9 Holistic Impact Assessment

The Proposal has potential to cause environmental impacts due to the combination of environmental factors or environmental values within the Mine and Exploration DE.

9.1 Identified Key Environmental Values

As presented in Plate 9-1 overleaf, the DEs contain and/or is in the vicinity of the following key environmental values:

- Northern Jarrah Forest ecosystems
- Drinking water quality in reservoirs
- Amenity of local townsites (i.e., Jarrahdale, Serpentine, Keysbrook, North Dandalup, Pinjarra and Dwellingup) and rural properties
- Jarrah forest recreation, tourism, and Aboriginal cultural values

Table 9-1 presents a holistic assessment of the combinations of environmental effects of factors or values that have the potential to result in a significant impact.

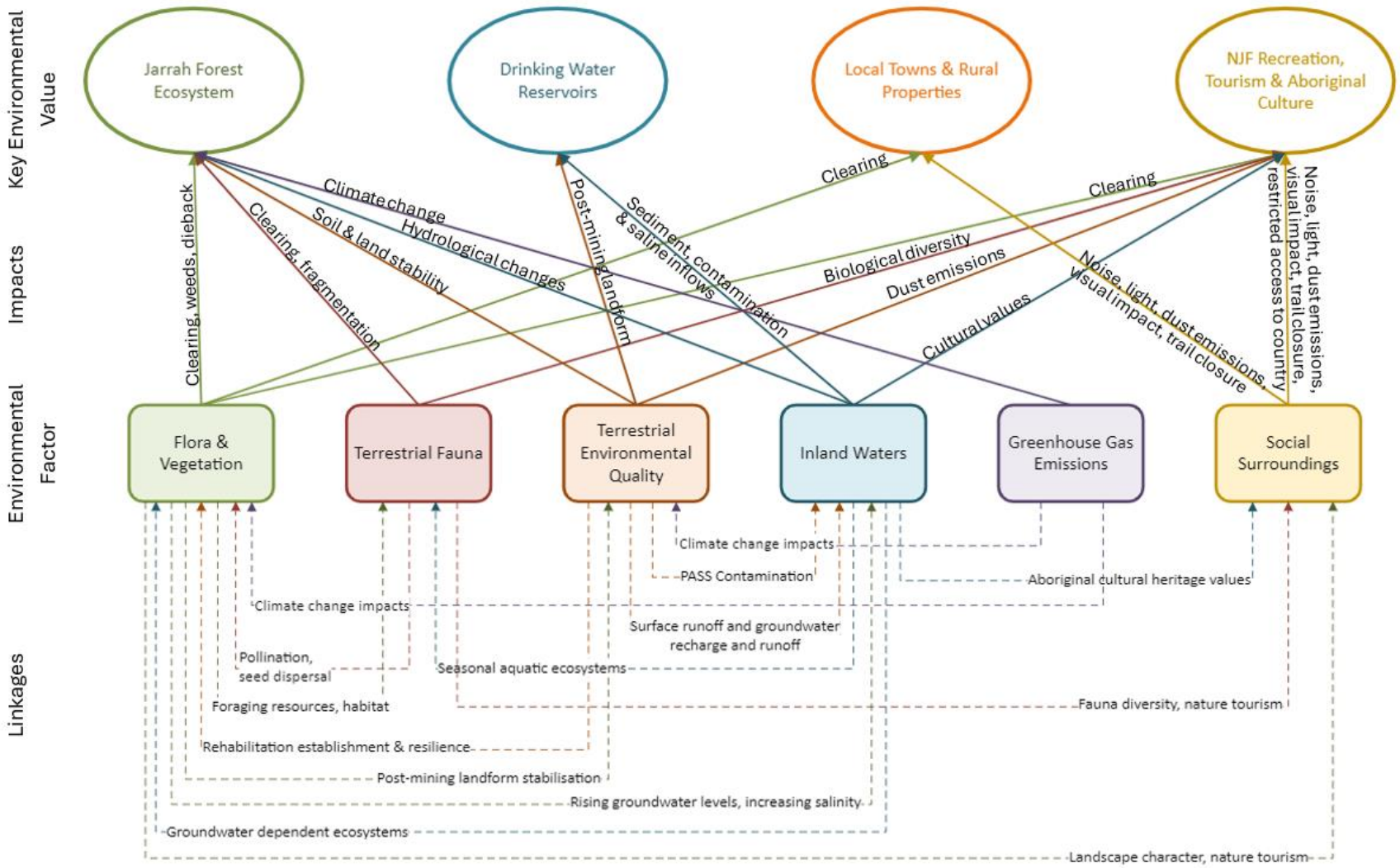

Plate 9-1: Holistic impact assessment

Table 9-1: Holistic impact assessment of combination of environmental effects from environmental factors or values that may potentially cause a significant impact

Key environmental values	Combination of environmental effects across environmental factors that may potentially cause a significant impact	Mitigation	Likelihood of significant residual impact	Offsets

Northern Jarrah Forest ecosystems	Mining creates a combination of environmental effects that has potential to significantly impact the ecosystems of the NJF, including:
	• Flora and vegetation: clearing of vegetation, potential impacts to threatened flora populations, and other conservation significant flora and vegetation such as priority flora, restricted range flora, novel species, TECs, and PECS, spread of weeds, *Phytophthora* dieback, and other forest diseases (i.e., Marri Canker Disease, and Australian Honey Fungus).
	• Terrestrial fauna: clearing of habitat, fragmentation, potential impacts to threatened fauna populations, and other conservation significant fauna such as priority fauna and BC Act listed species (including aquatic fauna such as Carter's Freshwater Mussel, BC Act, and EPBC Act listed species), potential impacts from light, and noise pollution.
	• Terrestrial environmental quality: increased erosion, potential contamination (PASS, hydrocarbons, or other chemicals), potential impacts to soil quality, and structure.
	• Air quality: dust deposition on vegetation, water ways, and nearby residential or recreational receptors.
	• Inland waters: hydrological, and water quality changes.
	The environmental factors are interconnected in supporting ecosystem values of the NJF. For example, flora and vegetation provide suitable foraging resources and habitat for native fauna, rehabilitated vegetation helps stabilise post-mining landforms, vegetation cover protects soils and topsoils from erosion, sediment transport, and reduces the impacts of surface water runoff. Flora and vegetation are also interconnected with groundwater recharge, hydrological regimes and water quality. Terrestrial fauna provide pollination and seed dispersal for flora. The soil and land quality of post-mining landforms supports rehabilitation establishment, development and resilience, which promotes vegetation structure and floristic and faunal diversity. Hydrological regimes and optimal water quality support potential GDEs in drainage floors and seasonal aquatic habitats for terrestrial fauna.
	NJF ecosystem integrity supports other key environmental values. Ecosystem integrity promotes vegetation coverage and landform stability in drinking water catchments, maintaining the filtering function of the catchment to minimise sediment transport via overland runoff, and subsequent increased turbidity in waterways. Ecosystem integrity supports the amenity of local townsites, rural properties, recreational trails and facilities through promoting native vegetation structure and floristic and faunal diversity. Ecosystem integrity also improves resilience to impacts from climate change, weeds, and diseases.
	The combination of environmental effects is not expected to result in significant impact beyond the effect of clearing and fragmentation. The loss of high-quality habitat in the period
		Alcoa's environmental management incorporates the mitigation hierarchy, which is in order of priority:
		• Impact avoidance;
		• Impact minimisation; and
		• Rehabilitation.
		To manage the combined environmental effects of mining on ecosystems, Alcoa will also implement best practice impact avoidance and minimisation measures, rehabilitation, *Phytophthora* dieback hygiene and dust management.
		Alcoa's commitment to mining avoidance, rehabilitation and support of DBCA's forest enhancement activities are consistent with the EP Act principle of conservation of biological diversity and ecological integrity.
		Avoid
		MAZs;
		• Old Growth Forest as identified by DBCA (Alcoa, 2023b)
		• National Parks and Nature Reserves (Alcoa, 2023b) including
		  ○ Lane Poole Conservation Reserve and portions of Formal Recreation Reserve.
		  ○ Falls Brook Nature Reserve
		  ○ Dwellingup Reserve
		• Threatened flora individuals
		• Recorded populations of Carter's Freshwater Mussel, as far as practicable.
		• Black Cockatoo protection zones
		• Black Cockatoo Nest and Significant trees (buffered 30 m, or 10 m for significant infrastructure, exploration, groundwater and rehabilitation).
		• Known Woylie populations
		• Known active breeding Chuditch dens
		Minimise
		Alcoa commits to limiting disturbance within the Mine DEs where possible to avoid/minimise impacts to SVTs associated with streamzones and threatened flora and threatened fauna high value habitats, including Major granite outcrops (>1 ha + buffered by 50 m) (Alcoa, 2023b).
		In accordance with the FVMP, Alcoa undertakes targeted flora and vegetation surveys in suitable habitat, prior to clearing to identify and better manage potential impacts.
		Phytophthora dieback hygiene practices implemented at Alcoa's operations have been demonstrated to limit the spread of *Phytophthora* dieback to less than 1% of the clearing extent. These practices will be continued.
		All stream crossings (within conservation significant fauna habitat) are designed and constructed to minimise ecological and hydrological impact.
		Hydrocarbon and other chemical storage standards and response mechanisms are in place to prevent and minimise impacts.
		Alcoa will continue funding contributions to DBCA's forest enhancement activities, weed control in the Murray valley and removal of pine wildlings.
		Rehabilitate
		The effectiveness of Alcoa's rehabilitation and *Phytophthora* dieback hygiene has been demonstrated through long-term monitoring and research and is at a high level of confidence.
			Likely
			Clearing results in a partial loss of biodiversity and ecosystem integrity, particularly in relation to Terrestrial Fauna. The Proposal clearing equates to 0.84% of the NJF subregion.
			Clearing will occur in the context of more widespread impacts in the NJF subregion, including historical and proposed mining, historical timber harvesting, climate change, fire, existing *Phytophthora* dieback, and recreational activities.
				Offset strategy to counterbalance the potential significant residual impacts to Terrestrial Fauna is presented in Section 8.

Key environmental values	Combination of environmental effects across environmental factors that may potentially cause a significant impact	Mitigation	Likelihood of significant residual impact	Offsets
	between clearing and establishment of rehabilitation may cause a significant impact to local populations of threatened Black Cockatoos, Woylie and Chuditch, but is unlikely to significantly impact State listed priority or conservation dependent fauna species due to the extent and diversity of habitats remaining in the NJF subregion. Dust deposition and hydrological and water quality changes are unlikely to cause significant impacts in surrounding vegetation or downstream areas.	Rehabilitation is expected to restore more than 80% of floristic diversity, a native species overstorey and understorey, and flora genetic diversity through topsoil salvage and return, and local provenance seed. Rehabilitation restores fauna foraging habitat in the short to medium term while Coarse Woody Debris and mature trees take long term (centuries) to recover. The results of monitoring collectively demonstrate that Alcoa's rehabilitation establishes and persists and is therefore self-sustaining, including during drought and heat wave events. This indicates that rehabilitation will be sustained over the long term with resilience to climate change comparable to that of un-mined Jarrah Forest (see Section 2.2.4).		

Drinking water quality in reservoirs	Mining creates a combination of environmental effects that have potential to significantly impact drinking water quality in reservoirs, including:
	• Flora and vegetation: clearing of Jarrah Forest
	• Terrestrial environmental quality: erosion of post-mining landforms, PASS, and potential contamination to soil, surface water, and groundwater.
	• Inland waters: sediment and contaminant discharges during mining, changes to inflow salinity during and post mining, and impacts to Carter's freshwater mussel.
	The environmental factors are interconnected in protecting the integrity of water catchments and therefore drinking water quality. Vegetation stabilises post-mining landforms and affects groundwater recharge and hydrological regimes. The soil and land quality of post-mining landforms supports rehabilitation establishment and resilience.
	The reservoirs also include a number of attributes associated with the social surrounds factor. Along with the significance of potable water supply to the broader Perth area, the reservoirs house several recreational facilities for which impacts to the quality and visual amenity would potentially inhibit their use. Significant impacts to the water quality have the potential to result in significant financial implications associated with water treatment or utilisation of alternative sources.
	The combination of environmental effects is not expected to result in significant impact beyond the component effects. The clearing of Jarrah Forest creates the potential for landform erosion and sediment discharges as assessed for terrestrial environmental quality and inland waters, however the effects between environmental factors are causal rather than additive. The effect of sediment and contaminant discharges during mining are as assessed for inland waters. Changes to inflow salinity are expected to be minor, well within freshwater quality and are not expected to cause a significant effect in combination with sediment or contaminant discharge.
		To manage the combined environmental effects of mining on drinking water reservoirs, Alcoa will implement preventative risk management and best practice rehabilitation for all cleared areas. Alcoa's preventative risk management incorporates multiple barriers to prevent hazards to downstream drinking water reservoirs from occurring or reduce them to acceptable levels.
		Avoid
		Alcoa has applied buffer zones (MAZ) for operation mining activities which includes:
		• Serpentine Pipehead Dam Catchment (Alcoa, 2023b) will have no clearing (excluding rehabilitation and monitoring) from December 2023. Clearing within this zone must be rehabilitated, stabilized, or have drainage controls in place within the first available rehabilitation season.
		• No new mine pit clearing within:
		  ○ 1 km of any reservoir Top Water Level from 1 July 2024 (Minister for State Development, 2023) & (Government of Western Australia, 2023)
		  ○ Areas with an average slope greater than 16% within Reservoir Protection Zones (RPZs) from December 2023 (Minister for State Development, 2023)
		  ○ 100 m buffer zone for mapped Stream Vegetation
		• Groundwater protection: Maintain a minimum clearance of 2 m between pit base and groundwater.
		This ensures that no clearing (for mining or exploration, however, excludes rehabilitation and infrastructure), mining and/or exploration activities occur within these higher risk areas.
		Alcoa plans the placement of all infrastructure to ensure no mine facilities, wastewater and sewage treatment plants are located inside the Reservoir Protection Zone.
		Minimise
		Alcoa has committed to additional barriers to further reduce the risk to downstream water quality, including designing mine drainage and rehabilitated mine pits to retain runoff from a 1% AEP (1 in 100 year) storm event. Additional control measures are included in Section 5.5.8.
		Alcoa's commitment to additional barriers to drinking water hazards is consistent with the EP Act precautionary principle, having been based on careful evaluation of mining to avoid, where practicable, serious damage to the environment. Alcoa's commitments are consistent with the EP Act principle of intergenerational equity, protecting catchment integrity to ensure that the productivity of the environment is maintained for the benefit of future generations.
			Unlikely	Not applicable

Key environmental values	Combination of environmental effects across environmental factors that may potentially cause a significant impact	Mitigation	Likelihood of significant residual impact	Offsets
		Rehabilitation The results of monitoring collectively demonstrate the effectiveness of Alcoa's long-term rehabilitation. Mine rehabilitation is expected to provide long term protection of soils from erosion and associated sediment discharge to reservoirs.		
Amenity of townsites and rural properties	Mining in the Mine DEs is unlikely to create a combination of environmental effects that significantly impact the amenity of neighbouring townsites, however minor impacts (dust and noise) to rural properties east of these townsites may occur. Holistic impacts to social surrounds culminate largely because of potential impacts to recreational use of the NJF and amenity values which associate with a feeling of place (visual and noise). Visual amenity values are proportionate to the presence of flora and vegetation, terrestrial fauna and inland waters which all may impacted by mining activities. Significant impact to the amenity of the NJF could have an impact on tourism in the area resulting in potential financial implications for small businesses or tourism operators in the area.	To manage the combined impacts to amenity and recreational uses, Alcoa will implement best practice impact avoidance and minimisation measures and undertake progressive rehabilitation. **Avoid** Alcoa commits to implement limited disturbance areas and mining avoidance zones (as above) which effectively avoids direct impacts to recreational areas. Buffer zones of 200 m, where possible, are placed along roads and other frequented routes to provide a vegetation screen obscuring views of mining activities. Noise sensitivity zones will be implemented to restrict mining activities in more sensitive areas to manage noise impacts to sensitive receptors. **Minimise** Visual, dust, and noise management plans are established in consultation with key stakeholders when mining is undertaken within 2 km. Alcoa applies internal noise limits of 110 dB at Dwellingup and the Yamba sub-division in Keysbrook, and 115 dB at all other locations, with mining adjacent to neighbouring properties scheduled for daytime only. **Rehabilitate** Rehabilitation will reduce potential dust impacts associated with the reduction of open areas. Rehabilitation is undertaken progressively and as soon as practicable.	Unlikely	Not applicable
Northern Jarrah Forest recreational, tourism and Aboriginal cultural values	Mining creates a combination of environmental effects that has the potential to significantly impact the recreational, tourism and Aboriginal cultural values of the NJF, including: • Flora and vegetation: clearing of predominantly immature age Jarrah Forest • Terrestrial fauna: clearing of habitat, fragmentation, fauna injury and death • Terrestrial environmental quality: erosion of post-mining landforms • Inland waters: sediment and contaminant discharges during mining, changes to inflow salinity during and post mining • Air quality: dust emissions • Social surroundings: closure/restriction to public access of State Forest, closure/restriction to access to country, noise and visual impacts to the Bibbulmun Track, haul road crossings of public roads Inland waters and access to country are key components of Aboriginal cultural values of the Jarrah Forest. Inland waters provide food resources and social and aesthetic values. Access to country supports spiritual and physical health and enables transfer of Aboriginal cultural knowledge. The environmental factors are interconnected in supporting the recreational and tourism values of the NJF and associated conservation and recreation reserves. The vegetation structure and biodiversity supports a high value landscape character, which is expected to be a key	To manage the combined environmental effects of mining on recreational and tourism values, Alcoa commit to mining avoidance zones, visual screening corridors and best practice rehabilitation. Alcoa's commitment to protecting drinking water quality is expected to protect Inland Waters as a key component of Aboriginal cultural values of the NJF. Alcoa will consult with Traditional Owners to identify opportunities to access country while meeting public safety requirements for mining in the Jarrah Forest. Alcoa's commitment to maintain public access and avoid direct impacts to recreational and tourism values is consistent with the EP Act precautionary principle, having been based on careful evaluation of mining to avoid, where practicable, serious or irreversible damage to the environment. **Avoid** Alcoa commits to implement limited disturbance areas and mining avoidance zones (as above) which effectively avoids direct impacts to recreational areas. Buffer zones of 200 m, where possible, are placed along roads and other frequented routes to provide a vegetation screen obscuring views of mining activities. Noise sensitivity zones will be implemented to restrict mining activities in more sensitive areas to manage noise impacts to sensitive receptors. **Minimise** Alcoa commit to maintaining public access to all formal and informal trails within the Mine DEs, with the exception of the Mount Solus Walk which is already closed as a result of current operations. The implementation of visual screening corridors will prevent visual impacts to almost all viewpoints, including townsites, rural properties,	Potential Mining may result in audible noise on the Bibbulmun Track sections in the Monadnocks Conservation Park and near Inglehope, cumulative with audible noise in the section near Boddington Gold Mine. Mining will cause long term visual impact to elevated viewpoints in the Monadnocks Conservation Park and Mount Wells, cumulative with impact to elevated viewpoints near the Boddington Gold Mine. Mining will restrict informal public access to State Forest, cumulative with existing restrictions from the Huntly Mine and Willowdale Mine. This may impact TO access to country and associated Aboriginal cultural values.	Not applicable

Key environmental values	Combination of environmental effects across environmental factors that may potentially cause a significant impact	Mitigation	Likelihood of significant residual impact	Offsets
	component of the sense of place for residents and visitors. Flora and fauna diversity supports nature-based recreation and tourism and Aboriginal cultural values from access to country (e.g., hunting, food and medicine collection, knowledge transfer). The soil and land quality of post-mining landforms supports rehabilitation establishment and resilience, which promotes vegetation structure and biodiversity. Hydrological regimes and water quality support potential GDEs in drainage floors and seasonal aquatic habitats for terrestrial fauna, which may support Aboriginal cultural values. The combination of environmental effects is not expected to result in significant impact beyond the component effects. The ecological effects of clearing will be contained within the Mine DEs, which will be closed to public access and thus not result in combined effects with social surroundings. Clearing creates the potential for landform erosion and visual impacts as assessed for terrestrial environmental quality and social surroundings, however the effects between environmental factors are causal rather than additive. The effect of closure, noise and visual impact is assessed under social surroundings and is not significantly increased in combination with other factors.	Serpentine National Park and Lane Poole Reserve. The exception is elevated viewpoints along the Bibbulmun Track (see Section 5.7). Visual management plans, dust management plans and noise management plans are established (as necessary) in consultation with key stakeholders when mining is undertaken within 2km of sensitive receptors. Alcoa applies internal noise limits of 110 dB at Dwellingup and the Yamba sub-division in Keysbrook, and 115 dB at all other locations, with mining adjacent to neighbouring properties scheduled for daytime only. **Rehabilitate** Rehabilitation will reduce potential dust and visual impacts associated with open areas. Rehabilitation is undertaken progressively and as soon as practicable. The duration of high to moderate visual impacts to elevated viewpoints is expected to last approximately 16-17 years from the commencement of operations to allow for the establishment of rehabilitation.		
Peel-Yalgorup System Ramsar wetlands of international importance	Mining is highly unlikely to create a combination of environmental effects that significantly impact the values of the Peel-Yalgorup System Ramsar wetlands (see Section 5.5). Mining will predominantly occur in regulated catchments that divert all or most inflows for public drinking water supply.	Mining will be in accordance with best practice environmental management as described in Section 5.5.	Highly unlikely	Not applicable

9.2 Summary of the Potential Effects of the Proposal on the Environment as a Whole

Mining in the Mine DEs will have a holistic impact on the ecological and recreational values of the NJF. The DE are bordered by Jarrahdale, Serpentine, Keysbrook, North Dandalup, Pinjarra and Dwellingup townsites and surrounding rural properties. Mining will result in progressive ecological and visual impacts and generate emissions, potential discharges and other localised disturbance to ecological, hydrological and social values over the short to medium term.

Impacts on one environmental factor are unlikely to occur in isolation with activities and impacts culminating to effect other environmental factors. For example, the impact from the Proposal to Flora and Vegetation through clearing will have multiple effects on other factors. Loss of vegetation will reduce habitat for fauna which in some instances will have a significant residual impact. Clearing can also affect soil quality through erosion and salinisation resulting from rising water tables and this in turn may impact on inland waters and the health of streams or public drinking water areas. Therefore, one impact associated with native vegetation clearing will have multiple flow on impacts across several Key Environmental Factors. Importantly, the combined impacts will affect people's perception of the health of the environment and further impact on social surroundings.

The ecological and visual impacts will continue post-mining for the medium to long term as rehabilitation establishes and develops. The presence of mining will result in localised closures for public safety, which will restrict public access to State Forest over the long term until rehabilitation is complete and the mine closed, at which point forest management in accordance with the State's FMP, will be reinstated. Restrictions on public access to State Forest may impact Traditional Owners access to country and associated Aboriginal cultural values.

It is important to note that Alcoa is already undertaking mitigation measures at its current operations which take into consideration the holistic impacts. This is evident in the rehabilitation undertaken where disturbed areas are returned to native vegetation. The practices employed also provide benefit to fauna through direct incorporation of habitat structures and prevent erosion, thus minimising impacts to inland waters and terrestrial environmental quality. The rehabilitation also improves visual amenity. This approach will be continued throughout the areas covered by the Proposal.

Alcoa undertakes other management practices particularly in design and planning stages to reduce impacts. Areas of significance are avoided, and appropriate buffers are placed around areas that are particularly sensitive such as heritage sites, recreational areas and water courses (Mine Avoidance Zones). The inclusion of MAZ to maintain appropriate separation distances from sensitive receptors is a key element of Alcoa's holistic management approach. For example, the management buffer provides initial protection to riparian vegetation, thereby contributing to the maintenance of water quality, fauna habitats and connectivity, heritage and amenity values associated with these features. Many mitigation measures implemented for individual environmental factors multiple environmental, social, and heritage factors reducing the likelihood and risk associated with holistic impacts.

9.3 Significant Residual Combined Environmental Effects

As presented in Table 9-1, there are likely to be residual environmental effects to key environmental values with respect to the NJF ecosystem and potentially significant recreational and tourism values and Aboriginal cultural values associated with the biophysical surroundings. This is due to the partial loss of ecosystem value and cumulative impact in the Jarrah Forest, the holistic effects of activities in regard to noise generation, visual impact, public access restriction to NJF recreational and tourism values, and restriction to Traditional Owner access. Alcoa has developed an Environmental Offset Strategy (Appendix 13) to counterbalance the Terrestrial Fauna significant residual impacts from the Proposal.

There are not anticipated to be any significant residual impacts associated with flora and vegetation with clearing activities impacting regionally widespread units. Despite this, significant residual impact remains for several fauna species (Section 5.3). The proposed mitigation measures and offsets have been developed to address this residual impact, but also to address other factors. Providing habitat for particular species has greater benefit through improved land management and reduction of cleared areas. As highlighted above, this leads to other environmental benefits. The mitigation measures and offsets cannot be considered in isolation from other key factors as they will provide benefit across a range of factors and provide a broader improved environmental outcome.

As presented in Table 9-1, the residual environmental effects are unlikely to be significant with respect to drinking water reservoirs and amenity and are highly unlikely to be significant with respect to the Peel-Yalgorup Ramsar wetlands.

No additional environmental outcomes are proposed. The environmental outcomes presented for each environmental factor throughout Section 5 are considered suitable and appropriate for holistic impact.

9.4 Consistency with EP Act Principles and EPA Objectives for Key Environmental Factors

As presented in Section 4.1 and Table 9-1, the Proposal incorporates mitigation that is consistent with EP Act Principles, including:

- Mining Avoidance Zones, Limited Disturbance Areas, best practice rehabilitation and support of DBCA's forest enhancement activities are consistent with the principle of conservation of biological diversity and ecological integrity.
- Preventative drinking water risk management incorporating additional barriers is consistent with the precautionary principle and the principle of intergenerational equity.
- Maintaining public access and Traditional Owner access to country and avoiding direct impacts to recreational and tourism values is consistent with the precautionary principle.

The mitigation is also consistent with the EPA's objectives for Key Environmental Factors as the mitigation aims to:

- Maintain biodiversity and ecological integrity.
- Maintain the quality of land and soil.
- Maintain hydrological regimes and water quality.

- Reduce air emissions and maintain air quality.
- Protect social surroundings from significant harm.

Maintaining the quality and integrity of ecological, land, hydrological and atmospheric systems is expected to protect the key environmental values dependent on the systems.