flotation area and concentrate storage. • Site offices, training rooms and workshop facilities. • Road haulage of concentrate to the Goonumbla rail siding for transport to Port Kembla. • An overland conveyor to transport ore from the hoisting shaft to the ore processing plant stockpiles. • Operation of four wastewater treatment plants.	**Construction and operation of:** • Tailings storage facilities to be augmented to connect existing and approved tailings facilities, through the development of TSF 3 southward from the existing southern embankment of TSF 2. The proposed TSF 3 will substantially include the approved TSF 3 (known as Rosedale). • Establishment of new stockpiles to store waste material generated during open cut mining campaigns, including a vehicle wash down area. • Continued operation of existing processing plant, site offices, underground access, water supply infrastructure and logistics connections. • Continued road haulage of concentrate to Goonumbla rail siding for transport to Port Kembla. • Closure of the existing site access road through the development of TSF3. • Provision of an upgraded site access road along a new alignment from McClintocks Lane. • Development of an access control and visitors car parking at the intersection of the proposed site access and McClintocks Lane. • Upgrade/sealing of McClintocks Lane between the NPM access road and Bogan Road. • Upgrades as required to the intersection of McClintocks Lane and Bogan Road.
Block Cave Knowledge Centre	• Onsite Rio Tinto Block Cave Knowledge Centre operates for the domestic and international training of underground block cave mining methodology.	• Continued operation of the Rio Tinto Block Cave Knowledge Centre.

1.2. Potential Surface Water Impacts

The aim of this surface water assessment is to identify the potential impacts on the surface water environment, including surface water quantity and quality as a result of the Project. Key features of the Project which may potentially impact on surface waters are assessed in this report and include:

- open cut mining;
- subsidence resulting from underground mining;
- extension of tailings facilities;
- additional/extension of waste rock dumps; and
- changes to site access and support infrastructure.

The surface water impact assessment has been undertaken for the NPM Project Area and the surrounding area (refer to **Figure 1.1**).

1.3. Structure of the Report

This surface water assessment report has been prepared to support the EA for the Project and identifies and assesses the potential impacts on surface water arising from the Project. The report is structured as follows:

- **Section 2.0** outlines the surface water planning context for the Project.
- **Section 3.0** of this report provides information on the existing surface water resources within the NPM area.
- **Section 4.0** outlines the water management system (WMS) associated with the current approved operations and for the proposed Project.
- **Section 5.0** describes the existing approved site water balance and the potential impacts with the proposed Project on the site water balance.
- **Section 6.0** presents the potential surface water impacts of the Project and proposed surface water management strategies.
- **Section 7.0** provides a discussion of the monitoring, licensing and reporting requirements for the Project.

2.0 Planning Context

2.1. Planning Instruments and Guidelines

This surface water assessment has been prepared to support the EA being prepared as part of a project application under Part 3A of the EP&A Act. The relevant planning instruments and guidelines for the surface water assessment are summarised below.

- *Water Management Act 2000*.
- *Water Act 1912*.
- *Protection of the Environment Operations Act 1997* (POEO Act).
- State Water Management Outcomes Plan (SWMOP) (Department of Natural Resources (DNR) undated).
- River Hydrology and Energy Relationships - Design Notes for the Mining Industry (Department of Water and Energy (DWE) 2007).
- Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Sources 2012.
- National Water Quality Management Strategy: Australian Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Environment and Conservation Council (ANZECC)/Agriculture and Resources Management Council of Australia and New Zealand (ARMCANZ) 2000).
- National Water Quality Management Strategy: Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC/ARMCANZ 2000).
- NSW Government Water Quality and River Flow Objectives (Department of Environment and Climate Change (DECC) 2006).
- Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (Department of Environment and Conservation (DEC) 2004).
- Managing Urban Stormwater: Soils and Construction (Landcom 2004) and associated Volume 2E: Mines and Quarries (DECC 2008).
- Managing Urban Stormwater: Treatment Techniques (DECC 1997).
- Managing Urban Stormwater: Source Control (DECC 1998).
- Floodplain Development Manual (Department of Infrastructure, Planning and Natural Resources (DIPNR) 2005).
- Flood Risk Management Guideline (Department of Environment, Climate Change and Water (DECCW) 2010).
- A Rehabilitation Manual for Australian Streams (Land and Water Resources Research and Development Corporation (LWRRDC) and Cooperative Research Centre for Catchment Hydrology (CRCCH) 2000).

- Storing and Handling Liquids: Environmental Protection, Participant's Manual (DECC 2007).
- Office of Water Guidelines for Controlled Activities (2012).
- In addition, Guidelines for Management of Stream/Aquifer Systems in Coal Mining Developments – Hunter Region (DIPNR 2005) has been used for guidance on potential surface water systems for the surface water assessment.

2.2. Director-Generals Requirements

In addition to the aforementioned planning provisions, guidelines and legislation, the Director-General of the DP&I has provided DGRs for the Project which identifies key issues for consideration in the EA. **Table 2.1** summarises those DGRs which relate to surface water resources and are subsequently addressed in this report. Only underlined sections of the DGRs presented below are assessed as part of this surface water assessment, with the other DGRs assessed as part of separate studies also supporting the EA.

Table 2.1 – Director-General's Requirements for Surface Water Resources

Water Resources, including:	**Section of Report/ Comments**
• A detailed assessment of potential impacts on the quality and quantity of existing surface and ground water resources in accordance with the NSW Aquifer Interference Policy, including:	NSW Aquifer Interference Policy is addressed in the Groundwater Assessment (Golder 2013)
▪ detailed modelling of potential groundwater impacts including identification of any highly productive groundwater (as defined by the Aquifer Interference Policy) or groundwater dependent ecosystems;	Addressed in the Groundwater Assessment (Golder 2013)
▪ impacts on affected licensed water users and basic landholder rights;	refer to **Section 6.0**
▪ impacts on riparian, ecological, geomorphological and hydrological values of watercourses, including watercourse diversions and environmental flows;	refer to **Section 6.0**
• a detailed site water balance, including a description of site water demands, water disposal methods (inclusive of volume and frequency of any water discharges), water supply infrastructure and water storage structures;	refer to **Section 5.0**
• an assessment of proposed water discharge quantities and quality/ies against receiving water quality and flow objectives;	refer to **Section 6.0**
• identification of any licensing requirements or other approvals under the *Water Act 1912* and/or *Water Management Act 2000*;	refer to **Section 7.0**
• demonstration that water for the construction and operation of the development can be obtained from an appropriately authorised and reliable supply in accordance with the operating rules of any relevant Water Sharing Plan (WSP);	refer to **Section 5.0**
• a description of the measures proposed to ensure the development can operate in accordance with the requirements of any relevant WSP or water source embargo; and	refer to **Section 7.0**
• a detailed description of the proposed water management system (including sewage), water monitoring program and other measures to mitigate surface and ground water impacts.	refer to **Section 4.0**

3.0 Existing Surface Water Environment

The NPM Project Area is located within the Macquarie-Bogan River Catchment. This section details the watercourses within and adjacent to the Project Area and their respective catchments, typical soil characteristics, rainfall and evaporation, water flows, water quality and downstream water users. The watercourses include the Bogan River, Tenandra Creek, Goonumbla Creek and Cookopie Creek.

3.1. Catchment Areas and Watercourses

The Project Area is located within the headwaters of the Macquarie-Bogan River catchment, which contributes surface water runoff from approximately 74,800 square kilometres to the Murray-Darling Basin System. The Bogan River, which forms part of the Macquarie-Bogan River system, starts in the Harvey Range near Goonumbla and flows north-west towards Nyngan before joining the Darling River near Bourke. Within the upper southern reaches of the catchment, the Bogan River collects flows from Tenandra Creek, Goonumbla Creek and Cookopie Creek (refer to **Figure 3.1**).

The Project Area is located within three subcatchments of the Macquarie-Bogan River Catchment, i.e. Tenandra Creek, Goonumbla Creek and Cookopie Creek. The watercourses, stream orders and sub-catchment boundaries, and the extent of the site WMS, are shown on **Figure 3.1**. The extent and relative portion of the Project Area within each of the catchment areas are listed in **Table 3.1**.

3.1.1. Stream Ordering

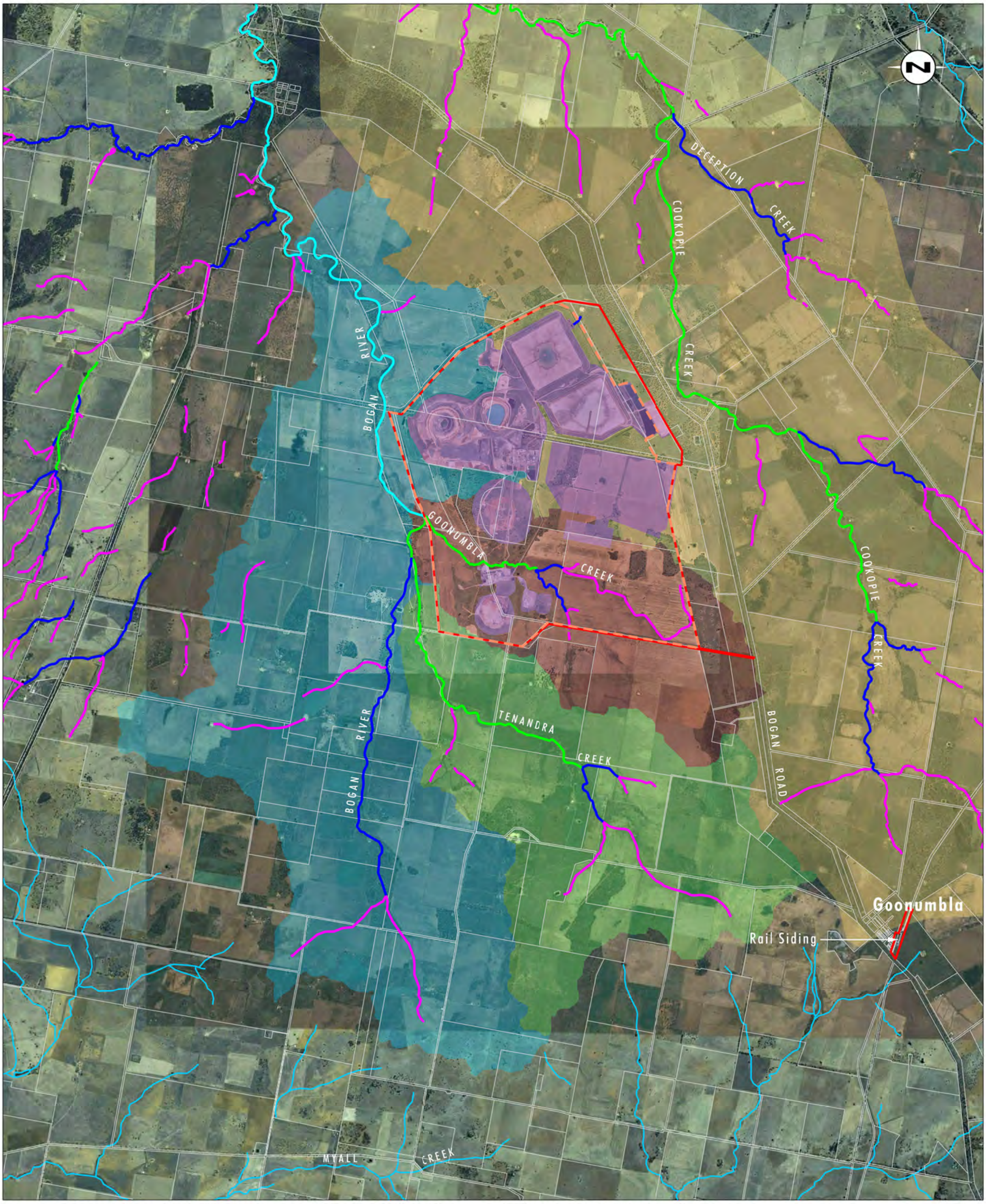
Stream ordering for each watercourse has been carried out in accordance with the Strahler ordering system as described in NSW Government Gazette no. 37 on 24 March 2006. Stream ordering is a hierarchical numbering system based on the degree of branching within a waterway and provides an indication of the complexity of a creek system and its potential catchment contribution. The Strahler ordering system begins in the headwaters of watercourses, with first order watercourses merging to form second order watercourses, second order watercourses merging to form third order watercourses, and so on.

Stream ordering is used by the NSW Office of Water (NOW) to assist in assessing the significance of potential water resource impacts of proposed developments. As no guidelines have been published by NOW for the Macquarie-Bogan region the guidelines published by NOW for the Hunter Region (DIPNR 2005) have been used for reference as these are considered to generally be appropriate to provide guidance for the Project.

Watercourses are categorised into three schedules (DIPNR 2005), specifically:

- Schedule 1 – usually intermittent and consisting of first or second order streams.
- Schedule 2 – third and higher order rivers that drain into primary catchment rivers.
- Schedule 3 – these watercourses are major rivers and their primary tributaries and associated alluvial groundwater zones.

For the watercourses within the NPM Project Area, the relevant stream order is shown in **Figure 3.1** and detailed in **Table 3.1**.



Source: Project Area: NPM (2013), Drainage Lines: LPMA (2011) Aerial: Google Earth (2006)

0 1 2.5 5km
1:100 000

Legend

- Project Area
- Existing Development Consent Boundary
- 1st Order Stream
- 2nd Order Stream
- 3rd Order Stream
- 4th order Stream
- Bogan River Catchment
- Tenandra Creek Cacthment
- Goonumbla Creek Catchment
- Cookopie Creek Catchment
- Approved Mine Water Management System Catchment

FIGURE 3.1

Existing Surface Water Environment

Table 3.1 –Summary of Watercourses and Catchments

Watercourse	Stream Order	Catchment (hectares)	Within Approved Development Consent Area (hectares)	Within Project Area (hectares)
Tenandra Creek	Schedule 2	2,866	21 (1%)	21 (1%)
Goonumbla Creek	Schedule 2	1,849	1015 (55%)	1025 (55%)
Cookopie Creek	Schedule 2	17,600	847 (5%)	983 (6%)
Bogan River (at Bogan Weir at Peak Hill) [1]	Schedule 3	103,600[2]	2,495 (2.5%)	2,641 (2.5%)
Bogan River [3]	Schedule 3	180,000,000[2]	2,495 (0%)	2641 (0%)

Notes: 1. Bogan River catchment upstream of Bogan Weir at Peak Hill.
2. Includes the subcatchment areas of Tenandra Creek, Goonumbla Creek and Cookopie Creek.
3. Bogan River catchment upstream of Nyngan. Below Nyngan, the catchment divide between the Bogan River and the Macquarie River are not clearly defined, with numerous flow paths passing through the alluvial fan into the Darling River.

3.1.2. Bogan River

The Bogan River flows from south to north immediately west of the Project Area (refer to **Figure 3.1**). Within the vicinity of the Project Area, Bogan River is generally ephemeral and surface water only flows after heavy or prolonged rainfall events. Approximately 2500 hectares of the approved development consent area lies within the Bogan River catchment. The proposed NPM Project Area includes approximately 2640 hectares of the Bogan River catchment, an increase of approximately 150 hectares (within the subcatchments of Goonumbla Creek and Cookopie Creek (refer to **Figure 3.1** and **Table 3.1**) when compared to the approved development consent area.

The catchment is relatively flat, with elevations in the Bogan River catchment upstream of the Project Area ranging from approximately 338 metres Australian Height Datum (mAHD) to 270 mAHD. Bogan Weir is located on the Bogan River approximately 35 kilometres downstream of the Project Area (i.e. approximately 6 kilometres due west of the township of Peak Hill) and is the site of Peak Hill's original water supply. Bogan Weir is now a used as a recreational area and no water is sourced from the weir for town water. The geomorphologic character and sediment transfer behaviour of Bogan River has been identified within the Catchment Management Plan (CMP) using the Riverstyles framework as being ‘unconfined valley setting/channelised fill’ within the upper reaches, and ‘swampy meadow group/valley fill fine grained’ to ‘unconfined valley setting/meandering fine grained’ within the majority of the Project Area.

3.1.3. Tenandra Creek

Tenandra Creek is an ephemeral watercourse and only flows after heavy or prolonged rainfall events. Tenandra Creek lies to the south and west of the Project Area (refer to **Figure 3.1**) and joins the Bogan River to the west of the Project Area. The area of the Tenandra Creek catchment within the proposed NPM Project Area is not increased from the currently approved development consent area of approximately 21 hectares (refer to **Table 3.1**).

The catchment ranges in elevation from 376 mAHD to 278 mAHD, with maximum slopes in the upper catchment of approximately 17 per cent over short distances. The CMP has categorised Tenandra Creek as having two geomorphologic riverstyles, being ‘unconfined valley setting/low sinuosity fine grained’ in the upper catchment and ‘swampy meadow group/valley fill fine grained’ in the lower catchment.

3.1.4. Goonumbla Creek

Goonumbla Creek is an ephemeral watercourse and only flows after heavy or prolonged rainfall events. Goonumbla Creek traverses the south-eastern portion of the Project Area from south-east to north-west and joins the Bogan River to the west of the Project Area (refer to **Figure 3.1**). Approximately 1041 hectares of the approved consent development area lies within the Goonumbla Creek catchment. Approximately 1051 hectares of the proposed NPM Project Area lies within the Goonumbla Creek catchment. This represents approximately a 1 per cent increase from the approved development consent area within the Goonumbla Creek catchment area.

The catchment elevations range from approximately 378 mAHD to 276 mAHD, with maximum slopes of approximately 22 per cent in the upper catchment. The riverstyles categorised by the CMP include ‘unconfined valley setting/channelised fill’ in the upper catchment and ‘unconfined valley setting/low sinuosity fine grained’ in the lower reaches.

3.1.5. Cookopie Creek

Cookopie Creek is an ephemeral waterway and only flows after heavy or prolonged rainfall events. Cookopie Creek flows approximately northwards to the east of the Project Area (refer to **Figure 3.1**). The proposed NPM Project Area includes approximately 983 hectares of the Cookopie Creek catchment area compared to approximately 847 hectares included in the currently approved development consent area. This represents approximately a 1 per cent increase to a total of 6 per cent of Cookopie Creek catchment from the approved development consent area within the Cookopie Creek catchment area.

The catchment ranges in elevation from 376 mAHD to 278 mAHD, with maximum slopes in the upper catchment of approximately 17 per cent over short distances. The CMP has categorised Cookopie Creek as having two geomorphologic riverstyles, being ‘unconfined valley setting/low sinuosity fine grained’ in the upper catchment through to ‘swampy meadow group/valley fill fine grained’ in the lower catchment.

3.2. Soil Characteristics

The Macquarie-Bogan River catchment lies within the Central West Catchment Management Area (CMA). The CMP for the Macquarie-Bogan River catchment defines the area south of Peak Hill as the Southern Slopes Catchment and identifies river reaches in the area as high risk (high fragility) due to the degraded state.

A Land and Soil Capability Classification for the Southern Slopes Catchment was undertaken as part of the CMP. The Soil Capability Classification is used to identify sustainable land management practices for the catchment based on a range of physical and environmental characteristics. The Land and Soil Capability classes vary across the Project Area from Class 1 (‘Very slight to negligible limitations – no special land management practices required’) through to Class 4 (‘Moderate to severe limitations – for higher impact land management practices’).

The catchments within the Project Area generally comprise of agricultural land with small pockets of vegetation. Typical soil types within the Project Area include chromosol, sodosol, and rudosol. Chromosol soil types can be susceptible to soil acidification and soil structure decline, whilst sodosol soil types have a high erodibility potential.

Within the Project Area, soil testing has been previously undertaken with two soil units identified by Cunningham (2006). Soil Mapping Unit 1 (SMU1) consisted of crests and outcrop areas, primarily the Limestone Forest and other remnant forest areas within the Project Area, whilst Soil Mapping Unit 2 (SMU2) consisted of the slopes and drainage lines within the Project Area. The erodibility of the top soil and subsoil of each soil unit was assessed using a Revised Universal Soil Loss Equation model. The outcomes of this assessment found topsoil within the Project Area generally had a moderate erodibility and subsoil was generally found to have a low erodibility. Selected samples were tested for electrical conductivity and the results demonstrated both the topsoil and subsoil of SMU1 were found to be non-saline, whilst for the SMU2 the topsoil sample was found to be non-saline, however the subsoil was found to vary in salinity from moderately saline to extremely saline.

3.3. Rainfall and Evaporation

Rainfall records for the NPM site have been recorded by a meteorological station installed at NPM in 15 minute intervals since 2008. The location of this meteorological station is shown on **Figure 3.2**.

The Bureau of Meteorology (BoM) operates a rainfall gauge at Goonumbla (Avondale) within the Cookopie Creek catchment. Rainfall at this station has been measured since 1942 and has a mean annual rainfall of 582 millimetres. The average monthly rainfall measured at Goonumbla (Avondale) is shown in **Chart 3.1**.

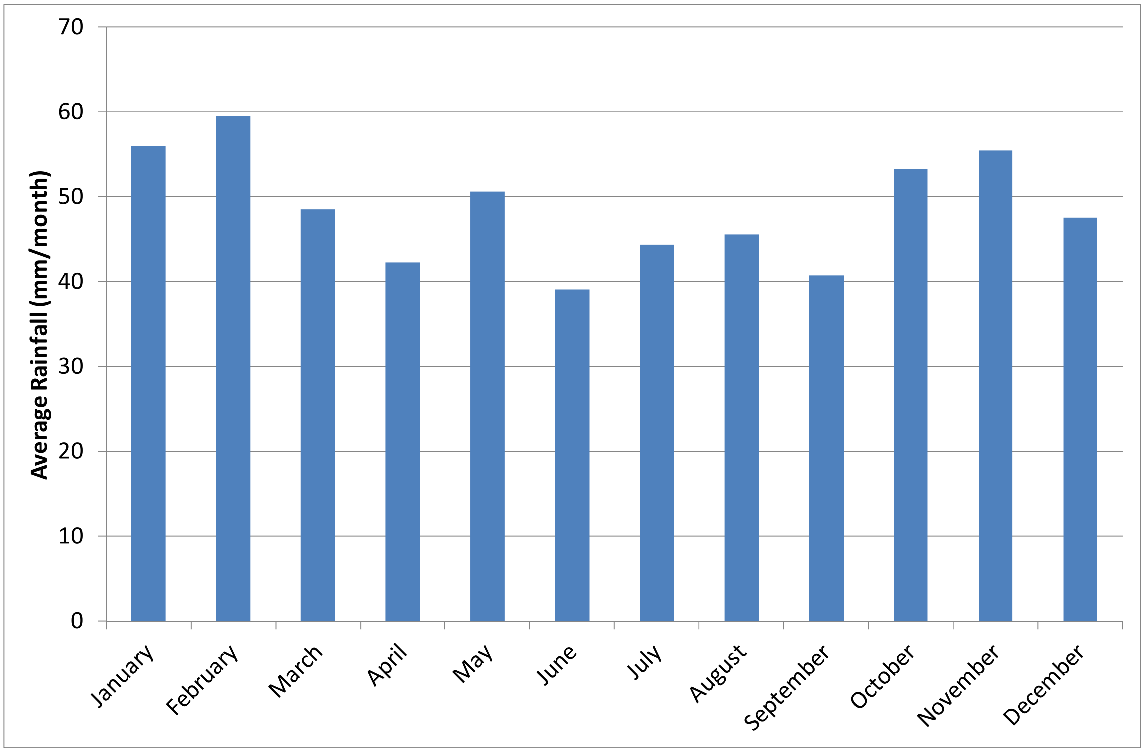
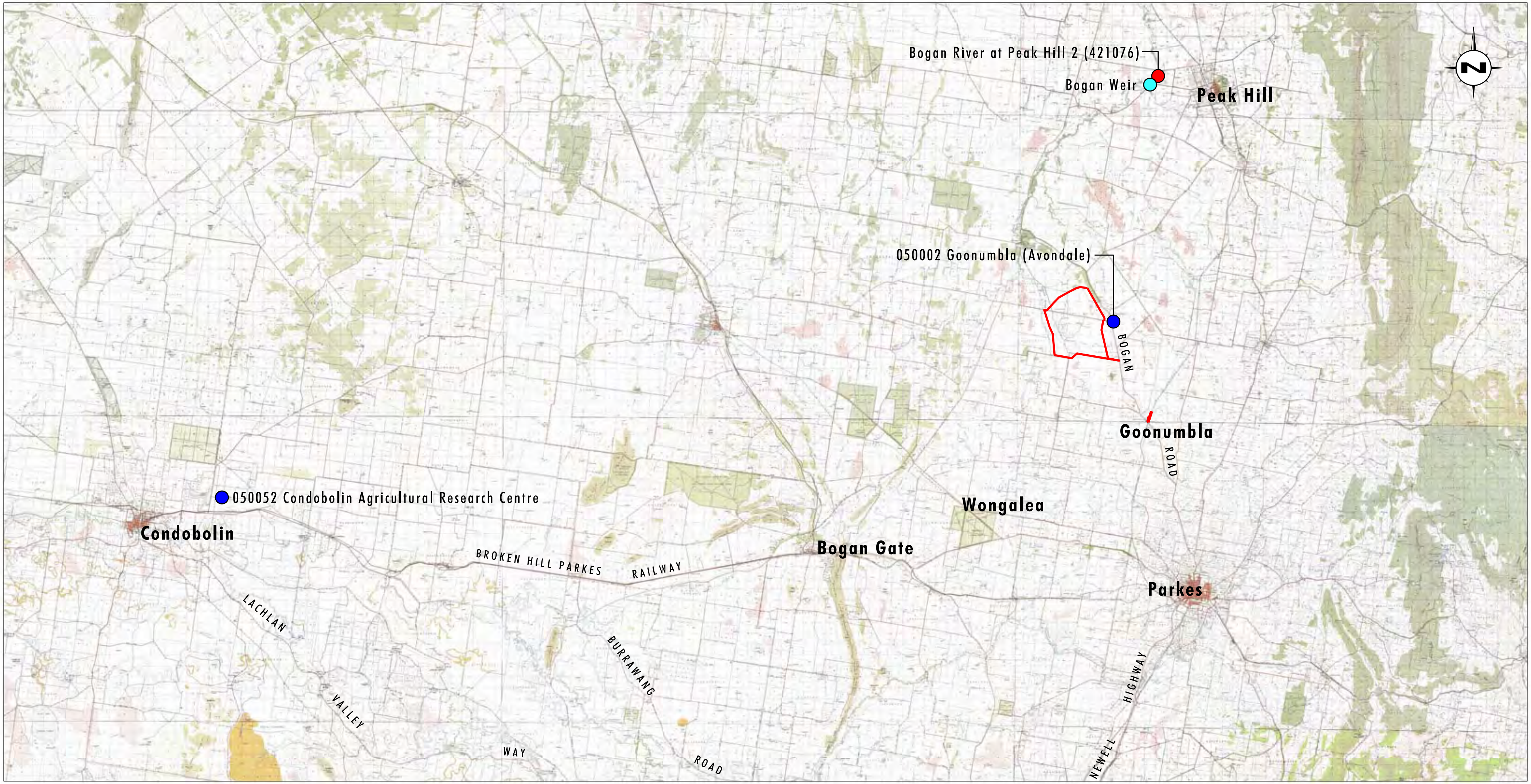


Chart 3.1 – Average Monthly Rainfall at Goonumbla (Avondale) Station 050002



Source: NPM (2013), Department of Lands (2006)

0 5 10 20km
1:500 000

Legend

Project Area
Rainfall Gauges
Streamflow Gauges
Weir

FIGURE 3.2

Rainfall and Streamflow Gauges

The variability of the Goonumbla (Avondale) annual rainfall is high. **Chart 3.1** shows that rainfall is typically higher during the summer months.

The BoM station at Condobolin (050052, approximately 50 kilometres west of the Project Area) includes observations of pan evaporation from 1972 to present. The average monthly pan evaporation measured at Condobolin is shown in **Chart 3.2**. The average monthly pan evaporation shown in **Chart 3.2** clearly shows the seasonality of evaporation for the Condobolin region, with the potential evaporation for summer up to approximately six times that of winter. The evaporation measured at Condobolin is considered representative of that at the NPM site as evaporation is regionally driven.

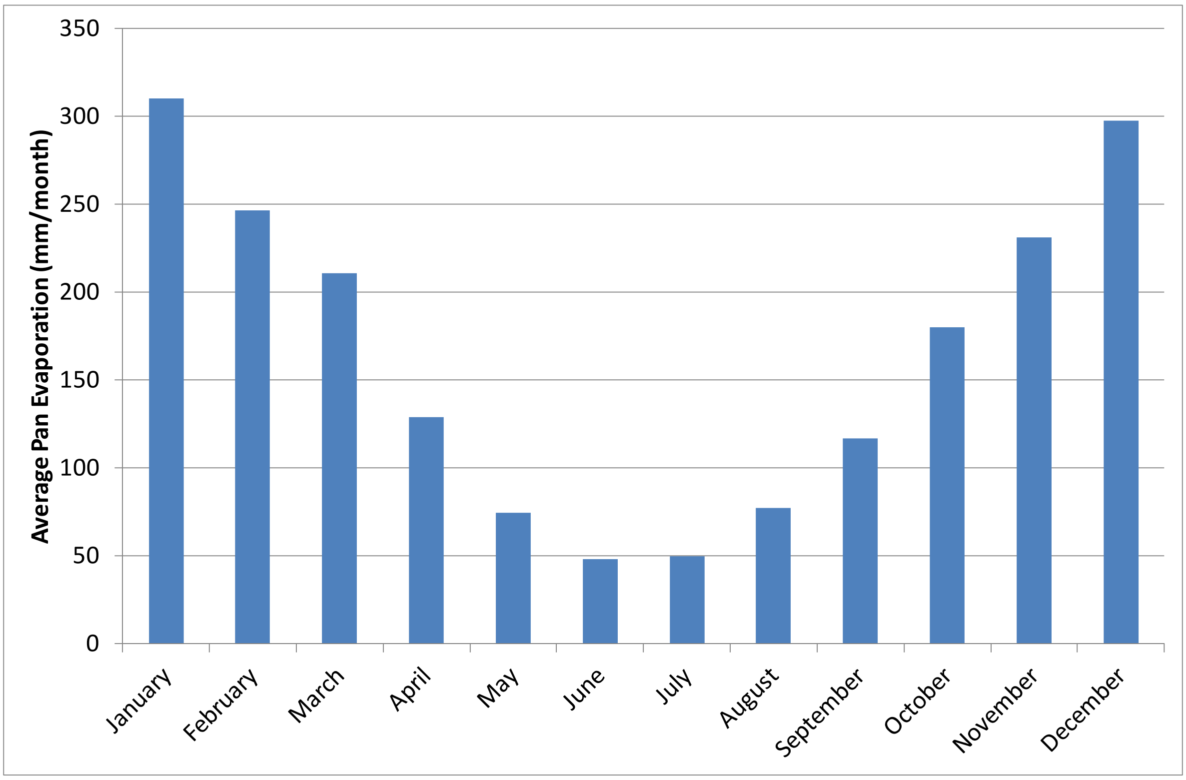


Chart 3.2 – Average Monthly Pan Evaporation at Condobolin Agricultural Research Station, Station 050052

3.4. Water Quality

Surface water monitoring is undertaken at NPM within the clean, dirty and contaminated water systems. The clean water system includes the surrounding watercourses and farm dams that are outside of the WMS. The dirty water system includes sediment dams that receive runoff from stockpile areas and tailings dam walls. The contaminated water system includes runoff from open cut mining areas, decant water from the TSFs and water that has potentially come into contact with copper. Surface water monitoring locations within each of these three water systems include:

- Clean Water System:
  - Farm Dams (WC) at 14 locations;
  - Watercourses (WC) at nine locations;
- Dirty Water System:
  - Sediment Ponds (SP) at eight locations;

- Contaminated Water System:
  - Borrow Pits;
  - Grease Traps (GT) at two locations;
  - Open Cut Pits (E) at one location;
  - Process Water Dams (PWD) at one location;
  - Retention Ponds (RP) at 22 locations;
  - Return Water Dams (RWD) at four locations;
  - Stilling Ponds (STP); and
  - TSF at two locations.

The location of each surface water monitoring point is included in **Figure 3.3**. The frequency of sampling and the water quality parameters that are tested are summarised in **Table 3.4**.

Table 3.4 – Surface Water Monitoring Program

Water System	**Sampling Frequency**	**Water Quality Parameters**
Clean Water System Watercourses	Minimum Annually [1]	pH, EC, TSS, TDS, Cu, Na, K, Ca, Mg, Cl, SO_4, HCO_3, CO_3
Clean Water System Farm Dams	Semi-annually	pH, EC, TSS, Cu
	Annually	pH, EC, TSS, TDS, Cu, Na, K, Ca, Mg, Cl, SO_4, HCO_3, CO_3
Dirty Water System	Minimum quarterly[1]	pH, EC, TSS, Cu
Contaminated Water System	Quarterly	pH, EC, Cu
	Annually	pH, EC, TSS, TDS, Na, K, Ca, Mg, Cl, SO_4, HCO_3, CO_3, Al, As, Ba, Be, Cd, Co, Cu, Cr, Mo, Ni, Pb, Se, Th, U, Zn

Note: 1. Minimum sampling frequency, with additional sampling following runoff generating rainfall events.

Table 3.5 summarises the default water quality trigger values from the ANZECC guidelines (2000) which are relevant to the Surface Water Assessment for NPM.

Table 3.5 – Water Quality Default Trigger Values (Upland Watercourses)

Water Quality Parameter	**Default Trigger Values**
pH	6.5 to 8.5
Electrical Conductivity (EC)	30 to 350 µS/cm
Total Suspended Solids (TSS)	40 mg/L (aquatic foods - freshwater)
Copper (Cu)	1.4 µg/L 95 per cent protection level

A summary of sampling results for the clean, dirty and contaminated water systems for 2005 to 2012 are compared against the ANZECC (2000) default trigger values (refer to **Table 3.4**) in **Charts 3.3** to **3.13**.

Umwelt
Environmental Consultants

Source: Project Area: NPM (2011), Drainage Lines: LPMA (2011), Aerial: Google Earth (2006)

0 1 2 3km
1:75 000

Legend

- Project Area
- Clean Water Monitoring Site
- Dirty Water Monitoring Site
- Contaminated Water Monitoring Site
- Drainage Line

FIGURE 3.3

Surface Water Monitoring Points

3.4.1. Clean Water System

The clean water system includes monitoring points within farm dams and watercourses. An analysis of the available water quality monitoring data (2005 to 2012) was undertaken. The findings of the analysis are outlined below and in **Charts 3.3** to **3.6**.

3.4.1.1. pH

For the monitoring locations within watercourses, a mean pH value of 6.9 was recorded across all available monitoring data. The pH exceeds the ANZECC default trigger value of 8.0 for at least one record at six of the nine watercourse monitoring locations (refer to **Chart 3.3**), and up to 16 per cent over all monitoring records for WC3, which is located at the confluence of Goonumbla Creek and the Bogan River. The analysis indicates that the recorded pH level of samples are below the minimum ANZECC default trigger value of 6.5 at least once across all watercourse monitoring locations (refer to **Chart 3.3**), and up to 31 per cent of all monitoring data at WC4 (upstream of the NPM on Tenandra Creek) and WC3 (at the confluence of Goonumbla Creek and the Bogan River). The maximum recorded value of pH is 8.75 at WC7 (upstream of NPM on Tenandra Creek).

For the monitoring locations within farm dams a mean alkalinity (pH) value of 8.0 was recorded across all available monitoring data, which is higher than that recorded for the watercourses. The recorded pH within the farm dams exceeds the ANZECC default trigger value of 8.0 at 12 of the 14 farm dam monitoring locations at least once (refer to **Chart 3.3**), and up to 72 per cent over all monitoring occasions at FD7 (north of NPM). The analysis indicated that pH has not been recorded below the ANZECC default trigger value of 6.5. The maximum recorded value of pH is 9.06 at FD21, located within the eastern section of the Project Area.

The higher pH within the farm dams compared to the watercourse monitoring locations may be the result of the capture and concentration (by evaporation) of alkaline materials within the farm dams.

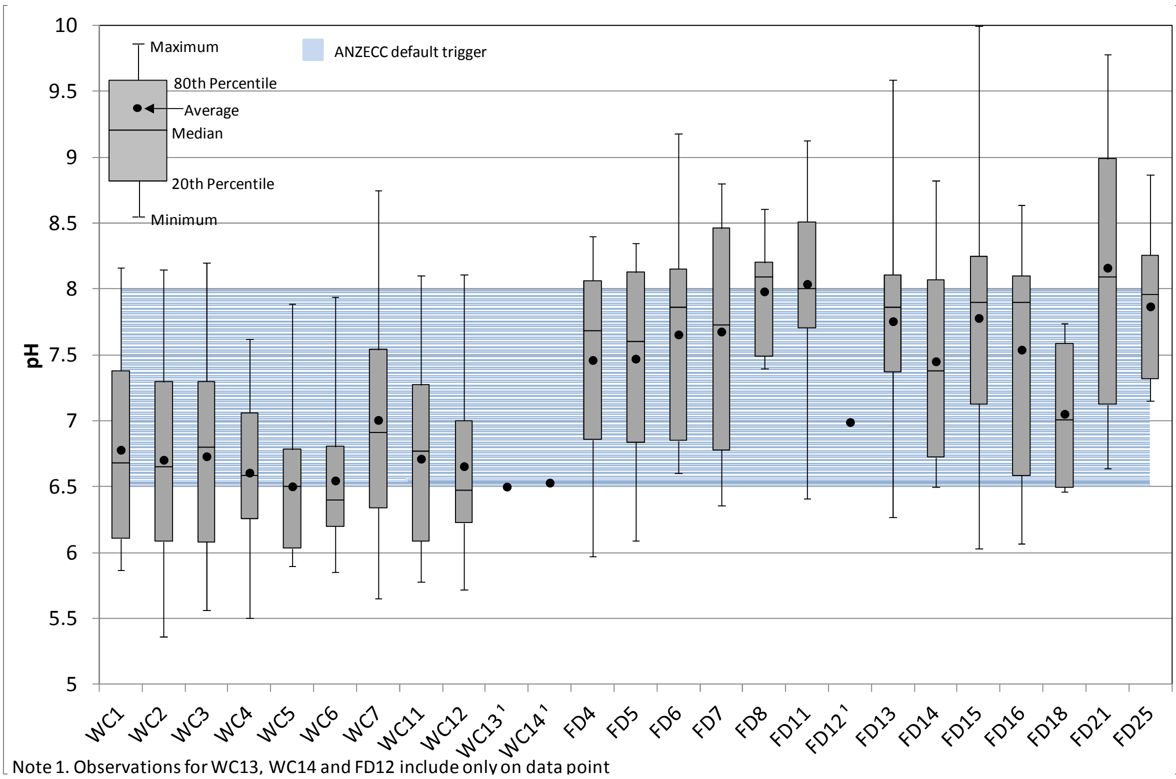


Chart 3.3 – Clean Water System – pH

3.4.1.2. **Electrical Conductivity**

The analysis of EC within the watercourses samples shows a mean EC value of 142 µS/cm across all watercourse monitoring data. The electrical conductivity exceeds the maximum ANZECC default trigger value of 350 µS/cm on one occasion at both WC7 (upstream of NPM on Tenandra Creek) and WC12 (downstream of NPM on Bogan River) (refer to **Chart 3.4**). The analysis indicates that EC was not recorded below the minimum ANZECC default trigger value of 30 µS/cm on any occasion at any watercourse monitoring location. The maximum recorded EC within the watercourse monitoring points was 515 µS/cm at WC7 (located upstream of NPM on Tenandra Creek).

The analysis of farm dam monitoring samples indicates a mean EC value of 469 µS/cm across all monitoring data. The EC exceeds the ANZECC default trigger value of 350 µS/cm at 13 of the 14 farm dam monitoring locations at least on one occasion and one at location, (FD18), where there is only one water quality monitoring sample taken the EC is found to exceed the ANZECC default trigger value (refer to **Chart 3.4**). The analysis indicates that EC did not drop below the minimum ANZECC default trigger value of 30 µS/cm on any occasion at any of the farm dam monitoring locations. The maximum recorded value of EC within the farm dam monitoring points is 4010 µS/cm at FD8.

The analysis indicates that the EC within the farm dams is typically higher than those within the watercourses. As with pH, this is likely to be the result of salts being concentrated within the farm dams as a result of evaporation.

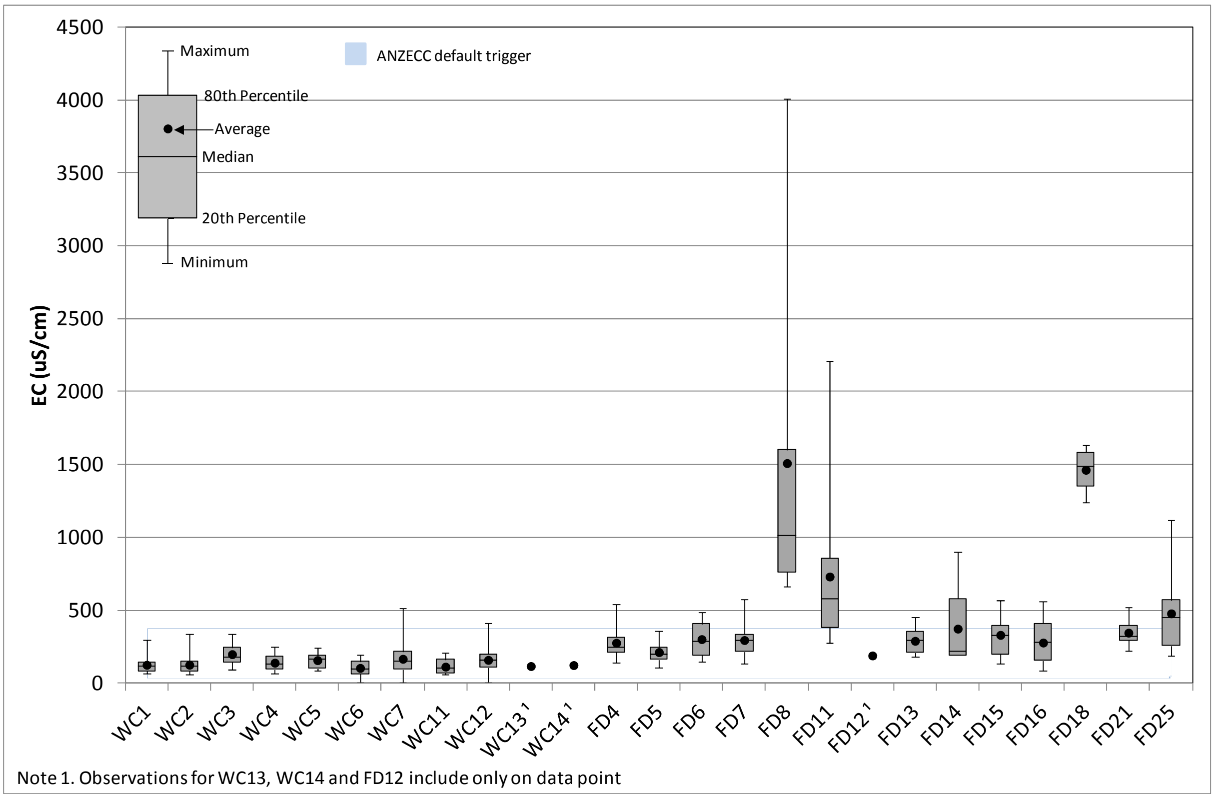


Chart 3.4 – Clean Water System – Electrical Conductivity

3.4.1.3. **Total Suspended Solids**

The analysis of the watercourse samples shows a mean TSS of 119 mg/L across all watercourse monitoring data. The TSS within the watercourses exceeds the maximum ANZECC default trigger value of 40 mg/L at all of the monitoring locations (refer to **Chart 3.5**), including all monitoring locations upstream of NPM and up to 75 per cent over all watercourse monitoring data at WC7 (upstream of NPM on Tenandra Creek). The maximum recorded value of TSS is 740 mg/L recorded at WC1 (downstream of NPM on Cookopie Creek).

The analysis of the farm dam monitoring samples show a mean TSS of 48 mg/L across all monitoring data. The TSS exceeds the maximum ANZECC default trigger value of 40 mg/L at nine of the farm dam monitoring locations (refer to **Chart 3.5**) and up to 60 per cent over all monitoring occasions at FD14 (located upstream of NPM and captures runoff from neighbouring agricultural fields). The maximum recorded value of TSS is 356 mg/L at FD21 (located to the east of NPM).

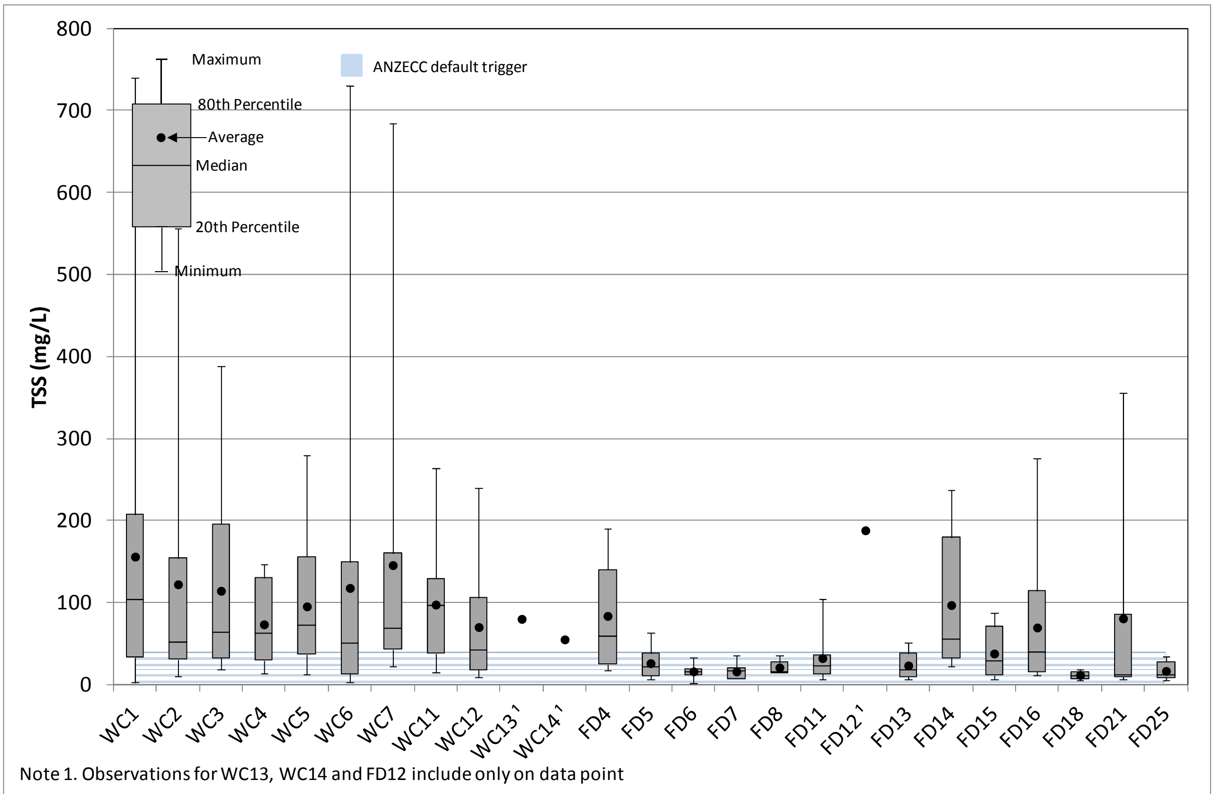


Chart 3.5 – Clean Water System – Total Suspended Solids

3.4.1.4. **Copper**

The analysis of watercourse samples shows a mean Cu concentration of 0.04 mg/L across all monitoring data. The Cu concentration is consistently above the ANZECC default trigger value of 1.4 µg/L within the watercourse monitoring locations (refer to **Chart 3.6**) with a maximum recorded value of 0.634 mg/L at WC2 (located to the west of NPM on the Bogan River; refer to **Figure 3.3**). Only WC12 (located downstream of NPM on the Bogan River; refer to **Figure 3.3**) recorded Cu concentrations below the ANZECC default trigger value.

The analysis of farm dam monitoring samples shows a mean Cu concentration of 0.03 mg/L across all monitoring data. The Cu concentration is consistently above the ANZECC default trigger value of 1.4 µg/L (refer to **Chart 3.6**) with a maximum recorded value of 0.254 mg/L at FD14. None of the farm dam samples included Cu concentrations below the ANZECC default trigger value.

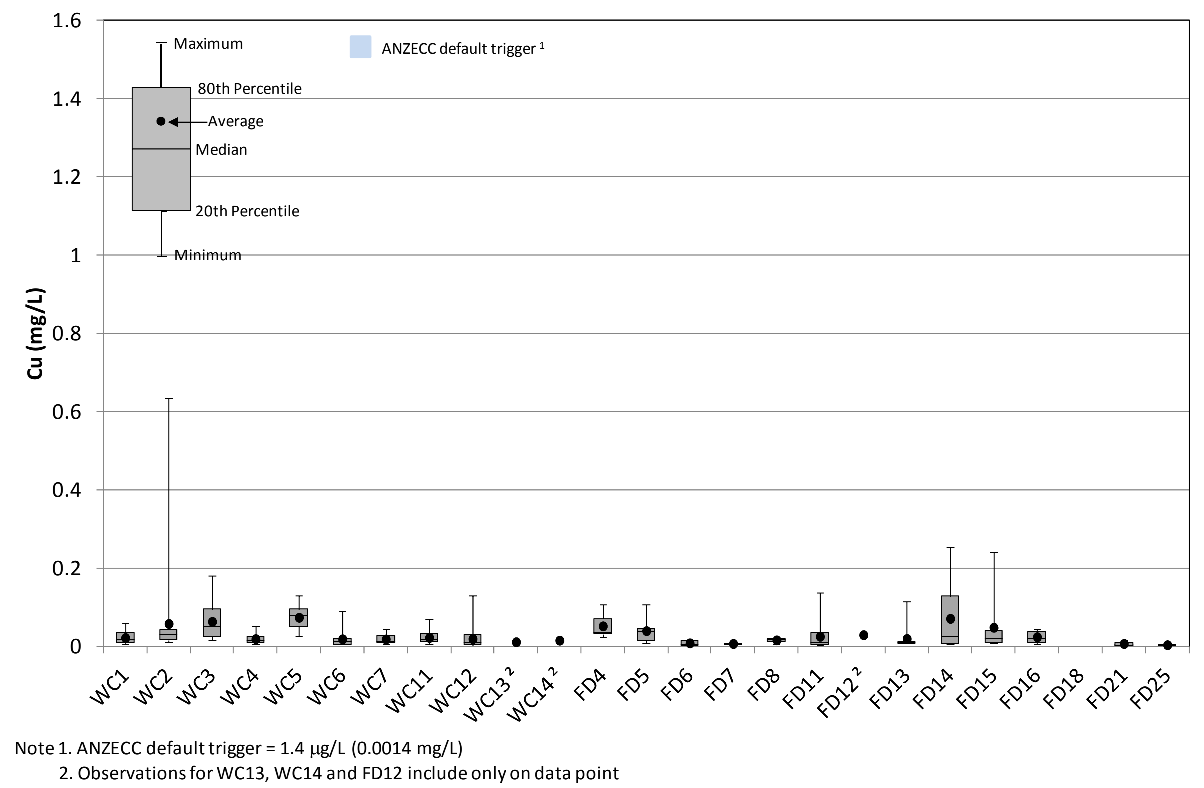


Chart 3.6 – Clean Water System – Copper

3.4.1.5. Summary

In summary, the monitoring results demonstrate that ANZECC default trigger values for copper have not been exceeded within any farm dam or watercourse monitoring measurements. Water quality monitoring of watercourses surrounding NPM indicates that WC7 and WC12 exceed ANZECC default trigger values for all recorded water quality parameters (except copper) on at least one occasion. Water quality monitoring of the farm dams indicate generally higher alkalinity (pH), higher salinity (EC), and higher suspended solids (TSS) when compared to water quality monitoring results for watercourses.

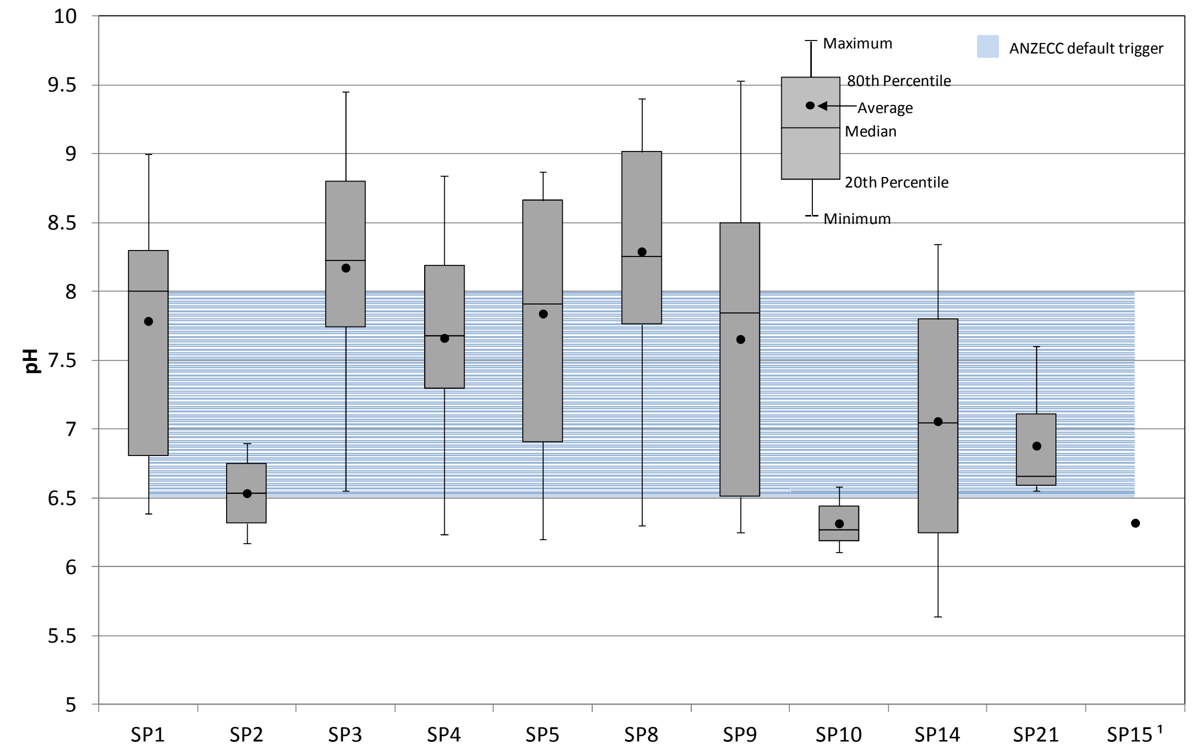
3.4.2. Dirty Water System

The dirty water system includes monitoring points within sediment ponds. An analysis of the available water quality monitoring data (2005 to 2012) was undertaken. The findings of the analysis are outlined below and in **Charts 3.7** to **3.10**.

Historical monitoring of the runoff within the dirty water system, including runoff and seepage from waste rock stockpiles, indicates that acid rock drainage (ARD) is not of concern at NPM. However, analysis does indicate that neutral rock drainage (NRD) does occur from some waste rock, with runoff from these areas appropriately captured within the WMS (refer to **Section 4.2**).

3.4.2.1. **pH**

The analysis indicates a mean pH value of 8.0 across all years of monitoring data, with pH levels typically high, exceeding the ANZECC default trigger value of 8.0 at seven of the eight monitoring locations at least once (refer to **Chart 3.7**). The pH within the dirty water system was found to be comparable to that of the clean water system (refer to **Chart 3.3**).



Note 1. Observations for SP15 includes only on data point

Chart 3.7 – Dirty Water System - pH

3.4.2.2. Electrical Conductivity

The analysis indicates that EC is consistently high across all sediment ponds, with EC values exceeding 20,000 µS/cm at SP8 (refer to **Chart 3.8**). EC values within the dirty water system are also higher than those within the clean water system (refer to **Chart 3.4**).

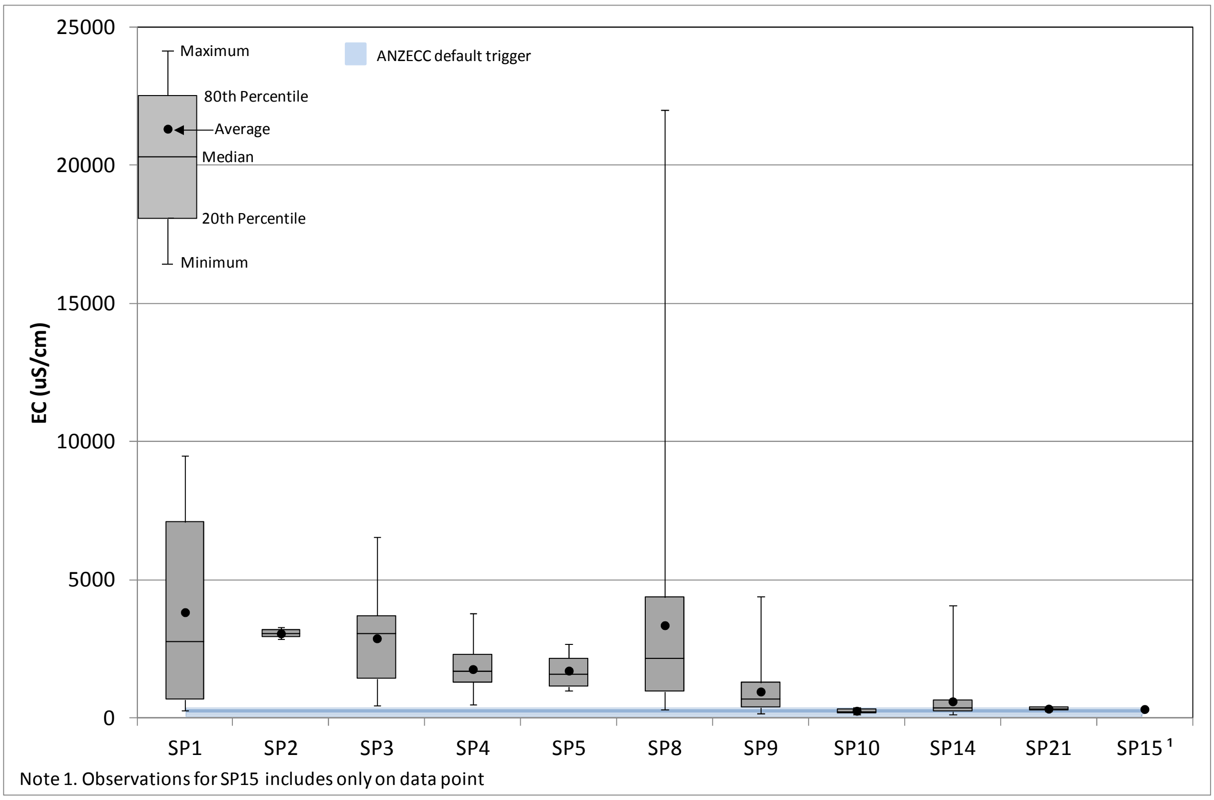


Chart 3.8 – Dirty Water System - Electrical Conductivity

3.4.2.3. **Total Suspended Solids**

The analysis indicates that TSS is typically above the maximum ANZECC default trigger value (refer to **Chart 3.9**), with the SP2 and SP3 being consistently in excess of the ANZECC default trigger value. EC values within the dirty water system are also higher than recorded within the clean water system (refer to **Chart 3.5**).

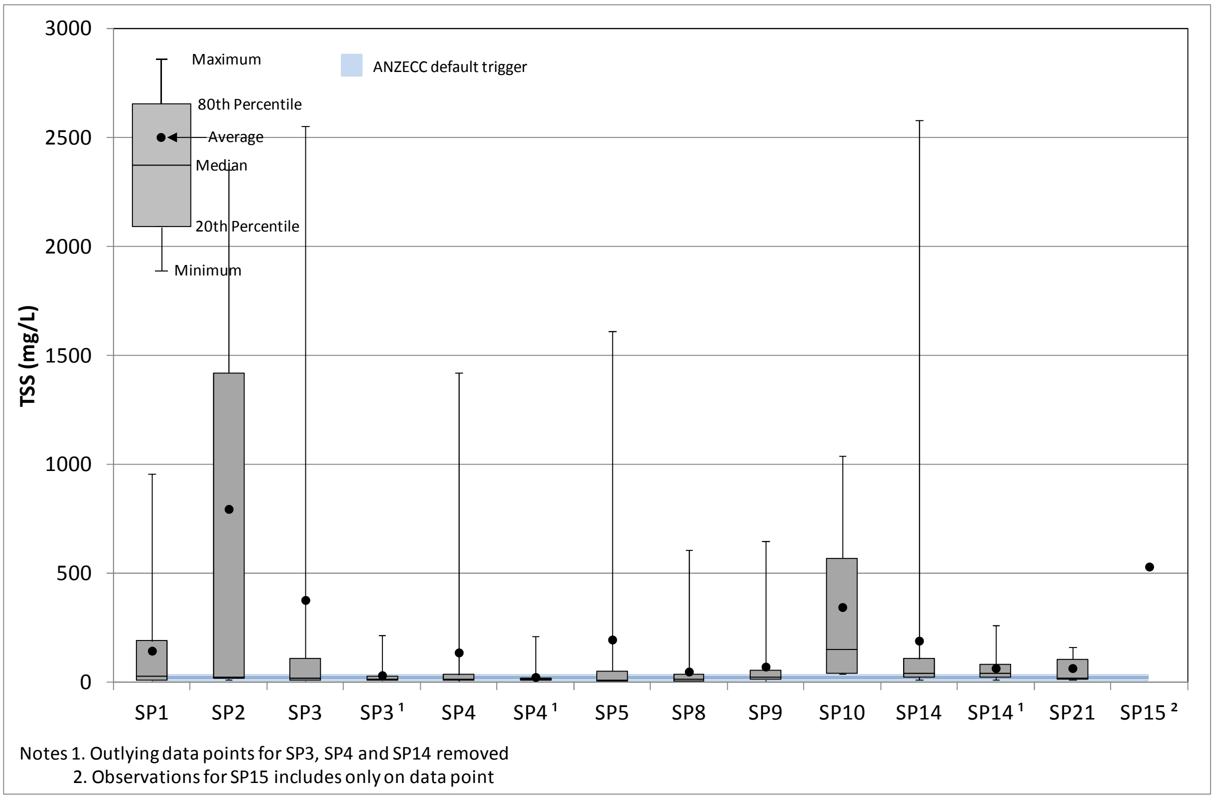
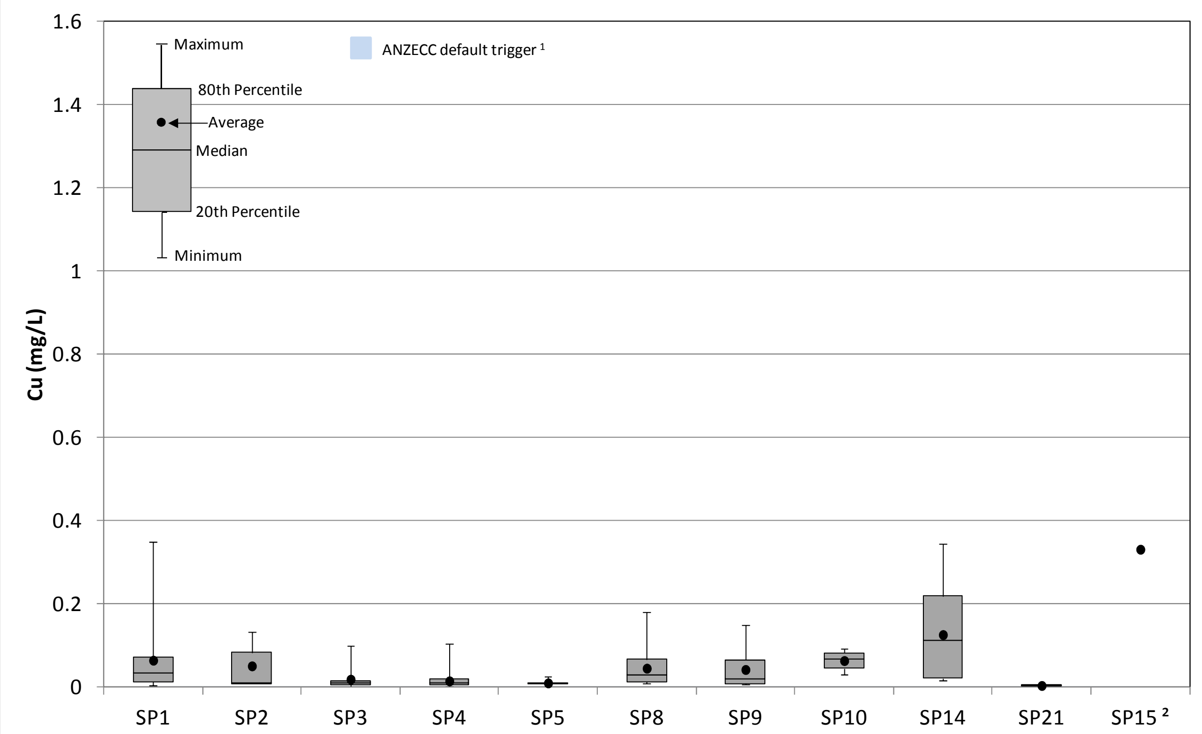


Chart 3.9 – Dirty Water System – Total Suspended Solids

3.4.2.4. **Copper**

The analysis of watercourse samples shows a mean (Cu) concentration of 0.07 mg/L across all monitoring data. The Cu concentration is consistently above the ANZECC default trigger value of 1.4 µg/L within the sediment pond monitoring locations (refer to **Chart 3.10**) with a maximum recorded value of 0.351 mg/L at SP1 (located north-west of TSF1; refer to **Figure 3.3**). Only SP2 (located north of E27; refer to **Figure 3.3**) recorded Cu concentrations below the ANZECC default trigger value.

The analysis indicates that Cu concentrations within the sediment ponds are typically comparable to the values recorded for the clean water system (refer to **Chart 3.6**).



Note 1. ANZECC default trigger = 1.4 µg/L (0.0014 mg/L)
2. Observations for SP15 includes only on data point

Chart 3.10 – Dirty Water System – Copper

3.4.3. Contaminated Water System

The contaminated water system includes monitoring points within a number water storages (refer to **Section 3.4**). An analysis of the available water quality monitoring data (2005 to 2012) was undertaken. The findings of the analysis are outlined below and in **Charts 3.11** to **3.13**.

3.4.3.1. pH

The analysis indicates that the mean pH within the contaminated water system is 7.9 across all monitoring data. pH levels within the contaminated water system are typically high, exceeding the ANZECC default trigger value of 8.0 at 27 of the 34 monitoring locations within the contaminated water system at least once (refer to **Chart 3.11**). Water within the RP tended to have a higher pH, albeit with a high variability of recorded pH values. Water within the pit areas (Caloola and Estcourt pits) also have higher pH values.

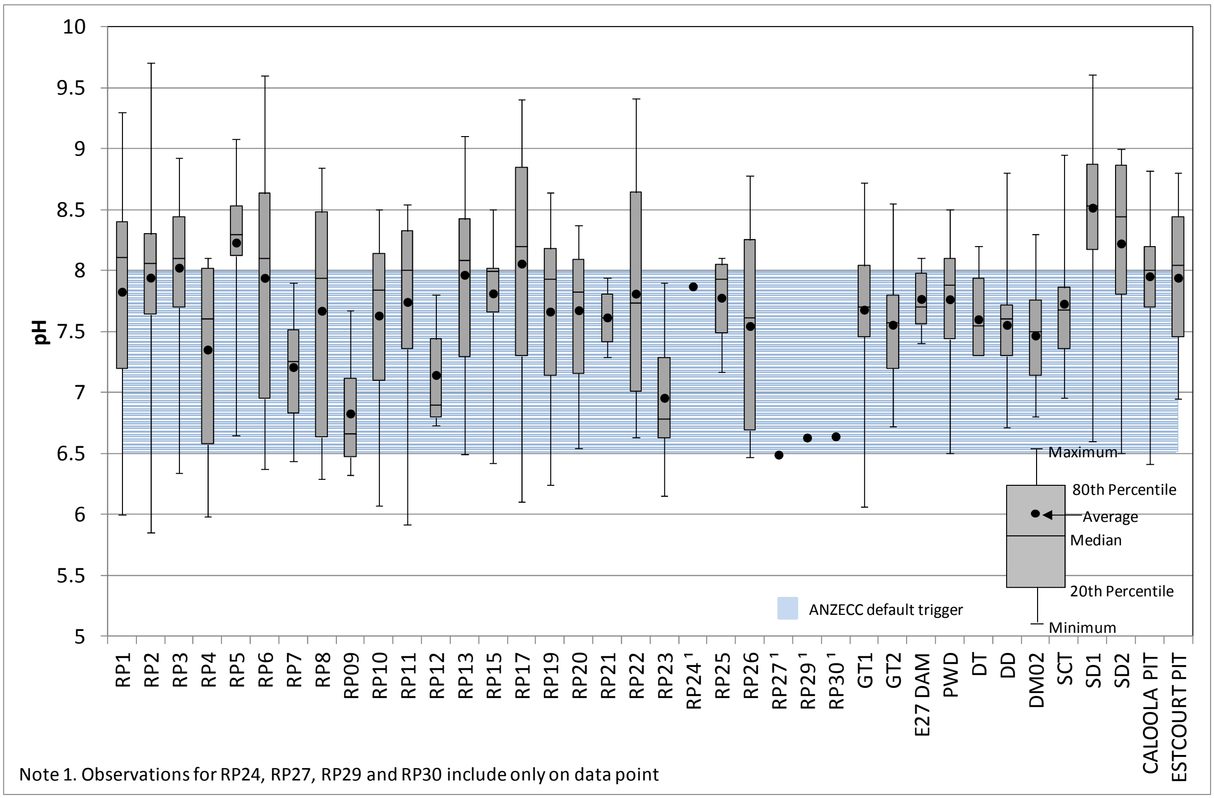


Chart 3.11 – Contaminated Water System - pH

3.4.3.2. **Electrical Conductivity**

The analysis indicates that EC within the contaminated water system is consistently high, with EC values reaching approximately 7500 µS/cm within the retention ponds and over 12000 µS/cm with SD1 and SD2 (refer to **Chart 3.12**).

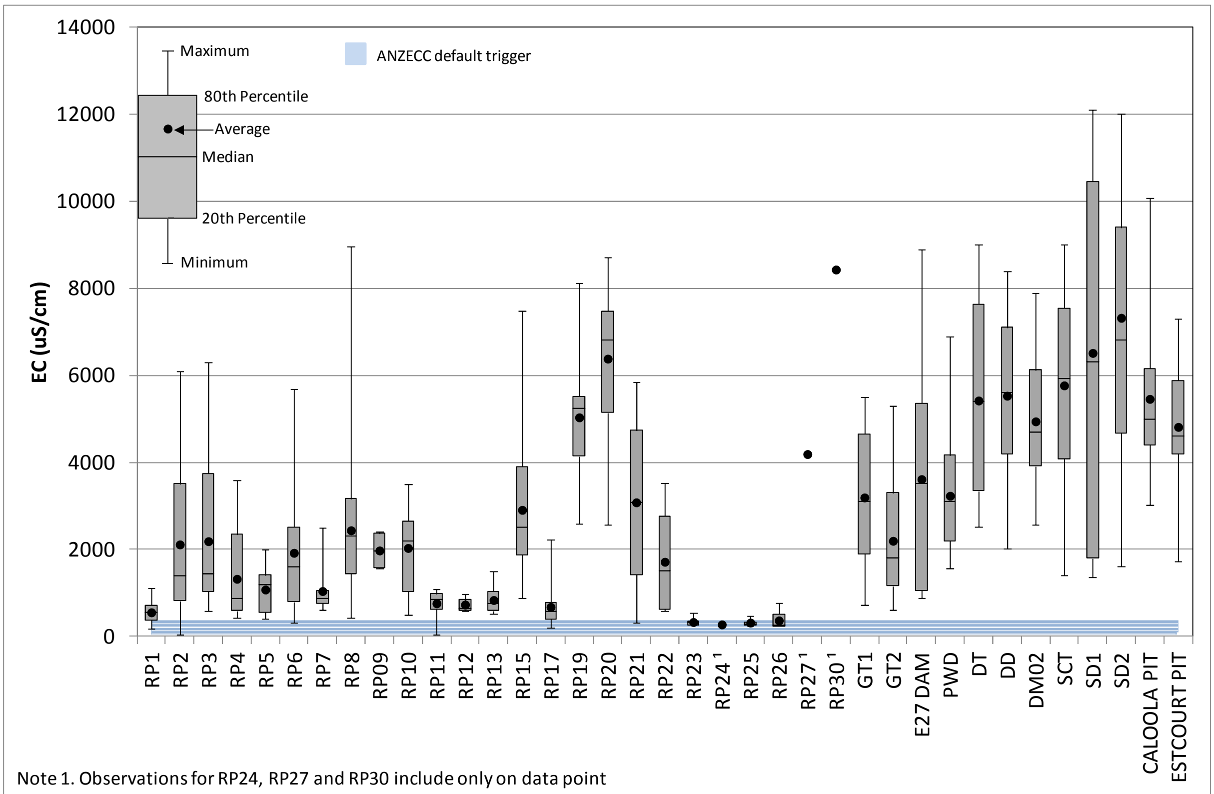


Chart 3.12 – Contaminated Water System - Electrical Conductivity

3.4.3.3. **Copper**

The analysis of watercourse samples shows a mean Cu concentration of 0.122 mg/L across all monitoring data. The Cu concentration is consistently above the ANZECC default trigger value of 1.4 µg/L within the contaminated water system monitoring locations (refer to **Chart 3.13**) with a maximum recorded value of 3.8 mg/L at GT1 (located between E48 and E27; refer to **Figure 3.3**). No recorded Cu concentrations were below the ANZECC default trigger value.

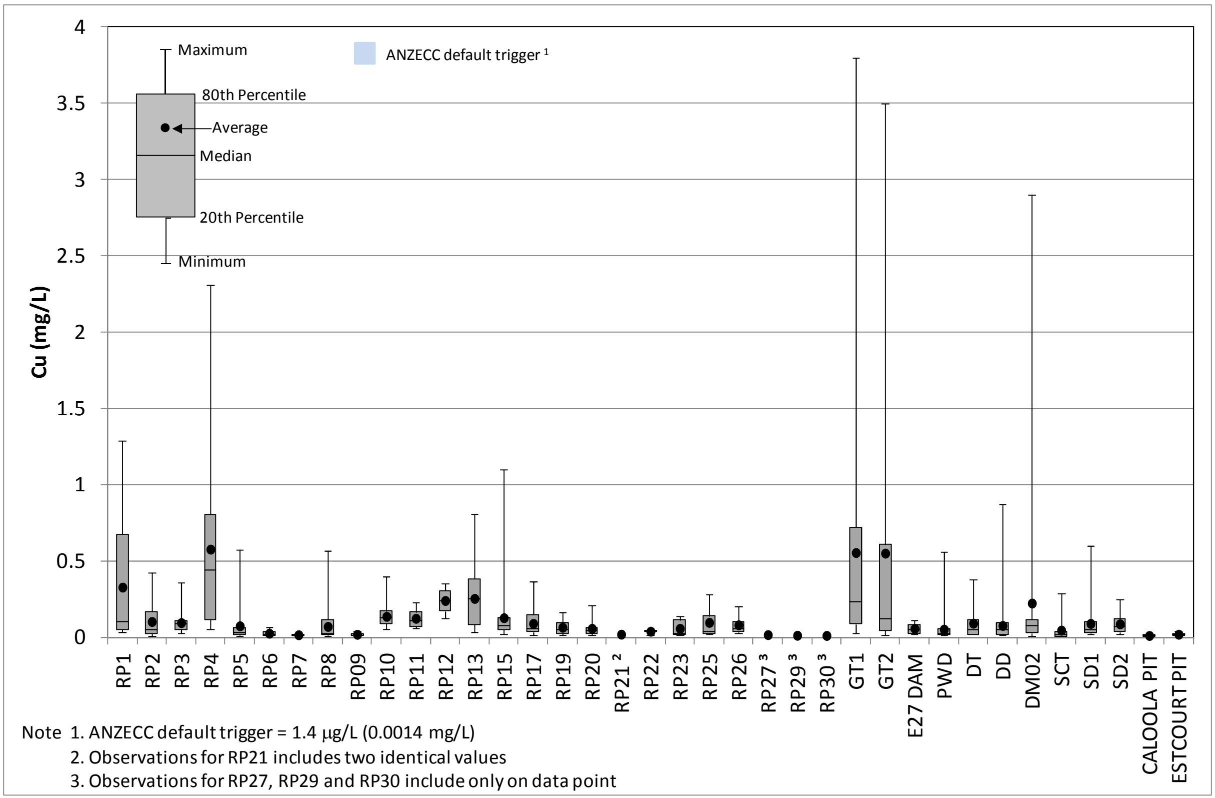


Chart 3.13 – Contaminated Water System – Copper

3.5. Water Quantity

Surface water constraints are highly dependent upon the nature of the flooding and dry weather flows within watercourses. As previously discussed, the Project Area directly interacts with two tributaries of the Bogan River. These waterways are typically ephemeral and only flow after heavy or prolonged rainfall events.

The NOW monitors surface water flows at gauging station 421076 on the Bogan River at Peak Hill, approximately 500 metres downstream of Bogan Weir, approximately 30 kilometres downstream of the Project Area (refer to **Figure 3.2**). Monitoring data for this location is available from 1925 (gauging station 421010 (now decommissioned) and 421076) and includes daily and continuous flow rates and levels.

3.5.1. Annual Flow Volumes

The annual flow volumes for a given watercourse are used as an indicator to help evaluate the existing watercourse health, the geomorphic and hydrologic pressures a watercourse and its ecosystem may be under, and the sensitivity of a watercourse or its ability to recover from potential stressors that may exist within its ecosystem.

Historical flow monitoring data at Bogan Weir was used to estimate the mean annual flows within the Bogan River at the Bogan Weir. These results were compared to the annual flow estimates from the Farm Dam Calculator which is designed to determine maximum harvestable rights from a catchment, and estimates 10 per cent of the average regional catchment runoff for given location and area.

- The catchment area of Bogan River at the flow gauging station 421076 downstream of Bogan Weir is approximately 103,600 hectares. An analysis of the historical flow data from the flow gauging station downstream of Bogan Weir indicates a specific mean discharge for the catchment of 0.204 ML/ha/year.

- The NSW Farm Dams Calculator (farmdamscalculator.dnr.nsw.gov.au) was used to estimate the average regional runoff from the Bogan River catchment at the flow gauging station downstream of Bogan Weir. The annual flow volume estimated by the farm dams calculator is 62,160 Mega Litres (ML), based on a harvestable right provision of 0.06 ML/ha/year being equivalent to 10 per cent of average regional runoff rates. As such the NSW Farm Dams Calculator estimates an average regional runoff rate of 0.6 ML/ha/year for the Bogan River catchment.

The NSW Farm Dams Calculator estimates a significantly higher annual flow rate than the flow gauge analysis indicates for the Bogan River catchment. The NSW Farm Dams Calculator is a simplified method used to estimate catchment runoff, and should not be used for detailed assessment where other methods of determining catchment runoff are available. In addition, the analysis of the historical streamflow intrinsically includes evaporation losses from the catchment, which can be up to six times greater than the rainfall during the same period (refer to **Section 3.3**).

3.5.2. Baseflow

The baseflow of a watercourse is the term given to the flows within a watercourse that persist between rainfall events. In very large catchments with terrains that have very high water storage capacities, or in river systems that include groundwater springs, baseflows can provide flows within a watercourse for many months or years. Like most Australian river systems however the upper reaches of the Bogan River is considered to be ephemeral and as such the river ceases to flow during dry periods. Baseflows within the Bogan River are therefore likely to account for only a small percentage of the total flows observed within the Bogan River.

A recursive digital filter (Arnold *et al.* 1995) was used to estimate the baseflow signal within the observed streamflow series at the Peak Hill flow gauge downstream of the Bogan Weir. The filter works by isolating the low frequency baseflow signal from the daily streamflow series by filtering the streamflow data three times: first forwards (Pass 1); then backwards (Pass 2); and finally forwards again (Pass 3). Example sections of the separated baseflow signal can be found in **Charts 3.14** and **3.15**.

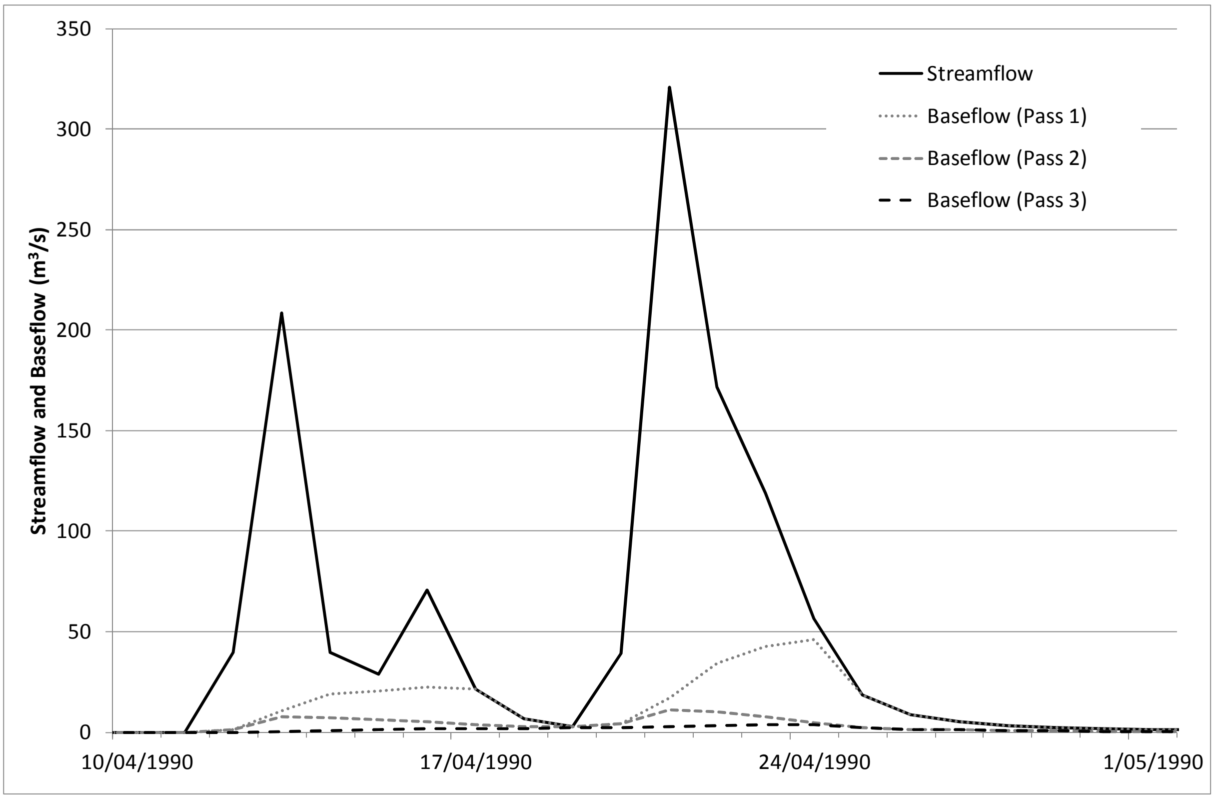


Chart 3.14 - Example Baseflow Separation (1990)

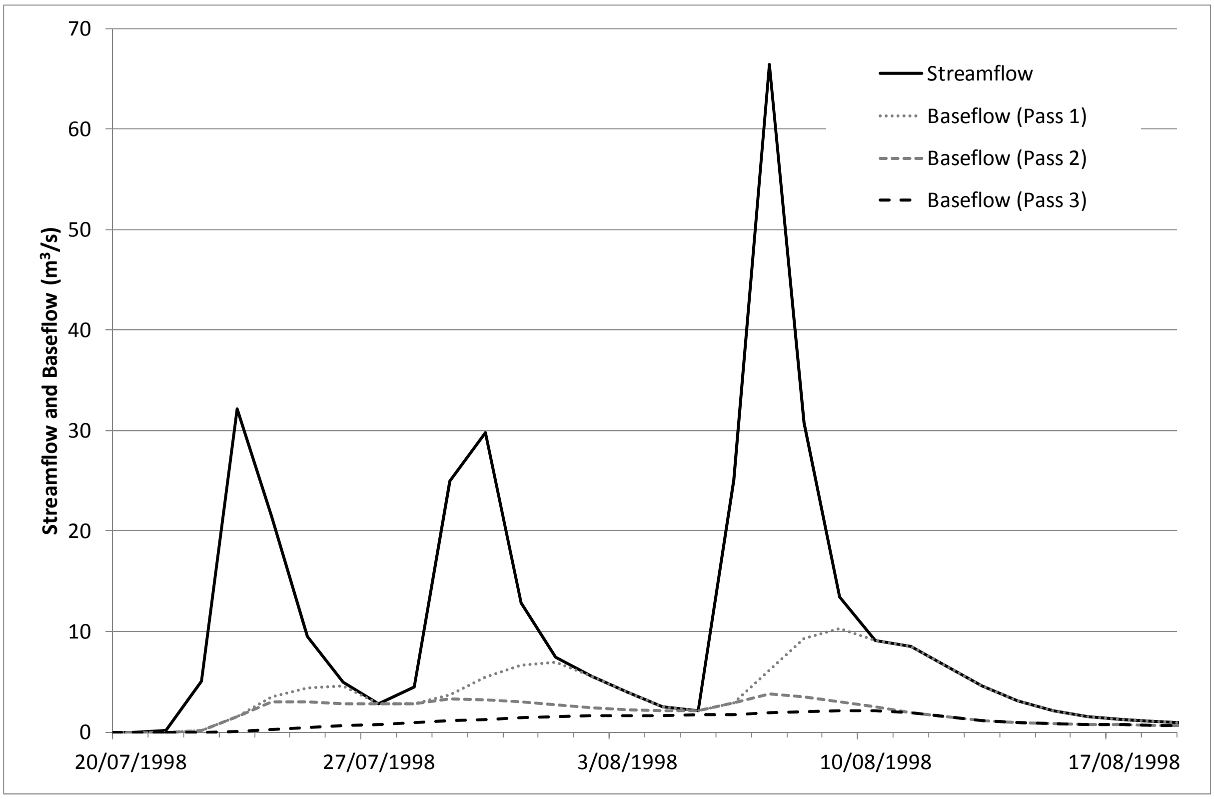


Chart 3.15 - Example Baseflow Separation (1998)

As shown in **Charts 3.14** and **3.15**, the baseflow separation analysis indicates that there is only a very small proportion of baseflow in the Bogan River. Analysis of the data indicates as little as 6 per cent of the observed streamflow is attributable to baseflow, equivalent to approximately 1400 ML/year of the mean annual flow at the flow gauge downstream of the Bogan Weir. This small fraction indicates that baseflows within the Bogan River are most likely the result of the slow drainage of soil moisture from the open pasture areas and alluvial soils that surround the Bogan River.

3.6. Flood Regimes

The one dimensional (1D) XP-Storm modelling package describes a watercourse on terms of a series of nodes and links. The links of the model describes the watercourse geometry, including cross sectional profile and longitudinal slope. The links are joined by nodes, which are also used as points of interface between the upslope runoff and watercourse routing. The 1D XP-Storm model was used in this study to estimate the flood response of watercourses within the Project Area and to identify any potential downstream impacts for four design storm events, including:

- 10 year Average Recurrence Interval (ARI), critical duration design storm event;
- 20 year ARI, critical duration design storm event; and
- 100 year ARI, critical duration design storm event.

Hydrodynamic modelling incorporated reaches of Tenandra Creek, Goonumbla Creek, Bogan River, and an unnamed tributary in the north-west of the Project Area. The total catchment area modelled was approximately 12,400 hectares subdivided into 25 subcatchments. A conservative assumption was made that all ponding areas and dams within the catchment were full and as such would not provide any attenuation of flood flows.

The modelled flood extent for the 100 year ARI critical duration design storm event is included in **Figure 3.4**. As can be seen from **Figure 3.4**, the existing operations are outside of the modelled 100 year ARI flood extent.

3.7. Downstream Water Users

It is understood that watercourses within the vicinity of NPM are ephemeral, with periods of limited or no flow during periods of low rainfall. The ephemeral nature would suggest that dependence on flows within these watercourses to downstream agricultural users is likely to be limited.

However, NPM is within the Upper Bogan water source as specified by the Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Sources 2012.

The Macquarie-Bogan system has a total catchment area of approximately 7,480,000 hectares, approximately 2641 hectares (0.04 per cent) of which lies within the proposed NPM Project Area. The Water Sharing Plan allows for basic landholder rights of 261 ML/day for domestic and stock access, with a further 154.5 ML/year available for extraction for domestic and stock access under extraction licences.

Source: Project Area: NPM (2011), Drainage Lines: LPMA (2011), Aerial: Google Earth (2006)

0 0.5 1 2km
1:40 000

Legend

- Project Area
- Proposed Tailings Storage Facility Extension
- Proposed TSF3
- New Underground Block Cave Mining Area
- Proposed Open Cut Areas
- Proposed Upgrade to McClintocks Lane
- Proposed Access Control and Visitor Car Park
- Proposed Waste Dumps
- Proposed Site Access Road
- Proposed Haul Road
- 1 in 10 year ARI
- 1 in 20 year ARI
- 1 in 100 year ARI
- Drainage Line

FIGURE 3.4

Modelled Flood Extents - 10 year, 20 year and 100 year ARI Critical Duration Design Storm Events

File Name (A4): R11/2949_247.dgn
20130510 13.25

4.0 Water Management System

4.1. Strategy

The NPM WMS aims to economically and efficiently collect and store water on site to minimise the need for external water supply inputs and supplement external water supply.

The water management strategy includes the separation of clean, dirty and contaminated water, preventing the contamination of clean water by mining activities and ensuring compliance with NPM statutory obligations. To achieve this, the key functions of the mine WMS include:

- collecting and storing on-site water as much as possible for reuse in the mining and processing operations;
- diverting clean water around mining operations to prevent the contamination by mining activities;
- controlling the diversion of onsite non-mine impacted waters away from mining activities to reduce the volume of mine impacted water;
- minimising adverse effects on downstream waterways (i.e. hydraulic and water quality impacts);
- collecting and containing all potentially contaminated water on site; and
- minimising the risk of pollution from the mine to the environment.

The existing water management system at NPM will continue to be implemented to control and treat runoff from the site, with all pit water and mine surface runoff directed to the mine WMS. Additional controls will be designed to supplement existing controls measures and will be integrated into the existing surface water management control measures at NPM.

For the purposes of the surface WMS, the water on site is divided into three categories based on water quality: 'clean', 'dirty' and 'contaminated'.

- **Clean Water** is categorised as surface runoff from areas of the mine site where water quality is unaffected by mining operations and includes runoff from undisturbed areas, rehabilitated areas, topsoil stockpiles and water imported from off site. The clean water system includes the surrounding watercourses and farm dams that are outside of the WMS.
- **Dirty Water** is categorised as surface runoff water from the catchments draining to the sedimentation basins. This runoff may contain sediment and silt, but does not contain contaminated material. In order to ensure compliance with the NPM conditions of operation and adopted water quality criteria this runoff must be of sufficient quality prior to being discharged off site into surrounding natural watercourses. The dirty water system includes sediment dams that receive runoff from waste rock stockpile areas and tailings dam walls.

- **Contaminated Water** is categorised as surface water and groundwater inflows from areas affected by mining and processing operations and normally containing chemicals of various types used in the mining operations. There are restrictions on the use and release of this water. Areas which may contain contaminated water include stilling ponds, sumps, retention ponds, process water dams and tailings impoundments. Process water, rainfall and ensuing runoff from these areas may also be potentially contaminated water and thus must be managed to avoid discharge of potentially contaminated water into the surrounding natural watercourses. The contaminated water system includes runoff from open cut mining areas and decant water from the TSFs.

4.2. Water Management System Design Criteria and Operational Management

The mine WMS is managed in accordance with the procedures and guidelines as presented in 'Managing Urban Stormwater: Soils and Construction' (the Blue Book) Volume 1 (Landcom 2004) and 'Volume 2E Mines and Quarries' (DECC 2008), which are outlined for each part of the system in **Sections 4.2.1** to **4.2.3**.

4.2.1. Clean Water

The clean WMS includes a series of diversion drains and dams (refer to **Figure 4.1**) around the perimeter of the active mine and infrastructure areas, in order to safely capture and divert upstream catchment runoff away from the areas disturbed by operations. As mining progresses, the clean water controls will be maintained by the construction of new drains and dams as needed.

Diversion drains are sized to safely convey flows generated by the 100 year ARI critical storm duration, as well as pumped flows from upstream clean water dams. Key design criteria include:

- a trapezoidal channel cross section with side batters between 1 (vertical) : 3 (horizontal) and 1 (vertical) : 6 (horizontal) to allow safe access and egress;
- longitudinal grades of approximately 1 (vertical) : 400 (horizontal) for unlined channels to ensure that the design flow velocities are non-scouring;
- grass lining where velocities permit;
- rock protection and energy dissipation structures at channel outlets (where required) to minimise scour and erosion within the downstream environment; and
- level sill outlets with stable grass cover downstream.

The clean water dams are designed to contain runoff generated by the 100 year 24 hour design storm event. The clean water dams are actively managed to maintain storage levels at or below 30 per cent to ensure maximum water storage potential and reduce evaporation loss.

Source: NPM (2013), Google Earth (2006,2010)

0 0.5 1.0 2.0km
1:40 000

Legend

- Project Area
- Approved Waste Rock Stockpile
- Approved Tailings Storage Facility (Rosedale)
- Existing Tailings Storage Facility
- New Underground Block Cave Mining Area
- Approved Water Management System Area
- Existing Bund
- Catch Drain
- Diversion Bank
- Farm Dams
- Sediment Dams

FIGURE 4.1

Approved Conceptual Water Management System

4.2.2. Dirty Water

The dirty WMS includes a series of catch drains and sediment dams located to capture and manage runoff from disturbed areas, including surface infrastructure areas that do not handle contaminated water. The treated runoff from disturbed areas is managed within the mine WMS. The dirty water system also captures runoff from potential areas of NRD.

The catch drains are designed to safely convey runoff generated by the 10 year ARI critical duration design storm event. The sediment dams are emptied using a pump and pipe system after rainfall events and managed to actively maintain storage at below 30 per cent to ensure maximum return, minimise potential for spills and reduce evaporative losses.

Key design criteria include:

- a trapezoidal channel cross section with side batters between 1 (vertical) : 3 (horizontal) and 1 (vertical) : 6 (horizontal) to allow safe access and egress;
- longitudinal grades of approximately 1 (vertical) : 400 (horizontal) for unlined channels to ensure that the design flow velocities are non-scouring;
- grass lining where velocities permit;
- rock protection and energy dissipation structures at channel outlets (where required) to minimise scour and erosion within the downstream environment; and
- level sill outlets with stable grass cover downstream.

Generally sediment dams are designed in accordance with 'Managing Urban Stormwater: Soils and Construction' (the Blue Book) Volume 1 (Landcom 2004) and 'Volume 2E - Mines and Quarries' (DECC 2008). The design criteria for the sediment basins assumes that:

- the clay content of top soils and subsoils on site suggest that sediment dams be designed for fine (Type F) soil types; and
- the sensitivity of the receiving environment is standard.

Sediment basins include:

- a capacity to adequately capture the intercepted runoff generated by the 90 th percentile five day duration rainfall event;
- a crest width should be a minimum of 3 metres wide;
- a crest height should be a minimum of 0.85 metre above spillway level (i.e. the flow depth expected during a 100 year ARI critical duration design storm plus 300 millimetres freeboard);
- a spillway designed to remain structurally sound for events up to and including the 50 year ARI critical duration design rainfall event;
- excavation and dam batters should be at least 1 (vertical) : 3 (horizontal);
- inlet and outlet channel batters should be 1 (vertical) : 6 (horizontal); and
- an outlet channel with a longitudinal slope of approximately 1 (vertical) : 400 (horizontal) if the channel is unlined.

4.2.3. Contaminated Water

NPM is a zero discharge operation and offsite release or pollution of water bodies on or offsite requires reporting to the Environment Protection Agency (EPA). Therefore, these water categories are managed through an infrastructure and drainage network so as to prevent pollution, off lease discharge and maximise water reuse within the NPM contaminated water system. Consequently, the contaminated water system is a closed circuit and is designed to maximise water reuse and minimise water discharge.

Process water dams are designed and operated maintain freeboard capable of containing the runoff generated by the 100 year 24 hour design storm event.

4.2.4. Potable Water

Potable water for site is imported from the PSC pipeline and processed in an onsite Water Treatment Plant for administration and office facilities.

4.2.5. Wastewater Management

Wastewater from the office and administration facilities is processed in a sewage treatment plant with effluent being pumped to the Contaminated Water System for reuse in the processing plant.

4.2.6. Erosion and Sediment Controls

Erosion and sediment controls are implemented to mitigate the impacts of construction and mining operations on nearby watercourses and the surrounding environment. Standard erosion and sediment control techniques are in accordance with the requirements of 'Managing Urban Stormwater: Soils and Construction' (the Blue Book) (Landcom 2004 and DECC 2008) and 'Volume 2E Mines and Quarries' (DECC 2008). Erosion and sediment control measures to be implemented to support the WMS during construction and operation include:

- clearly identifying and delineating areas required to be disturbed and ensuring that disturbance is limited only to those areas, clearing vegetation only as required to achieve the works and minimising machinery disturbance outside of these areas;
- limiting the number of roads and tracks established;
- constructing access road and earthworks cut and fill batters at slopes (of 1 (vertical) : 3 (horizontal) or less, where possible), to maximise long term stability;
- reshaping, topsoiling and vegetating road cut and fill batters as soon as practical;
- progressively stripping and stockpiling topsoil for later use in rehabilitation;
- diverting clean upstream runoff away from disturbed areas;
- regular maintenance of erosion control works and rehabilitated areas;

- prompt revegetation of areas as soon as earthworks are complete, where practical;
- the placement and maintenance of oil management systems downslope of key infrastructure and high traffic hardstand areas;
- sediment fences are to be placed around the downslope batter of all topsoil stockpiles to reduce the potential for sediment transport from the stockpile; and
- stockpiles that are to remain undisturbed for periods of greater than six months are grassed.

4.3. Approved Water Management System

Within the Project Area, the approved WMS includes catch drains, diversion bunds, sediment dams and process water dams that manage runoff water from the tailings and waste rock stockpiles areas, as well as the surrounding undisturbed catchment area. The key components of the approved WMS are outlined in the sections below as well as in **Figure 4.1**. A schematic of the existing WMS is included as **Figure 4.2**. The approved WMS manages runoff from a catchment area of approximately 1278 hectares within the Project Area.

4.3.1. Tailings

The approved WMS includes sediment dams and catch drains associated with the dirty water system for Estcourt TSF, TSF1 and TSF2. The contaminated water system for these tailings facilities includes a return water dam located between TSF1 and TSF2.

The approved TSF3 is located to the south of the existing TSFs (refer to **Figure 1.2**). The approved WMS includes three catch drains (CD1, CD3 and CD4; refer to **Figure 4.1**) which intercept runoff from tailings dam walls. The intercepted runoff is conveyed to Sediment Pond 7 to the north and the Raw Water Dam to the south.

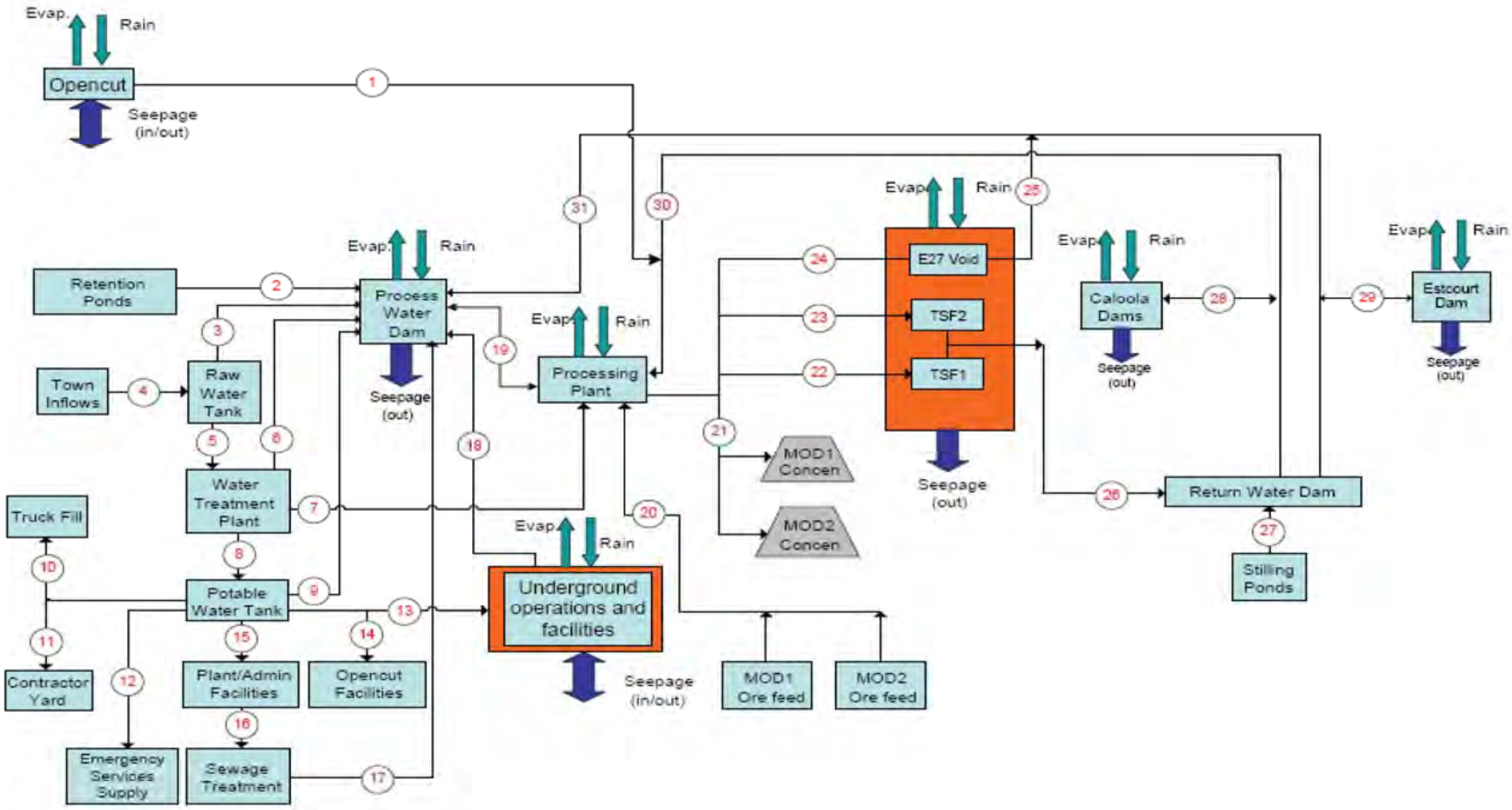
Where practical, runoff from clean upslope areas is diverted around TSF3 by diversion bunds (DB1 and DB3; refer to **Figure 4.1**). These diversions minimise the volume of water intercepted by the WMS and assist in maintaining natural flows within the surrounding watercourse system.

4.3.2. Waste Rock Stockpile

An approved waste rock stockpile is proposed to the east of E26 (refer to **Figure 4.1**). The approved WMS included a single catch drain (CD5) to the east and north of the waste rock stockpile to the south of Goonumbla Creek, which conveys potentially sediment laden runoff westwards into process water dam (RP6) for reuse on site as part of the dirty water system.

4.3.3. Open Cut and Underground Mining Areas

The approved WMS associated with the approved open cut and underground mining areas (E22, E26 and E48) include diversion bunds to prevent the interception of surface water. E27 is also used as an additional water storage to assist in meeting the ore processing requirements over the summer months.



Flows:

1. Water from Opencut to processing plant
2. Retention ponds pumped to process water dam
3. Overflow from RWT to PWD (including reagent water)
4. Raw water demand from town supply
5. Feed water to the water treatment plant (incl. clarifier)
6. Overflow from water treatment plant to PWD
7. Gland seal water & flocculant water
8. Treated water to potable water tank
9. Overflow from potable water tank to process water dam
10. Truck fill for dust suppression and other activities
11. Potable water to contractor yards for domestic use
12. Emergency services supply in the event of fire
13. Water supply to underground operations and facilities
14. Water supply to opencut facilities
15. Potable water supply to plant and admin for domestic use
16. Sewage from plant and admin facilities
17. Treated sewage return water
18. Return from underground operations
19. Process raw water supply & overflows back to PWD
20. Water in ore feed
21. Interstitial water in product (concentrate)
22. Tailings water discharge to TSF1
23. Tailings water discharge to TSF2
24. Tailings water discharge to E27 void
25. Water reclaimed from the E27 void TSF to PWD
26. Water reclaimed from the TSFs decant and phreatic drains
27. Captured water pumped to RWD
28. Temporary storage water to/from Caloola Dam
29. Temporary Storage water to/from Estcourt Dam
30. Return water to process plant
31. Return water to PWD

FIGURE 4.2

Approved Water Management System Schematic

Source: GHD (2009)

4.4. Proposed Modifications to the Water Management System

The proposed Project includes changes to the size and shape of the approved TSF3, extension of the approved waste rock stockpile to the east of E26 and an additional waste rock stock pile to the west, and five open cut mining areas (one within the subsidence zone associated with E26.

The changes to the approved development consent will require modifications to the WMS. The proposed modifications to the WMS are consistent with the current water management strategy for the operation (refer to **Section 4.1**). The proposed conceptual modifications to the existing WMS are outlined in **Sections 4.4.1** to **4.4.5** and shown in **Figure 4.2**. The proposed modifications to the WMS will increase the catchment of the WMS to approximately 1481 hectares.

4.4.1. Tailings

The modified TSF3 requires the modification of the associated dirty water and contaminated WMS. The Raw Water Dam is to be relocated away from the open cut E31N (refer to **Figure 1.2**), which in turn requires the modification of the catch drain (CD3) that drains into the Raw Water Dam (refer to **Figure 4.3**).

The northern extent of the eastern catch drain (CD4) is proposed to be moved to follow the toe of the modified TSF3. The modified CD4 will discharge sediment laden runoff into the relocated SD7 (refer to **Figure 4.3**).

The western catch drain (CD1; refer to **Figure 4.3**) will also be modified, no longer able to gravity feed runoff into the relocated Sediment Dam 7. Therefore, an additional sediment dam (SD8; refer to **Figure 4.3**) is required to manage the sediment laden runoff.

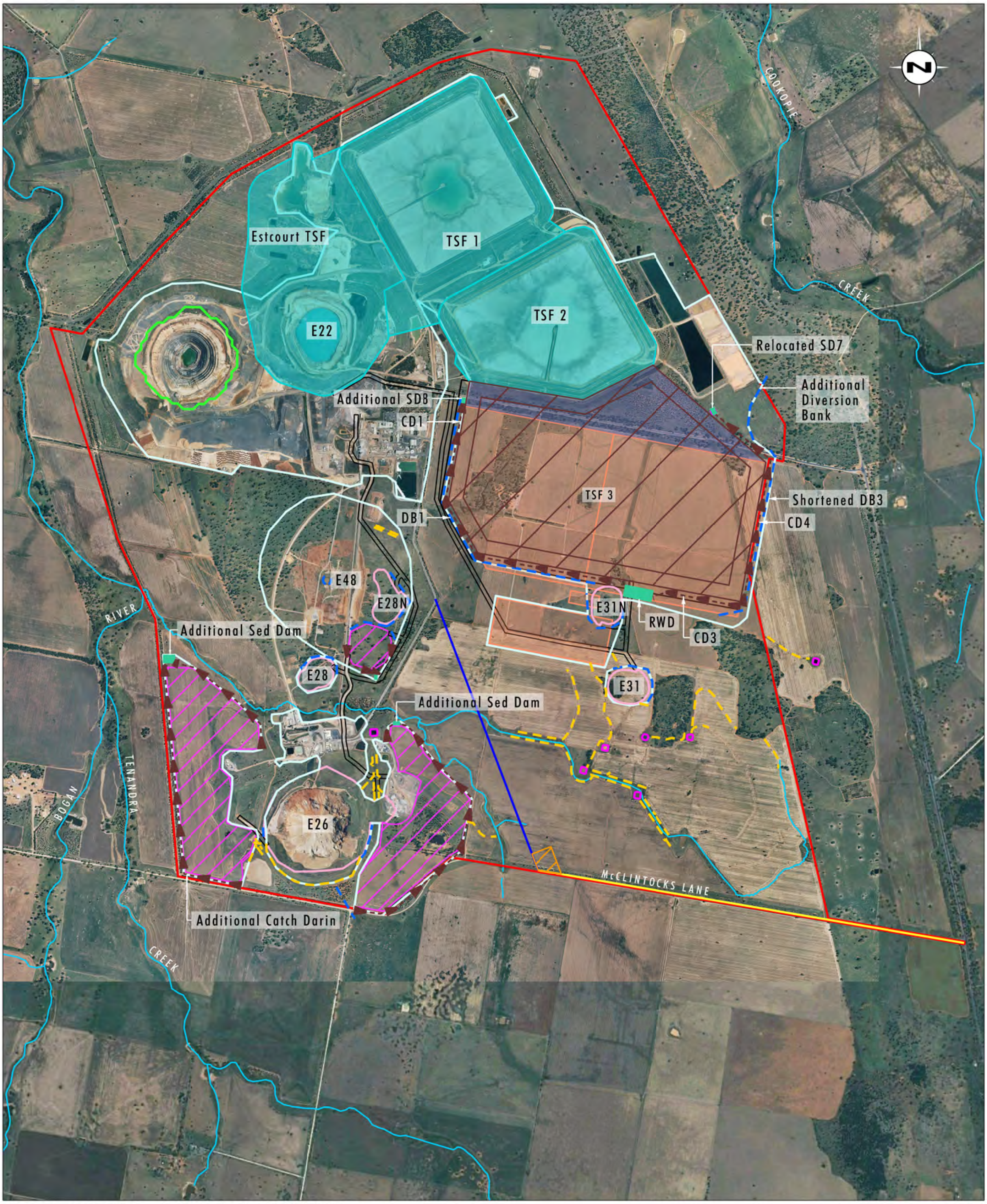
The diversion bank to the east of TSF3 (DB3) will also be modified to the southern extent of TSF3. An additional diversion bank to the north of DB3 will be required to assist in diverting clean runoff away from the operational areas.

The modifications to the WMS required in response to the proposed changes to TSF3 result in an increase in the catchment area of the WMS associated with TSF3 of approximately 52 hectares. This catchment area is primarily located within the Cookopie Creek catchment, and represents a reduction of approximately 2.2 per cent in the catchment area of Cookopie Creek (as shown in **Figure 3.1**).

4.4.2. Waste Rock Stockpile

The proposed additional waste rock stockpiles to the east and west of E26 and adjacent to the proposed E28 open cut (refer to **Figure 1.2**) require additional catch drains and sediment dams to be constructed (refer to **Figure 4.3**) within the dirty water system.

For the proposed waste rock stockpile located to the east of E26, the proposed catch drain will replace a previously approved catch drain (CD6). Two new catch drains are required to intercept sediment laden runoff from the proposed waste rock stockpile to the west of E26 (refer to **Figure 4.3**). These catch drains will be constructed at the toe of the proposed waste rock stockpiles and will incorporate a 1 metre high flood protection bund refer to **Section 6.3**). The intercepted runoff from the proposed E26 waste rock stockpiles will be conveyed to two additional sediment dams (retention dams will be constructed if required dependent on characterisation of the material to produce NRD) located to the north of the proposed E26 waste rock stockpiles, adjacent to Cookopie Creek (refer to **Figure 4.3**).



Source: NPM (2013), Google Earth (2006,2010)

0 0.5 1.0 2.0km
1:40 000

Legend

- Project Area
- Approved Tailings Storage Facility (Rosedale)
- Existing Tailings Storage Facility
- Proposed Tailings Storage Facility Extension
- New Underground Block Cave Mining Area
- Proposed TSF3
- Proposed Open Cut Areas
- Proposed Upgrade to McClintocks Lane
- Proposed Access Control and Visitor Car Park
- Proposed Waste Dumps
- Proposed Site Access Road
- Proposed Haul Road
- Proposed Water Management System Area
- Bund Levee
- Catch Drain
- Diversion Bank
- Farm Dams
- Sediment Dams
- Drainage Line

FIGURE 4.3

Proposed Conceptual Water Management System

The proposed waste rock stockpile located adjacent to the proposed E28 open cut area (refer to **Figure 1.2**) will require two catch drains to the south of the proposed E28 waste rock stockpile, which intercept sediment laden runoff and convey it towards a new sediment dam (refer to **Figure 4.3**). A diversion bank is also required to prevent runoff from upper catchment areas entering the WMS (refer to **Figure 4.3**).

The modifications to the WMS required for the proposed waste rock stockpiles will result in an increase in catchment area being managed within the WMS associated with the waste rock stockpiles of approximately 129 hectares. The proposed E26 western stockpile, with a WMS catchment area of approximately 77.8 hectares, lies primarily within the Bogan River catchment. The proposed E26 eastern stockpile, with a WMS catchment area of approximately 68.7 hectares (including approximately 22.5 hectares associated with the approved waste rock stockpile), lies primarily within the Goonumbla Creek catchment. The proposed E28 stockpile, with a WMS catchment area of approximately 4.7 hectares, is located within the Goonumbla Creek catchment. This is equivalent to approximately 3.4 per cent and 3.3 per cent of the Bogan River and Goonumbla Creek catchments (as shown in **Figure 3.1**) respectively.

4.4.3. Open Cut Mining Areas

Local protections, in the form of clean water diversion bunds, will be required to minimise the volume of clean runoff water entering the proposed open cut pits areas (E26, E28, E28N, E31 and E31N) (refer to **Figure 4.2**). The diversion bunds allow for runoff from clean catchment areas to be returned to the downstream environment without placing an unnecessary burden on the WMS. Runoff within the open cut mining areas will be managed within the contaminated WMS.

The modifications to the WMS required in response to the proposed increase in open cut mining areas result in an increase in the catchment area of to WMS associated with the open cut areas of approximately 21.3 hectares. This catchment area is primarily located within the Goonumbla Creek catchment, and represents a reduction of 1.5 per cent in the catchment area of Goonumbla Creek (as shown in **Figure 3.1**).

4.4.4. Underground Mining Areas

The proposed block cave mining operations within E22 (refer to **Figure 1.2**) will be undertaken in an area previously disturbed by open cut mining operations within E22. The modifications to the WMS required will result in an increase in the catchment area of the WMS associated with the underground mining areas of approximately 1.1 hectares.

4.4.5. Proposed Access Road Upgrades and Associated Facilities

Stormwater controls for the construction of the access road and associated facilities will be designed in accordance with the relevant requirements of the Blue Book (refer to **Section 6.1.1**). In addition the crossing of Goonumbla Creek will be designed to safely convey the 100 year ARI storm event flood flows.

5.0 Site Water Balance

5.1. Approved Site Water Balance

Water demands at the NPM site include ore processing (including tailings disposal), open cut and underground mining activities, dust suppression, construction activities and potable water requirements. Approximately 80 per cent of the total site water demand is required for ore processing. Water is also lost via evaporation from the on-site water storages.

The water demands on site are met from the capture of surface water runoff from active mining areas and rainfall onto water storages, groundwater inflows into mining operations, import of licensed water from the Lachlan River, groundwater bores and Parkes Shire Council (PSC).

The historical water volumes and recycled water used to meet the on-site water demands are summarised in **Table 5.1**.

Table 5.1 – Northparkes Mine Water Sources 2008 to 2011

Source	Quantity Used (ML)			
	2011	2010	2009	2008
Freshwater piped from the Lachlan Valley bore field (A)	2,379	3,141	3,499	3,471
On Site Surface Water Runoff (B)	1,054	1,627	430	304
Total Water Sourced (A + B)	3,433	4,768	3,929	3,775
Recycled water	1,898	1,375	1,797	1,288

The future annual water requirement at NPM for the current approved operations is summarised in **Table 5.2**.

Table 5.2 – Annual Water Requirement

Water Source	Current Approved Operations
External	4,416
Recycled [1]	2,091
Surface Water Runoff [2]	400
Groundwater	63
Total	**6,970**

Source: GHD 2009.
Notes: 1.Recycled water includes direct rainfall onto tailings storage facility surface as is located within Contaminated Water System.
2.Surface water runoff includes runoff within the dirty WMS.

The currently approved site water balance for NPM indicates that the site currently has a net water deficit of approximately 4400 ML per year which is met by imported water from external sources (refer to **Section 5.1.1**).

5.1.1. External Water Sources

External water sources include licensed bores, high security river water licences and external supply from PSC through jointly owned infrastructure (refer to **Table 5.3**).

Table 5.3 – NPM Water Licences

Licence Type	Licence Number	Entitlement (ML)
Bore licence – high security (Avondale, Bore 6)	70BL226550	1,600
Bore licence – high security (Avondale, Bore 7)	70BL230929	1,600
Bore licence – high security (Avondale)	70BL229975	14
Bore licence – high security (Dawes, Bore 8)	70BL226584	1,050
Bore licence – dewatering (E26 and E48)	80BL245448	232
Bore licence – dewatering (E22)	80BL245449	
Bore licence – dewatering (E27)	80BL245450	
Lachlan River water licence - general	70AL600028	2,976

In addition, NPM holds approximately 3000 ML of general and high security river allocations from the Lachlan, and has access to approximately 1000 ML from PSC through the established joint water user supply agreement.

5.2. Potential Changes to Site Water Balance Associated with the Project

The approved conceptual site water balance (GHD 2009) has been updated to consider the Project. The primary influence of the proposed Project on the site water balance is increases in the surface water runoff area. The Project is expected to reduce the predicted site water deficit and result in minor changes to the associated water management infrastructure and external sourcing of water. The potential impacts of the Project on the water balance and associated external sourcing of water is discussed in **Sections 5.1** to **5.3**.

5.2.1. Water Demands

The Project water demands are not expected to change from the currently approved water balance (refer to **Section 5.1**). Each demand and any potential impacts are discussed briefly below.

- Water Lost to Ore Processing:
  - The production rate for the Project is up to 8.5 Mtpa which is consistent with the existing approved production levels and as such no change in predicted water demands for ore processing are expected with the Project.
- Open Cut and Underground Mining Activities:
  - The open cut and underground mining activities are proposed to be operated on a campaign basis, and be able to provide a steady supply of ore to the processing plant. The water demands for the open cut and underground mining activities is therefore expected to remain consistent with the currently approved operations.

- Dust Suppression:
  - As the operational area of the proposed Project will remain similar at any one point in time no impact on the water demands for dust suppression in either open cut areas and waste rock stockpiles is expected.
- Construction Activities:
  - The water requirements of the construction of the proposed continued operations will be met by the existing water supply options within the NPM WMS.
- Potable Water:
  - No changes in the requirement for potable water are expected as a result of the proposed Project as there is not proposed change in employee numbers.
- Evaporation:
  - The proposed Project will not result in any major changes to the scale of approved water management infrastructure. As such, the losses to evaporation are not expected to change with the proposed Project.

5.2.2. Water Sources

External water sources are expected to remain unchanged from the existing water supply arrangements, including river water and bore licences, and water supply agreements with PSC. The reduced water deficit that is expected is primarily the result of an increase in the on-site surface water runoff and an increase in the estimated groundwater inflows.

A summary of the water sources is included below.

- External:
  - Licensed Bores (refer to **Table 5.3**).
  - High security river water licences (in times of low water security) (refer to **Table 5.3**).
  - External supply from PSC through jointly owned infrastructure.
- Recycled:
  - Water recovery and reuse from ore processing operations is not expected to change with the proposed Project as no changes are proposed to the processing plant or maximum ore processing levels. Nor are there expected to be significant fluctuations in the volume of water recovered from the tailings storage facilities compared to the currently approved water balance, with the total operating area of tailings storage facilities decreasing from the currently approved area of approximately 512 hectares to approximately 478 hectares for the proposed tailing storage facilities in the future.
- Surface Water Runoff:
  - The dirty WMS catchment area is estimated to increase from approximately 766 hectares to approximately 1002 hectares. This increase in surface water catchment area has the potential to increase on site water sourcing relative to water demands and as a result reduce the predicted site water deficit, relative to the currently approved site water balance (GHD 2009), with an increase of approximately 123 ML per year of runoff expected in an average rainfall year (refer to **Section 6.2.1**).

- Groundwater Inflows:
    - The currently approved site water balance indicates groundwater inflows of approximately 63 ML per year (i.e. 0.17 ML per day) into E48.
    - Based on the groundwater assessment of the proposed Project the groundwater inflow volumes modelled for the approved mine plan are expected increase with the proposed Project to an average predicted inflow of 0.8 ML per day. This equates to an increase in groundwater inflows to the operations of approximately 290 ML per year.

5.2.3. Water Disposal Methods

The WMS is design to adequately manage the runoff generated by storm events up to and including the 100 year ARI 72 hour design storm event. NPM is therefore in practical terms a nil discharge site in that no water from the contaminated water system is to be discharged off site. This strategy is proposed to continue with the Project.

5.2.4. Supply Infrastructure

No additional external water supply infrastructure is proposed with the Project. Some additional local surface water dams are required for the proposed WMS (refer to **Section 4.4** and **Figure 4.3**). However, all of the proposed surface water dams are located off line to creeks or on first or second order drainage lines.

5.3. Summary of Predicted Site Water Balance

In summary, NPM will continue to have a net water deficit with the Project in the order of up to 4050 ML per year. The predicted annual water demands for NPM will remain consistent with the currently approved water demands (refer to **Section 5.1**). The proposed Project will increase the area of the currently approved WMS by approximately 203 hectares (a 16 per cent increase in the currently approved WMS catchment area). As a result of the increase in the WMS catchment area, on site runoff is predicted in an average runoff year to increase from approximately 400 ML per year to 523 ML per year and groundwater inflows are predicted to increase from approximately 63 ML per year to 290 ML per year. The predicted increase in on site water supply volumes is equivalent to approximately 6 per cent of the annual site water demand of 6290 ML. In addition NPM will continue to manage water deficits through external water sources in accordance with existing licences and approvals.

6.0 Surface Water Impacts and Management

6.1. Water Quality

The existing and proposed components of the WMS will be managed in accordance with the requirements of the Blue Book (Landcom 2004 and DECC 2008). As a result, any controlled discharges from the sediment dams will be of a quality consistent with the requirements of the Blue Book.

The contaminated water system components of the WMS, including dams, pipes and pumps have been designed to manage contaminated water generated on site for rainfall events up to and including the 100 year ARI, 72 hour design rainfall event. Contingencies for additional water storage under extreme rainfall conditions include:

- temporarily increasing water storage within the TSFs to within design capacities; and

- water storage within mining voids.

As a result, it is considered that the proposed continuation of the operations at NPM are unlikely to have a significant impact of the existing water qualities of the surrounding environment, and will therefore be consistent with the river flow objectives and receiving water quality objectives.

6.1.1. Erosion and Sediment Controls

NPM implements various practices to minimise erosion from disturbed areas (refer to **Section 4.2.6**). These controls are outlined in the Northparkes Mines Water Management Plan (WMP) (2013). NPM proposes to continue operations using the controls listed in **Section 4.2.6** and as outlined below.

All erosion and sediment control measures are carried out in accordance with the relevant guidelines for erosion and sediment control, including 'Managing Urban Stormwater Soils and Construction' (the Blue Book) Volume 1 (Landcom 2004) and 'Volume 2E Mines and Quarries' (DECC 2008).

These controls are aimed at reducing potential sedimentation into nearby waterways and include:

- site disturbance permit process will assess individual clearing activities for their impact on water drainage and include specific controls where necessary;

- run off from disturbed areas are diverted to sediment ponds which are designed to hold the water for a period of time allowing the sediment to drop out prior to a potential release;

- installation and maintenance of drainage lines, diversion bunds and catchment dams;

- minimising cleared areas and promoting progressive rehabilitation; and

- restricted access to rehabilitated areas.

In addition to the above erosion and sediment control measures, construction plans will detail the specific inspection, maintenance and revegetation requirements for each works area where major construction or remediation works are required.

6.2. Water Quantity

Under most meteorological conditions, NPM will remain a net importer of water (refer to **Section 5.0**). As a result, discharges from NPM are unlikely, except under extreme rainfall conditions that exceed capacity of system and contingency measures.

6.2.1. Annual Flow Volumes

The Project will result in a reduction in the natural catchment area of the Bogan River by approximately 203 hectares, due to the increased catchment area that will be managed within the NPM WMS. The total Bogan River catchment area upstream of Bogan Weir is approximately 103,600 hectares (refer to **Table 3.1**), resulting in a net reduction in catchment area as a result of the proposed Project at Bogan Weir of approximately 0.2 per cent.

It is therefore considered that the proposed Project is unlikely to result in significant changes in annual flow volumes within the Bogan River system.

6.2.2. Baseflow

The baseflow analysis (refer to **Section 3.4.2**) indicates that baseflows account for only a small percentage of total flows within the Bogan River. In addition, as discussed in the Groundwater Assessment Report (Golder 2013), the Bogan River and its associated tributaries are ephemeral and are not considered to be hydraulically continuous with the groundwater, and as such inferred to receive no baseflow contribution from groundwater.

As a result, the potential for impacts on baseflows within the Bogan River system (and surrounding area) with the proposed Project is considered to be negligible.

6.3. Flood Regimes

All of the existing and proposed mining activities and associated infrastructure, including WMS components, are located outside of the 100 year ARI flood extent (refer to **Figure 3.4**). The modelled 100 year ARI flood extent at the closest point extends to within approximately 20 metres of the base of the proposed waste rock stockpiles within an existing agricultural area (refer to **Figure 3.4**). To manage potential flood risk NPM proposes to include a 1 metre high bank at the toe of the proposed waste rock stockpiles which will incorporate the proposed catch drain (refer to **Section 4.4** and **Figure 4.3**). Impacts on flood regimes are therefore considered to be unlikely as a result of the proposed Project compared to the currently approved development.

6.4. Downstream Water Users

NPM is within the Upper Bogan water source of the Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Sources (2012). The Water Sharing Plan allows for basic landholder rights within the Upper Bogan water source of 261 ML per year with a further 154.5 ML per year available under extraction licences. Local water utilities are licensed to extract 32 ML per year. There are a total of 1553 unit shares of unregulated river access licences for the Upper Bogan water source, with an additional provisions to allow for an additional 1082 unit shares under high flow conditions.

Watercourses within the vicinity of NPM are ephemeral, with periods of limited or no flow during periods of low rainfall. The ephemeral nature would suggest that dependence on flows within these watercourses to downstream agricultural users is likely to be limited. As outlined in **Section 6.2.1.**, the Project will result in a minimal reduction of catchment (0.02 per cent) which is unlikely to impact on downstream water users.

Specifically, the increases in the catchment area managed within the WMS will occur primarily within the catchment of Cookapie Creek, a tributary of the Bogan River. The portion of Cookapie Creek catchment area that is within the WMS varies depending on the reference point within Cookapie Creek. At the confluence of Cookapie Creek and Deception Creek, no part of the approved or proposed WMS lies within the Cookapie Creek catchment. At a point approximately 4.4 kilometres downstream of the confluence with Deception Creek however, the portion of the approved WMS within the Cookapie Creek is at a maximum, accounting for approximately 6.1 per cent of the Cookapie Creek catchment at this point. At this same point, the proposed WMS occupies approximately 6.9 per cent of the Cookapie Creek catchment. Therefore the proposed modifications to the WMS results in the removal of a maximum of approximately 0.8 per cent of the Cookapie Creek catchment at a point approximately 4.4 kilometres downstream of the confluence with Deception Creek.

There are no known licensed water users within Cookapie Creek downstream of NPM that will be effected by the small reduction in catchment area. Impacts are therefore limited to basic landholder rights to harvest surface water.

The proposed tailings storage facility results in minor changes to the flow shadows which has the potential to alter overland flow to surrounding properties. However no farm dams have been identified offline (i.e. outside of drainage lines) within the flow shadow area (i.e. downslope) of the existing, approved or proposed tailings storage facilities. As a result, no changes to inflows into private offline farm dams are expected as a result of the proposed changes to the TSFs.

NPM plans to maintain their existing surface water and groundwater licences and as such there is negligible predicted impact to downstream water users.

NPM plans to maintain their existing surface water and groundwater licences (refer to **Table 5.2**) and as such there is negligible predicted impact to downstream water users.

7.0 Monitoring, Licensing and Reporting

Surface water quality and quantity is monitored in the surrounding drainage system in accordance with the NPM Environmental Monitoring Plan (NPM 2009). The existing surface water monitoring locations are shown on **Figure 3.2**.

Water monitoring at NPM is undertaken to assess compliance against the Development Consent Conditions, provide data for the management of water within the mine and to assess the impacts of the mines operations.

In addition, NPM also undertakes monitoring for operational purposes. This monitoring is undertaken 'on an as needs basis' to assist the mine in its day to day management of its mine water operations. The frequency of monitoring and the parameters monitored for operational purposes is undertaken at the discretion of NPM. Monitoring at these operational monitoring locations is generally triggered by unexpected results from the statutory monitoring regime, i.e. operational monitoring is undertaken on as need basis or for project specific purposes.

Where no water quality criteria have been set under the various licences, the monitoring data is compared against:

- the previous range of data at that location; and/or;
- the trend associated with the previous data collected (i.e. seasonal movements, historical trends, etc.);
- forecast predictions or estimates; and/or
- ANZECC default trigger values or site specific trigger values were developed.

The surface water monitoring data is reporting annually as part of the Annual Review for the NPM.

It is considered that the current monitoring program will be sufficient for the proposed Project with all new proposed water management structures to be included in the current monitoring programs (refer to **Section 3.4**).

7.1. Erosion and Sediment Controls

Where construction and rehabilitation works are required, erosion and sediment controls will be monitored during the works period in accordance with the Blue Book (Landcom 2004 and DECC 2008) including regular inspections and inspection after rainfall events causing runoff (refer to **Section 6.1.1**).

7.2. Surface Water Quality Monitoring

Surface water quality monitoring will be undertaken in accordance with the surface water monitoring plan, included within the approved Environmental Monitoring Plan (NPM 2009).

The Environmental Monitoring Plan:

- details the integrated surface water monitoring strategy for Northparkes;
- outlines relevant surface water impact assessment criteria (trigger levels) and establishes a protocol for the assessment and response to monitoring data; and
- outlines the reporting requirements for the results of the monitoring program.

7.3. Licensing Requirements

The ‘Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Sources 2012’ applies to the NPM Project Area. In addition, the Upper Lachlan Alluvium has recently become subject to a WSP (2012) which establishes the rules and procedures governing water use within this water source.

Therefore, the surface waters of the NPM are governed by the *Water Management Act 2000* and the groundwater extraction areas (refer to **Table 5.3**) are also governed by the *Water Management Act 2000*.

NPM plans to maintain their existing surface water and groundwater licences (refer to **Table 5.2**) and do not propose to increase licence limits.

Notwithstanding the current surplus external water supply to meet operational needs over the life of the Project, there may be circumstances over the life of the Project that could limit external water supply. This may include extreme climatic changes and/or changes in available allocations under the WSP, for instance growth in use response rules providing for the NOW to limit allocations to be Long Term Average Annual Extraction Limit. Should this affect the security of the external water supply required for operations over the life of the Project, NPM will explore a range of options such as:

- review the availability of other licences within the water supply area for temporary/permanent purchase;
- review operational water usage and investigate options for improving water use efficiency; and
- review operational water usage requirements, and where applicable, adjust processing operations in line with available water allocations.

As NPM is managed as a nil discharge site, water discharges are not included in the site’s EPA.

7.4. Reporting

A summary of surface water monitoring results will be provided in the Annual Review. The following information will be reported in the Annual Review in accordance with the project approval conditions:

- a summary of monitoring results for surface water;
- an analysis of monitoring results against impact assessment criteria, historical monitoring results and the predictions in the EA;
- an identification of any trends in the monitoring results;
- any non-compliances reported during the year; and
- actions taken to address any non-compliances.

In addition, any significant findings regarding the implementation of the WMP will be reported in the Annual Report, including:

- the effectiveness of the erosion and sediment controls;
- changes to the site water balance; and
- any identified issues or exceedances of ANZECC default trigger values or site specific triggers (refer to **Section 7.2**).

The Annual Review will also document complaints relating to the performance, maintenance and/or failure of the NPM WMS.

8.0 References

ANZECC/ARMCANZ, 2000, National Water Quality Management Strategy: Australian and New Zealand Guidelines for Fresh and Marine Water Quality.

Arnold, J.G., P.M. Allen, R. Muttiah, G. Bernhardt, 1995, Automated Base Flow Separation and Recession Analysis Techniques, Groundwater, 33 (6), pp 1010 - 1018.

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

Department of Infrastructure, Planning and Natural Resources (DIPNR), 2005, Management of Stream/Aquifer Systems in Coal Mining Developments, Hunter Region.

Geoff Cunningham Natural Resource Consultants Pty. Ltd., 2006, Soils Survey and Land Capability Assessment, prepared for R.W. Corkery & Co. Pty. Limited on behalf of North Mining Limited.

GHD Pty Ltd, 2009. Northparkes Mines Section 75W Environmental Assessment.

Golder Associates, 2013. Northparkes Mine Extension Project - Groundwater Impact Assessment Report.

Landcom, 2004, Managing Urban Stormwater: Soils and Construction, Volume 1.

Northparkes Mine, 2009. Environment Monitoring Plan.

Northparkes Mine, 2013. Water Management Plan.

R.W. Corkery & Co. Pty. Limited, 2006, Environmental Assessment, Northparkes Mines - E48 Project, prepared for North Mining Limited.

WRM Water & Environment Pty Ltd, 2006, Surface Water Assessment of the Northparkes Mines - E48 Project, prepared for R.W. Corkery & Co. Pty. Limited on behalf of North Mining Limited.

Newcastle

75 York Street
Teralba NSW 2284

Ph. 02 4950 5322

www.umwelt.com.au