



Rustlers Roost and Quest 29 Open-Cut Mine Redevelopment

Draft Environmental Impact Statement (EIS)

Section 7.4 - Inland Water Environmental Quality

Prepared pursuant to the Environment Protection Act 2019

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Key Project Terms

Term	Definition
Adaptive Management	Systematic process for incrementally improving management practices by learning from the outcomes of past and current practices.
Carbon in Leach	This process uses a dilute alkaline cyanide solution to leach (dissolve) gold from the ore material. Activated carbon removes gold out of dilute cyanide solution by adsorption (sticking). The leaching agent and activated carbon are added together in a slurry of ore and water.
Development Envelope	Defined as the maximum area within which the Project footprint could occur. The development envelope for the Project encompasses 790 ha, inclusive of Rustlers Roost, Quest 29, the accommodation camp and haul road.
Environmental Aspect	An element of the Primary Gold's activities, products or services that can interact with the environment.
Environmental Impact	Change to the environment whether adverse or beneficial, wholly or partially resulting from the Primary Gold's environmental aspects. Environmental impacts can be caused directly or indirectly from a Project activity or cumulatively with other non-Project related activities in a set area.
Environmental Factor	The NT EPA listed environmental objectives to identify environmental matters that have value to the Northern Territory and that need to be protected; and to state the objective to be achieved for each matter. The NT EPA has prepared these environmental objectives and organised these in structured divisions of the environment, called environmental factors.
Existing Disturbance Footprint	Defined as the direct disturbance area from known historical activities associated with the Rustlers Roost, Quest 29, accommodation camp and haul road areas. For Rustlers Roost and Quest 29 this is taken from the existing Mine Management Plans. The existing direct disturbance footprint encompasses 169.4ha within the development envelope.
Heap Leach Pad	Existing areas where historic mining placed ore for processing via a leaching solution to dissolve and capture the mineral. The pads contain the remaining material.
Maximum Vegetation Clearing Extent	The maximum extent of native vegetation clearing proposed for the Project based on mapped vegetation extent layers which account for historic anthropogenic disturbances to the development envelope (e.g. historic mining and pastoral activities). This area constitutes a total of 368.86 ha.
Project	The Project includes the expansion of existing pits, waste rock landforms, water storage dams and internal roads in both the Rustlers Roost and Quest 29 MLs. Two new pits will be constructed at Rustlers Roost and new infrastructure includes an onsite processing plant, a tailings storage facility, a landfill, laydown area, magazine, administration office, accommodation camp and groundwater bores for water supply. The Project is inclusive of an expanded connecting haul road between the non-contiguous extraction areas and an accommodation camp.
Project Area	The Project area is defined as wholly including ML1083 (Rustlers Roost), ML 29783 (Quest 29), ML 29814 (accommodation camp) and the connecting haul road. The entire Project area covers 1,143.25 ha.
Direct Disturbance Footprint	Defined as the direct disturbance area based on the current proposed infrastructure and material placement inclusive of Rustlers Roost, Quest 29, the accommodation camp and haul road. This area covers both historically disturbed and undisturbed areas. The disturbance footprint encompasses 532.84 ha within the Project area.
Significant Impact	A significant impact of an action is an impact of major consequence having regard to: (a) the context and intensity of the impact; and (b) the sensitivity, value and quality of the environment impacted on and the duration, magnitude and geographic extent of the impact.
Study Area	Refers to the area of survey or investigation for a specific study. This area may be beyond the Project area or development envelope.
Tailings Storage Facility	A specially engineered and constructed impoundment into which tailings (residue) from the ore processing plant is deposited for placement in perpetuity. The storage facility is constructed with confining embankments consisting of earthen material (e.g. rock and soil) and capped following closure.
Waste Rock Dump	An engineered and constructed impoundment into which overburden from the mining process is placed for safe storage in perpetuity.

Acronyms, Abbreviations and Units

Abbreviation, Acronym or Unit	Definition
\$m	Million dollars
%	Percentage
+ve	Assessment of positive
μS	Microsiemens
4WD	Four-wheel drive
AADT	Average Annual Daily Traffic
AAS	Atomic Absorption Spectrophotometer
AAPA	Aboriginal Areas Protection Authority
AARL	Anglo American Research Laboratory
ABS	Australian Bureau of Statistics
AE	Aquatic Ecosystems
AEP	Annual Exceedance Probability
AFANT	Amateur Fishermen's Association of the Northern Territory
AHD	Australian Height Datum
ALA	Atlas of Living Australia
ALARP	As Low As Reasonably Practicable
AMD	Acid and Metalliferous Drainage
ANC	Acid Neutralising Capacity
ANCOLD	Australian National Committee on Large Dams
ANFO	Ammonium Nitrate
ANZG	Australia and New Zealand Government
ARI	Average Recurrence Interval
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
AS	Australian Standard
ASRIS	Australian Soil Resource Information System
ASX	Australian Stock Exchange
AS/NZS	Australian/New Zealand Standards
AUSRIVAS	Australian River Assessment System
BESS	Battery Energy Storage System
BoM	Bureau of Meteorology
BOO	Build-Own-Operate
BOOT	Build-Own-Operate-Transfer
Bq	Becquerel
BUD	Beneficial Use Declaration
CAD	Computer-Aided Design
CAPEX	Capital Expenditure
CCTV	Closed Circuit Television
CE	Community and Economy
CEO	Chief Operating Officer
CH ₄	Methane

Abbreviation, Acronym or Unit	Definition
CIL	Carbon in Leach
CO ₂	Carbon Dioxide
CO ₂ -e	Carbon Dioxide Equivalent
COPC	Contaminant of Potential Concern
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSL	Compact Soil Liner
CSM	Conceptual Site Model
C&D	Construction and Demolition
C&I	Commercial and Industrial
DAWE	Department of Agriculture, Water and Environment (Cth) (current)
DEPWS	Department of Environment, Parks and Water Security (NT) (current)
DGV	Default Guideline Value
DIDO	Drive-in Drive-out
DITT	Department of Industry, Tourism and Trade (NT) (current)
DIWA	Directory of Important Wetlands of Australia
DO	Dissolved Oxygen
DotE	Department of the Environment (Cth) (former)
DotEE	Department of the Environment and Energy (Cth) (former)
EC	Electrical Conductivity
EH&S	Environment, Health and Safety
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EMS	Environmental Management System
EPA	Environment Protection Authority
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
EPL	Environment Protection Licence
EP Act	<i>Environment Protection Act 2019</i>
ERA	Energy Resources of Australia
ERP	Emergency Response Plan
ESCP	Erosion and Sediment Control Plan
ESD	Ecologically Sustainable Development
GDE	Groundwater Dependent Ecosystem
GGAP	Greenhouse Gas Abatement Plan
GHG	Greenhouse Gas
GJ	Gigajoule
GL	Gigalitre (1,000 Megalitres)
GPS	Global Positioning System
GRP	Gross Regional Product
GST	Goods and Services Tax
g/t	Grams Per Tonne
GV	Guideline Value
GWP	Global Warming Potential
ha	Hectare

Abbreviation, Acronym or Unit	Definition
HDPE	High Density Polyethylene
HEC-HMS	Hydrologic Modelling System
HFC	Hydrofluorocarbons
HP	Hydrological Processes
HSE	Health, Safety and Environment
IAP2	International Association for Public Participation
IBC	Intermediate Bulk Container
ID	Identification
IECA	International Erosion Control Association
IFC	International Finance Corporation
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Provider
ISO	International Organisation for Standardisation
IWEQ	Inland Water Environmental Quality
JORC	Joint Ore Reserve Committee
kL	Kilolitre
km	Kilometre
km ²	Square Kilometre
kV	Kilovolt
L	Litre
L/s	Litre Per Second
LED	Light Emitting Diode
LiDAR	Light Detection and Ranging
LNG	Liquefied Natural Gas
LOM	Life-of-Mine
LPG	Liquefied Petroleum Gas
M	Million
m	Metre
m ²	Metre squared
m ³	Cubic metre
mAHD	Metres Australian Height Datum
mBGL	Metres Below Ground Level
MCP	Mine Closure Plan
MEDLI	Model for Effluent Disposal Using Land
mg	Milligram
ML	Mining Lease (Granted)
MLA	Mining Lease Application
mm	Millimetre
MMP	Mining Management Plan
MNES	Matter of National Environmental Significance
MP	Management Plan
mRL	Metres Reduced Level
Mt	Million Tonnes

Abbreviation, Acronym or Unit	Definition
Mtpa	Million Tonnes Per Annum
MW	Megawatt
N ₂ O	Nitrous Oxide
NAF	Non-Acid Forming
NAPP	Net Acid Producing Potential
N/A	Not Applicable
NGER Act	<i>National Greenhouse Energy Reporting Act 2007</i>
NLC	Northern Land Council
NMD	Neutral Mine Drainage
NORM	Naturally Occurring Radioactive Material
NOI	Notice of Intent
NO ₂	Nitrogen Dioxide
NSESD	National Strategy for Ecologically Sustainable Development
NT	Northern Territory
NTG	Northern Territory Government
NTU	Nephelometric Turbidity Unit
NT Act	<i>Native Title Act 1993</i>
NVIS	National Vegetation Information System
OPEX	Operational Expenditure
PAF	Potentially Acid Forming
PASS	Potential Acid Sulfate Soil
PER	Public Environmental Report
PET	Plecoptera, Ephemeroptera and Trichoptera
PFC	Perfluorocarbon
PGO	Primary Gold Limited, a wholly owned subsidiary of Hanking Australia Investment Pty Ltd
PMF	Probable Maximum Flood
PMLU	Post Mining Land Use
PMST	Protected Matter Search Tool
PPL	Perpetual Pastoral Lease
Q	Quarter
RL	Reduced Level
RMP	Risk Management Plan
RO	Reverse Osmosis
ROM	Run of Mine
RRMPL	Rustlers Roost Mining Pty Ltd
RSWL	Reduced Standing Water Level
SA	Statistical Area
SD	Saline Drainage
SDS	Safety Data Sheet
SEP	Stakeholder Engagement Plan
SEIFA	Socio-Economic Indexes for Areas
SF ₆	Sulfur Hexafluoride
SGV	Site-Specific Guideline Value

Abbreviation, Acronym or Unit	Definition
SIGNAL	Stream Invertebrate Grade Number – Average Level
SoBS	Site of Botanical Significance
SoCS	Site of Conservation Significance
SSAN	Security Sensitive Ammonium Nitrate
SSC	State Suburb Code
SSTV	Site-Specific Trigger Values
STP	Sewage Treatment Plant
SWGs	Stock Water Drinking Guidelines
SWL	Standing Water Level
t	Tonne
TAMS	Territory Asset Management Services
TARP	Trigger Action Response Plan
TBD	To Be Determined
TE	Terrestrial Ecosystems
TEC	Threatened Ecological Community
TEQ	Terrestrial Environmental Quality
Th	Thorium
TN	Total Nitrogen
ToR	Terms of Reference
TP	Total Phosphorus
TPWC Act	<i>Territory Parks and Wildlife Conservation Act 1976</i>
TSF	Tailings Storage Facility
TSS	Total Suspended Solids
TSSC	Threatened Species Scientific Committee
U	Uranium
UC	Uncertain
V	Volt
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNFCCC	United Nations Framework Convention on Climate Change
WCD	Water Control District
WDL	Waste Discharge Licence
WMP	Water Management Plan
WONS	Weed of National Significance
WRD	Waste Rock Dump
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant

7.4 Inland Water Environmental Quality

NT EPA Environmental Factor	Inland Water Environmental Quality
NT EPA Environmental Objective	<i>Protect the quality of groundwater and surface water so that environmental values including ecological health, land uses and the welfare and amenity of people are maintained.</i>
Relevant Policy and Guidance	- AS/NZS 1547:2012 – On-site domestic wastewater management; - AS/NZS 1940:2017 – The storage and handling of flammable and combustible liquids; - Best Practice Erosion and Sediment Control Guidelines (IECA 2008); - Cyanide Management, Leading Practice Sustainable Development Program for the Mining Industry (Australian Government 2008); - Land Capability Assessment for Onsite Wastewater Management Guidelines (DoH 2014); - Global Acid Rock Drainage (GARD) Guide (INAP 2014); - Guidelines for Fresh and Marine Water Quality (95%) (ANZG 2018); - Guidelines on Conceptual Site Models (NT EPA 2013); - Preventing Acid and Metalliferous Drainage, Leading Practice Sustainable Development Program for the Mining Industry (Australian Government 2016a); - Hazardous Materials Management, Leading Practice Sustainable Development Program for the Mining Industry (Australian Government 2016b); - Mine Closure, Leading Practice Sustainable Development Program for the Mining Industry (Australian Government 2016c); - Mine Rehabilitation, Leading Practice Sustainable Development Program for the Mining Industry (Australian Government 2016d); - Tailings Management, Leading Practice Sustainable Development Program for the Mining Industry (Australian Government 2016e); - Water Stewardship, Leading Practice Sustainable Development Program for the Mining Industry (Australian Government 2016f); and - Water Quality Objective for Darwin Harbour Region (DNREAS 2010).

This section interlinks hydrological processes (ground and surface water flow and directions) and aquatic ecosystems (aquatic biotic components) and addresses the importance of water quality to supporting environmental and social values. Furthermore, this section outlines the baseline water quality conditions of surface and groundwater within the Project area and surrounds. The environmental values that are supported by the factor are discussed in this section and the potential impacts and risks identified. Based on the risk assessment mitigation and management measures are proposed to address the risk to ensure that the NT EPA's objective for this environmental factor is met and relevant residual impacts are acceptable.

Section 7. Key Environmental Factors

7.4.1 Environmental Values

7.4.1.1 Beneficial Uses

An important part of water quality management is to identify how the community values and uses a water resource. Beneficial uses describe how a water resource benefits the community. Throughout the NT, beneficial uses or values have been set for major aquifers and river catchments. There are nine categories used to describe values for surface water and groundwater and these values are used to set water quality targets. The same water quality is not required for all types of water use.

Beneficial Use Declarations (BUDs) assist in the development of water management plans. The plans may result in an aim to improve the current water conditions, achieve different water quality in parts of a catchment or recognise that a water resource cannot achieve a certain quality in the short term. A BUD is also used to inform a WDL; they establish the objectives or guidelines for a water resource to protect against unwanted water quality impacts.

A BUD for the Mary River surface water catchment (including all tributaries, lakes, lagoons, swamps, and marshes) has been set and the defined beneficial uses are environment, riparian and cultural. There is no BUD over the Adelaide River catchment to the east of the river, including Marrakai Creek and its tributaries. However, the Darwin Rural Water Control District includes the Adelaide River catchment to the west of the river and with defined beneficial uses for all surface water and groundwater being agriculture, aquaculture, public water supply, environment, cultural, industry, rural stock and domestic, mining and petroleum activities. The objectives that apply are specified in the Australian Water Quality Guidelines for Fresh and Marine Waters (ANZG 2018). This BUD was gazetted on 13 February 2002 (Gazette G6). The Mary River Surface Water BUD transects the Rustlers Roost portion of the Project area and includes the historical mine area but not Annie's Dam (which forms part of the Adelaide River catchment).

There is also a BUD for the Mount Bunday Creek surface water which begins at the Arnhem Highway crossing of Mount Bunday Creek (approximately 16.5 km downstream of the Project area) and extends to just below the confluence with Coulter Creek (Figure 7-29 and Figure 7-30). Beneficial uses are stock water supply for the defined part of the waterway and aquatic ecosystem protection for the remainder. This BUD was gazetted on 11 June 1997 (Gazette G23). The nearest location to the Project area is an aquatic ecosystem protection zone.

No BUD declarations are in place for McKinlay River downstream of the Quest 29 portion of the Project (a declaration occurs on McKinlay River upstream); however, the section of McKinlay River between the Project area and Mary River is within the Mary River surface water BUD.

A BUD for the Mary River catchment groundwater has also been set with defined beneficial uses being environmental, riparian and agricultural.

Based on the BUD declarations for areas downstream of the Project, beneficial uses for the receiving environment include:

- Agricultural and stock water supply;
- Environmental and riparian; and
- Cultural.

These uses within the Project area, surrounds and downstream environment are discussed further below.

Section 7. Key Environmental Factors

Agricultural and Stock Water Supply

The aim of the BUD is to maintain the productivity of the land and the water resource to ensure agricultural and stock water supply in accordance with the principle of ecologically and economically sustainable development.

Historically, the Rustlers Roost and Quest 29 Project area has been concurrently used for pastoral activities including grazing of native vegetation by cattle as the mining leases are located on Old Mount Bunday Station and McKinlay River Pastoral Station.

PGO holds an access agreement with the existing leaseholder of Old Mount Bunday Station. A separate agreement with the leaseholder of McKinlay River Station will be finalised prior to Project construction and is expected to align with the existing agreement. The agreements require that PGO, consistent with operational requirements and approval conditions, take reasonable measures to limit interference with surface and groundwater resources, to maintain water quality suitability for stock water supply in accordance with ANZG (2018) stock drinking water guidelines.

The predominant agricultural land use in the region includes pastoral stations and orchards, with the most extensive land use in the vicinity of the Project area being pastoral, involving low intensity grazing of beef cattle over the woodland terrain. Grazing is also widespread in neighbouring areas including Adelaide River, Jabiru, Pine Creek and further afield in the greater Darwin and Katherine regions. Smaller agricultural activities like orchards and aquaculture have been identified within the BUD areas.

Environmental and Riparian

Identified environmental values such as the wetland and permanent water bodies in the Mary River Floodplain for surface water BUD and riparian vegetation associated with groundwater dependent ecosystems for groundwater BUD are dependent on good water quality and reliable stream flows. The surface water in the lower Mount Bunday creek, as a tributary to the larger Mary River Floodplain system is connected to the Project area and is of significance for the health of the aquatic ecosystems downstream of the Project area. Baseline and regular water monitoring will be undertaken to support the aquatic and riparian ecosystems of the Mary River Floodplain to confirm that water quality is in accordance with ANZG (2018) 95% species protection guidelines and Project related SSTV.

Cultural

The BUD also recognises that water resources have important cultural and spiritual values, particularly for indigenous peoples. While there were no recorded or registered sacred sites identified during an AAPA Certificates search, culturally significant areas relevant to the BUD and downstream of the Project area have been identified. A further AAPA Certificate application has been submitted for the entire Project area for mining activities. The AAPA process involves desktop anthropological research, Aboriginal custodian consultation and fieldworks.

From previous AAPA Certificates associated with the Toms Gully Mine or exploration activities associated with the Project, there is a recorded sacred site on the downstream section of Mount Bunday Creek, near the confluence with the Mary River. There is also a recorded sacred site in the Mary River floodplain, downstream of the Quest 29 portion of the Project. All other previously identified sites are either outside drainage areas or associated with drainage lines that are not impacted by the Project. As described in the Mary River National Park Joint Management Plan (Parks and Wildlife Commission 2015), these sites and places have spiritual, mythological and ritual significance to Traditional Owners and encompass the knowledge and cultural practices exercised in managing them. Some knowledge is open and can be communicated widely; however, other knowledge may be sacred and only passed on to those with appropriate authority.

Section 7. Key Environmental Factors

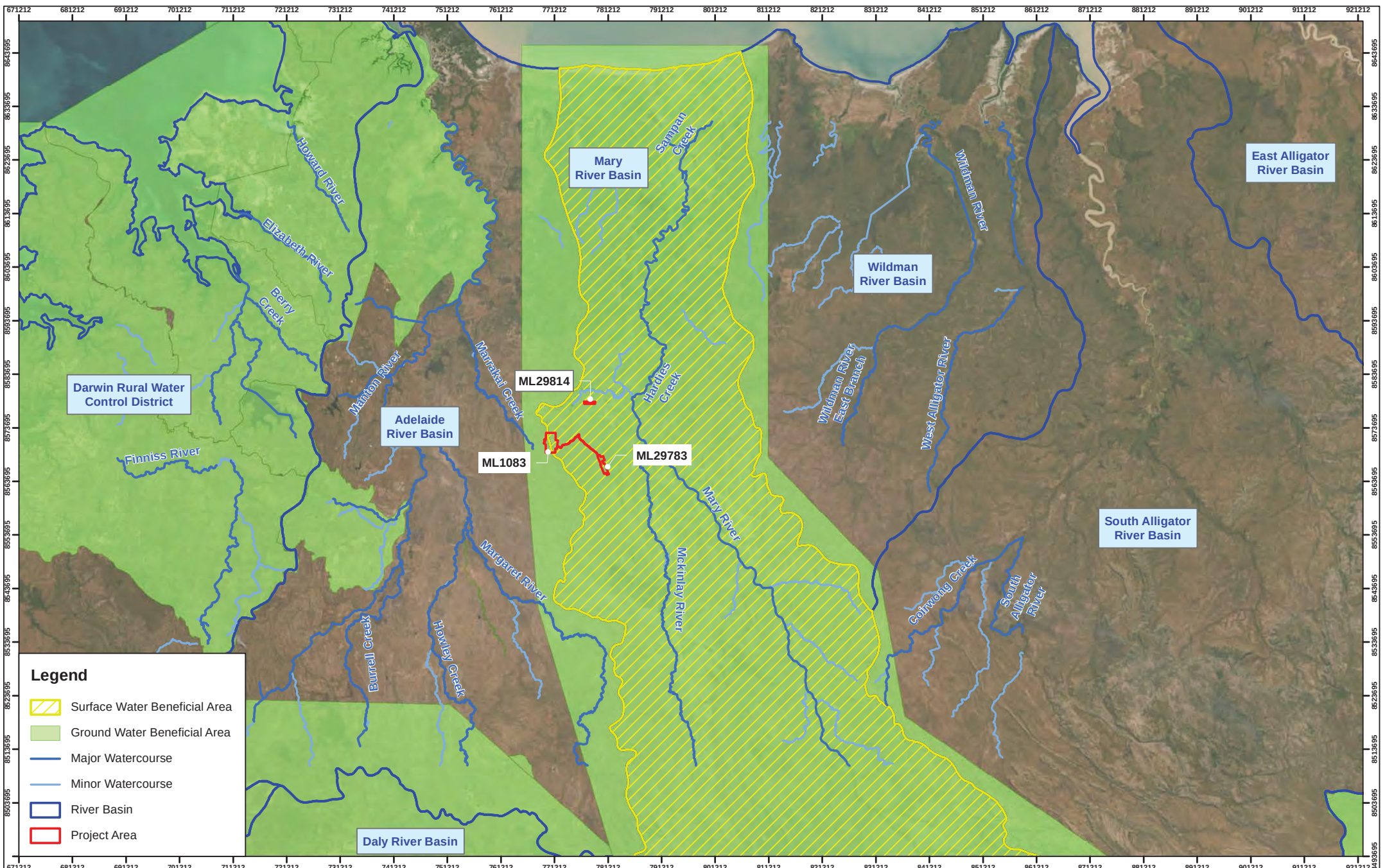
While PGO understands the locations of identified recorded sites through past AAPA Certificates, under the section 38 of the *Aboriginal Sacred Sites Act 1989*, a person shall not communicate information of a secret nature according to Aboriginal tradition. PGO is not aware of which sites are subject to secrecy. As such, the exact location of these sites in relation to the Project is not provided in this Draft EIS, nor on Figure 7-29 and Figure 7-30. Further, as the previous Authority Certificates were associated for exploration activities or the adjacent Toms Gully Mine, PGO have submitted a new application for an Authority Certificate for the current Project area. The new application is currently going through processing and consultation requirement but is anticipated to give more certainty that cultural values associated with sacred sites have been identified and will be protected from potential impacts from the Project.

Other cultural use may include recreational activities. For example, the Mary River floodplain is a major tourist and recreational fishing attraction for the region. Recreational fishing locations downstream within the Mary River system includes Hardies Creek (approximately 10 km downstream from the Arnhem Highway crossing), Corroboree Billabong (approximately 20 km downstream) and Shady Camp (approximately 60 km downstream). In addition, the Adelaide River floodplain is also a major tourist attraction for recreational fishing in the region and both floodplains host recreational activities such as four wheeled driving, boating, camping, hiking, wildlife spotting and photography (Parks and Wildlife Commission 2015)

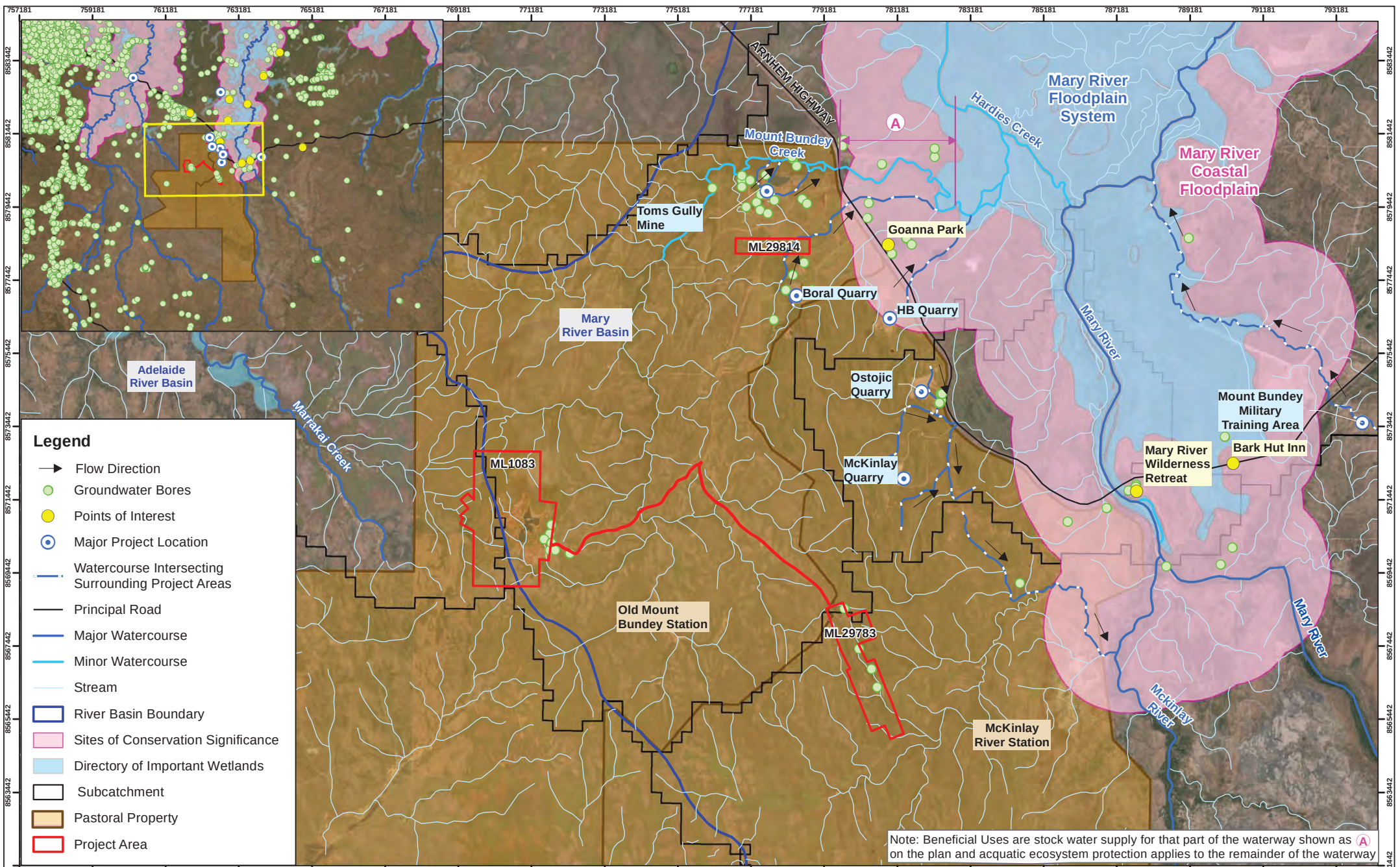
The Mary River National Park has been documented as supporting large Aboriginal communities. The Mary River National Park Joint Management Plan (Parks and Wildlife Commission 2015) details that pathways of ancestral spiritual beings, or Dreamings, are located throughout the region. The Dreamings are taken to be recorded at sacred sites located throughout the park (Mearnes 2009). There are more than 20 sacred sites registered within the park and many more remain unrecorded (Parks and Wildlife Commission 2015). The Dreamings are taken to be the spiritual connection between Indigenous people and the land and are a highly significant part of their culture. Mearnes (2009) notes that men's ceremonies have been held in the park within living memory and there are numerous sites associated with women's traditions.

The Joint Management Plan for the Mary River National Park notes that continuing use of country and its resources is a core right and responsibility for Traditional Owners and one of the most important ways that Traditional Owners maintain and manage country (Parks and Wildlife Commission 2015). Under the TPWC Act, Aboriginal people who have traditional rights within the park are permitted to hunt and gather on country for non-commercial purposes. The process of gathering native food, the cooking, consumption and rituals associated with it are important part of the continuing connection to the land for Traditional Owners (Mearnes 2009). Any degradation of these downstream environments could adversely affect the use of these areas for cultural heritage purposes, impact the Traditional Owners connection with the land and the ongoing transfer of knowledge.

While there is no specific guidance for protection of these values in the ANZG (2018) guidelines, consideration must be given to cultural issues in the planning and management of water resources. For example, to maintain water quality that supports cultural values the specific water quality objectives for the relevant environmental values are applied (e.g. ANZG (2018) 95% species protection) in the Project WMP.



R Details		Date	©COPYRIGHT CDM SMITH This drawing is confidential and shall only be used for the purpose of this project.				0 6,500 13,000 26,000 Meters 1 cm = 6,407 meters GCS GDA 1994 MGA Zone 52	DISCLAIMER CDM Smith has endeavoured to ensure accuracy and completeness of the data. CDM Smith assumes no legal liability or responsibility for any decisions or actions resulting from the information contained within this map. DATA SOURCE NT Government Open Source Data	DESIGNER 	CLIENT 	FIGURE 7-29 Mary River Groundwater and Surface Water Beneficial Use Areas
1	Final	26/08/21	DESIGNED	SS	CHECKED	TK					
-	-	-	DRAWN	SS	CHECKED	TK					
-	-	-	APPROVED	TK	DATE	26/08/21					
-	-	-	Notes:								
DRG Ref: 1001087-EIS-07-7.29											



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1	Final	26/08/21		DESIGNED		SS		CHECKED		TK		N 0 1,000 2,000 4,000 Meters 1 cm = 948 meters GCS GDA 1994 MGA Zone 52																											
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DISCLAIMER CDM Smith has endeavoured to ensure accuracy and completeness of the data. CDM Smith assumes no legal liability or responsibility for any decisions or actions resulting from the information contained within this map.										DESIGNER CDM Smith										CLIENT PRIMARY GOLD										FIGURE 7-30 Inland Water Downstream Environmental Values and Surface Water Beneficial Uses									
DATA SOURCE NT Government Open Source Data										DRG Ref: 1001087-EIS-07-7.30																													

Section 7. Key Environmental Factors

7.4.1.2 Surface Water Quality

A summary of the catchments and drainage lines within the Project area has been provided in the Hydrological Processes Section (Section 7.3). In summary, the Project drains into two separate major river systems. Easterly aspects of the Rustlers Roost Project area are located in the Mount Bunday Creek catchment of Mary River, whereas the western side drains into the Marrakai Creek catchment of Adelaide River (Figure 7-35). There is a small area to the north of Quest 29, nearby the BHS pit, that drains into a small tributary of Mount Bunday Creek, whereas the majority of the Quest 29 Project area is located in the McKinlay River catchment of the Mary River Basin (Figure 7-35). The watercourses and drainage features in the Project area are relatively small and highly ephemeral with flows ceasing early in the dry season.

Figure 7-31 and Figure 7-32 provide an overview of the existing surface water and groundwater monitoring locations within the 'upstream' Project area and in the 'downstream' reach of Mount Bunday Creek, where ongoing monitoring has been undertaken for several years for the Toms Gully Mine. This downstream baseline monitoring program includes site-specific guideline values (SGVs) developed based on the Australian and New Zealand Government (ANZG) protection guideline values (95% species protection) (Slightly to Moderately disturbed Ecosystem protection GVs), Livestock Drinking Water Guidelines (SWGs) and the 2018 CSIRO Review of SSTV for the Toms Gully Mine (Stauber and Batley 2018). SSTVs for physical parameters (i.e., pH, EC, TSS and turbidity) are based on the 80th percentile of reference site monitoring data.

Baseline Water Quality Monitoring Sites

Rustlers Roost Marrakai Creek Catchment – Adelaide River

Table 7-29 identifies the two surface water monitoring sites within the Marrakai Creek catchment. Both sites are located in the Project area.

Table 7-29 Rustlers Roost – Marrakai Creek Catchment – Surface Water Monitoring Locations

Site Name	Latitude	Longitude	Location Description
SW6	-12.923545	131.489554	Spill way proximal to Annie's Dam
SW7	-12.922619	131.48726	Downstream from Annie's Dam nearby lower pond in an unnamed tributary of the Marrakai Creek

Rustlers Roost Mount Bunday Creek Catchment – Mary River

Table 7-30 identifies the seven surface water monitoring sites within the upper Mount Bunday Creek catchment in proximity to the Rustlers Roost portion of the Project. Most of the sites are within the Project area with some being outside on pastoral land (Figure 7-31).

Table 7-30 Rustlers Roost Mount Bunday Creek Catchment Surface Water Sampling Locations

Site Name	Latitude	Longitude	Location description
SW2	-12.928670	131.501560	Creek line to the east of southern heap leach pond
SW5	-12.928539	131.501017	Southern heap leach pond
SW10	-12.922680	131.496812	ROM drainage before influence from heap leach
SW11	-12.924117	131.496836	Downstream from SW10 in drainage line at base of heap leach pad
SW12	-12.911724	131.493673	Northern drainage of WRD
SW22	-12.915881	131.497434	Pit lake western side

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Site Name	Latitude	Longitude	Location description
SWQ2	-12.913087	131.526381	Mount Bunday Creek culvert crossing, approximately 500m downstream of confluence with Quest 29 drainage line

Surface water monitoring sites have been sampled with changing frequency and intensity since at least 2011.

Quest 29 – Mount Bunday Creek Catchment – Mary River

Table 7-31 identifies the five surface water monitoring sites within the Mount Bunday Creek catchment relevant to the Quest 29 portion off the Project. Three sites are located within the Project area and two are outside, with one site (SWQ4) approximately 6 km downstream in Mount Bunday Creek. The second surface water sampling site (SWQ2) is further downstream at the haul road crossing of Mount Bunday Creek (Figure 7-31).

Table 7-31 Quest 29 Mount Bunday Creek Catchment – Surface Water Monitoring Locations

Site Name	Latitude	Longitude	Location description
SWQ1	-12.936324	131.574809	Charlies Creek, north of BHS pit at culvert crossing
SWQ2	-12.913087	131.526381	Mount Bunday Creek culvert crossing, approximately 500m downstream of confluence with Rustlers Roost creek line
SWQ4	-12.914471	131.536777	Mount Bunday Creek, approximately 6 km downstream from Quest 29 lease, upstream from Rustlers Roost creek line confluence
SWQ Leach	-12.938021	131.577894	Quest 29 lower leach pond
SWQ BHS Pit	-12.938386	131.576396	BHS pit lake

Surface water monitoring sites have been sampled with changing frequency and intensity since at least 2011.

Quest 29 – McKinlay River catchment – Mary River

Table 7-32 identifies the five surface water monitoring sites within the McKinlay River catchment. Four sites are located within the Project area and one site (SWQ8) is roughly 170 m south-east of the Project area (Figure 7-31).

Table 7-32 Quest 29 McKinlay River Catchment – Surface Water Monitoring Locations

Site Name	Latitude	Longitude	Location description
SWQ3	-12.958068	131.586851	Zamu pit
SWQ5	-12.958234	131.583856	Northern Taipan pit bund
SWQ6	-12.958795	131.586416	Small drain downstream of Zamu pit after confluence from SWQ3 and SWQ5
SWQ7	-12.954703	131.586032	Small drainage line upstream of Zamu pit
SWQ8	-12.965656	131.594375	Further downstream from SWQ6, approx. 200 m outside of Quest 29 lease boundary

Surface water monitoring sites have been sampled with changing frequency and intensity since at least 2011.

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Proposed Accommodation Camp – Coulter Creek – Mary River Catchment

Table 7-33 identifies four surface water quality monitoring sites downstream of the proposed accommodation camp location in Coulter Creek, a tributary to Mount Bunday Creek (Figure 7-32). While all sites have been sampled for aquatic ecosystem monitoring requirements at Toms Gully Mine project, only two sites provide Project relevant baseline data for current Coulter Creek WQ in this area (CC02 and CC01) and therefore, these are the two sites proposed for surface water monitoring.

Table 7-33 Accommodation camp – Coulter Creek Surface Water Monitoring Sites

Site name	Latitude	Longitude	Location description
CC02	-12.847370	131.563955	Coulter Creek approximately 500 m downstream from accommodation camp boundary.
CC01	-12.843499	131.573087	Coulter Creek approximately 1.5 km downstream from CC02 outside of mining lease.
CK7	-12.836734	131.577921	Coulter Creek at Arnhem Highway crossing.
CC03	-12.835209	131.585475	Coulter Creek approximately 400 m downstream from CK7.

Surface water monitoring sites have been sampled with changing frequency and intensity since at least 2016.

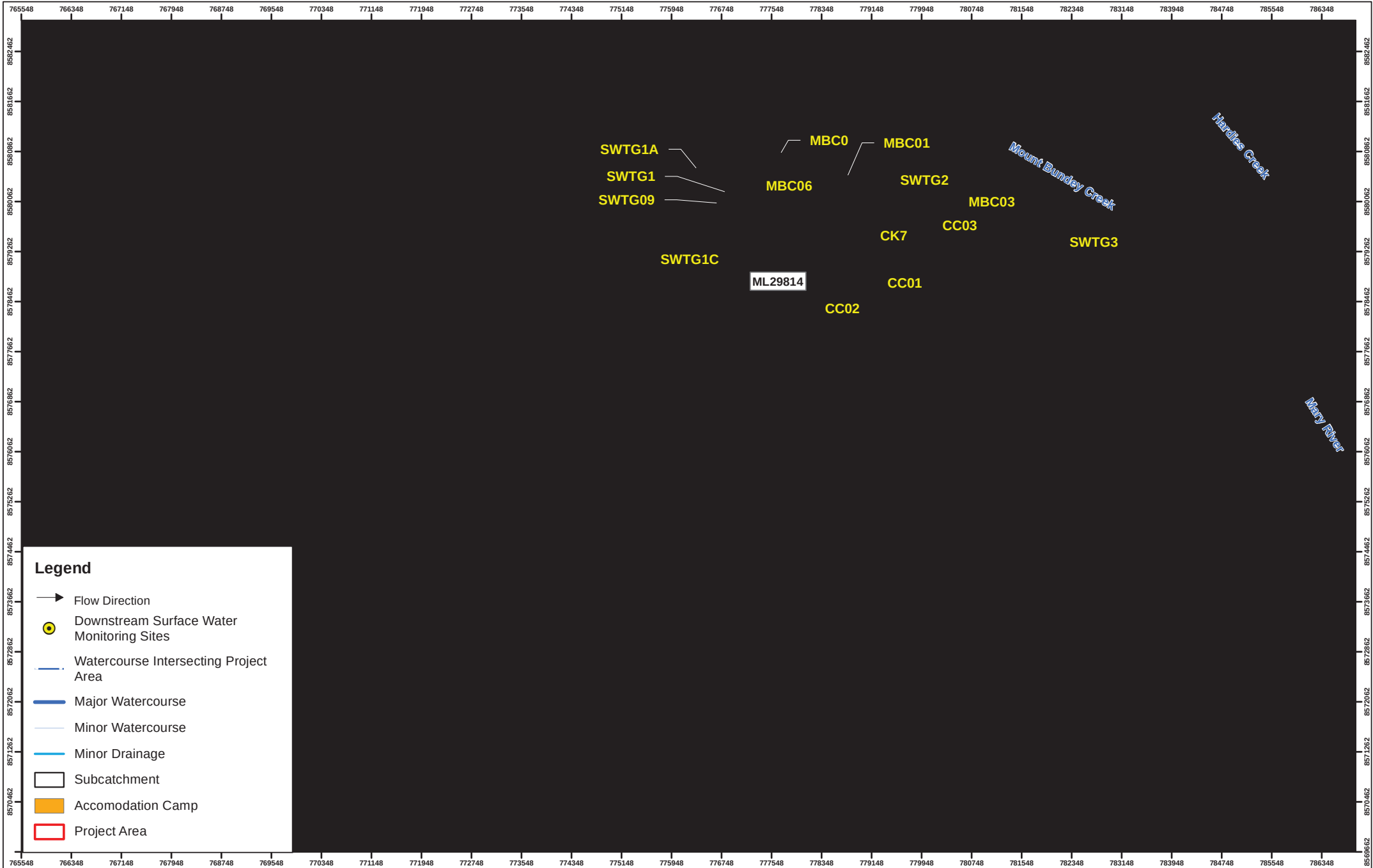
Toms Gully Mine – Lower Mount Bunday Creek – Mary River Catchment

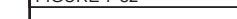
Table 7-34 identifies the eight surface water monitoring sites within the lower Mount Bunday Creek. While all sites have been sampled for aquatic ecosystem monitoring requirements at Toms Gully Mine project, only three sites provide Project relevant baseline data for current Mount Bunday Creek WQ in this area (SWG1A, SWTG2 and SWTG3). Therefore, these sites are in close proximity and downstream from the mine. The furthest upstream site (SWG1A) is also approximately 20 km downstream from the Rustlers Roost and Quest 29 Project area (Figure 7-32).

Table 7-34 Toms Gully Mine – Lower Mount Bunday Creek Surface Water Monitoring Sites

Site Name	Latitude	Longitude	Location description
SWG1C	-12.840458	131.539658	Mount Bunday Creek approximately 2.5 km upstream of SWTG1A.
SWG1A	-12.828336	131.545764	Mount Bunday Creek upstream of mine at lease boundary.
SWG1	-12.830286	131.550333	Mount Bunday Creek at confluence of drainage line from mine site.
MBC0	-12.825761	131.557606	Mount Bunday Creek approximately 1.5km downstream of SWTG1.
MBC01	-12.829051	131.567791	Mount Bunday Creek adjacent Toms Gully Mine Tailings Dam 2.
SWG2	-12.828622	131.574529	Mount Bunday Creek at Arnhem Highway Crossing.
MBC03	-12.831725	131.584946	Mount Bunday Creek approximately 1.8 km downstream of SWTG2.
SWG3	-12.837374	131.599889	300 m upstream of confluence between Mount Bunday Creek and Coulter Creek.

Surface water monitoring sites have been sampled with changing frequency and intensity since at least 2016.



R	Details		Date	©COPYRIGHT CDM SMITH This drawing is confidential and shall only be used for the purpose of this project.				 0 550 1,100 2,200 Meters 1 cm = 546 meters GCS GDA 1994 MGA Zone 52	DISCLAIMER CDM Smith has endeavoured to ensure accuracy and completeness of the data. CDM Smith assumes no legal liability or responsibility for any decisions or actions resulting from the information contained within this map. DATA SOURCE NT Government Open Source Data	DESIGNER 	CLIENT 	FIGURE 7-32
1	Final	26/08/21					Existing Downstream Surface Water Monitoring Sites					
-	-	-										
-	-	-	DESIGNED	SS	CHECKED	TK						
-	-	-	DRAWN	SS	CHECKED	TK						
-	-	-	APPROVED	TK	DATE	26/08/21						
-	-	-	Notes:								DRG Ref: 1001087-EIS-07-7.32	
-	-	-										

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7.4.1.3 Baseline Surface Water Quality

Surface water quality has been influenced by previous land uses such as pastoral uses and mining activities with legacy related water quality issues arising from pit lakes, WRD, and heap leach pads and ponds. The water quality results from data collected between 2011 and 2021 were compared to the ANZG (2018) guidelines default trigger values for physical and chemical stressors in tropical Australia in slightly disturbed ecosystems and the CSIRO Review of SSTV for Toms Gully Mine (Stauber and Batley 2018). The ANZG (2018) water quality guidelines outline the process for using SSTV based on circumstances where background concentrations cannot be measured at a site due to existing disturbance, or where measurement at an equivalent reference site is deemed to match closely the geology or natural water quality of the site of interest. If the background concentration has been clearly established and it exceeds the 95% trigger value, the 80th percentile of the background concentration as described in the ANZG (2018) guidelines can be accepted as the SSTV for the relevant water quality sites. The WMP discusses the baseline water quality and interpretation of regional influences in more detail as well as the derivation of relevant SSTV.

This section outlines the monitored water quality from the relevant surface water monitoring sites for the three areas of available data (Upstream – Rustlers Roost and Quest 29; downstream – Toms Gully,) in relation to the respective drainage system. Samples were taken throughout all seasons over a 10 year period. However, not all of the sites were sampled with the same intensity. Furthermore, water sampling has been conducted in water bodies associated with mining activities including like pit lakes and leach ponds and in creek and drainage lines. The different hydrological properties of the sampling sites may impact on the WQ results, occasionally presenting large value variations for individual parameters. For example, water quality in creek and drainage lines is highly dependent from flow caused by rainfall, whereas some of the permanent water structures may also be affected by accumulation of contaminants from runoff and evaporation during dry season.

The baseline water quality of the main water bodies and downstream sites within each receiving catchment are summarised in Table 7-35 to Table 7-40 below.

Baseline Water Quality at Rustlers Roost for Marrakai Creek Catchment

Table 7-35 Baseline Marrakai Creek Catchment Water Quality Parameters

Parameter	Water Quality Summary
Electrical Conductivity (EC)	Low EC average (20 µS/cm) has been recorded for times with significant flow. The range was between 10 to 49 µS/cm for the recorded sampling occasions at both sites, indicating very fresh-water quality, with water quality well below the ANZG (2018) trigger values for aquatic ecosystems of 250 µS/cm.
pH Dissolved Oxygen (DO)	pH was on average 5.91 for both sides for all sampling occasions with a range of 4.3 to 6.4. There was also a low mean DO of 60 % recorded with a range of 56 to 63 %. These mean values are below ANZG (2018)) trigger values with a pH between 6-8 and a DO between 80-120 %.
Turbidity (NTU)	Turbidity levels were on average 14.0 NTU with a range between 2.7 and 46.8 NTU. The range indicates variability in turbidity in response to rainfall events. The mean NTU value is below the ANZG (2018) water quality objective of 15 NTU.
Dissolved metals	Overall, there was exceedance of the ecosystem protection guideline values (GV) for dissolved metals for some of the sampling occasions (Aluminium (Al), Zinc (Zn), Copper (Cu)), with a maximum measured value of 0.22 mg/L for dissolved Al, 0.026 mg/L for Zn and 0.002 mg/L for Cu. ANZG (2018) default trigger values for these metals are 0.055 mg/L for Al, 0.008 mg/L for Zn and 0.0014 mg/L for Cu. ¹⁴

¹⁴ Aluminium toxicity to aquatic organisms in freshwater may be dependent from co-factors like pH, water hardness and water temperature. pH appears to have the greatest effect, as aluminum is more toxic in both acidic and alkaline waters. Therefore, the ANZG (2018) guidelines apply different aluminum default values for protecting aquatic ecosystems. A freshwater moderate reliability trigger value of 0.055mg/L was derived for aluminium at pH >6.5 using with 95% protection. A freshwater low reliability trigger value of 0.0008 mg/L was derived for aluminium at pH <6.5. The low reliability figures should only be used as indicative interim working levels. For the

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Parameter	Water Quality Summary
Nutrients	In general, total nitrogen levels (TN) had a mean value of 0.95 mg/L with a range between 0.4 mg/L and 1.2 mg/L. The results show an exceedance of the trigger values for TN set by the ANZG (2018) guidelines (0.2 mg /L). Total phosphorus (TP) levels have been consistently below the ANZG (2018) trigger values of 0.001 mg/L.

Overall, the water quality at the Annie's dam spillway (SW6) and downstream of the spillway within an unnamed tributary of the Marrakai Creek (SW7) has been within ANZG (2018) guidelines for most of the water quality parameters, with pH and DO readings below ANZG (2018) trigger values and occasional exceedance of ecosystem protection GVs for some dissolved metals (Al, Zn, Cu). It is expected that the sub-neutral pH conditions in streams and rainfall facilitate the mobilisation of metals from minerals in natural and mine impacted soils and rocks. Elevation of aluminium in the region is known and currently assumed to reflect influences from natural geology. The acidic pH value of 4.3 was recorded during December 2016 and may be attributed to a first flush event. This indicates that water quality may be influenced by past mining activities. The elevated TN levels from the water samples may be connected to the existing pastoral use and free roaming cattle within the Project area and surrounding lands that drain into the watercourse.

Baseline Water Quality at Rustlers Roost for Mount Bunday Creek Catchment

Table 7-36 Baseline Mount Bunday Creek Catchment Water Quality Parameters - Upstream

Parameter	Water Quality Summary
Electrical Conductivity (EC)	Low EC average (71 µS/cm) has been recorded in the permanent water bodies and during times of flow. The range was between 8 to 313 µS/cm for the recorded 46 sampling occasions at all six sites. SW5 exceeded the ANZG (2018) trigger value for aquatic ecosystems of 250 µS/cm on two sampling occasions (300 and 313 µS/cm). The SW5 location is at the southern heap leach pond. The high EC values were recorded during the dry season and may be related to evapo-concentration and lack of freshwater inflow into the pond.
pH Dissolved Oxygen (DO)	pH was on average 6.5 for all sites and all 46 occasions with a large range of 4.5 to 8.0. SW12 consistently showed pH levels below the ANZG (2018) trigger values between 6-8. SW12 receives runoff from the existing WRD. A low mean DO of 71 % was recorded with a range of 20 to 115 %. The mean value is below the ANZG (2018) trigger values for DO between 80-120%. The lowest DO levels were measured at SW11 with a range between 20 and 51 %.
Turbidity (NTU)	Turbidity levels were on average 102.8 NTU with a range between 0.7 and 899.0 NTU with SW2 showing the highest turbidity values. The range indicates the variability in turbidity may depend on rainfall events prior to sampling. The mean NTU values are above the ANZG (2018) water quality objective of 15 NTU.
Dissolved metals	Overall, there are occasional exceedances of the ecosystem protection GVs for dissolved metals, with a maximum measured value of 0.44 mg/L for Al at SW2, 0.073 mg/L for Arsenic (As) at SW2, 0.004 mg/L for Chromium (Cr) at SW2 and 0.15 mg/L Zn at SW5. ANZG (2018) trigger values for these metals are 0.055 mg/L for Al, 0.013 mg/L for As, 0.001 mg/L for Cr and 0.008 mg/L for Zn.
Nutrients	In general, TN levels had a mean value of 0.62 mg/L, with a range between 0.1 and 2.3 mg/L with the maximum at SW2. TP was 0.07 mg/L, with a range between < 0.01 and 0.32 mg/L with the maximum recorded also at SW2. Mean TN and TP was in exceedance of the ANZG (2018) trigger values (TN 0.2 mg/L, TP 0.01 mg/L).

Overall, the water quality in the upstream section of Mount Bunday Creek tributaries has been within ANZG (2018) limits for most of the parameters, sites and sampling. However, exceedance for some values (e.g. pH, turbidity, dissolved metals and nutrients) indicates that water quality is likely to be influenced by a range of

purpose of consistency and due to the recorded fluctuation of pH in the collected water samples the default trigger value of 0.055 mg/l for a pH >6.5 was chosen for this report across all locations. The site-specific trigger value for aluminium for future water quality monitoring will be outlined in more detail in the Water Management Plan (Appendix I).

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sources including storm events, natural geology as well as previous mining activities and current pastoral land use.

Baseline Water Quality at Quest 29 for Mount Bunday Creek Catchment

Table 7-37 Baseline Mount Bunday Creek Catchment Water Quality Parameters at Quest 29

Parameter	Water Quality Summary
Electrical Conductivity	Low EC average (313 $\mu\text{S}/\text{cm}$) has been recorded for times with significant flow. The range was between 12 to 1,574 $\mu\text{S}/\text{cm}$ for the 85 sampling occasions at all 5 sites. The mean value was above the quality objective for ANZG (2018) for aquatic ecosystems of 250 $\mu\text{S}/\text{cm}$. Water samples from the leach pond showed the highest EC values with a range between 427 and 1,574 $\mu\text{S}/\text{cm}$ potentially associated with evapo-concentration and ongoing leaching from the leach pad.
pH Dissolved Oxygen (DO)	pH was on average 6.7 for all sites and all sampling occasions with a large pH range of 3.9 to 8.8 with the lowest recorded at the leach pond. There was also a low mean DO of 85 % recorded with a range of 38 to 116 %. Lowest DO was recorded for SWQ1. These mean values are within ANZG (2018) trigger values for pH (6-8) and DO (80-120 %).
Turbidity	Turbidity levels were on average 67.3 NTU with a range between 2.7 and 1,500.0 NTU. The range indicates the variability in turbidity and influence by rainfall events prior to sampling. The mean NTU values are above the ANZG (2018) water quality objective of 15 NTU. One sampling occasion on the 20/12/2016 recorded NTU in excess of 1,200 at two sites (SWQ2 and SWQ4), potentially due to significant rainfalls, skewing the mean calculation.
Dissolved metals	Overall, there was exceedance of the ecosystem protection GVs for some of the dissolved metals (Al, As, Cd, Cu, Pb, Ni, Zn) for some of the sampling occasions, with a maximum measured value of 1.6 mg/L for Al, 0.018 mg/L for As, 0.0069 mg/L for Cadmium (Cd), 0.065 mg/L for Cu, 0.31 mg/L for Lead (Pb), 0.11 mg/L for Nickel (Ni), and 0.38 mg/L for Zn. All maximum values have been recorded from the leach pond. ANZG (2018) trigger values for these metals are 0.055 mg/L for Al, 0.013 mg/L for As, 0.0002 mg/L for Cd, 0.0014 mg/L for Cu, 0.0014 mg/L for Pb, 0.011 mg/L for Ni, and 0.008 mg/L for Zn.
Nutrients	In general, TN levels had a mean value of 0.52 mg/L with a range between <0.1 mg/L and 3.8 mg/L. TP was 0.07 mg/L, with a range between < 0.01 and 0.53 mg/L. Mean TN and TP was in exceedance of the ANZG (2018) trigger values (TN 0.2 mg/L, TP 0.01 mg/L).

Seasonal influences of first-flush, storm events, residual flow and evapo-concentration are expected to result in a broad range of water quality conditions observed. High turbidity readings reflect ongoing erosion from existing disturbance on site. Most of the elevated dissolved metal readings have been associated with water samples taken from the SWQ Leach point between 2016 and 2018, which is the historic heap leach ponds. Overall, the water quality results are consistent with previous mining and current pastoral activities in and surrounding the Project area.

Baseline Water Quality at Quest 29 for McKinlay River Catchment

Table 7-38 Baseline McKinlay River Catchment Water Quality Parameters at Quest 29

Parameter	Water Quality Summary
Electrical Conductivity (EC)	Low EC average (47 $\mu\text{S}/\text{cm}$) has been recorded for times with significant flow. The range was between 19 to 124 $\mu\text{S}/\text{cm}$ for the 45 sampling occasions at all 5 sites with the recorded high at SWQ8. The mean value was below the quality objective for ANZG (2018) trigger values for aquatic ecosystems of 250 $\mu\text{S}/\text{cm}$, indicating freshwater conditions.
pH Dissolved Oxygen (DO)	pH was on average 6.8 for all sites and all sampling occasions with a large pH range of 4.4 to 8.3. A mean DO of 84 % was recorded with a range of 54 to 167 %. The mean values were within ANZG (2018) trigger values for pH (6-8) and DO (80-120 %). Lowest pH and DO values were recorded at SWQ8, a location within a tributary to McKinlay River outside of the mining lease.

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Parameter	Water Quality Summary
Turbidity (NTU)	Turbidity levels were on average 22.0 NTU with a range between 1.2 and 120.0 NTU with the lowest recorded at SWQ3. The mean NTU values are above the ANZG (2018) water quality objective of 15 NTU.
Dissolved metals	Overall, there was exceedance of the ecosystem protection GVs for some of the dissolved metals (Al, As, Cd, Cu, Pb, Ni, Zn) for some of the sampling occasions, with a maximum measured value of 0.49 mg/L for Al at SWQ6, 0.28 mg/L for As at SWQ3, 0.07 mg/L for Cu at SWQ5, and 0.024 mg/L for Zn at SWQ6. ANZG (2018) trigger values for these metals are 0.055 mg/L for Al, 0.013 mg/L for As, 0.0014 mg/L for Cu, and 0.008 mg/L for Zn.
Nutrients	In general, TN values had a mean value of 0.45 mg/L with a range between <0.1 mg/L and 2.8 mg/L. Mean TP was 0.21 mg/L, with a range between < 0.01 and 1.54 mg/L. Mean TN and TP was in exceedance of the ANZG (2018) trigger values (TN 0.2 mg/L, TP 0.01 mg/L). Both maximum values for TN and TP were recorded at SWQ7.

The low pH and DO recorded at SWQ8 appears as an outlier in the data. The sampling location is in a creek bed outside of the Quest 29 lease but receives runoff from previously disturbed areas. Overall, the water quality results in the pit lakes, leach ponds and creeks are reflecting the hydrological properties of each sampling site. They are consistent with the ephemeral character of the creek flows, including first flush and storm events and residual flows and with impacts on water quality from disturbance due to previous mining and current pastoral lease activities in the Project area.

Baseline Water Quality at Toms Gully for Lower Mount Bunday Creek Catchment

Site specific trigger values for Toms Gully Mine have been developed and are outlined in Appendix I. These values represent the 80th percentile related to the freshwater species protection as outlined in the ANZG (2018) guidelines for dissolved metals, EC, pH and turbidity (Table 7-39).

Table 7-39 Baseline Water Quality at Toms Gully for Lower Mount Bunday Creek Catchment

Parameter	Water Quality Summary
Electrical Conductivity (EC)	Low EC average (71 µS/cm) has been recorded for times with significant flow. The range was between 11 to 385 µS/cm for the recorded sampling occasions at all three sites, indicating very fresh-water quality, with water quality well below the ANZG (2018) trigger values for aquatic ecosystems of 250 µS/cm but above the relevant Toms Gully SSTV of 41 µS/cm. SWTG2 was the only site that had readings significant exceedance of the relevant trigger values during recorded low flow periods.
pH Dissolved Oxygen (DO)	pH was on average 6.3 for both sides for all sampling occasions with a range of 4.5 to 7.4. These mean values are within the ANZG (2018) trigger value for pH (between 6-8). SWTG2 had the lowest mean pH value of all sites (5.9) and was the only side that had pH values lower than the SSTV threshold for Toms Gully Mine of 5.8-8. No readings above pH 8.0 were recorded. There were no available data for dissolved oxygen for the sites.
Turbidity (NTU)	Turbidity levels were on average 104.7 NTU with a range between 1.7 and 1600.0 NTU. The range indicates large variability in turbidity in response to rainfall events. The mean value was in exceedance of the ANZG (2018) of 15 NTU and relevant SSTV 87 NTU. SWTG3 had the highest recorded turbidity value (1600.0 NTU).
Dissolved metals	Overall, there was exceedance of the ANZG (2018) and SSTV ecosystem protection GVs for dissolved metals (Al, Cd, Cr, Cu, Mn, Ni, Zn) for some of the sampling occasions, with a maximum measured value of 6.4 mg/L for Al, 0.083 mg/L for Cd, 0.017 mg/L for Cr, 0.036 mg/L for Cu, 3.62 mg/L for Mn, 0.096 mg/L for Ni, and 0.37 mg/L for Zn. All exceedances and maximum values were recorded at site SWTG2. ANZG (2018) and site-specific trigger values for these metals are 0.055 / 0.295 mg/L for Al, 0.0002 / 0.0004 mg/L for Cd, 0.001 / 0.006 mg/L for Cr, 0.0014 / 0.0018 mg/L for Cu, 1.9 / 2.5 mg/L for Mn, 0.011 / 0.013 for Ni, and 0.008 / 0.015 mg/L for Zn.

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Parameter	Water Quality Summary
Nutrients	TN and TP values have not been sampled regularly at the sites. However, some available data for site SWTG2 from 2009 has shown elevated TN readings (0.47 and 1.36 mg/L). These readings were in exceedance of the ANZG (2018) trigger values (TN 0.2 mg/L). Concurrent TP levels were below the ANZG (2018) trigger value (TP 0.01mg/L). SSTV were not set for nutrients.

Overall, exceedance of dissolved metals was recorded at site SWTG2. This site appears to be most directly influenced by the mining activities from Toms Gully Mine as it is about 1 km downstream from mine related infrastructure (TSF). However, there was no significant dissolved metal exceedance recorded at SWTG3, a site that is further 5.5 km downstream from SWTG2. This indicates that the potential influence on water quality from dissolved metals associated with mining does not extend further downstream.

Baseline Water Quality Proposed Accommodation Camp for Coulter Creek

Site specific trigger values for Toms Gully Mine that shares the same mining lease with the proposed accommodation camp have been developed and are outlined in Appendix I. These values represent the 80th percentile related to the freshwater species protection as outlined in the ANZG (2018) guidelines for dissolved metals, EC, pH and turbidity (Table 7-40).

Table 7-40 Baseline Water Quality Proposed Accommodation Camp for Coulter Creek

Parameter	Water Quality Summary
Electrical Conductivity (EC)	EC average for both sites was 117 µS/cm has been recorded. The range was between 23 to 290 µS/cm for the recorded sampling occasions, indicating fresh-water quality, with water quality well below the ANZG (2018) trigger values for aquatic ecosystems of 250 µS/cm but above the relevant Toms Gully SSTV of 41 µS/cm.
pH Dissolved Oxygen (DO)	pH was on average 6.5 for both sides with a range of 5.0 to 8.4. The mean value was within the ANZG (2018) trigger value for pH (between 6-8). However, CK7 recorded pH below (5.0) and above (8.4) the ANZG 2018 and the Toms Gully site-specific trigger values (5.8 -8.0). There were no available data for dissolved oxygen for the sites.
Turbidity (NTU)	Turbidity levels were on average 17.9 NTU with a range between 2.6 and 66.0 NTU. The mean value was just above exceedance of the ANZG (2018) of 15 NTU and relevant SSTV 87 NTU.
Dissolved metals	Overall, there was exceedance of the ANZG (2018) and SSTV ecosystem protection GVs for dissolved metals (Al, Cd, Cu, Mn, Ni, Zn) for some of the sampling occasions, with a maximum measured value of 0.76 mg/L for Al, 0.014 mg/L for Cd, 0.007 mg/L for Cu, 2.6 mg/L for Mn, 0.043 mg/L for Ni, and 0.16 mg/L for Zn. Most of the maximum values have been recorded at CK7. ANZG (2018) and site-specific trigger values for these metals are 0.055 / 0.295 mg/L for Al, 0.0002 / 0.0004 mg/L for Cd, 0.0014 / 0.0018 mg/L for Cu, 1.9 / 2.5 mg/L for Mn, 0.011 / 0.013 for Ni, and 0.008 / 0.015 mg/L for Zn.
Nutrients	There were no nutrient data available for the Coulter Creek sites.

Most of the exceedance records for dissolved metals are associated with CK7. This site is outside of the Toms Gully mining lease area downstream of CCO2 where Coulter Creek may have been affected by disturbance from pastoral activities.

None of the samples for all water quality sites in upper and lower Mount Bunday Creek, Marrakai, McKinlay River and Coulter Creek catchment showed any exceedance with the default ANZG (2008) stock drinking water guidelines for all sampling occasions.

Piper Diagram for Surface Water Samples at Rustlers Roost and Quest 29

A Piper Diagram for the surface water at Rustlers Roost and Quest 29 has been produced to present the dissolved constituent of the water samples and to better understand seasonal and mining influence on surface water chemistry (Figure 7-33).

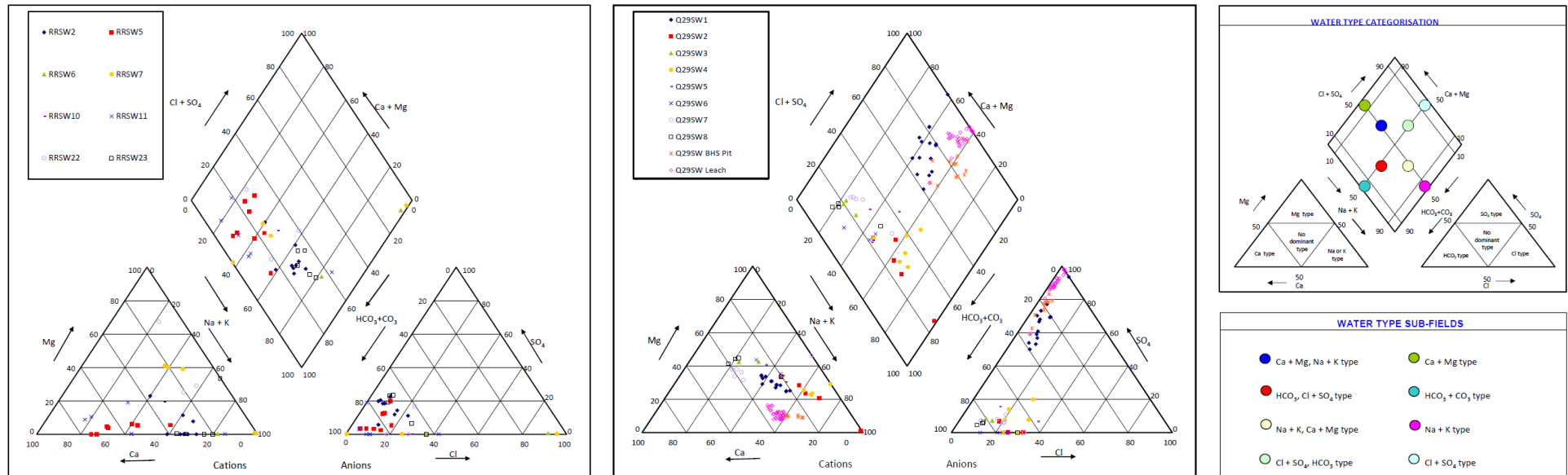


Figure 7-33 Piper Diagram for Rustlers Roost and Quest 29 Surface Water Ionic Composition

Rustlers Roost

The distribution of the values for each sampling occasion and location indicates that surface water monitoring sites at Rustlers Roost have been less affected by leaching of waste rock solutes and more so by seasonal variations. Furthermore, the plot supports geochemical assessments of low AMD potential of previously mined material at the Rustlers Roost location (Appendix D).

Quest 29

Surface water quality at the BHS pit (Q29SW BHS pit) and the nearby leach ponds (Q29SW Leach) presented with signals for potential influence from waste ore leachate. Furthermore, the plot also shows some connectivity between the leach ponds and the creek associated with Q29SW1. The spread of the values for Q29SW1 shows greater variation than the pit and the leach ponds, potentially representing seasonal influences on water quality. The values for site Q29SW4 (approximately 5.5 km further downstream from Q29SW1) indicate that the influence from mine site leachate do not extend further.

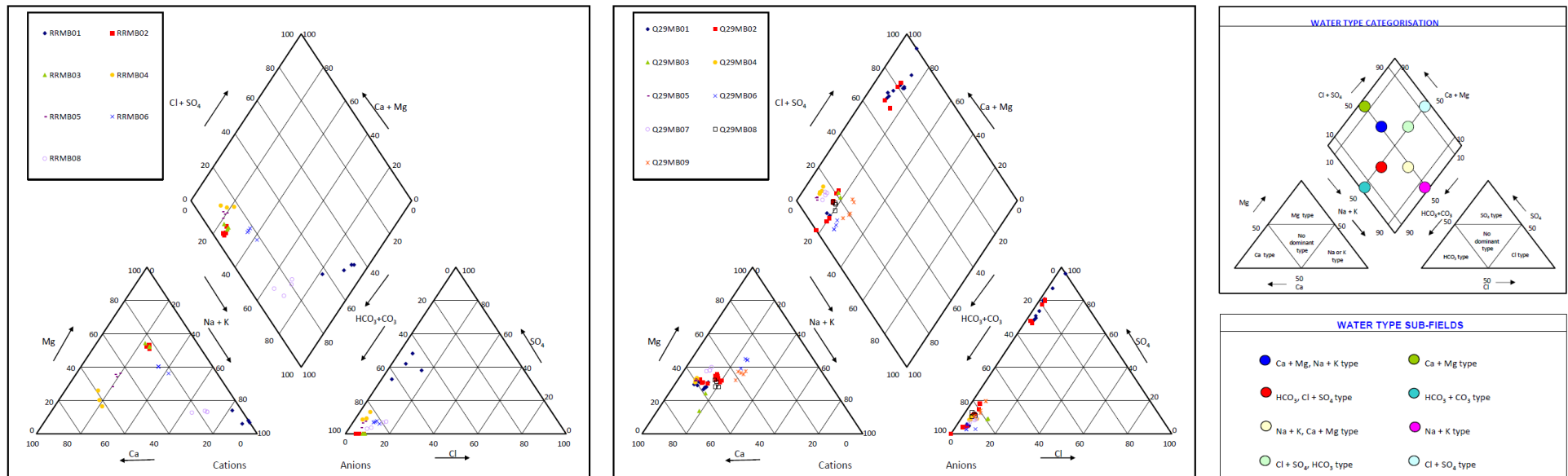


Figure 7-34 Piper Diagram for Rustlers Roost and Quest 29 Groundwater Ionic Composition

Rustlers Roost

The plot indicates that the groundwater monitoring bores show limited impacts from previous mining activities. Only RRMB01 which is located next to the heap leach pad shows signs of influence from potential waste rock leachate.

Quest 29

Most of the monitoring bores showed similar water chemistry with small variations indicating limited impacts from previous mining activities. Only MB01 and MB02 may have been affected at times by waste rock solutes with elevated sulfate levels from the BHS heap leach pad as both bores are in proximity to it.

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7.4.1.4 Surface Water Sediment Quality

In April 2021 a targeted sediment sampling survey was conducted to obtain a contemporary baseline of existing surface water sediment quality and to characterise potential impacts on surface water quality from previous mining activities at the Rustlers Roost portion of the Project area.

The sediment sampling sites with coordinates and description are shown in Table 7-41. The sites are also further discussed in the Aquatic Ecosystem section.

Table 7-41 Sediment Sampling Locations and Descriptions

Site ID	Latitude	Longitude	Description	Purpose
RRMCUS	- 12.9196239	131.4809763	Marrakai creek upstream site	Control
RRMCDS	- 12.9049505	131.4695765	Marrakai creek downstream Site	Impact
RRSW2	- 12.92867	131.50156	Upper Mount Bunday Creek tributary upstream, adjacent to leach heap pad	Impact
RRSW23	- 12.930765	131.50637	Upper Mount Bunt Creek tributary downstream from RRSW2	Impact

Water quality measurements on site were taken for pH, electrical conductivity (EC), turbidity, dissolved oxygen (DO), and Temperature using a pre-calibrated Pro DSS instrument. The sediment samples were taken in accordance with guidance provided in *Sediment Quality Assessment – A Practical Guide* (Simpson and Batley 2016), and the macroinvertebrate samples were collected following the method from the *User Manual for the Darwin-Daly Regional Australian River Assessment System (AUSRIVAS) Models – Northern Territory* (Lamche 2007). The detailed methodology has been outlined in the relevant report (Appendix Q).

Weak acid extraction was used by the laboratory for quantification of bioavailable metals in the sediment. All analytes with a ANZG (2018) default guideline value (DGV) recorded concentrations far below those guidelines. The large majority of results were below the laboratory's limit of reporting (LOR). Laboratory results for extractable metals covered by sediment toxicity DGV are provided in Table 7-42 and Table 7-43. The concentrations for extractable metals were generally greatest at RRSW2 and RRSW23. This was largely for metals without a DGV, such as aluminium, which recorded the highest concentration of 400 mg/kg at RRMCUS, and iron, with a concentration recorded at RRSW2 and RRSW23 of 1,830 mg/kg and 1,120 mg/kg respectively (Table 7-42 and Table 7-43). The concentrations of cyanide were below LOR at all sites.

The sediment concentrations for iron were highest at the downstream locations from the heap leach pad (RRSW2 and RRSW23). Other metals where concentrations were higher at these sites compared to RRMCDS and RRMCUS were Arsenic, Barium, Cobalt, Copper, Lead, Manganese, Vanadium and to a lesser extent Zinc and Nickel (only recorded at RRSW2). While these analytes have no applicable DGVs, the concentrations indicate a potential impact from the pre-existing mine site. Aluminium recorded a maximum concentration of 400 mg/kg at RRMCDS, the only occurrence of a site recording a greater concentration than that found at RRSW2 and RRSW23. All metals not discussed in this section recorded concentrations below the laboratory's limit of reporting (LOR). No exceedances as per the DGV and the fact that cyanide was below LOR indicate that there are no concerns regarding sediment toxicity at present.

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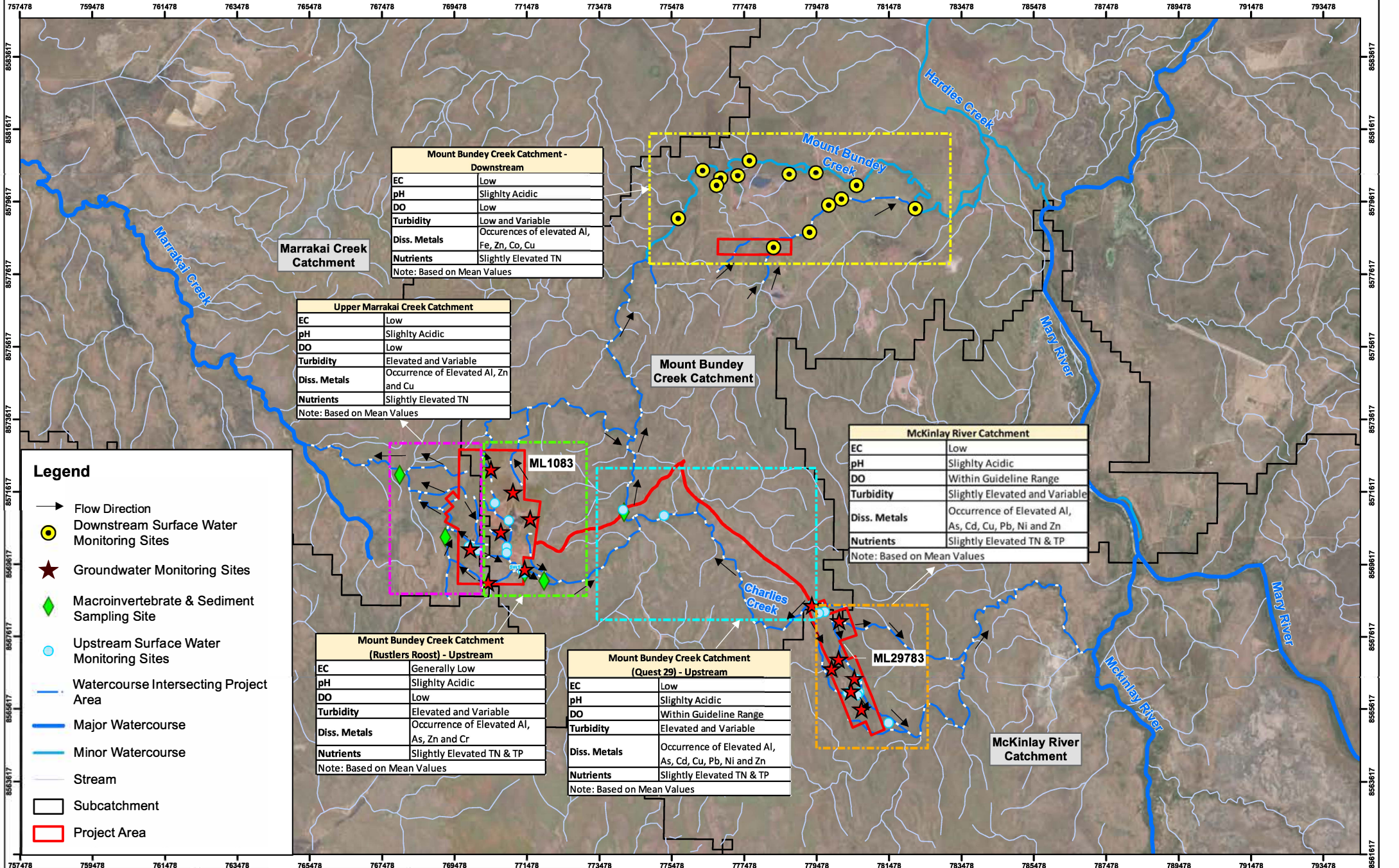
Table 7-42 Laboratory Result Summary for Sediment Toxicant DGV* Covered Dissolved Metals

Site ID	Antimony	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Silver	Zinc	Mercury
Sediment Toxicant DGV* (mg/kg)	2-25	20-70	1.5-10	80-130	65-270	50-220	21-52	1-4	200-410	0.15-1
RRMCUS	<1.0	<1.0	<0.1	<1.0	<1.0	1.4	<1.0	<1.0	<1.0	<0.01
RRMCDS	<1.0	<1.0	<0.1	<1.0	<1.0	1.6	<1.0	<1.0	<1.0	<0.01
RRSW2	<1.0	5.8	<0.1	1.1	9.9	2.7	1.2	<1.0	1.8	0.01
RRSW23	<1.0	2.4	<0.1	<1.0	3.1	3	<1.0	<1.0	1	0.01

*Sediment Toxicant DGV: Toxicant default guideline values for sediment quality (<https://www.waterquality.gov.au/anz-guidelines/guideline-values/default/sediment-quality-toxicants>)

Table 7-43 Laboratory Result Summary for Dissolved Metals (Without Toxicant Default Guideline Values)

Site ID	Aluminium	Barium	Beryllium	Boron	Cobalt	Iron	Manganese	Molybdenum	Selenium	Strontium	Uranium	Vanadium
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
RRMCDS	190	18.7	<1.0	<50	0.7	960	62	<5	<0.5	<5	<1.0	<2.0
RRMCUS	400	15.6	<1.0	<50	1.4	750	38	<5	<0.5	<5	<1.0	<2.0
RRWS2	290	30.4	<1.0	<50	2.2	1830	88	<5	<0.5	<5	<1.0	4.7
RRSW23	310	30.5	<1.0	<50	2.4	1120	91	<5	<0.5	<5	<1.0	2.5



R	Details	Date	©COPYRIGHT CDM SMITH This drawing is confidential and shall only be used for the purpose of this project.			
1	Final	24/09/21	DESIGNED	SS	CHECKED	TK
-	-	-	DRAWN	SS	CHECKED	TK
-	-	-	APPROVED	TK	DATE	24/09/21
-	-	-	Notes:			

0 1,000 2,000 4,000

Meters

1 cm = 948 meters

GCS GDA 1994 MGA Zone 52

DISCLAIMER

CDM Smith has endeavoured to ensure accuracy and completeness of the data. CDM Smith assumes no legal liability or responsibility for any decisions or actions resulting from the information contained within this map.

DATA SOURCE

NT Government Open Source Data

DESIGNER

CDM Smith

CLIENT

PRIMARY GOLD

FIGURE 7-35

Summary of Existing Inland Water Quality at Sampling Locations

DRG Ref: 1001087-EIS-07-7.36

7.4.1.5 Groundwater

Section 7.3 provides a detailed summary of the hydrogeology in the Project area and the aquifers relevant to the site. In summary, the aquifers in the Rustlers Roost area of the Project are associated with fracturing/structural permeability within the metasediments of the South Alligator Group and Burrell Creek formations. Yields in these formations are low with 0.5 – 5 l/s. Previous surveys have shown that the regional groundwater flow is likely towards east/northeast to Mary River and superficial local flow direction follows the natural surface gradient (refer to Section 7.3). Furthermore, pump testing showed confined to semi-confined aquifer conditions with transmissivity range of 71- 107 m²/day and storativity range of 2×10^{-3} – 10^{-5} (Appendix H).

Monitoring Bores

Three historical monitoring bores exist within the Project area, with one at Rustlers Roost and two at Quest 29. Bore MB01 at Rustlers Roost is to the south of the heap leach pad, between the pad and the leach ponds (Figure 7-31). The Quest 29 bores are located in the northern section of the Project area between the DHS pit and the leach pad and leach ponds (Q29MB01 and Q29MB02). Due to the lack of historic groundwater monitoring bores in the Project area, knowledge of historic groundwater quality is deficient. Existing water quality results indicate that groundwater may have been locally impacted by historical mining activities (i.e. Q29MB01 and Q29MB02).

Background groundwater quality at Rustlers Roost from historical bore reports with available water quality data (five bores drilled in 1994 and one bore drilled in 1985), indicate freshwater quality with an average pH of 6.8 and EC of 114 µS/cm. Water quality from two sampling occasions indicate pH values are slightly acidic, ranging between 5.9 to 6.2, EC is low (110 to 140 µS/cm) and exceedance of the aquatic ecosystem protection GVs for Zn and Ni.

Background groundwater quality at Quest 29 from historical bore reports with available water quality data (one bore drilled in 1999 and two bores drilled in 1976), indicates that groundwater is fresh and good quality, with an average pH of 7.06 and an EC of 262 µS/cm.

Recent monitoring of Q29MB01 shows elevated EC and dissolved metals in comparison to other sites. pH values range between 6.09 to 7.33, and elevated EC, well above the aquatic ecosystem protection GVs of 250 µS/cm (ranging from 210 to 1,213 µS/cm) and exceedance of the ecosystem protection GVs for Al, As, Cd, Cr, Cu and Zn.

Q29MB02 located west of the heap leach ponds and pad at Quest 29, has had elevated EC and occasional exceedances of the aquatic ecosystem protection GVs for As, Cd, Cr, Cu, Pb and Zn. pH values range from slightly acidic (6.49) to slightly alkaline (7.6), and elevated EC, above the aquatic ecosystem protection GVs of 250 µS/cm (ranging from 210 to 336 µS/cm).

Additional monitoring bores were constructed in 2020 in the Rustlers Roost and Quest 29 portions of the Project area to improve understanding of groundwater quality. The relevant technical data for these bores are presented in Table 7-44 and the location of these is shown in Figure 7-43.

Table 7-44 Current Groundwater Monitoring Bores

Bore Name	Latitude	Longitude	Depth (m)	Screened Interval (m)	Yield (l/s)
Rustlers Roost					
RR MB02	-12.928138	131.501481	39	27-36	1
RR MB03	-12.931479	131.492211	70	44-56	1
RR MB04	-12.923166	131.487615	70	41-47	1
RR MB05	-12.918846	131.49531	70	55-67	1

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Bore Name	Latitude	Longitude	Depth (m)	Screened Interval (m)	Yield (l/s)
RR MB06	-12.915522	131.502737	70	55-67	1
RR MB07	-12.908878	131.498342	68	56-65	1
RR MB08	-12.903331	131.492669	70	61-67	1
Quest 29					
Q29 MB03	-12.962217	131.587492	52	24-51	1
Q29 MB04	-12.957727	131.584775	54	40-52	1
Q29 MB05	-12.954557	131.585617	54	24-36	1
Q29 MB06	-12.952175	131.579835	54	19-37	1
Q29 MB07	-12.949718	131.58156	54	25-31	0.5
Q29 MB08	-12.940141	131.581646	53	46-52	0.5
Q29 MB09	-12.936416	131.574607	58	22-31	1

The water quality at the new groundwater monitoring bores has been sampled monthly over a six month period in 2020/2021.

Baseline Water Quality at the Rustlers Roost Groundwater Monitoring Bores

Table 7-45 provides a summary of select water quality parameters for the new monitoring bores at the Rustlers Roost site. The outlined aquatic ecosystem protection GV as ANZG (2018) trigger values are only relevant in case of abstraction of groundwater and discharge to surface water (i.e. pit dewatering).

Table 7-45 Baseline Groundwater Quality Parameters at Rustlers Roost

Parameter	Water Quality Summary
Electrical Conductivity	An EC average of 157 $\mu\text{S}/\text{cm}$ for a total of 32 sampling occasions across all 8 sites has been recorded over the 6-month period. The range was between 37.1 to 305.4 $\mu\text{S}/\text{cm}$ with highest at RR MB05. The mean value was below the quality objective for ANZG (2018) trigger values for aquatic ecosystems of 250 $\mu\text{S}/\text{cm}$, indicating freshwater conditions.
pH and Dissolved Oxygen (DO)	pH was on average 5.7 for all sites and all sampling occasions with a pH range of 3.8 to 6.8 indicating slightly acidic groundwater with lowest at RR MB07. Typical for groundwater conditions, there were low DO levels recorded over the monitoring period with a mean value of 14% and a range of 1% to 40%. The mean values were within ANZG (2018) trigger values for pH (6-8) and DO (80-120 %).
Bicarbonate alkalinity as CaCO_3	Bicarbonate alkalinity was continuously measured below <1mg/L for all samples. The low levels are reflected by the measured pH <7 and indicate the reduced buffer capability, hence reduced acid neutralising ability of the groundwater.
Hardness as CaCO_3	Mean total hardness (48.1 mg/L) with a range between <1 to 117 mg/L from all samples indicates general 'soft' water. Furthermore, Magnesium and Calcium ion levels were low throughout most of the samples with a maximum of 13 mg/L for Mg and 31 mg/L for Ca.
Dissolved metals	Overall, there was occasional exceedance of the aquatic ecosystem protection GV for some of the dissolved metals (Al, As, Cu, Zn), with a maximum measured value of 0.11 mg/L for Al at RR MB07, 0.035 mg/L for As at RR MB06, 0.033 mg/L for Cu at RR MB07, and 0.078 mg/L for Zn at RR MB03. ANZG (2018) trigger values for these metals are 0.055 mg/L for Al, 0.013 mg/L for As, 0.0014 mg/L for Cu, and 0.008 mg/L for Zn. While these maximum levels were observed, most of the samples at all locations recorded metals below detection levels.

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Parameter	Water Quality Summary
Nutrients	TN levels had a mean value of 0.16 mg/L with a range between <0.1 mg/L and 0.2 mg/L with maximum at RR MB07. Mean TP was 0.16 mg/L, with a range between < 0.01 and 0.74 mg/L with maximum TP detected at RR MB06. Mean TP was in exceedance of the ANZG (2018) trigger value (TN 0.2 mg/L, TP 0.01 mg/L).

Table 7-45 provides a summary of the select water quality parameters for the monitoring bores at the Rustlers Roost site. Overall, the groundwater quality monitoring has shown groundwater is typically fresh with exceedance of aquatic ecosystems GV's for some metals and nutrients at some sampling occasions and locations. The elevated phosphorus and metal concentrations may be associated with underlying mineralogical deposits entailing weathered zones.

Baseline Water Quality at the Quest 29 Groundwater Monitoring Bores

Table 7-46 provides a summary of the select groundwater quality parameters for the new monitoring bores at the Quest 29 site.

Table 7-46 Baseline Groundwater Quality Parameters at Quest 29

Parameter	Water Quality Summary
Electrical Conductivity	An EC average of 293 $\mu\text{S}/\text{cm}$ for a total of 28 sampling occasions across all 7 sites has been recorded over the 6-month period. The range was between 4.3 to 463 $\mu\text{S}/\text{cm}$ with highest at Q29 MB05. The mean value was above the quality objective for ANZG (2018) trigger values for aquatic ecosystems of 250 $\mu\text{S}/\text{cm}$, however still classified as freshwater.
pH Dissolved Oxygen (DO)	pH was on average 6.1 for all sites and all sampling occasions with a pH range of 4.7 to 6.6 indicating slightly acidic groundwater with lowest at Q29 MB03. Typical for groundwater, there were low DO levels recorded over the monitoring period with a mean value of 10% and a range of 1 to 33%. The mean values were within ANZG (2018) trigger values for pH (6-8), but below DO (80-120%).
Bicarbonate alkalinity as CaCO_3	Bicarbonate alkalinity was continuously measured below <1mg/L for all samples. The low levels are reflected by the measured pH <7 and indicates the reduced buffer capability, hence reduced acid neutralising ability of the groundwater.
Hardness as CaCO_3	Mean total hardness (121.9 mg/L) with a range between 7 to 200 mg/L from all samples indicating moderately hard water. This is also reflected by the Magnesium and Calcium ion levels with a maximum of 19 mg/L for Mg and 50 mg/L for Ca.
Dissolved metals	Overall, there was occasional exceedance of the aquatic ecosystem protection GV's for some of the dissolved metals (As, Cu, Zn), with a maximum measured value of 0.2 mg/L for As at Q29 MB04, 0.007 mg/L for Cu at Q29 MB03, and 0.074 mg/L for Zn at Q29 MB03. ANZG (2018) trigger values for these metals are 0.055 mg/L for Al, 0.0014 mg/L for Cu, and 0.008 mg/L for Zn. While these maximum levels were observed, most of the samples at all locations recorded metals below detection levels.
Nutrients	In general, total nitrogen levels (TN) had a mean value of 0.1 mg/L with a range between <0.1 mg/L and 0.3 mg/L with the maximum at Q29 MB03. Mean total phosphorus (TP) was 0.05 mg/L, with a range between < 0.01 and 0.13 mg/L with maximum at Q29 MB09. Mean TP was in exceedance of the aquatic ecosystems ANZG (2018) trigger values (TN 0.2 mg/L, TP 0.01 mg/L).

Overall, the groundwater quality monitoring has shown exceedance of water quality parameters at some sampling occasions and locations. The elevated phosphorus and metal concentrations may be associated with underlying mineralogical deposits entailing weathered zones.

Environmental Values associated with Groundwater and Surface Water Quality

The discussion in the previous section has shown that ground and surface water quality has exceeded aquatic ecosystem ANZG (2018) trigger values at some locations on certain occasions. While the exceedance may be associated with mining activities close to some of the sampling locations, natural variability in mineral deposits and acidic potential in soils may also contributed to the recorded elevated levels of dissolved metals. Furthermore, water quality investigations have

shown that any decreased water quality experienced from mining, may be limited to the direct vicinity of the disturbance.

As previously discussed, surface water and to some degree groundwater quality is linked to aquatic and terrestrial ecosystem quality. Therefore, any potential ecosystem interaction with decreased water quality has been illustrated in the relevant sections.

Furthermore, social and economic values have been also linked to water quality and quantity in the Project area. These topics are discussed in more detail in Section 7.6. Section 7.3 discusses the potential impacts of other groundwater users that may be affected from the groundwater drawdown from dewatering activities. Water quality related issues from discharge into drainage and creek lines are outlined in the following section.

7.4.2 Potential Impacts and Risks

This section identifies, describes, and assesses the potential impacts and risks to inland water quality, including surface water and groundwater quality from erosion, sedimentation and contamination, discharge of poor-quality water, and alteration of flows from mining activities. The environmental risk assessment discussed in Section 6 and presented in Appendix B identified and considered potential sources of impacts to existing Inland Water Environmental Quality.

7.4.2.1 Conceptual Site Model

A conceptual site model (CSM) has been developed to create a representation of the nature, potential transport pathways and endpoints of contaminants associated with Inland Water Environmental Quality and to inform the risk assessment process including avoidance and mitigation measures (Table 7-47). The development of the CSM has been informed by the draft NT EPA Guidelines Conceptual Sites Models (NT EPA 2013).

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Table 7-47 Tabulated Conceptual Site Model for Inland Water Environmental Quality Contaminant Pathways

Source and Transport Pathway	Drainage System/ Catchment	Stressor	Exposure Media / Compartment	Routes of Exposure	Receptors	Potential Ecological Effects (without controls)
Vegetation clearing – mobilisation of soils on slopes and during wet season in drainage lines	Marrakai Creek, Mount Bunday Creek, Coulter Creek, McKinlay River	Sediments	Surface water Soils	Ingestion, inhalation, adsorption, absorption	Terrestrial and aquatic biota, humans	Physical habitat change from softening, smothering, and increased turbidity resulting impacting on ecological processes and altering biota community structure. Affected human health.
		Nutrients	Surface water Groundwater Soils	Ingestion, adsorption, absorption	Terrestrial and aquatic biota	Change of biotic community structure and function (vegetation, eutrophication).
WRD – water seepage and runoff in drainage lines	Marrakai Creek, Mount Bunday Creek, McKinlay River	Acidic solutes	Surface water Groundwater	Ingestion, adsorption, absorption	Terrestrial and aquatic biota, life stock, humans	Change of biotic community structure and function, increased morbidity and mortality of aquatic fauna. Decline of drinking water quality affecting health of humans and life stock. Potential increased toxicity of metals.
		Metals	Surface water Groundwater	Ingestion, adsorption, absorption	Terrestrial and aquatic biota, life stock, humans	Change of biotic community structure and function, increased morbidity and mortality of aquatic fauna. Decline of drinking water quality affecting health of humans and life stock. Potential bioaccumulation from metals in organisms.
TSF – water seepage and runoff in drainage lines	Marrakai Creek, Mount Bunday Creek,	Acidic solutes	Surface water Groundwater	Ingestion, adsorption, absorption	Terrestrial and aquatic biota, life stock, humans	Change of biotic community structure and function, increased morbidity and mortality of aquatic fauna. Decline of water quality affecting health of humans and life stock. Potential increased toxicity of metals
		Metals	Surface water Groundwater	Ingestion, adsorption, absorption	Terrestrial and aquatic biota, life stock, humans	Change of biotic community structure and function, increased morbidity and mortality of aquatic fauna. Decline of water quality affecting health of humans and life stock. Potential bioaccumulation of metals in organisms.
		Cyanide	Surface water Groundwater	Ingestion, adsorption, absorption	Terrestrial and aquatic biota, life stock, humans	Change of biotic community structure and function, increased morbidity and mortality of aquatic fauna. Decline of water quality affecting health of humans and life stock

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Source and Transport Pathway	Drainage System/ Catchment	Stressor	Exposure Media / Compartment	Routes of Exposure	Receptors	Potential Ecological Effects (without controls)
Pit dewatering – discharge of dewatering effluent in drainage lines and surface water bodies	Marrakai Creek, Mount Bunday Creek, McKinlay River	Acidic solutes	Surface water Groundwater	Ingestion, adsorption, absorption	Terrestrial and aquatic biota, life stock, humans	Change of biotic community structure and function, increased morbidity and mortality of aquatic fauna. Decline of water quality affecting health of humans and life stock. Potential increased toxicity of metals.
		Metals	Surface water Groundwater	Ingestion, adsorption, absorption	Terrestrial and aquatic biota, life stock, humans	Change of biotic community structure and function, increased morbidity and mortality of aquatic fauna. Decline of water quality affecting health of humans and life stock. Potential bioaccumulation of metals in organisms.
Landfill – water seepage and runoff in drainage lines	Mount Bunday Creek	Nutrients	Surface water Groundwater	Ingestion, adsorption, absorption	Terrestrial and aquatic biota	Change of biotic community structure and function (vegetation, eutrophication).
		Organic compounds	Surface water Groundwater	Ingestion, adsorption, absorption	Terrestrial and aquatic biota, life stock, humans	Change of biotic community structure and function, increased morbidity and mortality of aquatic fauna. Decline of water quality affecting health of humans and life stock. Potential bioaccumulation of organic compounds in organisms.
Accommodation camp – wastewater management/ contamination from spills	Coulter Creek	Nutrients	Surface water Groundwater	Ingestion, adsorption, absorption	Terrestrial and aquatic biota	Change of biotic community structure and function (vegetation, eutrophication).
		Pathogens	Surface water Groundwater	Ingestion, adsorption, absorption	Terrestrial and aquatic biota, life stock, humans	Change of biotic community structure and function, increased morbidity and mortality of aquatic fauna. Decline of water quality affecting health of humans and life stock.
Processing, transport, and storage of chemicals – accidental contamination from spills	Marrakai Creek, Mount Bunday Creek, Coulter Creek, McKinlay River	Chemicals	Surface water Groundwater	Ingestion, adsorption, absorption	Terrestrial and aquatic biota, life stock, humans	Change of biotic community structure and function, increased morbidity and mortality of aquatic fauna. Decline of water quality affecting health of humans and life stock. Potential bioaccumulation of organic chemicals in organisms.

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Source and Transport Pathway	Drainage System/ Catchment	Stressor	Exposure Media / Compartment	Routes of Exposure	Receptors	Potential Ecological Effects (without controls)
Processing, transport, and storage of hydrocarbons – accidental contamination from spills	Marrakai Creek, Mount Bunday Creek, Coulter Creek, McKinlay River	Oil and fuels	Surface water Groundwater	Ingestion, adsorption, absorption	Terrestrial and aquatic biota, life stock, humans	Change of biotic community structure and function, increased morbidity, and mortality of aquatic fauna. Decline of water quality affecting health of humans and life stock.
Site infrastructure (e.g., haul road, processing plant, access roads) – runoff in drainage lines	Marrakai Creek, Mount Bunday Creek, Coulter Creek, McKinlay River	Erosion Nutrients	Surface water Surface water Groundwater	Ingestion, inhalation, adsorption, absorption Ingestion, adsorption, absorption	Terrestrial and aquatic biota, humans Terrestrial and aquatic biota	Physical habitat change from softening, smothering, and increased turbidity resulting impacting on ecological processes and altering biota community structure. Affected human health. Change of biotic community structure and function (vegetation, eutrophication).

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The CSM is one of the primary planning tools that has informed the environmental risk assessment and identified 24 potential sources of impacts to Inland Water Environmental Quality (Table 7-48).

Table 7-48 Potential sources of impact to Inland Water Environmental Quality

Risk No.	Source of Impact	Project Phase(s)	Summary of Potential Impacts
IWEQ-1	Vegetation clearing for the Project	Construction, Operation	Direct - Disturbing an additional 333.4 ha of land for the Rustlers Roost, 26.16 ha for Quest 29, 7.3 ha for the accommodation camp and 2 ha for the haul road. Loss of 368.86 ha of habitat. Resulting in destabilised soils, potential erosion, loss of topsoil and sedimentation of Marrakai Creek and Mount Bunday Creek. Characteristics of soils, including chemical, physical, biological, and aesthetic qualities are degraded in the vegetation clearing area. Resulting in less productive soils and potential impacts (through the abovementioned erosion). Indirect or Cumulative - Elevated sediments in waterways from the Project, nearby major operations (e.g. Toms Gully and Mount Bunday Training Area) and general anthropogenic activities (e.g. runoff from unsealed roads) may result in reduced biodiversity in affected areas. Sediment runoff into aquatic habitats can cause increased turbidity, decreased oxygen levels, reduced light penetration, changes in channel morphology and altered sediment composition in substrates. In addition, interference with flows may alter the local wetting and drying regime, including water heights, flow paths, retention times and ponding. Such changes can have flow-on effects on aquatic habitats, resulting in their loss or alteration and a reduction in the quality and/or quantity of important food sources. Cumulative or indirectly sediments that runoff due to vegetation clearing could adversely impact downstream aquatic habitats that support fish populations important to recreational fishing and traditional activities (reduced fish abundance).
IWEQ-2	Overtopping, embankment failure or seepage from the new TSF at Rustlers Roost leading to uncontrolled release of tailings material to surrounding environment.	Construction, Operation, Decommissioning, Closure	Direct - Contamination of surrounding water. Alteration of ecological characteristics, including chemical, physical, biological and aesthetic qualities. Adversely affecting the biological processes that depend on water quality (surface and groundwater). Direct result in the loss of ecological integrity and suitable native fauna habitat in the impacted areas. Indirect or Cumulative - Potential transportation of contaminated sediments and material throughout the Project area and beyond. Biological and human health implications (primary contaminants of concern being cyanide and metals). Groundwater pathways contributing to environmental contaminants mobilised in the surrounding environment through historic mining and quarrying activities. Potential for accumulation of excessive contaminants within sediments and fauna.
IWEQ-3	Overtopping, embankment failure or seepage from the process water storage at Rustlers Roost leading to uncontrolled release of process water to	Operation, Decommissioning, Closure	Direct - Contamination of surrounding water. Alteration of ecological characteristics, including chemical, physical, biological, and aesthetic qualities. Adversely affecting the biological processes that depend on water quality (surface and groundwater). Direct result in the loss of ecological integrity and suitable native fauna habitat in the impacted areas. Indirect or Cumulative - Potential transportation of contaminated

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Risk No.	Source of Impact	Project Phase(s)	Summary of Potential Impacts
	surrounding environment.		sediments and material throughout the Project area and external. Biological and human health implications (primary contaminants of concern being cyanide and metals). Groundwater pathways contributing to environmental contaminants mobilised in the surrounding environment through historic mining and quarrying activities. Potential for accumulation of excessive contaminants within sediments and fauna.
IWEQ-4	Embankment failure or seepages from the new WRDs at Rustlers Roost and Quest 29 to surrounding environment.	Operation, Decommissioning, Closure	Direct - Contamination of surrounding water. Alteration of ecological characteristics, including chemical, physical, biological, and aesthetic qualities. Adversely affecting the biological processes that depend on water quality (surface and groundwater). Direct result in the loss of ecological integrity and suitable native fauna habitat in the impacted areas. Indirect or Cumulative - Potential transportation of contaminants throughout the Project area and external (AMD, metals and NORMS). Biological and human health implications. Contamination of downstream environments resulting in human health risks that would necessitate the closure of watercourse to extraction of drinking water, stock watering, recreation and fishing. Groundwater pathways contributing to environmental contaminants mobilised in the surrounding environment through historic mining and quarrying activities. Potential for accumulation of excessive contaminants in environmental pathways should the same contaminants be released from the nearby Toms Gully Mine or already be present in the environment due to historic activities.
IWEQ-5	Embankment failure of Annie's Dam water storage or process water ponds and uncontrolled water and sediment release (temporary risk noting closure of dam for Rustlers Roost TSF).	Construction, Operation	Direct - Adverse impacts to the structure and quality of Marrakai Creek and downstream aquatic ecosystems with movement and deposition of sediments and damage to vegetation and fauna downstream. Localised severe scouring of the topsoils in the area surrounding the breach and exposure of subsoils to erosive factors leading to sedimentation where not immediately rectified. Indirect or Cumulative - Potential increase in cumulative concentration of sediments within the Marrakai Creek and Adelaide River as a result of any sediment discharged. Increased downstream depositions and siltation impacts. Also, indirect impact of reduced ability for successful revegetation due to loss of topsoils. Significant sediment runoff into aquatic habitats could cause widespread turbidity, decreased oxygen levels, reduced light penetration, changes in channel morphology and altered sediment composition in substrates. In addition, interference with flows may alter the local wetting and drying regime, including water heights, flow paths, retention times and ponding. Such changes can have flow-on (indirect) effects on aquatic habitats, resulting in their loss or alteration and a reduction in the quality and/or quantity of important food sources.
IWEQ-6	Poor quality runoff or seepage from the historic WRDs and heap leaches.	Construction, Operation, Decommissioning, Closure	Direct - Contamination of surrounding water features and alteration of water characteristics, including chemical, physical, biological and aesthetic qualities. Potential direct species health implication (reduced physical health or mortality) depending on contaminant in seepage material. Inability of impacted water features to maintain biological qualities to support standard flora

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Risk No.	Source of Impact	Project Phase(s)	Summary of Potential Impacts
			and fauna. Indirect or Cumulative - Potential transportation of contaminated sediments and material throughout the Project area and external. Biological and human health implications (primary contaminant of concern being cyanide). Contamination of downstream environments resulting in human health risks that would necessitate the closure of watercourse to extraction of drinking water, recreation, and fishing. Groundwater pathways contributing to environmental contaminants mobilised in the surrounding environment through historic mining and quarrying activities. Potential for accumulation of excessive contaminants in environmental pathways should the same contaminants be released from the nearby Toms Gully Mine or already be present in the environment due to historic activities.
IWEQ-7	Poor water quality released from site during wet season (stormwater).	Construction, Operation, Decommissioning, Closure	Direct - Primary contaminants of concern in wet season stormwater release is acidity and sediment, thus resulting in increased turbidity of waterways. This could result in poor quality drinking water for terrestrial fauna, reduced quality of habitat for aquatic fauna and sedimentation of riparian environments which intrinsically support the health of the inland aquatic ecosystems. Habitat modification and/or lifecycle disruption and/or impact on the size of a population (aquatic flora and fauna). Decrease in fish populations and species richness from ecotoxicity. Depending on geochemistry of the waste rock material to be exposed in the new pits and the placement on site, runoff may also contain heavy metals and NORMS. These would have direct fauna health implications should this water be ingested. Indirect or Cumulative - Decrease in fish populations and species richness resulting in decreased suitability of the environment for aquatic species. Potential for accumulation of excessive contaminants within sediments and fauna. Potential contamination of downstream environments resulting in human health risks that would necessitate the closure of watercourse to extraction of drinking water, stock water, recreation and fishing.
IWEQ-8	Indiscriminate use of existing waste rock for construction. Storage of waste rock outside of pit footprint for too long.	Construction, Operation, Decommissioning, Closure	Direct - AMD, heavy metals and NORMS leading to contamination of inland watercourse (specifically Marrakai Creek, Mount Bunday Creek and McKinlay River as initial receiving environments). Contamination of surrounding land and alteration of soil characteristics, including chemical, physical, biological and aesthetic qualities resulting in long-term leaching to inland waters and adversely affecting the biological processes that depend on water quality. Indirect or Cumulative - Potential transportation of leaching material, with potential to cause contamination, throughout the Project area and external. Indirect biological and human health implications in the immediate location of the placement and areas subject to seepage or runoff. Decrease in fish populations and species richness resulting in decreased suitability of the environment for aquatic species. Potential for bioaccumulation of excessive contaminants within native fauna (heavy metals) and risks of consumption of fish. Potential contamination of downstream environments resulting in human health risks that would necessitate the closure of

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Risk No.	Source of Impact	Project Phase(s)	Summary of Potential Impacts
			watercourse to extraction of drinking water, stock water, recreation and fishing.
IWEQ-9	Pit and groundwater dewatering exposing PAF and causing AMD.	Construction, Operation, Decommissioning, Closure	Direct - Reduction of onsite water quality and potential exceedance of site-specific trigger values (SSTVs), if discharged. AMD, heavy metals and NORMS leading to contamination of inland watercourse (specifically Marrakai Creek, Mount Bunday Creek and McKinlay River as initial receiving environments). Adverse impacts on downstream water quality, aquatic environment, and downstream users. Indirect and Cumulative - Potential transportation of PAF material, with potential to cause contamination, throughout the Project area and external. This would have the potential to lead to dieback of riparian vegetation. Indirect biological and human health implications in the immediate location of the placement and areas subject of seepage or runoff. Decrease in fish populations and species richness resulting in decreased suitability of the environment for aquatic species. Potential for accumulation of excessive contaminants within sediments and fauna. Potential contamination of downstream environments resulting in human health risks that would necessitate the closure of watercourse to extraction of drinking water, stock water, recreation and fishing.
IWEQ-10	Planned pit over topping or release to surface water features during extreme rainfall and flooding events.	Construction, Operation	Direct - Contamination of surrounding water features and alteration of water characteristics, including chemical, physical, biological and aesthetic qualities. Potential direct species health implication (reduced physical health or mortality) depending on contaminant in seepage material. Inability of impacted water features to maintain biological qualities to support standard flora and fauna. Indirect and Cumulative - Potential transportation of contaminated sediments and material throughout the Project area and external. Biological and human health implications (primary contaminants of concern being cyanide and metals). Contamination of downstream environments resulting in human health risks that would necessitate the closure of watercourse to extraction of drinking water, recreation, and fishing.
IWEQ-11	Unplanned pit overtopping or release to surface water features during extreme rainfall and flooding events.	Construction, Operation, Decommissioning, Closure	Direct - Contamination of surrounding water features and alteration of water characteristics, including chemical, physical, biological, and aesthetic qualities. Potential direct species health implication (reduced physical health or mortality) depending on contaminant in seepage material. Inability of impacted water features to maintain biological qualities to support standard flora and fauna. Indirect or Cumulative - Potential transportation of contaminated sediments and material throughout the Project area and external. Biological and human health implications (primary contaminants of concern being cyanide and metals). Contamination of downstream environments resulting in human health risks that would necessitate the closure of watercourse to extraction of drinking water, recreation, and fishing. Contribution of overtopping flows or embankment failures to discharges from Toms Gully Mine into the Mount Bunday catchment resulting in decreased water quality in the catchment.

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Risk No.	Source of Impact	Project Phase(s)	Summary of Potential Impacts
			Negative implications on the riparian environment and capacity to naturally accommodate wet season events.
IWEQ-12	Erosion of site infrastructure leading to sedimentation	Construction, Operation	Direct - Reduces surface water quality in the surrounding water features with increased sedimentation in creek bed. Potential AMD in downstream ecosystems. Indirect and Cumulative - Potential transportation of contaminated sediments and material throughout the Project area and external. Biological and human health implications (primary contaminants of concern being cyanide and metals). Contamination of downstream environments resulting in human health risks that would necessitate the closure of watercourse to extraction of drinking water, recreation and fishing.
IWEQ-13	Release of hazardous chemicals or materials during storage and handling onsite.	Construction, Operation, Decommissioning	Direct - Contamination of surface water and groundwater and alteration of water characteristics, including chemical, physical, biological and aesthetic qualities. Adversely affecting the riparian flora and fauna if the contaminants reach drainage lines and leading to vegetation dieback. Indirect or Cumulative - Potential transportation of contaminated sediments and material throughout the Project area and external. Resulting in reduced local capacity of surface water features to perform ecological functions. Biological and human health implications (primary contaminants of concern being cyanide and metals). Contamination of downstream environments resulting in human health risks that would necessitate the closure of watercourse to extraction of drinking water, recreation, and fishing.
IWEQ-14	Poor handling and management of tailings and waste rock		Direct - Release of AMD leading to contamination of surface water and groundwater quality and ecosystems. Alteration of water characteristics, including chemical, physical, biological, and aesthetic qualities. Adversely affecting the biological processes that depend on water quality (surface and groundwater). Direct result in the loss of ecological integrity and suitable native fauna habitat in the impacted areas. Indirect or Cumulative - Potential transportation of contaminated sediments and material throughout the Project area and external. Biological and human health implications (primary contaminants of concern being cyanide and metals). Groundwater pathways contributing to environmental contaminants mobilised in the surrounding environment through historic mining and quarrying activities. Potential for bioaccumulation of excessive contaminants within native fauna (heavy metals) and risks of consumption of fish.
IWEQ-15	Production of domestic waste and storage of the waste onsite	Construction, Operation, Decommissioning.	Direct - Contamination of surface water and groundwater in the area proximal to the domestic waste receptacle where inappropriate storage vessels and management is used. Alteration of water characteristics, including chemical, physical, biological and aesthetic qualities resulting in riparian or GDE impacts that impact hydrological processes (e.g. dieback of vegetation and increase scouring). Indirect or Cumulative - Potential transportation of contaminated sediments and material throughout the Project area and external. Resulting in reduced local capacity of surface water features to perform ecological functions and a cumulative increase in erosion

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Risk No.	Source of Impact	Project Phase(s)	Summary of Potential Impacts
			contributing to waterway sedimentation. Groundwater pathways contributing to environmental contaminants mobilised in the surrounding environment through historic mining and quarrying activities. Potential for accumulation of excessive contaminants within sediments and fauna.
IWEQ-16	Unfinished / unsuccessful rehabilitation of Project due to inadequate funds or natural disaster (e.g. cyclone).	Construction, Operation, Decommissioning, Closure	Direct - Site not rehabilitated to required standards. Increased potential for offsite impacts from AMD, erosion, and sedimentation. Degradation of water quality onsite and various forms of erosion (sheet, rill, wind etc.) transporting soils into water features, potentially resulting in sedimentation and backflows (afflux). Indirect or Cumulative - Potential transportation of contaminated sediments and material throughout the Project area and external. Biological and human health implications (primary contaminants of concern being cyanide and metals). Contamination of downstream environments resulting in human health risks that would necessitate the closure of watercourse to extraction of drinking water, recreation, and fishing. Given PGO is the same proponent for the nearby Toms Gully Mine project it would likely result in unfinished or unsuccessful rehabilitation at both sites. This would result in a large area of disturbed and unrehabilitated land in the Mount Bunday catchment cumulatively resulting in increased sediment loads to Mount Bunday Creek and the downstream Mary River.
IWEQ-17	Pit lake becomes a groundwater source.	Construction, Operation, Decommissioning, Closure	Direct - Gradual development of plume of contaminated groundwater. Pit lake water quality may become more acidic and with higher concentration of contaminants which may impact fauna species and local vegetation surrounding the landform. Indirect and Cumulative - Groundwater pathways contributing to environmental contaminants mobilised in the surrounding environment through historic mining and quarrying activities. Potential for bioaccumulation of excessive contaminants in environmental pathways should the same contaminants be released from the nearby Toms Gully Mine or already be present in the environment due to historic activities. Potential for accumulation of excessive contaminants within sediments and fauna.
IWEQ-18	Lack of rehabilitation materials leads to inadequate tailings closure and poor quality site rehabilitation.	Decommissioning, Closure	Direct - Completion criteria and environmental outcomes unable to be met. Potential soil erosion, loss of topsoil and sedimentation (through both water and wind erosive forces) affecting water quality in the surrounding water features. Characteristics of water, including chemical, physical, biological, and aesthetic qualities are degraded in the vegetation clearing area. Resulting in less productive water ecosystems and potential impacts (through the abovementioned erosion) on adjacent catchment. Indirect or Cumulative - Increased disturbance and lost productivity of water features in the wider Mount Bunday locality coupled with disturbance at Toms Gully Mine and nearby quarries and Mount Bunday Training Area, resulting in reduced local capacity of water to perform ecological functions and a cumulative increase in erosion contributing to waterway sedimentation.
IWEQ-19	Inappropriate management of the decommissioned	Closure	Direct - Unauthorised access to the site by externals (including public, leaseholders and livestock) negatively affecting rehabilitation potential and contributing to rehabilitation failure.

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Risk No.	Source of Impact	Project Phase(s)	Summary of Potential Impacts
	site, post closure landform.		Potential scouring, soil erosion, loss of topsoil and sedimentation resulting in the alteration of water quality on and off-site drainage features. Indirect or Cumulative - Increased disturbance of water features in the wider Mount Bunday locality coupled with disturbance at Toms Gully and the nearby Mount Bunday Training Area, resulting in reduced local capacity of water to perform ecological functions and a cumulative increase in erosion contributing to waterway sedimentation.
IWEQ-20	Ineffective operational implementation of site environmental management system, plans and procedures.	Construction, Operation, Decommissioning, Closure	Direct - Contamination of surface water and groundwater and alteration of water characteristics, including chemical, physical, biological, and aesthetic qualities. Adversely affecting the riparian flora and fauna if the contaminants reach drainage lines and leading to vegetation dieback and scouring of surface water features. Indirect or Cumulative - Rehabilitation success is affected by inappropriate operational procedures which results in decreased likelihood of achieving rehabilitation goals and closure requirements following decommissioning. Agreed PMLU cannot be achieved due to significant environmental incidents resulting in widespread ongoing contamination of water features. Potential increase in cumulative concentration of sediments within the downstream watercourse as a result of any sediment discharged. Increased downstream depositions and siltation impacts.
IWEQ-21	Use of Project machinery, equipment, vehicles and activities causing fire through sparks or heat ignition source.	Construction, Operation, Decommissioning, Closure	Direct - Damage to topsoil composition and vegetation binding soils. Thus, resulting in the increased ability for soils to erode and disperse which may decreased water quality in the surrounding water features. Also, potential runoff of contaminated soils into water features due to fire extinguishers (depending on where it happens) and material consumed by the fire. Indirect or Cumulative - Potential transportation of contaminated sediments and material throughout the Project area and external. Biological and human health implications (primary contaminants of concern being cyanide and metals). Contamination of downstream environments resulting in human health risks that would necessitate the closure of watercourse to extraction of drinking water, recreation and fishing.
IWEQ-22	Dust generation from Project activities such as vehicular movements and earthworks.	Construction, Operation, Decommissioning, Closure	Direct - Dust emissions impact upon local and nearby water features. Creating safety issue during operations. Loss of productive topsoil inhibiting growth potential of retained media. Characteristics of water, including chemical, physical, biological and aesthetic qualities are degraded by dust emission, resulting in less productive water ecosystems and potential impacts (through the abovementioned wind erosion) on adjacent catchment. Indirect or Cumulative - Potential cumulative dust lift-off and deposition in the wider area in conjunction with Toms Gully Mine, nearby quarries and the Mount Bunday Training Area. Potential increase in cumulative concentration of sediments within the downstream watercourse as a result of any sediment discharged. Increased downstream depositions and siltation impacts. Also, indirect impact of reduced ability for successful

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Risk No.	Source of Impact	Project Phase(s)	Summary of Potential Impacts
			revegetation due to loss of topsoils which may lead to further erosion.
IWEQ-23	Inappropriate liquid and solid waste disposal.	Construction, Operation, Decommissioning, Closure	Direct - Contamination of surface water and groundwater and alteration of water characteristics, including chemical, physical, biological, and aesthetic qualities. Adversely affecting the riparian flora if the contaminants reach drainage lines and leading to vegetation dieback and scouring of surface water features. Indirect or Cumulative - Rehabilitation success is affected by inappropriate operational procedures which results in decreased likelihood of achieving rehabilitation goals and closure requirements following decommissioning. Agreed PMLU cannot be achieved due to significant environmental incidents resulting in widespread ongoing contamination of water features. Potential increase in cumulative concentration of sediments within the downstream watercourse as a result of any sediment discharged. Increased downstream depositions and siltation impacts.
IWEQ-24	Major mechanical failure of processing plant	Operation	Direct - Contamination of surface water and groundwater and alteration of water characteristics, including chemical, physical, biological, and aesthetic qualities. Adversely affecting the riparian flora if the contaminants reach drainage lines and leading to vegetation dieback and scouring of surface water features. Indirect or Cumulative - Potential transportation of contaminated sediments and material throughout the Project area and external. Biological and human health implications (primary contaminants of concern being cyanide and metals). Contamination of downstream environments resulting in human health risks that would necessitate the closure of watercourse to extraction of drinking water, recreation, and fishing. Agreed PMLU cannot be achieved due to significant environmental incidents resulting in widespread ongoing contamination of water features.

The risk assessment process (Section 6) identified the following potential impacts on Inland Water Environmental Quality from the Project:

- Increased turbidity in downstream watercourses from erosion and sedimentation;
- Contamination of surface water and groundwater aquifer by AMD;
- Bacterial contamination due to leaks from onsite wastewater management systems; and
- Hydrocarbon and other chemical contamination due to leaks and spills.

Furthermore, potential impacts during closure and rehabilitation of the mine include:

- Landform instability and erosion resulting in increased turbidity in surface water;
- Ongoing contamination of surface and groundwater from TSF and WRD drainage;
- Interaction of groundwater with contaminated pit lake water; and
- Surface and groundwater contamination from unrehabilitated hydrocarbon and chemical spills.

The sections below consider the severity and extent of potential impacts to groundwater and surface water and the implications to ecological health, land use and the welfare and amenity of people.

7.4.2.2 Increased Turbidity in Downstream Watercourses from Erosion and Sedimentation

The existing heap leach pad at the Rustlers Roost Project area, shows signs of significant erosion impacting on the nearby landform, resulting in the potential increase of sediment load to associated drainage and creek lines. Turbidity in the watercourses downstream of the Project area (Mount Bunday, McKinlay River and Marrakai Creek catchments) may be increased by mobilised sediments at exposed surfaces from land clearing for mining and infrastructure. Furthermore, the expansion of the existing WRD and TSF may increase the risk of localised erosion and sediment release into adjacent drainage lines. Dewatering and discharge of mine water off site has also been identified as a driver for increased surface water turbidity.

During operations, it is expected that general surface water run-off within the Project area will contain increased levels of suspended sediments if appropriate controls are not implemented. Stream bank erosion in drainage and creek lines that receive run-off from the TSF, water storage and WRD may occur during times of dam overflow, extreme rainfall or pit dewatering activities. This may result in increased turbidity in receiving environments downstream of the Project site.

Post-closure landform instability and erosion may occur as a result of ineffective erosion and sedimentation control measures and insufficient rehabilitation efforts.

7.4.2.3 Contamination of Surface Water and Groundwater by Acid Metalliferous Drainage

As outlined in the section for aquatic ecosystems, decreased water quality in Mount Bunday Creek from AMD at the Toms Gully Mine site has potentially negatively impacted on aquatic fauna. Furthermore, surface water monitoring at Rustlers Roost and Quest 29 has identified potential legacy issues from previous mining activities.

Therefore, it is possible that the water quality in minor streams discharging to the Mount Bunday Creek, McKinlay River and Marrakai Creek catchments may deteriorate by poor quality mine site drainage in the event that preventative measures are not implemented. While it is unclear if groundwater has been affected by previous mining activities, the underlying groundwater aquifer could also be impacted by poor quality seepage from the WRD expansion and TSF, and historic heap leach infrastructure. If AMD is released from the site, then the surface water in Mount Bunday Creek and Marrakai Creek could be contaminated with metals, making the water unsuitable for stock and impacting aquatic ecosystems in close proximity to the discharge location. Furthermore, groundwater could be contaminated from WRD and TSF seepage, making it unsuitable for future use as a stock water supply or for other land uses. However, impacts to the larger Mary River and Adelaide River catchments are unlikely due to the large volumes of water shed and dilution within the regional catchment. The risk of AMD, neutral mine drainage (NMD) and saline drainage (SD) associated with the Project is currently uncertain and will depend on the volumes and characteristics of PAF materials and how these materials are managed on site. Further geochemical characterisation of waste rock and ore will determine material types and anticipated volumes, and the landform designs and AMDMP will be informed by this data. To prevent contamination of surface water and groundwater, the mine site design will need to provide for long-term prevention and/or containment of AMD.

The Rustlers Roost pit lake post-closure, if left as a void may potentially become impacted by AMD as the pit void recharges with surface water catchment and groundwater inflows. A recent survey of the current Rustlers Roost pit lake indicated good water quality at the time of the survey (EcOz 2021). While ammonia and a few metal exceedances of the ANZG 2018 aquatic ecosystem 95% species protection default guidelines were recorded (arsenic, chromium, copper, zinc), metals in general were in low concentrations. However, the predicted pit water quality post closure is currently unknown due to the proposed expansion of the existing pit and will be determined by the results of further geochemical characterisation, geochemical modelling and monitoring. During operations and post closure the water quality will be

monitored and assessed for risk to the environment, with mitigation measures implemented as required to prevent impact. Post closure, the pit level is expected to recover to current levels over a 60-year time period with groundwater driving stabilisation. Water from this pit is however highly unlikely to overflow to the surrounding environment. Influence on surrounding groundwater quality is likely to be spatially limited due to the nature of the pit as a groundwater sink.

The Quest 29 pits are to be backfilled and will not present a risk to the surrounding aquatic environment from overflow post closure.

7.4.2.4 Hydrocarbon and Other Chemical Contamination Due to Leaks and Spills

Hydrocarbon contamination of surface water or groundwater could be caused by leaks and spills from bulk diesel fuel storages or run-off from workshop/parking areas. Diesel powered machinery and equipment will be primarily utilised in the dewatering and mining processes. The risks of hydrocarbon contamination to land and soils were discussed in detail in Section 7.1. This concluded that there is a potential for soil contamination on a localised level if chemicals and hydrocarbons are not adequately stored and cleaned up in the event of a spill or leak being identified.

Chemical contamination due to the types of chemicals required for processing activities (such as cyanide), and quantities required to be used on site, pose an elevated risk to surface water and groundwater if released accidentally. It is proposed to store all chemicals on site in the processing area at Rustlers Roost. Accidental release may result in contamination of soils and drainage lines associated with the upper Mount Bunday Creek catchment. However, due to the limited amount of chemicals to be stored on site it is expected that impacts from spills will be highly localised and not effect environmental values further downstream on Mount Bunday Creek and Mary River. Chemicals and their storage volumes on site are listed in Section 4.12.

7.4.2.5 Offsite Surface and Groundwater Interaction with Recorded Aboriginal Heritage and Cultural Sites

A search for sacred sites by AAPA identified a number of sacred sites within 15 km of the Project area. There are two sites that may be affected by off-site surface water run off as they are associated with creek or drainage lines connected to the Project area. These are;

- Site 1 to the west of Rustlers Roost, small unnamed creek in the Marrakai Creek catchment; and
- Site 2 at Mount Bunday Creek downstream of Toms Gully Mine nearby the confluence with Hardies Creek.

Due to the location of the sites in drainage lines hydraulically connected downstream to the Project, it is considered possible that without controls, degradation of the value of the sites may occur from mining associated activities. Inland water related impacts to sacred sites could result in the following:

- Degradation of value of the site from contamination and vegetation dieback;
- Preventing access and use of the site for Aboriginal parties; and
- In ability to use the site for ongoing transfer of knowledge and education.

However, PGO understands the requirement to acquire a relevant Authority Certificate from the AAPA to ensure that sacred sites are identified, and potential impacts are avoided. PGO commits to adhere to conditions necessary to protect sacred sited given by AAPA. Furthermore, PGO will prohibit access to recorded and registered sacred sites by its workforce and contractors and acknowledges the right of entry by Traditional Owners for ongoing transfer of knowledge and education.

7.4.2.6 Cumulative Impacts

There are five mining projects that are currently undergoing approval that reside along or adjacent to the Arnhem Highway (NTG 2021b). The construction and operation of the Project has the potential to incrementally contribute to fragmentation of landforms and disruption of soil properties in a cumulative context and temporary displacement biota from the reduced habitat.

To address the ToR requirement for this Draft EIS, an assessment of the cumulative impacts of the Project across four spatial scales has been conducted. The spatial scales of consideration are:

- Property – defined as Mount Bunday Station and McKinlay River Station;
- Catchment – defined as the Mount Bunday Creek catchment, Marrakai Creek catchment and McKinlay River catchment;
- Region – defined as the Marrakai-Douglas Daly unincorporated area; and
- Bioregion – defined as the Pine Creek bioregion.

The cumulative impact assessment has considered the effects of multiple actions or impacts on the terrestrial environmental quality, including landforms) (refer to Table 7-49).

There is potential for cumulative impacts to water quality within Mount Bunday Creek associated with discharges from the Rustlers Roost and Quest 29 sites, combined with the discharges from Toms Gully Mine site downstream. Recent water studies at Toms Gully have shown elevated EC and concentrations of dissolved metals (e.g. Al, As, Co, Mn, Ni) in surface and groundwater samples taken in the vicinity of the mine (GHD 2019). However, these studies also indicated that impacts on water quality may be localised, as sampling sites further downstream from the mine showed comparative reduced concentrations of metals. Surface water sampling associated with Rustlers Roost drainage into Mount Bunday Creek has shown Al and As levels exceeding ANZG (2018) guidelines, but not the Toms Gully SSTV at site SW2 which is located just outside the Project area. Site QSW2, located approximately 6 km downstream of SW2, has shown Al levels exceeding the ANZG (2018), but not the Toms Gully SSTV, with all other metals below ANZG (2018) guidelines. This may confirm the observation of only localised effects of elevated dissolved metal levels from potentially contaminated mining discharge, therefore minimising the risk of cumulative impacts on water quality to Mount Bunday Creek and eventually Mary River. The potential residual risk of cumulative impacts will be managed within the relevant management plans (WMP, MMP, ESCP and AMDMP). For this purpose, groundwater and surface water monitoring will be undertaken to determine discharge water quality and to establish SSTVs similar to Toms Gully Mine for discharges that will protect the environmental values of Inland Water Environmental Quality in Mount Bunday Creek.

Furthermore, there are a number of quarries within the Mary River catchment that are not hydrologically connected via Mount Bunday Creek. While there are no data publicly available for this assessment, these operations could contribute to cumulative impacts on Mary River Water quality. In addition, there are two mining projects upstream of the potential area of influence on Mary River (Figure 7-46) with one iron ore (Frances Creek Mine) and one gold mine project (Union Reefs Mine). Water quality monitoring in the Mary River Catchment has shown overall elevated levels of dissolved metals (Cd, Cu, Ni), elevated nutrients, EC and hardness related to historical mining activities (Schultz *et al.* 2012). PGO commits to mitigating and minimising any further risks from potential cumulative impacts to Inland Water Environmental Quality by relevant environmental management processes such as rehabilitation, timing of pit dewatering activities, waste rock and tailings management and construction and maintenance of TSF and WRD as outlined in the MMP (to be developed) and Mine Closure Plan (Appendix J). This includes managing existing impacts from legacy mining within the Project area.

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Table 7-49 Potential Cumulative Impact to Inland Water Environmental Quality

Project	Property	Spatial Extent			Approx. Distance from Project	Impact Details	Reference
		Catchment	Region	Bioregion			
Toms Gully Mine	✓	✓	✓	✓	0 km	Approximately 76 ha of disturbance. Increased erosion and sedimentation risk with slopes > 2% on site that may affect water quality in the Mary River catchment. Furthermore, surface and groundwater water quality affected by AMD.	NT EPA 2020a
Boral Quarry	✓	✓	✓	✓	700 m	Approximately 35 ha of disturbance (including access road of 2.5km) Increased erosion and sedimentation risk with slopes > 2% on site that may affect water quality in the Mary River catchment.	NR Maps spatial mapping (DEPWS 2021)
HB Quarry	✓	✓	✓	✓	2 km	Approximately 47.5 ha of disturbance. Increased erosion and sedimentation risk with slopes > 2% on site that may affect water quality in the Mary River catchment.	NR Maps spatial mapping tool (DEPWS 2021)
McKinlay Quarry	✓	✓	✓	✓	3.5 km	Approximately 17.5 ha of disturbance (including access road of 3 km) Increased erosion and sedimentation risk with slopes > 2% on site that may affect water quality in the Mary River catchment.	NR Maps spatial mapping tool (DEPWS 2021)
Ostojic Quarry	✓	✓	✓	✓	4.4 km	Approximately 47.5 ha of disturbance. Increased erosion and sedimentation risk with slopes > 2% on site that may affect water quality in the Mary River catchment.	NR Maps spatial mapping tool (DEPWS 2021)
Mount Bunday Military Training Area			✓	✓	9 km	The Mount Bunday Training Area is a 117,300 ha. No publicly available data No more than 10 ha of disturbance Increased erosion and sedimentation risk with slopes > 2% on site that may affect water quality in the Mary River catchment	NR Maps spatial mapping tool (DEPWS 2021)
Woolwonga Mine				✓	47 km	Connected to Adelaide River via Margaret River catchment. Water quality may be affected by AMD runoff.	NR Maps spatial mapping tool (DEPWS 2021)
Hayes Creek Mine				✓	58 km	Native vegetation and fauna habitat loss = 33 ha Connected to Adelaide River via Margaret River catchment. Water quality may be affected by AMD runoff.	NR Maps spatial mapping tool (DEPWS 2021) LES 2017
Union Reefs Gold Mine				✓	60 km	Clearing of regrowth vegetation required = 1 ha Increased erosion and sedimentation risk with slopes > 2% on site that may affect water quality in the Mary River catchment. Furthermore, water quality may be affected by AMD runoff.	NR Maps spatial mapping tool (DEPWS 2021) NT EPA 2020b

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Project	Property	Spatial Extent			Approx. Distance from Project	Impact Details	Reference
		Catchment	Region	Bioregion			
Frances Creek Iron Ore Mine				✓	75 km	Clearing of approximately 172 hectares of native vegetation. Increased erosion and sedimentation risk with slopes > 2% on site that may affect water quality in the Mary River catchment. Furthermore, water quality may be affected by AMD runoff.	NR Maps spatial mapping tool (DEPWS 2021) MBS Environmental 2006
Finnis Lithium Mine					80 km	Native vegetation and fauna habitat loss = 100.9 ha Not hydrologically connected to the Project area.	NR Maps spatial mapping tool (DEPWS 2021) EcOz 2020
Fountain Head Gold Mine				✓	90 km	Native vegetation and fauna habitat loss = 80.6 ha. Connected to Adelaide River via Margaret River catchment. Water quality may be affected by AMD runoff.	NR Maps spatial mapping tool (DEPWS 2021) ERIAS 2021
Jabiru Hybrid Power Station				✓	140 km	Project area of 20 ha with 16.03 ha of disturbance. Not hydrologically connected to the Project area.	NR Maps spatial mapping tool (DEPWS 2021) CDM Smith 2021

7.4.3 Avoidance, Mitigation and Management

The Project risk assessment process identified suitable measures to avoid, mitigate and manage potential impacts to inland water environmental quality so that the NT EPA's objective for this key environmental factor is met. The risk assessment applied a hierarchical approach where avoidance is of highest priority, followed by mitigation and management (Table 7-50). The relevant residual risk post mitigation and management is addressed in Section 7.4.5.

Table 7-50 Potential Impacts to Inland Water Environmental Quality and Avoidance, Mitigation, and Management Measures

Potential Consequences	Measures
Increased erosion and sedimentation of surface water courses	Avoid - Only clearing what is absolutely necessary for the portion of the Project to be implemented - Clearly mark limits of clearing - Make use of already disturbed areas where possible - Adhere to buffer widths recommended by the Northern Territory Land Clearing Guidelines with regard to riparian vegetation in drainage lines - Avoid land clearing during the December to March portion of the wet season - Revegetation of exposed areas where not proposed to be utilised - Construction of Project infrastructure with suitable materials - Infrastructure design to withstand extreme events Mitigation and Management - Adherence to Ground Disturbance Procedures - Implement erosion and sediment controls in accordance with an ESCP - TSF to be planned, designed, constructed and operated in accordance with approaches details in the guideline Tailings Management: Leading Practice Sustainable Development Program for the Mining Industry (Australian Government 2016e) - Design TSF to contain a range of design storm and rainfall sequences events up to and greater than the required design criteria - Manage the site water balance to reduce any build-up of water - Geotechnical studies and assessment to ensure TSF and all water storage facilities structural stability. Engineering design to ANCOLD standard - Continued use of drainage controls and bunds - Maximise runoff pond capacity prior to wet season - Daily inspections for runoff and drainage problem areas - Compliance with the WDL - Implementation of AMDMP and WMP - Weekly inspections of freeboard, structural integrity, and pipelines - Tracking of the waste rock and dumping locations - WRD plan - Development of Monitoring Plan / Operational Manual which includes weekly inspections of the pits, WRD, TSF, water storage and process facilities - Tailings and Waste Rock will be managed in accordance with the Tailings Management Plan and Operational Manual (including inspections) - Improve site drainage controls Rehabilitation - Progressive clearing and rehabilitation of disused areas - Stable design of landforms - Implementation of detailed mine closure plan

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Potential Consequences	Measures
	- Early planning and financial provision for closure works - Financial provisioning for closure implementation - Recover topsoil from TSF, WRD and processing plant footprints
Increased turbidity of surface water from sedimentation	Avoid - Only clearing what is absolutely necessary for the portion of the Project to be implemented - Clearly mark limits of clearing - Make use of already disturbed areas where possible - Adhere to buffer widths recommended by the Northern Territory Land Clearing Guidelines with regard to riparian vegetation in drainage lines - Avoid land clearing during the December to March portion of the wet season. - Revegetation of exposed areas where not proposed to be utilised - Construction of Project infrastructure with suitable materials - Infrastructure design to withstand extreme events Mitigation and Management - Adherence to Ground Disturbance Procedures - Implement erosion and sediment controls in accordance with an ESCP - TSF to be planned, designed, constructed, and operated in accordance with approaches details in the guideline Tailings Management: Leading Practice Sustainable Development Program for the Mining Industry (Australian Government 2016e) - Design TSF to contain a range of design storm and rainfall sequences events up to and greater than the required design criteria - Manage the site water balance to reduce any build-up of water - Geotechnical studies and assessment to ensure TSF and all water storage facilities structural stability. Engineering design to ANCOLD standard - Continued use of drainage controls and bunds - Maximise runoff pond capacity prior to wet season - Daily inspections for runoff and drainage problem areas - Compliance with the WDL - Implementation of AMDMP and WMP - Weekly inspections of freeboard, structural integrity, and pipelines - Tracking of the waste rock and dumping locations - WRD plan - Development of Monitoring Plan / Operational Manual which includes weekly inspections of the pits, WRD, TSF, water storage and process facilities - Tailings and Waste Rock will be managed in accordance with the Tailings Management Plan and Operational Manual (including inspections) - Improve site drainage controls Rehabilitation - Progressive clearing and rehabilitation of disused areas - Stable design of landforms - Implementation of detailed mine closure plan - Early planning and financial provision for closure works - Recover topsoil from TSF, WRD and processing plant footprints - Financial provisioning for closure implementation
Surface water contamination with AMD, cyanide, metals,	Avoid Pit-dewatering only during wet season

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Potential Consequences	Measures
hydrocarbons, and other chemicals	- Install seepage control and underground drainage including a cut-off trench, compact soil liner, basin underdrainage collection system, underdrain collection sump and embankment tow drain. - Design, storage, and handling of hazardous materials to Australian Standards and regulations - Bunding of the process plant - Diesel in bunded storage tanks, waste oil in stored bunded tank - Chemical storage will be located a minimum 30m from any drainage line or watercourse - Design and construct landfill in accordance with relevant standards, implement leachate prevention and capture into landfill design Mitigation and Management - Implementation of Biodiversity Management Plan - Manage the site water balance to reduce any build-up of water - Capping of the WRD to reduce ongoing water infiltration and seepage - Calculations, identification, and provisioning of suitable cap material - TSF to be planned, designed, constructed, and operated in accordance with approaches details in the guideline Tailings Management: Leading Practice Sustainable Development Program for the Mining Industry. (Australian Government 2016e). - Design TSF to contain a range of design storm and rainfall sequences events up to and greater than the required design criteria - Development of Monitoring Plan / Operational Manual which includes weekly inspections of the TSF, survey pins to monitor the embankment and piezometers to measure pore water pressure - Tailings performance monitoring (e.g. TSF water volume, collection efficiency of underground system) - Groundwater and surface monitoring to check quality and any seepage - Implementation of AMDMP and WMP - Development of Monitoring Plan / Operational Manual which includes weekly inspections of the TSF and process water dams - Geotechnical studies and assessment to ensure structural stability - All water storage facilities geotechnically stable and engineered design to ANCOLD standard - Continued use of drainage controls and bunds - Maximise runoff pond capacity prior to wet season - Daily inspections for runoff and drainage problem areas - Compliance with the WDL - Implement erosion and sediment controls in accordance with an ESCP - Tracking of the waste rock and dumping locations - WRD plan - Testing of waste rock for AMD, heavy metals, and NORMS prior to use as on or offsite construction material - Sump below pit base to reclaim contaminated water - Treatment of pit and underground water to within SSTV criteria - Visual inspection of pit walls to identify locations and volumes of acid producing material - Specific adherence of the ANFO storage to <i>Dangerous Goods Act 1998</i> and the <i>NT Work Health and Safety (National Uniform Legislation) Act 2011</i> - Regular maintenance of storage facilities with containment bunding and SDS available - Weekly inspections of storage areas, tanks, containers - Develop Emergency Response Plan and include in inductions - Weekly inspections of storage areas for leaks or damages

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Potential Consequences	Measures
	- Spill kits available around the site and procedures and training for the cleaning up of hazardous spills - Implementation of hazardous materials management plan and training for emergency response - Cyanide management and storage will be aligned to the Commonwealth of Australia Leading Practice Handbook for Sustainable Mining - Cyanide Management (Australian Government 2008) - Establish dedicated hardstand at accommodation camp for waste receptacles - Weekly inspections of, waste area, landfill, and general tidiness of site - Burial of waste in dedicated landfill. - Infrastructure design to withstand extreme events - Ongoing management of levels in water infrastructure Rehabilitation - Implementation of detailed mine closure plan - Investigation and consideration of long-term closure options - Progressive rehabilitation of disused areas - Early planning and financial provision for closure works - Financial provisioning for closure implementation - Recover topsoil from TSF, WRD and processing plant footprints - Clearing and Topsoil Procedures Implementation of Mine Closure - Ongoing monitoring of rehabilitation
Groundwater water contamination with AMD, cyanide, metals, hydrocarbons and other chemicals	Avoid - Pit-dewatering only during wet season - Install seepage control and underground drainage including a cut-off trench, compact soil liner, basin underdrainage collection system, underdrain collection sump and embankment tow drain. - Design, storage and handling of hazardous materials to Australian Standards and regulations - Bunding of the process plant - Diesel in banded storage tanks, waste oil in stored banded tank - Chemical storage will be located a minimum 30m from any drainage line or watercourse - Design and construct landfill in accordance with relevant standards, implement leachate prevention and capture into landfill design Mitigation and Management - Implementation of Biodiversity Management Plan - Manage the site water balance to reduce any build-up of water - Capping of the WRD to reduce ongoing water infiltration and seepage - Calculations, identification and provisioning of suitable cap material - TSF to be planned, designed, constructed and operated in accordance with approaches details in the guideline Tailings Management: Leading Practice Sustainable Development Program for the Mining Industry. (Australian Government 2016e). - Design TSF to contain a range of design storm and rainfall sequences events up to and greater than the required design criteria - Development of Monitoring Plan / Operational Manual which includes weekly inspections of the TSF, survey pins to monitor the embankment and piezometers to measure pore water pressure - Tailings performance monitoring (e.g. TSF water volume, collection efficiency of underground system) - Groundwater and surface monitoring to check quality and any seepage

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Potential Consequences	Measures
	- Implementation of AMDMP and WMP - Development of Monitoring Plan / Operational Manual which includes weekly inspections of the TSF and process water dams - Geotechnical studies and assessment to ensure structural stability - All water storage facilities geotechnically stable and engineered design to ANCOLD standard - Continued use of drainage controls and bunds - Maximise runoff pond capacity prior to wet season - Daily inspections for runoff and drainage problem areas - Compliance with the WDL - Implement erosion and sediment controls in accordance with an ESCP - Tracking of the waste rock and dumping locations - WRD plan - Testing of waste rock for AMD, heavy metals, and NORMS prior to use as on or offsite construction material - Sump below pit base to reclaim contaminated water - Treatment of pit and underground water to within SSTV criteria - Visual inspection of pit walls to identify locations and volumes of acid producing material - Specific adherence of the ANFO storage to <i>Dangerous Goods Act 1998</i> and the <i>NT Work Health and Safety (National Uniform Legislation) Act 2011</i> - Regular maintenance of storage facilities with containment bunding and SDS available - Weekly inspections of storage areas, tanks, containers - Develop Emergency Response Plan and include in inductions - Weekly inspections of storage areas for leaks or damages - Spill kits available around the site and procedures and training for the cleaning up of hazardous spills - Implementation of hazardous materials management plan and training for emergency response - Cyanide management and storage will be aligned to the Commonwealth of Australia Leading Practice Handbook for Sustainable Mining - Cyanide Management (Australian Government 2008) - Establish dedicated hardstand at accommodation camp for waste receptacles - Weekly inspections of, waste area, landfill, and general tidiness of site - Burial of waste in dedicated landfill. - Infrastructure design to withstand extreme events - Ongoing management of levels in water infrastructure Rehabilitation - Implementation of detailed mine closure plan - Investigation and consideration of long-term closure options - Progressive rehabilitation of disused areas - Early planning and financial provision for closure works - Financial provisioning for closure implementation - Recover topsoil from TSF, WRD and processing plant footprints - Clearing and Topsoil Procedures Implementation of Mine Closure - Ongoing monitoring of rehabilitation

Key elements to describe the avoidance, mitigation and management measures to inland water environmental quality are the MMP, WMP, ESCP, AMDMP and WDL. The following sections discuss how potential environmental impacts will be avoided and minimised within the scope of the relevant management tools.

7.4.3.1 Increased Turbidity in Downstream Watercourses from Erosion and Sedimentation

The potential for erosion within the mine site will be minimised by adopting appropriate design criteria for expansion components (i.e., TSF, processing plant, WRD expansions, pit expansions, camp facilities and haul route). Details of the construction and operational erosion control measures and maintenance of existing controls are provided in an ESCP developed in accordance with the Best Practice Erosion and Sediment Control Guidelines (IECA 2008). The ESCP developed for this Project is presented in Appendix L, as the basis for implementation.

Rustlers Roost pit dewatering during operations will occur with in-pit sumps directly into a turkey's nest to be used for dust suppression. Excess water will be directed to the proposed raw water dam (Annie's Dam) to be used for process water and excess water discharged under an approved operational WDL in accordance with the WDL conditions. The MMP and associated WMP will specify routine control measures that will provide for detection of turbidity impacts and corrective actions to mitigate potential impacts.

Approval to discharge Rustlers Roost pit lake prior to operations is currently being sought independently to this referral through a MMP amendment under the *Mining Management Act 2001*, and a WDL under the *Water Act 1992*. Discharge of water will be managed in accordance with an approved WDL conditions, discharge plan, and construction and maintenance of erosion and sediment control measures.

7.4.3.2 Contamination of Surface Water and Groundwater by Acid and Metalliferous Drainage

The key mitigation measure to avoid the potential for AMD is limiting exposure of PAF material to atmospheric oxygen and water. Designing the TSF and WRD to adequately contain PAF material is a key mitigation measure. Key design measures include lining the TSF underdrainage, placement of benign NAF material on the outer annulus, slopes and batters of the WRDs, encapsulating the PAF in the central areas of the WRD and backfilling PAF within pits, covering with oxide material or water at depth. Materials characterisation testing is being undertaken on the 2018 Rustlers Roost drilling programme and the August 2020 drilling programme at Rustlers Roost and Quest 29. The program is targeting oxide, transitional and fresh material, and various lithologies of both waste and ore. Characterisation of the waste will identify any problematic material (PAF), allow AMD block models of the resource to be developed, and provide an estimate of anticipated volumes of problematic material, which will be used to develop management strategies for that material within the WRD and/or backfilled within the pit. Geochemical classification of the ore material will provide an indication of the tailings characteristics and identify the requirements for tailing dam design, tailings management during operations and closure.

As part of the approvals process, surface water and groundwater baseline monitoring has been undertaken to establish an understanding of the Project specific characteristics in terms of inland water environmental quality. Groundwater Enterprises (2020) conducted a review of the existing groundwater desktop assessment (CDM Smith 2019), available information and proposed mining infrastructure, and provided a recommendation for seven monitoring bores to be installed at each site. While all of the bores have been constructed in accordance with the recommendation, two of the monitoring bores (RMB03/ RMB04) at Rustlers Roost will be consumed by the expansion of the TSF and required reconstruction at an appropriate location outside the TSF footprint. Water quality monitoring will be on going throughout operations for early detection for potential AMD issues; during closure to ensure remediation is undertaken; and post-closure to monitor rehabilitation success.

Geochemical modelling of the Rustlers Roost pit lake post closure has been undertaken to predict the water quality of the pit lake. Pit lake water quality as an aquatic ecosystem habitat for the Rustlers Roost pit lake was moderately poor, with high nutrient concentrations and low oxygen concentrations. However, pit lake water quality as COPC concentrations was good, with only slight exceedances of ecosystem values for total iron and ammonium and drinking water for ammonium. While the groundwater modelling and water balance assessment indicate connectivity with the groundwater aquifers and potential loss of water from the pits into the aquifers (more likely during the dry season), the good water quality indicates that seepage of pit lake water into groundwater is unlikely to contribute significant

contaminants that would adversely affect the surrounding environment. The AMDMP includes a range of measures that will be employed to prevent and monitor potential AMD impacts to surface water (refer to Appendix T). The WMP also specifies routine control measures that will provide detection of water quality impacts and corrective actions to mitigate potential impacts (refer to Appendix I).

7.4.3.3 Bacterial Contamination Due to Leaks from Onsite Wastewater management system

The accommodation camp will be located on the current Toms Gully Mine ML, therefore bacterial contamination from wastewater within the Rustlers Roost and Quest 29 portions of the Project area is very unlikely. In general, the wastewater management system at Toms Gully Mine will be designed based on the maximum number of staff onsite during construction / operations and will be installed by a licenced plumber in accordance with the *NT Code of Practice for Onsite Wastewater Management*. The location and design of the system will also be subject to wastewater works design approval by the NT Department of Health pursuant to the *Public and Environmental Health Act 2011*.

7.4.3.4 Hydrocarbon and other chemical contamination due to leaks and spills

All hydrocarbons and chemicals will be stored in accordance with Australian Standard 1940:2017, the NT *Dangerous Goods Act 1998*, the NT *Work Health and Safety (National Uniform Legislation) Act 2011* and to the *Leading Practice Handbook for Sustainable Mining - Cyanide Management*. During closure, all hydrocarbons and chemicals will be removed from site. The MMP and associated Hazardous materials storage management plan and Emergency Response Plan will specify routine control measures, spill response, early detection of leaks and spills and corrective actions to mitigate potential impacts.

7.4.4 Monitoring and Reporting

PGO commits to a comprehensive surface water, groundwater and sediment monitoring program to improve knowledge of baseline conditions and environmental water quality parameters. The program will also include the potential area of influence to inform the requirement to assess potential cumulative impacts. Proposed water quality monitoring sites are outlined in the WMP (Appendix I) and the WDL. In addition, water quality will be reported in accordance with relevant legislative requirements.

In general, surface water quality monitoring is proposed to be completed at 19 sites, groundwater quality monitoring at 14 sites and nine sediment monitoring sites. The proposed sites and sampling frequency for surface water, groundwater and sediment are provided in Table 7-51, Table 7-52 and Table 7-53, respectively. The locations of the proposed ongoing monitoring locations are presented in Figure 7-36 and Figure 7-37.

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Table 7-51 Proposed Surface Water Monitoring Locations

Site Code	Sampling Location / Description	Position		Analysis Type* Frequency					
		Latitude	Longitude	0	1	2	3	4	
Rustlers Roost									
SW6	Spill way proximal to Annie’s Dam	-12.923545	131.489554	M	M	M	M	M	
SW7	Downstream from Annie’s Dam nearby lower pond in an unnamed tributary of the Marrakai Creek	-12.922619	131.487260	M	M	M	M	M	
SW2	Creek line to the east of southern heap leach pond	-12.928670	131.501560	M	M	M	M	M	
SW5	Southern heap leach pond	-12.928539	131.501017	M	M	M	M	M	
SW10	ROM drainage before influence from heap leach	-12.922680	131.496812	M	M	M	M	M	
SW11	Downstream from SW10 in drainage line at base of heap leach pad	-12.924117	131.496836	M	M	M	M	M	
SW12	Northern drainage of WRD	-12.911724	131.493673	M	M	M	M	M	
SW22	Pit lake western side	-12.915881	131.497434	M	M	M	M	M	
SWQ2	Mount Bunday Creek culvert crossing, approximately 500m downstream of confluence with Quest 29 drainage line	-12.913087	131.526381	M	M	M	M	M	
Quest 29									
SWQ1	Charlies Creek, north of BHS pit at culvert crossing	-12.936324	131.574809	M	M	M	M	M	
SWQ2	Mount Bunday Creek culvert crossing, approximately 500m downstream of confluence with Rustlers Roost creek line	-12.913087	131.526381	M	M	M	M	M	
SWQ4	Mount Bunday Creek, approximately 6 km downstream from Quest 29 lease, upstream from Rustlers Roost creek line confluence	-12.914471	131.536777	M	M	M	M	M	
SWQ Leach	Quest 29 lower leach pond	-12.938021	131.577894	M	M	M	M	M	
SWQ BHS Pit	BHS pit lake	-12.938386	131.576396	M	M	M	M	M	
SWQ3	Zamu pit	-12.958068	131.586851	M	M	M	M	M	
SWQ5	Northern Taipan pit bund	-12.958234	131.583856	M	M	M	M	M	
SWQ6	Small drain downstream of Zamu pit after confluence from SWQ3 and SWQ5	-12.958795	131.586416	M	M	M	M	M	

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Site Code	Sampling Location / Description	Position		Analysis Type* Frequency				
		Latitude	Longitude	0	1	2	3	4
SWQ7	Small drainage line upstream of Zamu pit	-12.954703	131.586032	M	M	M	M	M
SWQ8	Further downstream from SWQ6, approx. 200 m outside of Quest 29 lease boundary	-12.965656	131.594375	M	M	M	M	M
Accommodation Camp								
CC02	Coulter Creek approximately 500 m downstream from accommodation camp boundary	-12.847370	131.563955	M	M	M	M	M
CC01	Coulter Creek approximately 1.5 km downstream from CC02 outside of mining lease	-12.843499	131.573087	M	M	M	M	M
Toms Gully								
SWTG1A	Mount Bunday Creek upstream of mine at lease boundary.	-12.828336	131.545764	M	M	M	M	M
SWTG2	Mount Bunday Creek at Arnhem Highway Crossing	-12.828622	131.574529	M	M	M	M	M
SWTG3	300 m upstream of confluence between Mount Bunday Creek and Coulter Creek	-12.837374	131.599889	M	M	M	M	M

*M= Monthly

Type Analytes

Type 0 Water Height Level Reading (Particularly for wet season and during wet season discharge, also to gauge evaporation levels in dry season).

Type 1 Field parameters (pH, EC, Temp, Flow)

Type 2 Total and Filtered Metals (Al, As, Cd, Co, Cr, Cu, Fe, Pb, Mn, Ni, U and Zn)

Type 3 Major Cations (Ca, K, Na and Mg) Anions (Cl, SO4)– Filtered

Type 4 Titratable Acidity, Alkalinity, Hardness (CaCO3) and Total Suspended Solids (TSS) and Turbidity

Table 7-52 Proposed Groundwater Monitoring Locations

Site Code	Position		Analysis Type* Frequency				
	Latitude	Longitude	0	1	2	3	4
Rustlers Roost							
RR MB02	-12.928138	131.501481	Q	Q	Q	Q	Q
RR MB03	-12.931479	131.492211	Q	Q	Q	Q	Q
RR MB04	-12.923166	131.487615	Q	Q	Q	Q	Q
RR MB05	-12.918846	131.49531	Q	Q	Q	Q	Q

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Site Code	Position		Analysis Type* Frequency				
	Latitude	Longitude	0	1	2	3	4
RR MB06	-12.915522	131.502737	Q	Q	Q	Q	Q
RR MB07	-12.908878	131.498342	Q	Q	Q	Q	Q
RR MB08	-12.903331	131.492669	Q	Q	Q	Q	Q
Quest 29							
Q29 MB03	-12.962217	131.587492	Q	Q	Q	Q	Q
Q29 MB04	-12.957727	131.584775	Q	Q	Q	Q	Q
Q29 MB05	-12.954557	131.585617	Q	Q	Q	Q	Q
Q29 MB06	-12.952175	131.579835	Q	Q	Q	Q	Q
Q29 MB07	-12.949718	131.58156	Q	Q	Q	Q	Q
Q29 MB08	-12.940141	131.581646	Q	Q	Q	Q	Q
Q29 MB09	-12.936416	131.574607	Q	Q	Q	Q	Q

*Q= Quarterly

Type Analytes

Type 0 Water Height Level Reading (Particularly for wet season and during wet season discharge, also to gauge evaporation levels in dry season).

Type 1 Field parameters (pH, EC, Temp, Flow)

Type 2 Total and Filtered Metals (Al, As, Cd, Co, Cr, Cu, Fe, Pb, Mn, Ni, U and Zn)

Type 3 Major Cations (Ca, K, Na and Mg) Anions (Cl, SO₄) – Filtered

Type 4 Titratable Acidity, Alkalinity, Hardness (CaCO₃) and Total Suspended Solids (TSS) and Turbidity

Site specific trigger values for physico-chemical stressors, nutrients, and toxicants will be set in accordance with the site-specific recommendations based on ANZG (2018) guidelines. The WMP provides further details on the monitoring and reporting commitments.

Table 7-53 Proposed Sediment Monitoring Locations

Site Code	Sampling Location / Description	Position		Frequency
		Latitude	Longitude	
Rustlers Roost				
RRMCUS	Marrakai creek upstream site – control site	- 12.919623	131.480976	Annual
RRMCDS	Marrakai creek downstream site	- 12.904950	131.469576	Annual
RRSW2	Upper Mount Bunday Creek tributary upstream, adjacent to leach heap pad	- 12.928670	131.501560	Annual
RRSW23	Upper Mount Bunt Creek tributary downstream from RRSW2	- 12.930765	131.50637	Annual
Accommodation Camp				
CC02	Coulter Creek approximately 500 m downstream from accommodation camp boundary	-12.847370	131.563955	Annual

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Site Code	Sampling Location / Description	Position		Frequency
		Latitude	Longitude	
CC01	Coulter Creek approximately 1.5 km downstream from CC02 outside of mining lease	-12.843499	131.573087	Annual
Toms Gully				
SWTG1A	Mount Bunday Creek upstream of mine at lease boundary.	-12.828336	131.545764	Annual
SWTG2	Mount Bunday Creek at Arnhem Highway Crossing	-12.828622	131.574529	Annual
SWTG3	300 m upstream of confluence between Mount Bunday Creek and Coulter Creek	-12.837374	131.599889	Annual

Analytes:

Electrical Conductivity and pH.

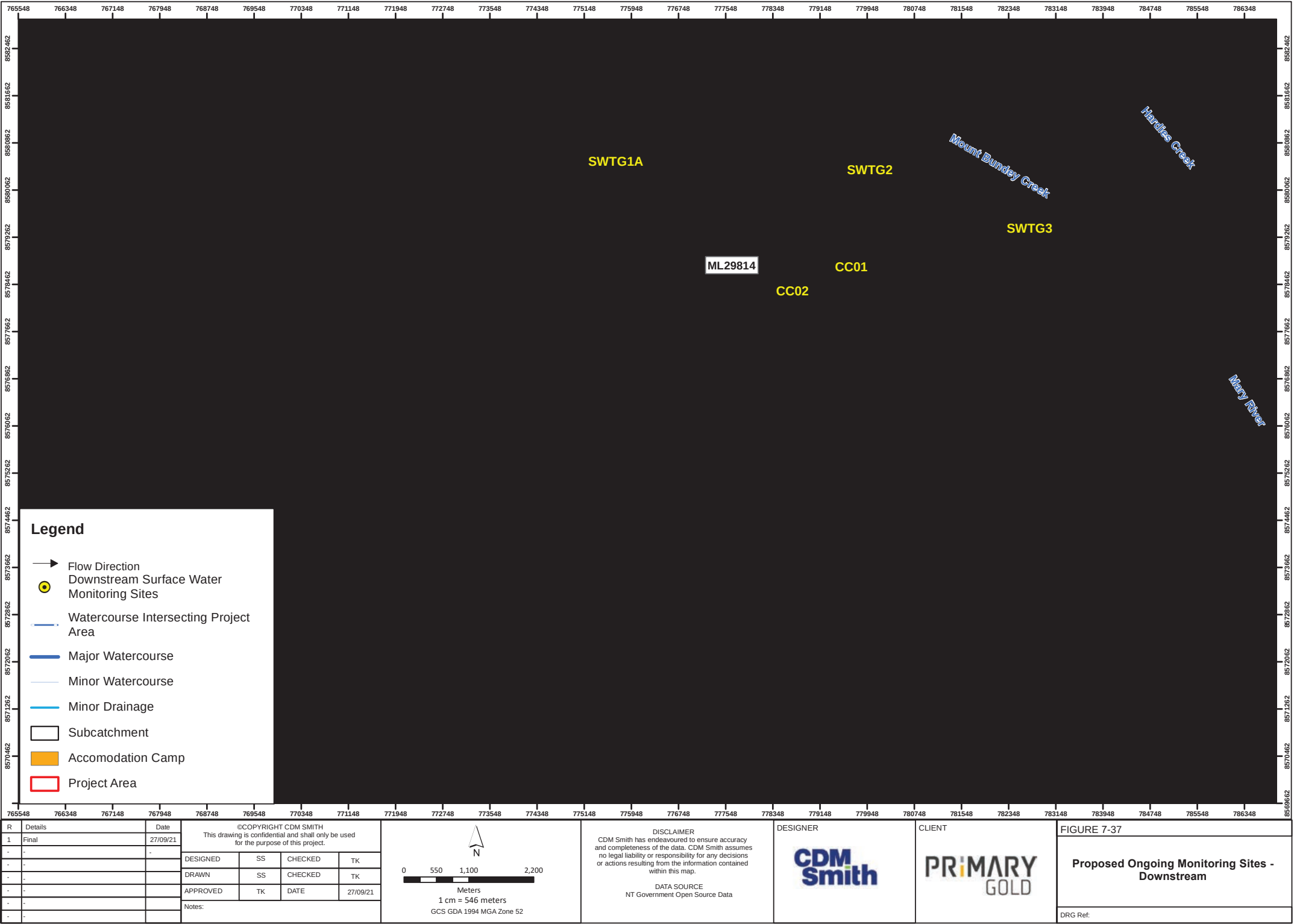
Metals (Al, As, Ag, Cd, Co, Cr, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Sb, Zn and U).

Major Cations and Anions (Na, K, Ca, Mg, Cl, SO₄, CO₃, HCO₃, NH₃, NO₃).

Particle Size.

Distribution (sieve and hydrometer).

Total Organic Carbon.



7.4.5 Residual Impact

The inherent risk ratings included five listed as extreme risk and nine a high risk. All potential residual impacts to inland water environmental quality were assessed as either moderate (12) or lower (12).

The potential environmental impacts caused by erosion and sedimentation, instigated by vegetation clearing for the Project, has been initially classified as presenting an extreme risk. However, relevant mitigation measures, such as only clearing of areas that are necessary to progress with the mining, no clearing over the wet season and the implementation of an ESCP has reduced the significance of the expected impacts to moderate.

Furthermore, overtopping, embankment failure or seepage from the new TSF and expanded WRD at Rustlers Roost leading to uncontrolled release of tailings material to surrounding environment has been classified as having a high inherent risk due to the potential widespread contamination and sedimentation outside of the Project area. The residual risk has been assessed as moderate after the application of mitigation measures, for which there is high certainty that the TSF and WRD embankment will remain stable. The TSF and WRD will be planned, designed, constructed and operated in accordance with approaches detailed in the guideline Tailings Management: Leading Practice Sustainable Development Program for the Mining Industry (Australian Government 2016e).

The risk from poor water quality releases due to extreme weather events with overtopping of TSF, water storage dam and pits has also been initially classified as extreme. Management of site water balance concurrently with the WMP and AMDMP has reduced the residual risk to moderate for this case.

During mining closure and rehabilitation, unsuccessful rehabilitation of disturbed areas due to inadequate funds or natural disaster also showed an extreme risk to the values of the key environmental factor. A Mine Closure Plan that addresses lack of funding and extreme events has reduced the overall residual risk for this source of impact to moderate.

Overall, impacts and risks associated with Project activities to inland water environmental quality can be managed through the mitigation measures identified in Section 7.4.3. PGO will develop detailed management plans (MMP, WMP) in consultation with the regulator to ensure the protection of the relevant environmental values for the Project area and surroundings are maintained.

The significance of the residual risk for inland water environmental quality from the Project have been assessed, assuming the successful implementation of avoidance, mitigation and management measure as outlined in Section 7.4.3. The residual risk for each source of impact is shown in Table 7-54.

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Table 7-54 Inland Water Environmental Quality Residual Impact Assessment Summary

Risk No.	Source of Impact	Project Phase(s)	Inherent Risk	Summary of Controls	Residual Risk
IWEQ-1	Vegetation clearing for the Project	Construction and Operation	Extreme	> Adherence to Ground Disturbance Procedures > Progressive clearing and rehabilitation > Implement erosion and sediment controls in accordance with an ESCP > Only clearing what is absolutely necessary for the portion of the Project to be implemented > Implementation of Biodiversity Management Plan > Clearly mark limits of clearing > Make use of already disturbed areas where possible. > Adhere to buffer widths recommended by the Northern Territory Land Clearing Guidelines with regard to riparian vegetation in drainage lines > Avoid land clearing during the December to March portion of the wet season.	Moderate
IWEQ-2	Overtopping, embankment failure or seepage from the new TSF at Rustlers Roost leading to uncontrolled release of tailings material to surrounding environment.	Construction, Operation, Decommissioning or Closure	High	> TSF to be planned, designed, constructed and operated in accordance with approaches details in the guideline Tailings Management: Leading Practice Sustainable Development Program for the Mining Industry. (Australian Government 2016e). > Design TSF to contain a range of design storm and rainfall sequences events up to and greater than the required design criteria. > An operational emergency spillway to be constructed as part of each embankment raise. > Development of Monitoring Plan / Operational Manual which includes weekly inspections of the TSF, survey pins to monitor the embankment and piezometers to measure pore water pressure. > Tailings performance monitoring (e.g. TSF water volume, collection efficiency of underground system). > Install seepage control and underground drainage including a cut-off trench, compact soil liner, basin underdrainage collection system, underdrain collection sump and embankment tow drain. > Groundwater monitoring to check quality and any seepage. > Implementation of AMDMP and WMP. > Manage the site water balance to reduce any build-up of water.	Moderate

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Risk No.	Source of Impact	Project Phase(s)	Inherent Risk	Summary of Controls	Residual Risk
IWEQ-3	Overtopping, embankment failure or seepage from the process water storage at Rustlers Roost leading to uncontrolled release of process water to surrounding environment.	Operation, Decommissioning and Closure	High	> Development of Monitoring Plan / Operational Manual which includes weekly inspections of the process water dams. > Groundwater / surface water quality monitoring > Manage the site water balance to reduce any build-up of water.	Moderate
IWEQ-4	Embankment failure or seepages from the new WRDs at Rustlers Roost and Quest 29 to surrounding environment	Operation, Decommissioning and Closure	Extreme	> Development of Monitoring Plan / Operational Manual which includes weekly inspections of the process water dams > Groundwater / surface water quality monitoring > Manage the site water balance to reduce any build-up of water > Capping of the WRDs to reduce ongoing water infiltration and seepage	Moderate
IWEQ-5	Embankment failure of Annie's Dam water storage or process water ponds and uncontrolled water and sediment release (temporary risk noting closure of dam for Rustlers Roost TSF)	Construction and Operation	Moderate	> Geotechnical studies and assessment to ensure structural stability > Engineering design to ANCOLD standard > WMP > Weekly inspections to check sufficient freeboard and structural integrity	Low
IWEQ-6	Poor quality runoff or seepage from the historic WRDs and heap leaches	Construction Operation Decommissioning Closure	Moderate	> Continued use of drainage controls and bunds. > Maximise runoff pond capacity prior to wet season > Ongoing monitoring of existing groundwater bores. > Investigation and consideration of long-term closure options > Cap with suitable waste rock > Calculations, identification and provisioning of suitable cap material > Implementation of AMDMP > Daily inspections for runoff and drainage problem areas	Low
IWEQ-7	Poor water quality released from site during wet season (stormwater)	Construction, Operation, Decommissioning or Closure	Extreme	> Compliance with the WDL > Implementation of AMDMP and WMP > All water storage facilities geotechnically stable and engineered to ANCOLD guidelines > Groundwater / surface water quality monitoring > Weekly inspections of freeboard, structural integrity and pipelines > Implement erosion and sediment controls in accordance with an ESCP	Moderate

Section 7. Key Environmental Factors

Risk No.	Source of Impact	Project Phase(s)	Inherent Risk	Summary of Controls	Residual Risk
IWEQ-8	Indiscriminate use of existing waste rock for construction. Storage of waste rock outside of pit footprint for too long.	Construction Operation Decommissioning Closure	Moderate	> Tracking of the waste rock and dumping locations > WRD plan > ESCP to prevent mobilisation > Implementation of AMDMP and WMP > Maximisation of placement within pits > Testing of waste rock for AMD, heavy metals and NORMS prior to use as on or offsite construction material	Low
IWEQ-9	Pit and groundwater dewatering exposing PAF and causing AMD.	Construction Operation Decommissioning Closure	High	> Sump below pit base to reclaim contaminated water > Implementation of AMDMP including ore and waste rock controls and tailings controls > Treatment of pit and underground water to within SSTV criteria > Visual inspection of pit walls to identify locations and volumes of acid producing material > Groundwater and surface water quality monitoring	Moderate
IWEQ-10	Planned pit over topping or release to surface water features during extreme rainfall and flooding events.	Construction Operation	Low	> Development of Monitoring Plan / Operational Manual which includes weekly inspections of the pits > Implementation of AMDMP and WMP > Manage the site water balance to reduce any build-up of water > Groundwater and surface water quality monitoring	Low
IWEQ-11	Unplanned pit overtopping or release to surface water features during extreme rainfall and flooding events.	Construction Operation Decommissioning Closure	Extreme	> Development of Monitoring Plan / Operational Manual which includes weekly inspections of the pits > Implementation of AMDMP and WMP > Manage the site water balance to reduce any build-up of water > Groundwater and surface water quality monitoring > Implement drainage diversions as per the ESCP	Low
IWEQ-12	Erosion of site infrastructure leading to sedimentation	Construction Operation	High	> Implementation of ESCP > Ongoing and regular (weekly) inspections of Project areas and after rainfall events > Avoid land clearing during wet season > Minimise concentrated flow of surface water and ponding (drain lines, sediment bunds, liners etc.) > Revegetation of exposed areas where not proposed to be utilised > Stable design of landforms > Construction of Project infrastructure with suitable materials	Moderate

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Risk No.	Source of Impact	Project Phase(s)	Inherent Risk	Summary of Controls	Residual Risk
IWEQ-13	Release of hazardous chemicals or materials during storage and handling onsite.	Construction, Operation, Decommissioning	Moderate	> Design, storage and handling of hazardous materials to Australian Standards and regulations. > Specific adherence of the ANFO storage to <i>Dangerous Goods Act 1998</i> and the <i>NT Work Health and Safety (National Uniform Legislation) Act 2011</i> > Regular maintenance of storage facilities > Bunding of the process plant > Ensure containment bunding is adequate and SDS available > Diesel in bunded storage tanks, waste oil in stored bunded tanks > Weekly inspections of storage areas, tanks, containers > Develop Emergency Response Plan and include in inductions > Weekly inspections of storage areas for leaks or damages > Spill kits available around the site and procedures and training for the cleaning up of hazardous spills > Implementation of hazardous materials management plan training for emergency response > Cyanide management and storage will be aligned to the Commonwealth of Australia Leading Practice Handbook for Sustainable Mining - Cyanide Management (Australian Government 2008) > Chemical storage will be located a minimum 30m from any drainage line or watercourse.	Low
IWEQ-14	Poor handling and management of tailings and waste rock		Moderate	> Daily monitoring of waste rock handling and tailings disposal > Tailings and Waste Rock will be managed in accordance with the Tailings Management Plan and Operational Manual (including inspections) > Use of a perimeter spigot with regular movement to evenly distribute tailings > Regular surveys to measure the tailings and waste rock deposition and water depths > Groundwater / surface water quality monitoring	Low

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Risk No.	Source of Impact	Project Phase(s)	Inherent Risk	Summary of Controls	Residual Risk
IWEQ-15	Production of domestic waste and storage of the waste onsite	Construction, Operation, Decommissioning.	Moderate	> Secure dustbin lids > Establish dedicated hardstand at accommodation camp for waste receptacles > Weekly inspections of, waste area, landfill and general tidiness of site > Burial of waste in dedicated landfill. > Design and construct landfill in accordance with relevant standards > Implement leachate prevention and capture into landfill design > Groundwater monitoring > Segregation of wastes and recycling of wastes where possible.	Low
IWEQ-16	Unfinished/unsuccessful rehabilitation of Project due to inadequate funds or natural disaster (e.g. cyclone).	Construction, Operation, Decommissioning and Closure	Extreme	> Progressive rehabilitation of disused areas > Implementation of detailed mine closure plan > Early planning and financial provision for closure works > Infrastructure design to withstand extreme events > Ongoing management of levels in water infrastructure > Improve site drainage controls	Moderate
IWEQ-17	Pit lake becomes a groundwater source.	Construction, Operation, Decommissioning and Closure	Moderate	> Geochemical assessment and modelling of pit water > Contingency to manage water chemistry changes > Investigate in pit water treatment options (i.e. use of lime or caustic) > Contaminant transport modelling further refined > Limit pit catchment post closure to reduce inflow > Ongoing groundwater monitoring program	Moderate
IWEQ-18	Lack of rehabilitation materials leads to inadequate tailings closure and poor quality site rehabilitation.	Decommissioning and Closure	High	> Financial provisioning for closure implementation > Calculation of material requirements and identification of extraction areas > Recover topsoil from TSF, WRD and processing plant footprints > Progressively rehabilitating the mine. > Clearing and Topsoil Procedures Implementation of Mine Closure	Moderate
IWEQ-19	Inappropriate management of the decommissioned site, post closure landform.	Closure	Moderate	> Implement fencing and access restriction to prevent vehicle and livestock accessing rehabilitation areas. > Ongoing monitoring of rehabilitation. > Progressive rehabilitation during mining to enable more established areas upon closure	Low

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Risk No.	Source of Impact	Project Phase(s)	Inherent Risk	Summary of Controls	Residual Risk
IWEQ-20	Ineffective operational implementation of site environmental management system, plans and procedures.	Construction, Operation, Decommissioning Closure	High	> Corporate commitment to EMS implementation via policy > Environmental Management System and various management plans (EMP, WMP, MMP etc.). > All events/incidents to be reported and managed through to resolution via event/incident reporting procedures. > All personnel will be inducted into the area and informed of the hazards and relevant management protocols of the areas. > All personnel will be trained in the appropriate management practices as is relevant to their position.	Moderate
IWEQ-21	Use of Project machinery, equipment, vehicles and activities causing fire through sparks or heat ignition source.	Construction, Operation, Decommissioning Closure	High	> Liaise with Bushfires NT regarding regional (and site) fire break > Establish hot work procedures > Regular inspections of generators and other sources of heat/power. > Fire extinguishers available around site and on all vehicles and machinery. > Training and inductions include Emergency Response Plan. > Establish and implement appropriate control fire regime for area in the MLs.	Moderate
IWEQ-22	Dust generation from Project activities such as vehicular movements and earthworks.	Construction, Operation, Decommissioning Closure	Moderate	> Implementation of Project EMP (incorporating fire and dust management measures). > Implementation of Biodiversity MP (incorporating dust mitigation and artificial lighting mitigation measures). > Site planning to minimise clearing activities and avoid clearing on significantly windy days > Comply with approved vegetation clearance. > Ground Disturbance Permit procedure to be adhered to	Low

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Risk No.	Source of Impact	Project Phase(s)	Inherent Risk	Summary of Controls	Residual Risk
IWEQ-23	Inappropriate liquid and solid waste disposal.	Construction, Operation, Decommissioning Closure	High	> Manage disposal of wastes in accordance with the Project EMP (including banded waste oil bins) > Hazardous materials stored in accordance with Australian standards > Spill kits available around site and spill clean-up procedures implemented > Employees and contractors trained in clean up procedures > Weekly inspections of, waste area, landfill and general tidiness of site > Burial of waste in dedicated landfill. > Design and construct landfill in accordance with relevant standards > Implement leachate prevention and capture into landfill design > Groundwater monitoring	Low
IWEQ-24	Major mechanical failure of processing plant	Operation	High	> Ensure appropriate warranties in place and maintain appropriate critical mechanical spares inventory > Regular maintenance and inspections of plant. > Engineer sign off before recommencement of plant > Construction of abandonment bund around the processing plant	Low

Section 7. Key Environmental Factors

7.4.6 Predicted Outcome and Conclusions

This section outlines the risks associated with the potential discharge of contaminated surface and groundwater to environmental values defined for Inland Water Environmental Quality. While mining can pose risks to surface and groundwater, the risk assessment process has demonstrated that the risks can be managed in accordance with legislative requirements by relevant management plans and licences. Furthermore, data analysis from similar mining activities within Mount Bundey Catchment (Toms Gully Mine) has shown that potential impacts in water quality are mostly localised and are not likely to impact on the Mary River system. This indicates minimal risk of cumulative impacts outside of the Project area, with the application of the management and monitoring controls committed in this section.

The water quality and aquatic fauna monitoring program as outlined in the WMP presents an opportunity to create valuable information to better understand the environmental values associated with inland water environmental quality in the associated Adelaide River and Mary River catchments.

The potential risks from uncontrolled discharge, spills and poor closure will remain throughout the Project. However, with the application of effective controls in accordance with the environmental decision framework, management and mitigation measures the risks will remain sufficiently low.

The environmental objective identified in the ToR (NT EPA 2021) is to protect inland water quality to support and maintain environmental values like aquatic and riparian ecosystems. As such, the Project is not determined to cause significant decline to relevant environmental, social, cultural and economic values at the local scale.

Considering the assessment of residual impacts, and the application of mitigation and monitoring committed to by PGO, it is concluded that impacts on Inland Water Environmental Quality are manageable, such that the ToR objective for this factor is able to be met.

7.4.7 Assumptions

The key assumptions made in assessing potential impacts on inland water quality are:

- The WRD and TSF design, construction strategies and AMD Management Plan will provide for effective long-term prevention and/or containment of AMD;
- Erosion risks associated with early or unexpected closure, would be addressed to the satisfaction of DITT through the MMP process;
- The WMP includes appropriate site-specific water quality guidelines and monitoring to prevent poor water quality impact on downstream aquatic ecosystems;
- A MCP will be implemented to make the site safe, non-polluting and mitigate long-term impacts; and
- Storage and handling of processing chemicals and hydrocarbons will be in accordance with accepted standards and guidelines.