Appendix 15 – Water Resources Management Plan

Alcoa of Australia Limited

Water Resources Management Plan

Huntly & Willowdale Mine

June 2023

Version	Description of Changes	Date	Approved by
Rev 0	Draft document for consideration by Environmental Protection Authority	28 May 2023	
Rev 1	Draft document for consultation by MMPLG	28 June 2023	

Table Of Contents

Table Index

Figure Index

Executive Summary

This Water Resources Management Plan (WRMP) has been prepared by Alcoa of Australia Limited (Alcoa) for the Huntly and Willowdale bauxite mines located within Alcoa's Mining Lease 1SA (ML1SA).

This WRMP specifically addresses management of the risks and potential impact of bauxite mining on key environmental values associated with Inland Waters Environmental Factor consisting of:

- Groundwater:
  - Groundwater Dependent Vegetation (GDV).
- Surface water:
  - Tributaries leading into reservoirs and ecosystem:
    - Aquatic fauna;
    - Aquatic vegetation; and
    - Associated riparian vegetation.
  - Potential refugial zones for terrestrial and aquatic fauna.
- Public Drinking Water Areas:
  - Streams; and
  - Reservoirs.

This WRMP also addresses compliance with the *Public Health Act 2010* for Drinking Water Quality Management in the Australian Drinking Water Guidelines (2011).

Executive Summary Table ES1 below presents the environmental objectives for the environmental factor to be met through implementation of this WRMP, as well as the management targets to measure achievement of the associated environmental objectives.

This WRMP should be considered a draft as further work (detailed in Section 3) and Mining and Management Program Liaison Group (MMPLG) consultation, particularly with Water Corporation, is required to determine the acceptability of management actions and appropriateness of the monitoring programme. However, Alcoa will commence staged implementation of the WRMP to provide assurances that mine activities are adequately managed to minimise groundwater and surface water impacts. Alcoa considers the management actions proposed to be sufficient to minimise impacts, particularly to the Public Drinking Water values. However, it is acknowledged that consensus on a risk-based approach to protecting Public Drinking Water values will not be immediate. Therefore, a robust monitoring programme (Section 2.1) with outcome-based provisions (including early response) have been developed and proposed to ensure any potential impacts are identified early and prevented.

Table ES1: Environmental criteria to measure achievement of environmental objectives

EMP Name	WA Mining Operations Water Resources Management Plan
Proponent Name	Alcoa of Australia Limited
Ministerial Statement Number	Willowdale Mine (Wagerup Refinery): • Ministerial Statement 1157 (preceding statements: 728, 897, 1069) • Ministerial Statement 646 Huntly Mine (Kwinana and Pinjarra Refinery): • Ministerial Statement 646
State Agreements	• Alumina Refinery (Kwinana) Agreement Act 1961 • Alumina Refinery (Wagerup) Agreement Act 1978 & Acts Amendment Act 1978 • Alumina Refinery (Pinjarra) Agreement Act 1969 • Alumina Refinery (Alcoa) Amendment Act 1987
Purpose of this EMP	*To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.*
Key Environmental Factor/s, outcome/s and/or objectives	Inland Waters EPA Objective: *To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.*
Management based provisions	**Environmental Objectives** • No impacts to public health from mining activities • Minimise changes to hydrological regimes from mining activities • Minimise changes to hydrogeological regimes from mining activities **Management Target/s** • No significant impact to public drinking water areas quality or supply from mining activities • No significant impact to public drinking water areas quality from pathogens from mining activities • No significant impact to public drinking water areas quality from hazardous materials and waste from mining activities • No significant impact to public drinking water areas quality from herbicides and fertiliser as a result of mining activities • No significant impact to surface water values as a result of increase in turbidity from mining activities • No significant impact to surface water values as a result of increase in turbidity from erosion of post-mining landforms

	• No significant impact to surface water values as a result of increase salinity from mining-induced saline groundwater discharge • No significant impact to surface water values as a result of hydrological regime changes from mining activities • No significant impact to groundwater values as a result of hydrogeological regime changes from mining activities
Proposed construction date	Not applicable
EMP required pre-construction	Not applicable

1 Context, Scope and Rationale

This Water Resources Management Plan (WRMP) has been prepared for management of groundwater and surface water values at the Huntly and Willowdale bauxite mines located within Alcoa's Mining Lease 1SA (ML1SA) in the Northern Jarrah Forest (NJF).

This WRMP has been developed to address the environmental management of groundwater and surface water, in accordance with:

- Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2016 (EPA 2016);
- Environmental Protection Authority's (EPA) Instructions on how to prepare *Environmental Protection Act 1986* Part IV Environmental Management Plans (EPA 2021); and
- *Rights in Water and Irrigation Act 1914* licensing requirements and *Water Services Act 2012.*

The WRMP includes the management of groundwater and surface water quantity and quality within the catchment of surface water sources (dams, reservoirs) and specifically addresses the Priority 1 Drinking Water Source Areas.

This WRMP should be considered a draft as further work (detailed in Section 3) and MMPLG consultation, particularly with Water Corporation, is required to determine the acceptability of management actions and appropriateness of the monitoring programme. However, Alcoa will commence staged implementation of the WRMP to provide assurances that mine activities are adequately managed to minimise groundwater and surface water impacts. Alcoa considers the management actions proposed to be sufficient to minimise impacts, particularly to the Public Drinking Water values. However, it is acknowledged that consensus on a risk-based approach to protecting Public Drinking Water values will not be immediate. Therefore, a robust monitoring programme (Section 2.1) is proposed to ensure any potential impacts are identified early and prevented.

1.1 Huntly and Willowdale Mine Regions

Alcoa of Australia Limited's (Alcoa) Western Australian (WA) mining operations comprise the Huntly and Willowdale bauxite mines, which are located in Alcoa's ML1SA within the NJF Interim Biogeographic Regionalisation for Australia (IBRA) subregion.

The Huntly Mine supplies bauxite to the Kwinana and Pinjarra alumina refineries. The Huntly Mine has operated since 1972, initially as the Del Park Mine, over six mine regions with a further two regions proposed (Table 1-1). This WRMP addresses all eight regions including current and future operations and past and future rehabilitation.

Table 1-1: Huntly Mine Regions

Mine region	Region area (ha)	Status	Years of operation
Del Park	3,507	Historic	1972-1987

Mine region	Region area (ha)	Status	Years of operation
Huntly 1&2	4,570	Historic	1986-1997
White	12,349	Historic	1989-2006
McCoy	15,512	Historic	2003-2015
O'Neil	12,838	Historic	2010-2015 2023-2025
Myara	20,829	Current	2014-present 2023-2025
Myara North	18,172	Proposed	~ 2025-2030
Holyoake	9,157	Proposed	~ 2030-2035

The Huntly Mine is predominantly located within the Shire of Serpentine-Jarrahdale and the Shire of Murray, extending from Dwellingup in the south to Jarrahdale in the north. The Huntly Mine lies within Dwellingup and Jarrahdale State Forest. The Huntly Mine is broadly bordered by Serpentine National Park and the Darling Scarp to the west, the Monadnocks Conservation Park and Albany Highway to the east, Dwellingup and Pinjarra-Williams Road to the south and the former Jarrahdale Mine to the north.

To the north of the Huntly Mine (Myara North region) lies the former Jarrahdale Mine, which was operated from 1963 to 1998 and is now closed and rehabilitated. This WRMP does not address the former Jarrahdale Mine.

The Willowdale Mine supplies bauxite to the Wagerup Alumina Refinery. The Willowdale Mine has operated since 1984 over three regions (Table 1-2).

Table 1-2: Willowdale Mine Regions

Mine region	Region area (ha)	Status	Years of operation
Arundel	6102	Historic	1984-2000
Orion	23,149	Historic	2000-2021
Larego	23,422	Current	2021-current 2023-2045 proposed

The Willowdale Mine is located within the Shire of Waroona and Shire of Harvey and is broadly bordered by Lane Poole Reserve in the east and north-east, the Darling Scarp to the west, and Harvey Dam and surrounding rural land to the south-east. The Willowdale Mine lies predominantly within Dwellingup State Forest and Lane Poole Reserve.

The WRMP has been prepared in accordance with the *Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans* (EPA 2021).

This WRMP addresses all phases of the WA Mining Operations including:

- Exploration;
- Construction;
- Mining; and
- Rehabilitation.

1.2 Key Environmental Factors

This WRMP has been developed to manage Alcoa's mining activities on water values. It has been developed to align with:

- the EPA's Inland Waters environmental factors including the factor objective and relevant policy and guidance;
- Drinking Water public health guidelines; and
- DWER's expectations under the *Rights in Water and Irrigation Act 1914* and *Water Services Act 2012.*

The EPA's objective for inland waters is: "*To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected."*

In the context of this objective, the environmental values are considered to be those detailed in Table 1-3. The potential impacts to these values from Alcoa's mine activities are summarised in Table 1-3.

Table 1-3: Key environmental values, potential impacts and potential pathways as addressed in this WRMP

Inland Waters Environmental Value	Potential Impacts (direct/indirect)	Pathways
Public Drinking Water Areas • Streams • Reservoirs **Surface water** • Tributaries leading into reservoirs and ecosystem: ○ Aquatic fauna ○ Aquatic vegetation; and ○ Associated riparian vegetation • Potential refugial zones for terrestrial and aquatic fauna **Groundwater**	<u>Surface water and sediment releases</u> – suspended solids /turbidity as a result of: • Native Vegetation Clearing • Pit development • Loss of Containment events • Drainage event • Haul roads and causeways • Vehicle movements • Mine facilities (Workshops, etc) • Rehabilitation management	• Flow into streams discharged into reservoir. • Flow directly into reservoirs
	Contamination (pathogens, hydrocarbons, PFAS, metals, salinity, fertilisers (nutrients), herbicides) as a result of: • Native Vegetation Clearing • Pit development including explosives use and personnel access • Loss of Containment events • Drainage event • Haul roads and causeways • Vehicle movements and associated hydrocarbon spills • Mine facilities (Workshops, etc) and associated hazardous material storage and use • Wastewater and sewage management • Surface water abstraction • Groundwater interactions with surface water • Rehabilitation management including fertiliser and herbicide application	• Flow into streams discharged into reservoirs. • Flow directly into reservoirs • Groundwater contamination

Inland Waters Environmental Value	Potential Impacts (direct/indirect)	Pathways
• Groundwater Dependent Vegetation (GDV)	Change in hydrological and hydrogeological regime as a result of: • Pit development • Rehabilitation management • Surface water abstraction	• Rising groundwater following clearing of vegetation and caprock mobilising salts in soils with potential to mobilise into groundwater and flow into streams • Surface water flow changes

1.3 Condition Requirements

Alcoa's Wagerup Ministerial Statement 728 defined the requirements for development of completion criteria for rehabilitation. The condition delegated responsibility for development of the completion criteria program to the Mining and Management Program Liaison Group (MMPLG). The condition requires:

- Public consultation prior to finalisation of the completion criteria;
- Public access to the completion criteria upon finalisation;
- Five yearly review and revision of the completion criteria via the MMPLG and public consultation;
- Application of best practice environmental management principles; and
- Certificate of acceptance supplied to Alcoa by the Department of Environment and Conservation (DEC now DBCA) on behalf of the State.

The Rehabilitation Completion Criteria identifies the standards that post mining rehabilitation must meet to ensure that landforms are stable and self-sustaining. Once completion criteria for mining area are met, Alcoa may then apply to hand over ownership of the land to the State Government. The rehabilitation is required to meet the standards of the day.

The completion criteria for different periods are:

- Completion criteria for early era (pre-1988).
- Rehabilitation Completion Criteria for 1988-2004.
- Rehabilitation Completion Criteria for 2005-2014.
- Rehabilitation Completion Criteria for 2016 Onwards (as shown in Table 1-4).

Table 1-4: Catchment Protection relevant Rehabilitation Completion Criteria for 2016 onwards

Criteria & Intent	Guidelines for acceptance	Standard
Rehabilitation Earthworks		
2.1 Rehabilitation establishment (a) Waste islands will be effectively rehabilitated	Waste islands will have caprock shattered and topsoil spread and scarified to prevent impeding vehicular or rubber tyred machine for fire access.	- No area greater than 0.1 of a hectare has unbroken caprock. Trafficability to agreed Alcoa/Parks and Wildlife Working Arrangements.
(b) There is an adequate cover of topsoil across the rehabilitated area.	Topsoil return and coverage is uniform within each individual rehabilitated pit.	- Direct return (or agreed surrogates) topsoil is spread over the rehabilitated area. No area >0.1 ha has no topsoil coverage. The cumulative area without topsoil does not exceed 10% of the rehabilitated pit.
d) The area has been contour ripped.	Ripping must be undertaken as per criteria established in Alcoa/Parks and Wildlife Working arrangements. Self-certification by Alcoa annually and inspection by Parks and	- No uncontrolled water runoff or unacceptable soil erosion in or adjoining the pit. Unacceptable erosion is that which: - restricts access through the area by 4 wheel drive vehicles

Criteria & Intent	Guidelines for acceptance	Standard
Rehabilitation Earthworks		
	Wildlife (where applicable) confirms rehabilitation ripping is acceptable. Ripping that meets the standard is deemed acceptable unless Parks and Wildlife writes to Alcoa within three months of self-certification to advise otherwise. Ripping does not prevent access for fire line construction by front end loader	- is unstable and degrading , or - will compromise landuse objectives. - Gully erosion will not exceed: - 30cm depth and - 30cm width , and - 100m in length - areas of unintended deposition >0.1 ha - These areas will be identified as part of 9 month monitoring
e) The pit floor has been ripped.	Ripping must be undertaken as per criteria established in Alcoa/Parks and Wildlife Working arrangements. Self-certification by Alcoa annually and inspection by Parks and Wildlife (where applicable) confirms pit floor ripping is acceptable.	- Pre-rip to be undertaken in accordance with Alcoa/Parks and Wildlife Working arrangements. Rip compacted pit floor to at least 1.2 m, excluding batters and waste islands.
2.3.1 Catchment Protection Rehabilitated areas conform to water catchment management guidelines.	Rehabilitated surfaces are stable and water quality standards are met.	- Turbidity monitoring is carried out according to the Water Working Arrangements. Areas will be stable with no evidence of recent erosion which would compromise stream water quality. There are no areas greater than 0.1 hectare with less than 0.5 native plants per square metre as identified from aerial photography or ground truthing on a 5-yearly basis.

1.4 Rationale and Approach

This WRMP provides provisions for potential impacts to water values specific to Alcoa operational activities.

1.4.1 State of knowledge

As a part of the mine planning process, a range of surveys are undertaken at the earliest possible stage prior to mine development to assess potential impacts on water values. This section presents the findings of the following:

- Past water related surveys, research and monitoring; and
- Water values and uses.

1.4.1.1 Public Drinking Water Areas

Alcoa's mining lease is located within Priority 1 drinking water catchments and classified as a Priority 1 Public Drinking Water Source Area (PDWSA) and assigned under "*values directly protected under State and /or Commonwealth legislation*".

WA Mining Operations are located within several proclaimed water catchments including PDWSAs and recreational water use catchments. At Huntly, the mining areas intercept Serpentine Dam, North Dandalup and South Dandalup PDWSAs and at Willowdale the Mining areas intercept the Samson Dam and Stirling Dam PDWSAs.

The Water Corporation (WC) has a responsibility for controlling access within PDWSAs and Reservoir Protection Zones (RPZs). RPZs are defined in the Metropolitan Water Supply, Sewerage, and Drainage By-laws 1981, and generally extend to 2 kilometres from the top water level of any reservoir, back into the defined PDWSA. RPZs are located within both mine sites. Surrounding the Serpentine Dam, North Dandalup Dam, South Dandalup Dam, Samson Dam and Stirling Dam.

Management zones within the RPZs identified in the Water Working Arrangements are the operational control area (OCA) Zone 1 – a 200 m buffer area that extends perpendicular from the top water level around PDWSA reservoirs – and OCA Zone 2 – a 300 m extension from Zone 1 perpendicular from the Zone 1 boundary.

1.4.1.2 Climate

Western Australia's southwest region has a 'Mediterranean' type climate characterised by typically high winter rainfalls and an intense summer drought.

Karnet Bureau of Meteorology Station (no. 009111) is proximal to the mining region and has rainfall data from 1963 to 2020, as well as temperature and solar exposure data. Monthly statistics for the site since its inception are shown in Figure 1-1 and SILO[1] point data was extracted annual rainfall plotted in Figure 1-2.

[1] Rainfall, temperature, and evaporation data sourced from the SILO data downloaded from https://legacy.longpaddock.qld.gov.au/silo/ppd/ on 5 June 2020. Point data from the SILO climate database (Queensland Department of Science, 2015) provides a continuous daily climatic record for a given point with gaps infilled based on interpolation of records from nearby weather stations.

The mean monthly maximum temperature ranges from 15.8°C in July to 30.9°C in January. Average annual evaporation (1,520 mm) typically exceeds average annual rainfall (1,153 mm), albeit rainfall exceeds evaporation during winter and shouldering months.

Western Australia's southwest region has undergone a 15 to 20% reduction in rainfall since the 1970s, as illustrated in Figure 1-2 (Petrone, et al. 2010). This trend has been forecast to continue with a further 2% to 14% reduction predicted by 2030. Temperature increase and potential evapotranspiration are also forecast to increase by 0.7°C and 2 to 3%, respectively (CSIRO 2009, DoW 2015).

Rainfall in the Darling Range is also known to decline with distance inland. The 1,100 mm annual rainfall isohyet (High Rainfall Zone or HRZ) and the 900 to 1,100 mm annual rainfall isohyet (Intermediate Rainfall Zone or IRZ) have been identified in research as defining features.

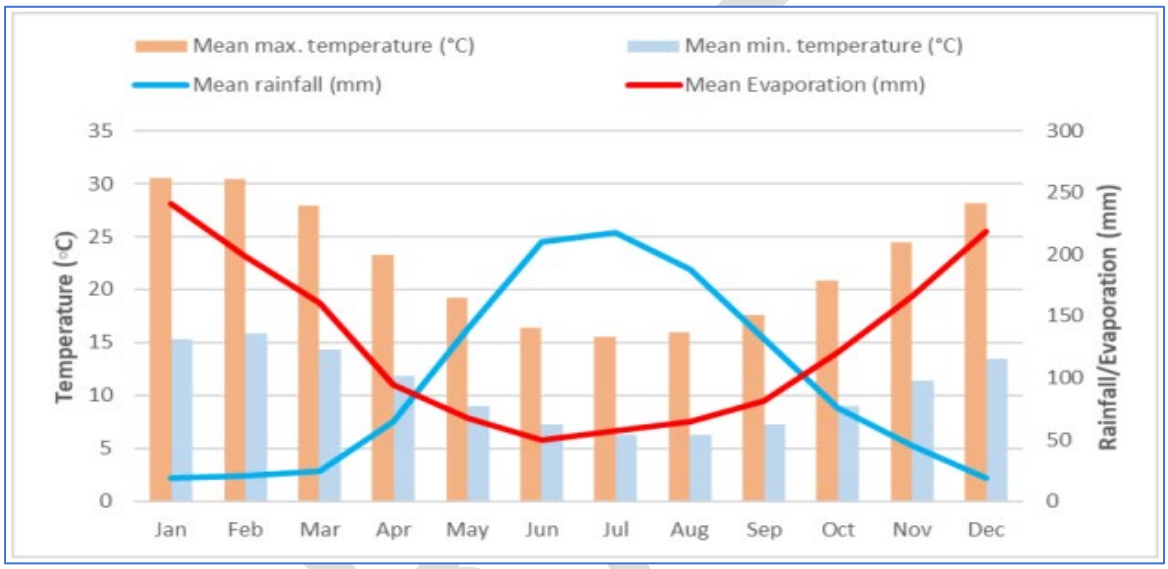

Figure 1-1: Monthly climate statistics at Karnet Station (1965 – 2020)

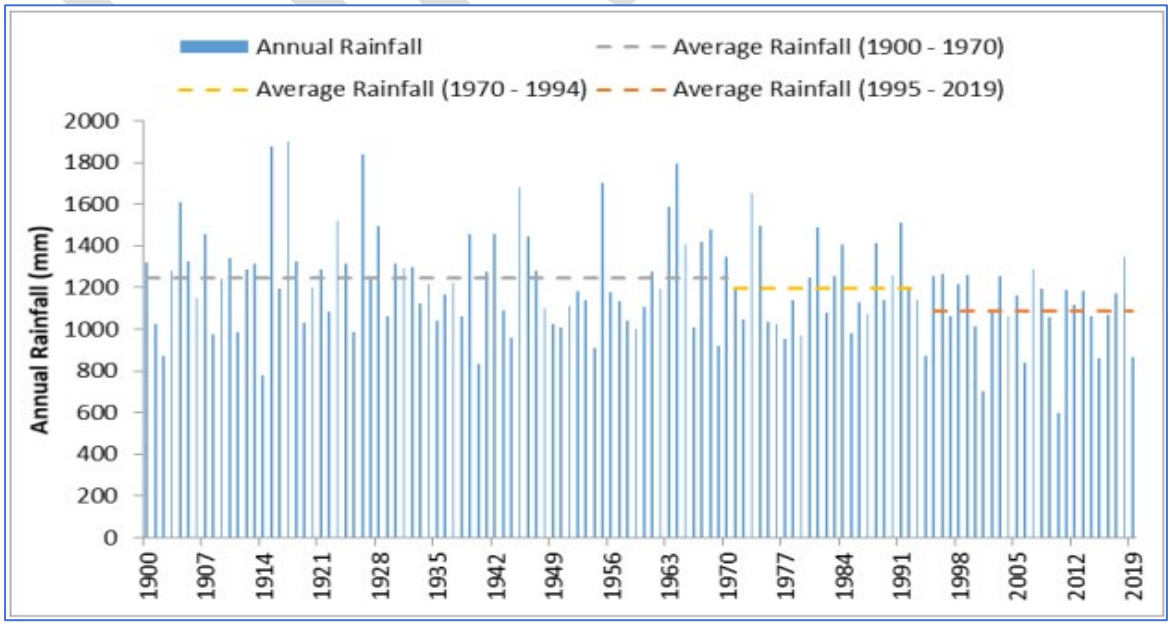

Figure 1-2: Annual rainfall at Karnet Station

1.4.1.3 Soils

The Huntly and Willowdale Mine lies within the Darling Plateau, an undulating lateritic plateau. Soils have developed over the granitic terrain in a typical laterite profile with sand and gravelly topsoils which transition into a saprolite zone of weathering.

Soils typically comprise gravels, sands and loams including a discontinuous cemented layer or duricrust mostly in mid- to upper slopes, merging with underlying mottled and pallid saprolite clays. Coarse gravels can be found on the upper slopes, trending to finer gravels downslope and sands near the valley floor, dominated by loams and clay loams (Churchward and Dimmock 1989).

Of hydrological significance, root channels penetrating vertically via fissures and discontinuities in the cemented layer and deep into the clay zones are a consistent feature in the lateritic profiles. These channels form preferential flow paths (bypass recharge) and are understood to form potentially large vertical fluxes into groundwater systems (A. H. Grigg 2017, McFarlane, Grigg and Daws 2017, Turner and Johnston 1987).

The ‘dry flats’ and ‘wet flats’ are broadly consistent with alluvial deposits, developed along major drainage lines and creeks which may contain finer fraction especially in their downstream sections. The ‘dry flat’ term includes both the edge of the valley floor and permanently dry’ slightly elevated part of the flat. The ‘wet flat’ is the part of the valley floor which is waterlogged during winter. The soil profile is sometimes missing along the deeply incised drainage lines or at elevated highs formed by the granite outcrops.

1.4.1.4 Regional geology

The Huntly and Willowdale Mine region is within the Yilgarn Craton granite basement area.

The bedrock outcrops over less than 10% of the region, as an extensive layer of Cainozoic lateritic profile developed over the basement. A typical lateritic profile in the Darling Range is distinctly zoned. The laterite has been derived from the weathering of parent rock and consists of a ferruginous or aluminous hard cap layer which overlies a pallid, and often mottled kaolinitic zone of varied thickness (saprolite). The transition zone between the fresh basement and saprolite is referred to as saprock.

The laterite layer hosts the bauxite resources which are proposed to be mined. Development of bauxite ore has been especially pronounced along the flanks and upper slopes of ridges. In the lower lying valleys, the occurrence of bauxite is limited (eroded). The lateritic (bauxite) horizon is on average 2 to 3 m thick for granite-derived bauxite.

Younger age tholeiitic quartz dolerite dykes also intrude the Archaean basement. The dykes are generally 10 m thick although the width can vary widely. These dykes generally follow east west to northwest to southeast directions. Observations of outcrops along the railway cutting near Jarrahdale suggest significant differences between the profile developed over meta granites and dolerites. These are related to the dominance or preservation of quartz in the profile developed over the meta granite whereas it is almost totally absent from the profile developed over the dolerite.

1.4.1.5 Hydrogeology

Regional hydrogeology

The Huntly and Willowdale mines lie within the Darling Plateau, an undulating lateritic regolith over Archaean granite with dolerite intrusions. The regional hydrogeology comprises aquifers predominantly within weathered and fresh Archaean basement rocks, as well as superficial aquifers within more recent sediments incised in the basement, coincident with existing and paleo drainage lines. Table 1-5 presents the main aquifer units that characterise the regional hydrogeology across the Darling Plateau, from surface level down to the basement.

Table 1-5: Main aquifer units within Darling Plateau geology

Aquifer unit	Description
Shallow weathered zone	Shallow gravely and sandy sediments, lateritic caprock and friable upper saprolite. The lateritic caprock and friable saprolite can contain economic bauxite and be subject to mining. Seasonal aquifer with significant storage, infiltration and flow capability.
Deep weathered zone	Lower saprolite layer. Aquifer of some storage potential, but limited bulk permeability, comprising clays. Clayey nature of this zone can be interspersed by macropore features developed along deep root systems which were subsequently filled with more clastic material.
Transition zone	Transition zone between fresh basement and saprolite, referred to as saprock, which typically has enhanced permeability
Fractured bedrock	Permeability and yields are dependent on facture development and connectivity of fractures

Local Hydrogeology

The groundwater host rocks of the Huntly Mine region predominantly comprise the weathered and fresh Archaean crystalline rocks. In addition, more recent sediments are incised into the basement rocks, coincident with existing drainage or palaeodrainage lines.

The understanding of the generalised hydrogeology of the regions comprises several aquifer units:

- Shallow weathered zone aquifer: comprising lateritic caprock and shallow gravely to sandy sediments which represents seasonal aquifers of variable connectivity. Given sufficient thickness can possess significant storage, infiltration and flow capability.
- Deep weathered zone aquifer (saprolite), an aquifer of some storage potential, but limited bulk permeability (comprising clays). The clayey nature of this zone can be interspersed by macropore features developed along deep root systems which were subsequently filled with more clastic material.
- Transition zone between the fresh basement and saprolite, referred to as saprock, which typically has enhanced permeability.
- Fractured bedrock aquifer, permeability and yields are dependent on facture development and connectivity of the fractures; and

- Structural features, such as faults and dolerite dykes, may have enhanced permeability along their strike.

Groundwater has been an active part of lateralisation process, particularly in development of cemented ferruginous hardcap (duricrust) often encountered on the surface. Formation of duricrust has been driven by groundwater flow and capillary action which led to precipitation of iron minerals leached from the weathered bedrock. Duricrust can also form in valley floors due to accumulation of iron brought by groundwater flow and its precipitation due to evapotranspiration or exposure to the surface (reduction of partial CO2 pressure).

Groundwater levels generally mimic topography, such that groundwater level is highest in areas of highest topography and lowest in areas of lowest topography. Where groundwater levels intersect the base of the creek drainage groundwater discharges provide baseflow, following winter rains (which top up aquifer storage and elevate groundwater levels).

Substantial amount of groundwater is removed by evapotranspiration. The tree cover of the jarrah forest removes water stored and/or transmitted in unsaturated and saturated zones. Root systems of some trees reportedly go to 40 m below ground although the primary effect of evapotranspiration active predominantly within the first ten metres.

1.4.1.6 Hydrology

Regional hydrology

The Huntly and Willowdale mine areas are located within the basins of the Serpentine, Murray and Harvey rivers. The entire Huntly mine area intercepts the catchments of four water supply catchments (Serpentine, North Dandalup, South Dandalup and Conjurunup), which release limited flows (<10 per cent of inflow) to maintain downstream beneficial uses. The dams are used for drinking water and their catchments comprise PDWSAs. The majority of the active Huntly mine region lies within the catchments of the Serpentine dam. The Willowdale mine area intercepts the catchments of Harvey Dam, Stirling Dam, Logue Brook Dam and Sampson Brook Dam. Two of these dams, Stirling and Sampson Brook, are used for drinking water and their catchments comprise PDWSAs.

The Serpentine, Murray and Harvey River Basins have their headwaters in the Darling Plateau, an undulating lateritic regolith over Archaean granite with dolerite intrusions that retains extensive forested land of the NJF. The Darling Plateau generally lies at elevations of approximately 250 to 350 metres Australian Height Datum (AHD), interspersed by isolated granite hills or ‘monadnocks’ that can exceed 400 mAHD. Rainfall is greatest in the western edge of the plateau near the Darling Scarp, decreasing to the north and east. The Serpentine and Murray rivers run in a characteristic north-west direction influenced by underlying granite and dolerite structures (Hickman et al 1992).

The Serpentine, Murray and Harvey rivers flow west off the Darling Plateau, via incised valleys through the Darling Scarp, and onto the Swan Coastal Plain (SCP). The SCP comprises deep sediments deposited from the ocean or washed down from the Darling Scarp, with a series of sandy dunes to the west and the relatively flat Pinjarra Plain to the east. The SCP lies at elevations from sea level on the coast up to 50 mAHD near the Darling Scarp with higher elevations in larger dune landforms. The SCP has been extensively developed for urban land uses over the sandy dunes, and for agricultural land use on the heavier soils of the Pinjarra Plain.

The Serpentine, Murray and Harvey rivers meander through the SCP towards the coast. The Serpentine River adopts a southerly direction due to the influence of north-south coastal dunes, before discharging into the Peel Inlet. The extensive agricultural development of the Pinjarra Plain has resulted in high nutrient loads and eutrophication of the Peel-Harvey Estuary (Hale and Butcher 2007). Along with river diversions, agricultural land use poses a key threat to the environmental values of the Peel-Yalgorup Ramsar site (Hale and Butcher 2007).

The Huntly Mine region is part of the Darling Plateau, which is characterised by sharply incised drainage lines forming dense drainage networks in the western, higher rainfall zone (HRZ), with these transitioning to open, flat-floored valleys in the eastern, lower rainfall zone (IRZ).

Some of the larger streams in the high rainfall zone (HRZ) have previously exhibited perennial flows (baseflow). However, the drying climate has caused a significant reduction in streamflow, leading to a shift from perennial to ephemeral streams and a decline in the runoff coefficient in recent decades.

Groundwater storage is a key factor influencing the step-change response in streamflow. Where permanent groundwater levels fall below the stream bed and become 'disconnected' after low rainfall years, this step-change in streamflow is observed (Figure 1-3).

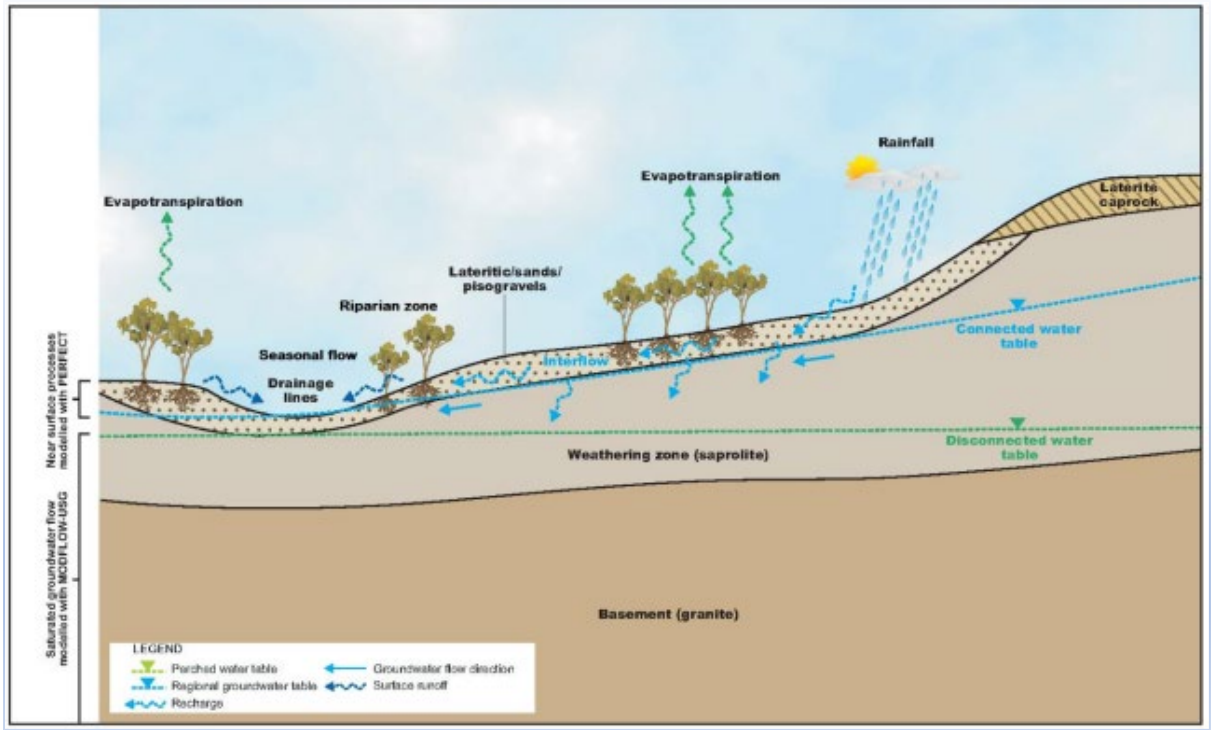

Figure 1-3: Conceptual representation of surface water groundwater interaction

Local Hydrology – Huntly

The majority of the Serpentine River within and upstream of the Huntly mine region is regulated by Serpentine Dam. Serpentine Dam was constructed in 1961 and supplies the Serpentine Pipehead Dam, which was constructed in 1957.

Serpentine Dam is used for public drinking water supply and diverts the majority of flow from its catchment for this beneficial use. Releases to the Serpentine River downstream of the Pipehead Dam are managed according to the Serpentine allocation statement

(DWER 2017a), which allows for the release of 0.8 GL/year for 'low-inflow' years (inflow to dam less than 30 GL) and 0.86 GL/year for 'standard' years (inflow to dam greater than 30 GL). Accordingly, for average inflows of approximately 14 GL/year, as was recorded over 2008- 2015 (DWER 2017a), Serpentine Dam would divert more than 94 per cent, with less than 6 per cent released downstream. For average inflows of approximately 33 GL/year, as was recorded over 1975-2008 (DWER 2017a), the dam would divert more than 97 per cent, with less than 3 per cent released downstream.

Within the Huntly mine area the Serpentine Dam is supplied by seasonal streams, with major tributaries being the Serpentine River and Big Brook. The seasonal streams are interspersed by headwater swamps that occupy colluvial and alluvial sediments in valley floors. The swamps comprise seasonally waterlogged wetlands with distinct vegetation types.

The Huntly mine area lies partially in the catchment of the North Dandalup River, which is regulated by North Dandalup Dam. North Dandalup Dam was constructed in 1994 and supplies the Integrated Water Supply Scheme (IWSS).

North Dandalup Dam is used for public drinking water supply and diverts the majority of flow from its catchment for this beneficial use. Releases from the dam to North Dandalup River downstream are managed according to the North Dandalup allocation statement (DWER 2017b), which allows for the release of 0.46 GL/year for 'low-inflow' years (inflow to dam less than 30 GL) and 0.51 GL/year for 'standard' years (inflow to dam greater than 30 GL). Accordingly, for average inflows of approximately 8 GL/year, as was recorded over 2008-2015 (DWER 2017b), North Dandalup Dam would divert more than 95 per cent, with less than 5 per cent released downstream. For inflows exceeding 30 GL/year, the dam would divert more than 98 per cent, with less than 2 per cent released downstream.

Within the Huntly mine area the North Dandalup Dam is supplied by the North Dandalup River. There is a stream gauging station at North Road (614036), approximately 1 km upstream of the reservoir. Annual flows in the North Dandalup River and North Dandalup Dam have declined from an average of 37.6 GL/year over 1960-1974, to an average of 17.1 GL/year over 1975-2007, to an average of 8.4 GL/year over 2008-2015 (DWER 2017b), attributable to a reduction in average annual rainfall of approximately 20% over the same period (DWER 2019).

The North Dandalup River is interspersed by a series of headwater swamps that occupy colluvial and alluvial sediments in valley floors.

Monitoring of surface water locations within sub-catchments intersecting the Huntly mine area have recorded mildly acidic to mildly alkaline (pH ranging from 3.6 to 8.0) and fresh (<1000 µS/cm since 2000) water quality. All records since 2010 (except MBF11) are below the Australian Drinking Water Guidelines (NHMRC, NRMMC 2011) aesthetic limit for TDS of 600 mg/L (EC equivalent of 937.5 µS/cm). The recorded exceedance at MBF11 occurred 12 July 2022 (1342 µS/cm). Other historical peaks greater than 900 µS/cm were recorded on 17 June 2018 and 12 July 2019. MBF11 is located within the O'Neil region within a sub catchment mined between 2011 and 2013 and rehabilitated between 2013 and 2021.

Local hydrology – Willowdale

The Willowdale mine area lies in the catchments of the Murray and Harvey. The Murray River catchment intersects the north-eastern portion of the Willowdale mine area within the Middle Murray and Lower Murray, unregulated sub-catchments of the Murray River. The Murray River

is perennial, however very low flows (< 10 ML/month) were recorded in autumn in 2011 and 2020 following record low rainfalls in 2010 and 2019.

Middle Murray and Lower Murray flow through shallow valleys of Yarragil landform transitioning to moderately incised valleys of Murray landform as they approach the Murray River. The Murray River flows through deeply incised valleys of the Murray landform and transitions to the steep, rocky Helena landform as it dissects the Darling Scarp.

The Harvey River catchment intersects with the majority of the Willowdale mine regions and is regulated by five dams. Two dams, Stirling and Sampson Brook supply the IWSS.

The Stirling Dam catchment has an area of 254 km^2. Elevation in the catchment is 80 m Australian Height Datum (AHD) at the reservoir to 320 m AHD at the head of the catchment. Water inflow to the reservoir is mostly from surface runoff over the winter months. However, there is subsurface flow year round due to the gravelly nature of the geology in the Darling Range.

Samson Brook Dam was completed in 1941. It is 31 metres high and impounds a reservoir of 8 GL volume and 104 ha surface area at a top water level of 245 m AHD. The estimated average annual streamflow into the reservoir is 16.6 GL from a catchment area of 64 km^2.

Monitoring of surface water locations within sub-catchments intersecting the Willowdale mine area have identified mildly acidic to neutral (pH ranging from 5.4 to 6.7) and fresh (<7000 µS/cm) water quality. Historical ranges and averages for monitoring sites with more than five samples are presented in Appendix 6. All records since 1980 are below the Australian Drinking Water Guidelines (NHMRC, NRMMC 2011) aesthetic limit for TDS of 600 mg/L (EC equivalent of 937.5 µS/cm).

1.4.1.7 Vegetation and Land Use

The Jarrah Forest vegetation is dominated by the predominant tree *Eucalyptus marginata* (Jarrah), which comprises about 60-80% of the leaf area index (LAI). Shallow rooted vegetation (shrubs and groundcovers) is estimated to comprise less than 10% of LAI and medium rooted vegetation (larger shrubs) approximately 10 % of LAI.

E. marginata has a dimorphic root system comprising dense lateral roots in the topsoil and overburden above the caprock, where 'sinker' roots extend vertically accessing moisture in moisture bearing clay, however the bulk of roots are in shallower soil which has the greatest potential to supply water in winter (but dries over summer and autumn). Loss of the bauxite friable fragmental layer has not been observed to result in impaired growth of health of rehabilitation, where monitoring has demonstrated that successful establishment and persistence of an LAI of 2-2.5 comparable to that of un-mined Jarrah Forest, and indicated a 80-100% of floristic diversity of un-mined forest, declining weed cover and sustained understorey coverage.

Current land uses and activities associated with Serpentine PDWSA are land and forest management, including timber harvesting; commercial land uses such as mining and pine plantations; linear infrastructure including pipelines, roads, tracks and telephone lines, and recreation.

1.4.2 Key assumptions and uncertainties

The key assumptions and uncertainties are considered to include:

- the extent to which climatic factors outside of Alcoa's control will affect surface water and groundwater regimes;
- Limited understanding of hydrogeological connectivity and possible impacts to riparian vegetation; and
- Limited understanding of the response of riparian vegetation to cumulative stressors.

1.4.3 Objective-based EMP – risk-based approach.

The WRMP has been developed using a risk-based approach that outlines management provisions to minimise risks. A preliminary risk assessment of the Serpentine Dam has been undertaken and is included in Appendix A – Risk Assessment. The assessment considered current knowledge from monitoring and assessments, conceptual models, controls and mitigations and mine plans (designs and engineering).

Further, the assessment also acknowledges climate change considerations such as potential decline of groundwater levels, declining periods of streamflow, change in fire intensity and frequency due to rising temperatures and more frequent storm events.

The assessment factors likelihood and consequence, and risk outcome are those used by Water Corporation (2018) and have been adopted for this specific management and monitoring draft provision.

1.4.4 Rationale for choice of provisions

The mitigation hierarchy of avoidance, minimise and rehabilitate has been adopted to manage potential impacts. Management based provisions have been selected to reflect the potential changes in mine plans and potential impacts. However, a robust monitoring programme with associated early response and trigger criteria have been developed to allow early detection of any impacts, particularly to PDWSAs. Given clearing occurs on an ongoing basis, the potential for environmental changes, particularly from external factors (other activities, climate change, the Forest Management Plan, etc), requires an adaptive WRMP.

Focus on Avoidance

Direct impacts to groundwater and surface water values will be avoided where possible. The internal vegetation clearing procedures will be utilised to control clearing within the operational areas and to avoid:

- The Serpentine Pipehead Catchment;
- Mine Facilities and Sewage Treatment facilities will not be located within RPZs;
- Mining within stream zones, with an additional 100m buffer around mapped Havel stream vegetation zone; and
- 200 m of top of water level for Public Drinking Water Reservoirs (Operational Control Area 1 (OCA)).

Minimising Potential Impacts

While the objective to avoid direct impacts to groundwater and surface water values is readily achievable, the potential for factors that may lead to potential adverse indirect impacts also needs to be addressed. For this reason, potential indirect impacts such as groundwater level fluctuations and associated salinity risk need to be minimised.

Indirect impacts will be minimised by using best practice risk management actions and a proactive monitoring programme with associated criteria.

Remediation/Rehabilitation actions where impacts cannot be avoided

Where direct impacts cannot be avoided, every effort will be undertaken to remediate these areas through rehabilitation activities.

Integration of Research into Completion and Closure

The findings of ongoing research programmes are integrated into water management actions and monitoring to ensure best practice. Ongoing consultation with key stakeholders, in particular the MMPLG ensures consistency with regulatory expectations.

Working Arrangements

An agreement exists between Alcoa, DWER and WC, known as the Water Working Arrangements (Version 5, 2019). This document provides a framework under which Alcoa manages its mining operations within the PDWSAs and includes management of mining adjacent to reservoirs, with key management actions detailed below:

- Operational Control Area 1 (OCA1): A 200 m buffer that extends perpendicular from the reservoir TWL. Access to OCA1 is generally prohibited except for the purposes of constructing, maintaining or travelling along roads or infrastructure, which are approved within the MMP, five-year mine plan or FCAs – or for the purpose of safety inspections prior to blasting activities.
- Operational Control Area 2 (OCA2): A 300 m extension perpendicular from OCA1 (total of 500 m from the TWL). OCA2 further extends 500 m upstream along reservoir tributaries (to an extent of 1,000 m) from the reservoir. Proposed mining and clearing activities within OCA2 are subject to submission of an environmental management plan (or equivalent document) to ensure Alcoa's activities have no impact on the water resource. Alcoa have previously used Drainage Control Management Plans (DCMPs) to undertake this risk assessment and outline controls to mitigate each identified risk. Alcoa proposes that future areas will be designed using the WA Mining and Haul Road Drainage Design Manual, as outlined in the process below.
- 1 km upstream of reservoir top water level (<1km TWL): clearing is restricted within 50 m of stream zone vegetation.
- Stream buffers: clearing is restricted within 20 – 30 m of stream zone vegetation, dependent upon stream order.
- OCA2: a risk assessment shall be applied as part of Clearing Advice and submission of an environmental management plan (or equivalent document).
- Approval for chemical use is required, as per "Alcoa Submission form for the Approval of Chemical Use in a Drinking Water Catchment".
- Alcoa to review compliance turbidity point data after every 20 mm or greater rain event or at a minimum monthly.
- Alcoa to engage Mining Operations Group (MOG) representative and seek approval locating new compliance monitoring points.
- Alcoa to provide letter indicating the quantity of pesticides (including herbicides) used at Alcoa mining operations annually.

Alcoa has historically applied variable width buffers to stream zone vegetation, based on the order of the watercourse and proximity to reservoirs as outlined above. The mine plan does not include any mining in the stream zone buffers but does provide allowance for infrastructure corridors i.e., haul roads, of which disturbance to stream zones is minimised.

Alcoa is required to prevent uncontrolled surface water runoff from its operations to the surrounding forest and/or surface water. All surface water captured within the mining operations must be retained on site to allow sufficient sediment settling prior to release from the mine. Adequate drainage design and construction is crucial to ensuring these conditions are met.

Water Quality Protection Notes

DWER's published Drinking Water Source Protection Plans, Water Quality Protection Notes (WQPN) and catchment protection policies establish a framework for managing water quality issues. They are based on current industry standards and incorporate best practice management.

The following WQPN's have been incorporated into the WRMP's management actions:

- Chemical blending (7);
- Groundwater monitoring bores (30);
- Land use compatibility in Public Drinking Water Source Areas (25);
- Liners for containing pollutants using synthetic membranes (26);
- Liners for containing pollutants, using engineered soils (27);
- Mechanical equipment washdown (68);
- Mechanical servicing and workshop facilities (28);
- Roads near sensitive water resources (44);
- Tanks for fuel and chemical storage near sensitive water resources (56);
- Toxic and hazardous substances- storage and use (65); and
- Vegetation buffers to sensitive water resources (6) (Section 4.2.2).

Australian Drinking Water Guidelines

Developed by the National Health and Medical Research Council, the Australian Drinking Water Guidelines (ADWG) have been developed after consideration of the best available scientific evidence and provide a framework for good management of drinking water supplies to ensure safety at point of use. They address both the health and aesthetic quality aspects of supplying good quality drinking water.

The Water Corporation has entered into a legally binding Memorandum of Understanding with the Department of Health to implement the “framework for the management of Drinking Water” and ensure that catchment management and source protection are key elements of the multi barrier approach to achieve safe drinking water.

This WRMP has been developed utilising the ADWG framework and guidelines, where available.

2 WRMP Components

This section of the WRMP identifies the provisions that Alcoa will implement to ensure the defined environmental objectives are met during the implementation. Monitoring has been designed to inform and respond if the corresponding environmental objectives are being achieved.

Objectives and management targets are summarised in Table 2-1. The associated management actions are detailed in Table 3-2, with further information on the monitoring programme provided in Table 2-3.

This WRMP will be updated to align with the adaptive management approach (refer to Section 3).

Alcoa is supportive of an 'act first, investigate second' response to identified events within the surrounding environment. On this basis, Alcoa will work with relevant MMPLG members to identify the criteria and process to support the management of events that may occur outside of its mine plan and may not be linked to its operations, while concurrently conducting investigations as to the root cause of such events.

This WRMP should be considered a draft as further work and MMPLG consultation is required to determine the acceptability, extent and scale of actions to be undertaken. However, Alcoa will commence implementation of the WRMP to provide assurances that mine activities are adequately managed to minimise groundwater and surface water impacts.

Table 2-1: Management Objectives and Targets

Specific water values	Activities	Impacts	Environmental objectives	#	Management Targets
Public Drinking Water Areas • Streams • Reservoirs	• Native Vegetation Clearing • Pit development • Loss of Containment events (drainage, turbidity, hazardous materials) • Haul roads and causeways • Vehicle movements • Mine facilities (Workshops, etc) • Wastewater and sewage management • Surface water abstraction • Groundwater interactions with surface water • Rehabilitation management	• Contamination (turbidity, pathogens, hydrocarbons, PFAS, metals, salinity, fertilisers (nutrients), herbicides) to water values	No impacts to public health from mining activities	1	No significant impact to public drinking water areas quality or supply from mining activities
				2	No significant impact to public drinking water areas quality from pathogens from mining activities
				3	No significant impact to public drinking water areas quality from hazardous materials and waste from mining activities
				4	No significant impact to public drinking water areas quality from herbicides and fertiliser as a result of mining activities

Surface water
• Tributaries leading into reservoirs and ecosystem:
  • Aquatic fauna
  • Aquatic vegetation; and
  • Associated riparian vegetation
• Potential refugial zones for terrestrial and aquatic fauna
		• Contamination (turbidity, pathogens, hydrocarbons, PFAS, metals, salinity, fertilisers (nutrients), herbicides) to water values
		• Changes to hydrological regime
			Minimise changes to hydrological regimes from mining activities	5	No significant impact to surface water values as a result of increase in turbidity from mining activities

				6	No significant impact to surface water values as a result of increase in turbidity from erosion of post-mining landforms
				7	No significant impact to surface water values as a result of increase salinity from mining-induced saline groundwater discharge
				8	No significant impact to surface water values as a result of hydrological regime changes from mining activities
Groundwater • Groundwater Dependent Vegetation (GDV)		• Contamination (turbidity, pathogens, hydrocarbons, PFAS, metals, salinity, fertilisers (nutrients), herbicides) to water values • Groundwater fluctuation (levels, salinity) from native vegetation clearing • Groundwater interception (turbidity) from pit development • Groundwater quality changes (metals) from Acid Sulphate Soils	Minimise changes to hydrogeological regimes from mining activities	9	No significant impact to groundwater values as a result of hydrogeological regime changes from mining activities

Table 2-2: Management Plan Provisions

	EPA factor/s and objective/s: *To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected* **Objective/s:** No impacts to public health **from mining activities** **Key environmental values:** Public Drinking Water Area streams and reservoirs **Key impacts and risks: Contamination (turbidity, pathogens, hydrocarbons, PFAS, metals, salinity, fertilisers, herbicides)**				
	Objective-based				
#	**Management targets**	**Management actions**	**Monitoring**	**Timing / frequency of actions**	**Reporting**

1	No significant impact to public drinking water areas quality or supply from mining activities	**Avoidance**
		• No mining activities within the Pipehead Dam catchment
		• No mining operational activities (excludes infrastructure) within applied buffer zones for:
		  ○ 200 m buffer zone from reservoir top water level (OCA1)
		  ○ 100 m buffer zone for mapped Stream Vegetation
		• No mine facilities, wastewater and sewage treatment plants inside the RPZ
		
		Minimisation
		• Minimise stream crossings and impacts through crossing location selection and design.
		• Minimise clearing with proximity to the reservoir
		• Western Australian Mining & Haul Road Design Manual (Design Manual) (Alcoa, 2022) includes minimum design requirements for drainage management.
		• Drainage Control Management Plans (DCMPs) developed for pits within OCA2
		• Vehicle access to RPZ requires an authorised permit.
		
		Monitoring & Review
		• Catchment Scale Risk Assessment tool will assist in the planning and review of surface water controls (ie pit size)
		• Drinking Water Risk Assessment to be completed if mining activities within the PDWA
		• Reconciliation against clearing boundaries ensuring buffers to OCA1 and Stream zone mapped vegetation are maintained.
		• Water Working Arrangements (between Alcoa, DWER and Water Corporation) include turbidity incident event reporting of turbidity exceeding 25NTU of 1 hour at compliance point.
		• Internal procedures which can adequately pick up false/positive turbidity events.
		• Incident reporting and investigation procedure.
			Monitoring and response programme as per Table 2-3 includes surface and groundwater monitoring upstream of reservoirs and at impact and reference sites	As required	Annual environmental report.
					
					If management target is exceeded, reporting as per internal Incident Reporting and Investigation Procedure

2	No significant impact to public drinking water areas quality from pathogens from mining activities	**Avoidance**
		• No mining activities within the Pipehead Dam catchment
		• No mining operational activities (excludes infrastructure) within applied buffer zones for:
		  ○ 200 m buffer zone from reservoir top water level (OCA1) provides potential for pathogen dilution, die-off from solar exposure and predation.
		  ○ 100 m buffer zone for mapped Stream Vegetation to encourage filtration
		• No sewage treatment plants inside the RPZ or within stream zones
		• No swimming or un-authorised immersion in drinking water reservoirs
		
		Minimisation
		• No composting toilets, portable toilets or portaloos.
		• Demountable ablution blocks are positioned close to active mine pits, which drain to a tank which is pumped out
		• Where practicable, personnel should use designated ablution block facilities, if this is not possible then biological waste must be bagged and disposed of at a designated disposal location outside of the RPZ
		Sewage Treatment Plants:
		• Ongoing maintenance and monitoring of Sewage Treatment Plants
		• DWER Licences for sewage treatment plants stipulates design and operational controls
		• Buffer zone of >50m around land irrigation area
		• Surface irrigation only, no sub-surface discharge
		• Drip irrigation used
		• Secondary treatment including chlorination and UV disinfection
		• Sewage infrastructure is not located in steep slopes or within proximity to stream zones
		Personnel management:
		• Reservoir Protection Zone Management Plan (AUACDS-2053-5554)
		• A Permit to Work in Close Proximity to Water Catchment Areas will be sought where work activities are carried out near a reservoir
			Monitoring and response programme as per Table 2-3 includes surface and groundwater monitoring upstream of reservoirs and at impact and reference sites	As required	Annual environmental report.
					If management target is exceeded, reporting as per internal Incident Reporting and Investigation Procedure

	EPA factor/s and objective/s: *To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected* **Objective/s:** No impacts to public health **from mining activities** **Key environmental values:** Public Drinking Water Area streams and reservoirs **Key impacts and risks: Contamination (turbidity, pathogens, hydrocarbons, PFAS, metals, salinity, fertilisers, herbicides)**				
	Objective-based				
#	**Management targets**	**Management actions**	**Monitoring**	**Timing / frequency of actions**	**Reporting**
		• Fit for work policy includes restriction to RPZ for personnel with gastrointestinal symptoms • Minimise worker access in stream zones • Worker training and awareness around hygiene practises within the RPZ **Monitoring & Review** • DWER Licences for sewage treatment plants include monitoring programme (Waste Water Monitoring Program AUACDS-2053-3267 and AUACDS-2056-62) • Drinking Water Risk Assessment to be revised to reflect potential impacts of pathogens. • Mine facilities are located outside of the RPZ, decreasing pathogen travel times • Incident reporting and investigation procedure			

3	No significant impact to public drinking water areas quality from hazardous materials and waste from mining activities	**Avoidance**
		• No mining activities within the Pipehead Dam catchment
		• No mining operational activities (excludes infrastructure) within applied buffer zones for:
		  ○ 200 m buffer zone from reservoir top water level (OCA1)
		  ○ 100 m buffer zone for mapped Stream Vegetation
		• No mine facilities and wastewater treatment plants inside the RPZ
		
		Hydrocarbon and chemical management
		• Bulk fuel tankers will not cross main river channels (for example, Serpentine River main channel, Big Brook Crossing and Samson Dam Causeway)
		• Planned maintenance of vehicles and equipment will occur within workshops, as far as practicable.
		• Vehicle re-fuelling will occur in designated fuel bays, as far as practicable
		• Storage of all hydrocarbon and chemicals will be undertaken within appropriately sized secondary containment in accordance with Dangerous Goods Safety (Storage and Handling of Non-explosives) Regulations 1997 as applicable to specific materials. Storage will take into consideration the requirements of WQPN 56 Tanks for fuel and chemical storage near sensitive water resources (DWER 2018).
		• Hazardous materials and wastes will be stored at designated construction compounds or other storage facilities in accordance with Dangerous Goods Safety (Storage and Handling of Non-explosives) Regulations 1997 as applicable to the specific materials. Storage will take into consideration the requirements of WQPN 56 Tanks for fuel and chemical storage near sensitive water resources (DWER 2018) and WQPN 65 Toxic and hazardous substances (DoW 2015).
		• No usage of petrol that contains higher BTEX/soluble fractions than diesel, with the exception of LPG in high risk areas
		• Stormwater runoff that may contain traces of hydrocarbons must be treated via a wastewater treatment system
		• Stormwater runoff from pits, hauls roads and other areas that are considered to have a low risk of hydrocarbon contamination may be discharged in a controlled manner that prevents sediment discharge
		• Wastewater treatment plants have associated maintenance and monitoring
		
		PFAS
		• Only PFAS-free firefighting foams will be used
		• All water supplies will be sourced from public water supply reservoirs or borefields that are tested and do not exceed PFAS limits as per Appendix B – Water Guidelines
		• All waste will be disposed off-site
		• PFAS affected water to be treated at the Myara PFAS Treatment Plant or offsite disposal at an appropriately licenced facility
		• PFAS affected water will be stored in dedicated storage facilities
		
		Waste
		• No waste is to be left within the RPZs
		• All waste (except for treated sewage effluent) will be temporarily stored in designated containers and then transported off-site
		
		Monitoring & Review
		• Drinking Water Risk Assessment to be revised to reflect potential impacts
		• Area inspections according to on-ground operational schedule
			Monitoring and response programme as per Table 2-3 includes surface and groundwater monitoring upstream of reservoirs and at impact and reference sites	As required	Annual environmental report.
					
					If management target is exceeded, reporting as per internal Incident Reporting and Investigation Procedure and Table 2-6

	EPA factor/s and objective/s: *To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected* **Objective/s:** No impacts to public health **from mining activities** **Key environmental values:** Public Drinking Water Area streams and reservoirs **Key impacts and risks: Contamination (turbidity, pathogens, hydrocarbons, PFAS, metals, salinity, fertilisers, herbicides)**				
	Objective-based				
#	**Management targets**	**Management actions**	**Monitoring**	**Timing / frequency of actions**	**Reporting**
		• Maintain annual audit inspections • Drinking Water Risk Assessment to be revised to reflect potential impacts of hydrocarbon spills and PFAS • Incident report and investigation procedure • Emergency response plan includes the requirements of WQPN 10 Containment spills – emergency response plan (DWER 2020) and spill response equipment will be made available where appropriate • Worker training in emergency spill response			
4	No significant impact to public drinking water areas quality from herbicides and fertiliser as a result of mining activities	**Avoidance** • No mining activities within the Pipehead Dam catchment • No mining operational activities (excludes infrastructure) within applied buffer zones for: o 200 m buffer zone from reservoir top water level (OCA1) o 100 m buffer zone for mapped Stream Vegetation **Fertiliser & Herbicide** • Buffer zone of 50 m is maintained to mapped Stream zone Vegetation during application of fertiliser application during rehabilitation activities • Applied fertiliser application per pit according to calculations for required amount • GIS coordinated adhered to for buffer zone maintenance via flight logs • Herbicide application locations recorded and submitted to Water Corporation • Only approved chemicals utilised within the PDWA **Monitoring & Review** • Drinking Water Risk Assessment to be revised to reflect potential impacts • Monitoring and response programme as per Table 2-3 includes surface and groundwater monitoring upstream of reservoirs and at impact and reference sites	Monitoring and response programme as per Table 2-3 includes surface and groundwater monitoring upstream of reservoirs and at impact and reference sites	As required	Annual environmental report. If management target is exceeded, reporting as per internal Incident Reporting and Investigation Procedure and Table 2-6.
	EPA factor/s and objective/s: *To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected* **Objective/s:** Minimise surface water quality and hydrology impacts from mining activities **Key environmental values: Public Drinking Water Areas, Streams and stream ecosystems (Aquatic fauna, Aquatic vegetation, Stream zone vegetation and associated fauna and Water resources for terrestrial fauna)** **Key impacts and risks: Contamination (turbidity, pathogens, hydrocarbons, PFAS, metals, salinity) and changes to surface water quantity**				
	Objective-based				
	Management targets	**Management actions**	**Monitoring**	**Timing / frequency of actions**	**Reporting**
5	No significant impact to surface water values as a result of increase in turbidity from mining activities	**Avoidance** • No mining activities within the Pipehead Dam catchment • No mining operational activities (excludes infrastructure) within applied buffer zones for: o 200 m buffer zone from reservoir top water level (OCA1) o 100 m buffer zone for mapped Stream Vegetation • No mine pits within streams **Minimise** • Minimise mining in areas of high slope and areas with high cleared areas with a high percentage of unrehabilitated (or) open areas • Staged clearing and development minimises open areas • Mine surface water control designs (detailed in Design Manual) informed by hydrological studies (flow, infiltration diversion for mine planning storage purposes): o Engineered and maintained mine drainage bunds and trenches intercept and convey runoff and sediment to in-pit sumps, preventing uncontrolled discharge o Drainage shots, also called water shots, comprise shallow (~1.8 m) blasted or ripped ground on the downslope perimeter of mine pit, if required by risk rating. Drainage shots capture and infiltrate surface runoff within the blasted voids.	Monitoring and response programme as per Table 2-3 includes surface and groundwater monitoring upstream of reservoirs and at impact and reference sites	As required	Annual environmental report. If management target is exceeded, reporting as per internal Incident Reporting and Investigation Procedure and Table 2-6.

	EPA factor/s and objective/s: *To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected* **Objective/s:** No impacts to public health **from mining activities** **Key environmental values:** Public Drinking Water Area streams and reservoirs **Key impacts and risks: Contamination (turbidity, pathogens, hydrocarbons, PFAS, metals, salinity, fertilisers, herbicides)**				
	Objective-based				
#	**Management targets**	**Management actions**	**Monitoring**	**Timing / frequency of actions**	**Reporting**
		○ Some mine pits have in-pit sumps and trenches that collect runoff from pit floors and/or in-pit drainage. In-pit sumps are designed to retain runoff from major storm events. • Ensure Design Manual implementation, including the following key controls: ○ Woody windrows (vegetation stockpiles) are aligned on the contour to interrupt downslope drainage ○ Adequate holding volume is available in each pit for a specified rainfall event ○ Drainage Protection Slots are installed to locally improve infiltration and recharge to groundwater ○ Infiltration sumps along haul roads approximately every 300-350m to infiltration water and retain silt. A designed overflow spillway is included. ○ Sedimentation sumps to retain water and allow sediment to settle. Short term sumps are designed to retain water for a minimum of five minutes during rainstorm intensities up to a 20 year storm event. Long term sumps (for haul roads or dieback free areas) are design for a 100 year storm event. ○ Sump capacity, performance assessments and maintenance • Development and implementation of Drainage Control Management Plans (DCMPs) as per Develop Water Resource Sensitive Zone Plan (AUACDS-2053-4109) for all increased risk (as per WC Working Arrangement) mining operations located within OCA1 and OCA2. DCMPs include: ○ Pits Risk Ranking contents ○ Drainage Control trigger assessments ○ Pit specific drainage control designs ○ Planned development mining and rehabilitation schedule ○ Drainage protection shot design ○ Groundwater levels in close proximity to the pit ○ Other drainage control measures • Clearing to preferentially occur outside of winter months • Area inspection of sumps and pumps pre-rainfall according to internal procedure. • All paved areas at mine facilities and all haul roads drain to interception sumps. Paved areas upstream of major rivers (e.g. Big Brook) drain to triple interceptor sumps. All sumps are designed to retain rainfall from major storm events. • Where practicable, all vehicles should use existing tracks and roads through the forest. • In the event of drainage failure, sediment laden runoff may discharge into streams. Sediment in stream flow is subject to deposition, filtration and dilution prior to discharge into the reservoir. • Groundwater Interception Assessment identifies when a designed pit is likely to intercept groundwater based on an interpreted maximum groundwater level. Pits that are identified as likely to intercept groundwater must be designed to ensure adequate surface water containment volume to a specified rain event and must have a rehabilitation plan established prior to clearing. **Streams** • Minimise stream crossings, where possible • Permit system is in placed to minimise risk associated with installation of stream crossings • Clearing or construction activities within stream zones will occur during summer or autumn months, as far as practicable • Stream crossing appropriately designed to minimise impacts and potential for erosion with appropriate surface water controls **Causeways:** • Sumps include T-joints to restrict hydrocarbon movement • Emergency overflow is rock pitched to decrease water velocity • Sumps designed for a 1 in 200 year rainfall event • Sumps design to minimise turbidity release • Winter cleaning of bitumen • 100m buffer between causeway and reservoir top water level unless WC agreed risk assessment in place • Decreased speed limits **Monitoring & Review** • Two years of surface water monitoring baseline data is gathered, where possible, to identify potential mining activity impacts. If insufficient baseline data is available, reference data may be used.			

	EPA factor/s and objective/s: *To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected* **Objective/s:** No impacts to public health **from mining activities** **Key environmental values:** Public Drinking Water Area streams and reservoirs **Key impacts and risks: Contamination (turbidity, pathogens, hydrocarbons, PFAS, metals, salinity, fertilisers, herbicides)**				
	Objective-based				
#	**Management targets**	**Management actions**	**Monitoring**	**Timing / frequency of actions**	**Reporting**
		• Ground Water Risk Assessment Framework provided by Water Corporation provides direction on groundwater bore installation in high priority areas • Drinking Water Risk Assessment (GHD 2021) included a review of turbidity results and found that available reservoir data did not indicate an increase in reservoir turbidity in associated with cumulative mining disturbance or mining drainage failures. Therefore, avoidance of mining in OCA1 increases the potential for dilution. • Drinking Water Risk Assessment (GHD 2021) and associated hydrological modelling to be revised to reflect potential turbidity impacts in RPZs from current mine plan			
6	No significant impact to surface water values as a result of increase in turbidity from erosion of post-mining landforms	**Avoidance** • No mining activities within the Pipehead Dam catchment • No mining operational activities (excludes infrastructure) within applied buffer zones for: o 200 m buffer zone from reservoir top water level (OCA1) o 100 m buffer zone for mapped Stream Vegetation **Minimise** • Integrate progressive rehabilitation into mine planning and operational activities. • Undertake rehabilitation activities in a timely and committed way to enable maximisation of progress on rehabilitation areas. • Schedule of rehabilitation to consider potential priority areas informed by current monitoring trends, including water quality monitoring (salinity), groundwater levels and/or scale where relevant. • Rehabilitation design minimises potential for erosion and sediment movement includes: o Deep ripping of compacted floors (regolith) to at least 1.2 m which improves infiltration o Landscaping batters, spreading minimum 200 mm overburden and topsoil where available o Contour ripping to increase retention and infiltration o Water containing design based upon 1% AEP 24-hour design event considering antecedent conditions o Seeding and tubestock to re-instate native vegetation • Rehabilitation prescription limits final landform to slopes less than 16 degrees. Downslope toe of rehabilitated pits can have a reverse batter that creates a 'sunken' landform that retains surface runoff and prevents discharge. • A rehabilitation design manual is under development and includes the incorporation of water storage controls • Maximize the use of all materials used in clearing and rehabilitation practices to minimise waste and utilise resources as available (including overburden/topsoil, native seeds, clearing debris, timber logs and waste) **Monitoring & review** • Visual inspections for stability will be undertaken • Maintain monitoring and assessment to enable rapid responses to invasive weeds and erosion within local areas within the rehabilitation areas. • Maintain regular monitoring program at 9 months, 15 months, and ongoing permanent plots to substantiate progress and respond to any issues that arise that will inform adaptive management choices to continually improve outcomes. • Undertake adaptive management based on research to encourage the return of native species and a self-sustaining forest ecosystem.	Indicator: Rehabilitation completed (clearing register) Method: Annual clearing/rehabilitation review Monitoring and response programme as per Table 2-3 includes surface and groundwater monitoring upstream of reservoirs and at impact and reference sites	Rehabilitation monitoring at 9 months and 15 months following rehabilitation completion and ongoing assessment of permanent plots in both rehabilitation and control areas. Annual review of Clearing Register	Annual environmental report. Comprehensive three yearly reporting. If management target is exceeded, reporting as per internal Incident Reporting and Investigation Procedure and Table 2-6.
7	No significant impact to surface water values as a result of increase salinity from mining-induced saline groundwater discharge	**Avoidance** • No mining activities within the Pipehead Dam catchment • No mining operational activities (excludes infrastructure) within applied buffer zones for: o 200 m buffer zone from reservoir top water level (OCA1) o 100 m buffer zone for mapped Stream Vegetation **Minimise** • Minimise groundwater fluctuations to prevent salinity increase by targeting priority rehabilitation • Groundwater Level Assessment is utilised with incorporation of a 3 m buffer between pit shell in DCMPs, where required • Mine Design informed by hydrological assessments where mine usually avoids pockets of high salinity areas. • Monitoring of trends via a regional bore network and surface water stream (when flowing) monitoring. • Minimise disturbance where possible and use existing cleared areas where practical • Optimise rehabilitation and minimise open areas as per Management Target 6 • Development of a groundwater predictive tool	Monitoring and response programme as per Table 2-3 includes surface and groundwater monitoring upstream of reservoirs and at impact and reference sites	As required	Annual environmental report. If management target is exceeded, reporting as per internal Incident Reporting and Investigation Procedure and Table 2-6

	EPA factor/s and objective/s: *To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected* **Objective/s:** No impacts to public health **from mining activities** **Key environmental values:** Public Drinking Water Area streams and reservoirs **Key impacts and risks: Contamination (turbidity, pathogens, hydrocarbons, PFAS, metals, salinity, fertilisers, herbicides)**				
	Objective-based				
#	**Management targets**	**Management actions**	**Monitoring**	**Timing / frequency of actions**	**Reporting**
		• Two years of surface and groundwater monitoring baseline data is gathered, where possible, to identify potential mining activity impacts. If insufficient baseline data is available, reference data may be used			
8	No significant impact to surface water values as a result of change in hydrological regime from mining activities	**Avoidance** • No mining operational activities (excludes infrastructure) within applied buffer zones for: ○ 100 m buffer zone for mapped Stream Vegetation **Minimise** • Minimise groundwater fluctuations as per Management Target 7 • Minimise surface hydrology changes through surface water abstraction management as per RIWI Act licences and associated operating strategies • Minimise turbidity increases as per Management Target 5 • Two years of surface and groundwater monitoring baseline data is gathered, where possible, to identify potential mining activity impacts. If insufficient baseline data is available, reference data may be used **Acid Sulphate Soils (ASS):** • ASS desktop assessment to be undertaken prior to clearing or dewatering in potential ASS areas (swamp and stream zones) with field investigations undertaken if required (in accordance with Identification and investigation of acid sulfate soils and acidic landscapes (DER 2015a). • Where ASS is confirmed as present within the excavation or groundwater drawdown area, construction will be reviewed to avoid disturbance as far as practicable. Where ASS disturbance is not avoidable, an ASS management plan (ASSMP) will be prepared in accordance with Treatment and management of soil and water in acid sulfate soil landscapes (DER 2015b).	Monitoring and response programme as per Table 2-3 includes surface and groundwater monitoring upstream of reservoirs and at impact and reference sites	As required	Annual environmental report. If management target is exceeded, reporting as per internal Incident Reporting and Investigation Procedure and Table 2-6
	EPA factor/s and objective/s: *To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected* **Objective/s:** Minimise groundwater fluctuations from mining activities **Key environmental values:** Groundwater Dependent Ecosystems (GDE) and interactions with surface water **Key impacts and risks:** Groundwater fluctuation (levels, salinity) from native vegetation clearing				
	Objective-based				
	Management actions	**Management actions**	**Management actions**	**Management actions**	**Management actions**
9	No significant impact to groundwater values as a result of change in hydrogeological regime from mining activities	**Avoidance** • No mining operational activities (excludes infrastructure) within applied buffer zones for: ○ 100 m buffer zone for mapped Stream Vegetation **Minimise** • Groundwater Level Assessment is utilised with incorporation of a 3 m buffer between pit shell in DCMPs • Mine Design informed by hydrological assessments where mine usually avoids pockets of high salinity areas. • Monitoring of trends via a regional bore network. • Minimise disturbance where possible and use existing cleared areas where practical • Optimise rehabilitation and minimise open areas as per Management Target 6 • Clearing induced groundwater rise predictive tool implementation and continuous improvement • Regolith depth mapping to support groundwater level assessment and rehabilitation planning • Two years of groundwater monitoring baseline data is gathered, where possible, to identify potential mining activity impacts. If insufficient baseline data is available, reference data may be used	Monitoring and response programme as per Table 2-3 includes surface and groundwater monitoring upstream of reservoirs and at impact and reference sites	As required	Annual environmental report. If management target is exceeded, reporting as per internal Incident Reporting and Investigation Procedure and Table 2-6

2.1 Monitoring program

An interim monitoring programme (Table 2-3) has been developed to:

- Address any uncertainty regarding potential impacts;
- Provide a monitoring programme, despite limited baseline and regional knowledge;
- Monitor any potential impacts associated with management targets;
- Address any higher risk management targets;
- Ensure environmental objectives are met; and
- Provide adaptive management, as a baseline and reference dataset is further developed.

The monitoring programme consists of a monitoring schedule, with details of indicative locations and monitoring methodology. Where possible, quantifiable early response levels, triggers and thresholds have been developed and appropriate response actions included. The Response actions should be considered a minimum standard.

The monitoring programme should be considered a draft as further work (detailed in Section 3) and MMPLG consultation, particularly with Water Corporation, is required to determine the appropriateness of the monitoring programme. In particular, refinement of early response levels, triggers and thresholds are expected. However, Alcoa will commence staged implementation of the WRMP to provide assurances that mine activities are adequately managed to minimise groundwater and surface water impacts.

Refer to Table 2-2 for further details on Management Actions and Section 0 for reporting requirements.

Table 2-3: Interim Monitoring Program

Receptor	#	Management target	Monitoring				Monitoring and management actions		
			Aspect	Monitoring parameters	Method	Timing / frequency	Investigate (Early response criteria)	Action (trigger criteria)	Mitigate – corrective actions (threshold criteria)
Management Objective:			No impacts to public health						
Public Drinking Water Streams & Reservoir	1	No impacts to public drinking water area quality or supply from mining activities	Surface water	Turbidity	Continuous logging at: • Compliance impact sites upstream of reservoir • Local reference sites distributed catchment wide A Receptor (reservoir) floating buoy array is proposed as a collaborative collective action "layered monitoring system" endeavour, however further consultation is required with Water Corporation.	Continuous (when water flowing)	**Early Response criterion:** Early response criterion to be developed in consultation with Water Corporation and DWER. In the interim, a qualitative early response criterion of any mine pit or haul road overflow incidents is proposed: • Drainage event associated with drainage from haul road or pit (not extending to surface water); or • Impact site records ≥25 NTU over 30 minutes (when flowing) **Response Actions may include:** • Review monitoring data to determine turbidity results • Review mining activities within sub-catchment to identify contributing factors. Undertake improvement actions, if required. • Review against baseline or reference dataset to identify other contributing factors (climatic conditions) • Mobilise equipment as required. Undertake additional on-ground investigations to determine extent / quality and/or additional or increased frequency of appropriate indicators • Develop a remedial action plan (if warranted) • Continue to monitor action mitigation procedures	**Trigger criterion:** Impact site records ≥25 NTU over one hour (when flowing) **Response Actions may include:** • Communicate trigger exceedance to Water Corporation within 24 hours of known event exceedance and initiate discussion on any mitigating actions • Review mining activities within sub-catchment to identify contributing factors. Undertake improvement actions, if required. • Undertake incident investigation to determine source of exceedance and if associated with mining activities. • Develop a remedial action plan (if required) Continue to monitor management action implementation and compliance • Review monitoring programme (locations and frequency) to ensure appropriate to determine scale of impact, if required	**Threshold criterion:** Turbidity ≥1 NTU over one hour at Receptor site with corresponding turbidity ≥25 NTU 1-hr at associated impact site/s or downstream Loss of Containment event **Response Actions may include:** • Communicate to Water Corporation within 24 hours of known event exceedance • Implement mitigation action/s as previously agreed with Water Corporation (including additional water treatment requirements) • Increase monitoring programme (locations and frequency) to determine scale of impact, particularly in reservoir • Undertake incident investigation to determine source of exceedance and if associated with mining activities. • Develop a remedial action plan • Continue to monitor management action implementation and compliance • Revise WRMP and associated procedures to prevent reoccurrence

Receptor	#	Management target	Monitoring				Monitoring and management actions		
			Aspect	Monitoring parameters	Method	Timing / frequency	Investigate (Early response criteria)	Action (trigger criteria)	Mitigate – corrective actions (threshold criteria)
	1	No significant impact to public drinking water areas quality or supply from mining activities	Surface water	ADWG parameters as per Table 2-5	Grab samples at: • PDWA Potential Impact sites upstream of Reservoir • Reference sites • Receptor site (Reservoir prior to treatment) • Baseline sites (prior to mining operations) Laboratory Analysis - ADWG analysis as per Table 2-5. A Receptor (reservoir) floating buoy array is proposed as a collaborative collective action "layered monitoring system" endeavour, however further consultation is required with Water Corporation.	Sampling during continuous flow will be conducted as least twice a year. Episodic flow will be sampled if possible.	**Early Response Trigger:** PDWA Potential Impact site records within the 80th percentile of the health-based ADWG (2011) guideline levels (Appendix B – Water Guidelines) **Response Actions may include:** • Undertake additional impact sampling and continue to monitor until parameter stabilisation • Review mining activities within sub-catchment to identify contributing factors. Undertake improvement actions, if required. • Review against baseline or reference dataset to identify other contributing factors (climatic conditions)	**Trigger:** PDWA Impact site records an exceedance of health-based ADWG (2011) guideline levels (Appendix B – Water Guidelines) **Response Actions may include:** • Communicate any trigger exceedances to Water Corporation and initiate discussion on any mitigating actions • Review monitoring programme (locations and frequency) to ensure appropriate to determine scale of impact, particularly in reservoir • Review mining activities within sub-catchment to identify contributing factors. Undertake improvement actions, if required. • Undertake incident investigation to determine source of exceedance and if associated with mining activities. • Develop a remedial action plan (if required) • Continue to monitor management action implementation and compliance	**Threshold:** Exceedance of health-based ADWG (2011) guideline levels (Appendix B – Water Guidelines) at Receptor site **Response Actions may include:** • Communicate to Water Corporation and initiate discussion on mitigating actions (including additional water treatment requirements) • Increase monitoring programme (locations and frequency) to determine scale of impact, particularly in reservoir • Undertake incident investigation to determine source of exceedance and if associated with mining activities. • Develop a remedial action plan • Continue to monitor management action implementation and compliance • Revise WRMP and associated procedures to prevent reoccurrence

Receptor	#	Management target	Monitoring				Monitoring and management actions		
			Aspect	Monitoring parameters	Method	Timing / frequency	Investigate (Early response criteria)	Action (trigger criteria)	Mitigate – corrective actions (threshold criteria)
	2	No significant impact to public drinking water areas quality from pathogens from mining activities	Surface water	*E. coli*	Grab sample at: • PDWA Impact sites upstream of Reservoir • Reference sites • Receptor site (Reservoir) • Baseline sites (prior to mining operations) Laboratory Analysis - Microbial analysis as per Table 2-5. A Receptor (reservoir) floating buoy array is proposed as a collaborative collective action "layered monitoring system" endeavour, however further consultation is required with Water Corporation.	Sampling during continuous flow will be conducted as least twice a year. Episodic flow will be sampled if possible.	**Early Response Trigger:** Impact site records 20 – 2,000 *E. coli* per 100 mL (Moderate contamination as per ADGW 2011) within PDWA and outside of RPZ **Response Actions may include:** • Undertake workplace inspections and interviews to ensure hygiene practises are being adhered to • Undertake additional impact sampling and continue to monitor until parameter stabilisation • Review mining activities within sub-catchment to identify contributing factors. Undertake improvement actions, if required. • Review against baseline or reference dataset to identify other contributing factors (climatic conditions, other activities)	**Trigger:** Impact site records >2,000 to 20,000 E. coli per 100 mL (Heavy contamination as per ADGW 2011) within PDWA and outside of OCA2 Impact site records 20 – 2,000 *E. coli* per 100 mL (Moderate contamination as per ADGW 2011) within RPZ **Response Actions may include:** • Communicate trigger exceedance to Water Corporation and initiate discussion on any mitigating actions • Review monitoring programme (locations and frequency) to ensure appropriate to determine scale of impact, particularly in reservoir • Review mining activities within sub-catchment to identify contributing factors. Undertake improvement actions, if required. • Undertake incident investigation to determine source of exceedance and if associated with mining activities. • Develop a remedial action plan (if required) • Continue to monitor management action implementation and compliance.	**Threshold:** Impact site records >2,000 to 20,000 *E. coli* per 100 mL (Heavy contamination as per ADGW 2011) within Receptor site **Response Actions may include:** • Communicate to Water Corporation and initiate discussion on mitigating actions (including additional water treatment requirements) • Increase monitoring programme (locations and frequency) to determine scale of impact, particularly in reservoir • Undertake incident investigation to determine source of exceedance and if associated with mining activities. • Develop a remedial action plan • Continue to monitor management action implementation and compliance • Revise WRMP and associated procedures to prevent reoccurrence

Receptor	#	Management target	Monitoring				Monitoring and management actions		
			Aspect	Monitoring parameters	Method	Timing / frequency	Investigate (Early response criteria)	Action (trigger criteria)	Mitigate – corrective actions (threshold criteria)
	3	No significant impact to public drinking water areas quality from hazardous materials and waste from mining activities	Ground water quality Surface water quality	Hydrocarbon analysis as per Table 2-5 and PFAS	Surface water grab sample at: • Impact sites (inclusion of upstream of Reservoir) • Reference sites • Receptor site (Reservoir) • Baseline sites (prior to mining operations) Laboratory Analysis – Hydrocarbon analysis as per Table 2-5 and PFAS analysis. A Receptor (reservoir) floating buoy array is proposed as a collaborative collective action "layered monitoring system" endeavour, however further consultation is required with Water Corporation.	Sampling during continuous flow will be conducted as least twice a year. Episodic flow will be sampled if possible.	**Early Response Trigger:** Impact site records a change greater than natural variation (using baseline or reference dataset) plus 1 standard deviation. **Response Actions may include:** • Undertake additional impact sampling and continue to monitor until parameter stabilisation • Review mining activities within sub-catchment to identify contributing factors. Undertake improvement actions, if required. • Review against baseline or reference dataset to identify other contributing factors (climatic conditions)	**Trigger:** Impact site records an exceedance of health-based ADWG (2011) guideline and PFAS NEPM levels (Appendix B – Water Guidelines) **Response Actions may include:** • If within PDWA, communicate any trigger exceedances to Water Corporation and initiate discussion on any mitigating actions • Review monitoring programme (locations and frequency) to ensure appropriate to determine scale of impact, particularly in reservoir • Review mining activities within sub-catchment to identify contributing factors. Undertake improvement actions, if required. • Undertake incident investigation to determine source of exceedance and if associated with mining activities. • Develop a remedial action plan (if required) • Continue to monitor management action implementation and compliance	**Threshold:** Exceedance of health-based ADWG (2011) guideline and PFAS NEPM levels (Appendix B – Water Guidelines) at Receptor site **Response Actions may include:** • Communicate to Water Corporation and initiate discussion on mitigating actions (including additional water treatment requirements) • Increase monitoring programme (locations and frequency) to determine scale of impact, particularly in reservoir • Undertake incident investigation to determine source of exceedance and if associated with mining activities. • Develop a remedial action plan • Continue to monitor management action implementation and compliance • Revise WRMP and associated procedures to prevent reoccurrence
			Surface water	Waste water analysis as per Table 2-4	Grab samples Wastewater discharge locations. Laboratory Analysis - Wastewater analysis as per Table 2-5	Prior to discharge	**Early Response Trigger:** Exceedance of the limits as per Table 2-4. **Response Actions may include:** • As per Waste Water Monitoring Program Procedure, discharge of waste water is placed on hold and re-analysis is required • If results still exceed limits, re-processing of wastewater is required prior to discharge • Undertake workplace inspections and verifications to identify any treatment plan maintenance or repairs	**Trigger:** Continued exceedance of the limits as per Table 2-4. **Response Actions may include:** • If results from Early Response Trigger still exceed limits or re-processing is not possible, arrange for wastewater to be disposed of offsite • Undertake investigation to determine source of exceedance. • Develop a remedial action plan (if required) • Continue to monitor management action implementation and compliance	**Threshold:** Exceedance of the limits as per Table 2-4 and discharge to the environment occurred. **Response Actions may include:** • If potential impacts to surface water could occur, initiate Emergency Response Procedure • Report as an incident to DWER Industry Regulation • Undertake monitoring to determine scale of impact • Undertake incident investigation to determine source of exceedance and associated control failures • Develop a remedial action plan • Continue to monitor management action implementation and compliance

Receptor	#	Management target	Monitoring				Monitoring and management actions		
			Aspect	Monitoring parameters	Method	Timing / frequency	Investigate (Early response criteria)	Action (trigger criteria)	Mitigate – corrective actions (threshold criteria)
	4	No significant impact to public drinking water areas quality from herbicides and fertilisers from mining activities	Surface Water	Total Nitrogen Total Phosphorous Pesticides / Herbicides	Grab sample at: • Impact sites (inclusion of upstream of Reservoir) • Reference sites • Receptor site (Reservoir) • Baseline sites (prior to mining operations) Laboratory Analysis – ADWG analysis as per Table 2-5	Sampling during continuous flow will be conducted as least twice a year. Episodic flow will be sampled if possible.	**Early Response Trigger:** Impact site records a change greater than natural variation (using baseline or reference dataset) plus 1 standard deviation. **Response Actions may include:** • Undertake additional impact sampling and continue to monitor until parameter stabilisation • Review mining activities within sub-catchment to identify contributing factors. Undertake improvement actions, if required. • Review against baseline or reference dataset to identify other contributing factors (climatic conditions)	**Trigger:** Impact site records an exceedance of health-based ADWG (2011) guideline levels (Appendix B – Water Guidelines) **Response Actions may include:** • If within PDWA, communicate any trigger exceedances to Water Corporation and initiate discussion on any mitigating actions • Review monitoring programme (locations and frequency) to ensure appropriate to determine scale of impact, particularly in reservoir • Review mining activities within sub-catchment to identify contributing factors. Undertake improvement actions, if required. • Undertake incident investigation to determine source of exceedance and if associated with mining activities. • Develop a remedial action plan (if required) • Continue to monitor management action implementation and compliance	**Threshold:** Exceedance of health-based ADWG (2011) guideline levels (Appendix B – Water Guidelines) at Receptor site **Response Actions may include:** • Communicate to Water Corporation and initiate discussion on mitigating actions (including additional water treatment requirements) • Increase monitoring programme (locations and frequency) to determine scale of impact, particularly in reservoir • Undertake incident investigation to determine source of exceedance and if associated with mining activities. • Develop a remedial action plan • Continue to monitor management action implementation and compliance • Revise WRMP and associated procedures to prevent reoccurrence
Management Objective:		Minimise surface water quality and hydrology impacts from mining activities							
	5	No significant impact to surface water values as a result of increase in turbidity from mining activities	Surface Water	Turbidity	Continuous logging at: • Compliance impact sites upstream of reservoir • Local reference sites distributed catchment wide	Continuous (when water flowing)	**Early Response criterion:** Early response criterion to be developed in consultation with Water Corporation. In the interim, a qualitative early response criterion of any mine pit or haul road overflow incidents is proposed:	**Trigger criterion:** Impact site records ≥25 NTU over one hour (when flowing) **Response Actions may include:** • Communicate trigger exceedance to Water Corporation within 24 hours of	**Threshold criterion:** Turbidity ≥1 NTU over one hour at Receptor site with corresponding turbidity ≥25 NTU 1-hr at associated impact site/s or downstream Loss of Containment event **Response Actions may include:**

Receptor	#	Management target	Monitoring				Monitoring and management actions		
			Aspect	Monitoring parameters	Method	Timing / frequency	Investigate (Early response criteria)	Action (trigger criteria)	Mitigate – corrective actions (threshold criteria)
	6	No significant impact to surface water values as a result of increase in turbidity from erosion of post-mining landforms			A Receptor (reservoir) floating buoy array is proposed as a collaborative collective action “layered monitoring system” endeavour, however further consultation is required with Water Corporation.		• Loss of Containment event associated with drainage from haul road or pit (not extending to surface water); or • Impact site records ≥25 NTU over 30 minutes (when flowing) **Response Actions may include:** • Review monitoring data to determine turbidity results • Review mining activities within sub-catchment to identify contributing factors. Undertake improvement actions, if required. • Review against baseline or reference dataset to identify other contributing factors (climatic conditions) • Mobilise equipment as required. Undertake additional on-ground investigations to determine extent / quality and/or additional or increased frequency of appropriate indicators • Develop a remedial action plan (if warranted) • Continue to monitor action mitigation procedures	known event exceedance and initiate discussion on any mitigating actions • Review mining activities within sub-catchment to identify contributing factors. Undertake improvement actions, if required. • Undertake incident investigation to determine source of exceedance and if associated with mining activities. • Develop a remedial action plan (if required) Continue to monitor management action implementation and compliance • Review monitoring programme (locations and frequency) to ensure appropriate to determine scale of impact, if required	• Communicate to Water Corporation within 24 hours of known event exceedance • Implement mitigation action/s as previously agreed with Water Corporation (including additional water treatment requirements) • Increase monitoring programme (locations and frequency) to determine scale of impact, particularly in reservoir • Undertake incident investigation to determine source of exceedance and if associated with mining activities. • Develop a remedial action plan • Continue to monitor management action implementation and compliance • Revise WRMP and associated procedures to prevent reoccurrence

Receptor	#	Management target	Monitoring				Monitoring and management actions		
			Aspect	Monitoring parameters	Method	Timing / frequency	Investigate (Early response criteria)	Action (trigger criteria)	Mitigate – corrective actions (threshold criteria)
	6	No significant impact to surface water values as a result of increase in turbidity from erosion of post-mining landforms	Rehabilitation	Gully Erosion Size Gully Deposition Size	Using stereometrics, the UAV photography is processed to produce Digital Elevation Models (DEMs) and Orthomosaics of the rehabilitated landscape. These two spatial datasets can be then used to look for erosion, and measure specific metrics for comparison with the completion criteria. Each rehabilitated area will be monitored.	Two years after rehabilitation completion	**Early Response Trigger:** Early response trigger to be developed in consultation with Water Corporation. In the interim, a qualitative trigger of any rehabilitation area incidents is proposed: Drainage event incident associated with drainage from rehabilitated areas **Response Actions may include:** • Review monitoring data to determine turbidity results • Review mining activities within sub-catchment to identify contributing factors. Undertake improvement actions, if required. • Review against baseline or reference dataset to identify other contributing factors (climatic conditions) • Mobilise equipment as required. Undertake additional on-ground investigations to determine extent / quality and/or additional or increased frequency of appropriate indicators • Develop a remedial action plan (if warranted) • Continue to monitor action mitigation procedures	**Trigger:** Gully erosion size > 30 cm wide or deep or >100 m long; or Gully deposition size > 0.1ha **Response Actions may include:** • Remediate erosion gully • Review mining activities within sub-catchment to identify contributing factors. Undertake improvement actions, if required. • Undertake incident investigation to determine source of exceedance and if associated with mining activities. • Develop a remedial action plan (if required) • Continue to monitor management action implementation and compliance	**Threshold:** Turbidity ≥1 NTU over one hour at Receptor site with corresponding turbidity ≥25 NTU 1-hr at associated rehabilitated site/s **Response Actions may include:** • Communicate to Water Corporation and initiate discussion on mitigating actions (including additional water treatment requirements) • Increase monitoring programme (locations and frequency) to determine scale of impact, particularly in reservoir • Undertake incident investigation to determine source of exceedance and if associated with mining activities. • Develop a remedial action plan • Continue to monitor management action implementation and compliance Revise WRMP and associated procedures to prevent reoccurrence

Receptor	#	Management target	Monitoring				Monitoring and management actions		
			Aspect	Monitoring parameters	Method	Timing / frequency	Investigate (Early response criteria)	Action (trigger criteria)	Mitigate – corrective actions (threshold criteria)
	7	No significant impacts to surface water values as a result of increase from mining-induced saline groundwater discharge	Ground water quality Surface water	Electrical conductivity (field)	Field analysis via surface water continuous loggers at: • Compliance impact sites upstream of reservoir • Local reference sites distributed catchment wide Grab samples may also occur	Continuous (when flowing) Quarterly grab samples may occur as required	**Early Response Trigger:** Impact site records a change greater than natural variation (using baseline or reference dataset) plus 1 standard deviation. **Response Actions may include:** • Review mining activities within sub-catchment to identify contributing factors. Undertake improvement actions, if required. • Review against baseline or reference dataset to identify other contributing factors (climatic conditions)	**Trigger:** Impact site records a change greater than natural variation (using baseline or reference dataset) plus 1 standard deviation over 7 days **Response Actions may include:** • Review monitoring programme (locations and frequency) to ensure appropriate to determine scale of impact. • Review adequacy of stream zone vegetation health monitoring sites to identify any potential impacts. • Review mining activities within sub-catchment to identify contributing factors. Undertake improvement actions, if required. • Undertake incident investigation to determine source of exceedance and if associated with mining activities. • Develop a remedial action plan (if required) • Continue to monitor management action implementation and compliance	**Threshold:** Significant (mortality) vegetation health decline observed following Trigger exceedance **Response Actions may include:** • Increase monitoring programme (locations and frequency) to determine scale of impact • Undertake incident investigation to determine source of exceedance and if associated with mining activities. • Develop a remedial action plan, including consideration for rehabilitation • Continue to monitor management action implementation and compliance • Revise WRMP and associated procedures to prevent reoccurrence
	8	No significant impact to surface water values as a result of hydrological regime changes from mining activities	Ground water level	Ground water level	Refer to Management Target 9 – Groundwater level				
			Surface water	Surface Water Volumes	Flow meters to measure surface water abstraction volumes	Fortnightly	**Early Response Trigger:** Increase in two monthly surface water abstraction rate in comparison to previous years. **Response Actions may include:** • Confirm flow meters are calibrated and accurate • Review total abstraction volumes to ensure annual water allocation has not been exceeded • Review site water balance to identify source of potential abstraction increase	**Trigger:** Exceedance of surface water abstraction annual water allocation **Response Actions may include:** • Report as an incident to DWER Industry Regulation • Undertake monitoring to determine scale of impact • Undertake incident investigation to determine source of exceedance and associated control failures • Develop a remedial action plan • Continue to monitor management action implementation and compliance	**Threshold:** Exceedance of Trigger limit and biological monitoring identifies a significant impact to aquatic ecosystem or stream zone vegetation **Response Actions may include:** • Provide a follow up report as an incident to DWER Water and JTSI • Undertake further monitoring to determine scale of impact • Develop a remedial action plan which include rehabilitation • Continue to monitor management action implementation and compliance

Receptor	#	Management target	Monitoring				Monitoring and management actions		
			Aspect	Monitoring parameters	Method	Timing / frequency	Investigate (Early response criteria)	Action (trigger criteria)	Mitigate – corrective actions (threshold criteria)
			Ground water quality	Comprehensive analysis – metals as per Table 2-4	Groundwater bore sampling at: • Active impact sites • Reference sites	6 monthly at active locations Reference sites will occur as required	**Early Response Trigger:** Metals >20% higher than baseline or reference sites for 2 or more consecutive monitoring rounds **Response Actions may include:** • Review mining activities within sub-catchment to identify contributing factors. Undertake improvement actions, if required. • Review against baseline or reference dataset to identify other contributing factors (climatic conditions)	**Trigger:** Impact site records a change greater than natural variation (using baseline or reference dataset) plus 1 standard deviation over one year **Response Actions may include:** • Review monitoring programme (locations and frequency) to ensure appropriate to determine scale of impact. • Ensure vegetation health monitoring sites are available to identify any potential impacts. • Review mining activities within sub-catchment to identify contributing factors. Undertake improvement actions, if required. • Undertake incident investigation to determine source of exceedance and if associated with mining activities. • Develop a remedial action plan (if required) • Continue to monitor management action implementation and compliance	**Threshold:** Significant (mortality) vegetation health decline observed following Trigger exceedance **Response Actions may include:** • Increase monitoring programme (locations and frequency) to determine scale of impact • Undertake incident investigation to determine source of exceedance and if associated with mining activities. • Develop a remedial action plan, including consideration for rehabilitation • Continue to monitor management action implementation and compliance • Revise WRMP and associated procedures to prevent reoccurrence
Management Objective:		Minimise groundwater fluctuations from mining activities							
GDEs	9	No significant impact to groundwater values as a result of hydrogeological regime changes from mining activities	Ground water	Groundwater level	Manual groundwater dips at sites: • Active impact sites • Reference sites Continuous loggers may be used, if available	6 monthly at active locations Reference sites will occur as required	**Early Response Trigger:** Change greater than 3 m (low case scenario in groundwater predictive tool for clearing induced groundwater rise) **Response Actions may include:** • Review mining activities within sub-catchment to identify contributing factors. Undertake improvement actions, if required. • Review against baseline or reference dataset to identify other contributing factors (climatic conditions)	**Trigger:** Change greater than 6 m (mid case scenario for clearing induced groundwater rise) **Response Actions may include:** • Review monitoring programme (locations and frequency) to ensure appropriate to determine scale of impact. • Establishing GDE health monitoring sites to identify any potential impacts. • Review mining activities within sub-catchment to identify contributing factors. Undertake improvement actions, if required. • Undertake incident investigation to determine source of exceedance and if associated with mining activities. • Develop a remedial action plan (if required) • Continue to monitor management action implementation and compliance	**Threshold:** Significant (mortality) vegetation health decline observed following Trigger exceedance **Response Actions may include:** • Increase monitoring programme (locations and frequency) to determine scale of impact • Undertake incident investigation to determine source of exceedance and if associated with mining activities. • Develop a remedial action plan, including consideration for rehabilitation • Continue to monitor management action implementation and compliance • Revise WRMP and associated procedures to prevent reoccurrence

Table 2-4: DWER Part V Licence Limits

Parameter	Limit - Huntly
pH	5.5 – 9.0
Total Dissolved Solids	1,000 mg/L
Surfactants (as MBAS)	5 mg/L
Total Phosphorous	2 mg/L
Oil and Grease	5 mg/L
Copper	1 mg/L
Chromium	0.06 mg/L
Zinc	5 mg/L
Total Suspended Solids (Willowdale only)	2,000 mg/L

Table 2-5: Water quality analysis suites

ADWG Analysis	Comprehensive Analysis	Hydrocarbon Analysis	Microbial analysis	Wastewater analysis
pH	pH	BTEX	*E. coli*	pH
Conductivity	Conductivity	Benzene	Thermophilic Amoebae	Total Dissolved Solids
Total Dissolved Solids	Total Dissolved Solids	Ethylbenzene	Thermophilic Naegleria	Surfactants (as MBAS)
Nitrate (as N)	Total Hardness (as CaCO3)	Polycyclic Aromatic Hydrocarbons (PAH) (Sum of Total)	Enterococci	Total Phosphorous
Nitrite (as N)	Total Alkalinity (as CaCO3)	Toluene	Faecal coliforms (Thermotolerant coliforms)	Oil and Grease
Ammonia as N	Calcium	Total Petroleum Hydrocarbons (TPH)		Total Suspended Solids (for Willowdale)
Sulphate	Magnesium	Xylene Total		
Aluminium	Sodium	>C10-C16 Fraction (F2 minus Naphthalene)		6- monthly:
Arsenic	Potassium			Copper
Barium	Phosphate			Chromium
Beryllium	Carbonate			Zinc
Boron	Nitrate			
Cadmium	Nitrite			
Copper	Aluminium - Dissolved			
Lead	Arsenic - Dissolved			
Manganese	Cadmium - Dissolved			
Mercury	Chromium - Dissolved			
Molybdenum	Iron - Dissolved			
Nickel	Lead - Dissolved			
Selenium	Manganese - Dissolved			
Uranium	Mercury - Dissolved			
Chromium (III+VI) (filtered)	Selenium - Dissolved			
Cobalt (filtered)	Zinc - Dissolved			
Glyphosate	Copper – Dissolved			
	Molybdenum – Dissolved			

ADWG Analysis	Comprehensive Analysis	Hydrocarbon Analysis	Microbial analysis	Wastewater analysis
	Nickel – Dissolved			
	Silver - Dissolved			
	Total Kjeldahl Nitrogen			
	Total Phosphorus			

2.2 Reporting

The reporting requirements relating to the implementation of the WRMP are detailed in Table 11.

All data collected will be presented graphically with time scales to facilitate the comparison of data. Long term graphical trends from previous years' will be included in the monitoring reviews.

Table 2-6: Reporting actions

Notification Event	Action	Responsibility	Timing
Management Target Exceedance	In the event that monitoring or investigations indicate that management targets are exceeded, Alcoa will: - report exceedances of management targets in monthly report to Water Corporation and DWER within 21 days of the exceedance being identified - provide a report to Water Corporation and DWER within 90 days of the exceedance	Environmental Department	Exceedances reported within 21 days of identification within the monthly report (8th day of the month) Report on exceedance within 90 days of identification
Turbidity Events at Compliance Monitors that exceed 25NTU for 1 hour or longer.	Reported as environmental incidents and investigated. Events should be reported to Water Corporation within 24 hours or as soon as practicable after the event is identified. All events should be investigated – even those deemed non-mining related. Any corrective actions will be discussed with Water Corporation. All events will also be reported in the monthly report supplied to Water Corporation.	Environmental Department	Exceedances reported within 21 days of identification Report on exceedance within 90 days of identification
Drainage events within OCA1, OCA2 and Proclaimed Catchment.	Notify Water Corporation within 24 hours of the event occurring. All events will also be reported in the monthly report supplied to Water Corporation.	Environmental Department	Exceedances reported within 21 days of identification Report on exceedance within 90 days of identification

Notification Event	Action	Responsibility	Timing
Loss of Containment	In the event of Loss of Containment of: - >100L within OCA1 - >500L within OCA2 - >1000L within RPZ - All volumes within Proclaimed Catchment Water Corporation should be notified and all events will be reported in the monthly report supplied to Water Corporation.	Environmental Department	Notification within 24 hours of the event.
Annual Environmental Reporting	Preparation of an Annual Environmental Review (AER) to JTSI	Environmental Department	Annually
Annual Environmental Reporting	Preparation of an Annual Environmental Review (AER) to DWER as per any Part V Annual Environmental Reporting guidelines	Environmental Department	Annually as per DWER Licence
Annual abstraction reporting	Submission of abstraction volumes as per Surface water licences	Environmental Department	Due 14 January each year
Annual environmental report	Preparation of a report as per Surface water abstraction licences.	Environmental Department	Due 31 March each year
Evaluation and revision of the WRMP	A review of this WRMP will be undertaken every two years. Any significant changes will include consultation with MMPLG.	Environmental Department	Every two years

3 Adaptive Management and Review of the EMP

Alcoa recognises the dynamic nature of ecosystems and supports adaptive management under this EMP. Adaptive management involves:

- implementing mitigation measures
- monitoring and evaluation against management targets
- systematically adapting management and mitigation measures and monitoring to meet the environmental objectives.

Any changes to management practices will instigate a review and consideration of management actions. Assumptions and uncertainties will be evaluated against collected monitoring data on a recurrent basis in a process of continual improvement and establishing early response indicators/criteria. Examples of adaptive management throughout operations include:

- the introduction of a different / alternative monitoring initiative to better understand monitoring of the non-operational and impact areas
- outcomes of Alcoa's water improvement programme, as per Table 3-1 with an associated framework in Figure 3-1
- outcomes of Alcoa's research programme
- changes to management actions and targets in response to monitoring data
- changes in technology.

Alcoa will update this EMP as required to include any adaptive management updates based on information gathered from monitoring results.

It is expected the WRMP will be further developed following MMPLG consultation and will be updated in 2024 with outcomes of additional technical investigations, then every two years after. In the interim, the management measures proposed are expected to minimise any potential impact to the water resources.

Table 3-1: Additional technical studies and monitoring

Item	Detail	Timeframe	Status
Groundwater Drilling Program and associated monitoring	The groundwater monitoring programme intent is to: - Monitor groundwater levels and quality - Increase baseline and reference site data to allow further refinement of Triggers and Thresholds - Inform mine planning and ore block shapes - Monitor mining activities impacts - Provide data to support management actions and any adaptive management required Installation of monitoring bores is ongoing. Indicative monitoring locations will be developed, however may vary dependent on the mine plan and monitoring outcomes. Proposed monitoring locations will be included in MMPs. Collation of data will take up to 24 months following bore installation.	Ongoing	Commenced and ongoing
Turbidity monitor installation and associated monitoring	The surface water monitoring programme intent is to: - Monitor surface water flow and quality - Increase baseline and reference site data to allow further refinement of Triggers and Thresholds - Monitor mining activities impacts - Provide data to support management actions and any adaptive management required Installation of loggers and surface water sampling is ongoing. Indicative monitoring locations will be developed, however may vary dependent on the mine plan and monitoring outcomes. Proposed monitoring locations will be included in MMPs. Collation of data will take up to 24 months. Installation and ongoing monitoring of Reservoirs are recommended, therefore consultation with Water Corporation will be required.	Ongoing	Commend and ongoing. Salinity and turbidity monitoring currently occurs at some stream flow sites
Water Monitoring Framework	Alcoa has engaged GHD to guide improvements to drainage and water monitoring practices at Alcoa mine sites, including the selection of monitoring sites and types of monitoring to be completed. The framework is split into three components:	2024	Commenced

Item	Detail	Timeframe	Status
	1. Monitoring framework – includes physical, data and system components results to ensure the monitoring system meets its objectives. 2. Monitoring prioritisation – a risk based approach based on subjects areas identified as important 3. Monitoring system implementation – includes defining potential monitoring site types, parameters and associated monitoring frequency A framework has been developed. The next steps include: • Early works to be implemented by August 2023, including catchment mapping and alignment of monitoring system based on catchment risk, groundwater bore installation and baseline surface water monitoring. • Phase 1 to be implemented by August 2024, including finalised design for upgraded monitoring system, trial new data management system, installation of new buoy/gauging station system, surface water and ground water monitoring locations		
Turbidity Triggers	Further consultation with MMPLG and WC is required to determine an appropriate Early Response Trigger and Threshold for turbidity at impact sites.	End 2023	Not yet commenced
Hydrological Modelling and Drinking Water Risk Assessment	A surface hydrology model will be developed for each RPZ with mining activities. Models currently exist for South Dandalup and Serpentine Dam, however, require revision for current mining activities. The surface hydrology model will quantitatively assess potential contamination and potential impacts on reservoirs. The impacts will then be used in the Drinking Water Risk Assessment. As further monitoring data is gathered, the model may be revised to ensure calibration.	End 2024	Under development
Catchment Scale Risk Assessment Tool	The purpose of the risk assessment is to improve our understanding of inherent and residual risks within our operations and ensure that the appropriate level of mitigations are applied. This will support the mine planning process and ongoing management of operational risks. Iteration 1 of the project has been completed, which developed the framework to provide an initial 'proof of concept' for review and feedback by internal and external stakeholders. Iteration 1 focuses on assessment of relevant water quality contaminants, sources, pathways which could combine to present a risk to the public drinking water source area (PDWSA) reservoirs. Contaminants of concern that are assessed include: • Turbidity • *E. Coli* and pathogens	End 2024	Under development

Item	Detail	Timeframe	Status
	• Hydrocarbons • Fire ash • PFAS • Salinity The basic steps taken to undertake the assessment are as per the below: • Step 1 – Delineate the stream network, catchment and sub-catchment boundaries • Step 2 – Upload the current and future mine plan • Step 3 – Undertake an assessment utilising a range of spatial inputs to identify inherent risks (i.e., risk assessment without mitigative controls applied) • Step 4 – Undertake a risk assessment with controls applied to understand the residual risk. The output of the process is a spatial risk assessment with outputs available in GIS format and a source-pathway-receptor table, which provides a summary of the results. The above process allows assessment of each individual sub-catchment, however also allows aggregation of sub-catchments to determine an overall assessment of the cumulative effects of mining along each stream network. The tool has completed the first phase and further refinement is occurring. MMPLG consultation will occur and the tool is expected to be used to: - Risk assess potential for drainage failures in current pits - Identify high risk pits and catchments where additional drainage design controls are required - Incorporated into pit design process to ensure adequate controls - Utilised to review constructed pits		
Design Manual	Alcoa intends to undertake further consultation with MMPLG to obtain approval of the Design Manual. The following steps are planned:	November 2022	Complete

Item	Detail	Timeframe	Status
	1. MMPLG Consultation 2. Design Manual Update 3. Peer Review 4. Design Manual Update 5. Design Manual approval by MMPLG If the Design Manual is endorsed, the application of the manual will still produce DCMPs for each pit, however, they will not always be required to be submitted to the MMPLG for approval.		
Field Infiltration Rate Test Program	Alcoa will undertake field infiltration testwork to confirm assumptions made in the Design Manual. The outcomes of the testwork will be incorporated into the Design Manual.	Late 2023	In Progress
Groundwater Stewardship Strategy – Water boreholes	The additional groundwater monitoring, aided by the improved hydrogeological knowledge acquired from airborne geophysics will be utilised to collate groundwater hydrographs. This programme included borehole location planning and installation for several year seasonal fluctuation hydrograph trend prior to clearing. The outcome of the hydrographs will influence groundwater management actions, the current interpreted groundwater level and the Groundwater Predictive Tool under development.	Mid 2024	In Progress
Groundwater Stewardship Strategy – Groundwater predictive tool	The Groundwater Predictive Tool development will involve an initial review of predictive modelling research relevant to jarrah forest. Then, coupled with recent methodologies, it will seek to improve predictive tool for clearing induced groundwater rise and rehabilitation recovery to natural trend. This outcomes of the tool will be used in the Design Manual.		
Rehabilitation Design Manual	Alcoa proposes the development of a Rehabilitation Design Manual. Similar to the Design Manual, it will stipulate the minimum standards for rehabilitation design, in particular of pits.	Late 2023	In progress

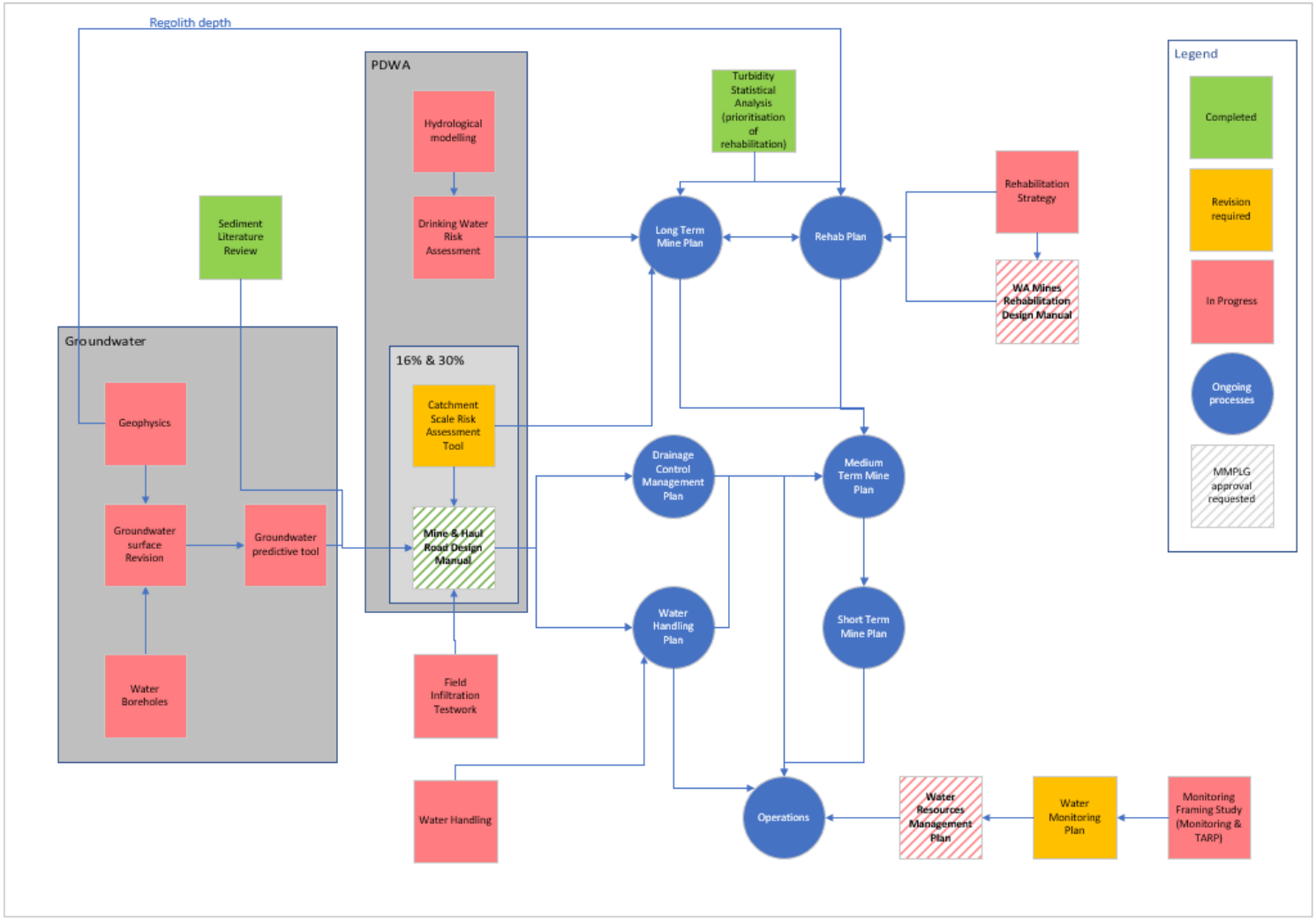

Figure 3-1: Water Improvement Actions - Framework

3.1 Changes to an EMP

Based on result of the review process Alcoa will update and adjust the measures and strategies as per Table 3-2 below.

Table 3-2 Changes to an EMP

Complexity of changes			**Minor revisions** ☐		**Moderate revisions** ☐		**Major revisions** ☐
Number of Key Environmental Factors			**One** ☐		**2-3** ☐		**> 3** ☐
Date revision submitted to MMPLG: DD/MM/YYYY							
Proponent's operational requirement timeframe for approval of revision Reason for Timeframe:				**< One Month** ☐	**< Six Months** ☐	**> Six Months** ☐	**None** ☐
Item no.	**EMP section no.**	**EMP page no.**	**Summary of change**	**Reason for change**			
1.							
2.							
3.							

4 Stakeholder Consultation

Alcoa has developed and implemented an external stakeholder consultation strategy for ongoing social engagement and community investment.

The stakeholder consultation strategy has adopted the principles from the Ministerial Council on Mineral and Petroleum Resources (MCMPR) *Principles for Engagement with Communities and Stakeholders* (2005). This includes:

- open and effective communication;
- two–way communication;
- clear, accurate and relevant information;
- timeliness;
- transparency, requiring a process for communication and feedback;
- collaboration, working cooperatively to seek mutually beneficial outcomes;
- inclusiveness, with the aim of recognising, understanding and involving stakeholders early and throughout the process; and
- integrity, with engagement undertaken in a manner that fosters mutual respect and trust.

The outcomes of the consultation strategy are recorded in the Stakeholder Consultation Register. Consultation to date has been comprised predominately of meetings and correspondence with a number of State and Federal Departments and Agencies, Local Government Authorities, Traditional Owners and non–government organisations and interest groups.

Alcoa is committed to ongoing stakeholder identification, communication, engagement and consultation through the planning and approval phase, and through to construction, operational and closure phases of the Project.

The key stakeholders in Water values include:

- State government;
- Federal government;
- Local government; and
- Non–government organisations and interest groups.

A comprehensive list of key stakeholders is provided in Table 5-1.

Table 4-1: Key Stakeholders

Stakeholder Group	Stakeholder	Key Interests
State Government	Environmental Protection Authority (EPA)	• Administration of the *Environmental Protection Act 1986* (EP Act) • Part IV (EP Act) Environmental Impact Assessments (EIA).

Stakeholder Group	Stakeholder	Key Interests
	Department of Water and Environmental Regulation (DWER)	• Input into environmental scoping and assessments. • Compliance reporting
	Water Corporation	• Catchment Management
	Department of Mines, Industry Regulation and Safety (DMIRS)	• Administration of the *Mining Act 1978* (Mining Act) • Tenement conditions • Closure and rehabilitation • Safety.
	Department of Biodiversity, Conservation and Attractions (DBCA)	• Administration of the *Biodiversity Conservation Act 2016* (BC Act) • Flora, fauna and habitat conservation. • State Herbarium specialists • TEC/PEC specialists
	Department of Planning, Lands and Heritage (DPLH)	• Native title and indigenous requirements • Heritage sites.
	Department of Fire and Emergency Services (DFES)	• Emergency services • Fire breaks • Fire reduction.
	DWER - Water	• Water catchments
	Main Roads Western Australia (MRWA)	• Use of public roads.
Federal Government	Department of Climate Change, Energy, the Environment and Water (DCCEEW)	• Administration of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) • Referral and assessment of environmental impact assessments of matters of national environmental significance.
Local Government	Shires of Armadale, Serpentine, Harvey, Waroona, Kwinana and Bunbury	• Use of public roads and infrastructure.
Non–government organisations and interest groups	Local landholders; Local NRM group (Peel-Harvey)	• Protection of conservation significant species • Forest management

Stakeholder Group	Stakeholder	Key Interests
	Institute of Foresters; Local Indigenous Groups Universities and Researchers; Dieback Working Groups; Conservation Council of Western Australia; Wilderness Society; WA Forest Alliance.	• Research groups • Potential interest in baseline flora and fauna survey data.

GLOSSARY

ABBREVIATION/ TERM	DESCRIPTION
ADWG	Australian Drinking Water Guidelines
Baseline	Baseline data is considered to be monitoring data collected prior to any mining activities occurring. Once mining activities commence, these sites may become impact monitoring locations and the baseline data used to identify any potential impact.
DBCA	Department of Biodiversity, Conservation and Attractions
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DFES	Department of Fire and Emergency Services
DPAW	Department of Parks and Wildlife (former)
DWER	Department of Water and Environmental Regulation
EPA	Environmental Protection Authority
EP Act	*Environmental Protection Act 1986 (WA)*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999 (Cth)*
FCA	Forest Clearing Advice
Infrastructure	Construction, operation and rehabilitation of mining related infrastructure by Alcoa within ML1SA. This includes: • Haul road, access road and causeways • Utilities (power, water, electricity) • Mine Facilities (for example, workshops, water treatment plants)
MCMPR	Ministerial Council on Mineral and Petroleum Resources
Mining Activities	All mining relations activities undertaken by Alcoa within ML1SA. This includes: • Exploration • native vegetation clearing • topsoil and over-burden removal • Pit development and operation • Haul road, access road and causeway construction and operation • Utilities (power, water, electricity) construction and operation • Construction and operation of Mine Facilities (for example, workshops, water treatment plants • Rehabilitation of pits and infrastructure
MMP	Mining and Management Program

ABBREVIATION/ TERM	DESCRIPTION
MMPLG	Mining and Management Program Liaison Group
Reference	Reference data or sites are considered to be monitoring locations which are not considered to be impacted by mining activities. Reference data or sites may be used if insufficient baseline data is used.
Significant	Significance associated with Management Targets is defined in the Monitoring Programme (Table 2-3).The Threshold Criteria is based upon significant impacts, which are reflective of potential impacts to receptors.
Stream	Epheremal

5 References

Australian Drinking Water Guidelines (ADWG) (National Health and Medical Research Council, 2011) – Guidelines for drinking-water quality (World Health Organization, 2017) –

Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG) (Australian and New Zealand Governments and Australian state and territory governments, 2018

Churchward, H M, and G M Dimmock. 1989. "The soils and landforms of the northern jarrah forest." In The Jarrah Forest. Geobotany, edited by Havel J.J., Malajczuk N. Dell B.

CSIRO. 2009. Surface water yields in south-west Western Australia. A report to the Australian Government from the CSIRO South-West Western Australia Sustainable Yields Project. Australia: CSIRO Water for Healthy Country Flagship.

DCCEEW, 2014. Environmental Management Plan Guidelines, Commonwealth of Australia 2014

Environmental Protection Authority, 2021. *Interim Guidance – Environmental outcomes and outcomes-based conditions*, EPA, Western Australia

GHD, 2022. Drinking Water Risk Assessment, Serpentine, Serpentine Pipehead, South Dandalup, and Wungong Brook Catchments. Prepared for Alcoa of Australia Limited

Grigg, Andrew H. 2017. "Hydrological response to bauxite mining and rehabilitation in the." Journal of Hydrology: Regional Studies (Elsevier B.V.) 12: 150-164. doi:http://dx.doi.org/10.1016/j.ejrh.2017.05.008.

Health Based Targets Manual (WSAA, 2015) – Department of Water and Environmental Regulation (DWER) Water Quality Protection Notes – By-Laws, international publications, and any other relevant publication for key contaminants of concern (e.g. turbidity, hydrocarbons and PFAS).

Holdgate, M. W.: A perspective of environmental pollution, Cambridge University Press Cambridge, UK, 1979

McFarlane, Craig, Andrew H Grigg, and Matthew I Daws. 2017. "A standardised Landsat time series (1973–2016) of forest leaf area index." Remote Sensing Applications: Society and Environment 6: 1-14. doi:http://dx.doi.org/10.1016/j.rsase.2017.01.006.

Petrone, Kevin C, Justin D Hughes, Thomas G Van Niel, and Richard P Silberstein. 2010. "Streamflow decline in southwestern Australia, 1950 - 2008." Geophysical Research Letters 37 (L11401): 1-7. doi:doi:10.1029/2010GL043102.

Risk management consequence, probability and risk matrix standard application (Alcoa AUACDS-2057-118

Turner, J V, and C D Johnston. 1987. "Environmental isotope hydrology of salinized experimental catchments." Journal of Hydrology 94 (1-2): 89-107.

6 APPENDICES

Appendix A – Risk Assessment

Risk is the combination of likelihood and consequence. The risk matrix used for this risk matrix is taken from Water Corporation (and thus differs to the ADWG 2011 matrix).

Risk matrix

Likelihood / Consequence	Rare E	Unlikely D	Possible C	Likely B	Almost Certain A
Catastrophic 5	High	High	Extreme	Extreme	Extreme
Major 4	Medium	High	High	Extreme	Extreme
Moderate 3	Low	Medium	High	High	High
Minor 2	Low	Low	Medium	High	High
Insignificant 1	Low	Low	Low	Medium	Medium

Likelihood Ratings/ Descriptors (Likelihood of consequence occurring)

Descriptor	WC Corporate Description	WC Corporate Frequency
Almost Certain	The event is expected or known to occur more than once per year	Will occur more than once per year
Likely	Known to re-occur approximately annually. Known to occur across like industries or within corporation	Will occur one per year
Possible	The event should occur at some time. Has occurred several times across like industries	Will occur once every 5 years
Unlikely	The event could occur at some time. Known to have occurred once or twice within industry	Will occur one in 10 years
Rare	The event may occur in exceptional circumstances. An example of this has occurred historically, but is not anticipated	Will occur once in 30 years or less

Consequence Ratings/ Descriptors

Rating	Descriptor	WC People and Public	WC Corporation Customer Service Interruption
5	Catastrophic	Multiple fatalities, and/or onset of life shortening illness for multiple persons	Significant widespread degradation of operations or services, and long, sustained, loss of operations or services for residential customers or key sensitive and unregulated customers
4	Major	Single fatality, and/or injury/illness resulting in significant permanent disability or life shortening disease	Widespread degradation of operations or services, and sustained service cessation for residential customers (>24 hours) or key, sensitive and unregulated customers
3	Moderate	Injury/illness, requiring specialist medical treatment, or hospitalisation, resulting in loss of functional ability (restricted work injury [RWI]), or time of work (lost time injury [LTI]	Widespread customer impacts or inconvenience – entire regional centre or country scheme, multiple metropolitan suburbs, and temporary loss of operations and services for residential customers (<24 hours) or key, sensitive and unregulated customers.
2	Minor	Injury/illness requiring medical treatment, nil loss of functional ability (Medical Treatment Injury [MTI]).	Localised operations or service interruption/ inconvenience for customers and temporary, short term service cessation for residential customers (<6 hours) or key, sensitive and unregulated customers. Multiple occurrences in one location.
1	Insignificant	Injury/illness requiring no treatment or first aid treatment only (Minor Injury [MI]).	Brief loss of local services, or inconvenience for customers and no measurable operational impact.

Spatial Descriptors

Rating	Descriptor	Extent
5	Regional	Potential impact occurs at significant distance from the source (>50 km) of source area or within the same catchment
4	Catchment	Potential impact occurs within catchment (>10 km [<50km]) of source area
3	Sub-catchment	Potential impact restricted to sub-catchment (local area) (>2km [<10km]) of source area
2	Surrounds	Potential impact restricted to immediate source area (within 2 km)

1	Immediate	Potential impact negligible, source area only

Temporal Descriptors

Rating	Descriptors
5	Centuries
4	Decades
3	Years
2	Months
1	Days

Risk Assessment

Alcoa has implemented a preventative risk management which incorporates multiple barriers to prevent hazards to drinking water from occurring or reducing them to acceptable levels, acting to prevent and minimise discharge of sediment and hydrocarbons into downstream reservoir.

Potential Threat/impact	Pathway	Likelihood	Consequence	Risk score	Spatial	Temporal
Surface water and sediment releases	Suspended solids/turbidity releases through overland flow during rainfall and wet ground conditions discharging into streams, and/or direct into reservoir	Rare	Major	Medium	Catchment	Days
Change in hydrological regime – Salinity	Rising groundwater mobilising salts in soils due to removal of caprock and vegetation	Possible	Minor	Medium	Catchment	Decades
Change in hydrological regime – contaminants of concern	Rising groundwater mobilising potential contaminants of concern (metals) in soils due to removal of caprock and vegetation	Unlikely	Major	High	Catchment	Decades
Change in hydrological regime-hydro chemicals, PFAS, ANFO	Contaminant mobilisation (hydrocarbons, PFAS, ANFO) associated with mine activities	Possible	Catastrophic	Extreme	Catchment	Centuries
Fuel storage and use Leaks and Spills	Potential overland flow of hydrocarbons during rainfall and /or wet ground conditions discharging into streams and/or directly into reservoirs. Seepage into groundwater	Unlikely	Insignificant	Low	Catchment	Years

Potential Threat/impact	Pathway	Likelihood	Consequence	Risk score	Spatial	Temporal
Vehicles and Heavy Machinery Fuel oils leaks and spills	Potential overland flow of hydrocarbons during rainfall and /or wet ground conditions discharging into streams or directly into reservoirs	Possible	Insignificant	Low	Catchment	Years
Cumulative undetected leaks and spills	Overland flow of hydrocarbons during rainfall and/or wet ground conditions discharging into streams or directly into reservoirs	Unlikely	Insignificant	Low	Catchment	Years
Application of fertiliser and/or herbicides during rehabilitation activities	Overland flow of nutrients, herbicides during rainfall discharging into streams Infiltration through soils into groundwater, subsurface flows discharging into stream or direct to reservoir	Likely	Minor	High	Catchment	Months

Appendix B – Water Guidelines

Analyte	Units	ADWG - Aesthetic	ADWG - Health	PFAS NEMP 2020 Drinking Water	PFAS NEMP 2020[2]	PFAS NEMP 2020 Recreational Water
Temperature	C					
pH	pH unit		**6.5-8.5**			
Total dissolved solids	mg/L	**600**				
Total suspended solids	mg/L					
Turbidity	NTU	**5 (8)**				
Glyphosate	mg/L		**1**			
e-coli (2)	unit/ 100mL		**ND**			
Faecol coliforms (Thermotolerant coliforms)	unit/ 100mL		**ND**			
Enterococci (2)	unit/ 100mL		**ND**			
Oil & grease	mg/L					
Benzene	µg/L		**1**			
Toluene	µg/L	**25**	**800**			
Ethylbenzene	µg/L	**3**	**300**			
Xylene (o)	µg/L	**19 (1)**				
Xylene Total	µg/L	**20**	**600**			
Naphthalene	µg/L	**0.12 (1)**				
>C10-C16 Fraction (F2 minus Naphthalene)	µg/L		**90 (3)**			
>C16-C34 Fraction (F3)	µg/L					
Acenaphthene	ug/L	**53 (1)**				
Anthracene	ug/L	**180 (1)**				
Benz(a)anthracene	ug/L	**0.03 (1)**				
Benzo(a) pyrene	ug/L		**0.01**			
Benzo(k)fluoranthene	ug/L	**2.5 (1)**				
Chrysene	ug/L	**25 (1)**				
Dibenz(a,h)anthracene	ug/L	**0.025 (1)**				
Fluoranthene	ug/L	**80 (1)**				
Fluorene	ug/L	**29 (1)**				
Indeno(1,2,3-c,d)pyrene	ug/L	**0.25 (1)**				
Naphthalene	ug/L	**0.12 (1)**				
Pyrene	ug/L	**12 (1)**				
PAHs (Sum of total)	ug/L		**0.01**			
1,2-dichlorobenzene	ug/L	**1**	**1,500**			
1,3-dichlorobenzene	ug/L	**20**				
1,4-dichlorobenzene	ug/L	**0.3**	**40**			
1,2,3-dichlorobenzene	ug/L	**5**	**30**			
4-chlorotoluene	ug/L	**25 (1)**				
Bromobenzene	ug/L	**6.2 (1)**				
Chlorobenzene	ug/L	**10**	**300**			
1,2-dibromoethane	ug/L		**1**			
Bromomethane	ug/L		**1**			
Dichlorodifluoromethane	ug/L	**20 (1)**				

[2] **Freshwater 99% level of protection**

Analyte	Units	ADWG - Aesthetic	ADWG - Health	PFAS NEMP 2020 Drinking Water	PFAS NEMP 2020[2]	PFAS NEMP 2020 Recreational Water
Trichlorofluoromethane	ug/L	520 (1)				
1,2,4-trimethylbenzene	ug/L	5.6 (1)				
1,3,5-trimethylbenzene	ug/L	6 (1)				
Isopropylbenzene	ug/L	45 (1)				
Styrene	ug/L	4	30			
Methyl Ethyl Ketone	ug/L	560 (1)				
4-Methyl-2-pentanone	ug/L	630 (1)				
Acetone	ug/L	1.4 (1)				
Allyl chloride	ug/L	0.00021 (1)				
Carbon disulfide	ug/L	81 (1)				
1,1,1,2-tetrachloroethane	ug/L	0.57 (1)				
1,1,1-trichloroethane	ug/L	800 (1)				
1,1,2,2-tetrachloroethane	ug/L	0.076 (1)				
1,1,2-trichloroethane	ug/L	0.041*				
1,1-dichloroethane	ug/L	2.8*				
1,1-dichloroethene	ug/L		30			
1,2,3-trichloropropane	ug/L	0.00075*				
1,2-dichloroethane	ug/L		3			
1,2-dichloropropane	ug/L	0.82*				
1,3-dichloropropane	ug/L	37*				
Bromochloromethane	ug/L	8.3*				
Bromodichloromethane	ug/L	60*				
Bromoform	ug/L	3.3*				
Carbon tetrachloride	ug/L		3			
Chlorodibromomethane	ug/L	100*				
Chloroethane	ug/L	2100*				
Chloroform	ug/L	300*				
Chloromethane	ug/L	19 (1)				
cis-1,2-dichloroethene	ug/L	3.6 (1)				
Dibromomethane	ug/L	0.83 (1)				
Dichloromethane	ug/L	11 (1)	4			
Trichloroethene	ug/L	20 (1)				
Tetrachloroethene	ug/L		50			
trans-1,2-dichloroethene	ug/L	6.8 (1)				
Vinyl chloride	ug/L		0.3			
Ethylene glycol	ug/L	4000 (1)				
Propylene glycol	ug/L	40000 (1)				
Triethylene Glycol	ug/L	4 (1)				
Perfluorooctanoic acid (PFOA)	µg/L		0.56	0.56	19	10
Perfluorobutane sulfonic acid (PFBS)	µg/L	40 (1)				
Perfluorohexane sulfonic acid (PFHxS)	µg/L		0.07	0.07		2
Perfluorooctane sulfonic acid (PFOS)	µg/L			0.07	0.00023	2
Sum of PFHxS and PFOS	µg/L		0.07	0.07		2
Anionic Surfactants as MBAS	mg/L	50 (1)				

Analyte	Units	ADWG - Aesthetic	ADWG - Health	PFAS NEMP 2020 Drinking Water	PFAS NEMP 2020[2]	PFAS NEMP 2020 Recreational Water
Nitrogen (Total)	mg/L					
Nitrate (as N)	mg/L		**50**			
Nitrite (as N)	mg/L		**3**			
Nitrite + Nitrate as N	mg/L					
Ammonia as N	mg/L		**0.41**			
Total Phosphorus (Organic Phosphate)	mg/L	**0.00004 (1)**				
Reactive Phosphorus as P (Orthophosphate as P)	mg/L					
Chloride	mg/L	**250**				
Magnesium	mg/L	**180**				
Sulphate	mg/L	**250**	**500**			
Aluminium	mg/L		**2 (1)**			
Arsenic	mg/L		**0.01**			
Barium	mg/L		**2**			
Beryllium	mg/L		**0.06**			
Boron	mg/L		**4**			
Cadmium	mg/L		**0.002**			
Cobalt	mg/L	**0.05**				
Copper	mg/L	**1**	**2**			
Lead	mg/L		**0.01**			
Manganese	mg/L	**0.1**	**0.5**			
Mercury	mg/L		**0.001**			
Molybdenum	mg/L		**0.05**			
Nickel	mg/L		**0.02**			
Selenium	mg/L		**0.01**			
Uranium	µg/L		**17**			
Zinc	mg/L	**3**				
Aluminium (filtered)	mg/L	**0.2**				
Arsenic (filtered)	mg/L		**0.01**			
Barium (filtered)	mg/L		**2**			
Beryllium (filtered)	mg/L		**0.06**			
Boron (filtered)	mg/L		**4**			
Cadmium (filtered)	mg/L		**0.002**			
Chromium (III+VI) (filtered)	mg/L		**0.05**			
Cobalt (filtered)	mg/L		**0.05**			
Copper (filtered)	mg/L	**1**	**2**			
Lead (filtered)	mg/L		**0.01**			
Manganese (filtered)	mg/L	**0.1**	**0.5**			
Mercury (filtered)	mg/L		**0.001**			
Molybdenum (filtered)	mg/L		**0.05**			
Nickel (filtered)	mg/L		**0.02**			
Selenium (filtered)	mg/L		**0.01**			
Uranium (filtered)	µg/L		**17**			
Vanadium (filtered)	mg/L	**0.0086 (1)**				
Zinc (filtered)	mg/L	**3**				